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CONTENTS

No. 1, March, 1944

No. 2, June, 1944

No. 3, September, 1944

No. 4, December, 1944

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Number 1, March	April 28
Number 2, June	July 18
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Taxonomic-Ecologic Studies of the Boletaceae in Northern Idaho and Adjacent Washington[1]

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This paper is the first product of an investigation by the senior author of the ecological relationships of the forest fungi of northern Idaho and adjacent Washington. At this time the Boletaceae appear to be the first group adequately represented in collections made in the course of the study. It is anticipated that other boletes will be found, but the 23 species discussed here are believed to represent the majority occurring in the region, since in the past two seasons no additional species have been observed.

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[2] Responsible for conduct of the project, and author of the manuscript.

[3] Responsible for identification and taxonomic treatment of species presented.

The study has been conducted thus far on the Kaniksu National Forest in Bonner County, Idaho, and Pend Oreille County, Washington, between the ridge of the Cabinet Mountains east of Priest Lake and the Pend Oreille River in Washington. No investigations have been made south of the Pend Oreille River in Idaho, or north of Hughes Meadows, Bonner County, Idaho, which lies about 10 miles south of the Canadian border. The area covers approximately 1400 square miles, virtually all of which is typical "white pine region" forest land. The term "white pine region", in the United States, has been applied to the area roughly including that part of Idaho north of the Clearwater River, west of the Bitterroot divide, and south of the Canadian border, and also the Cabinet and Kootenai River Mountains in northwestern Montana, and Pend Oreille County, Washington.

ZONATION AND SUCCESSION

The forest vegetation of the region comprises four distinct altitudinal zones, named for the species dominating the climax associations (Daubenmire, 1943). In order of increasing altitudinal position these zones are: *Pinus ponderosa* zone [*P. ponderosa* Douglas], *Pseudotsuga* zone [*P. taxifolia* (Lambert) Britton], *Thuja-Tsuga* zone [*Thuja plicata* D. Don and *Tsuga heterophylla* (Rafinesque) Sargent], and *Picea-Abies* or subalpine zone [*Picea Engelmanni* (Parry) Engelmann and *Abies lasiocarpa* (Hooker) Nuttall]. The first two are comparatively poorly represented in the region since it is so far from the arid basal plain to the southwest, around the borders of which *P. ponderosa* and *Pseudotsuga* reach their optimum development under semi-arid climate in the Columbia basin. In the moist region where the study has been conducted climax stands of *P. ponderosa* and *Pseudotsuga* occupy exposed, dry sites on south and southwest slopes, constituting a climax in which topography is the controlling factor; i.e., a topographic climax. The greater part of the forest area of the region is in the *Thuja-Tsuga* zone, and it is with this zone that the study is concerned. The *Picea-Abies* zone occupies the higher ridges, usually above 4500 feet elevation, although the southerly slopes of high, extremely exposed ridges support a grass-bald climax.

Although the four zones are altitudinal in their sequence, their limits in terms of elevation above sea level overlap greatly, since topography strongly affects the zonal pattern. Frequently, isolated segments or upward extensions of the *Pseudotsuga* zone occur even as high as the lower limits of the subalpine zone, where slope and exposure render the site too severe to support *Thuja-Tsuga* associations. Small stands of *P. ponderosa*, accompanied by many of the subsidiary species comprising this climax, extend up to relatively high altitudes on south-facing rock outcrops where soil is thin and exposure unusually severe. Likewise, long fingers of the

Picea-Abies zone extend down into the *Thuja-Tsuga* zone along the drainages on northerly slopes, where water relationships are maintained within the requirements of this association.

In the *Thuja-Tsuga* zone the arborescent components of the climatic climax may vary somewhat with seed source, historic factors, and perhaps edaphic conditions, but include *Thuja plicata, Tsuga heterophylla,* and *Abies grandis* Lindley. *Taxus brevifolia* Nuttall and several lower shrubs and forbs are equally typical of this climax, but all are not listed here since the tree species serve to characterize the associations. In some parts of this zone one of the three characteristic climax dominants may be rare or missing. The zone includes, in the seral association, *Pinus monticola* Douglas, *P. contorta* Douglas var. *latifolia* Engelmann, *Larix occidentalis* Nuttall, *Pseudotsuga taxifolia,* and rarely *Pinus ponderosa. Pseudotsuga,* although a climax species in the next lower zone or on drier sites, as indicated above, frequently is an important component of seral communities in the *Thuja-Tsuga* zone. On the other hand, *P. ponderosa* is rather rare in seral communities. With the exception of the latter, most seral stands contain all of these species and are usually dominated by one of them, thus forming a consociation. Some consociations, however, lack one or more of the seral species.

The successional pattern on secondary bare areas resulting from fire in this zone appears to be controlled largely by the immediate seed source. Usually burns develop stands of *P. contorta* var. *latifolia* or *Larix*, or both, as the first forest cover, primarily because the former has serotinous cones and the latter is strongly fire resistant. Burns rarely seed immediately to the climax species only. Frequently *P. monticola, Pseudotsuga, Thuja,* and *Tsuga* all appear along with *P. contorta* var. *latifolia* and *Larix*, or they may become established after some cover develops. Young stands in which all these species are present and of the same age often appear to consist almost exclusively of *P. contorta* var. *latifolia* or *Larix*, or both, since these species grow comparatively much more rapidly. These pioneers soon decline, the majority of the former dying out by the time the *P. monticola* has overtopped them. *Larix* often persists as relic individuals in the developing stand of *P. monticola, Thuja,* and *Tsuga,* but most of the *Larix* disappears from even moderately closely stocked stands before reaching 60 to 80 years old. Rarely individual *Larix* persist until the stand has reached essentially climax composition. *P. monticola* almost invariably achieves numerical dominance following decline of the *Larix* in the succession on most areas. The climax tree species, whether they germinate at the same time as *P. monticola* or enter later, develop beneath this last seral consociation. By the time the *P. monticola* is overmature all seral shrubs and forbs have also disappeared and are replaced by climax species.

Relative frequency	THUJA-TSUGA ZONE					PSEUDOTSUGA ZONE
	Seral associations				*Thuja-Tsuga* climax association	*Pseudotsuga* topographic climax association
	Epilobium association on new burns	*Pinus contorta* var. *latifolia* consociation	*Larix occidentalis* consociation	*Pinus monticola* consociation		
Most common species	None observed	*Suillus granulatus*	*Suillus elegans* *Boletinus ochraceoroseus* *Bol. cavipes*	*Suillus elegans* *S. granulatus* *Boletinus cavipes*	*Xerocomus Zelleri* *Boletus mirabilis*	*Boletinus amabilis*
Intermediate	None observed	*S.* ? *subaureus*	*S. aeruginascens*	*S. aeruginascens* *S. hirtellus* var. *mutans* *S. subluteus*	*X. subtomentosus* *X.* ? *pulverulentus*	—
Comparatively rare	None observed	*S. hirtellus* var. *mutans* *S. elegans* *S. subluteus*	—	*Bol. ochraceoroseus* *S. americanus*	16. *X. sp.* 17. *X. sp.*	—
Observed once only	None observed	—	*S. luteus* *Bol.* ? *appendiculatus*	—	*B. edulis* *B. fragrans* *Suillus granulatus* *S. hirtellus* var. *mutans*	—

BOLETES IN RELATION TO THE FOREST ASSOCIATIONS

In the *Thuja-Tsuga* zone the flora of the climax association is fairly distinct from the floras of the consociations comprising the seral association. This feature has long been recognized with regard to the higher plants, and it is one of the aims of this investigation to determine whether or not the fungi are similarly limited to specific plant associations. The species of the Boletaceae described here have been found to exhibit such a distributional pattern, many of them appearing to be confined to a particular association. With the limited number of collections and observations the element of chance cannot be ignored, but observations in the Boletaceae are abundantly supplemented by similar sociologic behavior of local species of the Agaricaceae, the majority of which likewise appear to be limited to single associations.

Of the eight stations intensively collected in this study, two are in burns which were less than two years old when work was begun and which support an herbaceous association dominated by species of *Epilobium*. Two are in climax *Thuja-Tsuga* stands, one is in the *Pseudotsuga* topographic climax, and the remaining three in seral forests. Each of these latter stands contains all species found in the seral association, but each is dominated by a single species and forms a consociation. The consociations differ but little in their vegetational potentialities, all showing ample evidence that they are progressing toward *Thuja-Tsuga* climax associations. These three stands, and others like them throughout the region, support essentially the same bolete flora, but the frequency of occurrence of species differs considerably among them. The accompanying table shows the boletes occurring in each association, including a rough comparison of frequency.

As indicated in the table, no boletes have been observed in the *Epilobium* association on recent burns. In the *Pinus contorta* var. *latifolia* consociation *Suillus granulatus* is the most characteristic bolete species, and is also one of the most common of the higher fungi. In the *Larix* consociation three species characteristically appear with approximately equal frequency: *S. elegans*, *Boletinus ochraceoroseus*, and *Bol. cavipes*. Somewhat less common is *S. aeruginascens*. The close similarity between the *Pinus monticola* and *Larix* consociations is indicated by their similar bolete floras. *Suillus granulatus* replaces *Bol. ochraceoroseus* among the commonest species in the former, and three other species are found here which have not been observed in the *Larix* consociation.

The bolete flora of the *Thuja-Tsuga* climax association is shown in the table to differ radically from that of the seral association. The most common species here are *Xerocomus Zelleri* and *Boletus mirabilis*. In this region to date, the genera *Xerocomus* and *Boletus* appear to be confined to the climax association in the *Thuja-Tsuga* zone, with rare exceptions. Only a single collection of one species of one of these genera has been found in a seral association, that species being 16. *X. sp.*

Boletinus amabilis is the only bolete species observed to date in the *Pseudotsuga* topographic climax. Near the ecotone, however, where tree species typical of the *Thuja-Tsuga* zone appear, other boletes common to the seral forests have been observed. *Bol. amabilis* is common also in the seral forests wherever *Pseudotsuga* is present.

MYCORRHIZAE

The boletes are of interest to foresters as well as mycologists because they constitute one of the few groups of the fungi which have been shown to contribute directly to the nutrition of forest trees through their mycorrhizal relations. Many species of the Boletaceae have been demonstrated to be fungal components of mycorrhizae, experimentally in culture, and by the somewhat less certain method of tracing mycelial connection between fruiting bodies and mycorrhizae *in situ* (e.g., Young, 1936, 1940; Hatch and Hatch, 1933; Peyronel, 1920, 1922; Romell, 1921; Melin, 1922, 1923a, 1923b; Masui, 1926; Doak, 1934; Rayner, 1938; How, 1940, 1941, 1942; and others). It is probable that all boletes are components of these relationships.

There is little doubt that the occurrence of certain boletes in a given association is controlled by the mycorrhizal relationships of the species concerned. Regardless of the cause, it becomes increasingly apparent as the study progresses that these species are important and regular constituents of their respective associations. Food relationships of the fungi constitute perhaps the most important factor controlling their associational distribution, but present lack of knowledge of this complex field does not allow more than speculation concerning the causes of their distribution, or the factors governing their maintenance as components of the communities.

Known mycorrhizal associates among the species treated here are indicated in the detailed species descriptions. The references cited do not constitute a complete bibliography of mycorrhizal association. No effort has been made in this study to trace mycelial connection between boletes and tree roots, but detailed records were kept of the trees within fifty feet of the majority of the fruiting bodies in each collection, thus presenting some circumstantial evidence of their possible mycorrhizal relationships.

EFFECT OF ASSOCIATION AND ENVIRONMENT UPON INTRA-SPECIFIC VARIATION

Peyronel (1922) has noted variations in *Leccinum scabrum* (*Boletus scaber*) which he believes may be due to the mycorrhizal associations of the various forms. There appears to be a change of form, size of the pileus, and diameter of the stipe, depending upon whether the species is mycorrhizal upon *Betula alba*, *Corylus*, *Quercus*, or *Castanea*. He further states that *Boletus rufus* (=*Leccinum aurantiacum*) is probably only a form of *L. scabrum* which forms mycorrhizae on *Populus tremula*, and he points out that such variation is of considerable taxonomic significance. There is good reason to doubt Peyronel's suggested synonymy, but that he recognized the potential taxonomic importance of such variation is worthy of note.

There has been relatively little investigation of the part played by climatic and other environmental factors in determining intra-specific variation in the fungi, although many have recognized the possibility that variation may be so effected. Observations by the senior author during the past four years indicate that variation both in immediate environment and in climatic conditions may account for many differences between individual collections of certain species, although at this time no specific data can be presented. Differences in viscidity in many species of boletes are obviously due to conditions of humidity and precipitation under which each collection has developed. *Suillus americanus*, although found twice in the same place, exhibited such differences between the specimens collected that identification was puzzling. Specimens of this species found during the unusually wet fall of 1940 (Plate 4, fig. C) showed large areas of red to brownish red gluten on the pileus and a definite annulus, the latter not reported from any other region. Also, the interior of the stipes at the base turned to blue when cut. Collections from the same spot made during the unusually dry fall of 1942 (Plate 4, fig. B) showed very small streaks of reddish color on the pileus and many had none at all, and only rarely was there even a trace of an annulus. The stipe interior in these latter collections showed no change to blue, but only a slight roseate tint when cut, entirely typical of the species as found in the eastern United States. All collections of this species in this region have a large and distinct hollow at the base of the stipe when mature, a feature not reported in eastern collections.

Boletinus ochraceoroseus appears considerably paler than usual in a season with much rain and little sun. Specimens seen in the spring of 1941, when there was comparatively little sun until late in June, were uniformly pale pink, while collections made in the spring of 1939 and 1940 were much darker, apparently because of higher total insolation, at least in part. Repeated observations of this phenomenon were made over the region in each season, since it is one of the more common species.

Such observations, unsupported by quantitative data, are obviously somewhat speculative, but similar variation has been observed in other groups, notably the Agaricaceae. As the study progresses it is the intention of the senior author to accumulate data which may cast more light upon such phenomena.

DISTURBANCE OF THE SUBSTRATA

Many species of boletes fruit most commonly along roadsides, ditches, road cuts, and trails (e.g., *Xerocomus ? pulverulentus*, 16. *X. sp.*, *X. subtomentosus*, in this region). Others fruit chiefly on the undisturbed forest floor (e.g., *Boletus mirabilis*, *Boletinus amabilis*, *Suillus elegans*, *S. ? subaureus*, *S. granulatus*, *S. subluteus*, *S. luteus*, and *Leccinum scabrum*). Still others appear to occur with approximately equal frequency on disturbed and undisturbed substrata, including *S. hirtellus* var. *mutans*, *S. americanus*, *S. aeruginascens*, *X. Zelleri*, *Bol. cavipes*, and *Bol. ochraceoroseus*. Early in the study these differences became evident to the senior author and it now appears that occurrence on disturbed or undisturbed substrata is almost specific for several of the species found in the region.

DESCRIPTION AND HANDLING OF COLLECTIONS

Species of the Boletaceae present many problems in collection and preservation. They are soft, fleshy, often rather watery, and change appearance so rapidly that it is almost essential to complete description of color and configuration immediately as the collections are made, or at least within a very few hours. In this study a mimeographed record sheet, including essentially the information given in the detailed species descriptions, is filled out as each collection is made. A cast of spores from mature specimens in each collection is made on white paper and attached to the record sheet under a strip of transparent cellulose tape, thus showing the spore color in mass and providing a convenient method for determining tube mouth size. A small piece of this spore cast paper is folded with the spores inside and attached under cellulose tape to the record sheet to provide material for microscope slide mounts of naturally cast spores. Specimens are dried in a portable drying cabinet in which they are supported on wire-screen shelves over a pressure gasoline lantern, or by exposure to full sun. Dependence upon sun-drying ruins many specimens, since during the optimum season for boletes there is little clear weather and they either become riddled by larvae before they dry or are carried off by red squirrels, which utilize them extensively for food. When dry the specimens are placed in new kraft bags with a small quantity of paradichlorbenzene crystals to kill insects, and the bag is sealed with gummed paper tape.

SPECIES DESCRIPTIONS

The detailed descriptions of species presented here may be found to differ in minor degree from European and eastern North American descriptions. Such differences chiefly involve color, which in many boletes is extremely variable. Where such variable species have been found to possess but a limited color variation in this region, this restriction is indicated.

Two parallel methods of color description have been employed. Maerz and Paul (1930) color plates have been referred to for the convenience of those desiring a specific color reference. These colors are indicated as a combination of two numbers and a letter, in parentheses, e.g. (9K1), the first number indicating the plate, the letter giving the column, and the remaining number the line for the color specified. Actual comparison of specimens with the Maerz and Paul plates was not made in the field, the senior author relying upon memory of the numerous collections and observations of the species made, coupled with the field descriptions of the colors. The alternative color designation employs descriptive terms in more or less common use, but it is notably unreliable because of the personal factor in interpreting the terms. The latter method, however, is the only one practical in field identification.

When dried and preserved as herbarium specimens, boletes bear little resemblance to the fresh specimens. Shrinkage is almost always severe, frequently accompanied by extreme distortion. Surface characters are obscured in many species by wrinkling, or the specimens are otherwise altered seriously. Color is rarely preserved, most dried specimens undergoing such radical color changes that, unless one is well versed in the possibilities of color change, they give no inkling of the original color. For this reason the detailed species descriptions include the characteristics of local specimens when dried, colors being given both in general descriptive terms and as references to the color plates of Maerz and Paul (1930), with which the herbarium specimens of the senior author's collections were compared. A few species lack color references, where collections consist of a single specimen, or a single collection of only a few individuals, since one or two specimens may differ considerably from the average range of color for the species in the region. Although several species are virtually indistinguishable when dried, these descriptions of herbarium specimens may help to remove uncertainty in distinguishing others.

Species collected during this study which dry with a minimum of color degradation and shrinkage include *Xerocomus Zelleri*, *X. subtomentosus*, *X. ? pulverulentus*, 16. *X. sp.*, *Boletus mirabilis*, *B. frustosus*, *Boletinus ochraceoroseus*, *Leccinum versipelle*, *L. scabrum*, and *Suillus subluteus*. Others in which the original color may be indicated but shrinkage is often severe are *Bol. cavipes*, *Bol. amabilis*, *S. elegans*, *S. americanus*, *S. hirtellus* var. *mutans*, *B. fragrans*, and 17. *X. sp.* In the following both change of color and shrinkage are usually extreme: *S. luteus*, *S. ? subaureus*, *S. granulatus*, *B. edulis*, and *S. aeruginascens*.

It should be emphasized that similar behavior may not occur in specimens collected in other regions, an example of which is found in *B. mirabilis*, one of the best species in the region for retaining its original characteristics when dried. When it was first described from the humid Puget

Sound region, Murrill (1912, p. 98) stated that it was difficult to preserve because of its extremely juicy consistency. This is perhaps another instance in which environmental factors control variation in the characteristics of a species.

The discussion following each species description includes a statement of the season in which it has been collected or observed fruiting during the period of this study. It is not intended to imply that these species do not occur in this region at times other than those indicated. The climate of the region between the Bitterroot Mountains and the Cascades is characterized by summer drought. Although this dry period usually extends from about June 15 to September 15, differences in amount and incidence of precipitation occur frequently enough to upset generalizations based upon phenologic data covering only a few years. Total annual precipitation records are of little assistance in determining whether a given season has approached optimum moisture conditions, unless precipitation distribution is also considered. The spring rainy season may continue until late in July occasionally, or it may terminate in May. Fall rains may begin as early as mid-August, or they may not begin until just before freezing weather in late October. Moisture conditions in the substrata apparently determine date of first appearance and number of individuals of a species. The fall of 1942 was unusually dry, with only rare storms until a week or ten days before the first snow, near the end of October. Few boletes appeared, localities which usually support large colonies of several species producing only rare individuals. Agarics were also comparatively scarce. Many species of fleshy fungi common in a normal season were not encountered anywhere in the region. Species collected were those customarily appearing first each season, although the tardy beginning of wet weather apparently postponed their first appearance several weeks.

Seasonal temperature differences, above freezing, probably exert much less influence upon the date of first appearance of the earliest species than does amount and incidence of precipitation in this region. Given two seasons with similar precipitation patterns there is little doubt that a larger number of individuals, and perhaps even more species of fleshy fungi would appear in the warmer season, particularly in the spring, if moisture conditions were adequate. It is doubtful, however, that the difference in occurrence would be significant unless temperatures differed considerably. As a general rule a wet season is also appreciably colder.

Despite the limitations imposed by possible variations in moisture and temperature conditions throughout the region, the phenologic data presented may be expected to be substantially reliable in most seasons, with the exception of years in which gross abnormalities in climatic conditions occur.

ICONES

A list of selected icones has been compiled for those species which have been illustrated in the literature. It has not been possible to indicate which of these illustrations is most closely characteristic of the species as represented in this region, since a few have been unavailable for examination. Certain ones have been eliminated since they proved grossly unlike collections made in the course of this study.

The illustrations accompanying this paper are copies of a series of Kodachrome and Dufaycolor slides photographed by the senior author from specimens in his collections. These were made *in situ*, with a minimum of disturbance of the immediate environment, and are believed to be typical of the species as found in this region.

KEYS

Two types of keys are employed in this paper. The first is based on gross characters, ignoring generic differences, and was developed primarily for field use with the 23 species described. Although useful for field identification, this type of key may prove confusing if species are encountered which are not included in it, since their characteristics may lead to erroneous identification. It is urged that all specimens identified with the aid of this key be carefully compared with the detailed species descriptions. The second key is based on generic distinctions. It is distributed throughout the text, each of the five genera represented in the collections being treated separately. Characteristics found in the collections are emphasized in both keys, sometimes ignoring misleading characteristics as reported in other regions.

A synopsis of the genera of the Boletaceae as proposed by Snell (1941, 1942) is included. Sixteen genera are included in the family, only five of which are represented in collections made in this region to date.

Synonyms cited for the species described are the names commonly accepted prior to combinations according to Snell's (*op. cit.*) proposals.

BOLETACEAE--SYNOPSIS

Fleshy hymenomycetous fungi, stipitate, the hymenium lining tubes beneath a thick, usually convex pileus. Annual, terrestrial, or very rarely lignicolous.

Subfamily BOLETEAE--Spores smooth.

Tribe EUBOLETEAE—Spores long-elliptical or subfusiform, colored; hymenophore tubulate, boletinoid, or even lamellate; tubes compound or simple.

Genus BOLETINUS—Tubes arranged radially in rows, usually with more or less prominent veins between, at least when young; not easily separable from the carpophore and not at all from each other.

SUILLUS Stipe not reticulate, except at the very apex or above annulus in a few forms; tubes adnate or decurrent, not free and not stuffed when young; pileus viscid when wet or at all times; spores elliptical.

Xerocomus Pileus dry, never viscid, may be glabrous, subpruinose, or subtomentose; tubes simple or compound, never stuffed or with red mouths; spores subfusiform; stipe never truly reticulate or subbulbous.

Boletus Fruiting body rather stout and robust; tubes simple; stipe stout and more or less bulbous, especially at first: spores subfusiform.

Sections:

Calopodes Stipe reticulate; tubes adnate, not stuffed when young.

Edules Tubes free, or if adnate then stuffed when young.

Luridi Tube mouths some shade of red. None collected in the region.

Leccinum Tubes white, at least at first, free or adnate, stuffed when young if the latter; stipe more or less slender and scabrous, tapering upward; spores more or less fusiform elliptical.

The following genera were not collected in the course of this study.

Phylloporus Tubes lamellate, anastomosing; spores subfusiform.

Pulveroboletus Pileus and stipe more or less pulverulent; tubes simple; spores small, ellipsoid to ovoid.

Tylopilus Tubes and spores flesh colored.

Porphyrellus Pileus pilose; spores reddish.

Tribe Gyrodonteae Spores small and oblong to short elliptical or nearly subglobose, colored; hymenophore more or less boletinoid and more or less lamellate; tubes short to very short.

Boletinellus Hymenophore very lamellate, merulioid; spores very broadly elliptical, thick-walled. One species only: *B. merulioides* (*porosus*).

Gyrodon Spores very small, short ellipsoid.

Tribe Leucosporelleae Spores oblong or short-elliptical to narrowly ellipsoid, hyaline, white (?) or yellow in mass; carpophore imputrescible; tubes simple, at first white, then usually yellow; stipe hollow or solid.

Gyroporus Stipe not reticulate, spongy within, soon hollow; pileus dry; spores oblong or short-elliptical, about twice longer than broad.

Leucogyroporus Stipe glabrous, solid; pileus dry, glabrous, felted, or subtomentose; spores narrowly-ellipsoid to more or less cylindric or subfusiform, 3 to 4 times longer than broad.

Subfamily Strobilomyceteae Spores ornamented, reticulate, striate, or verrucose.

Strobilomyces Spores reticulate, globose; pileus squarrose-scaly; tubes not boletinoid; separable from the carpophore with difficulty and not at all from each other.

Boletellus Spores longitudinally striate or wrinkled, or verrucose, elliptical, large.

Polyporoletus Spores verrucose, spherical.

TENTATIVE KEY TO BOLETACEAE OF THE THUJA-TSUGA ZONE ON THE KANIKSU NATIONAL FOREST[1]

1. Color of flesh of pileus or stipe, or both, changing to blue when cut or broken . . . 2
Color of flesh of pileus or stipe, or both, changing to some other color when cut or broken, or not changing 12

2. Margin of pileus tomentose when young, usually loosely and densely so, the tomentum disappearing before pileus is half expanded, color yellow, with or without red brown or vermilion streaks or patches, stains hands yellow from sticky-viscid gluten; stipe unusually slender and tough, almost always hollow at base in this region, densely glandular dotted, the glandules greenish brown, conspicuous, frequently confluent . . . . 12. *Suillus americanus*
Margin of pileus never tomentose 3

3. Pileus some shade of bright yellow or orange, glabrous or fibrillose-scaly; tube surface dull or dirty yellow, changing to blue on injury; stipe various shades of yellow, masked by glandular-dots which are pale when young, brown when mature, annulus none . . . . 5. *Suillus hirtellus* var. *mutans*
Pileus some shade of gray, olive, brown, or rose, not yellow or orange 4

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[1] This key is designed only for use with the 23 species described in this article. Specimens identified with the aid of this key should be carefully compared with the detailed descriptions, since generic distinctions are omitted as such and species not included may prove confusing.

4. Stipe dirty white, scabrous to squamulose, changes to greenish blue where bruised; pileus slightly reddish brown, dull orange, or yellowish orange, glabrous, viscid; tube surface dirty white . . . . 22. *Leccinum versipelle*

Stipe neither white nor squamulose-scabrous 5

5. Pileus viscid, particularly in wet weather, gray brown to gray, sometimes with irregular patches of red brown or blue, or both; tube surface sand brown to brownish gray, usually changing to blue where bruised; stipe dirty white to faintly brownish gray, reticulate at apex, rarely almost to middle of stipe, annulus small, usually disappearing. . 6. *Suillus aeruginascens*

Pileus not viscid, at most somewhat moist. 6

6. Flesh of pileus with bitter taste, pileus olive brown; stipe lemon yellow, conspicuously reticulate almost to base in our collection, but usually regarded as not reticulate or only slightly so. . . . . 19. *Boletus fragrans*

Flesh of pileus without bitter taste, although some may be unpleasant. 7

7. Stipe some shade of red, at least in part. 8

Stipe yellow or brown, not red. 11

8. Tube surface not turning blue where bruised, its color bright lemon to olivaceous yellow; pileus dark greenish brown, stipe deep crimson to brownish red; flesh of stipe and pileus changing to blue slowly, usually from 10 to 30 minutes following cutting; apparently occurring only in western redcedar – western hemlock associations. . . . . 13. *Xerocomus Zelleri*

Tube surface turning blue where bruised. 9

9. Stipe uniformly red at base, yellow at apex; pileus olivaceous khaki, rimose-areolate over whole surface, the cracks sometimes reddish. . . . . 16. *Xerocomus* sp.

Stipe not uniformly red at base, at most red only in limited areas, or uniformly pinkish brown. 10

10. Pileus rose, beneath a yellowish bloom which may be rubbed off, not rimose; stipe yellow with red areas; tube surface ochre yellow . . . . 17. *Xerocomus* sp.

Pileus warm brownish khaki to dull brown, with mustard colored bloom, subtomentose, not rimose, or rarely rimose-areolate to rimose-diffract, at least in part; stipe pinkish brown, or with a mustard cast; tube mouths large (to 3 mm.), angular, in mature specimens; a large species. . . . . 14. *Xerocomus subtomentosus*

11. Stipe, tubes, and flesh bright lemon yellow, changing immediately to deep blue where cut or bruised; pileus olivaceous khaki, rimose-areolate to rimose-diffract. . . . . 15. *Xerocomus ? pulverulentus*

Stipe brown, or pinkish brown, with mustard cast; pileus warm brownish khaki to dull brown with mustard colored bloom, subtomentose, not rimose, or rarely rimose-areolate to rimose-diffract, at least in part; tube mouths large (to 3 mm.), angular, in mature specimens; a large species . . . . 14. *Xerocomus subtomentosus*

12. Tubes boletinoid (arranged more or less in rows radiating outward from stipe) in all specimens 13

Tubes not boletinoid, or at least not so in all specimens. 15

13. Stipe hollow, yellow from decurrent tube surface above annulus, brown below; pileus mahogany or chocolate brown, or rarely golden yellow, fibrillose-scaly; common in western larch western white pine associations. . . . . 1. *Boletinus cavipes*

Stipe solid. 14

14. Pileus some shade of red or pink, with yellowish cast present in varying degree, coarsely fibrillose scaly; tube surface mustard to dull olivaceous yellow, decurrent on stipe forming reticulation almost to base; common in western larch western white pine associations. . . . . 3. *Boletinus ochraceoroseus*

Pileus light brownish yellow, glabrous to faintly fibrillose, stipe dull yellow, no annulus. . . . . 4. *Boletinus ? appendiculatus*

15. Pileus deeply cracked (rimose-diffract), buff to sand brown, closely canescent; tubes short, mouths extremely small, being rarely larger than 0.15 mm.; stipe buff to sand brown, reticulation on top half only. . . . . 21. *Boletus frustosus*

Pileus not deeply cracked. 16

16. Stipe brownish red to dull crimson, bulbous to subbulbous, tapering strongly upward, reticulate near apex; pileus dark chocolate brown, tomentose to fibrillose-scaly, the scales often in the form of conic points or projections about the center; tube surface bright lemon yellow

to dull mustard yellow; common only in western redcedar western hemlock associations. . . . 20 *Boletus mirabilis*

Stipe some shade of white, gray, yellow, or brown; not red 17

17\. Stipe reticulate almost full length, light yellowish brown, no annulus; pileus khaki, glabrous; tube surface white at first, then greenish white 18. *Boletus edulis*

Stipe not reticulate almost full length, although some may be reticulate near apex 18

18\. Stipe scabrous, rough, dirty white with projections gray or brown; pileus glabrous, color variable in shades of brown; tube surface dull white to fawn 23. *Leccinum scabrum*

Stipe not scabrous 19

19\. Stipe hollow at maturity, unusually slender and tough, densely glandular dotted, the glandules greenish brown; pileus golden to mustard yellow, with or without brownish red or vermilion patches or streaks; flesh of stipe and pileus changing to faintly roseate when cut, or very rarely to faint blue at base of stipe only 12. *Suillus americanus*

Stipe not hollow 20

20\. Annulus usually appressed-cylindric, wide, persistent, of the same color and surface texture as the pileus, varying from bronze through olive drab to a dirty buckskin yellow; stipe yellow at apex, white to base, masked by the dense greenish brown glandular dots; pileus glabrous, but appearing conspicuously fibrillose (fibrillose virgate), viscid only when wet; tube surface lemon to dull mustard yellow, the mouths flecked with brownish glandules. . . 10. *Suillus subluteus*

Annulus none, or if present not appressed cylindric 21

21\. Annulus none at any stage of development 22

Annulus present at least when immature 24

22\. Margin of pileus never tomentose, rarely fibrillose appendiculate; flesh of pileus pure white when young, later pale yellow near tubes and white above; stipe finely glandular dotted usually less than half the length . . 9. *Suillus granulatus*

Margin of pileus tomentose when young, before halfway expanded 23

23\. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted, glandules greenish brown and frequently confluent, conspicuous; pileus yellow, with or without red brown or vermilion streaks or patches, stains hands yellow with sticky-viscid gluten . . . 12. *Suillus americanus*

Stipe stout, solid, closely glandular-dotted, glandules brown; pileus dull yellow to buffish yellow, duller than *S. americanus*, rarely may be marked with red brown or vermilion streaks or patches; readily confused with *S. granulatus* or *S. americanus* . . 8. *Suillus ? subaureus*

24\. Pileus gray or gray brown, viscid, particularly in wet weather; stipe dirty white to faintly brownish gray, may change to blue where bruised; flesh of stipe and pileus also commonly changes to blue where cut or broken, but some specimens show no change, these chiefly immature; flesh soft, frequently watery . . . 6. *Suillus aeruginascens*

Pileus yellow to brown, not gray or gray brown . . 25

25\. Pileus dry, not viscid, coarsely fibrillose to fibrillose scaly, cocoa brown; stipe yellow from decurrent tube surface to annulus, brown, like the pileus, below; common only in association with Douglas fir, in this region. . . . . . 2. *Boletinus amabilis*

Pileus not dry, usually viscid. 26

26\. Stipe not glandular-dotted, usually brown-fibrillose over golden yellow; annulus prominent, persistent, but not flat and wide; pileus bright, shiny golden brown or chestnut, viscid; tube surface bright golden yellow; common in western larch western white pine associations . . . . 7. *Suillus elegans*

Stipe glandular-dotted. 27

27\. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted; annulus absent in approximately half specimens collected, but when present tomentose, not flaring, usually fragmentary; pileus yellow, with or without red brown or vermilion streaks or patches, stains hands yellow with sticky-viscid gluten. . . . . 12. *Suillus americanus*

Stipe stout, not particularly tough, glandular-dotted, especially above the annulus; annulus prominent, glutinous, flaring upward at least when young and usually to maturity; pileus dark buckskin or yellowish brown to reddish brown, thickly sticky-viscid. . 11. *Suillus luteus*

TEXT KEY AND SPECIES DESCRIPTIONS

A. Tubes boletinoid
(except sometimes in *Boletinus amabilis.*)

BOLETINUS Kalchbrenner

Tubes arranged radially in rows, usually with more or less prominent veins between, at least when young; tubes not easily separable from the carpophore and not at all from each other.

1. Stipe annulate, even when mature..........2
   Stipe exannulate, at least at maturity..........3
2. Stipe hollow..........1. *Bol. cavipes*
   Stipe solid; tubes in many specimens *not* boletinoid..........2. *Bol. amabilis*
3. Pileus some shade of red or pink, usually with yellowish cast, fibrillose-scaly..........3. *Bol. ochraceoroseus*
   Pileus light brownish yellow, glabrous to faintly fibrillose..........4. *Bol. ? appendiculatus*

1. BOLETINUS CAVIPES (Opatowski) Kalchbrenner

Plate 1, fig. A; and Plate 7, fig. A.

SELECTED ICONES.—Kallenbach (1926–37, pls. 27, 33); Migula (1925, pl. 42B); Macku (1925, fig. 286); Farlow (1929, pl. 92); Michael-Schulz (1927, pl. 268); Konrad and Maublanc (1924–37, pl. 420); Juillard-Hartmann (1919 et seq., 4: 196 (4)).

HABIT. Gregarious, rarely caespitose. PILEUS—*Shape:* broadly convex, usually subumbonate. *Margin:* sometimes partly fibrillose-appendiculate when young. *Diameter:* 6–25 cm., usually 8–15 cm. *Surface:* soft, fibrillose-squamulose to squamose, rarely somewhat rimose in old specimens; color mahogany (8L6) to a reddish chocolate brown (8L8), or tawny brown, rarely a dull golden yellow (11K6). *Flesh:* firm, sometimes somewhat soft; color lemon to pale yellow, deeper near tubes; taste farinaceous to slightly bitter; odor faintly acrid, or not distinctive. *Tubes:* decurrent, short, strongly sublamellate, radiating; color bright sulphur yellow (10K1) when young to chartreuse yellow (11L1), or dingy ochraceous in age; mouths compound, angular, 0.5–3 mm. diameter. *Veil:* white, evanescent, partly adhering to the margin of the pileus and partly to the stipe. STIPE—*Shape:* tapering upward, subbulbous, or even subequal. *Annulus:* delicate, conspicuous, white at first, then ochraceous. *Reticulation:* more or less, tube dissepiments usually decurrent to the annulus. *Surface:* fibrillose-scaly below annulus, or floccose, dry; color brown or tawny, like top of pileus, below annulus; yellow, like tubes, above. *Interior:* hollow, the cavity large, occupying most of the base of the stipe at maturity, sometimes stuffed when young; color yellow about the cavity, pale brown to pinkish brown zone beneath cortex. *Length:* 4–10 cm. *Diameter:* 1.5–4.5 cm. at point of maximum diameter. SPORES *Color in mass:* olivaceous-ochraceous when fresh, changing later to yellowish-ochraceous. *Shape:* ellipsoid. *Color under microscope:* pale yellowish, the membrane somewhat bright. *Dimensions:* 7.5 10×3 4μ, few 14 18×5 6μ, mostly 8 10×3.5μ. CYSTIDIA Rare. *Shape:* clavate, or fusiform, occasionally truncate at apex. *Color under microscope:* hyaline. *Dimensions:* 58 85×6 8μ.

Four collections (UIFP *1072, 2581, 3270, 3010*) of a golden yellow form of this species were made in the course of the study. In every respect except color, these specimens conformed to the description of *Bol. cavipes*. Perhaps these should be referred to the variety *aurea* Rolland, but since golden specimens have been found intermixed with the more common brown forms, there seems little justification for use of this varietal distinction.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* wet specimens dry with extreme shrinkage, frequently losing 75% of the original volume. Best results are obtained with collections made during dry weather, or at least when there has been no rain for several days, for much water is taken up by this species. Edges often curl badly, and the fibrillose texture of stipes and pilei is often lost. Features of the tube surfaces are often well preserved, and, since immature specimens shrink less, the veil and annulus are usually preserved. *Color of pileus:* light coffee brown (15A11), the golden form dull golden yellow (11L5 to 11L6) in young specimens; ochraceous yellow, the scales brown, in mature forms; to warm brown, or dull cinnamon brown (14G11) in old, wet specimens. *Color of tube surface:* suntan khaki (13L7) in young specimens, to a cinnamon brown (14J10), or lighter, in mature ones, or even raw sienna (13L10). *Color of stipe:* same as pileus.

DISTINGUISHING CHARACTERISTICS. The only known species of *Boletinus* with a hollow stipe. The hollow is clearly seen in Plate 1, fig. A. Here, as in *Bol. amabilis*, the stipe is divided into two color zones by the annulus, the upper yellow like the tubes, the lower brown or golden, like the pileus. These two species are grossly different in appearance, *Bol. cavipes* being broader, much darker brown characteristically, and loosely fibrillose squamulose.

HABITAT NOTES. This species occurs generally in consociations dominated by *Pinus monticola* and *Larix*, and is common in the region. All collections recorded were made in the 61 80 year age class, but specimens were observed in stands as young as 21 40 years. It has not been observed in older age classes, perhaps because these classes are relatively rare in the more accessible parts of the area studied. In other regions the species has been reported commonly associated with *Larix* species, and *L. occidentalis* was present in all associations in which collections were made, although in some instances *P. monticola* appeared to be most closely associated. It has not been observed in the spring, all collections being made between mid-September and late October. It frequently occurs on roadside banks, but is at least equally common on the forest floor away from roads and trails.

MYCORRHIZAE. Reported on *Larix decidua* in Italy (Peyronel, 1922).

EDIBILITY. Kallenbach (1926 37) states that it is edible and savory.

COLLECTIONS. U. of Idaho For. Path. Herb. *3276* (Wash.), *1972*, *2563*, *2576*, *2584*, *3237*, *3640*, *3657* (Idaho).

2. **Boletinus amabilis** (Peck) Snell, comb. nov.

Boletus amabilis Peck

Plate 1, fig. B; and Plate 7, fig. B.

SELECTED ICONES.—None known.

HABIT. Usually solitary, sometimes gregarious. PILEUS—*Shape:* convex. *Margin:* somewhat appendiculate with veil remnants at least when young, sterile in places. *Diameter:* 3 17 cm., usually 3- 10 cm. *Surface:* fibrillose to fibrillose-scaly, moist only under conditions of high humidity, never viscid in this region; general color effect cocoa brown, a combination of brown fibrils over a yellowish brown cuticle; cannot be accurately described by reference to a single color. *Flesh:* firm; color variable, a pale old ivory (10G3), lemon yellow (10K3), or yellowish buckskin (11K4), the latter in older specimens, darkening to brown after several minutes when cut; taste and odor mild, not distinctive. *Tubes:* adnate to subdecurrent, the latter rarely; separable; color light sulphur yellow (9K1) when young, dandelion yellow (9L4) at maturity, light ochre (11L6) when old, turning brown where bruised; mouths glandular-dotted, angular, radially elongate, more or less completely radiately arranged (boletinoid) and sublamellate, in many specimens at least halfway to the margin, but in many others not at all boletinoid, over half our specimens the latter form, 0.5–1.5 mm. diameter. *Veil:* thin, fibrillose, white, ivory, or brownish, fibrillose patches adhering to the stipe below annulus, fragments adhering to margin of pileus when young. STIPE *Shape:* subequal, or tapering upward. *Annulus:* near apex, straw-colored, whitish when young, fibrillose-scaly, narrow, usually poorly defined at maturity. *Reticulation:* none, or slightly reticulate with tube dissepiments decurrent almost to annulus in rare specimens. *Surface:* glabrous, or sometimes sparsely glandular-dotted above annulus, fibrillose to fibrillose-scaly, patches of veil adhering below annulus; color above annulus yellow like tubes, below, cocoa brown, or reddish brown, like pileus, the annulus usually sharply dividing the two color zones. *Interior:* solid; color pale lemon yellow (10J2) to brilliant lemon yellow (10K3), darkening to reddish brown after some time. *Length:* 4 9 cm. *Diameter:* 1 2.5 cm. SPORES *Color in mass:* coffee brown. *Shape:* elliptical. *Color under microscope:* hyaline, to pale olivaceous, a few deep olivaceous. *Dimensions:* 8 11×3 4µ, mostly 9×3.5µ. CYSTIDIA Rather common, clustered, two forms. *Shape:* cylindrical-clavate, or fusiform. *Color under microscope:* hyaline. *Dimensions:* 50 60×4 5μ. *Shape:* cylindrical-clavate. *Color under microscope:* brown. *Dimensions:* 50 55×6 7μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* often severe, some specimens shrinking 75% in volume. The fibrillose texture of the pilei, and the sublamellate, boletinoid, arrangement of the tubes, where present, are preserved. The annulus is also clearly visible in most specimens. Color of the pileus is somewhat lighter than when fresh, but the tube surfaces turn brown. *Color of pileus:* grayish brown (14E7) to light cinnamon brown (14I9), the fibrils dark brown. *Color of tube surface:* bronze brown (14K9) to cocoa brown (15C11). *Color of stipe:* brown, somewhat lighter than the pilei.

DISTINGUISHING CHARACTERISTICS. This species cannot be confused with any other described here. The cocoa brown, coarsely fibrillose, or fibrillose-scaly pileus, and the stipe divided into two color zones by the annulus, the upper zone yellow, like the tubes, the lower zone brown, like the surface of the pileus, characterize this species without fail. Both these characteristics are visible in Plate 1, fig. B. No other species collected shows such closely appressed, loosely interwoven, coarse, brown fibrils, through which the yellowish brown cuticle appears. Its association with *Pseudotsuga* is also diagnostic, at least in this region.

HABITAT NOTES.- *Bol. amabilis* is the only species collected which appears commonly in both the *Thuja-tsuga* and *Pseudotsuga* zones in the region. It is the only bolete found to date in the latter zone, and appears in all associations of the former in which *Pseudotsuga* occurs. There is no doubt that *Pseudotsuga* is the typical associate, since this bolete occurs commonly in pure stands of that species. Collections have been made both spring and fall, the best development occurring from two weeks to a month following the beginning of fall rains, in a normal season. Although frequently found along roadsides, specimens occur with approximately equal frequency under the forest canopy.

MYCORRHIZAE. No record found, although its constant association with *Pseudotsuga* suggests such a relationship.

EDIBILITY. Apparently not demonstrated.

COLLECTIONS. -U. of Idaho For. Path. Herb. *1539*, *2577*, *2589*, *3045*, *3241* (Idaho).

3. BOLETINUS OCHRACEOROSEUS Snell

Plate 1, fig. C; and Plate 7, fig. C.

SELECTED ICONES.—None published.

HABIT.—Gregarious. PILEUS—*Shape:* convex, center usually depressed. *Margin:* appendiculate with fragments of veil when young only. *Diameter:* 6 20 cm. *Surface:* dry, coarsely fibrillose-squamulose, fibrillose-scaly, to almost squamose, soft to the touch; color variable, from rose pink (1E8), to brick red (5K10), the roseate color somewhat masked by an over-all ochre yellow cast which varies in its conspicuousness; generally darker in dry seasons, paler in seasons with prolonged wet, sunless periods. *Flesh:* firm; color pale ochre yellow, unchanging; taste mild, not distinctive; odor somewhat resinous. *Tubes:* decurrent, short, inseparable; color a bright mustard yellow (11L2) to dull olivaceous yellow (12L2), the walls somewhat glandular-dotted, but rarely visibly so under a hand lens; mouths radiately arranged and sublamellate, much as in *Boletinellus merulioides*, but less prominently so, compound, 0.5–3 mm. diameter. *Veil:* delicately membranous, white to buff. STIPE—*Shape:* tapering up to subbulbous. *Annulus:* evanescent, at first prominent, then consisting of fibrillose fragments, then disappearing, some specimens having no annulus at any stage of development. *Reticulation:* rotund- or venose-reticulate, usually above annulus, but sometimes below, particularly when stipe is short. *Surface:* glabrescent, or pilose-velutinous to fibrillose-squamulose in places, the latter rarely; color ochre yellow, the reticulations brownish, sometimes rose at base. *Interior:* solid; color ochre yellow, unchanging. *Length:* 2–4 cm. *Diameter:* 1.5–2.5 cm. SPORES—*Color in mass:* deep red brown, the red most evident when fresh, later changing to cocoa brown. *Shape:* narrowly-elliptical. *Color under microscope:* pale greenish yellow. *Dimensions:* 8-10×2.8 3.5μ, mostly 9×3+μ. CYSTIDIA—Two forms, clustered and single. Clustered, especially at the mouths. *Shape:* clavate. *Color under microscope:* hyaline. *Dimensions:* 30–35×5–6μ. Single on the tube walls. *Shape:* clavate, to irregularly ventricose-rostrate, or hyphoid. *Color under microscope:* hyaline. *Dimensions:* 50–55×5–7μ.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* shrinks only moderately, the texture and appearance being unusually well preserved in most specimens. Stipe reticulation is lost in all but rare specimens and traces of the annulus can be found only rarely. The reddish tints are little changed, but the ochraceous cast is usually lost. *Color of pileus:* a yellowish buff (10H4) to dull but definite red (5K3), or mixtures of lighter shades of red and darker buff browns. Rare specimens show some yellowish tinge. *Color of tube surface:* various shades of brown, from dull brownish khaki (14J7) to chocolate browns (8H10 to 8J11). *Color of stipe:* often same as tube surface, or dull golden yellow shades, sometimes red-tinted, the base usually with a covering of creamy mycelium.

DISTINGUISHING CHARACTERISTICS.—The only species of *Boletinus* found in the region with a red or pinkish pileus. Usually a striking species.

HABITAT NOTES.—This species appears in all associations of the *Thuja-Tsuga* zone which include *Larix*. There is little doubt that *Larix* is the typical associate. Throughout the region spring appearances of species of the Boletaceae are relatively rare, this being perhaps the outstanding exception. Certain areas regularly support fairly large numbers each spring, although, as in the other species, optimum development occurs during the fall, in late September and early October in a normal season.

MYCORRHIZAE. Not demonstrated, but almost certainly a mycorrhizae-former with *Larix*, as indicated by its virtually constant association.

EDIBILITY. Not demonstrated.

COLLECTIONS. U. of Idaho For. Path. Herb. *1041*, *1971*, *2127*, *2128*, *2565*, *3046*, *3085* (Idaho).

4. BOLETINUS ? APPENDICULATUS Peck

Plate 7, fig. D.

SELECTED ICONES. None known.

HABIT. -Solitary. PILEUS *Shape:* convex. *Margin:* appendiculate with a thick, incurved, conspicuous veil. *Diameter:* 10 20 cm. *Surface:* glabrous, faintly fibrillose when young; color light brownish yellow when young, later ochraceous yellow. *Flesh:* color pale yellow, unchanging; taste and odor not recorded. *Tubes:* decurrent; color dull yellow, becoming darker, or brownish, when wounded; mouths rather small, angular, unequal. *Veil:* thin, incurved, the remnants attached to margin of the pileus. STIPE *Shape:* slightly thickened at base. *Annulus:* none. *Reticulation:* near apex only, from dissepiments of decurrent tubes. *Surface:* moist, glabrous; color yellow. *Interior:* characters not noted. *Length:* 5 7 cm. *Diameter:* 0.8 1.2 cm. SPORES *Color in mass:* not recorded. *Shape:* oblong-ellipsoid. *Color under microscope:* pale yellow. *Dimensions:* 10 12×4μ (Peck's measurements). CYSTIDIA Characters not noted.

REMARKS. This collection agrees closely with Peck's description of *Bol. appendiculatus*, with the exception of spore dimensions, those of this specimen being somewhat smaller. However, since the specimen was obviously immature when collected, there is little doubt concerning its identity.

CHARACTERISTICS OF DRIED SPECIMENS. The senior author's single, very small specimen offers insufficient material for accurate description.

DISTINGUISHING CHARACTERISTICS. The glabrous, or only slightly fibrillose, surface of the pileus serves to distinguish this species from others of the genus described here, the remainder being conspicuously fibrillose, or more or less coarsely fibrillose-scaly. In color it can be confused only with the golden form of *Bol. cavipes*, which differs in having a hollow stipe and a coarsely fibrillose, or fibrillose-scaly pileus.

HABITAT NOTES. The single collection of this species was found in a

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PLATE 1. Figure A. *Boletinus cavipes* (Opatowski) Kalchbrenner, UIFP[5] *2503*. B. *Boletinus amabilis* (Peck) Snell, UIFP *3045*. C. *Boletinus ochraceoroseus* Snell, UIFP *3046*.

[5] University of Idaho Forest Pathology Herbarium number.

PLATE 1. (See opposite page for explanation.)

consociation dominated by *Larix*. Trees in proximity were *Larix* and *Pinus monticola*. The specimen was collected in late June, and, although the area has been revisited many times, no additional specimens have been seen.

MYCORRHIZAE. No record found.

EDIBILITY. Apparently the species has not been tested.

COLLECTIONS.- U. of Idaho For. Path. Herb. *3086* (Idaho).

B. Tubes not boletinoid.

I. Stipe not reticulate, except at very apex or above annulus in a few forms; not scabrous.

a. Pileus viscid when wet, or at all times, at least in some degree; tubes adnate or decurrent, not free, and not stuffed when young; spores elliptical.

SUILLUS Micheli ex S. F. Gray

Pileus viscid or glutinous, at least when wet; tubes compound, not radiately arranged or separated by lamellae, adnate or decurrent, not stuffed when young; stipe not reticulate, except at very apex or above annulus in a few forms, annulate or exannulate; spores narrowly elliptical.

1. Color of flesh of pileus or stipe, or both, changes to blue when cut or broken 2

Color of flesh of pileus or stipe not changing to blue, although a change to brown may occur in some species.............................. 4

2. Pileus yellow or orange, with or without streaks or patches of red brown or vermilion. ... 3

Pileus gray or gray brown, soft; tubes sand brown or brownish gray.... 6. *S. aeruginascens*

3. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, very rarely changing to blue at base of stipe when cut or broken, densely glandular-dotted, glandules greenish brown and frequently confluent; pileus may be streaked red brown or vermilion, stains hands yellow with sticky viscid gluten . . 12. *S. americanus*

Stipe neither slender nor particularly tough, never hollow, glandular dotted, the glandules small, brown but not greenish-brown; pileus without reddish markings, color bright yellow or orange, does not stain hands yellow; flesh changes to clear blue when cut or broken . ...5. *S. hirtellus* var. *mutans*

4. Stipe not glandular-dotted.............................. 5

Stipe glandular dotted 6

5. Pileus gray brown, glabrous, soft; tubes sand brown to brownish gray, usually changing to blue where bruised, but some specimens show no change........... 6. *S. aeruginascens*

Pileus shiny golden brown or chestnut; tubes bright golden yellow........ ....7. *S. elegans*

6. Annulus present, at least in a few specimens.............................. 7

Annulus not present at any stage of development.............................. 9

7. Margin of pileus never tomentose at any stage of development.............................8

Margin of pileus tomentose when immature, usually loosely and densely so, the tomentum disappearing before pileus is fully expanded, color yellow, with or without red brown or vermilion streaks or patches, stains hands yellow from sticky-viscid gluten; stipe unusually slender and tough, densely glandular-dotted, glandules greenish-brown, conspicuous, frequently confluent.............................12. *S. americanus*

8. Veil not sheathing the whole stipe, entirely superior; annulus usually wide, appressed-cylindric, of same color and texture as pileus, fibrillose-virgate, viscid when wet; pileus broadly subconic to convex, typically the former; stipe densely glandular-dotted, glandules confluent

into large greenish-brown patches toward base . . . . 10. *S. subluteus*
Veil sheathing the stipe; annulus usually flaring upward, not appressed-cylindric, viscid when wet, often disappearing at maturity; pileus relatively thick, rounded pulvinate approaching hemispherical; stipe glandular-dotted, especially above the annulus . . . . 11. *S. luteus*
9. Margin of pileus tomentose when young 10
Margin of pileus never tomentose, rarely fibrillose-appendiculate; flesh of pileus pure white when young, later pale yellow near tubes and white above; stipe finely glandular-dotted usually less than half the length. . . . . 9. *S. granulatus*
10. Stipe unusually slender and tough, hollow at maturity at the base in almost all individuals in this region, densely glandular-dotted, glandules greenish-brown and frequently confluent; pileus yellow, may be streaked red brown or vermilion, stains hands yellow with sticky-viscid gluten . . . . 12. *S. americanus*
Stipe stout, solid, closely glandular-dotted, glandules brown; pileus dull yellow to buffish yellow, duller than *S. americanus*, rarely may be red brown or vermilion streaked, readily confused with *S. americanus* and *S. granulatus*. . . . . 8. *S.* ? *subaureus*

5. **Suillus hirtellus** (Peck) Snell, comb. nov.
var. **mutans** Peck *apud* Snell

Boletus hirtellus Peck var. *mutans* Peck *apud* Snell in Mycologia 33: 26. 1941.[6]

Boletus tomentosus Kauffman

Plate 2, fig. A; and Plate 7, fig. E.

SELECTED ICONES.—None known.

HABIT.—Gregarious, rarely caespitose. PILEUS—*Shape:* convex, commonly hemispheric, rarely slightly subumbonate. *Diameter:* 4–12 cm. *Surface:* texture extremely variable, even among individuals of the same collection, some glabrous, others fibrillose, fibrillose-scaly, as in Plate 2, fig. A, squamulose, or rarely rimulose; moist, somewhat viscid in wet weather, rarely completely dry; color golden yellow (10L7) when young to various shades of yellow when mature, from light sulphur yellow (9K1) to yellowish cream (9H2). *Flesh:* firm, rarely soft in old specimens; color light sulphur yellow (9K1), sometimes paler, changing to blue almost immediately following cutting or breaking; taste mild, not distinctive; odor slightly acid. *Tubes:* adnate, adnate-depressed, adnexed, rarely almost free, or even slightly subdecurrent; color dull or dirty olivaceous golden yellow (12L6), changing to blue where bruised; walls glandular-dotted; mouths angular, often radially subelongate, glandular-dotted, 0.5 1.5 mm. diameter. STIPE—*Shape:* tapering upward, often subequal, or even subbulbous. *Annulus:* none. *Reticulation:* none. *Surface:* glandular-dotted entire length, sometimes tomentose, or fibrillose-squamulose toward base, often white-mycelioid at base, usually dry; color various shades of yellow, usually masked by the brownish glandular-dots, darkening with age as the color of the glandules deepens, frequently changing to blue

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[6] Peck never published a description of his variety *mutans*. The name appears on a specimen from Idaho in Peck's herbarium and also in his notebook Vol. 26, pp. 14 and 40, with a brief description.

where bruised. *Interior:* solid; color light sulphur yellow (9K1), or sometimes paler, if the latter, then deeper yellow under the pellicle, changing to blue shortly following cutting. *Length:* 3–10 cm. *Diameter:* 1–3 cm. SPORES. *Color in mass:* olive brown. *Shape:* elliptical, or slightly subfusiform. *Color under microscope:* pale yellowish-greenish to pale olivaceous. *Dimensions:* 7–11×2.5–3.5μ, mostly 8–9×3 or 3+μ. CYSTIDIA. Generally two forms, in glandular-dots on tubes and stipe, and scattered in the hymenium. In glandular-dots, *shape:* clavate to ventricose-rostrate, some irregularly curved, knobbed, or gnarled. *Color under microscope:* hyaline, to deep yellow brown. Scattered in the hymenium, *shape:* clavate to short ventricose-rostrate. *Color under microscope:* hyaline to deep brown. *Dimensions:* 35–60×8–15μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* Specimens shrink as much as 75% in volume, but distortion is only moderate, texture of the pilei is usually well preserved, stipe glandules are usually plainly visible without a hand lens. Colors are generally much degraded, but young specimens frequently remain somewhat brighter than older ones. *Color of pileus:* light ochre yellow (11L6), chamois (11J5), light brownish khaki (13K7), or rarely as dark as light burnt umber (15C12). *Color of tube surface:* bronze (14L9) to dark olive brown (15L9), the tube mouths blackish in the latter. *Color of stipe:* light suntan khaki (13J7), deep olivaceous gray (15E5), or medium gray (14H4), often with a bluish, or greenish cast in the gray colors; the glandules usually prominent, black.

DISTINGUISHING CHARACTERISTICS. Its bright yellow color, and almost immediate change to blue when cut or bruised make it impossible to confuse this species with others collected in the region.

HABITAT NOTES. This is one of the most common species of boletes found in seral associations in the *Thuja-Tsuga* zone, only a single collection being found in climax *Thuja-Tsuga*. It has not been observed in either the *Pseudotsuga* or *Pinus ponderosa* zones in the region. Apparently there is no consistent association with one or two tree species. Fruiting bodies appear both spring and fall, but are comparatively rare in spring. They usually appear in largest numbers between September 15 and October 31, optimum development occurring from two weeks to a month after fall rains begin. They develop in humus and mineral soil, and are more common under the forest canopy than along roadside banks and trails. The largest concentrations have been found in improved campsites where some thinning has been done, and in areas where small logging operations were carried on a few years earlier.

MYCORRHIZAE. No reports found.

EDIBILITY.--Apparently has not been tested.

COLLECTIONS. U. of Idaho For. Path. Herb. *1540*, *1541*, *2571*, *2603*, *2618*, *2621*, *3044*, *3226*, *3238*, *3252*, *3639* (Idaho).

6. **Suillus aeruginascens** (Secretan) Snell, comb. nov.

Boletus viscidus L. ex Fries

Plate 2, fig. B; and Plate 7, fig F

SELECTED ICONES. Kallenbach (1926–37, pls. 18, 25); Konrad and Maublanc (1924 37, pl. 416); Jaccottet (1925, pl. 59); Michael-Schulz (1927, pl. 269).

HABIT.—Gregarious, sometimes caespitose. PILEUS—*Shape:* at first globose, then pulvinate, occasionally subumbonate, rarely plane. *Margin:* fibrillose-appendiculate when young only. *Diameter:* 4–13 cm. *Surface:* viscid when wet, variously fibrillose-tomentose, fibrillose-squamulose, innately fibrillose, or entirely glabrous, the latter form most common in this region, characters of the surface frequently varying with the weather; color shiny drab brown when young, later gray, smoke gray, or gray brown (varying from 36A1 or 36A2 to 6A8) at maturity, sometimes with irregular roseate to red brown areas, or indefinite bluish patches, or both colors appearing on the same individual; in other regions varying from dark reddish brown, through gray tints, to almost entirely white, becoming paler and more glabrous in wet weather. *Flesh:* firm when young, soft at maturity; color white to pale yellowish white, often hygrophanous, changing to blue when cut, rare individuals show no color change, the latter usually immature; taste somewhat fruity, or mild and not distinctive; odor none, or faintly resinous. *Tubes:* adnate, rarely subdecurrent; color light sand brown (12B3) when young to light smoke gray (5A8) at maturity, usually changing to blue where bruised, or at least turning darker; mouths irregular, angular, rather large, sometimes more or less radiately arranged and somewhat lamellate-compound (see Plate 2, fig. B), 0.5 1.5 mm. diameter. STIPE *Shape:* subequal, to tapering upward. *Annulus:* small, near apex, tangled-fibrous to floccose-membranous, perhaps sheathing to base, grayish, but occasionally colored brown by the spores, usually disappearing early, but occasionally persisting to maturity. *Reticulation:* usually reticulate above annulus from dissepiments of decurrent tubes, in rare specimens extending downward almost to middle of stipe, but rather faint at this point. *Surface:* somewhat viscid when wet, usually slightly pitted, lacerate-fibrous, or fibrillose-scaly; color dirty white to light smoke gray (5A8), sometimes changing to greenish blue in limited areas where bruised; has been reported from other regions variously with yellowish tints and clothed with reddish brown, or brownish red. *Interior:* solid, fibrous; color white, yellowish toward base, changing to bluish or greenish chiefly at base when cut. *Length:* 3 11 cm. *Diameter:* 0.8–2 cm. SPORES—*Color in mass:* more or less faded, grayish brown, to almost ferruginous-brownish, or chocolate brown. *Shape:* elliptical to subfusiform. *Color under microscope:* pale olivaceous. *Dimensions:* 8 14×3.5 5μ, rarely to 17×6μ, mostly 10 13×3.5 4μ. CYSTIDIA Abundant on mouths, less so on walls, clustered or single. *Shape:* saccate-clavate to ventricose rostrate, some strangulated, often encrusted. *Color under microscope:* hyaline, yellow, or brown. *Dimensions:* 40 80×5 11μ. BASIDIA Clavate to subclavate, 25 28×7 9μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* Because of its initially high water content, this species dries very badly, losing from 75% to 90% in volume. The surface frequently wrinkles extensively, obscuring the original texture. If dried on a smooth surface, such as waxed paper, with tubes uppermost, this wrinkling is minimized when the specimens are badly watersoaked, the fibrillose character of the pileus being moderately well preserved. Some old specimens dried in this manner, although losing little in diameter, shrink to about 2 mm. in thickness. In young specimens the veil is usually well preserved, and the annulus is also readily discernible. *Color of pileus:* grayish brown (14J6 to 14J8) to shades of umber brown (15A12 to 15H11), young specimens usually darker. *Color of tube surface:* dark browns (16A10 to 16A12). *Color of stipe:* light chamois (approximately 11G5) in very young specimens, a dull buff (approximately 12H6) to blackish brown in old, watersoaked specimens.

DISTINGUISHING CHARACTERISTICS. The only viscid, gray bolete seen in the region in which the flesh changes to blue when cut or bruised.

HABITAT NOTES. This species occurs in consociations dominated by *Larix occidentalis* and *Pinus monticola.* It has been observed in all age classes of the seral association in which *Larix* is present in appreciable numbers, except those in which this tree is represented only by widely scattered, overmature individuals, relics of a preceding stand. It is generally considered, with *S. elegans*, a laricophilous species, occurring in Europe, as well as North America, in association with that species under *Larix.* These two boletes are characteristically found together in the same consociations in this region. Fruiting bodies are seldom abundant, but are most common in the fall, from two weeks to a month after fall rains begin. Spring appearance is rare. Although found along roadside banks and trails, they are more common under the forest canopy.

MYCORRHIZAE. -Reported as the probable fungal component of mycorrhizae on *Larix decidua* in Britain (How, 1942) and Italy (Peyronel, 1920). Experimentally, this species has also formed mycorrhizae on *Pinus caribaea* and *P. taeda* in Australia (Young, 1940).

EDIBILITY.—Reported edible by European authorities, but Kallenbach (1926–37) states that it is not worth recommending, since it is slimy and the flesh is usually soft and watersoaked.

COLLECTIONS.—U. of Idaho For. Path. Herb. *2567, 2579, 2580, 2587, 2611, 3047, 3623* (Idaho).

7. **Suillus elegans** (Fries) Snell, comb. nov.

Boletus elegans Fries

Boletus Clintonianus Peck

Plate 2, fig. C; and Plate 7, fig. G.

SELECTED ICONES. –Kallenbach (1926–37, pls. 17, 25); Farlow (1929, pl. 72); Michael-Schulz (1927, pls. 84, 271); Bresadola (1931, pl. 902); Macku (1925, fig. 137); Migula (1925, pl. 42); Jaccottet (1925, pl. 59); Juillard-Hartmann (1919 et seq., 4: 185 (1)).

HABIT.—Gregarious, rarely caespitose. PILEUS—*Shape:* convex, often becoming plano-convex, occasionally depressed in the center, or subumbonate. *Margin:* occasionally appendiculate with veil remnants, especially in dry weather. *Diameter:* 4–15 cm., usually 5–10 cm. *Surface:* glabrous, viscid, usually with a heavy yellowish to reddish brown gluten which dries radially, virgate-spotted in other regions; color usually chestnut brown (7J12), sometimes with a faint grayish, metallic cast, or lighter golden chestnut brown, often with a narrow yellow margin; in other regions commonly much lighter, pale lemon yellow, golden yellow, reddish yellow, or rich chestnut brown as in our specimens; the paler yellows rare with us; note that many icones show the paler colors not characteristic of this region. *Flesh:* firm; color various shades of yellow, from the characteristic brilliant golden yellow (10L6) to deep lemon (10L2), occasionally with a hygrophanous, brownish cast in an indefinite layer beneath the cuticle in old specimens; taste mild, not distinctive; odor faintly resinous, somewhat resembling turpentine, or faintly acid. *Tubes:* adnexed, adnate, or even slightly subdecurrent, comparatively short; color bright golden yellow (10L6), rarely brownish yellow in old specimens, becoming lilaceous, or brownish, where bruised; mouths angular, in part compound, 0.5–1.5 mm., usually 0.5-0.75 mm. diameter. *Veil:* pale lemon to golden yellow, becoming paler as it stretches, perhaps extending to the base, withdrawing to form the annulus. STIPE—*Shape:* tapering upward, to subequal. *Annulus:* prominent, near apex, thick, dark yellow to reddish brown, sometimes none in dry weather. *Reticulation:* usually finely reticulate near apex, occasionally in patches below the annulus. *Surface:* texture below the annulus very variable, subpruinose to fibrillose, or tomentose-punctate, rarely rugose to faintly scabrous, or even glabrous; color extremely variable, an indistinctly fibrillose outer layer, commonly in shades of brown, or golden brown over bright golden yellow cuticle, the apex brilliant yellow, like the tubes. *Interior:* solid; bright golden yellow to lemon yellow, becoming dingy brownish yellow. *Length:* 4–12 cm. *Diameter:* 1–2.5 cm. SPORES - -*Color in mass:* golden brown to chestnut brown, drying ochraceous brown. *Shape:* elliptical to somewhat elliptic-fusiform. *Color under micro-*

scope: pale yellowish olivaceous. *Dimensions:* 7 11×3 4μ, mostly 9×3.5μ. CYSTIDIA Numerous on tubes, mostly clustered. *Shape:* saccate clavate to somewhat acuminate, many constricted, or capitate. *Color under microscope:* hyaline to yellow, or golden brown. *Dimensions:* 25 75×4 10μ. MYCELIUM White to yellowish.

The rich reddish, chestnut brown form of this species has been known as *Boletus Clintonianus* Peck. The yellow form, typical *Suillus elegans*, is rare in this region.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* severe, the surface of the pilei wrinkling badly. The annulus usually remains clearly discernible. Colors become seriously degraded, particularly the brilliant yellow of tubes and stipes. *Color of pileus:* brown, with a tan cast (7C12), bay (7E11) to dull blackish brown (8E3); a few individuals dry somewhat glossy, but the majority become dull. *Color of tube surface:* dull golden tan (13L8) to a cocoa brown (15E11) with a faint golden cast. *Color of stipe:* olivaceous golden yellow (12L6), honey colored (12J6) to bay (7E11), or almost cocoa brown. In over 50% of dried specimens the stipes are brown, showing no indication of the original yellow color.

DISTINGUISHING CHARACTERISTICS. The shiny, viscid, rich chestnut brown pileus, brilliant golden yellow tube surface, and annulate stipe of this common species distinguish it from all other forms in the region. It is possible that rare specimens of *S. luteus* might be confused with this species, but the glandular-dotted stipe of *S. luteus* should remove all doubt concerning its identity. That confusion may sometimes occur between these two species is borne out rather well by a plate of photographs by Güssow and Odell (1927, pl. 94), illustrating *Suillus luteus* (*Boletus luteus*). The specimens shown here are almost identical in appearance with our *S. elegans*, with the possible exception of two in the upper row in which the annulus is somewhat larger than most of ours. There is, however, a wide variation in the size and shape of the annulus in this, and other, species, and it is to be anticipated that typical specimens of *S. elegans* will be collected in which the annulus is fully as large, and similar in shape to those illustrated by Güssow and Odell.

HABITAT NOTES. This is the commonest bolete species in consociations dominated by *Larix* and *Pinus monticola*. Its association with *Larix* species is generally accepted throughout the range of the genus, Melin (1922) suggesting obligate parasitism. *Larix* is also its most frequent associate in this region. Although it has been collected in every month between June and November, the optimum season is in early fall in a normal year, some specimens appearing until the onset of winter weather.

PLATE 2. Figure A. *Suillus hirtellus* (Peck) Snell var. *mutans* Peck *apud* Snell, UIFP 2603. B. *Suillus aeruginascens* (Secretan) Snell, UIFP 2567. C. *Suillus elegans* (Fries) Snell, UIFP 2560.

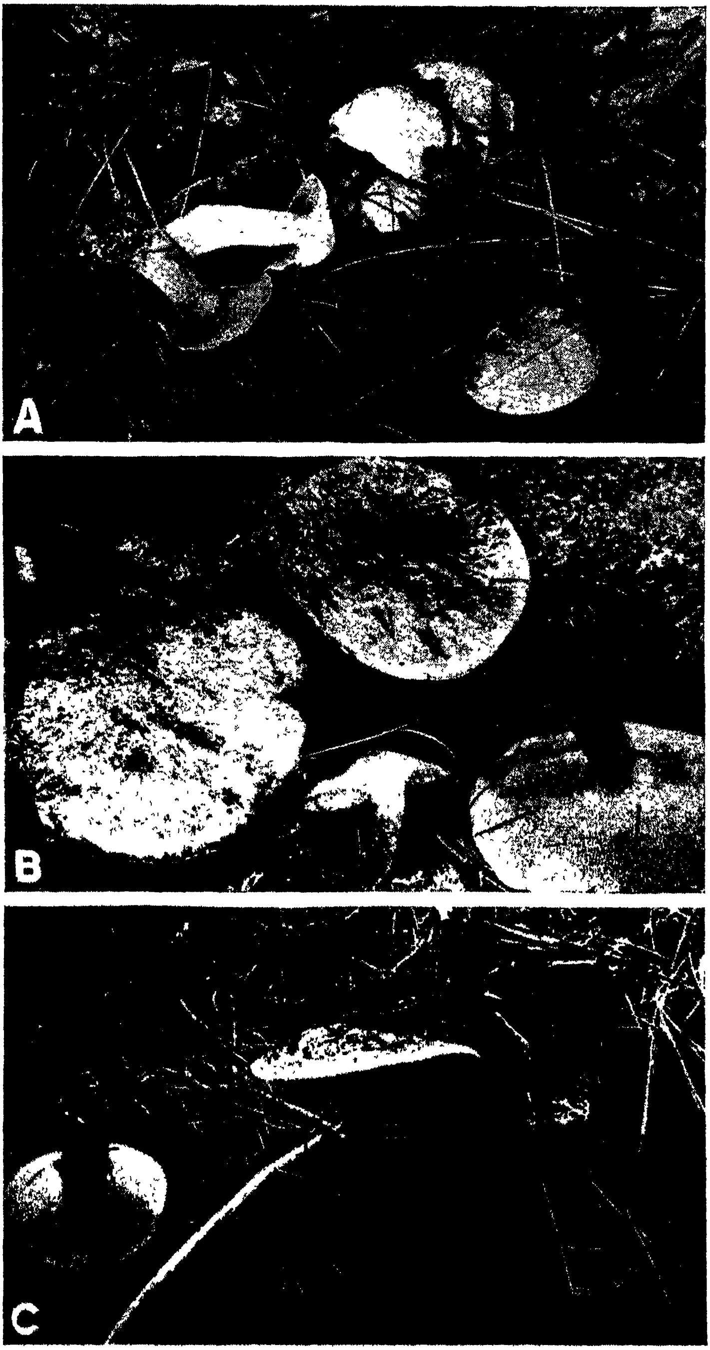

PLATE 2. (*See opposite page for explanation.*)

MYCORRHIZAE. Reported on *Larix decidua* (Melin, 1922), *L. sibirica*, and *L. leptolepis* in Sweden (Romell, 1921), *L. decidua* in Britain (How, 1942) and Italy (Peyronel, 1920, 1922), and has produced mycorrhizae experimentally on *Pinus caribaea* and *P. taeda* in Australia (Young, 1940), the latter indicating that the species may not be strictly limited in its mycorrhizal relationships to species of *Larix* as Melin (1922) suggested.

EDIBILITY. Kallenbach (1926 37) states that *S. elegans* (as *Boletus flavus*) is delicate and savory, but Peck (1889) believes that, though it is edible, it is not delicate.

COLLECTIONS. U. of Idaho For. Path. Herb. *1685*, *1930*, *1973*, *2009*, *2564*, *2566*, *3048*, *3084*, *3205*, *3253* (Idaho).

8. **Suillus** ? **subaureus** (Peck) Snell, comb. nov.

Boletus subaureus Peck

Plate 3, fig. A; and Plate 7, fig. H.

SELECTED ICONES. Peck (1900, pl. 61); Güssow and Odell (1927, pl. 97).

HABIT. Gregarious. PILEUS *Shape:* convex. *Margin:* when young, slightly grayish-tomentose. *Diameter:* 5 11 cm. *Surface:* viscid to glutinous when wet, glabrous when dry; color pale, dull yellow, or buffish yellow, sometimes with darker spots from drying of the gluten which is usually reddish in wet weather, occasionally vermilion streaked; our collection yellowish buckskin (11K4), with tiny brown patches evenly distributed. *Flesh:* firm; color pale yellow, or lemon yellow (10J1); taste mild, not distinctive, or pleasant; odor slightly acid. *Tubes:* adnate to subdecurrent, in our collection adnexed; color a yellowish buff (10J4) when young, to dull canary yellow (11L4) at maturity, walls glandular-dotted; mouths somewhat angular to irregular, diameter to 1 mm., mostly smaller, glandular-dotted, exuding yellow drops which darken with age. STIPE *Shape:* subequal, stout. *Annulus:* none. *Reticulation:* none. *Surface:* usually dry, closely glandular dotted; color yellow, brownish yellow, or pale buff at the base, covered with yellowish to reddish brown glandules which darken with age. *Interior:* solid; color yellow, but darker yellow to orange, or deep reddish toward base. *Length:* 4 7 cm. *Diameter:* 0.8 1.8 cm. SPORES *Color in mass:* fawn brown, or ochraceous-ferruginous. *Shape:* elliptical to somewhat subfusiform. *Color under microscope:* hyaline. *Dimensions:* 7 10×3 4μ, mostly 7.5 8.5×3μ. CYSTIDIA · *Shape:* clavate to irregular, or more or less fusiform. *Color under microscope:* hyaline. *Dimensions:* 40 70×6 8μ.

REMARKS. -Specimens of this species marked on the pileus with streaks or patches of red brown or vermilion may be *Suillus subaureus* (Peck) Snell var. *rubroscriptus* Peck. This form has not been found in the course of this study.

Since specimens collected in this region do not conform strictly to descriptions of *S. subaureus*, this identification must be accepted with minor reservations. Despite this uncertainty it was thought best to include the description and give the species a place in the keys.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* the tops of the pilei wrinkle severely, the patchy character of the surface being completely lost. Stipes furrow extensively, the glandules often being barely discernible without a hand lens. Colors are seriously degraded. *Color of pileus:* light umber brown (15C9), with irregular areas lighter (approximately 14J9). *Color of tube surface:* suntan khaki (13L7), the tube mouths dark brown, dulling the color of the whole tube surface. *Color of stipe:* a light grayish brown (approximately 14G8), darkened, in some cases almost black, by the blackish glandules.

DISTINGUISHING CHARACTERISTICS.—This species has been commonly confused with *Suillus americanus* which it closely resembles when the pileus is marked by reddish gluten. *S. americanus* is characterized by brighter yellow color than the dull yellow to buffish yellow of *S. subaureus.* Its stipe is also thinner. Specimens of *S. subaureus* collected in this region have been lacking in reddish gluten and are rather difficult to distinguish from *S. granulatus*, as indicated by those shown in Plate 3, fig. A. Color of *S. subaureus* is generally more yellowish and lighter than *S. granulatus*, and the stipe is entirely yellow, or perhaps discolored somewhat, yellow within, with the flesh reddish or dark red at the base, while the stipe of *S. granulatus* is yellow at the top, white below beneath the glandular dots, and white within. Both are found under lodgepole pine, reach their optimum development at the same time, and are frequently closely similar.

HABITAT NOTES. --This species has been observed only in consociations dominated by *Pinus contorta* var. *latifolia* in this region. While only one collection was made, specimens were frequently observed during intensive collection of the study area in this consociation, growing on duff, humus, and mineral soil. The typical associate is undoubtedly *P. contorta* var. *latifolia*. Optimum development is usually between late September and early November. No specimens have been observed in the spring.

MYCORRHIZAE. No record found.

EDIBILITY. - Reported edible by Güssow and Odell (1927). These authors state that the species is regarded by some authors as "among the most valuable of our [Canada] food species, being found when other fungi are scarce." In this region appearance of the species coincides with the optimum season for the majority of the fleshy fungi. Güssow and Odell regard *S. americanus* as a synonym, and their remarks concerning edibility include that species.

COLLECTIONS.—U. of Idaho For. Path. Herb. *3261* (Idaho).

9. **Suillus granulatus** (L. ex Fries) Snell, comb. nov.

Boletus granulatus L. ex Fries

Plate 1, fig. A, and Plate 7, fig. J.

SELECTED ICONES. Farlow (1929, pl. 75); Hard (1908, fig. 283); Murrill (1913, pl. 80, figs. 3, 4; 1916, fig. 5); Güssow and Odell (1927, pl. 93); Kallenbach (1926–37, pl. 48); Michael-Schulz (1927, pl. 272); Juillard Hartmann (1919 et seq., 4: 191 (6)); Bresadola (1931, pl. 907); Migula (1925, pl. 45D); Jaccottet (1925, pl. 60); Macku (1925, fig. 135).

HABIT. Gregarious, sometimes solitary, rarely caespitose. PILEUS *Shape:* convex. *Margin:* when young, occasionally fibrillose-appendiculate, particularly in wet weather. *Diameter:* 4–20 cm., but rarely larger than 10 cm. in this region. *Surface:* very viscid when wet, often obscurely virgate-spotted, especially near the center in larger specimens; color extremely variable, in this region from a metallic burnt umber (15A12), or perhaps somewhat lighter, when very young, through shades of light chamois to pale old ivory (11G5 to 10F3), becoming paler with age; in other regions reddish brown, pinkish gray, fading to yellowish white or white with brownish stains when rain washed. *Flesh:* firm, becoming soft in large, old specimens; color pure white when young, later pale yellow near tubes and white above, or occasionally pale yellow throughout, becoming brownish with age, unchanging; taste mild, somewhat mucilaginous; odor faintly acid to occasionally somewhat fetid. *Tubes:* adnate, rarely slightly subdecurrent; color pale creamy yellows (9I2 to 9I4), rarely dirty yellowish in large, old specimens, unchanging; mouths subrotund to irregular, compound, conspicuously glandular-dotted in other regions, occasionally so in our collections, the glandules appearing granular, lending a brownish cast to the tube surface, diameter of mouths 0.25–1 mm., usually 0.25–0.5 mm. STIPE *Shape:* subequal, or tapering upward. *Annulus:* none; but very rarely a small, evanescent false annulus is present in this region near apex of stipe, disappearing well before maturity. *Reticulation:* none. *Surface:* finely glandular-dotted from apex downward usually less than half the length, dry, rarely somewhat moist; color varying from chalky white to pale sandy brown, yellow near apex, stained pinkish to brownish in age, the glandules yellow to pinkish brown, darker on drying. *Interior:* solid; color white to pale yellowish. *Length:* 2–8 cm. *Diameter:* 0.6–3 cm., usually 1.5–2 cm. SPORES *Color in mass:* yellowish brown. *Shape:* elliptical. *Color under microscope:* hyaline. *Dimensions:* 6-10×2.5–3.5μ, mostly 6–7×2.5–3μ, perhaps 7–8μ in some specimens. CYSTIDIA Clustered at the mouths to form glandular-dots, or single in the hymenium. *Shape:* clavate. *Color under microscope:* hyaline, occasionally more or less yellowish on stipe. *Dimensions:* 45–90×7–15μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* moderate to extreme, surface of the pilei wrinkling severely, large, soft specimens becoming almost worthless. *Color of pileus:* sun tan khaki (13L7), warm brown (14L11) to chocolate brown (8H10), the latter in large, soft specimens. *Color of tube surface:* bronze brown to dull golden tan (14K9 to 13L8), the mouths dark brown, giving the tube surface a strong brown cast. *Color of stipe:* shades of dark brown, the blackish glandules usually visible without a hand lens.

DISTINGUISHING CHARACTERISTICS.—The color of this species, usually some shade of brown, is so variable that, at first glance, several variations may be mistaken for different species. The surface is thickly viscid when wet, old specimens appearing virgate-spotted beneath the glutinous coating. The stipe offers the most dependable means of separating it from the closely similar *Suillus ? subaureus*, being yellow at the apex, white below, and usually white within, while that of the latter is yellow for its whole length, or discolored, and reddish or pinkish within, at least at the base. Diameter of the pileus also varies widely, the range in association with *Pinus contorta* var. *latifolia* being 5 10 cm., while specimens as large as 20 cm. across have been collected in other associations. Specimens shown in Plate 4, fig. A, were photographed during dry weather and show no evidence of viscidity. The margin of the pilei of these specimens is fibrillose-appendiculate, a comparatively rare character, and the stipe shown is unusually short.

HABITAT NOTES.—This species is found in all stages of the forest succession in the *Thuja-Tsuga* zone, except thinly-stocked burns. Observation over the past four years has led to the conclusion that *Pinus contorta* var. *latifolia* is perhaps the most important associate, although occasional association with several tree species is indicated by records of the individual collections. In consociations dominated by *P. contorta* var. *latifolia*, *S. granulatus*, at its optimum season, is not only the commonest bolete, but outnumbers all other species of the family ten to one. It appears in its greatest concentration when fall rains have thoroughly saturated the litter accumulation, but occasional collections have been made during wet weather as early as July. The largest specimens were found in nearly climax stands of *Thuja-Tsuga* which included large *Pinus monticola* approximately 200 years old.

MYCORRHIZAE. -*S. granulatus* has been reported probably forming mycorrhizae on *P. radiata*, *P. patula*, *P. echinata*, and *P. longifolia* in Australian plantations (Young, 1936), and producing mycorrhizae experimentally on *Araucaria cunninghamii*, *Pinus caribaea*, *P. taeda* (Young, 1940), *P. Strobus*, *P. Mugo* (Hatch and Hatch, 1933), *P. merkusii* (Rayner, 1938), *P. radiata* (Walker, 1931), and *P. sylvestris* (Melin, 1923a).

EDIBILITY. -Edibility of this species is well established, but there is some difference of opinion as to its desirability. Peck (1889) repeats

Badham's assertion that it has a flavor similar to that of *Boletus edulis*, considered among the best of edible fungi. Others report that it is slimy, but this, perhaps, can be minimized by removing the tube layer and peeling the pileus before cooking. Farlow (1929) and McIlvaine (1902) agree that it is highly regarded as an edible species.

COLLECTIONS. U. of Idaho For. Path. Herb. *1512*, *1513*, *1598*, *2568*, *2569*, *2570*, *2586*, *2017*, *2026*, *3236*, *3239*, *3213*, *3661*, *3662* (Idaho).

10. **Suillus subluteus** (Peck) Snell, comb. nov.

Boletus subluteus Peck.

Plate 3, figs. B and C; and Plate 7, fig. K.

SELECTED ICONES. Peck (1897, pl. 33); Farlow (1929, pl. 71); Hard (1908, fig. 297).

HABIT. Usually solitary, occasionally gregarious. PILEUS *Shape:* broadly subconic to convex, rarely almost applanate. *Margin:* often partly appendiculate with veil remnants. *Diameter:* 4–10 cm. *Surface:* viscid or glutinous when moist, glabrous when dry, but characteristically rather strongly fibrillose-virgate; color varying from bronze (14L9), through an olivaceous khaki (14L6) to olivaceous golden yellow (12L6), the darker fibres contrasting with the lighter color beneath. *Flesh:* firm, rarely soft; color pale to dull yellow, grayish ivory in old specimens, no color change; taste pleasant to faintly acid; odor somewhat farinaceous to slightly acid. *Tubes:* adnate, sometimes adnexed; color light sulphur yellow (9K1) when young, a dull olivaceous yellow in age (12L3); mouths subrotund to irregular, 0.5–1.5 mm. diameter, conspicuously glandular dotted, as are the tubes, the glandules light colored and inconspicuous when young, becoming brown and extremely conspicuous when old, dulling the color of the tube surface. *Veil:* submembranous, glutinous, more or less rolled at the bottom, slaty gray, collapsing to form the annulus. STIPE *Shape:* moderately slender, subequal to tapering slightly upward. *Annulus:* usually wide, appressed cylindric, shiny, fibrillose virgate, viscid to glutinous when wet, persistent; may be narrow, inconspicuous, or even lacking, but rarely so in this region. *Reticulation:* none, or rarely near apex from decurrent tube dissepiments. *Surface:* densely and conspicuously glandular dotted, the glandules frequently confluent into irregular patches measuring 2 or 3 mm. across; color yellow at apex, white at base, the colors dulled in varying degree by the glandules which darken with age, becoming greenish brown at maturity; many specimens possess such dense glandular-dots that the stipe color becomes predominantly greenish brown. *Interior:* solid; color pale to dull yellow, more yellow than the flesh of the pileus, deeper toward base. *Length:* 6–10 cm. *Diameter:* 1–2 cm. SPORES –*Color in mass:* ochraceous-ferruginous to cinnamon brown. *Shape:* elliptical to elliptic-fusiform.

Color under microscope: pale yellow. *Dimensions:* 8–13×2.5 4μ, mostly 8–10×3μ. CYSTIDIA—Two forms, caespitose at mouths of tubes, and rare in the hymenium. Caespitose at mouths of tubes. *Shape:* clavate, or cylindric-clavate. *Color under microscope:* yellow. *Dimensions:* 50–60×7–8μ. Rare in the hymenium. *Shape:* clavate. *Color under microscope:* hyaline. *Dimensions:* 28 30×7–8μ. BASIDIA—*Shape:* cylindric to clavate. *Dimensions:* 21–26×7–9μ.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* shrinkage is only moderate, but the surface of the pilei becomes deeply wrinkled, the fibrillose-virgate character being lost completely, except in rare specimens. The annulus remains conspicuous; and the glandules almost completely cover the stipe surface in most specimens, turning black. *Color of pileus:* suntan khaki (13L7) to bronze (14L9 or 14L10), the surface glossy. *Color of tube surface:* bronze (14L10), but darkened by the blackish tube mouths. *Color of stipe:* blackish brown from the dried glandules, small areas ivory at irregular intervals; annulus bronze, or yellowish.

DISTINGUISHING CHARACTERISTICS.—See the description of *Suillus luteus* for distinctions between it and this closely related species. *S. subluteus* is readily identified among other species described here by its usually appressed-cylindric, glutinous annulus 1–2 cm. wide, and the stipe bearing the densest, most conspicuous glandular-dots of any bolete found in the region, the glandules dark greenish brown when mature. *S. americanus* approaches this species in density of glandular dots on the stipe, but its stipe is much more slender, is hollow at maturity in this region, and rarely is annulate; also the pileus is a brighter yellow, commonly with brownish red patches. Specimens pictured in Plate 3, figs. B and C, show the appressed-cylindric annulus on both immature and mature individuals. Figure C shows the fibrillose-virgate nature of the mature pileus, and remnants of the veil may be seen on margins of the pilei in both figures. Both figures show the dense glandular-dots on the stipe, darkening with age.

HABITAT NOTES. Found in almost all associations of the *Thuja-Tsuga* zone, this species also appears in the subalpine *Picea-Abies* zone in this region. In the former zone it has been collected in young consociations of *Pinus contorta* var. *latifolia* on areas burned over about 15 years earlier, and almost at the other extreme of the forest succession, in nearly climax associations of *Thuja-Tsuga* with *P. monticola* over 200 years old. Although *Thuja* was found near most specimens collected, the species is apparently not limited in association to this tree, *P. monticola* and *Larix* also being occasional associates. Collections have been made between September 15 and October 31, but it has not been observed in the spring during the period of this study. Earliest occurrences were during a season in which fall rains began in the latter part of August, somewhat earlier than in a normal year. It is probable that optimum moisture conditions on the forest floor are reached between 3 and 4 weeks after fall rains begin in this region, unless precipitation is unusually deficient. Fruiting bodies develop in the duff, humus, and mineral soil, and are usually found under the forest canopy rather than along roadside banks and trails.

MYCORRHIZAE. No reports found.

EDIBILITY. Although the species is edible, no reports concerning its quality could be found.

COLLECTIONS. U. of Idaho For. Path. Herb. *2572*, *2585*, *2613*, *3265*, *3659* (Idaho).

11. SUILLUS LUTEUS (L. ex Fries) S. F. Gray

Boletus luteus L. ex Fries

Plate 7, fig. L.

SELECTED ICONES. Peck (1897, pl. 33); Murrill (1916, fig. 10; 1920' pl. 2, fig. 1); Atkinson (1903, figs. 173, 174); Kallenbach (1926 37, pls. 19' 24, 25); Michael-Schulz (1927, pl. 85); Bresadola (1931, pl. 901); Macku (1925, fig. 136); Migula (1925, pl. 42C).

HABIT. Solitary, or caespitose. PILEUS *Shape:* rounded pulvinate, approaching hemispherical, to plano convex. *Diameter:* 4–13 cm. *Surface:* smooth, shining, extremely glutinous, or slightly sticky-viscid in dry weather, virgate-streaked on drying; color grayish brown, yellowish brown, reddish brown, to chocolate brown, often with variations of yellow and brown, or with a sallow cast, becoming darker and duller with age, our single collection dark honey-colored (approximately 12J6). *Flesh:* soft-cottony, often watery; color at first whitish, then lemon yellowish with age, especially near the tubes, becoming tinged with dull reddish brown when cut; taste mild, not distinctive; odor faintly acid, or not distinctive. *Tubes:* adnate, or slightly decurrent, seceding in our collection; color bright lemon to golden yellow, darker with age; mouths irregular, angular, glandular-dotted, 1–1.5 mm. diameter. *Veil:* membranous, sheathing the stipe, at first white, thick, then thinner as it dries, becoming grayish, withdrawing upward to form the annulus. STIPE *Shape:* tapering upward to subequal. *Annulus:* prominent, usually flaring upward, particularly when young, glutinous, gray, to dark violet, or blackish brown in some forms, yellowish to brownish in others, yellow brown on upper side. *Reticulation:* more or less, at very apex. *Surface:* pruinose to glandular-dotted above and below annulus, especially above; color at first pale yellowish, then yellow at apex, white, or buff at base, the glandules brownish

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PLATE 3. Figure A. *Suillus ? subaureus* (Peck) Snell, UIFP *3261*. B. *Suillus subluteus* (Peck) Snell, UIFP *2613*. C. *Suillus subluteus* (Peck) Snell, UIFP *3265*.

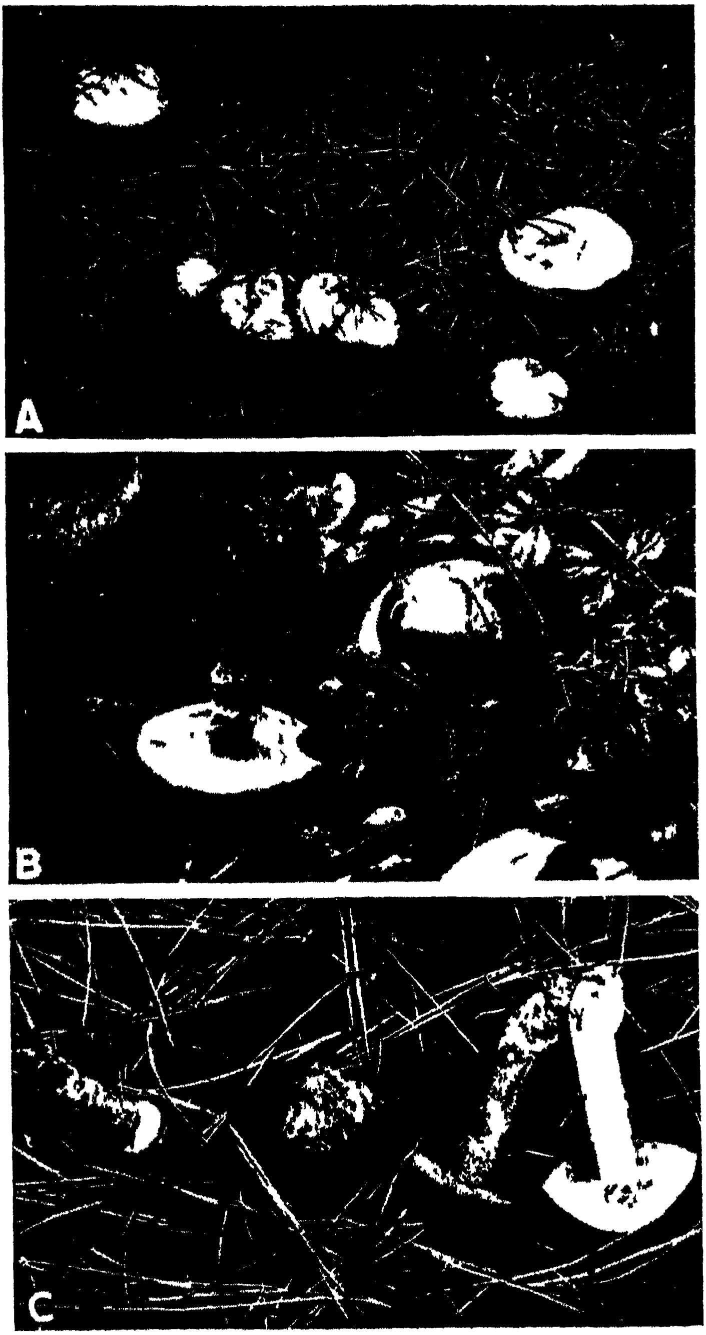

PLATE [illegible] (See opposite page for explanation.)

or yellowish. *Interior:* solid, fibrous; color like flesh of pileus, but grayish, or brownish at base and near cortex, or brighter yellow and flesh-colored in streaks. *Length:* 3 11 cm. *Diameter:* 1 2.5 cm. SPORES *Color in mass:* rusty ochraceous brown when fresh, drying to dull ochraceous brown. *Shape:* almost elliptical to elliptic fusiform. *Color under microscope:* pale yellow. *Dimensions:* 6 11×2.5 4μ, mostly 8 9×3μ. BASIDIA *Shape:* clavate. *Dimensions:* 21 25×6 7μ. CYSTIDIA Clustered at the mouths, making glandular-dots, and single in the hymenium. *Shape:* saccate-clavate to somewhat rostrate. *Color under microscope:* hyaline, pale yellow, to dark brownish. *Dimensions:* 24 60×6 14μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* our single collection shrank approximately 50% in volume, with moderate distortion, colors darkened considerably, pilei becoming umber brown, tube surfaces cinnamon brown, or somewhat darker, stipes blackish brown, lighter in places. No color comparisons determined.

DISTINGUISHING CHARACTERISTICS. Closely related to *S. subluteus*, this species has a thicker stipe, the ratio of stipe diameter to cap diameter being about 1:5, while that of *S. subluteus* is between 1:8 and 1:10. Stipes of both are glandular-dotted, but glandules are more conspicuous above the annulus in *S. luteus*, below the annulus in *S. subluteus*, in which they are large, confluent, and frequently almost hide the cuticle toward the base. In the latter the annulus collapses at maturity, or somewhat earlier, while it is strongly flared upward in *S. luteus*, frequently persistently so. *S. luteus* also commonly has reticulations at the apex of the stipe. It is possible that this species might be confused with glabrous forms of *S. hirtellus* var. *mutans*, where abnormally dark specimens of that species are concerned. Flesh of both pileus and stipe of the latter changes to blue when cut or broken, and its stipe has no annulus.

HABITAT NOTES. The single collection of *S. luteus* was found in an association of *Larix*, *Pinus monticola*, and *Pseudotsuga*, with no indication of the typical associate. The collection was made in June and the species has not been observed in any other part of this region during the past four years.

MYCORRHIZAE. Reported on *Pinus montana* (Romell, 1921), *P. nigra* var. *austriaca* (Rayner, 1927), and *P. sylvestris* (Rayner, 1927; Rayner and Levisohn, 1941). It has produced mycorrhizae experimentally on *P. caribaea*, *P. taeda* (Young, 1940), *P. contorta* var. *latifolia*, *P. nigra* (Rayner, 1934), *P. radiata* (Rayner, 1938), *P. Mugo*, *P. Strobus*, *Picea Abies*, *Larix decidua*, and *L. occidentalis* (Hatch and Hatch, 1933). Two of the tree species on which mycorrhizae were produced experimentally are members of the seral association in the *Thuja-Tsuga* zone in this region, *Larix occidentalis* and *Pinus contorta* var. *latifolia*, the former occurring in the association from which our collection was made.

EDIBILITY.—Kallenbach (1926-37) states that this species is equal in quality to *Suillus elegans*. Peck (1889) says the flesh is tender, but the tubes should be scraped away, as in all species, before cooking.

COLLECTIONS.—U. of Idaho For. Path. Herb. *3050* (Idaho).

12. **Suillus americanus** (Peck) Snell, comb. nov.

Boletus americanus Peck

Plate 4, figs B and C; and Plate 7, fig M

SELECTED ICONES.—Murrill (1913, pl. 80, fig. 5, as *Rostkovites subaureus*); Farlow (1929, pl. 73); Atkinson (1903, fig. 171); Hard (1908, fig. 304); White (1905, pl. 29).

HABIT.—Gregarious. PILEUS—*Shape:* convex, frequently subconic or subumbonate. *Margin:* more or less thickly tomentose-appendiculate when young. *Diameter:* 5–10 cm., mostly 5–8 cm. *Surface:* glabrous, sticky-viscid, but thinly so; color dandelion yellow (9L4) when young, to dull canary yellow (11L4) when old, more or less irregularly-patchy, or streaked, with pinkish brown (6F10) to reddish brown (7L8), or rarely more reddish; the patches, or streaks, often sparse, or even lacking, but frequently covering over half the surface. *Flesh:* firm when young to soft when old; color lemon to mustard yellow, darkening somewhat with a pinkish roseate hue when cut or broken; taste somewhat resembling raw turnip, but often mild, not distinctive; odor mildly acrid. *Tubes:* adnate, rarely adnexed, or even subdecurrent; color warm lemon yellow (10K4) to a dull olivaceous yellow (12L3), changing to brownish yellow on injury, the walls and mouths glandular-dotted; mouths angular, irregular, 0.5 1.5 mm. diameter. *Veil:* thickly tomentose, separating early from the stipe, adhering to the margin of the pileus, sometimes leaving an annulus. STIPE *Shape:* slender, subequal, to tapering slightly downward. *Annulus:* tomentose, well-defined in some specimens, but none in about half the collections. Eastern forms of the species have no annulus. *Reticulation:* near apex from decurrent tube dissepiments, many individuals with none. *Surface:* glandular-dotted, the glandules varying from very small and widely separated, to large, confluent, and conspicuous, covering the major portion of the surface in some old specimens; moist to sticky; color lemon to mustard yellow, usually more or less masked by the brown glandular-dots, which often color the whole a dirty greenish brown; extreme base usually sheathed in pinkish white, closely appressed mycelium. *Interior:* solid when young, but in this region almost always hollow when mature, chiefly at the base; color lemon to mustard yellow, becoming faintly pinkish roseate when cut or broken, one only of four collections changing to blue at base when cut. *Length:* 6 9 cm. *Diameter:* 0.8–2 cm., the latter rarely, mostly 0.8 1.5 cm. SPORES –*Color in mass:* cinnamon brown. *Shape:*

elliptical to subfusiform. *Color under microscope:* pale yellowish to golden brown. *Dimensions:* 8–11×3.5–4.5μ, mostly 9–10×4–4.5μ. CYSTIDIA Numerous, clustered in glandular dots in the hymenium and at tube mouths. *Shape:* usually strangulated, or distorted, rarely cylindric clavate. *Color under microscope:* golden brown, or hyaline. *Dimensions:* 50–60×6–8μ.

REMARKS. Hollow stipes have apparently not been reported for this species from any other region, although nearly every specimen collected in the course of this study exhibits this peculiarity.

The annulus found on many of these specimens is also not reported from other regions. Examination of 44 dried specimens representing four collections revealed 22 with no annulus, 19 with at least a fragmentary annulus, and only 3 with a complete annulus.

Also one of the four collections exhibited a change to blue at the base of the stipe when cut, a feature not before reported. Despite these three differences from the characteristic eastern form, establishment of a new species, or even a variety is not considered justified, since the collections conform perfectly to the original descriptions in all other respects.

Plate 4, fig. B shows the tomentose margin of the young pileus and a typical hollow stipe. Note the comparatively sparse markings on the pilei in this 1942 collection. Fig. C shows a 1940 collection, with much more conspicuous red brown patches or streaks on the pilei. These two photographs were made from the same camera position, although taken two years apart. The specimens undoubtedly arise from the same substratum, and perhaps the same mycelium.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* severe, the surface of the pilei wrinkling badly, and the margins twisting more or less severely. Patches and streaks on the surface are usually clearly discernible; glandular-dots on tube walls and mouths remain conspicuous; the annulus, when present, is plainly visible, and the stipe glandules are extremely conspicuous; the cavity in the stipe is large and obvious when the stipe is broken at the base. *Color of pileus:* light ochre yellow (11L6), olivaceous golden yellow (12L6), or somewhat darker. *Color of stipe:* black, over all, or most, of the surface from the dried glandules, usually with scattered spots of gray, or yellowish gray showing through; the annulus, where present, buff, or yellowish.

DISTINGUISHING CHARACTERISTICS. This is the only species collected in the region which stains the hands yellow with the gluten from the top of the pileus. The unusually slender and tough stipe is its most valuable diagnostic characteristic. The stipe is usually densely glandular-dotted,

PLATE 4. Figure A. *Suillus granulatus* (L. ex Fries) Snell, UIFP *2560*. B. *Suillus americanus* (Peck) Snell, UIFP *3658*. C. *Suillus americanus* (Peck) Snell, UIFP *2578*.

PLATE 4 (*See opposite page for explanation.*)

the base commonly sheathed in pinkish mycelium, and the margin of the young pileus appendiculate with thick tomentum. In mature specimens the base of the stipe is almost always hollow in this region.

HABITAT NOTES. This species occurs in consociations dominated by *Pinus monticola* in this region. It was collected in four localities only, in stands between the ages of 10 and 80 years, the best development noted occurring along Benton Creek, in the Priest River Experimental Forest. The remaining localities were all within two miles of this point, the species having been seen in no other part of the region during the past four years. It has not been observed in the spring, all collections occurring between mid-September and late October. *P. monticola* is apparently the typical tree associate.

MYCORRHIZAE. No reports found.

EDIBILITY. Reported edible by Farlow (1929). See *Suillus ? subaureus* for further discussion.

COLLECTIONS. U. of Idaho For. Path. Herb. *2578*, *3638*, *3618*, *3658* (Idaho).

b. Pileus dry, never viscid; glabrous, subpruinose or subtomentose; tubes simple or compound; spores subfusiform.

XEROCOMUS Quélet

Pileus dry, never viscid, may be glabrous, subpruinose, or subtomentose; tubes simple or compound, never stuffed or with red mouths; spores subfusiform; stipe rugose or striate in some species, never truly reticulate or bulbous.

1. Stipe some shade of red, at least in part . . . 2
   Stipe yellow or brown, not red . . . 5
2. Tube surface not turning blue where bruised, its color bright lemon to olivaceous yellow, pileus dark greenish brown; stipe deep crimson to brownish red . . . 13. X. *Zelleri*
   Tube surface turning blue where bruised . . . 3
3. Stipe uniformly red at base, yellow at apex; pileus khaki, rimose areolate . . . 16. X. sp.
   Stipe not uniformly red at base, at most red only in limited areas, or uniformly pinkish brown 4
4. Pileus rose, beneath a yellowish bloom which may be rubbed off, not rimose; stipe yellow with red areas; tube surface ochre yellow . . . 17. X. sp.
   Pileus warm brownish khaki to dull brown with mustard colored bloom, subtomentose, not rimose, or rarely deeply rimose diffract, at least in part; stipe pinkish brown, or with a mustard cast; tube mouths large (to 3 mm.), angular, in mature specimens; may or may not change to blue when cut or broken, but never suddenly or deeply; a large species. 14. X. *subtomentosus*
5. Stipe, tubes, and flesh bright lemon yellow, changing immediately to deep blue where cut or bruised; pileus olivaceous khaki, rimose-areolate to rimose-diffract. . . . . 15. X. ? *pulverulentus*
   Stipe brown, or pinkish brown, with mustard cast; pileus warm brownish khaki to dull brown with mustard-colored bloom, subtomentose; not rimose, or rarely deeply rimose diffract, at least in part; tube mouths large (to 3 mm.), angular, in mature specimens; may or may not change to blue when cut or broken, but never suddenly or deeply; a large species . . . . . . 14. X. *subtomentosus*

13. **Xerocomus Zelleri** (Murrill) Snell, comb. nov.

Ceriomyces (Boletus) Zelleri Murrill

Plate 5, fig A; and Plate 8, fig. A.

SELECTED ICONES.—Zeller (1914, pls. 140, 141).

HABIT.—Usually gregarious, frequently caespitose. PILEUS—*Shape:* convex, rarely plano-convex. *Diameter:* 4–18 cm., usually 6–12 cm. *Surface:* appearing glabrous when wet, when dry plainly pruinose with a very delicate, inconspicuous bloom usually disappearing with age; cuticle rarely cracks, in some cases widely, but not deeply, the cracks light buff; dry, rarely moist; color a dark, more or less metallic bronze brown (approaches 16E12), without lustre, the most metallic individuals resembling very badly tarnished brass; the greenish cast due to the fine bloom which, when present, may be rubbed off, revealing a dull, olivaceous brown; in other regions may be Prussian red, seal brown, or cameo brown, the margin usually somewhat paler and browner. *Flesh:* firm; color varying in different specimens from ivory (10B2), through shades of pale yellow (10C1 to 10J1) to lemon yellow (10K3), pinkish under cuticle and near stipe in most cases, the pink color sometimes showing through cracks in the cuticle, a thin hygrophanous line usually marking the junction between tubes and flesh; color changes to blue, but very slowly, the change not appearing before 10 to 30 minutes following cutting, some individuals showing no color change; taste slightly acid, or somewhat mucilaginous; odor mild, not distinctive. *Tubes:* adnexed to adnate-depressed; color light sulphur yellow (9K1) when immature, dulling with age to a somewhat olivaceous yellow (12L1) in very old specimens; no change to blue noted on the tube mouths following injury in any collection although one old but still firm individual when collected had large, irregular, blue patches on the tube surface; mouths irregular in shape, compound, rotund to subangular, 1–2 mm. diameter. *Veil:* none at any stage of development. STIPE—*Shape:* subequal, or tapering upward. *Annulus:* none. *Reticulation:* none. *Surface:* glabrescent, appearing finely striate with a vertical fibrous pattern; color in shades of red from deep garnet red (6K6) to brownish ruby red (7H6), the latter rarely, sometimes yellow brown at base. *Interior:* solid; color lemon to golden yellow when young, with indefinite reddish areas which increase with age, a zone of red extending approximately to 2 mm. beneath the surface; color changes to blue, sometimes very bright, but only after 10 to 30 minutes following cutting, some individuals showing no color change. *Length:* 5-10 cm. *Diameter:* 1–4 cm. SPORES—*Color in mass:* olive brown. *Shape:* elliptic-subfusiform. *Color under microscope:* pale greenish, or yellowish. *Dimensions:* 9-15×4–6μ, mostly 12×4.5μ. CYSTIDIA - Numerous. *Shape:* variously irregular-cylindrical, lageniform, to narrowly ventricose-rostrate, or even clavate. *Color under microscope:* hyaline. *Dimensions:* 40 60×7 15μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* usually moderate, pilei wrinkling somewhat in most cases. Color and texture of pilei and stipes, particularly the latter, are frequently well preserved, with little change. *Color of pileus:* light grayish olive (14E4), dark olive brown (15L8) to dark umber brown (16A11), the latter rarely; cracks in cuticle sometimes reddish; surface usually dull due to bloom, rarely somewhat glossy. *Color of the tube surface:* approaching dull canary yellow (11L3 or 11L4) in very young specimens, olivaceous golden yellow (12L6), or more commonly shades of suntan khaki to olivaceous umber brown (13L7 to 15H11). *Color of stipe:* maroon (7L7), or darker red, to reddish brown, the latter rarely. The red color of the stipe is commonly brighter in young specimens, tending toward brown in overmature specimens.

DISTINGUISHING CHARACTERISTICS. The stipe deep red, pileus dull metallic, greenish brown, usually resembling badly tarnished brass, and the tube surface yellow make this a striking species. Among the species collected it resembles only number 16. *Xerocomus* sp., which is closely similar in color. The latter, however, has a consistently rimose areolate pileus, its stipe is usually considerably more slender, and the flesh changes to blue much more rapidly when cut or broken. Both species have been collected in the same habitat. Plate 5, fig. A, pictures a closely caespitose group, a condition encountered occasionally.

HABITAT NOTES. This species is characteristic of the climax forest association of the *Thuja-Tsuga* zone. In fact, since it is apparently limited to this association, this should be noted as a distinguishing characteristic. Only one collection was made on a site not occupied by a climax, or nearly climax, association, in an area which had been burned 10 years earlier. These specimens were in close proximity to a patch of *Tsuga* reproduction, however, the burn being rather sparsely covered with reproduction of this species, *Larix occidentalis*, *Pinus monticola*, and a few *Thuja plicata*, the conifers scattered among shrubby species of *Salix*. It has not been concluded whether this species is most commonly associated with *Thuja* or *Tsuga*, but it has been observed occurring where *Tsuga* alone was present within 15 meters (approx. 50′). In a normal season optimum development occurs during late September and through October, individuals appearing until freezing weather begins. The earliest collection was made on July 7 in a wet season.

MYCORRHIZAE. No record was found, but UIFP *2707* was attached directly to the root collar of a living seedling, 2 feet in height, of *Pinus monticola*. The seedling showed pronounced mycelial development in all cracks in the root epidermis and all short roots left attached were mycorrhizal.

EDIBILITY.--Not reported in the literature.

COLLECTIONS. U. of Idaho For. Path. Herb. *1595*, *2582*, *2614*, *2696*, *2707*, *3664* (Idaho); *2632*, *2684*, *3656* (Wash.).

14. XEROCOMUS SUBTOMENTOSUS (L. ex Fries) Quélet

Boletus subtomentosus L. ex Fries

Plate 5, fig. B; and Plate 8, fig. B.

SELECTED ICONES.—Farlow (1929, pl. 79); Hard (1908, fig. 284); Bresadola (1931, pl. 914); Michael-Schulz (1927, pl. 88); Juillard-Hartmann (1919 et seq., 4: 192 (6)); Murrill (1910, pl. 19, fig. 6); Soc. Myc. Fr. (1931, pls. 42, 43); Migula (1925, pl. 43B); Macku (1925, fig. 131).

HABIT.—Usually gregarious, sometimes solitary. PILEUS—*Shape:* convex, often plane. *Diameter:* in this region commonly 15- 25 cm., but usually 3–15 cm. in other regions. *Surface:* subtomentose, tomentose, to villose-tomentose, not rimose, sometimes rimose-areolate, at least in part, or very rarely deeply rimose-diffract, moist, or dry; color bronze (14L8) to cocoa brown (15C11), with a mustard-colored bloom in our collections, in other regions variously yellowish brown, tawny olive, brownish olivaceous yellow, or reddish brown, the chinks, as in ours, yellow. *Flesh:* firm; color pale lemon (10J2) to paler yellow, occasionally with a brownish zone beneath cuticle, changing to blue after some time where the cut surface is bruised, but never suddenly or deeply, or rarely unchanging; taste and odor mild, not distinctive. *Tubes:* adnate, usually narrowly so, or slightly depressed, perhaps slightly decurrent, or, as in many of ours, with tube dissepiments prominent, descending the stipe for some distance, often becoming nearly free, tubes very long; color dull olivaceous yellow (12L3), golden, or sulphur yellow when young, changing to blue where bruised in our specimens, but may be unchanging; mouths large, very irregular, more or less compound, 1–3 mm. diameter, usually the larger extreme. STIPE—*Shape:* subequal, or tapering upward in ours, but usually tapering slightly downward in other regions. *Annulus:* none. *Reticulation:* prominent, at apex, from decurrent tube dissepiments, or perhaps wholly or partially pseudo-reticulate, or rugose-reticulate, or only slightly so. *Surface:* glabrous, pruinose, minutely punctate-scabrous, or even furfuraceous, often somewhat ribbed-sulcate; color light pinkish brown (4A10), or with a mustard cast in ours, pale yellow, or often bright yellow above with superficial markings of reddish brown or brown, brown where bruised, dry. *Interior:* solid; color pinkish brown to light brown, or even yellowish white, changing slowly to faint blue. *Length:* 4–12 cm. *Diameter:* 2- 3 cm. SPORES—*Color in mass:* olivaceous when fresh, yellowish brown to umber brown when older. *Shape:* elliptical to subfusiform. *Color under microscope:* pale yellow, with greenish center. *Dimensions:* 10–15×3.5–5μ, mostly 11–12×4μ. CYSTIDIA—*Shape:* ventricose-fusiform, occasionally clavate. *Color under microscope:* hyaline, some lemon yellow. *Dimensions:* 50–60×7–10μ.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* shrinkage is severe, but the tomentose nature of the surface of the pilei, cracking of the surface, and stipe reticulations are all well preserved.

Colors change slightly to somewhat darker. *Color of pileus:* dull, not glossy, bronze (14L9) to reddish chocolate, or chocolate brown (approximately 8H11), the cracks olivaceous golden yellow (12L6 to 12L7). *Color of the tube surface:* greenish, or dull olivaceous yellow (12L3 or 12L4). *Color of stipe:* pale olivaceous yellow (12J2).

DISTINGUISHING CHARACTERISTICS. Although usually much smaller in eastern North America, specimens of this species were the largest boletes collected in the region. In this region specimens have a distinct mustard-colored bloom on the pilei, the general color effect being a warm, mustard-tinted khaki. Some individuals are deeply cracked, the cracks yellow and conspicuous. When making spore casts on white paper, the paper is stained yellow by the tube surface at points of contact. It is unlikely that this species will be confused with others of the same genus described here, for both *X. Zelleri* and 16. *X.* sp. have red stipes in contrast with a pinkish brown in *X. subtomentosus*, and the flesh of *X.* ? *pulverulentus* changes immediately to deep blue, as does that of some specimens of 16. *X.* sp. The species, however, is noted for its variability, and specimens may be collected which could prove confusing.

HABITAT NOTES. *X. subtomentosus* was collected only twice, each time in *Thuja-Tsuga* associations which included isolated individuals of *Pinus monticola* approaching overmaturity. Although the first collection was made in 1941, the species was observed in the same location both in 1939 and 1940. The second collection was made in 1942 at a point 50 miles distant. Both *Thuja* and *Tsuga* occurred close to each collection, making it impossible to decide which was the typical associate. It has not been observed in any other association in the region. All occurrences of the species were in late fall, after the middle of October. Both collections were on banks of road cuts, and in the cleared strip between the road and the timber.

MYCORRHIZAE. Has been reported on *Betula alba* and *Castanea sativa* in Italy (Peyronel, 1922), and its ability to form mycorrhizae on *Pinus montana* has been demonstrated experimentally (Modess, 1941).

EDIBILITY. Reported edible by European authorities, but Peck (1889) says it is only of medium quality.

COLLECTIONS. U. of Idaho For. Path. Herb. *3309*, *3063* (Idaho).

15. XEROCOMUS ? PULVERULENTUS ((Opatowski) Gilbert

Boletus pulverulentus Opatowski

Plate 8, fig. C.

SELECTED ICONES.—Kallenbach (1926 37, pls. 6, 12); Konrad and Maublanc (1924 37, pl. 411); Michael-Schulz (1927, pl. 281); Morgan (1884, pl. 1, as *B. mutabilis*).

HABIT.—Gregarious, or sometimes caespitose. PILEUS *Shape:* convex in ours, in other regions undulated, or irregular when mature. *Diameter:* 5–9 cm., reported to 15 cm. elsewhere. *Surface:* dry, minutely, but densely tomentose, later appressed-tomentose, patchy-fibrillose, or fasciculately fibrillose, rimose-areolate, to rimose-diffract, elsewhere not rimose, glabrous and shiny in age; color olivaceous browns (15L10 to 15L7), sometimes an olivaceous khaki (14K7), the cracks considerably lighter. *Flesh:* firm; color sulphur yellow (10J1), changing to deep blue immediately when cut or broken; taste and odor of our collections not recorded, but not distinctive elsewhere. *Tubes:* adnate, very short; color deep lemon yellow (10L2), changing to deep blue immediately where bruised; mouths more or less compound, angular, unequal, 0.5–1 mm. diameter. STIPE—*Shape:* stout, subequal, may be thickened or tapering toward base, subsulcate. *Annulus:* none. *Reticulation:* none. *Surface:* pruinose in ours, in other regions tomentose-punctate, tomentose-scaly, or perhaps finally more or less glabrous; color deep lemon yellow (10L2), changing to blue where bruised. *Interior:* solid; color deep lemon yellow (10L2), changing to deep blue immediately when cut or broken. *Length:* to 5 cm. in ours, reaching 13 cm. elsewhere. *Diameter:* 0.6–3.5 cm. SPORES—*Color in mass:* dark umber brown. *Shape:* fusiform-elliptical. *Color under microscope:* yellow. *Dimensions:* 10–17×4–6μ, rarely 21×7–8μ, mostly 12–14×5–5.5μ. CYSTIDIA—Numerous at the mouths, often caespitose. *Shape:* ventricose-clavate, fusiform-rostrate to subulate, often granular at the apex. *Color under microscope:* pale yellow to perhaps golden yellow. *Dimensions:* 40–77×5–15μ.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* firm specimens dry very well, the surface characters being little altered, but old, larvae-infested specimens shrink badly and may become almost black. Color of pilei usually becomes somewhat lighter, while the bright yellow tubes and stipes turn almost the same color as the pilei. *Color of pileus, tube surface, and stipe:* an olivaceous khaki (14K7), light brownish khaki (13K7) in cracks, to brownish olive drab (15L7). No trace of blue remains on dried specimens.

DISTINGUISHING CHARACTERISTICS.—This species shows the most spectacular color change of all boletes collected in the region. The bright lemon yellow of tubes and stipe changes almost immediately to deep blue where bruised in handling. It is difficult to determine the color of the interior accurately, since the change to blue occurs so rapidly following cutting or breaking. When making spore casts the tube surface stains white paper blue at points of contact, and if the stipe is immersed in water during the process, the blue leaches out, coloring the water. There is only one species among those described here with which it might be confused; 16. *X.* sp. also showing, in some individuals, a rapid change to blue, but its stipe is red, the pileus is never rimose-diffract, as are almost all specimens of *X.* ? *pulverulentus* collected in the region, but merely rimose-areolate.

Color of the pileus also differs, the latter being more olivaceous or greenish khaki, and closely tomentose. These two species occur in the same association, but there should be little difficulty distinguishing them.

HABITAT NOTES. This species is not common, and has been observed only in *Thuja Tsuga* associations which included few, scattered *Pinus monticola*. There is little doubt that *Tsuga* is the typical associate. Its best development, on the site from which three of our four collections were taken, was on a northeast-facing slope, at an elevation of 4250 feet, in an association dominated by *Tsuga* over 200 years old. Specimens were found in disturbed humus on the roadside, none being seen under the trees away from the road. The occurrence of specimens of this species only where the litter accumulation had been removed and the mineral soil disturbed to a depth of perhaps half a meter indicates the possibility that such disturbance may influence production of fruiting bodies. Several species of boletes commonly occur on such a substratum. Collections of this species have been made from the same spot both in spring and fall of the same year. Perhaps the best development is in early fall in a normal season.

MYCORRHIZAE. No record found.

EDIBILITY. Kallenbach (1926 37) states that he was not harmed by eating *X. pulverulentus*, but since specimens in this region are not strictly typical of the species as it is commonly known, it is perhaps advisable to avoid eating it, or at least to employ extreme caution in testing it.

COLLECTIONS. U. of Idaho For. Path. Herb. *2430*, *2551*, *2583*, *2616* (Idaho).

16. XEROCOMUS sp.

Plate 5, fig. C; and Plate 8, fig. D.

HABIT. Usually gregarious, often caespitose. PILEUS *Shape:* convex. *Diameter:* 8 10 cm. *Surface:* glabrous, rimose-areolate, occasionally approaching rimose diffract, dry; color dark olive brown (15L9), the cracks lighter to dingy yellowish brown (12I5), reddish, or rose colored in some specimens. *Flesh:* firm; color lemon yellow (10K3) to pale yellowish buff (10H3), with a reddish zone beneath cuticle; color changes to deep blue almost immediately when cut or broken, making it difficult to determine the original color; taste sharply acid, or none; odor slightly acrid, or none. *Tubes:* adnexed; color bright mustard yellow (11L3) to olivaceous yellow (12L3), changing rapidly to blue where bruised; mouths irregular, 1 1.5 mm. diameter. STIPE *Shape:* subequal. *Annulus:* none. *Reticulation:* at extreme apex only, from decurrent tube dissepiments; also a false reticulation at the base of the stipe in some individuals, consisting of a network of color, described below. *Surface:* subpruinose to pruinose, dry; color lemon yellow (10K3) at apex, dark red at base, becoming lighter toward apex, fading gradually into the yellow; the false reticulation at the base, when present, consisting of an open network of the dark red coloration, through which the yellow color of the cortex shows. *Interior:* solid; color lemon yellow (10K3) to light golden yellow (10K5) at top, a reddish zone of varying width beneath the surface, sometimes reddish at base; color changes to deep blue immediately when cut or broken, rare individuals show no change, or the blue color appears more slowly. *Length:* 5–10 cm. *Diameter:* 1 1.5 cm. SPORES *Color in mass:* dark umber to slightly olivaceous brown. *Shape:* elliptical, to subfusiform. *Color under microscope:* pale olivaceous. *Dimensions:* (40 only) 12–15×5–6μ, mostly 13–14×5.5μ. CYSTIDIA—None observed. BASIDIA—*Shape:* subglobose, to pyriform, somewhat encrusted. *Dimensions:* (10 only) 15–20×9–15μ.

REMARKS.—Although this is probably an undescribed species, adequate description must await further collections and critical study.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* moderate, the surface characters being well preserved. Color becomes slightly lighter in firm specimens, darker in old, soft specimens. The red color of the stipe disappears in many specimens, but may be detected at the base in some cases on careful examination. The tube surfaces darken seriously, approaching the color of the top of the pilei, or often darker. *Color of pileus:* slightly olivaceous brown (15H9), brownish olive drab to dark olive brown (15L7 to 15L9), the cracks lighter to buff, some individuals with deep, wide cracks appearing much lighter. Rarely suffused with faint red in indefinite areas, either in the cracks only, or generally over the surface. Old, soft specimens become blackish. *Color of tube surface:* an olivaceous khaki (approximately 14L7) to dark mouse gray (16C2). *Color of stipe:* approximately suntan khaki (13L7), dull brownish khaki (14J7), or perhaps dark clove brown (16A7).

DISTINGUISHING CHARACTERISTICS.—Superficially this species looks like a rimose variant of *X. Zelleri*, but its stipe is considerably more slender, and the flesh changes to blue much more rapidly when cut or broken. It is also generally smaller. Darkening of the tubes seen in the sectioned pileus in Plate 5, figure C, is caused by the change to deep blue following cutting.

HABITAT NOTES. This species has been collected both in the *Thuja-Tsuga* and *Picea-Abies* zones in this region. The associations in which it occurred in the *Thuja-Tsuga* zone included all the tree species characterizing the zone, but *Abies grandis* was the only tree common to all three communities. The fourth collection was found in the subalpine *Picea-Abies* climax association at an elevation of 5500 feet, in close association with *Abies lasiocarpa*. In each of the four collections species of *Abies* occurred close by, and there is little doubt that these trees are the typical associates. Collections have been made between the last of August and the third week in October. It has not been found in the spring. The specimens were growing in humus and mineral soil, and all were found on roadside banks where there had been moderate disturbance of the substratum between 1 and 5 years prior to date of collection.

MYCORRHIZAE. No attempt made to demonstrate mycorrhizal relationship with the typical associates.

EDIBILITY. Not demonstrated.

COLLECTIONS. U. of Idaho For. Path. Herb. *2615*, *3157*, *3212*, *3000* (Idaho).

17. XEROCOMUS sp.

Plate 8, fig. E.

HABIT. Solitary. PILEUS *Shape:* convex. *Diameter:* 9 cm. *Surface:* moist, subpruinose; color rose, beneath a yellowish bloom which may be rubbed off. *Flesh:* firm; color ochre yellow, changing to blue near tubes when cut; taste and odor mild, not distinctive. *Tubes:* adnexed; color ochre yellow, changing to blue where bruised; mouths rounded, 0.5 1 mm. diameter. STIPE *Shape:* subequal. *Annulus:* none. *Reticulation:* none. *Surface:* subpruinose; color ochre yellow, with pronounced red areas. *Interior:* solid; color yellow, no color change recorded, but a change to blue is probable. *Length:* 7 cm. *Diameter:* 2 cm. SPORES *Color in mass:* no spore cast obtained. *Shape:* subfusiform, to fusiform-elliptical. *Color under microscope:* pale olivaceous. *Dimensions:* (32 only) 13 17×4.5 6μ, mostly 15 16×5 5.5μ. CYSTIDIA Rare. *Shape:* clavate, or somewhat strangulated. *Color under microscope:* brownish. *Dimensions:* (7 only) 35 50×4 10μ, mostly 40 45×6μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* severe, the pileus shrinking and twisting badly, the tube mouths closing completely. This single specimen became extremely hard when dried, in contrast to the fragility of most species. *Color of pileus:* a reddish brown (7L9), with irregular yellowish areas. *Color of tube surface:* brownish black. *Color of stipe:* yellowish tan (12K7) in a small area, the remainder of the surface black.

REMARKS. Although this description covers but a single specimen, it appears probable that it is an undescribed species. Another large collection was carried off by squirrels while being dried in the sun, and the species has not been encountered again. Adequate description must await collection of additional material.

DISTINGUISHING CHARACTERISTICS. This is one of two roseate-ochraceous species collected in the region, the other being *Boletinus ochraceoroseus*. Since the latter is a *Boletinus*, with the tubes in rows radiating outward from the stipe, it is readily distinguished from this species. Also, the

PLATE 5. Figure A. *Xerocomus Zelleri* (Murrill) Snell, UIFP *2614*. B. *Xerocomus subtomentosus* (L. ex Fries) Quélet, UIFP *3300*. C. *Xerocomus* sp. (No. 16), UIFP *3157*.

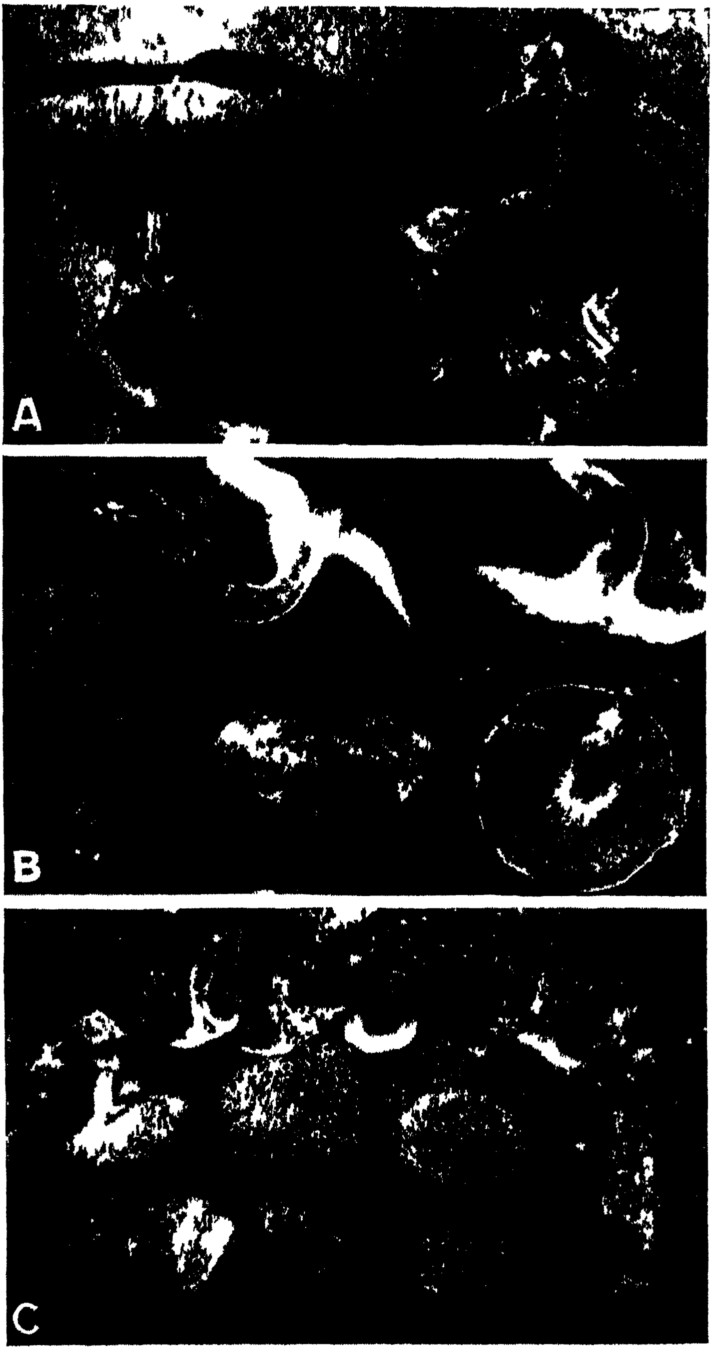

PLATE 5 (*See opposite page for explanation.*)

surface of the pileus of this species is smooth and subpruinose, compared to the roughly fibrillose-scaly surface of *Bol. ochraceoroseus*.

HABITAT NOTES. Both collections occurred in climax *Thuja-Tsuga* associations, in proximity to both *Thuja* and *Tsuga*. The collections were made in the spring, no specimens being observed in the fall.

MYCORRHIZAE. Not demonstrated.

EDIBILITY. Not demonstrated.

COLLECTIONS. U. of Idaho For. Path. Herb. *2429* (Idaho).

II. Stipe truly reticulate from apex to below center, excluding those reticulate only at apex above an annulus; or if not, then tube mouths red, or tubes stuffed when young.

BOLETUS Dillenius ex Fries

Fruiting body rather stout and robust; tubes simple; stipe stout and more or less bulbous, especially at first; spores subfusiform.

1. Tubes and mouths of the same color 2
Tubes and mouths differently colored, mouths some shade of red. (None collected in the region.) . . . . Section LURIDI
2. Tubes free or adnate; if the latter, then stuffed when young . . . Section EDULES 3
Tubes adnate, not stuffed when young. . . . . Section CALOPODES 4
3. Tubes white at first, then greenish yellow; pileus khaki, glabrous; stipe light yellow brown; color of flesh unchanging . . . . 18. *B. edulis*
Tubes lemon yellow to greenish yellow; pileus brown, slightly olivaceous, subtomentose; stipe lemon yellow, turning brown where bruised; color of flesh changing to blue where cut or broken, taste bitter. . . . . 19. *B. fragrans*
4. Pileus dark chocolate brown, tomentose to fibrillose scaly; stipe brownish red to dark crimson, bulbous. . . . . 20. *B. mirabilis*
Pileus buff to sand brown, closely canescent, deeply rimose diffract, at least in part; tubes very short, mouths very small; a large species. . . . . 21. *B. frustosus*

18. BOLETUS EDULIS Buillard ex Fries

Plate 8, fig. F.

SELECTED ICONES. Peck (1897, pl. 36; 1898, pl. 54; 1900, pl. 65); Atkinson (1903, pl. 55, fig. 2; pl. 56, fig. 164; pl. 57, fig. 165); Clements (1910, fig. 54); Hard (1908, figs. 280, 290); Gibson (1895, pl. 20); Bresadola (1931, pl. 923); Michael-Schulz (1927, pl. 93); Macku (1925, fig. 132); Jacottet (1925, pl. 61).

HABIT. Solitary, or gregarious. PILEUS *Shape:* convex, or nearly plane. *Diameter:* 7–22 cm. *Surface:* moist, viscid at times, sometimes very slimy when wet, glabrous; color variable, khaki, grayish red, brownish red, tawny brown, or pale ochraceous, often paler on the margin. *Flesh:* at first firm and compact, later sometimes soft; color white, or yellowish white, perhaps pinkish occasionally, may be reddish under the cuticle and next the tubes; taste sweet and nutty; odor not distinctive, strongly fungous, or nutty. *Tubes:* adnexed to nearly free; color white when young, later yellow with a greenish tinge, becoming more or less ochraceous where bruised; mouths nearly circular, small to minute. STIPE—*Shape:* subequal, or bulbous, straight, or flexuous, stout. *Annulus:* none. *Reticulation:* more or less whitish-reticulate almost full length, but especially above, sometimes becoming almost rugose toward base. *Surface:* glabrous, pruinose, or possibly white-tomentose at very base; color whitish pallid, light yellowish, to light brownish. *Interior:* solid; color pure white to reddish, or more or less streaked reddish. *Length:* 5–22 cm. *Diameter:* 1.2–3.6 cm., to 5.5 cm. at base. SPORES—*Color in mass:* deep olivaceous brown, becoming deep ochraceous brown. *Shape:* fusiform-elliptical. *Color under microscope:* pale olivaceous. *Dimensions:* $12–18 \times 4–6\mu$, mostly $14–16 \times 5\mu$. CYSTIDIA—Not abundant. *Shape:* ventricose-subulate to ventricose-rostrate. *Color under microscope:* hyaline. *Dimensions:* $50–60 \times 7–10\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* the single collection shrank severely, losing over 75% in volume. The pilei wrinkled badly, but reticulation on the stipe remained clearly visible over the apical one-third of its length. The pilei lightened considerably in color, but the stipe darkened to a light yellowish brown. No color references were determined.

DISTINGUISHING CHARACTERISTICS.—The flesh of this species shows no color change on cutting, but in *B. fragrans*, the only species collected with which it can be confused, the flesh changes to blue. The stipe is prominently reticulate to the ground line in this collection, the pileus khaki; tube surface white.

HABITAT NOTES.—This species was collected in a climax *Thuja-Tsuga* association. On the basis of a single collection, no conclusion could be reached regarding the typical associate, although it is reported in the east under *Tsuga* and hardwood mixtures. Other western reports indicate that it is also associated with firs (*Abies* spp. ?) and *Picea*. The collection was made in mid-August.

MYCORRHIZAE.- Reported forming mycorrhizae on *Larix* in Sweden (Rayner, 1927). Its ability as a mycorrhizae-former on *Betula* was demonstrated experimentally by Melin (1923b).

EDIBILITY.—*B. edulis* is one of the best of all edible fungi. Highly prized by European mycophagists, it was known to the Romans.

COLLECTIONS.—U. of Idaho For. Path. Herb. 3206 (Wash.).

19. BOLETUS FRAGRANS Vittadini

Plate 8, fig. G.

SELECTED ICONES.—Bresadola (1931, pl. 926); Soc. Myc. Fr. (1931, Atlas plate 45).

HABIT.—Often caespitose. PILEUS—*Shape:* convex. *Diameter:* 3–10 cm. *Surface:* dry, subtomentose, then glabrescent, finally rimose-areolate;

color a deep, bright brown, perhaps olivaceous brown, pallid brown, or even bronze. *Flesh:* firm, very thick; color yellow, or yellowish white, or perhaps whitish, usually changing to blue when cut, but perhaps unchanging; taste at first bitter, then pleasant; odor fragrant, or not distinctive. *Tubes:* adnate and depressed, or almost free; color lemon yellow, then cinereous-olivaceous, changing to blue on injury; mouths small, 0.25–0.33 mm. diameter, rotund to sinuate. STIPE *Shape:* stout, short, ventricose, usually tapering at the base, later extending, even. *Annulus:* none. *Reticulation:* almost full length, conspicuous in our collection, but usually regarded as not reticulate, or only very slightly so. *Surface:* glabrous above, slightly viscid, tomentose to pubescent at base only; color lemon yellow above, below yellow tinged reddish, pinkish, olivaceous, or brownish, the base quite brown, sometimes more pallid all over, the lighter colors changing to rosy where bruised. *Interior:* solid; color like flesh of pileus, perhaps more yellowish at base, often with a reddish line of demarcation between flesh of stipe and that of pileus, changing to blue when cut. *Length:* 4–8 cm. *Diameter:* 2.5–5 cm. at base. SPORES *Shape:* subfusiform. *Color under microscope:* pale yellow to pale olive. *Dimensions:* 10–15×4.5–5.5μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* severe, the pileus of this single specimen shrinking and wrinkling badly. Despite shrinkage, surface texture, and even color, were well preserved. Color of the tube surface turned grayish brown. The stipe wrinkled extensively and turned dark brown with black areas, the reticulation being completely lost. No color references were determined for this single collection.

DISTINGUISHING CHARACTERISTICS. Likely to be confused only with *B. edulis*, this species has a bitter taste when young, yellow tubes turning blue where bruised, as does the flesh when cut, while *B. edulis* has a pleasant taste, or at least not bitter, white or greenish white tubes which do not turn blue, and the flesh does not turn blue.

HABITAT NOTES. The single collection of this species was found in a closely subclimax association of *Thuja-Tsuga*. It was growing in the duff layer at the immediate base of a small *Tsuga* and was collected in early August.

MYCORRHIZAE. No record found.

EDIBILITY. Reported edible by European authorities.

COLLECTIONS. U. of Idaho For. Path. Herb. *2516* (Idaho).

20. BOLETUS MIRABILIS Murrill

Ceriomyces mirabilis Murrill

Plate 6, figs. A and B; and Plate 8, fig. H.

SELECTED ICONES. Overholts (1940, figs. 13, 14). The only plate published of this species. Not typical of collections from this region.

HABIT.—Usually solitary, may be gregarious, or rarely caespitose. PILEUS—*Shape:* convex, very rarely upturned. *Margin:* often partially appendiculate with a sterile, incurved flap, 1–3 mm. wide, which is yellow on the extreme edge and underneath, in the young plant connecting with the outer layer of the stipe. *Diameter:* 5–16 cm. *Surface:* dry, sometimes moist, closely tomentose to fibrillose-scaly on parts of the pileus, resembling rather coarse, suede-type leather, the fibrillose scales often in the form of projecting, conic, floccose to fibrillose points about the center of the pileus; color dark reddish chocolate brown (8J3), occasionally somewhat lighter, particularly when old. *Flesh:* firm; color reddish brown, darkest under cuticle, paler toward stipe, may be lemon yellow when young, slowly changing to incarnate, or perhaps more reddish when cut or bruised; taste mild, not distinctive; odor slightly acid. *Tubes:* adnexed, often narrowly depressed, very long; color bright sulphur yellow (9K1), dulling with age to pale mustard yellow (11L2), no color change immediately upon injury, but bruised areas turn deep mustard yellow after some hours; mouths subcircular to irregularly angular, 0.75—1 mm. diameter. STIPE—*Shape:* tapering upward strongly, subbulbous to bulbous, usually stout and often abruptly narrowed at base. *Annulus:* none. *Reticulation:* near apex, shallowly lacunate to rugose to base, the depressions vertically elongated and perhaps to be considered downward extension of reticulation. *Surface:* glabrous, with a silvery hoariness, particularly toward base, which has been considered remnants of a universal veil; color reddish brown to dull garnet red (7L8 to 7J5), or maroon, silvery pink in the lacunate depressions, giving the stipe a striking appearance, the extreme base sometimes white. *Interior:* solid; color white, golden yellow at base, becoming more or less reddish in age. *Length:* 12–20 cm. *Diameter:* 1–3.5 cm. at apex, 4–8 cm. at base. SPORES—*Color in mass:* olive brown. *Shape:* ventricose-subfusiform. *Color under microscope:* wall with a reddish tinge, contents deep olivaceous yellow. *Dimensions:* 14 24×6.5 9μ, mostly 21–24μ long. CYSTIDIA—Usually fairly abundant, sometimes scarce. *Shape:* ventricose-rostrate, the apex obtuse. *Color under microscope:* hyaline. *Dimensions:* 50–90×8–24μ.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* Murril (1912, p. 98) states "it is one of the most difficult species to preserve, owing to its extremely juicy consistency." Although shrinking perhaps 65% in volume, these specimens dried perhaps the best of all species of the family collected. Surface characters are excellently preserved, except for the stipes, which wrinkled until the shallow depressions were lost. Color of the pilei changed but little, the tubes darkened somewhat, but less so than in most species. Color of stipes showed the greatest change, some becoming lighter, others darker. *Color of pileus:* vandyke brown (7A11), to chocolate brown (8H10). *Color of tube surface:* golden olivaceous yellow (12L6) to dark olivaceous yellow (13L6), usually dulled by the chocolate brown of the tube walls, which show through the wide tube mouths. *Color of stipe:* light suntan khaki (13J7) with narrow reddish or brown streaks, dull brown (8E1) with black streaks to almost black.

DISTINGUISHING CHARACTERISTICS. This chocolate brown species, with the feel and appearance of soft, rather coarse, suede type leather, is unique in the region. The stipe, in all but rare specimens, tapers upward strongly from a somewhat bulbous base, the apex frequently measuring less than one fifth the diameter of the base. No other species found exhibits such extreme taper in the stipe. The most beautiful bolete in the region. The upturned margin of the specimen pictured in Plate 6, figure B, is somewhat unusual.

HABITAT NOTES. *Boletus mirabilis* has been observed only in climax *Thuja Tsuga* associations. It is almost impossible to conclude whether *Thuja* or *Tsuga* is the typical associate, since climax stands in this region usually exhibit such uniform intermixtures that all specimens observed were near trees of both species. All but rare individuals were growing in windfalls which were in a condition of advanced decay, as the specimen shown in Plate 6, figure A. Such windfalls were usually more than half buried in the litter accumulation, the wood being extremely friable and usually having tree,or other plant roots growing through it. In several instances such roots were found immediately adjacent to the mass of white mycelium at the base of the stipes. No effort was made to trace these roots or to identify them. This is the only bolete collected growing primarily in wood. It has not been observed in the spring, but is common in many climax forest areas in the fall, after the forest floor becomes saturated by fall rains. One collection was made on July 28. Optimum development is usually between late September and early November. Apparently a favorite food of rodents, the fruiting bodies are frequently partly eaten and none are left long enough to become decayed.

MYCORRHIZAE. No record found.

EDIBILITY. No record found.

COLLECTIONS. U. of Idaho For. Path. Herb. *2033, 3158* (Wash.). The species was also observed on the Priest River Experimental Forest in Idaho.

21. BOLETUS FRUSTOSUS Snell and Dick

Plate 8, fig. J.

SELECTED ICONES. None published.

HABIT. Gregarious. PILEUS *Shape:* convex. *Diameter:* 7 25 cm. *Surface:* dry, scarcely subtomentose, or closely canescent, deeply rimose-diffract, broken into large frusta, or rarely only rimose-areolate; color yellowish buff to honey-colored (12J6), or grayish brown. *Flesh:* firm to solid; color whitish, whitish yellow, or pale sand brown, unchanging; taste very bitter; odor somewhat soapy. *Tubes:* adnate, separating; very short; color yellow to greenish yellow, or dull sand brown, readily changing to blue where bruised, drying with a more or less reddish cast; mouths yellow, almost circular, very small to medium, 0.1–1.5 mm., usually 0.1–0.5 mm. diameter. STIPE—*Shape:* very thick, subcylindric, or ventricose, usually with a fusiform base. *Annulus:* none. *Reticulation:* most of length, the reticulations fine, subrotund. *Surface:* dry, pruinose-furfuraceous, to almost subtomentose above, often punctate-furfuraceous, glabrescent below, often fibrillosely cracked; color yellowish buff to honey-colored (12J6), tinged red at the apex, cracks yellow where present. *Interior:* solid; color whitish to whitish yellow, red at the base, tinged red throughout, changing to blue only in the center. *Length:* 3–13 cm. *Diameter:* 4–9 cm. SPORES—*Color in mass:* ochraceous brown. *Shape:* subfusiform, mostly narrowed at the distal end, to almost pointed. *Color under microscope:* pale greenish yellow. *Dimensions:* $11–15\times4–5.5\mu$, very rarely $16\times6\mu$ or longer, mostly $13–14\times4.5–5\mu$. CYSTIDIA—Single on the walls, or clustered at the mouths. *Shape:* clavate, fusiform, or ventricose-rostrate. *Color under microscope:* hyaline, or colored. *Dimensions:* $25–35\times8–12\mu$.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* this species dries very hard, not fragile, with moderate shrinkage and little surface distortion. Texture and the rimose-diffract character of the pileus are perfectly preserved. Color changes little in many specimens, but in others, notably those which were old or larva-infested when collected, certain areas turn dark brown. Stipes are not seriously distorted, the surface characters being fairly well preserved. *Color of pileus:* dull buff, or honey-colored (12J6), or slightly lighter, often with blackish brown areas. *Color of tube surface:* light suntan khaki (13J7) to a dull umber brown (15E10). *Color of stipe:* like pileus.

DISTINGUISHING CHARACTERISTICS. *B. frustosus* is a large species, buff, or light sand brown in color, with the pileus surface commonly deeply rimose-diffract, broken into large, subpyramidal frusta. Flesh of the pileus has an extremely bitter taste in contrast to the mild taste of *Xerocomus subtomentosus*, the only species in this region likely to be confused with it. The tube mouths are abnormally small for such a large species, seldom exceeding 0.5 mm.

HABITAT NOTES.—The single collection of this species was made by R. T. Bingham on Sands Creek, Coeur d'Alene National Forest, Kootenai County, Idaho, late in July. The specimens occurred in a climax stand of *Tsuga heterophylla* over 200 years old. This site is about 75 miles south of the region in which the study was conducted, but still well within the inland extension of the *Thuja-Tsuga* zone. Here, however, the climax association rarely includes *Thuja*.

MYCORRHIZAE. Not demonstrated.

EDIBILITY. Not demonstrated.

COLLECTIONS. U. of Idaho For. Path. Herb. *3150* (Idaho).

III. Stipe scabrous, or at least squamulose, tapering; tubes white, at least at first, not stuffed when young; spores more or less broadly fusiform elliptical.

LECCINUM S. F. Gray

Tubes white, at least at first, free, or adnate, stuffed when young if the latter; stipe more or less slender and scabrous, tapering upwards; spores more or less broadly fusiform.

1\. Color of stipe surface changing to blue where bruised, at least at base; pileus yellowish orange, orange yellow, or somewhat reddish brown, glabrous, viscid . . . 22 *L. versipelle*
Color of stipe surface unchanging where bruised, or at least not changing to blue; pileus variable, warm brownish chamois to dull walnut brown, or grayish brown, glabrous, dry . . . . 23 *L. scabrum*

22. **Leccinum versipelle** (Fries *apud* Hök) Snell, comb. nov.

Boletus versipellis Fries *apud* Hök[7]

Plate 8, fig. K.

SELECTED ICONES. Peck (1897, pl. 34); Michael-Schulz (1927, pl. 94); Bresadola (1931, pl. 935, as *B. rufus*); Hard (1908, fig. 295); Macku (1925, fig. 125); Konrad and Maublanc (1924 37, pl. 408); Clements (1910, fig. 55).

HABIT. Solitary. PILEUS *Shape:* convex. *Margin:* appendiculate with the projecting cuticle. *Diameter:* 4 21 cm. *Surface:* usually dry, subviscid when moist, at first compactly and minutely tomentose, then fibrillose squamulose to fibrillose, occasionally fibrillose-granulose, or rarely glabrous; color mostly dull orange yellow, but also grayish brown to ochraceous brown, or even somewhat orange, our single collection slightly reddish brown. *Flesh:* very firm to somewhat soft; color white or whitish, then more or less roseate, becoming more or less violaceous roseate and then

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[7] It is perhaps advisable to note that the specific epithet here employed for this species is not widely accepted. It has been called *Boletus rufescens* Secretan, and *Krombholzia floccopoda* (Rostk.) Gilbert. There is a distinct possibility that it may prove to be *Leccinum aurantiacum* (Bull. ex Roques) S. F. Gray (=*B. rufus* Schaeffer ex Fries), in which case *L. aurantiacum* would have priority.

PLATE 6. Figure A. *Boletus mirabilis* Murrill, UIFP *2633*. B. *Boletus mirabilis* Murrill. C. *Leccinum scabrum* (Bulliard ex Fries) S. F. Gray, UIFP *3250*.

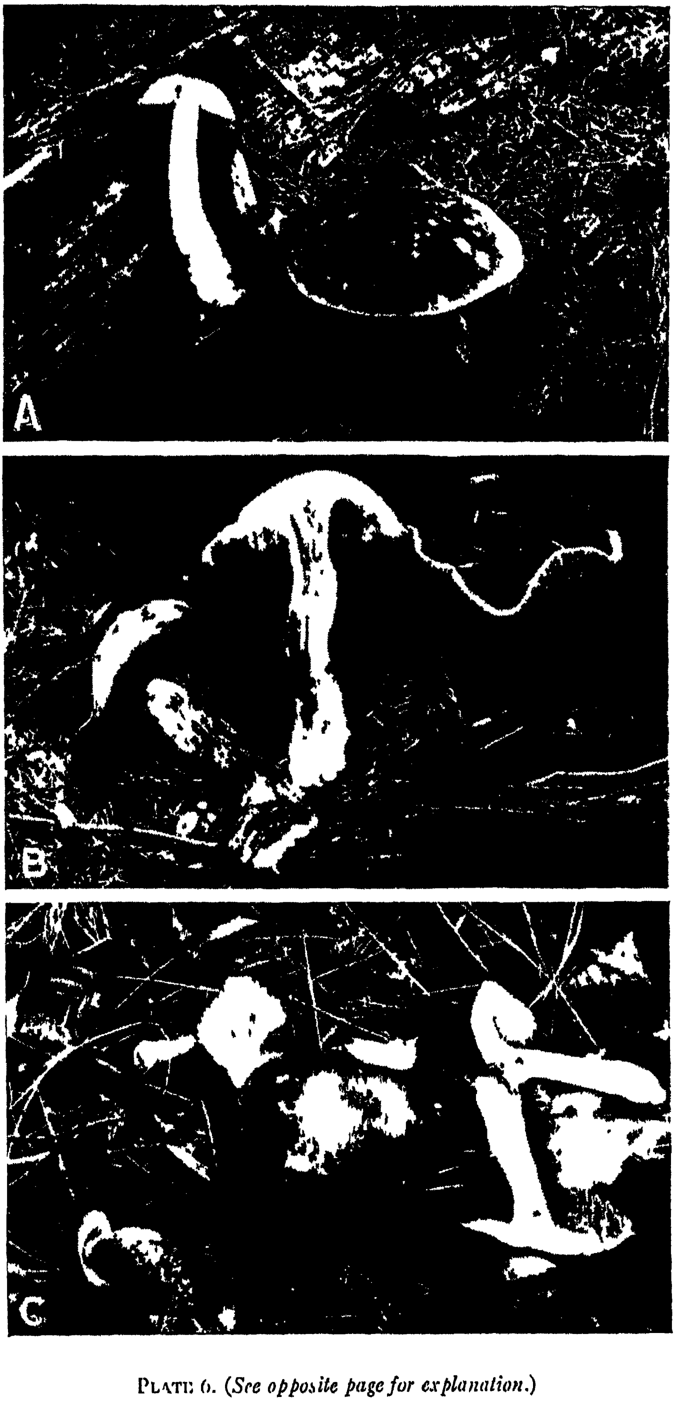

PLATE 6. (*See opposite page for explanation.*)

gray or blue at edges when cut or bruised; taste and odor mild, not distinctive. *Tubes:* adnate, adnexed, becoming free or nearly so, depressed-concave, or plane; very long; color dirty white to gray; mouths rotund to irregularly circular, small, to 0.75 mm. diameter. STIPE *Shape:* slender, more or less bulbous, tapering upward. *Annulus:* none. *Reticulation:* none, or more or less pseudo reticulate or rugose reticulate. *Surface:* somewhat viscid when wet, scabrous to squamulose, fairly densely so toward apex, or more or less rugose to sulcate from splitting of the cortex; color dirty white, the projections or squamules brown or brownish cinereous below, variously stained, changing to greenish blue at base when bruised. *Interior:* solid; color white to dingy, becoming more or less roseate to violaceous-roseate at base, often more or less yellow, becoming lightly tinged or spotted with blue or green at base when bruised, or perhaps changing to greenish blue at edges only. *Length:* 5 20 cm. *Diameter:* 1 5 cm. SPORES *Color in mass:* snuff brown. *Shape:* narrowly elliptic fusiform to quite fusiform. *Color under microscope:* pale greenish or olivaceous. *Dimensions:* 11 17×3.5 5μ, mostly 14×4 4.5 or possibly 5μ. CYSTIDIA Rare to abundant. *Shape:* fusiform-ventricose, fusiform-clavate, apiculate, or ventricose-rostrate with long beaks, and all intergradations in form. *Color under microscope:* hyaline. *Dimensions:* 35 50×7 10μ.

CHARACTERISTICS OF DRIED SPECIMENS. *Shrinkage and distortion:* moderate. Pileus of the single specimen shrank approximately 40%, the surface wrinkled somewhat, but not seriously. Color darkened, but relatively little. The stipe shrank considerably in diameter, little in length. Its color changed to pale yellow at the base and dirty brown above. The scabrous nature of the stipe remained conspicuous. No color references were determined for this single collection.

DISTINGUISHING CHARACTERISTICS. This species closely resembles *L. scabrum*, but its appendiculate margin serves to distinguish it from that species in most cases. It is also predominantly yellow orange or orange yellow, although sometimes brown or white. *L. scabrum* never shows the orange colors, and only rarely is at all yellowish. The flesh of the stipe and pileus usually changes to greenish blue when cut or broken, in spotty, restricted areas, as does the outside of the stipe where bruised. *L. scabrum* shows no color change.

HABITAT NOTES.- *L. versipelle* is reported occurring in association with species of *Populus* in other regions. Unfortunately, no record was made of the association in which this single collection was found. It was collected on August 31.

MYCORRHIZAE. No record found.

EDIBILITY.--Peck (1889) reports *L. versipelle* edible, "but scarcely to be commended."

COLLECTIONS. -U. of Idaho For. Path. Herb. *3227* (Idaho).

23. LECCINUM SCABRUM (Bulliard ex Fries) S. F. Gray

Boletus scaber Bulliard ex Fries

Plate 6, fig. C; and Plate 8, fig. L.

SELECTED ICONES.—Peck (1897, pl. 35); Michael-Schulz (1927, pl. 95); Hard (1908, fig. 282); Gibson (1895, pl. 21); Bresadola (1931, pl. 936); Murrill (1909, pl. 1, fig. 5); Marshall (1905, pl. 46, p. 108); Güssow and Odell (1927, pl. 96); Murrill (1916, fig. 2); Migula (1925, pl. 42D); Jaccottet (1925, pl. 63); Macku (1925, fig. 123).

HABIT.—Solitary to gregarious. PILEUS—*Shape:* convex, hemispherical, or even subconical. *Margin:* not appendiculate with an overhanging cuticle. *Diameter:* 5–21 cm. *Surface:* glabrous, to sparsely and minutely fibrillose, slightly to very viscid when moist, often completely dry, at length perhaps rugulose or rivulose, sometimes rimose-areolate, particularly where exposed to full sun; color extremely variable, from warm brownish chamois (11H5) to dark sepia brown (8A10), or grayish walnut brown (8E7), in other regions reported possibly whitish, or very rarely even yellowish. *Flesh:* firm; color white, hardly changing when young, when older becoming grayish on exposure to the air, or perhaps pinkish, or violaceous brownish in places; taste mild; odor not distinctive. *Tubes:* adnexed to almost free, depressed; very long; color dull white to chamois (11J5), becoming flesh color or blackish where bruised, brownish with age; mouths rotund to slightly irregular, 0.4–2 mm., usually 0.4–1 mm. diameter. STIPE—*Shape:* tapering upward, often sharply so, subbulbous. *Annulus:* none. *Reticulation:* none. *Surface:* fibrillose-scaly, or more commonly scabrous, more or less costate or pseudo-reticulate, at least toward base, dry; color dirty white to ivory, the scales gray, or brown. *Interior:* solid, tough, and very fibrous; color white, becoming grayish, sometimes changing to a definite dull rose when cut or broken, or may show no color change, often greenish at base. *Length:* 5–15 cm. *Diameter:* 2–5 cm. at base. SPORES—*Color in mass:* coffee brown, or snuff brown. *Shape:* fusiform-elliptical. *Color under microscope:* olivaceous brown. *Dimensions:* 13–21×4–7μ, occasionally to 35×9μ, mostly 16–18×4–6μ. CYSTIDIA—Lacking, or rare. *Shape:* clavate, to ventricose-rostrate. *Color under microscope:* hyaline. *Dimensions:* 25–60×7–10μ.

A single aborted specimen, with tube surface extending down the stipe to the ground, forming an almost cylindrical fruiting body (UIFP *3263*), was found in 1941. The tube mouths were large, to 2.0 mm., extremely irregular, the openings frequently compound and of a dark sand brown color. The pileus was light umber brown. This specimen was old and had begun to putrefy, the colors being undoubtedly considerably degraded.

CHARACTERISTICS OF DRIED SPECIMENS.—*Shrinkage and distortion:* moderate, the surface usually wrinkling considerably less than in most species. The pilei, however, often become somewhat contorted. The scabrous nature of the stipe surface is usually well preserved. *Color of pileus:*

shades of dull buff (approx. 12H6) to dark brown (16C10). *Color of tube surface:* dark coffee brown (8H12) to darker, blackish brown. *Color of stipe:* shades of dull buff and light grayish brown (12F5 to 14H8) to light coffee brown (15A11).

DISTINGUISHING CHARACTERISTICS. *Leccinum scabrum* is an extremely variable species, the most constant character being its scabrous, white stipe. *L. versipelle* has a closely similar stipe, but its surface usually turns to greenish blue where bruised, in spotty, restricted areas, as does flesh of both stipe and pileus. The former shows no color change on the stipe surface, or at most turns somewhat darker. Margin of the pileus is not appendiculate in *L. scabrum*.

HABITAT NOTES. The four collections of this species were made in 21–40 year associations consisting of a mixture of most of the seral tree species occurring in the *Thuja-Tsuga* zone. The typical associate is *Betula*, as in other regions. One collection was made in early July, but the best development occurs in September and early October in a normal season.

MYCORRHIZAE. Peyronel (1922) believes that this species may change form according to the tree species with which it occurs in mycorrhizal association, the forms differing in size of pileus, color, and diameter of the stipe. It has been reported forming mycorrhizae on *Betula alba* in Sweden and Russia (Rayner, 1927), *Corylus avellana* and *Quercus robur* in Italy (Peyronel, 1922), and *Populus tremula* in Italy (Peyronel, 1922) and Sweden (Melin, 1923b). There is reason to believe that the fungus forming mycorrhizae on the latter species is not a form of *L. scabrum*, as Peyronel believes possible, but is a distinct species, *Boletus rufus* Schaeffer ex Fries [*B. aurantiacus* Bulliard ex Rocques, or *Leccinum aurantiacum* (Bulliard ex Rocques) S. F. Gray, according to Snell's (1941, 1942) conception of the genera]. Mycorrhizae were formed experimentally by *L. scabrum* on *Pinus caribaea* and *P. taeda* in Australia (Young, 1940).

EDIBILITY. Several authorities agree that the species is edible.

COLLECTIONS. U. of Idaho For. Path. Herb. *3153*, *3250*, *3203*, *3304* (Idaho).

PLATES 7 and 8. Spore photomicrographs, showing portions of fields photographed through a Whipple eyepiece micrometer. Each of the five small graduations along the upper left margin of each figure measures approximately 5.2µ. All figures 910X.

PLATE 7. Figure A. *Boletinus cavipes* (Opatowski) Kalchbrenner. UIFP *2584*. B. *Boletinus amabilis* (Peck) Snell. UIFP *3045*. C. *Boletinus ochraceoroseus* Snell. UIFP *3085*. D. *Boletinus ? appendiculatus* Peck. UIFP *3080*. E. *Suillus hirtellus* (Peck) Snell, var. *mutans* Peck *apud* Snell. UIFP *3252*. F. *Suillus aeruginascens* (Secretan) Snell. UIFP *3047*. G. *Suillus elegans* (Fries) Snell. UIFP *3084*. H. *Suillus ? subaureus* (Peck) Snell. UIFP *3261*. J. *Suillus granulatus* (L. ex Fries) Snell. UIFP *2570*. K. *Suillus subluteus* (Peck) Snell. UIFP *2572*. L. *Suillus luteus* (L. ex Fries) Snell. UIFP *3050*. M. *Suillus americanus* (Peck) Snell. UIFP *2578*.

PLATE 8. Figure A. *Xerocomus Zelleri* (Murrill) Snell. UIFP *2614*. B. *Xerocomus subtomentosus* (L. ex Fries) Quélet. UIFP *3663*. C. *Xerocomus ? pulverulentus* (Opatowski) Gilbert. UIFP *2583*. D. *Xerocomus* sp. (No. 16). UIFP *2615*. E. *Xerocomus* sp. (No. 17). UIFP *2420*. F. *Boletus edulis* Bulliard ex Fries. UIFP *3206*. G. *Boletus fragrans* Vittadini. UIFP *2546*. H. *Boletus mirabilis* Murrill. UIFP *2033*. J. *Boletus frustosus* Snell and Dick. UIFP *3150*. K. *Leccinum versipelle* (Fries *apud* Hök) Snell. UIFP *3227*. L. *Leccinum scabrum* (Bulliard ex Fries) S. F. Gray. UIFP *3250*.

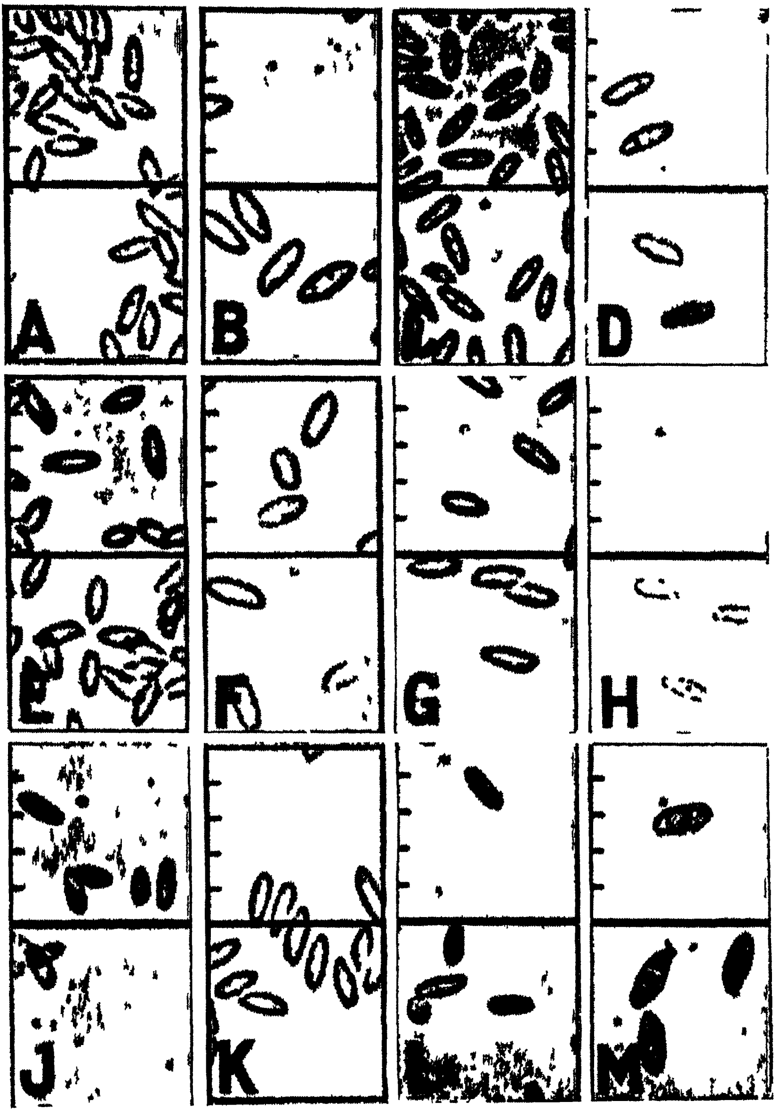

PLATE 7 (*See opposite page for explanation*)

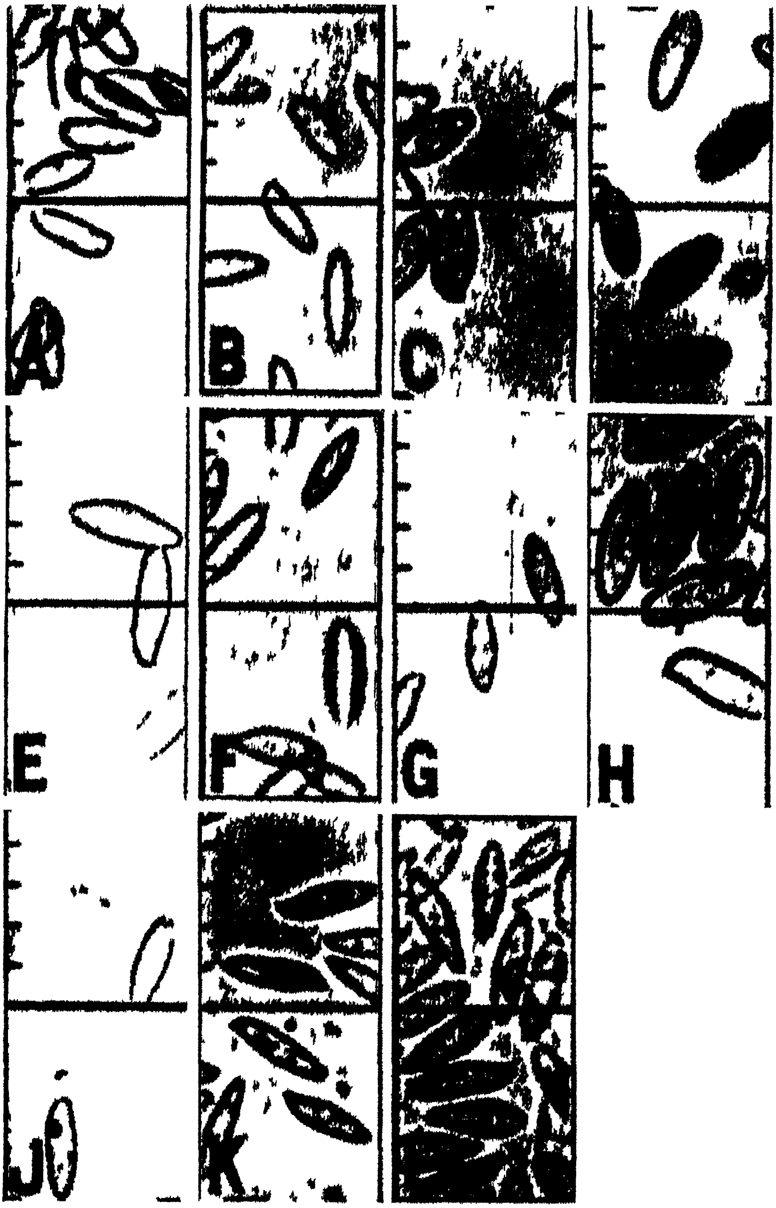

PLATE 5. (*See page 62 for explanation.*)

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New or Noteworthy Tropical Fungi. III

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Pseudovalsa tropicalis Wehmeyer, sp. nov.

Figs. 1–3

Stromatibus corticolis tectis, dein erumpentibus, angularibus, nigro-brunneis vel nigris, 1–2 mm. diam., peridermatibus circumdatis; ostiolis cylindraceo-conicis, interdum recurvatis; peritheciis dispersis, saepe polystichis in stromatibus; ascis cylindraceis, parietibus crassis, 200—250×27–32μ; paraphysibus latis taeniformibus, fugaceis; sporidiis monostichis, latis elliptico-fusoideis, hyalinis, didymis, dein obscure 5–7-septatis, media parte constrictis, 55–62×19–22μ. Status conidiophorus *Corynei* sp. sistit; conidiis in superficie stromatum, elliptico-fusoideis vel cylindraceo-fusoideis, atro-brunneis, 6–11-septatis, 45–135×18–22μ.

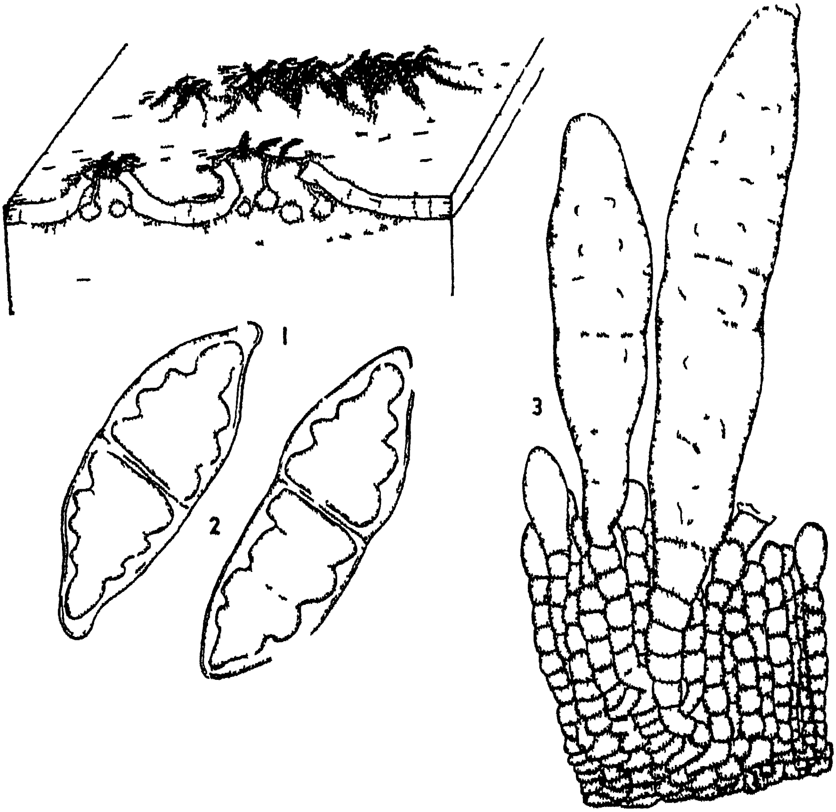
Appearing on the surface as scattered to longitudinally seriate, angular, erumpent, black-brown to black, roughened, stromatic discs, 1–2 mm. in diameter, with a collar of adherent periderm; ostioles cylindric-conic, with a tapered apex, sometimes slightly elongate, often recurved, scattered over the surface of the disc; stromata gray-black, sharp-margined, pulvinate, originating in the upper bark cortex and erumpent through the thick periderm as the widely erumpent discs, composed of brown-walled fungous pseudoparenchyma; perithecia 600–800×400–500μ, irregularly scattered, often polystichous, immersed in the stroma, with long narrow emergent necks; asci cylindric-clavate, thick-walled, 200–250×27–32μ; paraphyses, apparently, broad, band-like, evanescent; spores obliquely uniseriate, broad fusoid-ellipsoid, hyaline, with a definite central septum and 4–6 secondary septa consisting of a mere division of the protoplast or fine extensions of the thickened gelatinous inner layer of the outer wall, hence eventually 6–8-celled, usually constricted at the central septum, with an irregularly thickened inner wall layer, 55–62×19–22μ.

Conidial stage a *Coryneum*. Conidia borne on the surface of the perithecial stromata as terminal developments of the chains of parenchymatoid cells of the stroma; fusoid-ellipsoid to cylindric-fusoid, somewhat tapered toward the basal stalk cell and the more blunt apical cell, which is often lighter in color; dark brown, 7–12-celled, not constricted at the septa, 45–135×18–22μ.

Panamá: Prov. Chiriquí. Valley of upper Rio Chiriquí Viejo, 1600–1800 m., July 3, 1935, G. W. M. 2416, Type. On bark of large prostrate trunk.

This species has the characteristic well-defined, sharp-margined stroma, with no sharp distinctions between ecto- and ento-stroma, of the genus

Pseudovalsa. The spores are of the same type as in *P. lanciformis* and *P. umbonata* but are of a more primitive aspect, remaining hyaline and having thickened inner walls and poorly developed septa in the two primary cells. The necks are also more elongate than in the two species mentioned.



FIGS. 1–3. *Pseudovalsa* [illegible]. 1, Radial and surface view of perithecial stroma, enlarged. 2, Ascospores ×750. 3, Detail of surface of conidial stroma showing conidia and their attachment ×750. Drawn by Dr. L. E. Wehmeyer.

SEBACINA MUCEDINEA Pat.

Fig. 4

Originally described from Ecuador (Bull. Herb. Boiss. 3: 60. 1895) on the basis of a collection by Lagerheim, this species seems not to have been recorded since. To it I refer, with some reservation, two collections from Panama. One, C. W. Dodge, 3928, August 3, 1925, is from Barro Colorado Island on dead cane of bamboo. The other, G. W. M. 2018, was collected in Balboa at the foot of Ancon Hill on a decorticate branch, in June, 1935.

Patouillard's diagnosis is reproduced with slight change in the Sylloge Fungorum 14: 214, where the species is referred to *Thelephora*. The distinctive characters are the thin, almost arid fructification, the pallid color and pruinose surface and the curved, cylindrical spores produced on cruciate-septate basidia. Patouillard notes that the species is close to *S. Letendreana* Pat., which Bourdot and Galzin (Hymén. France 45. 1928) regard as a form of *S. calcea*. Through the kindness of Dr. D. H. Linder, I have been permitted to examine the type of *S. mucedinea*, now in the Farlow Herbarium. It is very scanty, consisting of a few fragments of a

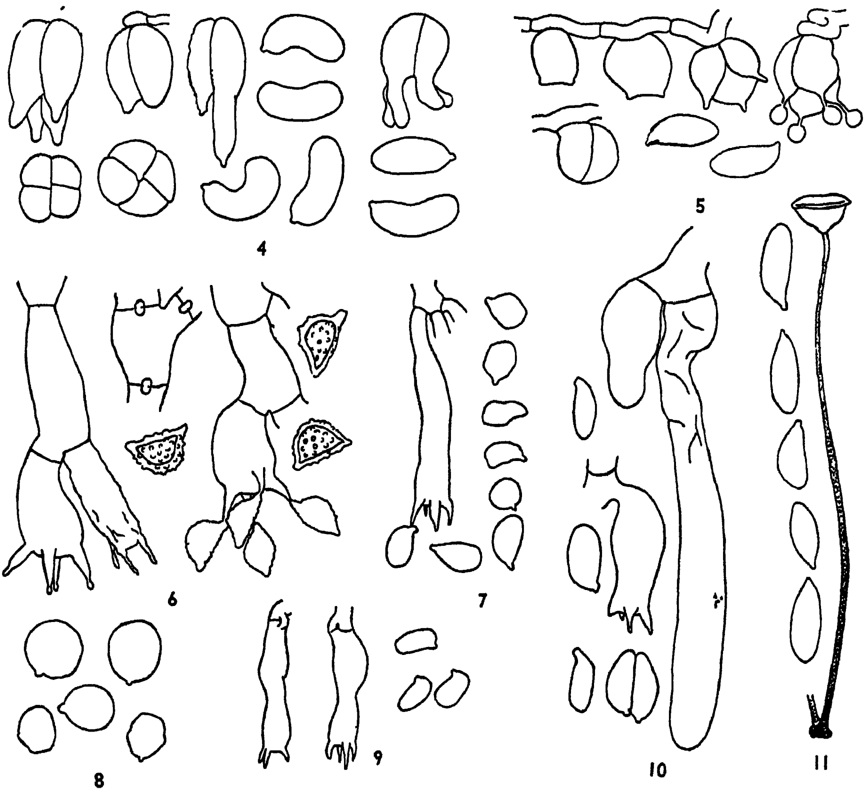


FIG. 4. *Sebacina mucedinea.* The basidium and two spores at the right are from G. W. M. 2018; the others are from C. W. Dodge 3928, ×1000. FIG. 5. *Sebacina obscura.* Basidia and spores, showing characteristic truncate appearance of probasidia. Type, ×1000. FIG. 6. *Pellicularia biapiculata.* Basidia, hyphal segment with plugged septa and basidiospores. Type. ×833. FIG. 7. *Stereum cyphelloides.* Basidium, two smooth and five rough spores, ×1000. FIG. 8. *Stereum radicans.* Three smooth and two rough spores, ×1000. FIG. 9. *Peniophora gemmea.* Basidia and basidiospores. Type, ×833. FIG. 10. *Pellicularia digitata.* Basidium, basidiospores and cystidium. Type, ×833. FIG. 11. *Cymatella longipes.* Type. Habit, ×4; basidiospores, ×1000. Figures 6, 9 and 10 are based on camera lucida drawings by Mrs. D. P. Rogers.

decayed twig on which the *Sebacina* appears in the form of dingy white to pale pinkish arachnoid patches, in some places thicker and then more pruinose. The hyphae bear obscure clamp connections. The spore size given in the original description is 10×5μ. The few spores seen in the two mounts I ventured to make were somewhat longer and narrower, 10.5–11.2×3.5–4.2μ. Dr. Rogers, who has also examined the type, found some as large as 13×5μ. The two collections from the Canal Zone agree essentially in all respects except that neither shows any dense, pruinose areas. The Barro Colorado collection is rather conspicuous against its dark, polished substratum. The Balboa collection is much more tenuous and scarcely visible. The differences between the three collections are all such as may be regarded as within the limits of variation to be expected in a single species of this genus.

Sebacina obscura sp. nov.

Fig. 5

Effusa, indeterminata, tenuissima, arachnoidea, subinvisibilis; basidiis primum globosis, dein truncatis, sessilibus, 8μ diam., demum cruciato septatis; epibasidiis nullis; basidiosporis elliptico fusoideis, 9–10×4μ.

Broadly effused, indeterminate, very thin, appearing as a faint, whitish arachnoid growth on substratum, beneath which a grayish gelatinous film appears when soaked; basidia globose, sessile on repent hyphae, becoming cruciate-septate and then appearing truncate at apex; epibasidia lacking, each basidial segment producing a short, slender sterigma directly, upon which a basidiospore is produced; basidiospores elliptical fusoid, somewhat curved, 9–10×4μ; germination not seen.

PANAMÁ: Canal Zone. Summit, July 19, 1935. G. W. M. 2873, Type. On dead leaf stalk of date palm still attached to living plant. In herb. Univ. Iowa; portion in herb. Missouri Bot. Gard.

Although this species is inconspicuous, it was readily seen with the naked eye and tentatively assigned to *Sebacina* after examination with a hand lens. It lacks cystidia, hence belongs in the section *Eusebacina* as defined by McGuire (Lloydia 4: 11. 1941) although the basidia suggest those of certain species of the section *Bourdotia*, especially *S. Grandinioides* and *S. Eyrei*, but there is no evidence of the erect hyphae bearing clusters of basidia at the tip subtended by the bract-like remnants of discharged basidia so typical of those species. On the contrary, the basidia are broadly sessile on repent hyphae. The curious truncate aspect of the developing probasidia in lateral view and the subfusiform spores are characteristic. It is quite probable that the lack of an epibasidium in this species, as in the arid Bourdotias, is a reflection of the lack of a gelatinous layer interposed between the body of the basidium and the air in which the basidiospore must be formed.

TJIBODASIA BRUNNEA Martin

This species was based on a Brazilian collection sent to me by the Rev. J. Rick. In the description (Lloydia 4: 262. 1941) the color, based upon the soaked specimen, was given as brown and this suggested the specific name assigned. In a letter written since its publication, Father Rick informs me that when fresh the hymenium is white. Holtermann (Mykol. Unters. aus den Tropen 44. 1898) describes *T. Pezizoides*, the type and only other species of the genus, as yellowish red when fresh. The difference in color furnishes an additional reason for regarding the species from Brazil as distinct from the Javanese species. It is unfortunate, however, that the specific name assigned should be misleading so far as the appearance of the living fungus is concerned.

Pellicularia biapiculata Rogers, sp. nov.

Fig. 6

Fructificatio hypochnoidea, alutacea, sub lente minute manipularis; hyphae plerumque breviter articulatae, rectangule vel pseudodichotome ramosae, enodulosae, (4.5-) 7- 10 (12.5)μ diam.; basidia obovato-clavata, 14 17×10 10.5μ, sterigmata 4 subuliformia, 5.5--7μ longa, gerentia; sporae biapiculatae, corpore centrali ellipsoideo, 10–11.5×6.5–7μ, tunica incrassata, verruculis minutis ornata, haud per repetitionem germinantes.

Fructification hypochnoid, between Pinkish Buff and Cream Buff (R), under the binocular coarsely tufted; hyphae mostly short-celled, branching at right angles, or pseudodichotomous, without clamps (4.5–) 7–10 (12.5)μ in diameter, with a hyaline plug in the septal pore, the basal sometimes long-celled, slightly thick-walled, yellowish; basidia obovate-clavate, 14 17×10- 10.5μ, bearing 4 subulate sterigmata 5.5–7μ long; spores biapiculate, with a short-ellipsoid central body, tapering abruptly to the laterally borne truncate true apiculus and more gradually to the obtuse false apiculus, 10 11.5×6.5–7μ, the wall minutely tuberculate, strongly refractive, moderately or greatly thickened (–1.5 or even 2μ), not germinating by repetition.

BRAZIL: Estado do São Paulo. São Leopoldo, December, 1939. Rev. J. Rick, Type. In herb. Univ. Iowa *1555*.

In appearance of the fructification to the naked eye and under the binocular, and in all microscopic characters but the spore-wall, *P. biapiculata* closely resembles certain forms of *P. flavescens* (Bon.) Rogers. The sterigmata are somewhat smaller than those usually shown by *P. flavescens* but not smaller than those of some specimens of the latter fungus (compare the figures here given with those in Univ. Iowa Stud. Nat. Hist. **17**, pl. II, fig. 8). The spores of *P. biapiculata* do not germinate by repetition, while those of *P. flavescens* commonly do. The chief differences, however, which seem sufficient to make necessary the separation, are the great thickening of the spore-wall in *P. biapiculata* and its minutely warted surface.

In the key to the genus *Pellicularia* published in Farlowia 1: 97, 98, the present species would be sought under dichotomy no. 3, where it may be inserted as a third choice:

"3 Spores biapiculate	**biapiculata.**"

Pellicularia digitata Rogers, sp. nov.

Fig 10

Fructificatio tenuis, pruinosa, pallide cremea, sub lente farinoso-arachnoidea, setulis minutis ornata; hyphae breviter articulatae, rectangule ramosae, enodosae, 6 11μ diam.; cystidia tenuiter tunicata, laevia, hyalina, plerumque aseptata, subcylindracea vel digitiformia (spathulata), obtusa, 60 105×10 12μ; basidia ad basim ventricosa, parte superiore subcylindracea, 17 22×9 10.5μ, sterigmata 4 parva, 2.5μ longa, gerentia; sporae ellipsoideo-fusiformes vel naviculiformes, 10.5 11.5×4 5.5μ, laeves, hyalinae.

Fructification pruinose, lighter than Ivory Yellow (R), under the binocular delicately farinose-arachnoid, set with minute hyaline setulae; hyphae short-celled, branching at right angles and with abundant cruciform cells, without clamps, 6 11μ in diameter, the basal strands longer-celled and with walls somewhat thickened; cystidia thin-walled, even, subcylindric, digitiform, or spathulate, rarely once-septate, 60 105×10 12μ; basidia borne in fairly regular cymes, at first stout-obovate, at maturity with ventricose base and narrowed subcylindric apical portion, 17 22×9 10.5μ, bearing 4 small curved sterigmata (2.5μ in length); spores long-ellipsoid-subfusoid to navicular, obtuse at the apex, with a thick truncate apiculus at the base, colorless and even-walled, 10.5 11.5×4 5.5μ.

PANAMÁ: Prov. Chiriquí. Valley of upper Rio Chiriquí Viejo, 1600 1800 m., Aug. 3, 1935. G. W. M. 2387, Type. On completely charred wood. In herb. Univ. Iowa.

Pellicularia digitata resembles *P. ansosa* Jackson & Rogers, from which it differs most obviously in complete lack of clamps, and also in the often spathulate cystidia, the larger spores, the basidia invariably strongly ventricose, and the possession of four rather than six sterigmata. In the key to *Pellicularia* published in Farlowia the present species may be distinguished by an alteration in the choices provided under no. 7:

"7. Cystidia thick-walled, etc.	**6. ochroleuca**
7. Cystidia thin-walled, etc.	**7. bis**
7 bis. Hyphae with clamps .	**7. ansosa**
7 bis. Hyphae without clamps .	**digitata**"

Peniophora gemmea Rogers, sp. nov.

Fig 9

Fructificatio tenuis, pallide lilaceo- vel ochraceo-grisea, sub lente subtiliter medullosa, minutissime guttifera; hyphae zygodesmatibus praeditae, 2.5 5μ diam.; cystidia tenuiter tunicata, longe emergentia, obtusa, subulata, 70–90×2μ, ad basim ventricosa, ad 4μ diam.; basidia ventricosa, 15–20×5.5-6μ, sterigmata 4 recta gerentia; sporae oblongae, lateraliter apiculatae, 6-8.5×4.5μ.

Fructification thin, separable in small bits, when dry pruinose-crustose, under the binocular minutely reticulate-poroid (with the appearance of fine-grained bread), dotted with very small droplets of amber-colored resin, in color between Pale Vinaceous Fawn and Tilleul Buff (R); hyphae loose, distinct, 2.5–5μ in diameter, with clamps throughout; cystidia very slender, obtuse-subulate, thin-walled, long-emergent, 70–90μ long, about 2μ in diameter, somewhat ventricose at the base and there up to 4μ in diameter, borne among the basidia; basidia at first obovate, then short-clavate, at maturity with a ventricose base 5.5–6μ in diameter abruptly narrowed to a subcylindric or narrowly clavate apical portion 4μ in diameter, the whole 15-20μ long, bearing 4 slender straight sterigmata 4–4.5μ long; spores oblong, obtuse at both ends, somewhat drawn out to the truncate, distinctly lateral apiculus, 6–8.5×4.5μ.

COLOMBIA: Dept. Magdalena. Cerro Quemado trail above Hacienda Cincinnati, 1500–2300 m., Sierra Nevada de Santa Marta, Aug. 24, 1935. G. W. M. 3698, Type. In herb. Univ. Iowa.

The present species is a member of *Peniophora* sect. *Gloeocystidiales* Bourd. & Galz., and of a group of species, characterized not only by thin-walled, gloeocystidioid cystidia but also by the presence of resin-dots in the hymenium, which may for the present be considered a subsection of that section. This group includes *Peniophora argillacea* (Bres.) Sacc. & Syd., *P. fusca* Burt, *P. mediburiensis* Burt, *P. montana* Burt, *Corticium pallidum* Bres., and *Gloeocystidium macedonicum* Litsch. From all of these species *P. gemmea* differs in the extremely slender cystidia and the relatively minute oblong spores. In the key to *Peniophora* in the Hyménomycètes de France the present species would fall in dichotomy no. 74 (p. 277), where it would be distinguished by "Spores oblong; hyphae 2.5–5μ."

TROPICAL STIPITATE STEREUMS

The stipitate Stereums are predominantly tropical and warm temperate fungi. The numerous species established by earlier mycologists, such as Fries, Montagne, Léveillé, Berkeley and Cooke, were based almost entirely upon external characters. These were compiled by Massee (Jour. Linn.

Soc. Bot. **27:** 158–177. 1890) but little was added to the original descriptions. Lloyd (Myc. Writ. **4.** Stipitate Stereums 15–44. 1913) also stresses external characters, but gives excellent photographic illustrations of numerous species and suggestive comments on synonymy; Burt (Ann. Missouri Bot. Gard. **7:** 81–116. 1920: **13:** 325–326. 1926) brought a high degree of order into the group by paying careful attention to hymenial structures and spore size, and while his main divisions continue to be based on habit, the impression given by his work is that related species have, for the most part, been grouped together. The separation between central-stemmed and lateral-stemmed species appears to be unduly stressed and the size and shape of gloeocystidia are less reliable than would seem to be suggested, although the presence or absence of these structures appears to be significant.

Burt lists seven species of stipitate Stereums with gloeocystidia: *Ravenelii*, *surinamense*, *pergamenum*, *elegans*, *cristatum*, *decolorans* and *aculeatum*. To these should be added *S. tomentipes* Overholts (Myc. Expl. Venezuela 308. 1934). I have collections which I refer to the first four species and submit the following comments on them and on certain of the non-cystidiate species in the hope that they may serve to clarify our knowledge of the group.

STEREUM RAVENELII Berk. & Curt.

Originally described from South Carolina, Burt (l.c. 7: 90) lists additional collections from Alabama, Louisiana, Mexico, the West Indies and Brazil. As Burt notes, the species is close to *S. pergamenum*. He states that it is constantly infundibuliform, with a slender and more conspicuous stem than that species and that it grows from the soil rather than on dead wood. The microscopic characters are not significantly different. The differences do not seem very convincing. I have, however, a single, fairly ample collection (G. W. M. 2056) growing in peaty soil on the Llanos del Volcán, Chiriquí, which seems clearly distinct from the specimens referred to *pergamenum* not only in its habitat and slender stem, but in its brighter and thinner pileus. Most of the fructifications are infundibuliform, but a few are flabellate. Burt gives the size of the spores as 3–4×2.5–3µ. I find them distinctly larger, 5–6×3.5–4µ, in this respect very close to *pergamenum*.

STEREUM SURINAMENSE Lév.

Burt (l.c. 7: 91), upon whose excellent description I base the reference of my specimens to this species, gives the range as the West Indies, Honduras and Dutch Guiana. Lloyd (l.c. 26) says it is common in the tropics and illustrates a very large specimen from Samoa. It may be recognized by its thin, usually infundibuliform pileus, abundant gloeocystidia and small, broadly oval spores, 3–4×2–3µ. It appears to be one of the commonest species on Barro Colorado Island, represented by eight collections. I also have a collection from the Canal Zone, east of Arraiján, and refer here a collection from Nicaragua by C. L. Smith. Burt keys it out as a species which is always infundibuliform as contrasted with those that may sometimes be lateral-stemmed. As in the case of *S. Ravenelii*, this is not quite accurate, as occasional pilei may be nearly or quite flabellate and in one small collection, consisting of two pilei, both are bilabiate, the two lips extended horizontally as in a scrophulariaceous blossom, the hymenium being on the lower side of each lip, hence the hymenium of the upper lip is borne on the morphological surface which is customarily sterile.

STEREUM PERGAMENUM Berk. & Curt.

The distribution of this species is, according to Burt (l.c. 7: 101), "Ohio and North Carolina to Mexico and in the West Indies." Burt suggests that the name may be a synonym of the previously published *S. nitidulum* Berk., and Overholts (Sci. Surv. P. R. 8(1): 154. 1926), in reporting it from Puerto Rico, uses the latter name, noting that the species occurs in Brazil, Ceylon and Australia. Lloyd (l.c. 25, 27) illustrates both species, which he treats as distinct, although with no reference to microscopic characters. Burt keys it among those forms which may be either infundibuliform or lateral-stemmed. I have nine collections from the Sierra Nevada de Santa Marta of Colombia which I refer to this species. There is rather a wide range of variation, not only between different collections but between pilei from the same collection, but the differences are in such characters as size, central or lateral attachment of stipe, color and length and hairiness of stem, with practically complete gradation throughout. Some collections were growing directly on wood, others on soil, presumably from buried wood. All have smooth, oval, conspicuously guttulate spores, 4.5 5.5×3- 4μ and all have gloeocystidia. There is a gradation in length and staining capacity of the gloeocystidia from younger to older parts of the hymenium, but this is true of all gloeocystidiate species I have studied. The hymenium of the older fructifications is denser and more strongly agglutinated than that of the younger. Some of the specimens would fit the description of *S. tomentipes* Overholts (Myc. Expl. Venezuela 308. 1934), but the characters which Overholts stresses are precisely those which appear to vary within wide extremes in this species, as in *P. surinamense*. In view of the gradation noted and the general satisfactory agreement with Burt's description of *S. pergamenum*, it seems wise to assign them, with the others, to the older species. Two specimens collected by C. L. Smith in Nicaragua appear to belong here.

STEREUM ELEGANS (Meyer ex Fries) Lloyd

Originally described from what is now British Guiana, Lloyd (l.c. 24) speaks of *S. elegans* as "widespread in the tropics of both hemispheres."

Burt (l.c. **7:** 105) gives the range as Puerto Rico to British Guiana, although he refers to the type, incorrectly, as from Dutch Guiana. Cleland (Fung. S. Austr. 251. 1935) notes its occurrence in South Australia, Victoria, New South Wales and Queensland. Both Lloyd and Burt note the fact that various other Stereums have from time to time been referred incorrectly to *S. elegans.* Burt's concept of the species, fortified by the original description, which he quotes, calls for densely caespitose, brown, azonate, more or less petaloid pilei concrescent above, with an ashy, plicate hymenium containing gloeocystidia. The spores he describes as hyaline, even, subglobose, 3.5–4.5μ in diameter. I have a single, but very abundant collection from the Sierra Nevada de Santa Marta (G. W. M. 3574) which is clearly referable to this species. Two or three hundred of the bright tan pilei with pale hymenial surfaces were growing from buried wood in a dense cluster, the stems distinct, but the upper portions grown together in tufts of varying size and degrees of complexity. Very few could be described as infundibuliform. Burt says the gloeocystidia are barely distinguishable. They are perhaps somewhat less conspicuous than in the other species, nevertheless they are clearly apparent in thin sections stained in Phloxine and even more so when such sections are slightly crushed. The hyphae bear rather conspicuous clamp-connections, which I have failed to observe in the other species studied. Copious spore prints were secured; spores from these were broadly oval, 5–5.5×3–3.5μ. A collection from Hainan, China (S. Q. Deng 4442), distributed by S. C. Teng as this species, has broadly oval or nearly subglobose spores, those which appear to be mature being about 5×4μ. I believe it is correctly determined. Cleland (l.c.) describes the spores as "subspherical, smooth, hyaline, 5–6×3.5–4μ."

STEREUM CYPHELLOIDES Berk. & Curt.

Fig. 7

Originally described from Cuba (Jour. Linn. Soc. Bot. **10:** 331. 1868), Burt (Ann. Missouri Bot. Gard. **7:** 112. 1920) lists an additional collection from Puerto Rico. In his key to species, Burt distinguishes *S. Cyphelloides* from *S. pusiolum,* in part, by saying that the former grows on wood, the latter on the ground. The original description says: "on the ground amongst moss." Massee (Jour. Linn. Soc. Bot. **27:** 172. 1890) adds little to the original description, but describes the spores as globose, 4μ in diameter. Burt describes them as hyaline, even and 4–5×3–3.5μ. He emphasizes the soft, bibulous texture of the pileus and the absence of cystidia or gloeocystidia, and gives the thickness of the pileus as up to 600μ.

What I am convinced is this species was extremely common in 1935 in the Sierra Nevada de Santa Marta of Colombia. It is represented by four collections (G. W. M. 3203, 3229, 3402, 3526) but many more could have been made. All were growing directly from the soil of steeply inclined, sandy banks, some almost bare, others more or less covered with mosses, liverworts and lichens. The tiny spathulate pilei, up to 12 mm. long and 10 mm. wide, but mostly smaller, were pure white when collected but are now pinkish buff (R) on both surfaces. The larger pilei are up to 1000μ thick just above the base, gradually thinning to 150μ at the margin. The hyphae are slender, gelatinized and without clamp-connections and the basidia are long-clavate and 4-sterigmate, 26–28×4–5μ excluding sterigmata. The spores are very curious. They are colorless, at first oval or pip-shaped, 5–6×3–3.5μ, essentially as Burt describes them, but by far the larger number seen are curiously angled and distorted and their dimenmensions are then altered so that many are 7μ long and proportionately thinner, while others are angularly globose.

Because of their pure white color and despite their small size, the pilei are strikingly conspicuous against the background of dark earth in which they grow. While travelling by truck from El Volcán to Concepcion in Chiriquí, Panamá, in July, 1935, I saw a steep earth bank bearing hundreds of pilei of what must have been this species. As the road was well-nigh impassable and an imminent tropical deluge threatened to make it completely so, it was not possible to stop for a collection, but the observation suggests that the species may be common in the tropics.

STEREUM HYDROPHORUM Berk.

This is a rather large species characterized by a deep funnel-shaped, velvety pileus and usually a relatively long stem. Burt (l.c. 7: 89) gives its range as Venezuela, British Guiana and Brazil and adds "it may possibly occur also in the West Indies or Central America." A single collection from Barro Colorado Island (G. W. M. 3089) seems to belong here. The stem is very short, being almost entirely replaced by a conical tomentose pad, and the colors are somewhat paler and brighter than those given by Burt, but the large, leathery pileus, the hymenium lacking noteworthy structures other than basidia, and the small globose or subglobose spores 3–3.5μ in diameter seem to be ample warrant for the reference.

STEREUM RADICANS (Berk.) Burt

Fig 8

The original description, as quoted by Burt (l.c. 7: 108), gives little that is distinctive other than the statement that the stem gives off strongly branched roots at the base. Burt did not see the type but based his concept of the species upon a collection from Cuba by Wright which had been determined by Berkeley, and included with it five other specimens from the West Indies and British Honduras. From Burt's discussion, as from his illustrations, it may be inferred that the radicating base is not a constant character, stress being placed upon the raised lines upon the upper side of the thick pileus, the variable color, the lack of cystidia and gloeocystidia and the spores, at first globose, then angular. I have three collections which I refer to this species, one from Barro Colorado Island, one from the Province of Panamá and one from the Sierra Nevada de Santa Marta. All were growing on wood and none shows a radicating base, but in other respects they fit Burt's description very satisfactorily. The two collections from Panamá show only the roughened or angular spores, but a good spore print was secured from the Colombian collection, the spores from the print being smooth, nearly globose and about 6–7μ in diameter, somewhat larger than the dimensions 6×5μ given by Burt. Angular spores were present to a slight extent in the spore print and abundant on the hymenium of this specimen. All three collections approach *Cladoderris*.

STEREUM HARTMANNI (Mont.) Lloyd

The distinctive characters of this species are the greatly incised tips and margins with hymenium-bearing teeth on the edges and often on the lower surface. Originally reported from "Carolina" it has, according to Lloyd, never again been collected in the southern United States. Lloyd (l.c. 34) gives its range as the West Indies; Burt (l.c. 7: 112) adds Bolivia. What is either this species or a closely related and apparently undescribed species is represented by a collection made by Dr. R. E. Woodson, Jr., south of Las Cruces, Canal Zone, August 5, 1937. The pilei are now tan with pallid hymenium and white stipes and may well have been white or whitish when collected. The spores are subglobose, 4.5×3.5μ, which accords perfectly with the dimensions given by Burt, and the hymenium contains neither cystidia nor gloeocystidia. This is scarcely a *Stereum* in the usual sense, since the "teeth" stressed by Burt occur not only on the margin but abundantly rather than rarely on the hymenial surface. In places they are elongate and radial, suggesting portions of gills; elsewhere they anastomose, forming incomplete pores. There is no suitable genus to receive such a fungus, but *Stereum* may be stretched to accommodate it for the present.

CLAVARIA MUCIDA Pers. ex Fries

In commenting on collections of this species from Panamá and Colombia (Lilloa 5: 191. 1940) I stated that the basidiocarps were pendent. This was based on misinterpretation of a note on the packet of one of the collections, aided by a faulty memory. In my field notes, made at the time of collection, both collections are recorded as growing erect exactly as does *Calocera*.

CLAVARIA AURANTIO-CINNABARINA Schw.

Through the kindness of Professor H. H. Whetzel I have been permitted to examine the portion of the collection from Venezuela reported by Overholts (in Chardon and Toro, Mycol. Expl. Venez. 306. 1934) and entered in the Cornell collection as Fungi of Venezuela 824. This specimen shows the same curious geniculate basidia which I described and illustrated in reporting the species from Barro Colorado Island (Lilloa **5**: 195. 1940, fig. 5).

Cymatella longipes sp. nov.

Fig 11

Fructificatio marasmioides; pileo subinfundibuliformi, subgelatinoso, albo, 1–2 mm. lato; stipite filiformi, glabro, 16 mm. longo, superne albo, inde abrupte flavo-brunneo et paulatim ad basim nigro; hymenio inferiore, glabro; basidiis clavatis, 30–35 × 7μ; basidiosporis sublacrimaeformibus apiculatis, 9–11 × 4μ.

Fructifications marasmioid, solitary or in small clusters of two or three, pileate and stipitate, arising from a small basal pad; total height 14–18 mm.; pileus cupulate to broadly funnel-shaped, subgelatinous, 1–2 mm. broad and slightly less in depth, pure white when fresh, drying translucent yellow-brown and horny; upper surface sterile; hymenium on lower surface, smooth, without cystidia; stipe slender, hairlike, up to 16 mm. long and 150 185μ in diameter, pure white just below pileus then abruptly yellow-brown, shading to nearly black at glabrous, pulvinate base; basidia simple, slender, clavate, 4-spored, 30–35 × 7μ; basidiospores sublacrimate, apiculate, 9–11 × 4μ.

COLOMBIA: Sierra Nevada de Santa Marta, 1250–1500 m. Aug. 17, 1935. G. W. M. 3469, Type. On bark of fallen branch.

The genus *Cymatella* was established by Patouillard (Bull. Soc. Myc. Fr. **15**: 193. 1899). It was based on a collection from Guadeloupe, *C. minima* Pat., to which were added by transfer *Craterellus Marasmioides* B. & C. and *C. pulverulentus* B. & C., both from Cuba. Patouillard describes the cap as without a pellicle, contrasting it in this respect with *Skepperia*, in which the upper surface is pelliculose, composed of swollen, cystidium-like cells which may also occur as a delicate pubescence on the stipe. He emphasizes the resemblance of *Cymatella* to *Marasmius* and suggests that its species are essentially species of *Marasmius* without gills. He states emphatically that they have nothing in common with *Cantharellus* nor should they be regarded as teratological forms of *Marasmius*.

In the species under discussion, there are vesicular cells on the upper surface of the pileus, particularly at the center. In no other respect, however, does it suggest *Skepperia*. The stipe is slender, very long in proportion to the pileus, and, both when wet and dry, the resemblance to *Marasmius* is striking.

Höhnel (Sitzungsb. K. Akad. Wiss. Wien, Math.-Nat. Kl. Abt. 1., **119**: 887. 1910) points out that *Cymatella* and *Discocyphella* P. Henn. (Monsunia

1: 43. 1899)* are synonyms, published practically simultaneously. He selects *Cymatella* as preferable, since it is more clearly described and is based on a better understanding of the relationships of the fungus, and transfers Hennings' two species to *Cymatella*. He suggests that both *Gloiocephala* Massee (Grevillea 21: 33. 1892) and *Hymenogloea* Pat. (Tax. Hymén. 147. 1900) may also belong to the same genus. If this is true, Massee's generic name would, of course, be valid, but Höhnel does not actually propose combining these genera and reference to Massee's original description and illustration is far from convincing.

Burt (Ann. Missouri Bot. Gard. 11: 6. 1924) lists Patouillard's three species and reports an additional collection of *C. pulverulenta* from Puerto Rico. Referring to this collection, he states: "the specimens are not notably marasmioid in the recent specimens I have seen and the genus seems unnecessary."

The Colombian collection here reported seems quite distinct from any of the five previously recognized species, but is perhaps closest to *Cymatella ciliata* (P. Henn.) Höhn. described from Chile. From this species it differs in its pure white pileus and stem apex, the lack of coarse hairs at the base of the stem and the much longer spores. It is definitely marasmioid, far removed from *Craterellus*, in which genus Burt implies *Cymatella* should be included, and has little but superficial characters to justify reference to the stipitate Stereums. Except for the vesiculose cells in the upper surface, *Cymatella*, as defined, fits it exactly and seems to be needed for this and for its presumed relatives.

Killermann (in Engler & Prantl, ed. 2. 6: 259. 1926) includes *Cymatella* in the tribe Marasmieae of the Agaricaceae, which is in accord with Patouillard's view of its relationships. He publishes an illustration of *C. minima* (Fig. 149 C) said to be "nach Patouillard." Reference to Patouillard's original figure (l.c. Pl. 9, Fig. 6), reproduced in part as Fig. 73 of the Essai Taxonomique and copied by Burt, shows that Killermann's figure is highly formalized and imaginative, particularly in the unwarranted emphasis of the very faint radiating folds, which are made to appear as blunt gills.

I wish to express my indebtedness to Dr. L. E. Wehmeyer of the University of Michigan for the description and illustrations of *Pseudovalsa tropicalis*, to Dr. D. P. Rogers of the American International College for the descriptions of *Pellicularia biapiculata*, *P. digitata* and *Peniophora gemmea* and to Mrs. D. P. Rogers for the drawings illustrating these species.

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* In Engler & Prantl, ed. 2. 6: 151 the page reference to Hennings' name is given as 141. I have not seen the original.

Studies in the Simaroubaceae. III. The Genus Simaba

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The genus Simaba was proposed in 1775 by Aublet, in his *Histoire des Plantes de la Guiane Francoise*, the single species being named *S. guianensis*. In the same work Aublet proposed the genus *Aruba*, with *Aruba guianensis* as the type. It is apparent from the figures and descriptions that the two genera were founded on different collections of the same species. Although *Aruba* has page priority, *Simaba* was until 1891 unanimously adopted by other authors, who reduced *Aruba* to synonymy.

In 1891 Otto Kuntze transferred all the names in *Simaba* to *Aruba*, presumably because of page priority. According to the present International Rules, these transfers were not validly published, since he gave neither descriptions nor references to previously published descriptions. The names are accordingly omitted from the synonymy of the species. Three other names, *Phyllostema*, *Zwingera*, and *Homalolepis*, have been given to this genus, but are universally and correctly reduced to synonymy.

Simaba is related on the one hand to *Quassia*, and on the other to *Simarouba*. From *Simarouba* it is well separated by its perfect flowers and capitate or slightly lobed stigmas, *Simarouba* having unisexual flowers and long divergent stigmas. A helpful vegetative character is that the leaflets of *Simaba* are usually opposite, while those of *Simarouba* are almost always offset.

Quassia, as represented by *Quassia amara* L., differs from *Simaba* in its broadly winged leaf rachis, ordinarily racemose inflorescence, erect petals which are glabrous except for a few hairs near the base within, and conspicuously jointed pedicels. *Simaba* has a wingless leaf rachis, paniculate inflorescence, pubescent petals which are more or less spreading at anthesis, and pedicels which are jointless or sometimes jointed at the base. The African species which has been referred to *Quassia*, *Q. africana*, resembles *Simaba* in its wingless leaf rachis, jointless pedicels, and spreading petals. Although it was described as having a raceme, specimens at hand are clearly paniculate. It resembles *Quassia* in having the petals hairy only at the base, and in the short broad appendages of the filaments. Mere distribution of hair on the petals scarcely seems of great importance, and the size and shape of the appendage is highly variable in *Simaba*. I believe it is better to refer *Q. africana* to *Simaba*, as Baillon at first did, leaving *Quassia* as a monotype.

Another African genus, *Odyendea*, is probably not to be separated from *Simaba*, the only distinctions ever having been brought out residing in the aestivation of the corolla, being apparently fictitious.

Engler has proposed three sections in the genus, which are here maintained. The small-flowered species, with the petals merely puberulent, form the section *Tenuiflorae*; the species with flowers of moderate size and the petals villous-tomentose make up the *Floribundae*, and the very large flowered species with the petals villous tomentose form the *Grandiflorae*. *S. africana*, and probably at least some of the species now referred to *Odyendea*, should be segregated into a fourth section, but we are here concerned only with the American species.

The section *Tenuiflorae* is confined to the moist regions of the Amazon basin and northward; the sections *Floribundae* and *Grandiflorae*, with the exceptions of *S. paraensis* and *S. cedron*, are limited to the drier and more open regions of southern and eastern Brazil, and Paraguay. There is a cleaner break between the *Tenuiflorae* and *Floribundae* than between the *Floribundae* and *Grandiflorae*. It is interesting to note that on the basis of anatomy Boas has proposed two sections; *Aruba*, for the species without secretory passages, coinciding with Engler's *Tenuiflorae*; and *Homalolepis*, for the species with secretory passages, including Engler's *Floribundae* and *Grandiflorae*.

The main evolutionary trend in the genus has been toward the development of larger flowers, with long, narrow, firm petals, and long slender appendages of the filaments. Beyond that, and the statements of affinity given with the notes on the species, I do not feel able to elucidate the phylogeny of the group.

The genus includes species of very diverse habit, from good sized trees to small shrubs or subshrubs, and suffruticose plants with the leaves all basal. Where information is available, I have included habit notes in the key, but these must be used with caution, since data is scanty, and several of the species may be either arborescent shrubs or trees. Precise limits of measurements of flower parts are likewise subject to change as more material is accumulated.

It seems noteworthy that of the 24 species recognized in this paper, 19 were described by 1874, when Engler's excellent treatment appeared in the *Flora Brasiliensis*, and only 5 others, all valid, have been proposed since. Probably two more undescribed species are represented among the sheets assembled for this study, but the specimens are either sterile or only in bud, so they must remain undescribed for the present.

I wish to thank Dr. R. T. Major, Director of the Research Laboratory of Merck & Co., Inc., who made this study possible, Dr. H. A. Gleason, Dr. Bassett Maguire, Mr. B. A. Krukoff, of the New York Botanical Garden, who have given helpful advice and criticism, and aided in obtaining necessary material, and the curators of the following herbaria (designated hereinafter by the letters at the left), who have loaned specimens for study:

A—Arnold Arboretum, Harvard University,
F—Field Museum, Chicago, Ill.
G—Gray Herbarium, Harvard University,
MO—Missouri Botanical Garden, St. Louis,
Mich—University of Michigan, Ann Arbor,
NY—New York Botanical Garden,
US—United States National Herbarium, Washington, D. C.,
Y—Yale University School of Forestry, New Haven, Conn.

Specimens cited as Kr. Herb. are mostly vouchers received by Mr. Krukoff in connection with samples for chemical analysis. In cases of some contemporary South American collectors, herbarium distribution numbers have been cited as if they were collector's numbers, both to identify the collection and because it is sometimes difficult to tell whether the number accompanying the specimen is that of the collector or that of the herbarium.

All measurements of flower parts are taken from flowers restored to normal size by boiling.

SIMABA Aubl.

Trees, shrubs, or suffrutescent plants with the leaves all basal; leaves pinnately compound, with usually opposite leaflets, only the terminal one present in two species; inflorescence a simple or mixed panicle; pedicels not jointed, or sometimes jointed at the base; flowers perfect; sepals 4–5, united at the base or to above the middle; petals 4–5, distinct, pubescent, more or less spreading at anthesis; stamens twice as many as the petals, each bearing a more or less hairy appendage which may be attached throughout or merely joined at the base; gynoecium borne on an evident disk or gynophore; carpels 4–5, weakly united, each bearing one ovule; style 1, but the part from each carpel discernible; stigma capitate or slightly lobed; fruit of several distinct drupes, sometimes only one maturing.

KEY TO THE AMERICAN SPECIES

1\. Petals 4–7 mm. long, merely puberulent on both sides........................(*Tenuiflorae*)
 2\. Leaflet 1; appendage with only the two points of the tip free.
  3\. Leaves borne on well developed petioles about 4–15 mm. long; petals evidently puberulent on the outside; appendage long-hairy within, the hairs conspicuously spreading beyond the margins; small tree...6. *S. obovata*
  3\. Leaves subsessile, the petioles only 1–3 mm. long; petals very nearly glabrous on the outside; appendage short-hairy within, the margins nearly smooth; shrub 1 m. high or less. ....7. *S. monophylla*
 2\. Leaflets several; flowers various.
  3\. Fruit short-pilose with brownish hairs, about 3 cm. long; arborescent shrub 2–4 meters tall...4. *S. crustacea*
  3\. Fruit glabrous or finely puberulent, 1–3 cm. long.
   4\. Free portion of the appendage very short, much shorter than the attached portion; appendages about 1.8 mm. long or less, equalling or shorter than the ovary; inflorescence, at least in *S. multiflora*, ample, many-flowered; fruit mostly 1.5–3 cm. long; leaflets from obovate and rounded at the tip to lanceolate and acute, sometimes abruptly short-cuspidate.

5. Appendages less than half as long as the gynophore; fruit slender, asymmetrical, 2.5–3 cm. long; tree. 5. *S. orinocensis*

5. Appendages equalling or surpassing the gynophore; fruit stout, symmetrical, 1.5–2.5 cm. long; aborescent shrub, or sometimes a tree as much as 15 meters high. . . . . 3. *S. multiflora*

4. Free portion of the appendage longer than the attached portion; appendages equalling or surpassing the ovary, usually 1.8 mm. long or more, sometimes a little less; inflorescence small, relatively few flowered; fruit about 1–1.3 cm. long; leaflets narrowly diamond shaped to broadly elliptical or ovate, obtuse and emarginate at the apex to abruptly cuspidate or frequently abruptly long acuminate.

5. Petals about 6–7 mm. long; filaments about 4.7–6.0 mm. long; arborescent shrub or small tree. . . . . 2. *S. guianensis*

6. Leaflets with a long acuminate tip. . . . . 2a. *S. guianensis* var. *typica*

6. Leaflets obtuse or short pointed. . . . . . 2b. *S. guianensis* var. *ecaudata*

5. Petals about 4–6 mm. long; filaments about 3.0–4.7 mm. long; arborescent shrub 2–4 meters tall, or sometimes a small tree. . . . . 1. *S. cuspidata*

6. Leaflets with a long acuminate tip. . . . . . 1a. *S. cuspidata* var. *typica*

6. Leaflets obtuse or short pointed. . . . . 1b. *S. cuspidata* var. *nigrescens*

Petals 7.5–30 mm. long, the surfaces closely villous tomentose and often ferrugineous.

2. Petals 7.5–16 mm. long; filaments 5–10 mm. long; appendages 3–7 mm. long. (*Floribundae*)

3. Suffruticose; leaves all basal.

4. Inflorescence precocious; petals 10–12 mm. long; filaments 8 mm. long; appendage free for about the upper ⅔. . . . . 16. *S. praecox*

4. Inflorescence appearing with the leaves; petals about 8–9 mm. long; filaments about 5–5.5 mm. long; appendage free for less than half its length. . . . 17. *S. suffruticosa*

3. Trees, shrubs, or subshrubs; cauline leaves present.

4. Leaflets 15–20 pairs; tree 4–5 meters tall. . . . . 18. *S. insignis*

4. Leaflets 2–6 pairs.

5. Appendages with only the two points of the tip free, the rest joined to the filament.

6. Leaves velvety pubescent beneath; small shrub or subshrub about 1 meter high. . . . . 11. *S. Warmingiana*

6. Leaves essentially glabrous beneath, except sometimes on the midrib.

7. Calyx parted to about the middle; gynophore apparently about 4 mm. long; shrub. . . . . 9. *S. floribunda*

7. Calyx parted to near the base; gynophore 1–2 mm. long.

8. Small shrub or subshrub of Sao Paulo, Brazil, to Paraguay, not over 1 meter tall; petals 2 mm. wide or less; midrib of the leaflets light colored; main veins visible beneath as evident furrows or light colored ridges; leaves glabrous. . . . . 10. *S. glabra*

8. Medium sized or large tree of Para and Amazonas, Brazil; petals 2.3–3.7 mm. wide; midrib and main veins of the leaflets usually dark beneath; leaflets often with a few hairs beneath, especially along the midrib. . . . . 8. *S. paraensis*

5. Appendage with the upper part free from the filament.

6. Leaves velvety-pubescent beneath; subshrub less than 1 meter high. . . . . 12. *S. ferruginea*

6. Leaves essentially glabrous beneath, except sometimes on the midrib.

7. Filaments 9–10 mm. long; appendage 7 mm. long; petals 12–16 mm. long. . . . . 19. *S. intermedia*

7. Filaments 5.0–7.5 mm. long; appendages 3.2–3.8 mm. long; petals 7.5–10.5 mm. long.

8. Appendage free almost to the base; inflorescence narrow; presumably a small shrub. . . . . 15. *S. suaveolens*

8. Appendage with only about the upper half free from the filament; inflorescence ample, the branches divaricate.

9. Leaflets mostly elliptical, broadest at or near the middle; appendage free for about 1.8–2.2 mm., its hairs straight or nearly so; ovary and gynophore densely long pilose; shrub or small tree up to 5 meters tall. . . . . 14. *S. subcymosa*

9. Leaflets mostly narrowly obovate, broadest above the middle; appendage free for about 0.8–2.0 mm., its hairs somewhat curled and twisted; ovary and gynophore short-pilose; arborescent shrub, or tree up to 20 meters tall............ . ...13. *S. cuneata*

2. Petals mostly 20–35 mm. long; filaments 12.5–25 mm. long; appendages 10–20 mm. long. (*Grandiflorae*)

3. Sufruticose; leaves all basal; petals 3 cm. long or more; filaments about 25 mm. long; appendages about 18–20 mm. long........................ .. ..24. *S. salubris*

3. Shrub or tree; cauline leaves present; flowers variable but mostly a little smaller than in *S. salubris*

4. Leaflets 2–6 pairs.

5. Leaflets puberulous above, densely velvety beneath; shrub about 1 meter high. .... 20. *S. trichilioides*

5. Leaflets essentially glabrous................ .... 21. *S. Pohliana*

4. Leaflets 7-many pairs.

5. Leaflets mostly 10–15 pairs, commonly but not always tipped with a conspicuous, indurated, black or dark brown subglobose gland, puberulous on the midrib above and occasionally sparsely so below, otherwise glabrous; arborescent shrub or slender tree up to 15 meters tall..... ....23. *S. cedron*

5. Leaflets 7–11 pairs, merely acuminate, not gland-tipped, or only inconspicuously so, the midrib and main veins puberulous beneath, the lower surface sometimes also sparsely puberulous; arborescent shrub 2–4 meters tall............22. *S. Maiana*

INDIVIDUAL TREATMENT OF THE SPECIES

1. SIMABA CUSPIDATA Spruce ex Engl. in Mart. Fl. Bras. 12^2: 212. 1874.

1a. **Simaba cuspidata** var. **typica** Cronquist, nom. nov.

Simaba cuspidata Spruce ex Engl. in Mart. Fl. Bras. 12^2: 212. 1874.

Type: *Spruce 1751, "Alto Amazonas ad oram septentrionalem fluminis Amazonum ad ostium fl. Rio Negro,"* (F-photo, NY, NY-photo).
Distribution: Amazonas, Brazil, where reported by Ducke to be common in the forest; reported by Engler from Surinam.

1b. **Simaba cuspidata** var. **nigrescens** (Engl. in Mart.) Ducke ex Cronquist, comb. nov.

Simaba nigrescens Engl. in Mart. Fl. Bras. 12^2: 213. 1874.

Type: *Riedel 1604, "in provinciae Para umbrosis arenosis pr. Santarem."*
Illustrations: Mart. Fl. Bras. 12^2: t. 41. 1874.
E. & P. Nat. Pfl. 3^4: 214. 1896.
Distribution: Para, where, according to Ducke, it is *"limitée à la petite forêt seche de la lisiere de campos et de plages sablonneuses."*

BRAZIL: *Riedel s.n.*, (G-probably an isotype). Para. *Ducke 8480*, (US), *8868*, (US), *14109*, (US); *Huber 2156*, (F-photo and fragment, US).

Ducke, speaking of *S. cuspidata* and *S. nigrescens*, says, *"Les formes de transition entre les deux sont frequentes et tres evidentes . . . ,"* and refers to "var. *nigrescens* (Engl.) Ducke." However, since he gives neither a description nor a reference to a previously published description, the combination is not validly published according to the rules. It is therefore here published as Ducke ex Cronquist.

This species is very closely related to *S. guianensis* Aubl. and may not be distinct. The only obvious differences lie in the flowers, and there is no real discontinuity. I believe, however, that two entities are involved, and since each appears to have two leaf forms worthy of varietal recognition, they may for the present at least be retained as species.

2. SIMABA GUIANENSIS Aubl. Pl. Gui. **1**: 400. 1775.

2a. **Simaba guianensis** var. **typica** Cronquist, nom. nov.

Simaba guianensis Aubl. Pl. Gui. **1**: 400. 1775.
Aruba guianensis Aubl. Pl. Gui. **1**: 203. 1775.
Quassia crocea Vahl. Eclog. Am. **3**: 12. 1806.
Simaba Aruba A. St. Hil. ex DC. Prodr. **1**: 734. 1824.
Zwingera Aruba Spreng. Syst. **2**: 310. 1825.
Quassia guianensis D. Dietr. Syn. Pl. **2**: 1416. 1840.
Quassia Aruba D. Dietr. Syn. Pl. **2**: 1416. 1840.

Type: *Aublet s.n.*, "*in sylvis Orapu*," French Guiana.
Illustrations: Aubl. Pl. Gui. t. 115, 153. 1775.
Mém. Mus. Par. **12**: t. 27, part 45b. 1825.
Distribution: Known from French Guiana, Para and Amazonas, Brazil, and British Guiana.

BRAZIL: Amazonas. Basin of Rio Madeira. *Kuhlman 18081*, (US). Para. Basin of Rio Tapajos. *Kuhlman 18011*, (US). BRITISH GUIANA: *Wood s.n.* (Kr. Herb. #10722).

2b. **Simaba guianensis** var. **ecaudata** Cronquist, var. nov.

Foliolis apice rotundis emarginatus non attenuatis, ceteris similis var. typico.

Type: *Froes 11724*, low land, high forest, Island of Sao Luiz, Maranhao, Brazil, January, 1940, (NY); isotypes, (A, MO). Cotype: *Froes 11725*, fruiting specimens, same time and place as #*11724*, (A, MO, NY).
Distribution: Known only from the type and cotype collections, Maranhao, Brazil.

The type of var. *ecaudata* has longer filament appendages than any other specimens of the species available to me (3.4–3.6 mm.), but this is probably merely an individual difference.

3. SIMABA MULTIFLORA A. Juss. Mém. Mus. Par. **12**: t. 27. 1825.

Simaba foetida Benth. Jour. Bot. & Kew Misc. **3**: 370. 1851.
Simaba angustifolia Benth. *loc. cit.*
Simaba guianensis var. *Schomburgkiana* Engl. in Mart. Fl. Bras. $\mathbf{12^2}$: 212. 1874.
Simaba guianensis var. *angustifolia* Engl. in Mart. *loc. cit.*
Simaba multiflora var. *Schomburgkiana* Sandw. Kew Bull. **1929**: 81. 1929.
Simaba multiflora var. *angustifolia* Sandw. *loc. cit.*

Type: A figure published by Jussieu, without reference to a specimen. The figure may perhaps have been taken from the *Martin* collection cited below.
Local names: Cajurana, ciruelito, pitombeira, tambaquiy.

Distribution: Widespread and common along streambanks and periodically inundated lowlands, from Loreto, Peru, to Para, Brazil, north to French Guiana, Venezuela, and Trinidad.

PERU. Loreto. *Poeppig 2897*, (F, US); *Schunke 254*, (F). BRAZIL. Amazonas. Basin of Rio Salimoes. *Kuhlman 18977*, (US). Basin of Rio Negro *Spruce 1128*, (G, NY), *1129*, (F-photo, NY-photo). Para. *Capucho 532*, (F); *da Costa 312*, (F); *Ducke 10260*, (US), *11739*, (US); *Spruce 507*, (F-photo, NY, NY-photo). FRENCH GUIANA· *Martin s.n.*, (F). DUTCH GUIANA: *Hastman 141*, (G, NY); *Schweinitz s.n.*, (NY). BRITISH GUIANA: *Wood s.n.*, (Kr. Herb. *#16221*). VENEZUELA: Bolivar *Williams 13311*, (A, F). TRINIDAD: *Alexander 6943*, (NY).

This widespread species was confused by Engler with *S. guianensis*, which is readily separated by the appendages of the filaments, size of the inflorescence, and shape of the leaflets. The situation was rectified in 1929 by Sandwith.

S. multiflora has three forms of leaflets, by which it might conceivably be separated into varieties, but there is frequently considerable variation even on a single branch as represented on a herbarium sheet, and Ducke reports that plants with various forms of leaflets grow together without any geographic segregation. It seems unwise, at present, to attempt to separate these phases as varieties.

It will be noted that this species is found in the lowlands that are subject to flooding, while its relatives, *S. guianensis* and *S. cuspidata*, grow on higher and drier ground.

4. SIMABA CRUSTACEA Engl. in Mart. Fl. Bras. 12^2: 211. 1874.
Type: *Riedel 1490*, "*in sylvis prov. do Matto Grosso*," (F-photo).
Distribution: Known only from the type collection.

The narrowly obovate rounded leaflets of this species, as a photograph of the type shows, are much like those of *S. orinocensis* and some forms of *S. multiflora*, whence Engler placed it in the *Tenuiflorae*, its flowers being yet unknown. Probably it is a distinct species, but it may be merely a form of *S. multiflora*.

5. SIMABA ORINOCENSIS H. B. K. Nov. Gen. et Sp. **6**: 18. 1823.

Zwingera orinocensis Spreng. Syst. **2**: 319. 1825.
Quassia orinocensis D. Dietr. Syn. Pl. **2**: 1416, 1840.

Type: *Humboldt & Bonpland s.n.*, "*crescit in arenosis, calidis, prope Carichana.* (*Miss. del Orinoco*)."
Illustration: H. B. K. Nov. Gen. et Sp. **6**: t. 514. 1823.
Distribution: Known only from the type collection.

This species is evidently related to *S. multiflora*, from which it is separated by the long gynophore, very short appendages of the filaments, and slender asymmetrical fruit.

6. SIMABA OBOVATA Spruce ex Engl. in Mart. Fl. Bras. 12^2: 210. 1874.
Type: *Spruce 3340* (cited by Engler as *5340*), "*ad flumina Casiquiari,*

Vasiva, et Pacimoni," Amazonas, Venezuela, (NY, NY photo, F-photo).
Distribution: Lowlands of northern Amazonas, Brazil, and Amazonas, Venezuela.

BRAZIL: Amazonas. Basin of Rio Tonantins. *Ducke 20,114*, (US). Basin of Rio Negro. *Ducke 187*, (A, F, MO, NY, US), *7113*, (US). VENEZUELA: Amazonas. *Spruce 3317*, (F photo, NY, NY photo).

This species is evidently related to *S. multiflora*, differing chiefly in its solitary leaflets.

7. **Simaba monophylla** (Oliv.) Cronquist, comb. nov.

Simarouba monophylla Oliv. Ic. Pl. **14**: t. 1387. 1882.

Type: *G. S. Jenman 1013*, Kaietur Savannah, Potaro River, British Guiana, Sept. Oct., 1881 (Georgetown Botanic Garden, British Guiana).
Distribution: Known only from the type collection.

Although obviously related to *S. obovata*, this species is clearly distinct. In addition to the characters given in the key, it differs from *S. obovata* in its stouter pedicels, and longer and relatively narrower leaflets, which look much like the leaflets of *Simarouba amara* var. *typica* in shape and texture. The twigs on the single sheet available are a bright and shiny black, which may be a characteristic feature, or may be due merely to the vicissitudes of preparation.

8. SIMABA PARAENSIS Ducke, Arch. Jard. Bot. Rio de Jan. **4**: 105. 1925.
Type: *Ducke 18947*, "*in silvis primariis non inundatis civitate Para; prope Obidos*, October 5, 1915."
Distribution: Amazonas and Para, Brazil, on "terra firma."

BRAZIL: Amazonas. Basin of Rio Purus. *Krukoff 5270*, (A, MO, NY, US). Para. *Siqueira 18098* (*9651*), (F photo, NY photo, US).

This species may well represent the basal part of the section *Floribundae*.

9. SIMABA FLORIBUNDA A. St. Hil. Mém. Mus. Par. **10**: 277. 1823.

Zwingera floribunda Spreng. Syst. **2**: 315. 1825.
Quassia floribunda D. Dietr. Syn. Pl. **2**: 1416. 1840.

Type: *St. Hilaire s.n.*, "*in locis siccis prope urbem Villa-do Fanado in Minas-novas*," Minas Geraes, Brazil.
Illustration: A. St. Hil. Pl. Rem. Bres. **1**: t. 10. 1824.
Distribution: Minas Geraes and Matto Grosso, Brazil.

10. SIMABA GLABRA Engl. in Mart. Fl. Bras. **12**^{2}: 218. 1874.

Simaba glabra subsp. *trijuga* Hass. Repert. Sp. Nov. **10**: 347. 1912.
Simaba glabra subsp. *trijuga* var. *emarginata* Hass. *loc. cit.*
Simaba glabra subsp. *trijuga* var. *inaequilaterala* Hass. *loc. cit.*

Type: *Riedel 483, "in prov. S. Paulo ad Rio Pardo,"* (F-photo, G.).
Illustration: Mart. Fl. Bras. 12^2: t. 43. 1874.

PARAGUAY: *Hassler 10569*, (A), *10569a*, (A).

The specimens on which Hassler's proposed segregates are based look very much like the type collection of the species.

11. SIMABA WARMINGIANA Engl. in Mart. Fl. Bras. 12^2: 217. 1874.
Type: *Warming 2466, "in prov. Minas Geraes in campis ad Lagoa Santa,"* (F-photo, NY-photo).
Distribution: Minas Geraes and Bahia, Brazil.

BRAZIL: Minas Geraes. *Mello Barreto* 754, (F).

12. SIMABA FERRUGINEA A. St. Hil. Mém. Mus. Par. 10: 277. 1823.

Zwingera ferruginea Spreng. Syst. 2: 319. 1825.
Simaba bahiensis Moric. Mem. Soc. Phys. Gen. 7: 251. 1836.
Quassia ferruginea D. Dietr. Syn. Pl. 2: 1416. 1840.
Homalolepis Blanchetii Turcz. Bull. Soc. Nat. Moscow 21^1: 575. 1848.
Simaba Blanchetii Turcz. *loc. cit.* 31^1: 444. 1858.
Simaba ferruginea var. *Blanchetii* Engl. in Mart. Fl. Bras. 12^2: 215. 1874.

Type: *St. Hilaire s.n., "inveni in campis intersitis arboribus retortis, in deserto occidentali (Certao) provinciae Minas-Geraes prope praedium Macauba,"* (F-fragment).
Illustrations: Mem. Soc. Phys. Gen. 7: t. 9. 1836, (as *S. bahiensis*).
St. Hil. Fl. Bras. Merid. 1: t. 14. 1825.
Local name: Calunga.
Distribution: Minas Geraes to Piauhy, Brazil.

BRAZIL: *St. Hilaire 1898*, (F-fragment) Goyaz. *Burchell 6450*, (G). Piauhy. *Gardner 2514*, (NY). Bahia. *Blanchet 1666*, (NY), *3143*, (F, MO, NY).

Simaba Blanchetii has slightly larger flowers, and a larger and more congested inflorescence than *S. ferruginea*, but the differences are minor and not entirely correlated, so that the two are certainly not distinct species. Perhaps one might reasonably treat *S. Blanchetii* as a variety of *S. ferruginea*, as Engler has done, but I think the burden of proof rests upon those who would recognize it as a taxonomic entity of any sort.

13. SIMABA CUNEATA A. St. Hil. & Tul. Ann. Sc. Nat. II, 17: 138. March, 1842.

Simaba laevis Casar. Nov. Stirp. Bras. 10. May, 1842.

Type: *Riedel 1032, "in silvis maritimis prope Rio de Janeiro, Brazil,"* (F-fragment).
Local names: Quina do matto, quina quina.
Distribution: Rio de Janeiro, Bahia, and probably Minas Geraes, Brazil.

BRAZIL: *Riedel s.n.*, (F, G). Rio de Janeiro. *Riedel 1000*, (F-photo, NY-photo). Minas Geraes. *Glaziou 12929*, (F). Bahia. *Froes 17*, (Kr Herb *#12651*); *Froes 56*, (Kr. Herb. *12691*).

The floral differences between this and *S. subcymosa* are minor, but the shape of the leaflets, while somewhat variable, is distinctive. Also *S. cuneata* is commonly a small tree, while *S. subcymosa* was described as an "*arbuscula tortuosa*."

14. SIMABA SUBCYMOSA A. St. Hil & Tul. Ann. Sc. Nat. II, **17**: 137. 1842.
Type: *Guillemin 727*, "*in monte Corcovado, prope Rio de Janeiro*," Brazil, (F, F-photo, NY).
Distribution: Rio de Janeiro, Brazil.

BRAZIL: Rio de Janeiro. *Glaziou 17074*, (F); *Kuhlman 815*, (US).

This species is closely related to *S. suaveolens*, differing in the much more ample inflorescence, more hairy gynophore, and shorter free portion of the appendage of the filaments.

15. SIMABA SUAVEOLENS A. St. Hil. Mém. Mus. Par. **10**: 278. 1823.

Zwingera suaveolens Spreng. Syst. **2**: 319. 1825.
Quassia suaveolens D. Dietr. Syn. Pl. **2**: 1410. 1840.

Type: *St. Hilaire 3*, "*in sylvis primaevis montis dictis Piriquito prope Itabira-de-mato-dentro (provincia Minas-Geraes)*," Brazil, (F-photo).
Illustrations: Mem. Mus. Par. **10**: t. 11A. 1823.
St. Hil. Pl. Rem. Bras. t. 11A. 1824.
Local name: Piriquito.
Distribution: Known only from the type collection in Minas Geraes, Brazil.

16. SIMABA PRAECOX Hassler, Bull. Herb. Boiss. II, **7**: 723. 1907.
Type: *Hassler 9497*, "*in campis pr. Yhu*," Paraguay, (F photo).
Distribution: Known only from the type locality.

17. SIMABA SUFFRUTICOSA Engl. in Mart. Fl. Bras. $\mathbf{12}^2$: 213. 1874.
Type: *Riedel 2471*, "*in prov. Minarum campis pr. Uberaba alibique in hac prov.*," (G).
Illustrations: Mart. Fl. Bras. $\mathbf{12}^2$: t. 42. 1874.
E. & P. Nat. Pfl. $\mathbf{3}^1$: 214. 1896.
Local name: Calunga.
Distribution: Minas Geraes and Goyaz, Brazil.

18. SIMABA INSIGNIS A. St. Hil. & Tul. Ann. Sc. Nat. II, **17**: 137. March, 1842.

Simaba glandulifera Gardn. Lond. Jour. Bot. **1**: 169. April, 1842.
Simaba longifolia Casar. Nov. Stirp. Bras. 9. May, 1842.

Type: *Gardner 20*, "*in mont. Serra da Estrella, prope Rio de Janeiro*," (F-fragment & photo, G, NY).
Distribution: Rio de Janeiro, Brazil.

Local names: Calunga, parahyba-mirim, simarouba-mirim.

BRAZIL: *Nadeaud s.n.*, in 1862, (F). Rio de Janeiro. *Casaretto s.n.*, (F-fragemnt); *Gardner 19* (NY); *Helmreichen 57*, (F); *Miers 3805, 3806*, (US).

Three names were published for this species in three consecutive months, two of them based on the same collection. Although *Simaba insignis* A. St. Hil. & Tul. was based on Gardner's plant, the name appears to have been published a month before Gardner's name, *S. glandulifera*, and thus must be adopted. Although it is kept in the section *Floribundae* by the size of its flowers, this species resembles *S. cedron* in some respects, and is probably related to that species.

19. SIMABA INTERMEDIA Mansfeld, Notizbl. Bot. Gart. Berl. **9**: 39. 1924.
Type: *Luetzelburg 1504*, Goyaz, Brazil, August, 1922, (F-photo, NY-photo).
Distribution: Bahia and Goyaz, Brazil.

20. SIMABA TRICHILIOIDES A. St. Hil. Mém. Mus. Par. **10**: 279. 1823.

Zwingera trichilioides Spreng. Syst. **2**: 315. 1825.
Quassia trichilioides D. Dietr. Syn. Pl. **2**: 1416. 1840.

Type: *St. Hilaire s.n.*, "*in campis occidentalibus provinciae Minas-Geraes . . . prope urbem Paracatu*," (F-photo & fragment).
Illustrations: Mém. Mus. Par. **10**: t. 11B. 1823.
A. St. Hil. Pl. Rem. Bres. t. 11B. 1824.
Local names: Guardamor, calunga.
Distribution: Minas Geraes and Matto Grosso to Piauhy and Ceara, Brazil.

BRAZIL: *Pohl 2222*, (F). Matto Grosso. *Kuntze s.n.*, (NY); *Malme 1755*, (G, US). Goyaz. *Rawitscher s.n.*, (Kr. Herb. #16416). Piauhy. *Gardner 2515*, (G). Ceara. *Ule 9045*, (US).

21. SIMABA POHLIANA Boas, Beih. Bot. Centr. **29**^{1}: 337. 1913.
Type: *Pohl s.n.*, Brazil.
Distribution: Goyaz, and perhaps elsewhere in Brazil.

BRAZIL: *Pohl 1900*, (F, US). Goyaz. *Burchell 7593*, (G), *7986*, (G).

The leaflets of this species frequently have a well-developed, dark, indurated gland at the tip, as in *S. cedron*.

22. SIMABA MAIANA Casar. Nov. Stirp. Bras. 10. 1842.
Type: *Casaretto 1257*, "*in sylvulis arenosis maritimis . . . prope Rio de Janeiro*," (F-photo and fragment).
Distribution: Rio de Janeiro to Piauhy and Maranhao, Brazil.
BRAZIL: Rio de Janeiro. *Riedel s.n.*, (NY); *Riedel 999*, (F-photo). Piauhy. *Pohl 745d* (=*4306*), (F).

There is considerable variation in the length of the free portion of the appendage in the group of species which includes *S. salubris*, *S. cedron*, *S. Maiana*, *S. Pohliana*, and *S. trichilioides*, but more material is needed to determine the limits of variation before the taxonomic worth of that character can be established.

23. SIMABA CEDRON Planch. Lond. Jour. Bot. 5: 566. 1846.

Quassia cedron D. Dietr. Syn. Pl. 2: 1316. 1840.

Type: *Purdie s.n.*, "*ad ripas fluminis Magdalenae, prope pagum Sao Paulo, Novae Granadae.*"
Illustrations: Jour. Bot. & Kew Misc. 2: t. 11. 1850.
E. & P. Nat. Pfl. 3^1: 214. 1896.
Local names: Cedron, vela de muerto, (Central America); pau de gafanhoto, (Brazil).
Distribution: Apparently native to the Amazon basin; now widely cultivated in Brazil, northern South America, and Central America.

BRAZIL: *Archer s.n.*, (Kr. Herb. *10266*). Amazonas. Basin of Rio Madeira. *Krukoff 6615*, (A, NY, US). Basin of Rio Negro. *Killip & Smith 30203*, (NY). Para. *Ducke 1875*, (US), *1008*, (US). Maranhao. *Froes 26*, (US), *1807*, (A, MO, NY), *11058*, (NY). FRENCH GUIANA: *Melinon 370*, (US). BRITISH GUIANA: *Bailey 201*, (G); *de la Cruz 2222*, (NY), *2042*, (NY), *3137* (NY); *Hitchcock 17300*, (NY, US); *Jenman 4230*, (US), *7171*, (US); *Persaud 133*, (F, NY); *Tutin 161*, (US), *373*, (US); *Wood s.n.*, (Kr. Herb. *#15088Y*, *#10108*). VENEZUELA: *Broadway 770*, (NY, US). Bolivar. *Williams 11320*, (F, US), *11581*, (F, US). COLOMBIA: *Dawe 425*, (US). Boyaca. *Haught 2032*, (A). TRINIDAD: *Britton & Hazen 1187*, (NY, US); *Dean s.n.*, (Kr. Herb. *#10235*); *Trinidad Botanical Garden 3*, (US). PANAMA: *Pittier 6560*, (NY, US). COSTA RICA: *Brenes 750* (= *12271*), (F), *810* (= *12331*), (F). *Brenes & Quiros Calvo 662*, (F); *Tonduz 94*, (US), *6087*, (US), *9948*, (NY, US); *Valerio 305*, (F); *Valerio & Rodriquez s.n.*, (Kr. Herb. *#10100*). EL SALVADOR: *Calderon 2348*, (F).

24. SIMABA SALUBRIS Engl. in Mart. Fl. Bras. 12^2: 219. 1874.
Type: *Riedel 585*, "*in prov. Sao Paulo in campis ad Rio Pardo,*" (G).
Illustration: Mart. Fl. Bras. 12^2: t. 44. 1874.
E. & P. Nat. Pfl. 3^1: 214. 1896.
Local names: Calunga, calumba.
Distribution: Known only from the type collection.

EXCLUDED SPECIES

Simaba bicolor Zucc. Abh. Akad. Muench. 1: 353. 1829-30 = *Decatropis bicolor* (Zucc.) Radlk.

Simaba indica Baill. Hist. Pl. 4: 440. 1873. = *Samadera indica* (Baill.) Gaertn.

Simaba quassioides D. Don. Prod. Fl. Nep. 248. 1802. = *Picrasma quassioides* (D. Don.) Benn.

Simaba undulata Guill. & Perr. Fl. Seneg. Tent. 1: 136. 1830-1833. = *Hannoa undulata* (Guill. & Perr.) Planch.

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The Relation of Pharmacy to Botany*

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INTRODUCTORY

Plants have been used as sources of medicines throughout the history of mankind. In his search for food man discovered early that some plants produced peculiar effects which under certain conditions of ill-health and disease proved beneficial-medicinal plants. These utilitarian aspects were undoubtedly the basic factors which dominated the study of plants and furnished the primary motives for research and investigation in the field of botany. "From the beginning the study of plants has been approached from two widely separated standpoints—the philosophical and the utilitarian. Regarded from the first point of view, botany stands upon its own merits as an integral branch of natural philosophy; whereas, from the second it is merely a by-product of medicine and agriculture."[1] As a matter of fact, until about 1600 botany was primarily studied for the purpose of discovering, describing, and cultivating plants as sources of drugs for use as healing agents. We know that the physician, Valerius Cordus (1515-1544) also one of the pioneers of scientific botany, was influenced by two pharmacists to compile one of the earliest and most important European official pharmacopoeias, and his botanical works were likewise promoted by these two pharmacists; namely, his uncle Rolla, owner of a pharmacy in Leipzig, and Kaspar Pfreund, son-in-law of the famous painter Lucas Cranach, and manager of the latter's pharmacy in Wittenberg.[2] His descriptions of plants are said to exceed all earlier ones in accuracy and definiteness. The historian of botany, E. H. F. Meier, accredits him with an awareness of the differences of species and classes unknown to his predecessors.[3] The Swiss naturalist, Conrad Gessner (1516–1565), who was considered the most scientific botanist of his time, expressly referred to the

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[1] Agnes Arber, Herbals, Their Origin and Evolution, Cambridge 1938.

[2] Herman Schelenz, Geschichte der Pharmacie, Berlin 1904, p. 415.

[3] E. H. F. Meyer, Geschichte der Botanik, Königsberg 1857, 4: 3/20/21.

assistance he was given in his botanical studies by apothecaries, mentioning among others the apothecary, Peter Coudenberg of Antwerp.[4]

PHARMACISTS PROMOTE BOTANY THROUGH BOTANICAL GARDENS

Cultivation of medicinal plants was encouraged through the establishment of botanical gardens. In the establishment and maintenance of these plant gardens pharmacists took an active and important part. The "Jardin des Apothicaire" in Paris was established by the pharmacist Nicolaus Houel in the Sixteenth Century and this was later taken over by the Association of Parisian Apothecaries.[5] The "physick garden" at Chelsea, England was established by the Society of Apothecaries of London in 1673.[6] Both of these are recognized as among the most important institutions of their kind and have contributed immensely to the study of botany. Of such gardens established in more recent times the famous garden of Melbourne, Australia was founded by the pharmacist, Ferdinand Müller. He was also Australia's greatest botanist and his studies of the flora of Australia are recorded in forty volumes which still constitute the fundamental work on this subject.[7]

PHARMACISTS ORIGINATE PLANT CHEMISTRY

Pharmacists were among the first to discover and disclose that the medicinal virtues of plants are due to certain chemical constituents and to engage in research and experimentation in this field. The Swedish apothecary, Carl Wilhelm Scheele, who was the first individual systematically to separate and prepare plant constituents as chemical compounds is regarded as the founder of modern plant chemistry. He isolated a number of acids from plant sources and his methods of procedure are still used by modern scientists and laboratories.[8] The isolation of alkaloids, stimulated by the discovery of morphine and its basic character by the apothecary, Serturner, between 1806 and 1817, was for decades almost exclusively the work of pharmacists. This type of study changed the focus of scientists of that period from the botanical aspects to the study of plant contents, and was responsible for the development of plant chemistry. Investigations in the field of plant chemistry have been extensive and this has now become an important branch of scientific pharmacy.

PHARMACOGNOSY APPLIED BOTANY

However, the discovery that the medicinal virtues of many plants are

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[4] F. A. Flückiger und A. Tschirch, Grundlagen der Pharmacognosie, Berlin 1885, p. 28.

[5] Centenaire de L'école Superieure de L'Université de Paris, 1904, pp. 9, 10.

[6] P. E. F. Perredes, London Botanical Gardens, London 1906, p. 53 ff.

[7] Kremers-Urdang, History of Pharmacy, Philadelphia, 1940, p. 355.

[8] E. Kremers, Phytochemistry, Bull. Univ. Wis. Ser. No. 1732, Gen. Ser. No. 1506 Madison, Wis. 1931, p. 15.

due to chemical constituents, and that these vary with the plant, reemphasized the necessity for authentic and dependable botanical description and identification of such plants and plant material. This, in turn, emphasized and vitalized taxonomy and gave it practical significance. It also stimulated the study of plant anatomy and plant histology. The fact that plants were chemical laboratories encouraged study and research in plant physiology. These constitute some of the fundamental aspects of the subdivision of pharmacy which is now known as pharmacognosy. The motives provided by the utilitarian nature of pharmacognosy have been important and significant factors in broadening the scope and influencing the trends of botanical study and research particularly during the last half century.

PHARMACOGNOSY EXTENDS SCOPE OF BOTANY

Pharmcognosy may be said to have begun with the work of Theodor Martius, an apothecary of Erlangen, Germany.[9] He embodied the results of a series of studies on plant drugs during the period 1825–1832 in a volume entitled "Grundriss der Pharmakognosie des Pflanzenreiches" which is considered the first extensive treatise on pharmacognosy.

Development of histology.—Histological pharmacognosy dates its beginning with the announcement in 1838 by M. J. Schleiden, a German botanist, that the cell is the fundamental unit of plant structure and that all tissues are combinations of cells. In 1847, in an excellent investigation of the rhizome of sarsaparilla he showed pharmacists the usefulness of the microscopical examination of plant drugs. In 1857, Schleiden published one of the early books on pharmacognosy entitled "Handbuch der Medicinisch-Pharmazeutischen Botanik und Botanischen Pharmacognosie." In this book he points out that plant drugs must be identified by their cellular differences.[10] We find also that during this period the Swiss pharmacist, Flückiger (1828- 1894) and his English colleague, Daniel Hanbury (1825 1875) published their "Pharmacographia" and many other contributions covering pharmacognostical research. This tradition of combining botanical and pharmacognostical research has been followed by other pharmacists and each has made important contributions, notably Alexander Tschirch (1856-1939), A. Meyer (1850 1922), and L. Guignard (1853–1928).

Alexander Tschirch's voluminous "Handbuch der Pharmakognosie" represents a unique contribution to pharmacy as well as to botany. Tschirch nevered failed to stress his association with pharmacy and his work may well be regarded as a striking example of the relation of pharmacy to botany. Arthur Meyer who, like Tschirch, never failed to stress his close connection with pharmacy, may well be regarded as the outstanding exam-

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[9] H. W. Youngken, A Text Book of Pharmacognosy, Philadelphia, 1936, p. 15.

[10] Ibidem.

ple of the relation of pharmacy to botany. The following sentences are quoted from the necrology which his American student, Henry Kraemer, himself an eminent pharmacognosist and botanist, published after Meyer's death in 1922:[11]

> Arthur Meyer . . . attained fame in the branches of botany and pharmacognosy His two volumes on "Scientific Drug Knowledge" are one of the greatest contributions ever made to pharmacognosy. . . . His earlier work on the starch grain was probably equal to Nageli's master work on the same subject and which was considered by Wallace to be one of the greatest intellectual feats of the last century. . . . His "Handbook of Botany" dealing with the microscopical study of plants, has been very much appreciated by laboratory workers. . . . Starting as a drug clerk he studied under the masters of science and himself became a master and a guide. . . .

Plant cell contents. It is generally recognized that A. Meyer's studies concerning starch grains and chromatophores laid the groundwork for our present concepts of these significant constituents of plant cells. According to Harvey Gibson, A. Meyer, as early as 1885 "showed that in many plants starch is never formed at all and that such plants produce sugar instead. . . ."[12]

L. Guignard contributed to botanical research by his studies on the origin and structure of the seeds of a large number of plant families. He also made valuable contributions to plant chemistry by his investigations of diastases, glucosides, and plant principles which produce cyanhydric acid in various plants, and the constituents of members of the cruciferous and some other plant families.[13]

It is to be noted that progress and trends in botanical studies were not only influenced by pharmacy but were also reflected in modifications and enlargements of botanical descriptions of plant drugs in the United States Pharmacopoeia. This became particularly significant during the period of agitation for Federal Food and Drug Laws and following the enactment of the Federal Food and Drug Law of 1906. In the earlier editions of the United States Pharmacopoeia, namely, those of 1820 to 1870 inclusive, only a catalog of plant drugs indicating the scientific name and part used was included. The 1880 revision introduced brief botanical descriptions of the unground drug the part used. The 1900 revision introduced in a few monographs descriptions of the ground drug or powdered drug which included internal structures. In the 1910 revision descriptions of internal structures were considerably enlarged and more generally utilized with more specific and detailed emphasis on cells and cell structures. The 1920 revision introduced the policy of subclassification of botanical descriptions under the subheads, Unground, Structure, and Powder, which policy has been continued in subsequent revisions.

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[11] Am. Journ. Pharm. **11**: 984, 1922.

[12] Harvey and Gibson, Outlines of the History of Botany, London, 1919, pp. 215, 238, 239.

[13] Journal Am. Pharm. Assoc. **17**: 613, 1928.

PHARMACY OFFERS PRACTICAL FIELD FOR PLANT PHYSIOLOGY

The use of plants as medicinal agents encouraged and stimulated the study of plant contents, as pointed out above. It was only logical therefore that this should promote study and research concerning plant physiology. Here again it is significant to note the important role of pharmacists in this field of scientific investigation, and the influence of pharmacy in the development of this aspect of botany. One of the greatest plant physiologists of all time, Wilhelm Pfeffer (1845–1920), was closely associated with pharmacy during his early youth and throughout his entire academic career. His father was the proprietor of the only pharmacy in the small town of Grebenstein, Germany, and young Wilhelm grew up in the work and atmosphere of pharmaceutical activity and it was presumed that he would become his father's successor. During his entire academic career he was a teacher and examiner of pharmacists. After having earned his Doctorate Degree at the age of twenty, he returned to his native town and worked for two years as an apprentice in his father's pharmacy. His scientific ambitions, however, urged him back to the University where he engaged in botanical research. In 1881, at the age of thirty-six, he published his fundamental work on plant physiology. The botanist, Haberlandt, stated of this book that "an enormous intellectual achievement is presented in this great work which is unique in the entire botanical literature of all civilized peoples."[14] Harvey-Gibson states that Pfeffer "greatly extended our knowledge of osmotic phenomena" as early as 1877[15] and helped to lay the fundamentals for our present concept of photosynthesis, anabolism, and transport of proteins,[16] of the linking up of respiration and fermentation[17] and of sensitivity and movement.[18]

PHARMACISTS INFLUENCED BOTANICAL STUDIES IN ALL PARTS OF THE WORLD

In all countries of the world knowledge of local floras has been decidedly promoted by practicing pharmacists. In the German and French histories of pharmacy numerous examples are given.[19] It is of special interest that the main work of exploring and describing the flora in the French colonies in

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[14] W. Haberlandt, Zum Siebzigsten Geburtstag von Wilhelm Pfeffer, Die Naturwissenschaften, Berlin, 1915.

[15] Harvey and Gibson, l. c., p. 185.

[16] Ibidem, pp. 214, 215.

[17] Ibidem, p. 221.

[18] Ibidem, p. 243.

[19] Herman Schelenz, Geschichte der Pharmacie, Berlin 1904; A. Adlung und G. Urdang, Grundriss der Geschichte der Deutschen Pharmacie, Berlin 1935; L. Andre-Pointier, Histoire de la Pharmacie, Paris 1900; M. Bouvet, Histoire de la Pharmacie en France, Paris 1937.

Algiers, Saint Domingo, Tahiti, etc. was done by French military pharmacists serving in the areas concerned."[20]

PHARMACY PROVIDES MOTIVES FOR BOTANICAL RESEARCH IN AMERICAS

In the Americas, the relation of pharmacy to botany became obvious with discovery and colonization. Botanical research began with the discovery of new vegetable drugs. The works of Nicolas Monardes, Francisco Hernandez, Charles L'Ecluse (Carolus Clusius) and other botanical authors of the 16th and 17th Centuries deal with medicinal plants of the Americas. In these works the plant drugs as such were given at least as much emphasis as the botanical aspects of the plants used as medicinal agents.

Despite the fact that professional pharmacy as an integrated and organized body developed very slowly in North America, it is significant to note that early American pharmacists were also active and productive in botanical research and the relation between pharmacy and botany was duly exemplified and bore fruit on American soil. Upon the death of the Irish born pioneer of American professional pharmacy, Christopher Marshall, Sr. (1709–1797), his biographer called him "an apothecary, druggist, botanist, and chemist."[21] The great American clergyman and botanist, G. H. E. Muhlenberg (1753–1815), consistently sought the advice of apothecaries in his studies concerning "indigenous officinalia."[22] These "indigenous officinalia," as Muhlenberg called the American plants used for medicinal purposes, may be considered as one of the most important incentives for the creation of a Pharmacopoeia of the United States of America at a time when professional medicine and pharmacy were still in the pioneer stages. The American botanist, Benjamin Smith Barton (1766–1815), in his "Collections for an Essay Towards a Materia Medica of the United States" published in 1798 referred to the desirability of giving American drugs "a place in the Pharmacopoeia of this country when such a desideratum shall be supplied."[23] The authors of the Pharmacopoeia of the Massachusetts Medical Society (1808), the forerunner of the Pharmacopoeia of the United States of America, apparently followed the advice of Barton and included a number of indigenous medicinal plants and the Boston Physician, James Thacher (1754–1844), included a greater number in the American New Dispensatory which he published in 1810 as a commentary on the Massachusetts Pharmacopoeia. In 1817–1818 Jacob Bigelow, M.D. "Rumford Professor and Lecturer on Materia Medica and Botany in

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[20] M. Bouvet, l. c. p. 304.
[21] Kremers and Urdang, l. c., p. 141.
[22] Ibidem, p. 150.
[23] Reprinted in Bull. Lloyd Libr. 1.

Harvard University" published his famous work entitled "American Medical Botany, Being a Collection of the Native Medicinal Plants of the United States, Containing Their Botanical History and Chemical Analysis, and Properties and Uses in Medicine, Diet and the Arts." Jacob Bigelow also took a prominent part in the preparation of the first United States Pharmacopoeia (1820) serving as one of the five members of the committee appointed to prepare "for the press the National Pharmacopoeia."[24] Wood and Bache in the first edition of their "The Dispensatory of the United States of America" (1833), a commentary on the United States Pharmacopoeia, made it a special point, stressed in the preface, to include "Botanical descriptions of the plants from which the medicines treated of are derived."

A typical American development characterizing the close relationship and interdependence of pharmacy to botany was the so-called "Eclectics" a group of medical practitioners whose materia medica was based fundamentally on the use of vegetable drugs. Several eclectic pharmacies were established in the east and in the middle west and one of them, Boericke and Tafel, Philadelphia and New York, sponsored the publication of Millspaugh's "American Medicinal Plants."[25] The Eclectics, under the inspiring leadership of Lloyd Brothers, John Uri, Curtis Gates, and John Ashley, also sponsored a medical school in Cincinnati, Ohio, for a number of years. The Lloyd Brothers developed a well-known pharmaceutical manufacturing plant devoted to the production of Eclectic Remedies. The fundamental text of this specific medical group was C. S. Rafinesque's "Medical Flora; or Manual of Medical Botany of the United States of North America" published in Philadelphia, 1828–1830. This book was not only an important contribution to pharmacy but also to botany. The book of John Uri and Curtis Gates Lloyd on "Drugs and Medicines of North America" should be noted as one of the later contributions of American Pharmacy to botany.[26] The Lloyd Library developed by Lloyd Brothers and now consisting of over one hundred thousand volumes, and some sixty thousand pamphlets dealing with pharmacy, medicine, and botany, is considered one of the best of its kind in existence.[27]

It has been pointed out that European pharmacists were instrumental in promoting the study of botany by establishing botanical gardens and that as a matter of fact in all countries of the world pharmacists have contributed to the knowledge of the local floras in their respective communities. The same can be said of the pharmacists of the United States. Elias

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[24] United States Pharmacopoeia 1820, p. 3.

[25] C. F. Millspaugh, American Medicinal Plants, Philadelphia 1878.

[26] Bull. Lloyd Libr. reprinted 1930 as No. 29, reproduction series No. 9; Vol. 1; Vol. 1, pt. 2; Vol. 2.

[27] Corinne Miller Simmons, The Lloyd Library and Museum—a Brief History of the Founders and its Resources. Reprinted from College and Research Libraries, June, 1941.

Durand (1790-1873), owner of a drug store in Philadelphia, was not only a botanical author of note but collected an herbarium containing over 10,000 species and over 100,000 specimens from all parts of North America. This collection was presented in 1868 to the Garden of Plants Museum, Paris, where "it has been arranged in a special gallery and labelled 'Herba Durand'."[28] Charles Deam, former state forester of Indiana and world renowned botanist, and author of excellent books on the Flora of the State of Indiana, began his career as a pharmacist in Bluffton, Indiana. Joseph E. Harned, proprietor of a pharmacy in Oakland, Maryland, quite recently (1931), published a noteworthy piece of work on "Wild Flowers of the Alleghenies."[29]

Pharmacy continues to provide incentives for study and investigation of heretofore unthought of sources of healing principles from the vegetable kingdom. Witness the spectacular development of antibiotics such as Penicillin, a new connection with botany or more specifically mycology. It has been discovered that several bacteria and molds yield antibiotic substances which have bacteriostatic properties. Their bacteriostatic capacity in vivo may differ quantitatively from that in vitro, hence, their usefulness is limited and varied because of toxicity. Apparently Penicillin, a principle of *Penicillium notatum*, is today the most useful and most important of these antibiotic substances for it is evidently sufficiently non-toxic to be used in vivo.[30] Hence, the unfolding of new vistas showing the interdependence of Pharmacy and Botany goes on and on. Undoubtedly Mother Nature still has many secrets not yet divulged to man but which may be revealed for the benefit of mankind at opportune times. It is our hope that Pharmacy will continue to play as significant a role in the discovery and utilization of nature's resources in the future as it has in the past.

[28] Am. Journ. Pharm. **45**: 508-517, 1873.

[29] K. Scarborough, Botanists Heaped Honors on Maryland Druggist, The Sun, Baltimore, August 3, 1941.

[30] Albert L. Elder, Penicillin, Sci. Monthly **58** (6): 405, June 1944.

The African Oil Palm: Its History, Cultivation and Importance

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Palm oil and palm kernel oil are among the most important vegetable oils imported into the United States. The United States has imported as much as 411 million pounds of palm oil and 179 million pounds of kernels and kernel oil in a single year (1937), after which importations were somewhat interrupted by world conditions. There is apparently a large potential market for these products here. Increased needs for vegetable oils and their valuable by-products should be an incentive to tropical American countries further to develop and exploit the vast stands of oil-producing palms which grow within their borders. It has been authoritatively stated that in Brazil the potential value of the wild babassu palm nut (*Orbignya barbosiana* Burret) crop, alone, is five times the value of the coffee crop (23). The importance of this latter crop in Brazil's economy is common knowledge.

PRODUCT AND ITS SOURCE

The palm oil of commerce is obtained from the oily, fibrous pericarp or outer layer of the fruit of numerous varieties and strains of the African oil palm (*Elaeis guineensis* Jacq.), the "Palmier à huile" of commerce, a member of the coconut family (Palmae). Palm kernel oil is derived from the kernel of the African oil palm seed. This species is one of the few palms which yield a commercial oil from both the pericarp and seed-kernel.

This palm has an erect, thick or slender, simple (rarely branched) trunk, ringed with the successive leaf-scars, and a crown composed of long, spreading, pinnate leaves from whose axils are borne the large, head-like flower clusters. The tree averages about 30 feet in height, but may attain a height of 80 feet, and the trunk is 6 to 15 inches in diameter. The staminate and pistillate flowers are borne in separate inflorescences (called "heads," "cones," or "hands") on the same plant. The oil palm at maturity (about 15 years old), should produce from 6 to 10 heads of fruit each year, but the yield may be as little as 3 heads per year. The heads weigh as much as 35 or more pounds each, and bear on the average several hundred fruits each, although sometimes as many as a thousand fruits are produced. Usually a little more than half of the weight of a head is fruit the remainder being stem and branches. The ellipsoid fruits are pointed at the apex and are 1 to 2 inches long and up to 1½ inches in diameter. When mature, they may weigh from 3 to 25 grams each and are variously colored, being

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yellow, orange, reddish brown or almost black, depending upon the variety, of which there are many. The fruit usually contains only one seed, but 2 or 3 seeds to a fruit are not uncommon. The oil content of the pericarp ranges from approximately 30% to 80%, while the oil content of the kernel is 44% to 53% (19). The proportion of pericarp to the nut is subject to extreme variations, since the seeds of the numerous varieties differ greatly in size as well as in the thickness of their shells.

Palm oil, as it exists in the fresh fruit, is an almost neutral fat, consisting of 10% glycerin, in combination with various fatty acids (6). However, during the extraction from the fruit, some fermentation inevitably occurs and part of the oil is split up into glycerin and free fatty acids, often resulting in a marked acidity in the oil. In the fresh state, the oil is said to be tasty and wholesome.

Hot palm oil is a clear red liquid, which on subsequent cooling deposits a solid. When cooled quickly the oil forms an orange-colored paste, because the solid separates in a very fine state of division. However, when it is cooled very slowly the solid (stearin) separates in a coarse, granular form and sinks, leaving an upper layer of clear red oil (olein). Palm stearin, which includes solidified glycerides of palmitic and stearic acids, etc., is a suitable material for the manufacture of soap and as a source of fatty acid for candles. Palm olein is suitable for direct use as an edible oil. However, refining is usually necessary with a consequent loss of vitamin content. Constants of the whole oil, as produced in British Malaya, are as follows (11): Temperature of total liquification, 40° to 45° C.; iodine value, 50.3 to 52.7; mean molecular weight, 846; free fatty acid content, 4.2%.

According to Jamieson (19), the range of characteristics of palm oil obtained by various observers is as follows: Specific gravity (at 15° C.), 0.9209 to 0.9250; refractive index (at 40° C.), 1.4531 to 1.4580 and (at 60° C.) 1.4451 to 1.4518; saponification value, 196 to 205; saponification equivalent, 268.9 to 279.3; iodine number or value, 48 to 60; unsaponifiable matter, 0.2 to 0.5%; titer, 38° to 47° C. (usually between 42° and 44°).

Palm kernel oil is a white-yellow fat and is similar in physical and chemical properties to coconut oil, with which it is interchangeable for most commercial uses. Unlike palm oil, kernel oil readily becomes rancid.

The characteristics of kernel oil, according to Jamieson (19), are as follows: Specific gravity (at 99°/15° C.), 0.873 and (at 40°/15.5°C.) 0.9119; iodine number, 16 to 23; saponification value, 244 to 255; Reichert-Meissl value, 4.8 to 7; Polenske number, 9.4 to 11; refractive index (at 40° C.), 1.4492 to 1.4517 and (at 60° C.) 1.4430 to 1.4435; titer of fatty acids, 20° to 25° C.; melting point of fat, 24° to 30° C.

USE AND IMPORTANCE

Palm oil is used primarily in the process of manufacturing tin and terne plate, and for making soap and stearic acid. It is used to a lesser degree in the manufacture of margarine, shortenings, edible fats, candles and lubricating greases, and more recently in the cold reduction process of producing sheet steel. Until recently, palm oil was thought to be indispensable in the tin plating industry, for which purpose the United States uses approximately 30 million pounds annually (7). Bauer and Markley, however, found that hydrogenated cottonseed oil is an excellent substitute for palm oil in the production of tin plate and cold reduced sheet steel (9); in this case, palm oil is no longer indispensable for this purpose.

In West Africa, palm oil is a basic food and for more than 100 years palm oil and kernels have been the chief articles of commerce from this region. The importance of this palm to West Africa is emphasized by the fact that the image of an oil palm tree is embossed upon a coin of British West Africa. For centuries the natives in this part of the world have practiced the extraction of palm oil, and it is extensively used by them for eating as butter, for cooking and as an illuminant and to some extent as an ointment for their bodies. In Brazil, palm oil is used locally in cooking.

According to Buckley (12), unbleached red palm oil may be recommended for culinary or medicinal use on the basis that it contains carotene, the precursor of Vitamin A. Except for its lack of Vitamin D, its potency is such that it could be regarded as a good substitute for cod liver oil. The vitamin activity is not destroyed by ordinary cooking processes. The palatability of the oil has been found to be increased by removing the solid component, and the resulting liquid is richer in carotene than the original whole oil. Since the consistency and melting point of palm oil is near that of butter, it is suitable for the manufacture of margarine. Unlike butter, it has little tendency to become rancid.

Another potential use for palm oil is that of a fuel for engines. Little research has been done in this direction, and methods for use of the oil as a fuel have not been perfected. In 1917 (21), however, experiments were conducted in Belgium in running crude oil engines on low grade palm oil with reported success. Also, in 1922 (20), in the Belgian Congo several river boats were using palm oil as a fuel, at a cost of one-third that of kerosene.

Palm kernel oil may be used in place of coconut oil and is principally used in the manufacture of soap, while glycerin is an important by-product. It is also used in the manufacture of margarine and candy and is used to a limited extent in the manufacture of pharmaceutical and toilet preparations. Palm kernel oil is especially valuable because of its high lauric acid content and glycerin yield, which are equivalent to those of coconut oil. The residual palm kernel cake, after most of the oil has been expressed, is a valuable ingredient of cattle, hog and poultry food. According to Jamieson (19), "The European oil cake contains about 16 per cent protein, 10 of oil, and 38 of carbohydrates, while the extracted meal contains about 2 per cent of oil, 19 of protein, and about 48 of carbohydrates."

According to Dalziel (16), kernel oil is used by the natives of West

Africa for cooking and illumination and for anointing their hair and bodies, and is sometimes mixed with camwood as a medicine for craw-craw, or as a vehicle for other medicines. Among some tribes the making of soap from the kernel oil, along with the ash from various trees, is said to be a considerable industry.

As early as 1909, the meat of the palm kernel was ground and placed on the market by a German firm in Mannheim as "Palmira." This was a hard, snow-white vegetable cooking fat. When mixed with egg-yolk and water it was found to make an acceptable substitute for butter.

In West Africa, the tree, itself, is utilized by the indigenous population in the making of wine, for food and shelter, and in the production of fiber. Fiber is laboriously extracted from the leaves and used extensively along the coast of the Gulf of Guinea for fishing lines and other purposes requiring a fiber of great strength (3). The fiber is not as yet produced in commercial quantities, although it is considered to be one of the most valuable and lasting of tropical fibers.

Dalziel (16) gives an excellent account of the uses made of the oil palm by the West African natives. He writes, "The petioles . . . are used for hut poles and rafters, fences, beds, etc., and are occasionally used for torches. A coarse fibre . . . can be extracted from the outer layer. From the young leaflets a fine fibre of great strength and elasticity is prepared and used for fishing-lines, snares, fine cordage, plaited articles, fly-whisks, strainers, etc., but no economic method of extraction has been devised. A coir-like fibre at the base of the petiole . . . is used as tinder. It was at one time made into a coarse cloth. The midribs of the leaflets are tied up to use as brooms, and the inner portion of the fruit-stalk beaten out makes a short brush used for cleaning the stones used for grinding corn. From the same material in Gold Coast a fibre is extracted and made into hair-brushes and tooth-brushes."

Dalziel also states that the broken shells are put on forest paths as a substitute for gravel, and are beaten into the earthen floor of huts. He notes that "The shell is also polished and carved into ornamental objects or cut into flat beads and rings, the larger sizes worn by women as waist-bands . . . and often regarded as of considerable value, the smaller as armlets and necklaces." The stem is not considered durable and is subject to attack by termites. It is, however, occasionally used for rafters, bridges, fences, etc., and a fiber, which is used for twine, fish traps, strings of musical instruments, etc., is obtained from its base (16). In some parts of Africa the natives use the leaf-stalks to build their houses and barns, and the leaves are used for thatching. Some of the more primitive tribes use the palm fruit as an article of barter. These practical and domestic uses of the oil palm have, to some extent, a direct influence upon the production of oil in these regions.

The large terminal bud, known as "palm-cabbage," is often used as a food. Its removal always results in the death of the tree. The African natives tap the oil palm to obtain the fermentable sap to make palm wine, a beverage with an alcoholic strength of nearly 6%. Usually a deep incision is made in the stalk of the male inflorescence, the immature infrutescence or in the growing point of the palm. In some cases, the tree is felled and tapped below the crown of leaves, the flow of sap being stimulated by fire (16). The wine is said to be commonly used as yeast in making bread. In certain regions of the Ivory Coast the palm is said to be cultivated solely for the wine.

Among the fats and oils imported into the United States, palm oil ranks next to coconut oil in point of volume (9). The world's largest exporters today are European colonial possessions in West Africa, mainly British West Africa (especially Nigeria), the Belgian Congo and French West Africa, with a small amount exported from Latin America, primarily Brazil. Nigeria and the Belgian Congo, alone, have supplied approximately three-fourths of the world's production of palm oil and kernel oil. Before the present war, the Netherlands Indies and British Malaya supplemented greatly the palm oil and kernels imported from West Africa.

In 1931, the United States imported 258 million pounds of palm oil and 39 million pounds of palm kernels and palm kernel oil. Following this there was a steady yearly increase of importations (with minor fluctuations) until a peak was reached in 1937, during which year 411 million pounds of palm oil (valued at about 23 million dollars) and 179 million pounds of palm kernels and palm kernel oil (valued at about 11 million dollars) were imported (28). The bulk of this oil and kernels came from the Netherlands Indies, Belgian Congo and Nigeria. Since 1937, however, there has been a sharp decline in importations, and, in 1939, only 288 million pounds of palm oil and a little more than 2 million pounds of palm kernels and palm kernel oil were imported (29). Considering the steady increase in importations into the United States up to 1937, apparently interrupted by world conditions and not the lack of a market, there should be a large, steady market in the United States for palm oil and kernels after the war.

HISTORY AND DISTRIBUTION OF PLANT, WILD AND CULTIVATED

The African oil palm is today found spontaneously or under cultivation throughout most of the tropics. It occupies a large part of coastal West Africa in a belt up to 300 miles across in some places, from the Cape Verde region in French West Africa, south to below São Paulo de Luanda in Portuguese Angola. Within this region the palm is most productive along the northern side of the Gulf of Guinea from Sierra Leone to the Cameroons (4). It also extends far inland in forested regions where it is found near Lake Tanganyika, on the Zambesi River, and on the west shore of Lake

Nyassa in the south, and northward to the southern frontier of Wadai, Ubangi, the Upper White Nile and the Albert Nyanza. The oil palm is often of local occurrence in some of the Central African regions, and may be of comparatively recent introduction. It is also found sparingly in East Africa in Uganda, Tanganyika and Zanzibar, where it is less productive than in West Africa.

The regions of West Africa where palm oil is produced for commerce include Angola, the Cameroons, Belgian and French Congo, Dahomey, Guinea, Gaboon, Gambia, the Gold Coast, the Ivory Coast, Liberia, Nigeria, Portuguese Guinea, Senegal, Sierra Leone and Togoland.

The oil palm also occurs, either as an introduction or spontaneously, in Brazil, British Guiana, Venezuela, Colombia and the West Indies, especially in regions situated on or near the coast. It has been introduced as an ornament or for food throughout the tropics and subtropics of the world, and in recent years it was being developed very successfully as a plantation crop in the Netherlands Indies (Java and Sumatra), British Malaya and, to some extent, in West Africa and Brazil. It has also been introduced into Ceylon, and Indo- and Cochin-China, but its development has been slow in these places. The oil palm grows well in southern Florida, where it is hardy as far north as Orlando (13). It is known to have been introduced from the Philippines in 1899 and from the Gold Coast in 1902.

The African oil palm was originally thought to be indigenous to West Africa, whence it had been introduced into the Western Hemisphere. In recent years, however, some authors have considered it to be a native of Brazil and an introduction into Africa. As late as 1940, Cook (13) asserted that although the oil palm could have been taken from Africa to the West Indies in the 17th century, an earlier transfer might have been made from Brazil to the Portuguese slave-trading settlements in West Africa. Regardless of its origin, the oil palm is now well-established in Brazil, where man, animals and birds have caused it to become widely distributed.

According to Cook (13), "Palm oil began to figure as a commercial article in the period of the slave trade, that at first was conducted by way of Brazil. Even before the discovery of America, Portuguese missionaries had worked among the natives of the Congo, and the Portuguese colonies in Brazil were the first agricultural settlements in America. The use of the palm oil in Brazil apparently goes back to colonial times."

Although the oil palm was known and utilized for some time before, it was not formally known to science until 1763 when it was described and figured from Martinique by Jacquin (Selectarum Stirpium Americanarum Historia 1: 280; 2: t. 172). Believing that the tree had been introduced from Guinea, Jacquin gave it the specific name, *guineensis*. He also noted that he had never observed it in a wild state in America. In 1767, Linnaeus adopted Jacquin's name in his "Mantissa" (vol. 1:2 1), where he spelled the generic name as "Elais." The nut and seed were later described and figured (as *E. melanococca* Gaertn.) by J. Gaertner in 1788 (De Fructibus et Seminibus Plantarum, vol. 1: 18, t. 6, fig. 2).

The development of the oil palm as a plantation crop in the East Indies was begun only about 30 years ago. Although it was first introduced into Java and Sumatra in 1848, the oil palm did not receive serious attention until about 1910. It was not until 1918 that attention was directed to possibilities of developing this crop in Malaya (17). Present world conditions terminated an enterprise which had developed by 1935 into an agricultural export industry which ranked fourth in importance in Malaya. Plantations have been developed to a limited extent in West Africa, particularly in the Belgian Congo. Plantation methods have, however, been applied in many regions of West Africa to the vast stands of naturally produced trees which are readily accessible.

HORTICULTURE

In nature, the oil palm is found on a variety of soils. It has been found to grow best in deep, well-drained, moist humus-soils in warm regions of at least 50 inches annually of well-distributed rainfall. It seems to produce equally as well in any region where the rainfall ranges between 70 and 250 inches (4). Because of its sensitivity to drought, however, prolonged dry periods even in a region of abundant rainfall affect the production of oil. The oil palm will not thrive in heavy, swampy or peaty soils, nor is it tolerant of shade. Those palms found growing in dense jungles have been sown mostly by birds or animals and are usually spindly and often sterile. In West Africa, it flourishes in extensive almost pure stands in warm, damp valleys and lowlands, but it may be found on grasslands up to 2,000 feet altitude in the Cameroons, where it still produces fairly good crops (5). The upper limit of the oil palm may be considered to be about 4,000 feet in the Cameroons. At this altitude, however, it does not attain its normal height and development, but it can still be tapped for wine.

The oil palm is said to thrive in Liberia on high, sandy beaches exposed to the sea breeze, or along the coast in gravelly laterite soils around native villages which are more or less permanently located (13). There are an estimated 40 million mature oil palms in Liberia which are said to form forests so dense that production of the fruit is seriously hampered (19). It is thought that Liberia would eventually become an important source of this oil if these forests were properly thinned. In Sumatra, the oil palm will grow inland on gently undulating land and has been planted up to an altitude of 1,000 feet where the same success is met with as in plantations nearer to the sea (24).

Palm oil has for several centuries been a basic food of the natives of West Africa. As an industry, however, it has existed only since about 1790.

and the valuable palm kernel industry did not attract attention until about 1842 (3). Since that time palm oil and palm kernels have become the major export products of West African trade.

In parts of West Africa the natives have practiced a crude form of conservation and plantation procedure. They, as well as animals and birds, have aided the spread of the oil palm by discarding seeds around their villages and along the trails. In the Belgian Congo, the natives are said never to cut a palm tree (20). They make clearings for their crops around trees and then, after several years of cultivation, abandon the area to the palms. This system of shifting cultivation has greatly facilitated the spread of the oil palm in West Africa, and accounts to some extent for the abundance of the palms in secondary forests. To some extent, oil palms are cultivated and protected for palm wine. However, the destructive methods of obtaining the sap by tapping or felling the trees, as practiced in some regions, are not conducive to the production of more oil.

The application of plantation methods to the already existing vast forests of oil palms in West Africa, particularly in the Belgian Congo, began in 1910, about the same time that serious attention was given to establishing plantations in the Netherlands Indies and British Malaya. Large concessions were obtained by business interests in the Belgian Congo and selection and thinning in the groves were undertaken. Trees between the ages of 10 and 20 years were considered the most productive and, consequently, were the ones selected in establishing the groves. Several thousand acres were also planted during this early period, and a steady increase in plantations has continued ever since. Today, there are said to be about 275 thousand acres of oil palms under cultivation in the Belgian Congo (9).

Up to 1942, the Netherlands Indies and British Malaya had developed the plantation system to an extremely productive level. Through a well-planned and scientific program, with its goal the production of palm oil with a minimum of waste and a maximum of quality, these colonies had made rapid progress during the thirty years since oil palm plantations were started. A large part of our horticultural literature concerning the oil palms is the result of experiments and investigations undertaken in these colonies. Experimental plantations have also been set out in various other parts of the tropics, such as the Philippines and Madagascar.

Although the oil palm was introduced into Sumatra in 1848, the impetus to produce oil on an estate scale did not develop until about 1910. By 1932, 155,000 acres had been planted in Sumatra, of which 97,120 acres were fruiting at that time (22), and in British Malaya 61,025 acres had been planted, of which 17,974 acres were producing (7). There is every reason to believe that up to the outbreak of the war thousands of additional acres had been planted and were in bearing.

In establishing oil palm plantations in the East, selection of terrain and soil corresponding in physical conditions to that in which the palm grows naturally was of the first consideration. In Malaya, an alluvial loam with a clay subsoil was considered to be among the most suitable for growing the oil palm (17), and the palm was found to be at its best on well-drained flats of deep rich soil with abundant atmospheric and soil moisture. The flat coastal areas and areas along certain river banks were found to be suitable if properly drained. Light, sandy soils or swampy soils were considered undesirable and detrimental to the palm.

The entire procedure of propagation and horticultural technique in the treatment of oil palms in Malaya has been so concisely stated by Eaton (17) that it seems best to quote his statement in its entirety, supplementing it where necessary with additional information. This procedure described by Eaton is essentially that used or followed by others in developing oil palm plantations, and is applicable to oil palm plantations wherever they may be.

"The palm is propagated from seed which is planted in suitably prepared nursery beds consisting of nearly pure sand about one foot deep. Ripe fruit only should be selected, and after removing the pericarp (outer fleshy and fibrous layers of the fruit) the nuts should be planted at once just below the surface of the soil. The seed germinates very slowly, even in the case of seed from fresh ripe fruits, so that unless seedlings can be purchased from other estates the preparation of nursery beds and the planting of seed should be one of the first operations on the estates. The nursery beds should be exposed to the sun and kept moist by constant watering.

[Curtler (15) found that germination of oil palm seeds could be expedited and a higher percentage of germination could be obtained by soaking the seeds for one week in warm water or for two days in 1% hydrochloric acid, rinsing afterwards for two days. The majority of viable seeds from 2½ year old palms were found to germinate more quickly than old seeds and those fermented germinate more quickly than untreated seeds.]

"When the two-leaf sheaths appear about the ground, which may not be for two to three months, the seedlings are removed from the nurseries and planted about 1 to 1½ feet apart in another prepared nursery bed on flat land, where they remain until ready for transplanting in the field, which may be from eight to ten months later. [Seedlings are usually planted 30×30 feet apart, giving about 55 trees per acre.] The holes for planting should be dug about 2 ft. square by 2 ft. deep and filled with good surface soil, and the seedlings should be planted so that the base of the leaves is just above the soil surface. The area for several feet around each palm should be forked three or four times per annum. The whole area should either be kept free from weeds or suitable green (leguminous) cover crops should be planted. [Lamtro (*Leucaena glauca* (L.) Benth.) is commonly grown, with a mixture of *Centrosema pubescens* Benth. and *Pueraria phaseoloides* (Roxb.) Benth. sown between the rows of lamtro.] If the land is clean-weeded and the area is flat and has been cleared of all timber, ploughing and harrowing can be done at intervals.

[Dalziel (16) writes, "The tap-root of the seedlings soon disappears and lateral roots from the bole develop. These form a network of secondary feeding rootlets in the upper layers of the soil which anchors the tree. Adventitious or aerial roots also may develop, and some of the secondary roots develop pneumathodes composed of spongy tissue concerned with aeration so that the palm can withstand submersion."]

" . . . After the palms come into bearing in the third to fourth [sometimes as much as 8 years are needed, depending on the location] leaf pruning is usually carried out by removing the fronds below the bunches of fruit shortly before the fruit ripens. In no case should drastic pruning be adopted since this affects fruit production, and the palms are also liable to be attacked by beetles, resulting possibly in the death of the palm.

"Male and female inflorescences (flowers) are borne by the same palm, but not necessarily at the same time, hence pollination of the female flowers is effected by pollen from the male flowers on other palms - i.e., cross pollination takes place. The female flowers have been proved to be receptive for only two or three days, and only during this period can they be fertilised. Experience in the East has shown that natural pollination [normally by wind] in the case of the young palms often fails, and this has led to experiments on artificial pollination by hand. [Artificial pollination was practiced as early as 1864 in Java.] The pollen is collected from the male flowers by shaking these over a funnel which is held over a suitable receptacle . . . into which the pollen falls. [If kept dry, pollen will maintain its germinating power for 2 or 3 months.] The pollen should be collected preferably in the afternoon and dusted on the receptive female flowers during the following morning. The ripe inflorescences are noted by the distinctive odour of aniseed which is emitted, while the colour and other characters of the female flowers also indicate their receptivity."

Artificial pollination results in a much greater yield, but the process is said to exhaust the trees and impoverish the soil (16). This can be overcome to some extent by manuring and by controlling pollination.

Some experiments have been undertaken to develop improved varieties through natural and scientific selection. This work has been undertaken, however, only in recent years and there has not been sufficient time to obtain definite results. There is little doubt, however, that oil production can be increased through plant breeding to increase the yield of fruits and to raise the oil content of the pericarp and kernels. The palms of West Africa are said to yield fruits with a thin pericarp and thick shell which give relatively a small amount of palm oil and a large amount of kernel oil, whereas those in Malasia yield fruits with a thick pericarp and a relatively small amount of kernels, thus giving a larger amount of palm oil in proportion to kernel oil (7). The so-called African types are said to be variable as to shape of fruit and thickness of shell and are not constant in inheritance (25). On the whole, the fruits obtained from plantations in Malasia are said to be heavier and richer in oil than those from wild palms in West Africa. This may be considered the result primarily of selective planting in Malasia. It may be, however, the result of climatic differences of the two regions; a very humid type of climate prevails in Malasia where the palm is cultivated, whereas a drier type of climate is prevalent in the region of its native habitat in Africa and also in Brazil. As Dalziel (16) noted, the oil palm " . . . is more luxurious and productive in the equatorial zone than in regions where the dry season is prolonged. In general the yield of oil is more and the proportion of kernel less in climatic conditions approaching the equatorial type, and the reverse in more distinctly tropical conditions of less rainfall with a well-marked dry period."

The desired palm is one that produces a large crop of fruits with a thick pericarp having a high percentage of oil, together with a thin shell and a large kernel of high oil-content.

There is a host of so-called varieties or types of oil palms which bear vernacular and, in some cases, scientific names. The vernacular names are legion since the same type may bear a different name in each country or community where it grows. There is some question as to the taxonomic status of the varietal names applied to the oil palm. There are, however, some few outstanding and well-known types of commercial value. These varieties or types are based, for the most part, on arbitrary characters such as the thickness of the shells, the relative percentage of pericarp and its oil-content, and the relative percentage of kernel and its oil-content. Such a basis for designating varieties can be misleading since the oil-content of the pericarp of fruits from various heads from the same tree can show differences of 20% to 25% (25). It is difficult to determine whether the differences in the types or varieties are the result of genetic influences or are entirely environmental, or both. It is known that oil production is affected by local soil and moisture conditions and it is believed that geographic location may also influence fruit formation and development, with a consequent effect on the quality and amount of oil produced. Jamieson (19), however, suggests that " . . . the variations found in the composition of the oils are due largely to the inherent varietal characteristics of the palms themselves rather than to differences of their environment."

No attempt has been made to evaluate, from a taxonomic standpoint, the large number of proposed varieties or "types" which comprise *Elaeis guineensis.*

Some of the better known accepted varieties of commercial importance and some of their characteristics are as follows:

The "Congo type" ("var. *macrocarya*") is common in the Belgian Congo and is thick-shelled, the shell being 4-8.5 mm. thick and comprising 50% by the weight of the fruit.

The "Deli type" ("var. *dura*") comprises the bulk of the oil palms grown in Sumatra and to some extent in British Malaya. It has large fruits and is thin-shelled, the shell being 2-5 mm. thick, and comprising 30% by weight of the fruit. The fruit forms are said to be constant by inheritance and the production, measured in weight of fruit heads, is high (22).

The "Lisombé type" ("var. *tenera*") is commonly grown in British Malaya and is thin-shelled, the shell being 1–2.5 mm. thick and comprising 10% by weight of the fruit. This variety is said to be ideal but does not breed true to type and is therefore not safe for plantations (18).

The "Pisifera type" ("var. *pisifera*") has no nutshell and only a small kernel. It is doubtless an abnormality and is not important because of its low yield of fruit

Dalziel states that all four forms can be produced by self- or cross-pollination of palms with "var. *tenera*" (16).

The basis for selection and planting of oil palms should be on the total yield from individual trees of a given variety in a particular region. In this way the variety best suited to a particular region could be found and experiments could then be undertaken to improve it. This entails a long-range program.

Some work has been done on the analysis of the fruits of the oil palm from various regions. Some of these analyses are given below.

The following analysis was made of fruit obtained in Sierra Leone. After having been picked for two days the fruits were placed in cold storage for 25 days before the analysis was made (27): Pericarp, 48.4%—palm oil, 72.93%; moisture, 15.55%; free fatty acid in palm oil (as palmitic acid), 6.86%; Nut, 51.6%—shell, 60.3%; kernel, 39.1%—palm kernel oil, 45.56%; moisture, 13%; free fatty acid in kernel oil (as lauric acid), 00.69%.

According to Eaton (17), the fruit grown in British Malaya has the following average composition: Pericarp, 58%—palm oil, 53%; moisture, 33%; fiber and residue, 14%; Nut, 42%—shell, 85%; kernel, 15% palm kernel oil, 43%; moisture and residue, 57%; Palm oil in whole fruit, 31%; Kernel in whole fruit, 7%.

According to Geraldes (18), the average composition of some of the varieties grown in Angola is as follows:

"Variety *sempernigra*": Pericarp, 48.87%—palm oil, 46.32%; water, 39.19%; residue, 14.49%; Nut, 51.12%—shell, 77.37%; kernel, 22.62%—palm kernel oil, 42.19%; water, 15.69%.

"Variety *communis* forma *dura*": Pericarp, 51.77%—palm oil, 44.35%; water, 40.29%; residue, 15.36%; Nut, 48.22%—shell, 75.16%; kernel, 24.83%—palm kernel oil, 42.13%; water, 16.59%.

"Variety *communis* forma *tenera*": Pericarp, 71.45%—palm oil, 44.70%; water, 40.53%; residue, 14.77%; Nut, 28.55%—shell, 51.39%; kernel, 48.60%—palm kernel oil, 45.02%; water, 11.50%.

"Variety *macrocarya*": Pericarp, 47.64%—palm oil, 51.82%; water, 33.50%; residue, 15.43%; Nut, 52.35%—shell, 77.81%; kernel, 22.19%—palm kernel oil, 49.06%; water, 6.67%.

"Variety *repanda*": Pericarp, 50.23%—palm oil, 51.94%; water, 36.68%; residue, 11.38%; Nut, 49.76%—shell, 76.24%; kernel, 23.75%—palm kernel oil, 42.68%; water, 14.47%.

"Variety *intermedia*": Pericarp, 73.36%—palm oil, 45.28%; water, 41.62%; residue, 13.10%; Nut, 26.63%—shell, 49.92%; kernel, 50.07%—palm kernel oil, 48.91%; water, 11.06%.

On the east coast of Sumatra the fruit of the Deli type, the large-fruited variety, has the following composition (25): Pericarp, 52%—palm oil, 28 to 29% (the oil of the pericarp averages 16 to 17% of the weight of the fruit-head); water, 24%; residue, 10%; shell, 30%; kernel 7 to 8%; palm kernel oil, 45 to 50%.

The oil palm yields throughout the entire year, there being very few months of the year when a substantial yield of palm fruits is not available. When the palms are intensively cultivated, however, two well-defined fruiting periods become pronounced, aggregating to nearly six months each year (26). In Lagos, Nigeria, the world's greatest palm oil region, the main crop is gathered during the period from February to May.

Forest-grown trees have been found to respond quickly to cultivation provided they are young enough. Trees between the ages of 15 and 30 years, whether forest-grown or cultivated, are considered to be at their prime in the production of oil. Those above 30 years of age should be discarded; the production of oil, however, may continue until a tree is 60 years or more of age, but the decline is noticeably perceptible after the fortieth year.

When oil palms come into full bearing (about the fifteenth year) they produce from 6 to 10 bunches of fruit each year. The yield of oil should amount to at least 2,000 pounds per acre per year and the yield of kernels about 500 pounds per acre per year (17).

In West Africa, the natives usually cultivate their gardens among the palm trees, and in many places where the oil palm is cultivated catch crops are grown. These are usually leguminous plants, among which are French beans and pigeon peas, and also maize and garden produce. In British Malaya, maize, sweet potatoes and groundnuts are commonly cultivated in the oil palm plantations.

In most cases, artificial fertilizing of the soils has been found unnecessary. Belgrave (10), however, found that in Malaya, if the yield of oil was less than 1,500 pounds per acre per year (estimate based on 55 eight year old trees per acre) on normal soils of an inland type, manuring with phosphatic manures was remunerative. Rock phosphate was found to be as good as basic slag for this purpose. The addition of nitrogen and potash did not seem to be necessary. In Sumatra, the most usual form of manuring was by the use of Cheribon rock phosphate applied annually at the rate of 4.4 pounds per palm, broadcast over the soil (22). Also, in addition to artificial fertilizer, all trash and fruit residues from the factory were returned to the plantations. In most plantations leguminous plants are grown as catch crops or simply to enrich the soil. It has been observed that the productive soils are often poor in lime, phosphate and potash, neutral or alkaline and usually rich in humus.

Excluding damages done to the fruits of young palms by rodents and other animals, cultivated palms have been comparatively free from attack by pests and fungus diseases. However, the rhinoceros or coconut beetle (*Oryctes rhinoceros* L.) and the red-striped weevil (*Rhynchophorus ferrugineus* (Oliv.)) have caused some damage (21). The rhinoceros beetle has been known to cause the death of oil palms (23). In West Africa, a fungus (*Ganoderma* sp.) has been observed to cause trunk rot and the boring beetle (*Oryctes owariensis* Beauv.) has caused some damage (30). Several species of caterpillars (*Psychiae* and *Limacodidae*) have been found on oil palms (24). These might become serious with the planting of larger areas of trees. The grub of the beetle, *Pachymerus nucleorum* of authors, has been found to damage the nuts in British Guiana and Brazil. It is thought by some that the numerous beetles which have been referred to the above name, are a major deterrent to the development of the oil palm in Brazil. The grub of the beetle, *Coelaenomenodera elaeidis* Maulik, has been recorded as attacking the foliage in the Gold Coast, which is said to greatly affect the production of oil. Two scale insects, *Aspidiotus destructor* Sign. and *Ischnaspis filiformis* Dougl., have been recorded as occurring on oil palms in the Seychelles Islands. In Malaya, a little understood rot which affects the fruit-bunches in high-yielding strains has been observed (1). This rot was thought to result from a nutritional disturbance caused by soil deficiency. It was also thought that this nutritional disturbance might either be aggravated or induced by artificial pollination, since this would result somewhat in an artificial dislocation of the nutrient supply. The normal life span of the oil palm is estimated to be somewhere between 100 and 200 years.

HARVESTING AND PROCESSING

The major difficulties encountered in the growing of oil palms on a plantation scale are the gathering and transporting of the fruits and the lack of adequate methods and machinery for extracting the oil from the pulp and for cracking the thick, hard shells in order to obtain the kernels. In some regions, the lack of labor to work the plantations is a problem. In planning a plantation, a thorough network of communications between all parts of the estate and the factory or factories should be included.

In plantations, oil palms do not at first grow very tall and for the first few years, until the trees are about 12 years of age, it is possible to gather the heads of fruits from the ground. This is seldom true, however, of those trees growing in nature. Since the average height of a tree at maturity is about 30 feet, it is necessary to climb it in order to harvest the fruit. This is the method employed by the natives of West Africa. The African climbs the palm by means of a rope, loop or belt around the tree and himself. With his feet against the tree and his back braced in the hoop he is able to maintain his balance. By throwing his body suddenly forward a little he throws up the hoop and takes a step. This is rapidly repeated until he reaches the top of the palm.

The mature fruit bunches are cut and conveyed to collecting sheds for several days storage in order to complete the ripening of immature fruits or are brought directly to the factory for processing. The fruit, in any case, should not be allowed to ferment since the oil is split up into free fatty acids and glycerin if fermentation occurs. If possible, the fruit should be treated the same day it is harvested because as soon as the bunch is cut, and especially if the fruit has been bruised in any way, the formation of free fatty acids begins, with consequent loss of glycerin.

Palm oil is almost always extracted in the countries of production, whereas the kernels are almost entirely shipped to European countries and the United States where the oil is expressed. The bulk of palm oil is prepared by primitive native methods along wasteful and inefficient lines, and for the most part, is of a quality inferior, because of its high free fatty acid content, to that produced on plantations. The native methods obtain only 7 to 10% of the oil, whereas a modern factory should obtain about 25% (20) or more. The percentage of free fatty acids present in the oil depends on the extent to which fermentation has occurred and is usually an indication of the method by which the oil was prepared, whether by natives or by a modern method (6). Since the freed glycerin, unlike the free fatty acids, is soluble in water, especially if it is hot, and is lost during the extraction of the oil, it is assumed that the free fatty acid content of an oil is inversely proportional to the glycerin content. Therefore, each 10% of free fatty acids indicates a 1% loss of glycerin (6). Oils with a high glycerin content, with a consequent low percentage of free fatty acids, command the highest prices. The lower the free fatty acid content (below 6% is best), the more suitable the oil is for edible purposes.

Different methods of extracting the oil are employed by the natives of West Africa; the methods employed vary in details according to the locality. Fermentation processes are the ones commonly used. In these methods the fruits are first warmed or boiled, or placed fresh in a leaf-lined pit where, after they are moistened and covered with leaves, they are left to ferment for a certain number of days (usually about 2 weeks) before the oil is extracted from the pulp, which by that time is easily separated from the seeds. The fruits are then removed from the pits and placed in a stone-lined hole and pulverized, after which the crushed fruits are transferred to another hole lined with a mixture of palm oil and wood ashes where the mash is left for about a week. Oil collects in the bottom of the pit. Additional oil is removed by boiling the pulp in water. This fermentation greatly increases the free fatty acid content of the oil produced, sometimes as much as 70% (27). Some natives boil the perfectly ripe fruits, after which the nuts are removed and the pulp is kneaded under water so that the oil floats free on the surface where it is skimmed off and clarified. This method is said to produce a very good edible oil comparable to that produced by modern methods (20), and is much superior to that ordinarily prepared for export.

There are not many instances of adulterations in palm oil. Nevertheless, some adulteration of oil has been practiced on the Gold Coast (2). A peculiar fine, red earth is said to be used for mixing by the middlemen and sometimes over-ripe plantains and sour kanki (*Borassus* sp.?) are mixed with the oil.

Modern methods for the extraction of palm oil involve the use of solvents and the centrifugal and press systems, all of which seem to be efficient although the press system recovers more oil but is said to be more expensive to install. The oil from palm kernels is extracted by solvents or expressed by the use of various types of hydraulic presses, similar to those used for expressing oil from other oil-bearing seeds. Some mills grind the press cake and extract it with solvents for further recovery of oil (19).

The entire head of fruits is usually first heated in hot water or sterilized with steam before the fruits are removed by a threshing machine. Heating or sterilizing the fruits before bruising inactivates the enzymes, which otherwise rapidly split the fat into free fatty acids and glycerin, resulting in an oil unsuitable for edible purposes.

In the press system, as used in Sumatra, the first pressing of the fruits is made under comparatively low pressure (below 100 atmospheres) and yields only oil mixed with a considerable amount of water but otherwise pure. The fruits are then dried in the sun, depulped, heated with steam, and again pressed under high pressure (about 425 atmospheres) in order to remove the remaining 20% of oil. The dried pits are then cracked and the kernels are separated and pressed.

The centrifugal system, as used in British Malaya (17), is essentially as follows: The fruits, after being threshed from the heads, are placed in large cylindrical steamers or kettles and steam-heated for about 15 minutes at a pressure of about 3 pounds above atmospheric. In this way, the fruit is sterilized, the oil is rendered more fluid and is also partly liberated from the pericarp. The hot fruit is then placed in steam-heated centrifugal machines, similar to those used for extracting sugar from the concentrated cane juice in sugar factories. In these machines, the oil is efficiently separated from the pulp and is then conducted into settling tanks where it is separated from the water and any dirt or trash which may be present. The oil floats on top of the water and is drawn off through pipes into suitable containers. The residual pulp and nuts from the centrifugal machines are then passed through a horizontal cylindrical rotary dryer, which is heated by exhaust gases from the steam-boiler. This treatment almost completely separates the oil-free pulp from the nuts. It is necessary, however, to transfer this mass to rotary sieves in which the complete separation is effected. The fiber is used for fuel in the boilers and the nuts are transferred to nut-cracking machines. After the nuts are cracked the shells and kernels are transferred to a brine bath of suitable density, in which the heavy shells sink and the kernels float. The kernels are then skimmed off in wire baskets and the shells in the bottom of the bath are recovered. Both are transferred to centrifugal machines in which the adhering brine is recovered and returned to the bath. The shells are used for fuel and the kernels are bagged for shipment.

THE OIL PALM IN AMERICA

As noted above, the oil palm is now well-established in the American tropics, especially in Brazil, where it is thought by some authors to be indigenous. It seems quite possible that a plantation system of palm cultivation similar to the Malayan, Sumatran and Belgian Congo developments might be realized in tropical America. In many regions of Central and South America both edaphic and climatic factors are favorable for such a development. The problems of an adequate supply of labor and means of transport should be overcome in time.

Cook (13) advocates the planting of oil palms in Florida, where they will grow well and yield regularly, primarily for the purpose of producing edible oils for local consumption. He also emphasizes the necessity of planting the palms in clumps so as to insure cross-pollination with consequent assured fruit production. It would seem that, considering the lack of large areas of suitable land in Florida, the oil palm could never be grown on a commercial scale in the state. The most feasible plan would be to cooperate with tropical American countries in the development of oil plantations within their domains.

In 1942, a United States Oil Commission (23) investigated, among other things, the possibilities of assisting Brazil to develop the vast stands of oil palms growing in that country. They found that several of the Brazilian States could become large producers of palm oil and palm kernels on a plantation basis, particularly the State of Bahia, which produced more than 30 thousand pounds of palm oil in 1940. The Commission found that the African oil palm, known as *dende* palm in Brazil, is widely distributed over the State of Bahia, there being an estimated 1,500,000 trees in that State, alone. If this estimate is correct (on the basis of 55 trees per acre as is customarily planted in plantations) there are in Bahia about 27 thousand acres with a potential production capacity of approximately 50 million pounds of palm oil and 13 million pounds of palm kernels annually. Since the trees are doubtless scattered over a vast area which could support the oil palm, thousands of additional acres could probably be planted in Bahia. One plantation observed on Itaparica Island, in Bahia, contained 37 thousand trees and was producing palm oil and kernels. An estimated 300 thousand trees, thought originally to have been introduced from Africa by the Portuguese, grew on the island. The oil palm is thought to have started as a door-yard industry in both Bahia and West Africa. That is, the caboclo (native) in Brazil would plant a few trees in his yard and use the oil for home culinary purposes.

Other coastal States of Brazil, in areas where there is sufficient rainfall, and fertile regions in the interior in the State of Matto Grosso, and in northern Minas Gerais were thought to be equally suitable for the cultivation of the oil palm. However, the ever-present problems of lack of transportation, modern machinery and labor were found to be barriers to overcome in these States.

The Commission strongly recommended that technicians in the United States who were familiar with the plantation development of the oil palm industry in the Netherlands Indies, British Malaya and Belgian Congo be sent to Brazil to work there with the Federal and State governments in ascertaining the localities where the *dende* palm will best flourish and will, therefore, be most profitable when grown on plantations.

The two types of oil palms now used in the plantation development in Brazil are the "sombra" variety, which produces a medium-sized fruit, and the "caboclo" variety, which was developed in Bahia. The latter variety produces an enormous fruit cluster and the individual fruits are said to be as large as a small apple.

The *corozo* palm (*Alfonsia oleifera* H.B.K. or *Corozo oleifera* (H.B.K.) Bailey), of Central America, Colombia and the Amazon region, formerly confused with *Elaeis melanococca* Gaertn. (a synonym of *E. guineensis*), produces fruit that yields both palm oil and kernel oil, similarly to the African oil palm. It is said to be tolerant of shade and grows in marshy places, swamps and on wet clay soils. This being the case, this species might supplement *Elaeis*, which cannot tolerate these conditions, with the result that an undulating country with poor drainage might be completely utilized for palm plantations. The fruit is said to consist of 16% pulp, 62%

shell and 22% kernel, and the pulp to contain about 30% of an orange semi-liquid oil (19). In Panama, small use is made of the oil of the *corozo* palm in cooking and eating, and to some extent as a medicine, hair tonic, illuminant and leather softener.

Vast stands of additional oil-producing palms occur in the wild from Mexico to southern Brazil. The full value of this great natural wealth and resource is not yet fully recognized. With the rise of new and greater needs for vegetable oils and an increasing market, it should not be long before commercial production of these oils reaches a much higher level than ever before.

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The Taxonomy of the Mexican, Central American and West Indian Species of Ouratea (Ochnaceae)

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The history of the Mexican, Central American, and West Indian species of the arborescent genus *Ouratea* revolves mainly about the work of four authors: Engler (American species), Urban (Antillean species), van Tieghem, and Riley (Mexican, Central American and West Indian species). While Engler in his treatment (2), described several species and made numerous combinations, his correlation between the North American species and the South American species is particularly interesting. Van Tieghem (7), in his monograph of the Ochnaceae, elected to divide the genus *Ouratea* into thirty-four genera, describing ten species from North America. Unfortunately his descriptions of species are poor, with undue emphasis on anatomical characters. In this paper I am reducing to synonymy seven of these species. Urban in his *Symbolae Antillanae* (6), in addition to a fine bibliographical survey, includes numerous combinations of van Tieghem's species; I have retained two of the six species proposed by Urban. Riley's more recent treatment (4) of the Ourateae is well-balanced although few specimens are cited. Since Riley's survey, three species have been described by Britton, all of which I am reducing to synonymy, and three species proposed by Standley, one of which I am retaining. If the fifty-five specific names in current use for the North American species of the Ourateae, twenty-six are valid, one is deserving of varietal rank, three are doubtful because of inadequate description and lack of material, and twenty-five are invalid. I am describing two new species in this paper.

Planchon (Hook. Lond. Bot. **6**: 12. 1847) sums up well the difficulty one has in studying the genus *Ouratea:* "Les différences spécifiques sont, dans ce genre, si difficiles à rendre par des mots qu'il est souvent impossible d'arriver à des déterminations sûres d'après de simples descriptions." Worthwhile floral differences other than that of the relative size of parts, are rare. The shape, size, and secondary venation of the leaf-blades and the habit and size of the vegetative portions of the inflorescence serve to distinguish the Ourateas vegetatively. Stipules and bracts rarely persist and are of little practical importance in a taxonomic study of the genus. While the size and shape of the fruit provide workable characters, few fruiting specimens are available for study; those specimens which have mature fruit usually lack drupes; the torus which persists, frequently provides key-characters. I have constructed my key to species in view of these facts but I do not consider the key to be a natural one. Success with the key depends mainly on the condition of the inflorescence of the material to be keyed.

Three terms which occur in the key and which refer to the habit of the inflorescence are illustrated by photographs of representative collections of the species: *hemispherical* (Fig. 1, *O. laurifolia*), *arborescent* (Fig. 2, *O. elegans*), and *pyramidal* (Fig. 3, *O. insulae*). I have also included a fourth figure: the rarely collected *O. jurgensenii* (Planch.) Engler.

The Mexican, Central American, and West Indian species of *Ouratea* range from lianas to tall trees. *O. insulae* Riley may attain a height of 25 meters. As a rule, however, the Ourateas are small trees or shrubs. As is characteristic of the majority of the genera of the Ochnaceae, the lustrous leaf-blades of *Ouratea* tend to be grouped and to persist at the apices of the twigs, thus giving the plants an attractive appearance.

Baillon (1) notes that the concoctions of the roots of the Antillean species, *O. ilicifolia*, are described as "amères, stomachiques, digestives, antivomitives." Engler (Mart. Fl. Bras. 12(2): 366–367. 1876) states as much for the same species but he fails to mention any other species of *Ouratea* as being medicinally important. He does assert, however, that many of the Ourateas have properties similar to those ascribed to the genus *Quassia*. Roig (Dicc. Bot. 844–845. 1928) lists the common names of five Cuban species: "Cordon de soldado" (*O. ilicifolia* (DC.) Baillon), "Orilla de arroyo" (*O. alaternifolia* (A. Rich.) Maza), "Guanabanilla de monte" (*O. nitida* (Sw.) Engler), "Rascabarriga" (*O. elliptica* (A. Rich.) Maza), and 'Guanabanilla" (*O. revoluta* (C. Wright) Engler. Several collectors have listed common names on their labels. Gentle's collection (*526*) of *O. nitida* from British Honduras bears the common name "wild corkwood." In Dominica, according to Valeur's label on his collection *858*, *O. ilicifolia* is commonly known as "chicharon." Harris' collection of *O. jamaicensis* (*9071*) is labelled "cabbage bark." Duss labels his collection of *O. longifolia* (3243) as "coffee-wood," while Fishlock notes that a species well-known in Porto Rico, *O. litoralis* is termed "bedstead-wood." Two collectors assign three different names to *O. insulae:* von Hagen and von Hagen (*1313* and *1397*) note the common names 'Urado" and "Buhki," while Lundell (*6369*) appends "chilillo-che." Bartlett (12631) records a variation this last name, viz., "Utop-chiliche," on a collection of *O. insulae*. On another collection in British Honduras Bartlett (*12240*) records the common name "Ixpambul" for *O. guatemalensis*. Several names are assigned to *O. guildingii:* "Bois cafe" (*Duss 1383*), "Bois cagnette" (*Duss 3689*), and "Picquanier" (*L'herminerii* without number). According to Standley (5) *O. mexicana* is known in Mexico as "Cinco Negritos" or "Zapotillo de la Costa."

The geographical distribution of the Mexican, Central American, and West Indian species of *Ouratea* is presented in tabular form (Table 1).

No attempt is made in this paper to redescribe the species studied, except those which are new or have not been adequately described. I have elabo-

TABLE 1. *The Distribution of the Mexican, Central American, and West Indian Species of Ouratea.*

	Mexico	Guatemala	Honduras	Brit. Hond.	Nicaragua	Costa Rica	Panama	Cuba	Haiti	Dom. Republic	Jamaica	Porto Rico	Antigua	Monserrat	Guadeloupe	Dominica	St. Lucia	St. Thomas	St. Vincent	Trinidad
1. *O. purdieana*																				x
2. *O. ligans*						x														
*3. *O. nitida*	x		x	x				x			x									
4. *O. globosa*	x																			
*5. *O. curvata*							x													
6. *O. tuerckheimii*		x																		
*7. *O. gigantophylla*		x																		
8. *O. mexicana*	x						x													
9. *O. ilicifolia*								x	x			x								
10. *O. laurifolia*								x			x									
11. *O. jamaicensis*											x									
12. *O. elegans*											x									
13. *O. longifolia*															x	x				
14. *O. revoluta*								x												
15. *O. litoralis*												x						x		
16. *O. elliptica*								x												
17. *O. alternifolia*								x												
18. *O. striata*								x				x								
19. *O. pyramidalis*	x	x					x													
20. *O. valerii*						x														
21. *O. insulae*		x	x	x																
22. *O. jurgensenii*	x																			
*23. *O. lucens*							x													
24. *O. guatemalensis*	x	x	x	x			x													
25. *O. madrensis*	x																			
26. *O. podocarpa*							x													
27. *O. prominens*						x														
*28. *O. guildingii*							x				x		x	x	x	x	x		x	x

* These species are found outside of the limits discussed in this paper.

rated on several of Riley's original descriptions which, while lengthy, are not always satisfactory.

The author wishes to thank the Directors of the institutions listed below who were kind enough to allow him to examine herbarium material of *Ouratea*. For purposes of citation a letter designating the particular institution is used:

Field Museum of Natural History, Chicago, Ill.	(F).
Gray Herbarium, Cambridge, Mass.	(G).
New York Botanical Garden, New York, N.Y.	(NY).
United States National Herbarium, Washington, D.C.	(US).

The author wishes to express especial thanks to Dr. A. C. Smith who read the manuscript, and to Fleda Griffith of the New York Botanical Garden who made the photographs.

KEY TO SPECIES

Floral bracts persistent until late anthesis.... . . .. 1. *O. purdieana*
Floral bracts not persistent until late anthesis.
Secondary veins of leaf blades insculptate or impressed on upper surface.
Leaf blades up to 15 cm. long; bases of leaf blades not crowded and contiguous at apices of twigs.
Leaf blades coriaceous; pedicels 1½–2× longer than buds.... ... .3. *O. nitida*
Leaf blades submembranaceous; pedicels 3× longer than buds.... . .... 4. *O. globosa*
Leaf blades 20–40 cm. long; bases of leaf blades crowded and contiguous at apices of twigs.
Lowermost branches of panicle 1–10 cm. long; Panama ... . 5. *O. curvata*
Lowermost branches of panicle 10–20 cm. long; Guatemala.
Pedicels longer than the oblong-ovoid buds.... . . . . 6. *O. tuerckheimii*
Pedicels shorter than the ovoid buds..... ... . 7. *O. gigantophylla*
Secondary veins of leaf-blades obviously not insculptate or impressed.
Leaf blades spinose-margined.......... ....9. *O. ilicifolia*
Leaf blades obviously not spinose-margined.
Rachis of inflorescence pluriramose, the branches obvious, the inflorescence either hemispherical in shape or arborescent in habit of branching or obviously pyramidal-paniculate in shape.
Inflorescence either hemispherical in shape or arborescent in habit of branching.
Inflorescence hemispherical in shape (5–9 cm. long, 6–8 cm. wide), densely flowered; fruit narrow-oblong (3× as long as wide). ... . 10. *O. laurifolia*
Inflorescence obviously not hemispherical in shape; arborescent in habit of branching; fruit oblong or rotund (up to 2× as long as wide).
Ovary short stipitate; leaf blades up to 15 cm. long; Jamaica.
Secondary veins of leaf blades prominulous beneath; leaf blades oblong-lanceolate... ....11. *O. jamaicensis*
Secondary veins of leaf blades prominent beneath; leaf blades narrow-lanceolate.... . ...12. *O. elegans*
Ovary long-stipitate; leaf-blades 20–40 cm. long; Dominica and Guadeloupe.... ....13. *O. longifolia*
Inflorescence a terminal pyramidal-panicle; West Indian and Central American.
Leaf blades 6–9 cm. long; West Indian.
Buds 6–7 cm. long.
Margins of leaf blades distinctly revolute; apex of some leaf blades retuse; Cuba ....14. *O. revoluta*
Margins of leaf blades not distinctly revolute; apex of leaf blades not retuse; Porto Rico, St. Thomas.................. ....15. *O. littoralis*
Buds 4–5 mm. long.
Pedicels at anthesis 8–15 mm. long; inflorescence densely flowered; torus of fruit about 5 mm. long..... ....16. *O. elliptica*
Pedicels at anthesis 4–8 mm. long; inflorescence few-flowered; torus of fruit about 10 mm. long.
Leaf blades elliptic or oval, obtuse at apex...... ....17. *O. alaternifolia*
Leaf blades lanceolate, linear-lanceolate or ovate-lanceolate; short-acuminate at apex...18. *O. striata*
Leaf blades 10–50 cm. long; Central American.
Leaf blades finely serrate...............................19. *O. pyramidalis*
Leaf blades not finely serrate.
Inflorescence with numerous flowers, the basal branches 10–25 cm. long, the rachis 3–5 mm. wide at base.
Leaf blades obtuse at apex; branches of inflorescence arcuate-ascending.... ....20. *O. valerii*

Leaf blades acute or acuminate at apex, the branches of inflorescence subhorizontal or angular-ascending.. .. . . 21. *O. insulae*

Inflorescence few-flowered, the basal branches up to 5 cm. long, the rachis 1 1.5 mm. wide at base.......... . .. . 22. *O. jurgensenii*

Rachis of inflorescence not obviously pluriramose, the flowers usually fasciculate, the clusters appressed to the simple rachis or rarely on short branches.

Secondary veins of leaf blades prominent beneath... ... . . . 27. *O. prominens*

Secondary veins of leaf blades not prominent beneath (although frequently prominulous).

Rachis bearing short stiff patent branches from which the flowers are quickly deciduous, the bare branches resembling spines..... ... .8. *O. mexicana*

Rachis either simple or bearing short branches which obviously do not become spine-like.

Rachis solitary at the tips of the twigs.

Leaf blades 8–10 cm. long; buds consistently 0.9–1 cm. long; rachis, peduncles, and pedicels obviously granulose.......... .... 23. *O. lucens*

Leaf blades 8–16 (usually 12–16) cm. long; buds 4–7 mm. long; rachis, peduncles, and pedicels obviously not granulose.

Buds 4–6 mm. long, those 6 mm. long about 4.5 mm. wide at base, obtuse to acute at apex.

Flowers solitary (or infrequently fasciculate in pairs) on a non-erect rachis.

Buds subacute at apex; tree.. . . . .24. *O. guatemalensis*

Buds very acute at apex; liana..... . .. .2. *O. ligans*

Flowers fasciculate on short peduncles (the inflorescence often subpaniculate), the rachis erect or angular-ascending...... . 25. *O. madrensis*

Buds about 7 mm. long, 3.5 mm. wide at base, subacuminate at apex...... .... 26. *O. podocarpa*

Rachises several at the tips of the twigs.................... 28. *O. guildingii*

1. OURATEA PURDIEANA van Tieghem, Ann. Sci. Nat. VIII. 16: 263. 1902.

Gomphia nitida Grisebach, Fl. Brit. W. Ind. 105. 1859. Not Sw.

Twigs smooth, olive-gray or gray-black when dry, lustrous; leaf-blades well spaced near apices of twigs, drying brown, the petioles 0.5–1.5 cm. long, the surface cracking transversely, stiff and thin-coriaceous, often curled and inaequilateral, oblong-lanceolate, 8–20 cm. long, 3–6 cm. wide, tapering (often widely) into a deltoid point or short acuminate at apex, cuneate or subrotund at base, the costa smooth, lustrous above and below, prominent above, subprominent or subplane below, the lateral veins arcuate-ascending, immersed above and below (seemingly more so beneath), of these 12–20 passing regularly to margin, the margin slender-callose, serrate, the teeth patent and argute (especially toward apex of blade), distinctly falcate, often incurved, 0.5–1 mm. long, about 1–3 mm. apart toward base (frequently absent toward base); inflorescence terminating the twigs as a patent terminal panicle, up to 25 cm. long, often 20 cm. wide, the rachises solitary or as many as three arising from the axils of the uppermost leaf-blades, 3–5 mm. wide at base, smooth, angular (especially toward apex), the branches frequently triquetous, whorled, subplane, the lowermost 3–13 cm. long, 1–2 cm. apart, arcuate or angular-ascending; bracts ovate-oblong, 3–4 mm. long, acute, the margin irregular; buds ovate, up to 6 mm. long; sepals narrow-ovate, 5–8 mm. long, about 2.5 mm. wide, tapering narrowly into an acute point, obtuse to subrotund toward base; petals obovate-rhomboid or obovate, about 5.6 mm. long, 5.2 mm. wide, obtuse at apex, widely cuneate at base; anthers sessile, linear, about 4 mm. long; ovary about .8 mm. long, the style subulate, about 3.2 mm. long; fruit marcescent, drying black, the torus compressed-rotund, up to 7 mm. long, 10 mm. wide, usually broader than long, the pedicels ascending, often slightly curved, 7–10 mm. long, the drupes not seen.

Type Locality: Trinidad, West Indies.

Distribution: Known only from Trinidad.

TRINIDAD: Lucutche, *Dannouse 6739* (NY); *Purdie* s.no. (F, frag., NY, type collection).

Van Tieghem failed to give an adequate description of this species and in view of this I am giving a complete one.

While the veins of the leaf-blades of *O. purdieana* are insculptate on both surfaces (not merely on the lower surface as van Tieghem states (loc. cit.)), and thus give evidence of its relationship with *O. nitida* (Sw.) Engler, *O. purdieana* is readily distinguished from all of the North American species of *Ouratea* by the bracts which persist until late anthesis, with the exception of *O. insulae* to which it seems closely related. I could not ascertain from the few flowers available for dissection whether the petals are shorter than the sepals. Although *Dannhouse 6739* (NY) is a mature fruiting specimen, no drupes were available for examination, having fallen from the persistent torus.

2. **Ouratea ligans** Dwyer, sp. nov.

Liana; petiolis brevibus subcrassatis saepe horizonaliter gracili-striatis (circ. 5 mm. longis); laminae gracili-coriaceae vix tortae oblongo-lanceolatae, 4-8 cm. longae, 1.5 3 cm. latae, basi cuneatae apice angusto-acuminatae costa utrimque subprominente venis lateralibus, alibus (circ. 10 distinctis) prominulis utrimque et eis circ. 1 cm. distantibus arcuato-ascendentibus mox parallelibus margini et eventualiter consocie vene exteriore anastomosis, alibus numerosissimis prominulis aut (minoribus) subimmersis irregularibus crebris non argute ascendentibus margine vix revoluto argute serrato supra medium dentibus subfalcatis, 1.5 2 mm. distantibus; stipulae deciduae supra-axillares longitudine striatae lanceolatae-subulatae; inflorescentiae terminales floribus solitariis aut in fasciculis racemosis in 1–2 rachides porriginosos virgas terminantibus bracteis pluribus (hic evidenter in gemma olim rhachides tectis) persistentibus crebris in circitu dispositis longitudine gracili-striatis ovato-lanceolatis vel lanceolato-sublatis ad 3.5 mm. longis; gemmae distincte conicae, circ. 5.5 mm. longae, basi 3 mm. latae, apice acutae, pedicellis gracilibus nigris in siccitate saepe granulosis curvatis ad 1 cm. longis; sepala angusto-ovata, circ. 8.5 mm. longa, 2.5 3 mm. (basi) lata, ad apicem angusto-attenuata basi obtusis venis circ. 10 erectis vix ramosis; petala flava obovato-rotunda obovata vel oblonga, 7–10 mm. longa, 5–6.7 mm. lata, apice obtusa vel rotunda basi obtusa vel subspatulata venis numerosis gracilibus flabellatis; antheris linearibus, 6–6.5 mm. longis, inverse S-figuratis; ovarium stipite 0.5-1 mm. longo, circ. 1 mm. longum, 1.5 mm. latum, stylo crasso-subulato, 4.5–6 mm. longo ad apicem, attenuato; fructu non viso.

Type Locality: San Pedro de San Ramōn, Alajuela, Costa Rica.

Distribution: Known only from the type locality.

Costa Rica: Alajuela: San Pedro de San Ramōn, *Brenes 3606* (F, type).

O. ligans differs from all of the Mexican, Central American, and West Indian species of *Ouratea* in being a liana; from this character the species derives its name. Its general foliar character, in addition to the size and the habit of the inflorescence, points to its close relationship with the complex species *O. guatemalensis*. The conical and markedly acute buds offer an excellent character distinguishing it from this species.

3. Ouratea nitida (Sw.) Engler in Mart. Fl. Bras. 12(2): 310. 1876.

Ochna nitida Sw. Prodr. 67. 1788.
Gomphia nitida Vahl, Symb. **2**: 49. 1791.
Gomphia acuminata A. Rich. Ess. Fl. Cub. **10**: 139. 1845.
Gomphia magdalenae Hemsl. Biol. Centr. Veg. Bot. **1**: 176. 1879.
Ouratea cubensis Urban, Symb. Ant. **1**: 363. 1899.
Trichouratea nitida (Sw.) van Tieghem, Ann. Sci. Nat. VIII. **16**: 235. 1902.
Ouratea panamica van Tieghem, Ann. Sci. Nat. VIII. **16**: 263. 1902.

Type Locality: Jamaica, West Indies.

Distribution: Known from Mexico, British Honduras, Honduras, Cuba, Jamaica, and British Guiana.

Mexico: Chiapas: Río Leche, *Mell 2028* (NY); Tabasco: Balancan, *Matuda 3804* (NY); Campeche: Irtubide, *Flores* s.no. (F); British Honduras: Without definite locality, *Gentle 526* (NY); *Record* 4 (F); Stann Creek: *Gentle 2967* (NY); *Schipp 193* (NY); Belize District: *Gentle 99* (NY). Honduras: Yoro: Tela, *Chickering 45* (F). Cuba: Without locality, *Wright 2115* (NY); Pinar del Río; Río Guao, *Britton*, *Britton*, and *Cowell 9640* (NY); El Jiqui, *Roig* and *Cremata 2146* (NY); Laguna Jovero, *Shafer 10834* (NY), *10845* (NY); Santa Clara, Cienfuegos, *Combs 171* (?) (NY); Ciénaga de Zapata, *Leon* and *Loustalot 9510* (NY); Oriente: Loma del Gato, *Leon*, *Clement*, and *Roca 10836* (NY); Isle of Pines: without definite locality, *Taylor 100* (NY); Los Indios, *Britton*, *Britton*, and *Wilson 14795* (NY); San Juan: *Britton*, *Britton*, and *Wilson 15526* (NY); *Roig* and *Cremata 1816* (NY); Santa Barbara, *Earle* s. no. (NY); Nueva Gerona, *Jennings 214* (NY); Managua, *Palmer* and *Riley 1100* (NY). British Guiana: Arubaru River, Mazaruni River, *Pinkus 277* (NY).

O. nitida is characterized by oblong-lanceolate leaf-blades with the secondary veins clearly insculptate below. The inflorescence is pyramidal-paniculate; in representative material it does not exceed the leaf-blades in length; the flowers are borne on elongate pedicels.

I must agree with Riley (loc. cit.) in the reduction of *O. cubensis* Urban to synonymy, despite the fact that nearly all of the material from Cuba bears this name.

4. OURATEA GLOBOSA Engler in Mart. Fl. Bras. 12(2): 323. 1876.

Type locality: Lizando, Michoacàn, Mexico.

Distribution: Known only from the type locality.

MEXICO: Michoacàn: Lizando, *Wavra 273* (F, photo of type).

I am retaining this species despite the fact that some of the important specific characters are indeterminable in the photograph of the type, viz., the membranaceous leaf-blades and impressed secondary veins of the leaf-blades. Membranaceous leaf-blades among the Ourateas are rarely found in the species within the range treated in this paper. Engler's description of the leaf-blades of *O. globosa* as acute at the base is inaccurate since at least one leaf of the type specimen is obtuse at the base.

O. globosa is related to two species: *O. subscandens* (Planch.) Engler, a species known from Brazil, Dutch Guiana, and British Guiana, and to the well-known and widely distributed *O. nitida* (Sw.) Engler. It resembles both these species in having the secondary veins of the leaf-blades insculptate, in leaf-blade shape, and especial relationship to *O. nitida* is manifested in its distinctly globose drupes. Unfortunately the fruit of *O. subscandens* has not been described. *O. globosa* differs from *O. nitida* in possessing membranaceous leaf-blades and a compressed inflorescence which does not exceed the uppermost leaf-blades in length.

5. OURATEA CURVATA (St. Hil.) Engler in Mart. Fl. Bras. 12(2): 306. 18

Gomphia curvata St. Hil. Fl. Bras. Merid. 1: 69. 1825.
Ouratea crassinervia Engler in Mart Fl. Bras. 12(2)· 337. 1876.
Ouratea costaricensis Standl. Mus. Nat. Hist. 18(2): 694. 1937.

Type Locality: Itapacorá (?), Brazil.

Distribution: Known from Costa Rica, Isla de Colón, Panama, and Brazil.

PANAMA: Bocas del Toro, Isla de Colón, *Woodson*, *Allen*, and *Seibert 1918* (F) BRAZIL. Itapacorá (?), *Pohl* (?) s. no. (F, photo and frag. of cotoype collection); *Herb Vindob.* (F, photo of cotype collection.)

Engler made the combination *O. curvata* in his key to the species rather than in the text. Unfortunately in the same text one finds *O. crassinervia* described as a new species following the numeral corresponding to the numeral designating *O. curvata* in the key. Examination of type material of *O. crassinervia* leaves no doubt that it is conspecific with *O. curvata*.

6. OURATEA TUERCKHEIMII J. D. Smith in Bot. Gaz. 23: 294. 1902.

Type Locality: Cubiliquitz, Alta Verapaz, Guatemala.

Illustration: J. D. Smith in Bot. Gaz. 23: *pl. 10, f. 1–10*, 1902.

Distribution: Known only from the type locality.

GUATEMALA: Alta Verapaz: Cubiliquitz, 350 m. alt., *Tuerckheim 378* (NY).

Tuerckheim's collection is from the type locality and in every detail matches J. D. Smith's original description. The immersed secondary veins of the leaf-blades, while arcuate-ascending, do not ascend very sharply. There is no doubt that *O. tuerckheimii* is related to *O. gigantophylla.*

7. OURATEA GIGANTOPHYLLA (Erhard) Engler in Mart. Fl. Bras. **12**(2): 338. 1876.

Gomphia gigantophylla Erhard, Fl. **32**: 250. 1849.
Gomphia theophrasta Lind. Cat. **14**: 8. 1859.
Wolkensteinia theophrasta (Erhard) Regel, Gartenfl. **14**: 131. 1865.
Ouratea theophrasta (Lind.) Baillon, Hist. Pl. **4**: 359. 1873.

Type Locality: Brazil.

Illustration: Hook. in Curtis' Bot. Mag. f. *5642* as *Gomphia theophrasta,* 1867; L'Hér. in Hortic. Fr. **21**: 15. f.1., 1864; Regel, Gartenfl. **14**: 131. f. 471, as *Wolkensteinia theophrasta,* 1865.

Distribution: Known from the State of Alta Verapaz, Guatemala and from southeastern Brazil.

Although I have not seen material of this species, I propose to retain it since it has been well described in the literature. Riley (loc. cit.) elected to segregate *O. theophrasta* from *O. gigantophylla* on the grounds that the type collections of the two species were made in widely separated areas, i.e., Guatemala and Brazil, and secondly that they differ in stipule shape.

The genus *Wolkensteinia* Regel is known to have been described from abnormal flowering material.

8. OURATEA MEXICANA (H. and B.) Engler in Mart. Fl. Bras. **12**(2): 312. 1876.

Gomphia mexicana H. and B. Pl. Aequin. **2**: 21. 1809.
Ouratella mexicana (H and B.) van Tieghem, Ann. Sci. Nat. VIII. **16**: 289. 1902.
Ouratea pallida Standl. Contr. U. S. Herb. **23**: 820. 1923.

Type Locality: Acapulco and Chipancingo, Chiapas (or Guerrero), Mexico.

Illustration: H. and B. Pl. Aequin. **2**: *pl. 74.* 1809.

Distribution: Known from Mexico and Panama.

MEXICO: Oaxaca: *Mell 2263* (NY); Chiapas or Guerrero: Chipancgo, *Humbolt* and *Bonpland* s.no. (F, photo and frag. of type collection of *Gomphia mexicana*); Acapulca, *Palmer 412* (NY); Acaponeta, Tepic, *Rose, Standley,* and *Russell 14445* (NY, type collection of *O. pallida*); Las Tres Mariás, Maria Madre, *Nelson 4238* (F). PANAMA: Penonome, *Williams 353* (NY).

Llewelyn Williams (collection *9698*) gives elucidating field notes concerning this species: "Armed shrub or small tree . . . Crown spreading with numerous branches. Trunk short . . . leaves leathery; fruit black when mature; calyx cup pale yellow; twigs armed with spines up to 1 inch long." Actually the "spines" mentioned by Williams are the short strict rachises of the inflorescence from which the flowers are soon deciduous after anthesis.

9. OURATEA ILICIFOLIA (DC.) Baillon, Hist. Pl. 4: 366. 1873.

Gomphia jabotapita Sw. Fl. Ind. **2**: 740. 1798. Not Linn.
Gomphia jabotapita DC. in Ann. Mus. **17**: 418. 1811. In part.
Gomphia ilicifolia DC. in Ann. Mus. **17**: 418. 1811.
Ouratea spinulosa Urban, Symb. Ant. **1**: 302. 1899.
Camptouratea spinulosa (Urban) van Tieghem, Ann. Sci. Nat. VIII. **16**: 214. 1902.
Camptouratea ilicifolia (DC.) van Tieghem, Ann. Sci. Nat. VIII. **16**: 214. 1902.
Camptouratea agrophylla van Tieghem, Ann. Sci. Nat. VIII. **16**: 214. 1902.
Ouratea plumieri van Tieghem, Ann. Sci. Nat. VIII. **16**: 256. 1902.
Ouratea jaegeriana Urban, Symb. Ant. **5**: 425. 1908.
Ouratea agrophylla (van Tieghem) Urban, Symb. Ant. **5**: 426. 1908.
Ouratea lenticellosa Urban, Repert. Sp. Nov. **18**: 366. 1922.

Type Locality: Dominica, West Indies.
Distribution: Known from Cuba, Haiti, Dominica, and Porto Rico.

CUBA: Without locality: *De Candolle* s.no. (F, photo of type collection of *Gomphia ilicifolia*); *Wright 2117* (NY); Pinar del Río: Sierra de Cabra, *Britton*, *Britton*, and *Cowell 9798* (NY); Los Palacios, *Shafer 11911* (NY); Sumdiéro, *Shafer 13451* (NY); Habana, *Leon 2045* (NY); San Antonio, *Shafer 214* (NY); San Antonio, *Hitchcock* s.no. (F); San Antonio, *Curtis 684* (NY); San Antonio, *van Hermann 815* (NY); San Antonio de los Baños, *Abarca 4771* (NY); Playa de Marianao, *Britton* and *Wilson 4510* (NY); Loma de Ramirez, *Leon 9720* (NY); Santa Clara: Without locality, *Luna 473* (NY); Punta Diabolo, *Britton* and *Wilson 572* (NY); Loma Cruz, *Britton*, *Britton*, and *Cowell 10226* (NY); Cienfuegos, Milpa, *Jack 5119* (NY); Sabana de San Marcos, *Leon 9205* (NY); Motembo, *Leon*, *Edmund*, and *Fortun 8575* (NY); Camagüey: Without locality, *Shafer 867* (NY); Sierra Cubitas, *Shafer 490* (NY); Camagüey, *Britton*, *Britton*, and *Cowell 13249* (NY); *Britton 2363* (NY); Oriente: Manazanillo, *Combs* s. no. (NY); Holquin, *Shafer 1284* (NY). HAITI: Dept. du Nord: St. Michel del'Atalaye, *Leonard 7556* (NY). DOMINICA: San Gabriel, *Abbott 1242* (NY); Samaná Peninsula: *Abbott 2294* (NY); Mongon, *Valeur 858* (NY). PORTO RICO: Viegues: Cucarache, *Curbela* ×*79* (NY).

O. ilicifolia is the easiest species of *Ouratea*, within the range treated in this paper, to recognize since the leaf-blades are spinose-margined. Both Urban and van Tieghem elected to describe their species principally on the variation of the marginal toothing; they failed however to give worthwhile floral, fruit, and inflorescence differences.

9a. **Ouratea ilicifolia** (DC.) Baillon var. **savannarum** (Britton and Wilson) Dwyer, comb. nov.

Ouratea savannarum Britton and Wilson, Bull. Torrey Club **48**: 342. 1921.

I do not consider the reduction in the marginal toothing and the width of the leaf-blades sufficiently strong characters to warrant retaining Britton and Wilson's species. It seems, however, to be deserving of varietal rank.

10. OURATEA LAURIFOLIA (Sw.) Engler in Mart. Fl. Bras. 12(2): 350. 1876.

Gomphia laurifolia Sw. Fl. Ind. **2**: 741. 1798.
Ochna laurifolia Kuntze, Rev. Gen. 106. 1891.

Type Locality: Jamaica, West Indies.
Illustration: Rendle and Fawcett, Fl. Jamaica 5: 175. *pl. 66, a d.* 1926.
Distribution: Known only from Jamaica and Cuba.

FIG. 1. A photograph of typical material of *O. laurifolia* showing the hemispherical shape of the inflorescence.

CUBA: Pinar del Río: Cayajabos, 400 m. alt., *Leon 13817* (NY). JAMAICA: Without locality: *Macfayden* s. no. (G); Cherry Garden, *Harris 5513* (NY); Plato, *Harris 5535* (NY); Holly Mount, *Harris 8898* (NY); Peckham Woodland, Upper Clarendon, *Harris 10870, 10875* (NY); Constant Spring, *Harris 11919* (NY); St. Andrew, *Harris 10104* (NY).

O. laurifolia is a shrub 3–5 m. in height; collections indicate that it is restricted to altitudes of 400–700 meters. Characters distinguishing this species, are: the small buds, subrotund in shape, averaging 3 mm. in length, the multi-flowered inflorescence with the flowers disposed on the slender pedicels of the secondary branches. The inflorescence is arborescent in habit with the bifurcations of the branches distinct; in addition the inflorescence is disposed as a semi-circle which scarcely (or obviously not) exceeds the uppermost leaf-blades in length (cf. Fig. 1). *Harris 10875* (NY) which has mature fruit, permits us to elaborate on Engler's original description of "drupis globosis." Here the drupes are not globose but narrow-oblong or narrow-obovate and measure about 1 cm. in length and 0.4 cm. in width; the surface of the drupes (1-2 per torus) is longitudinally striate and glistening black in color; the torus is subrotund and about 0.3 cm. in length.

11. OURATEA JAMAICENSIS (Planch.) Urban, Symb. Ant. 1: 362. 1899.

Gomphia jamaicensis Planch. Hook. Jour. Bot. 6: 11. 1847.
Gomphia guianensis A. Rich. Griseb. Fl. Brit. W. Ind. 105. 1859. In part.
Ouratea guianensis Aubl. ex Engler in Mart Fl. Bras. 12(2): 314. 1876. In part.

Type Locality: Jamaica, West Indies.
Distribution: Known only from Jamaica.

JAMAICA: Troy, Cockpit Co., *Britton 609* (NY); Troy, *Harris 9071* (NY); Hollymount, *Harris 6529* (NY); Peckham Woods, Upper Clarendon, *Harris 10999* (NY).

The patent secondary branches of the inflorescence which are arborescent in their manner of branching and the elongate pedicels of the flowers point to the fact that *O. jamaicensis* is related to *O. elegans* Urb. and *O. longifolia* (DC.) Engler. It differs from both of these species in having the secondary veins of the leaf-blades prominulous and not prominent beneath, and in having a short-stipitate ovary.

12. OURATEA ELEGANS Urb. Symb. Ant. 5: 428. 1908. Rev. spelling of *elaegans*.

Type Locality: Woodstock near Beaufort, Jamaica.
Distribution: Known from Jamaica and Venezuela.

JAMAICA: Woodstock, *Britton 1564* (NY); Woodstock near Beaufort, *Harris 9912* (NY, cotype collection). VENEZUELA: Lower Río Orinoco, *Rusby* and *Squires 447* (NY).

I consider this species to be distinct from *O. jamaicensis* to which it is closely related. Not only is the inflorescence larger and more patent, but the flowers are borne on much more slender pedicels, likewise the leaf-

FIG. 2. A photograph of typical material of *O. elegans* illustrating the arborescent branching of the inflorescence.

blades are typically salicoid (in the two Jamaica collections). *Rusby* and *Squires 447* (NY) has a fragmentary inflorescence but in general the plant seems referable to *O. elegans*. The leaf-blades are atypical, being broader and having a serrate margin. Although Rusby and Squires do not list the locality of this collection, their adjacent collection numbers indicate that it was probably made at Santa Catalina, Delta Amacuro, lower Rio Orinoco, Venezuela.

13. OURATEA LONGIFOLIA (DC.) Engler in Mart. Fl. Bras. **12**(2): 316. 1876.

Gomphia longifolia DC. Ann. Mus. Paris **17**: 417. 1811.

Type Locality: Guadeloupe, West Indies.
Illustration: DC. Ann. Mus. Paris **17**: *t. 10, f. a-l*, 1811.
Distribution: Guadeloupe, French Guiana, and in British Guiana (Engler loc. cit., including var. *microcalyx* Engler).

GUADELOUPE: Bois de Gommier, *Duss 3243* (G, NY); Bois de Gommier, *Stehlé 1280* (NY); Sofaya above Ste. Rose, *L. R. Holdridge 439* (NY).

The texture, size, and venation of the leaf-blades of this species show its relationship with *O. guianensis* Aublet, the type species of the genus. The leaf-blades, on the other hand, are obtuse to subcordate at the base. The inflorescence of *O. longifolia* is few-flowered with the fascicles borne on slender irregular branches while the inflorescence of *O. guianensis* is many-flowered, the fascicles being borne on rigid and arcuate-ascending branches. Its loose inflorescence-pattern indicates that it is in part related to *O. elegans*.

14. OURATEA REVOLUTA (C. Wright) Engler in Mart. Fl. Bras. **12**(2): 346. 1876.

Gomphia revoluta C. Wright in Griseb. Mem. Acad XI. **8**: 166. 1860.
Ouratea xolismaefolia Britton and Wilson, Bull. Torrey Club **50**: 52. 1923.

Type Locality: Oriente, Cuba.
Distribution: Known only from the Province of Oriente, Cuba.

CUBA: Oriente: Without definite locality, *Wright* s.no. (G, NY, type collection of *Gomphia revoluta*); Sierra Maestra, 1000 m. alt., *Ekman 14244* (NY); Sierra de Nipe, 725 m. alt, *Ekman 12514* (NY); High Maestra, *Leon 10911* (NY, type of *O. xolismaefolia*).

Comparison of the type collections of *O. revoluta* and *O. xolismaefolia* leaves no doubt that the two are conspecific. Outside of differences in the color (when dry) and in the size of the leaf-blades, the division into two species is apparently unwarranted.

15. OURATEA LITORALIS Urban, Symb. Ant. **1**: 363. 1899.

Gomphia nitida DC. Ann. Mus. Paris **17**: 419. 1811. Not Sw.

Type Locality: Porto Rico.

Illustration: DC. Ann. Mus. Paris **17**: *pl. 13, f. m–o*, 1811.

Distribution: Known only from Porto Rico and St. Thomas, West Indies.

PORTO RICO: Without locality: *Holdridge 458* (NY); Locality obscure (Serpentine), *Velez 1121* (NY); Virgin Gorda, *Fishlock 307* (F, NY); Laguna Tortuguero: *Britton*, *Britton*, and *Boydton 8234* (NY); *Britton* and *Chardon 6841* (NY); *Britton*, *Cowell*, and *Brown 3843* (NY); Arecibo: Vega Bajo: *Heller* and *Heller 1318* (NY); *Underwood* and *Griggs 928* (NY); Mayaguez: Guanajibo, *Britton 4354* (NY); Susúa, *Holdridge 3* (NY); San German, *Palmer* s. no. (NY); San Juan: Río Piedras, Fuica, *Hioram* s. no. (NY); Río Piedras, *Stevenson 2149* (NY); Miraflores, *Morss 2* (G); Humacao: Playa de Fajardo, *Britton* and *Shafer 1564* (NY); Fajardo, *Liateus* s.no. (G); Fajardo, *Sinten 913* (G, NY).

O. litoralis is a well-defined species, apparently confined to Porto Rico and to the Island of St. Thomas. Although closely related to the Cuban species, *O. revoluta* is distinguished by its larger and acuminate leaf-blades which are scarcely revolute on the margin. The prominulous secondary veins of the leaf-blades have a characteristic reticulation which cannot be adequately described. In addition, the leaf-blades have a distinguishing color when dry.[1]

16. OURATEA ELLIPTICA (A. Rich.) Maza, Anal. Soc. Esp. Hist. Nat. **23**: 45. 1894.

Gomphia elliptica A. Rich. in Ess. Fl. Cub. **10**: 140. 1845.
Gomphia pinetorum C. Wright in Griseb. Cat. Pl. Cub. 37. 1845.
Camptouratea elliptica van Tieghem, Ann. Sci Nat. VIII. **16**: 214. 1902.
Ouratea pinetorum (C. Wright) van Tieghem, Ann. Sci., Nat. VIII. **16**: 257. 1902.

Shrub (1 m. high?); petioles crassate, about 3 mm. long; twigs drying gray-brown or black; leaf-blades often distichously arranged, stiff-coriaceous, oblong, oblong-rotund to sublanceolate, 2–10 cm. long, 1–4 cm. wide, obtuse (round or narrowly so) at apex, cuneate to obtusely truncate at base (rarely subcordate), frequently inaequilateral, the costa prominent beneath, subprominent above (plane in middle and at base), the secondary veins prominulous (or rarely immersed above), forming a conspicuous reticulum above, the veins of two kinds, some (7–10) arcuate-ascending as they leave costa, then sharply ascending and usually irregular or branching toward margin, the lowermost vein often paralleling margin of leaf-blade to middle before evanescing, the others (very numerous) prominulous or rarely immersed, crowded, forming a dense and conspicuous reticulum, the margin entire, scarcely revolute; stipules deciduous; inflorescence terminal or disposed on terminal axillary branches, compressed-paniculate or patent-paniculate, the rachis shorter than or exceeding uppermost leaf-blades in length, rubescent, angular, the basal branches (when inflorescence patent) subhorizontal, subarcuate or angular-ascending, 2–3 cm. long, 0.7–1 mm. wide, 0.3–1.5 cm. apart, the flowers very dense, solitary or fasciculate, the pedicels lax, 8–15 mm. long, 0.3–0.4 mm. wide; buds ovate,

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[1] Cf. Ridgway's "Color Standard and Color Nomenclature," *pl. 15*, color-hue *17*, tone *k* (Dresden-brown), 1912.

4 mm. long; sepals oblong or ovate-oblong, unequal in length, 5–6.5 mm. long, 2.5–2.8 mm. wide (not flattened), obtuse at apex and base, the veins numerous, erect, branching; petals yellow, inaequilateral, 6–7.5 mm. long, 6–9 mm. wide, often wider than long, obovate-rotund, retuse or round-obtuse at apex, spatulate to widely cuneate at base; anthers linear, about 6 mm. long, 1 mm. wide at base; stipe of ovary about 0.5 mm. long, the carpels about 6 mm. long, the ovary 0.75–1 mm. long, the style 4–5 mm. long; torus obovate to rotund (or compressed-rotund), about 5 mm. long; drupes not seen.

Type Locality: Cuba.

Distribution: Known only from Cuba.

CUBA: Without definite locality, *Wright 2116* (G, type collection of *Gomphia pinetorum*), *2118* (NY); Pinar del Río: Without definite locality, *Cuesta 653* (NY); Las Gras, *Britton 10030* (NY); Herradura, *Earle 658* (NY); Arroyo Mantua, *Ekman 10988* (NY); Pinares, *Leon* and *Charles 4878* (NY); San Diego de los Baños, *Leon* and *Charles 4879* (NY); Río Viñales, *Cuesta 444* (NY); *Leon 14346* (NY); Isle of Pines: La Canada, *Britton*, *Britton* and *Wilson 14403* (NY); Nueva Gerona, Curtiss 377 (NY); Los Indios, Jennings 325 (NY); Hato Nuevo, *Roig* and *Cremata 1800* (NY).

17. OURATEA ALTERNIFOLIA (A. Rich.) Maza, Anal. Soc. Esp. Hist. Nat. 23: 46. 1894. Emended spelling.

Gomphia alaternifolia A. Rich. Ess. Fl. Cub. **10**: 139. 1845.
Ouratea alternifolia (A. Rich.) Engler in Mart. Fl. Bras. **12**(2): 339. 1876.
Cerouratea alaternifolia (A. Rich.) van Tieghem, Ann. Sci. Nat. VIII. **16**: 277. 1920.
Camptouratea alaternifolia van Tieghem, Jour. Bot. **16**: 192. 1902.

Type Locality: Habana, Cuba.

Distribution: Known only from Cuba.

Although I have not seen any material of *O. alternifolia*, I have included this species in the paper because of the differences which Urban lists (loc. cit., **5**: 427); he cites several characters which distinguish it from *O. striata*: its elliptic or oval leaf-blades which are obtuse at the apex and are strongly coriaceous (3.5–5 cm. long, 1.3–2.5 cm. wide), the characteristic venation of the leaf-blades, its larger flowers with sepals 7 mm. long, and lastly its subquadrate anthers. It is interesting to note that Urban does not cite any specimens of *O. alternifolia*. The differences mentioned by Urban have been gleaned from Richard's and van Tieghem's original descriptions.

18. OURATEA STRIATA (van Tieghem) Urban, Symb. Ant. **5**: 427. 1908.

Camptouratea striata van Tieghem, Ann. Sci. Nat. VIII. **16**: 422. 1902.
Ouratea affinis Britton, Mem. Torrey Club **16**: 87. 1920.
Ouratea roigii Britton, Mem. Torrey Club **16**: 82. 1920.

Shrubs or trees, 3–8 m. high; twigs waxy-gray, the surface frequently cracking, often angular; petioles 3–9 mm. long; leaf-blades coriaceous, often curled when dry, lanceolate, linear-lanceolate or ovate-lanceolate, 4–11 cm. long, 1.5–3.5 cm. wide, acute or short-acuminate at apex, cuneate or cuneate-rotund at base, the costa prominent above and below, the secondary veins of two sorts, some (4–8 per side) prominulous and leaving the costa at a 70°-80° angle, immediately arcuate-ascending and eventually paralleling the margin, the lowermost vein joining the vein above at or about the middle of the blade, gradually evanescing, others (very numerous) subprominulous, subhorizontal, pluriramose and forming a dense reticulum, the margin distinctly revolute; stipules deciduous; inflorescence terminal or axillary at apices of twigs, usually both types present on one specimen, pyramidal-paniculate, patent or compressed, the lowermost branches frequently less than 1 cm. long, the flowers seemingly racemosely disposed, or when inflorescence patent, the basal branches frequently measuring up to 3 cm. in length, 0.7–1.3 cm. apart, angular-ascending or frequently subhorizontal, the rachis and its branches often triquetous or plane, the flowers solitary or fasciculate on a short sympodium, the pedicels slender, 4–8 mm. long; buds oblong-rotund to rotund, about 4 mm. long at maturity; sepals elliptic-oblong, about 5 mm. long, 2.7–3 mm. wide; petals obovate, 5–6 mm. long, 4–4.5 mm. broad; anthers linear, 3.5–4 mm. long; stipe of ovary about 1 mm. long, the ovary about 1.5 mm. long, 1 mm. wide, the style falcate, about 3 mm. long, somewhat crassate at base; torus in fruit obovate, about 1 cm. long at maturity, 0.5–0.6 mm. wide (toward apex), the drupes drying lustrous-black, irregular-striate, obovate-oblong, obviously inaequilateral toward base, 0.8–1 cm. long, 0.6–0.8 cm. wide.

Type Locality: Monte Verde, Oriente, Cuba.

Distribution: Known only from the Province of Oriente, Cuba, and from Porto Rico.

CUBA: Oriente: Sierra de Nipe, *Ekman 5012* (NY), *9696* (NY), *9915* (NY), *Shafer 3564* (NY); Monte Verde, *Hioram* and *Manuel 3829* (NY); Monte Verde, *Wright 58* (NY, type collection of *Camptouratea striata*); La Prenda, *Hioram* and *Manuel 4745* (NY); Yateras, *Maxon 4176* (F, NY); Cañete, *Roig 67* (NY, type of *O. Roigii*); Río Naranjo, *Shafer 3869* (NY, type of *O. affinis*). PORTO RICO: El Yunque, *Horne* s. no. (NY); Cayey, *L. E. Gregory 80* (NY).

This is the first critical description of *O. striata*, a species closely related to the almost exclusively Porto Rican species, *O. litoralis*. *Gregory 80* (NY) is an excellent fruiting specimen and the only one in fruit which I have seen.

19. OURATEA PYRAMIDALIS Riley, Bull. Kew 107. 1924.

Type Locality: Atasta, Tabasco, Mexico.

Distribution: Known from Mexico, Guatemala, and Panama.

PANAMA: *Hayes 506* (NY).

The single specimen cited above is one of the three listed by Riley (also cf. loc. cit. 364). It matches his description perfectly. Although *O. pyramidalis* is obviously related to *O. guatemalensis*, it is readily distinguished by the argutely dentate margin of its leaf-blades, with the teeth approximate and extending to the base of the lamina, and by its very patent panicle.

20. OURATEA VALERII Standl. Field Mus. **18**: 694. 1937.

Type Locality: Playa Blanca, Golfo Dulce, Costa Rica.

Distribution: Known only from the type locality.

COSTA RICA: Playa Blanca, Golfo Dulce, *Valerio 435* (F, type collection).

O. valerii possesses the largest leaf-blades among the Central American and West Indian species of *Ouratea*, reaching up to a half a meter in length and up to 15 cm. in width. Coupled with the large leaf-blades is an equally large inflorescence with alternate angular arcuate-ascending branches, the latter bearing well-spaced (1.5–2 cm. apart) flowers along their length. The secondary veins of the leaf-blades are prominulous; this character readily distinguishes it from three long-leaved species to which it is related: *O. curvata*, *O. tuerckheimii*, and *O. gigantophylla*. A study of the large-leaved Ourateas of the Old World and New World seems necessary to establish the specific relationships within this complex.

21. OURATEA INSULAE Riley, Bull. Kew 106. 1924.

Gomphia nitida Hemsl Biol Centr. Veg. Bot. 4: 111. 1887. Not Sw. (1788).

Trees 12–25 m. high; twigs round in cross section, smooth, ashen-gray; petioles 0.7–1 cm. long, 1–3 cm. apart; leaf-blades well spaced toward apex, lustrous, coriaceous, yellow-brown or brown when dry, oblong-lanceolate or narrow oblong-lanceolate, 12–31 cm. long, 3.5–8 cm. wide, cuneate or round-obtuse at base, acute at apex, often short-acuminate, the costa prominent above, often subplane above base, prominent and longitudinally striate beneath, the secondary veins of two kinds, some (25–50) distinctly prominulous, arcuate-ascending, paralleling the margin for a distance and eventually passing into a marginal tooth, others (very numerous) crowded, irregular, immersed or prominulous, scarcely ascending, the margin serrate (except entire for 2-3 cm. at base (or not infrequently up to middle)), the teeth often subfalcate, 0.3–2.5 cm. apart; inflorescence strictly terminal, pyramidal-paniculate, the rachis stout, 3 5 mm. wide at base, 9 22 cm. long, usually not exceeding the uppermost leaf-blades in length, angular, contorted, usually becoming caudate and lax toward apex, the basal branches 6–13 cm. long (averaging 11 cm. in length), 1 2.5 cm. apart, becoming progressively shorter toward apex, the upper quarter of rachis simple, the branches subhorizontal, often somewhat deflexed, angular or arcuate-ascending, the flowers fasciculate on a short sympodium or on compressed tertiary branches, the pedicels granulose (often distinctly so), slender, 7–10 mm. long 0.5 mm. wide, swollen toward apex; bracts persistent, ovate, 1 mm. or less long, acute, curled; sepals subcarnose, dorsally marcescent-rugose (especially toward apex), linear-ovate, 6–7.5 mm. long, 2–2.8 mm. wide at base, acute at apex, obtuse at base, the veins 3 or more, well-spaced, ascending, erect; petals yellow, obovate-spatulate, 8.5 9 mm. long, 6–7.5 mm. wide, inaequilateral and bilobed, rotundate and often

FIG. 3. A photograph of typical material of *O. insulae* showing the characteristic pyramidal-shaped panicle.

retuse in the middle, subspatulate at base, the veins subflabellate, the median veins (or vein) somewhat more conspicuous or immersed in the white thick claw; anthers sessile, linear, 5–6 mm. long; stipe of pistil 0.5 mm. long, the ovary about 1.2 mm. long, the style subulate, about 5.5 mm. long, attenuate at apex; pedicels (of fruit) bright red (in vivo), curved, 6.5–8.5 mm. long, 0.75 mm. wide in middle; torus drying dull red-black, obovate-oblong to rotund, 5–10 mm. long, the drupes inaequilateral, plump oblong-rotund, up to 9 mm. long, up to 8 mm. wide.

Type Locality: Ruatan Island, Honduras.

Distribution: Known from British Honduras, Honduras, and Guatemala.

BRITISH HONDURAS: Temash River, *Schipp S 652*; Camp 33, B. H. Guatmala Survey, 800 m. alt., *Schipp 1239* (NY); El Cayo: Vacca, *Gentle 2459* (NY); Valeatin, *Lundell 6296* (NY), *6369* (NY). GUATEMALA: Peten: Tipal, *Bartlett 12631* (NY); Vera Paz and Chiquimula: *Sereno Watson 75* (G). HONDURAS: Colon: Garunta, Wispernini Camp, *von Hagen* and *von Hagen 1307* (NY).

O. insulae, a species of the rain-forests and river-banks apparently attains the greatest height of any of the Mexican, Central American, and West Indian species of *Ouratea*. It has been frequently confused with *O. pyramidalis*. I have elected to redescribe this species because Riley based his original description on but one collection.

Two collections listed above are worthy of special note: *Gentle 2459* (NY) has buds and pedicels which are granulose in appearance to the naked eye; the second, *von Hagen* and *von Hagen* 1397 (NY), the only collection which I have seen from Honduras, has its leaf-blades narrowly deltoid toward apex and has much shorter buds; the secondary branches of the inflorescence are strongly angular-ascending. While in these points the plant appears different, I cannot convince myself that this collection is worthy of consideration as the basis of a new species.

22. OURATEA JURGENSENII (Planch.) Engler in Mart. Fl. Bras. 12(2): 351. 1876. Emended spelling of Engler's comb.

Gomphia jurgensenii Planch. Hook Jour. Bot. 6: 11. 1847.
Notouratea recurva van Tieghem, Ann. Sci. Nat. VIII. 16: 220. 1902.

Type Locality: Mexico.

Distribution: Known only from two collections in Mexico.

MEXICO: Without locality: *Jurgensen 779* (F, photo and frag. of type); Oaxaca(?): Chinantla, *Galeotti 7243* (F, NY).

This is a sharply defined species with salicoid well-spaced leaf-blades with prominulous secondary veins. Especially striking is the terminal inflorescence with its very slender rachis bearing 1–3 equally slender subhorizontal branches, 2–4 cm. apart; the flowers are few and are borne on very slender and lax pedicels which measure about 1.5 cm. in length.

FIG. 4. A photograph of *O. jurgensenii* [collection by Galeotti (7243) (F)].

23. OURATEA LUCENS (H.B.K.) Engler in Mart. Fl. Bras. 12(2): 350. 1876.

Gomphia lucens H.B.K. Nov. Gen. & Sp. 7: 1825.
Ouratea isthmica Riley, Bull. Kew 108. 1924.

Type Locality: El Zapote, 360 m. alt., Colombia.
Distribution: Known from Panama and northern Colombia.

PANAMA: Bohio Soldado, *Cowell 220* (NY); Gatum, *Hayes 466* (NY). COLOMBIA El Zapote, *Bonpland 1455* (F, frag. of type collection of *Gomphia lucens*); Puerto Colombia near Barranquilla, *Elias 919* (NY); Puerto Colombia, *Paul 919* (F).

Riley in his original description of *O. isthmica*, states that the anthers are 9; this is undoubtedly either a miscount or it represents an odd number which was encountered in an abnormal flower; the number of stamens in *Ouratea* are markedly constant in number, viz., ten. Riley, in citing *Hayes 466* (NY) as *O. isthmica* neglects to describe the fruit; the torus of the fruit is compressed-rotund to somewhat compressed obovate, smooth, scarcely coriaceous, and its pedicels are sharply ascending.

O. lucens is closely related to *O. guatemalensis* although its buds are considerably larger and the leaf-blades are more constant in shape.

24. OURATEA GUATEMALENSIS Engler in Mart. Fl. Bras. 12(2): 345. 1876.

Gomphia nitida Hemsl. Biol. Veg. Bot. 1: 176. 1879. Not Sw.
Stenouratea wrightii van Tieghem, Ann. Sci. Nat. VIII. 16: 219. 1902.
Ouratea peckii Riley, Bull. Kew 109. 1924.
Ouratea stenobotrys Riley, Bull. Kew 109. 1924.
Ouratea wrightii (van Tieghem) Riley, Bull. Kew 110. 1924.

Type Locality: Guatemala.
Distribution: Known from Mexico, British Honduras, Honduras, Guatemala, Costa Rica, and Panama.

MEXICO: Without locality, *Matuda 00386* (NY); Chiapas, Tabasco: Balancan, *Matuda 3151* (NY); Oaxaca: Cafetal Concordia, *Morton & Makrinius 2698* (F). BRITISH HONDURAS: Yucatan Peninsula, Maskall, *Gentle 1155* (NY), *1256* (NY); Stann Creek Valley, *Gentle 3211* (NY), *3521* (NY); Freshwater Creek, *Heyder & Kinlock 34* (F); Temash River, Cornejo Creek, *Kinlock 32* (F). HONDURAS: Colon: Garunta, *von Hagen & von Hagen 1313, 1311* (NY). GUATEMALA: Without locality, *Friedrichsthal 9679* (F, photo & frag. of type collection of *O. guatemalensis*); Petén: Uaxactun, *Bartlett 12240* (NY); Izabal: Puerto Barrios, *Standley 73067* (F). COSTA RICA: Alajuela: Santiago & San Ramõn, *Brenes 6469* (?) (F). PANAMA: Torosi (?), *Mell* s.no. (NY); Penonome: *R. S. Williams 577* (NY); Canal Zone, Barro Colorado Island: *Shattuck 243* (F); *Wetmore* and *Abbe 127* (F), *141* (F); *Wilson 53* (NY), *158* (F); *Woodworth & Vestal 389* (F), *509* (F), *617* (F); Bocas del Toro: Bocas Island, *C. P. Cooper 465* (NY).

After a study of more than thirty collections, including a photograph and fragment of the type collection, as well as an analysis of the original descriptions made by Riley, I decided to maintain a single species, *O. guatemalensis*. Not only does Riley fail to offer substantial differentiating characters but he bases his trio of species on a paucity of material. While the wholesale reduction to synonymy of these species makes it easier for workers, *O. guatemalensis*, as I define it, is not an unnatural species. Its inflorescence, unbranched (or rarely with very short basal branches) and lax, offers a strong distinguishing character.

25. OURATEA MADRENSIS Riley, Kew Bull. 364. 1924.

Type Locality: Sierra Madre, Guerrero, Mexico.

Distribution: Known only from the States of Tabasco and Guerrero, Mexico.

MEXICO: Tabasco: Balacan, S. Isidro, *Matuda 3371* (NY).

Although I have not seen type material of this species, Matuda's collection which is cited above as lying about 500 miles to the east of the type collection, matches Riley's original description in every detail. Since the type collection lacked fruit, I am supplying the following description which is based on *Matuda 3371* (NY): the pedicels lustrous, slender, less than 1 mm. wide, the torus compressed-rotund, wider than long (averaging 8 mm. in width, 5 mm. in length), the drupes obovate-oblong, about 9 mm. long, drying black. *O. madrensis* possesses a strict inflorescence with the fascicles of flowers being borne on definite peduncles; this readily distinguishes it from *O. guatemalensis* to which it is obviously related.

26. OURATEA PODOCARPA Sprague and Riley, Kew Bull. 364. 1924.

Type Locality: Penonome, Panama.

Distribution: Known only from the type locality.

PANAMA: Penonome, *R. S. Williams 223* (NY, type collection); Bismarck above Penonome, *R. S. Williams 546* (NY).

Further collection will be necessary to evaluate this species properly as it is closely related to *O. guatemalensis* in many characters, and may prove, when adequate material is available for study, to be conspecific. The flower buds which are subacuminate at the apex, seem to represent a reliable distinguishing character.

27. **Ouratea prominens** Dwyer, sp. nov.

Virgae obscuro-brunneae laeves; petioli 2–4 mm. longi; folia terminalia, 1.5–3 cm. distantia salicina atque angusto-lanceolata, 9–14 cm. longa, 2.5-3.5 cm. lata, gracili-coriacea vel submembranacea apice acuta basi cuneata, costa supra prominula (ad basim plana) infra prominente, venis secundariis prominulis vel evidenter supra immersis, duorum generum, alibus (10–15) conspicuioribus et evidenter supra prominentibus arcuato-ascendentibus, 0.3–1 cm. juxta costam distantibus, venibus inferioribus margini secundum mediam foliorum laminam appropinquantibus, alibus (numerosissimis) non argute ascendentibus prominulis ramosis obscurum dispositis, margine distincte revoluto serrato dentibus minoribus; stipulae deciduae; floribus et bracteis non visis; rhachidibus (hic in fructu) terminalibus vel axillaribus gracilibus simplicibus superioribus laminis foliorum brevioribus, circ. 3–4 mm. longis, circ. 1 mm. (basi) latis, floribus solitariis vel fasciculatis articulationibus et sympodiis persistentibus, 1–2.5 mm. longis, saepe in latitudine rachidibus aequis, pedicellis (hic in fructu) evidenter paullum rhachidibus crassioribus vix arcuatis, 10–12 mm. longis, toro persistente globoso aut oblongo-rotundo, circ. 5 mm. lato.

Type Locality: Santiago & San José de San Ramõn, Costa Rica.

Distribution: Known only from the type locality.

COSTA RICA: Santiago & San José de San Ramõn, *Brenes 6838* (F, type).

O. prominens is marked by its very thin-coriaceous leaf-blades which may be described also as being submembranaceous in texture, and by its very prominent secondary veins on the lower surface of the leaf-blades. I have been unable to relate this species to any of the species included in this paper.

28. OURATEA GUILDINGII (Planch.) Urban, Symb. Ant. **1**: 364. 1899.

Gomphia guildingii Planch. Hook. Jour. Bot. **6**: 12. 1847.
Gomphia pyrifolia Griseb. Fl. Brit. W. Ind. 105. 1859.
Ouratea pyrifolia (Griseb.) Engler in Mart. Fl. Bras. **12**(2): 320. 1876.
Trichouratea guildingii (Planch.) van Tieghem, Ann. Sci. Nat. VIII. **16**: 236. 1902.
Ouratella l'herminieri van Tieghem, Ann. Sci. Nat. VIII. **16**: 290, 1902.
Ouratea l'herminieri (van Tieghem) Urban, Symb. Ant. **5**: 430. 1908.

Type Locality: St. Vincent, West Indies.

Distribution: Panama, Jamaica, Antiqua, Monserrat, Guadeloupe, Martinique, St. Lucia, St. Vincent, Tobago, and Trinidad. According to Engler (loc. cit. p. 321) the species *O. pyrifolia*, listed in synonymy above, occurs in Venezuela.

PANAMA: Cristobal Colón, *Broadway 414* (NY), *546* (NY), *797* (NY). JAMAICA: Bridge Hill, *Harris 6978* (NY). GUADELOUPE: Pigeon, *Duss 2307*, *3689* (NY); Bouillante, *L'Herminier* s.no. (F, frag. of type of *O. l'herminieri*). MARTINIQUE: Without definite locality, *Duss 6* (G), *61383* (NY). TOBAGO: Logwood, *Broadway* s.no. (NY); Mile End Road, *Broadway 2110* (F, NY). TRINIDAD: Teteron Bay, *Britton 490* (NY); Without definite locality, *Britton & Hazen 1701* (NY); Chacachacare, *Britton, Freeman & Watts 2687* (NY). VENEZUELA: Miranda, Río Chico, *Jahn 1265* (G).

O. guildingii has oblong-lanceolate leaf-blades borne on angular, often horizontal, light-gray branches; the slender pedicelled flowers are solitary and dense, and terminate the short angular and frequently opposite branches; the inflorescence rarely exceeds the leaf-blades in length. While *Duss 3689* (NY) and *Duss 61383* (NY) have the leaf-blades reaching 11 dcm. in length and have more elongate pedicels, both are referable to *O. guildingii*.

EXCLUDED SPECIES

The following species have been omitted from the body of the paper as I have not seen material of them and since I consider the descriptions to be inadequate.

29. OURATEA FINLAYI (van Tieghem) Urban, Symb. Ant. **5**: 430. 1908.

Ouratella finlayi van Tieghem, Ann. Sci Nat. VIII. **16**: 290. 1902.

Type Locality: Trinidad? cf. Urban, loc. cit. p. 430 & Symb. Ant. **3**: 47. 1902.

30. OURATEA PODOGYNA J. D. Smith in Bot. Gaz. **17**: 183. 1893.

Type Locality: Pansalma Forest, Alta Verapaz, 1140 m. alt., Guatemala.

This species, according to Riley (loc. cit.), is closely related to *O. gigantophylla* and *O. tuerckheimii.*

31. OURATEA OBLITA Riley, Kew Bull. 108. 1924.

Type Locality: Mexico.

Riley (loc. cit.) relates this species to two other species described in this paper: *O. isthmica* and *O. insulae.* He separates *O. oblita* from these in his key, stating that the leaf-blades of *O. oblita* are "not or very short acuminate" at apex, while those of the latter are "strongly acuminate" at the apex.

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Studies in the Geoglossaceae of Yunnan*

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Yunnan, the type locality of the genus *Hemiglossum*, seems to possess a geoglossaceous flora of unusual richness. On account of transportation and other difficulties, however, collections have been made only in a few places in this province: Kunming in the east, Cheli in the south, and Tali and its vicinity in the west. Despite such limited collecting, many new and interesting forms were brought to light. For instance, intergrading forms between *Geoglossum glabrum* and *G. nigritum* were discovered. Their discovery raises the question whether it is still proper to retain these two species as distinct. Two 4-spored species of *Microglossum* were also found.

Sinden and Fitzpatrick (Mycologia **22**: 60, 1930) observed that the young ascus of the 4-spored species *Trichoglossum tetrasporum* and *T. velutipes* contains the fundaments of 8 spores. Of these only four develop into spores, whereas the others finally become either 4 indistinct protoplasmic strands or 4 small subhyaline spores. These authors also suggested that *T. tetrasporum* arose from *T. hirsutum* or from a common ancestor with 8-spored asci. A similar condition was found by the present writer in the 4-spored species, *Trichoglossum yunnanense*, and in the normally 8-spored species, *T. kunmingense* and *Leotia chlorocephala*. He concurs with them in the suggestion that the 4-spored species are derived from the 8 spored ones (Fig. 35).

In the following descriptions the measurements and colors of the ascophores are based on fresh material or on notes and colored drawings made from fresh plants.

MICROGLOSSUM Gillet

M. partitum was reported by Patouillard in 1890 from Tsangshan, Tali, Yunnan (Rev. Myc. **12**: 135, 1890), although recently it has been made a synonym of *Corynetes atropurpureus* by Imai (Ann. Myc. **38**: 273, 1940). Of the four species reported below two are described as new.

MICROGLOSSUM FUMOSUM (Peck) Dur. Ann. Myc. **6**: 408, 1908.
On ground in woods, Tsangshan, Tali, 7454.**

MICROGLOSSUM OLIVACEUM (Pers.) Gill. Disc. Fr. 25, 1879.
On ground in woods, Kunming, 7414, 7417.

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Microglossum capitatum sp. nov.

Figs. 2, 17

Ascomatibus 3 3.5 cm. altis; clavula capitata, plus minusve compressa, longitudinaliter sulcata, "smoky yellow" (M. & P. 13L6), 1 cm. alta, 0.8 1.2 cm. lata; stipite tereti, glabro, 2 2.5 cm. longo, 3-5 mm. crasso, concolore, fibroso; ascis angustato-clavatis, 137 169×12-14μ, tetrasporis; sporidiis cylindraceis, hyalinis, levibus, curvatis, 69-89×4-5μ, (13-15?) septatis; paraphysibus filiformibus, hyalinis, flexuosis v. leniter curvatis, sursum leniter incrassatis.

Type: on ground, Cheli, Yunnan, August 10, 1939, H. S. Yao, 7422; 8051 from same locality.

The plants are clustered. The ascigerous portion is little distinct from the stipe which is of the same color or of a darker shade than the former. The smoky yellow color and capitate ascigerous portion and larger asci and spores distinguish this species from the following, *M. tetrasporum.*

Microglossum tetrasporum sp. nov.

Figs. 1, 16

Ascomatibus clavatis, 2.5 6 cm. altis; clavula elliptica, "dark beaver" (M. & P. 15A10), compressa, sulcata, convoluta, 1.0-2.5 cm. longa, 6-15 mm. lata; stipite compresso v. tereto, concolore sed paullo dilutiore (M. & P. 15E11), 4 6 mm. crasso; ascis clavatis, 74-123×11-13μ, tetrasporis; sporidiis cylindraceis, curvatis, primo continuis, demum 11-17-septatis, hyalinis, levibus, 49-72×4.3-5.7μ; paraphysibus filiformibus, hyalinis, ramosis, sursum curvatis v. uncinatis, apicibus ellipsoideis v. clavatis.

Type: on ground, Cheli, August 20, 1939, H. S. Yao, 7423.

This species differs from *M. capitatum* microscopically by its brown clavate ascigerous portion and microscopically by its smaller asci and spores, and from the other species of *Microglossum* by its four-spored asci.

GLEOGLOSSUM Durand

GLEOGLOSSUM GLUTINOSUM (Pers.) Dur. Ann. Myc. **6**: 419, 1908.

On ground in woods, Kunming, 7413. Bintsuan, 7421. Cheli: 8052, 8053, 8054. The Yunnan plant is smaller in size (2.5 5 cm. high), and the spore has a smaller range in length (81 97μ).

GEOGLOSSUM Pers. emend. Dur.

Geoglossum elongatum sp. nov.

Figs. 10, 32

Ascomatibus 1.2 10 cm. altis, clavatis; clavula piriformi-elliptica, angustate elliptica v. oblonga, 3.5 10 mm. longa, 1.0-4 mm. crassa, plus minusve compressa, atra; stipite tereti v. plus minusve compresso, squamuloso, 0.7–1.5 mm. crasso (plerumque 1 mm.), brunneo-atro; ascis clavatis, 125–194×16–22μ, octosporis; sporidiis parallele positis, cylindraceis, 7-septatis, fuligineis, rectis v. curvatis, 64–104×4.5 6.0μ; paraphysibus septatis, cellula terminali clavata, rare globosa, curvatis v. circinatis, brunneolis.

Type: on ground or on fallen leaves and twigs in woods, Shishan, Kunming, July 3, 1938, Jen Hsu, 7420; 7440, 7444, 7439, 7455, 8243 from same locality. Chichushan, Bintsuan, 7437, 7415, 7438, 7421. Tsangshan, Tali, 7441, 7451.

The shape of the paraphyses of this species is quite variable. Paraphyses are often closely septate or, quite rarely, have globose terminal cells.

This species differs from *G. nigritum* by its cylindrical and longer spores, and from *G. glabrum* by its cylindrical and narrower spores and different paraphyses. Macroscopically, collection No. 7415 is exceptional by being ribbon-like, but is microscopically identical with the other collections.

Geoglossum glabrum Pers., var. **angustosporum** var. nov.

Sporidiis 67–89(79–84)×6–7μ; ascis 16–19 latis, aliter ut in forma typica.

Ascomata 5.5–9 cm. high; ascigerous portion lanceolate, compressed, 2–2.7 cm. long, 2.5–5 mm. wide, $\frac{1}{4}$–$\frac{1}{3}$ of the total length, not sharply distinct from the stipe, black; stipe terete or compressed, 1.5–2 mm. thick, brownish black, squamulose or smooth. Asci clavate-cylindrical, shortly stipitate, 150–200×16–19μ, 8-spored; spores in a parallel fascicle in the ascus, clavate, fuliginous, 7-septate, usually slightly curved, 67–89(79 84)×6–7μ; paraphyses closely septate near the apex, the terminal cells abruptly enlarged, moniliform, constricted at septum, brown above, straight or curved.

This variety differs from the species by its shorter and narrower spores and narrower asci.

Type: on ground in woods, Chichushan, September 18, 1938, C. C. Cheo, 7424; 7449, 7418, 7450 from same locality.

Geoglossum nigritum is separated from *G. glabrum* mainly by the remotely septate and scarcely moniliform paraphyses, and the smaller asci and spores. In studying the Yunnan collections the writer found intergrading forms which could not be placed in either of the species. It might, therefore, be well to include *G. nigritum* in *G. glabrum*, the latter name to apply to all the brownish black or black Geoglossums with brown, 7-septate spores and free, brown, septate paraphyses.

GEOGLOSSUM NIGRITUM Cooke, Mycogr. 205, pl. 96, fig. 345, 1878.

On ground in woods, Kunming, 7419, 7445. Chichushan, 7448, 5311. Tali, 7446, 7447. Cheli, 8064.

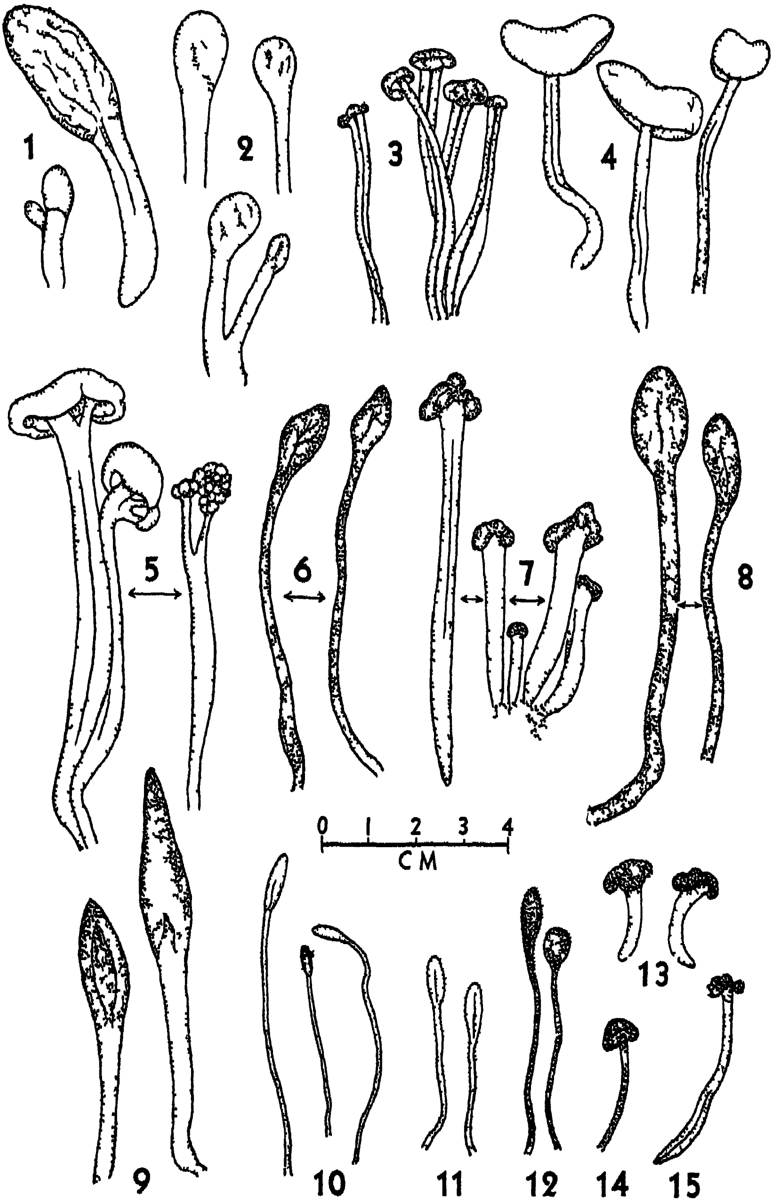

PLATE 1. 1 *Microglossum tetrasporum* 2 *Microglossum capitatum* 3 *Leotia Kunmingensis* 4 *Cudonia helvelloides* 5 *Leotia portentosa* 6 *Trichoglossum yunnanense* 7 *Leotia aurantipes* 8 *Trichoglossum longisporum* 9 *Trichoglossum sinicum* 10 *Geoglossum elongatum* 11 *Geoglossum Durandii* 12 *Trichoglossum gracile* 13 *Leotia atrovirens* 14 *Trichoglossum Persoonii* 15 *Leotia gracilis*

Geoglossum nigritum Cooke, var. **Cheoanum** var. nov.

Sporidiis 7-8.5 latis; ascis 175 212×19–25μ; aliter ut in forma typica.

Type: on ground, Hsiakuan, Yunnan, August 21, 1938, C. C. Cheo, 7442.

This variety differs from the species by its much broader and longer asci and wider spores. It is distinct from *G. glabrum* by its shorter spores and different paraphyses.

GEOGLOSSUM FALLAX Dur. Ann. Myc. **6:** 428, 1908.

On ground in woods, Shishan, Kunming, 7416.

GEOGLOSSUM SUBPUMILUM Imai, Trans. Sapporo Nat. Hist. Soc. **13:** 179, 1934. (Figure 33).

On ground in woods, Tali, 7443. Kunming, 8246.

GEOGLOSSUM UMBRATILE Sacc. Mich. **1:** 444, 1878.

Plants 4.5–5.5 cm. high clavate; ascigerous portion lanceolate, not sharply distinct from the stipe, compressed, about ½ of the total length, "sepia" (M. & P. 8A10), 2–2.3 cm. long, 3–3.5 mm. thick, longitudinally furrowed; stipe compressed, slightly tapering towards the base, 2 2.5 mm. thick, densely squamulose, "Mandalay Friar+" (M. & P. 8L12); asci clavate, short-stalked, narrowed at apex, 129–160×16–20μ, 8-spored, multiseriate; spores remaining hyaline for a long time, becoming brownish olivaceous, straight or slightly curved, 3–9-, mostly 7-septate, subcylindrical, 64–81×6–7μ; paraphyses longer than asci, slender, slightly and gradually thickened above, much coiled and twisted at the tip, branched, usually remotely septate, brownish.

On ground under Quercus, Shishan, Kunming, 8247.

G. Barlae Boud. and *G. umbratile* Sacc. are the two species of *Geoglossum* which have 7-septate spores and much coiled and twisted paraphyses. Collection No. 8247 differs from *G. Barlae* in its much smaller asci and smaller spores, but resembles closely *G. umbratile* to which it is tentatively referred.

Geoglossum pusillum sp. nov.

Fig 23

Ascomatibus 9–13 mm. altis; parte ascigerante elliptica v. late ovata, plus minusve compressa, 4–5 mm. longa, 2–3 mm. lata, atra; stipite tereti, squamuloso, 5–8 mm. longo, 1–1.5 mm. lato, atro-brunneo; ascis clavato-cylindraceis, apice rotundatis v. leniter contractis, 200–227×18–23μ, octosporis, rare tetrasporis; spiridiis cylindraceo-clavatis, olivaceo-brunneis, 11–15-septatis, rectis v. curvatis, 111–144×5–6μ; paraphysibus anguste clavatis v. clavatis, brunneolis, remote septatis, cellula terminali cylindrica v. clavata, 21–51×4–7μ.

Type: on ground, Taiho, Kiangsi, 1937, Hsing-mei Yang, Chekiang University Plant Pathological Herbarium No. 694.

This species differs from *G. pygmaeum* by its smaller ascomata, larger asci, different paraphyses and variable septation of the spores; from *G. pumilum* in the smaller asci and longer spores; and from *G. subpumilum* in the longer asci, longer spores of different shape, and different paraphyses.

Trichoglossum Boudier

Five species and two varieties of *Trichoglossum* have been reported from China: *T. hirsutum* Pers. (Jour. de Bot. 7: 343, 1893; Sinensia 5: 448, 1934), *T. Durandii* Teng (Contr. Biol. Lab. Sci. Soc. 8: 52, 1932), *T. rotundiformis* (Kawamura) Tai et Wei (Sinensia 4: 98, 1933), *T. Wrightii* Dur. (Sinensia 5: 449, 1934), *T. confusum* Dur. (Sinensia 5: 450, 1934), *T. hirsutum* var. *capitatum* (Pers.) Teng (Sinensia 6: 186, 1935). Re-examination of the specimens formerly referred to *T. rotundiformis* by Mr. Wei and the writer shows that it is identical with *T. Farlowi*. Regarding *T. hirsutum* var. *capitatum*, *T. Farlowi* var. *rotundiformis* and *T. Durandii*, the specimens of which are not available for study, a comparison of the descriptions leads the writer to the conclusion that *T. hirsutum* var. *capitatum* seems to be *T. hirsutum; T. Farlowi* var. *rotundiformis* apparently is *T. Farlowi;* but *T. Durandii* is a good species. Should this conclusion be correct, up to 1935 only five species (*T. Farlowi*, *T. confusum*, *T. Wrightii*, *T. Durandii*, and *T. hirsutum*) of *Trichoglossum* would have been known from China. In this paper ten species and two varieties are reported. Of these, six species and one variety are described as new. The total number of species and varieties of *Trichoglossum* now known from China is, therefore, thirteen species and two varieties.

In the material examined by the writer, clavate setae with rounded apices are often found in *T. sinicum*, *T. kunmingense* and *T. cheliense* (Fig. 26). Sometimes these clavate setae attain the size and shape of an ascus. They arise among the paraphyses from a hypha, the apex of which is one to three-celled and fuliginous in color. At this stage the seta is hardly distinguishable from the paraphyses except by its fuliginous color. The septation of the mature seta is usually four, but sometimes one, three, five or six. As the seta approaches maturity, it becomes darker and darker, whereas the septa become less and less evident until they disappear entirely.

Key to the Species of Trichoglossum Known from China

1.	Spores 45–100μ long	2
	Spores 100–190μ long	3
2.	Spores 0–6-septate, clavate-cylindrical	*T. Farlowi*
	Spores 7-septate, clavate	*T. confusum*
3.	Spores 100–160μ long	4
	Spores 160–190μ long	12
4.	Spores 8 in each ascus	6
	Spores 4 in each ascus	5

5. Spores 7–11-septate .... *T. velutipes*
Spores 15-septate, 117–136μ long .... *T. tetrasporum* var. *brevisporum*
6. Spores 15-septate 7
Spores 7–12-septate 10
7. Spores cylindrical-clavate .... *T. hirsutum*
Spores clavate-cylindrical 8
8. Spores with one end blunt and the other slightly pointed; ascomata densely velvety or not 9
Spores with pointed ends; ascomata not densely velvety .... *T. gracile*
9. Spores brown; ascus 200–231×18–22μ; stipe densely velvety, black .... *T. cheliense*
Spores pale brown, remaining hyaline for a long time; ascus 175–212×16–19μ; stipe and ascigerous portion conspicuously hairy, light cinnamon brown or Verona brown when fresh, black when dry .... *T. Durandii*
10. Spores 7-septate, subcylindrical .... *T. kunmingense*
Spores 8–12-septate 11
11. Spores 8–9-septate, rarely 5, 6 or 7 .... *T. Wrightii*
Spores 8–12-septate .... *T. hirsutum* f. *variabile*
12. Spores 8 in each ascus, rarely 4; 15-septate 13
Spores 4, rarely 2 or 8; 15-septate .... *T. yunnanense*
13. Spores 5–6μ wide, with sharply pointed ends .... *T. Persoonii*
Spores 6–7μ wide, with obtuse ends 14
14. Spores 147–175μ long; stipe "wood rose" (sorghum brown); setae short and slender (6–7μ wide) .... *T. sinicum*
Spores 156–190μ long; stipe densely velvety and black; setae long and stout (10–13μ wide) .... *T. longisporum*.

TRICHOGLOSSUM HIRSUTUM (Pers.) Boud. Bull. Soc. Myc. Fr. **1**: 110, 1885.

On ground in woods, Kunming, 5084. Tali: 5263, 5087, 5093, 5262, 5090. Chichushan: 5086, 5264, 5260, 5261, 5094.

The writer includes in *T. hirsutum* all forms which have a dull black ascigerous portion, densely velvety and black stipe, and cylindrical-clavate, 15-septate spores that are about 100 to 160μ long and 6 to 7μ broad. The shape and size of the ascigerous portion, both of which vary greatly, could not be used as criteria for distinguishing species.

TRICHOGLOSSUM HIRSUTUM (Pers.) Boud. f. VARIABILE Durand, Ann. Myc. **6**: 437, 1908.

Cheli: 8055, 8056, 8058, 8073, 8244.

This form differs from *G. Wrightii* by its shorter and narrower asci, narrower spores and the larger number of septa. The number of septa in the spores is quite variable; thus, in collection No. 8055 the majority of the spores are 7-septate, in 8056 8-septate, in 8073 and 8058, 10–11-septate.

TRICHOGLOSSUM GRACILE Pat. Bull. Soc. Myc. Fr. **25**: 131, 1909.

Figs. 12, 34

Ascomata 1.8–6 cm. high, conspicuously hairy, black when dry; ascigerous portion rotund, rarely elliptic, rounded, rarely slightly compressed, about ⅛ to ⅕ of the total length, distinct from the stipe when fresh, 2–4 mm. in diameter, black; stipe slender, flexuous, equal, 0.5–1.0 mm. thick, "café noir" when fresh, black when dry, terete; asci clavate-cylindrical, 168–237×16–19μ; spores 8, clavate-cylindrical, slightly tapering from the middle, more or less pointed at the ends, 15-septate, brown, 110–162

(126–156)×5 6μ; paraphyses pale brown or brown, slightly thickened at apex, curved or uncinate, septate, often branched at the base; setae projecting about ⅓ to ½ of their length above the hymenium, 8.5–14μ wide.

On ground in woods, Kunming: 5083, 5078, 5080, 5082, 5097, 6884. Chichushan: 5081, 5096.

This species differs from *T. hirsutum* by its conspicuously hairy ascoma, slender stipe, clavate-cylindrical and narrower spores and narrower asci, but agrees closely with the description of *T. gracile* Pat. and is tentatively referred to this species.

TRICHOGLOSSUM DURANDII Teng, Contr. Biol. Lab. Sci. Soc. **8**: 52, 1932.

Figs. 11, 31

Ascomata 2.5 4 cm. high, clavate, conspicuously hairy, entirely and densely covered with black hairs, light cinnamon brown or Verona brown when fresh, becoming black when dry; ascigerous portion elliptic or lanceolate, 0.8–1 cm. long, 2–2.5 mm. wide, more or less compressed, not distinct from the stipe; stipe 1.5–3 cm. long, about 1 mm. wide, conspicuously hairy as in the ascigerous portion, terete, straight or more or less flexuous; asci clavate, 175 212×16 19μ, 8-spored; spores clavate-cylindrical to subcylindrical, with one end blunt and the other slightly pointed, remaining hyaline for a long time, finally becoming brownish, mostly 15- sometimes 12–14-septate, 117–129×5–6μ; paraphyses clavate, thickened at the tip, the terminal cell brownish or subhyaline, septate, straight or slightly curved; setae projecting one third or usually one half or more of their length above the hymenium, 10-14μ wide, black.

Cheli: 5312, 5313, 6883, 8050, 8074.

This species is distinct from *T. cheliense* by its conspicuously hairy ascomata, shorter and narrower asci and paler spores. It is very close to *T. Durandii* Teng except that the plants are larger and not whitish, and that the spores are mostly 15-septate. The specimens on which Teng based his original diagnosis may be immature.

Trichoglossum cheliense sp. nov.

Fig. 24

Ascomatibus 3–6 cm. altis, clavatis, simplicibus v. bifurcatis; clavula elliptica, rotundata v. furcata, compressa 0.5–1.4 cm. alta, 5–10 mm. crassa, brunneo-atra; stipite tereti v. compresso, hirsuto, atro, 3–4.5 cm. longo, 1.5–3 mm. crasso; ascis clavatis, 200–231×18–22μ; 8-sporis; sporidiis clavato-cylindraceis v. subcylindraceis, 15- raro 13–14-septatis, brunneis, 89–151 (104–132)×5 6μ; paraphysibus septatis, sursum brunneis v. pallide brunneis, uncinatis, leniter incrassatis.

Type: Cheli, August 1939, H. S. Yao, 6885; 5316, 8065, 8066 from same locality. The specimens of collection No. 6886 are lobed, while those of No. 5316 are not. Microscopically they are identical.

This species is closely related to *T. hirsutum* but is distinct by its subcylindrical and narrower spores.

Trichoglossum kunmingense sp. nov.

Fig 26

Ascomatibus 1.5–3.5 cm. altis; clavula lanceolata v. elliptica, compressa, 5.5–8 mm. longa, 3–4 mm. crassa, brunneo-atra; stipite tereti v. compresso, 2–3 mm. crasso, hirsuto, atro; ascis clavatis, 175–225×19–25μ, 4 v. 8-sporis, plurimis 8; sporidiis clavato-cylindraceis v. subcylindraceis, brunneis, 7- raro 3–6-septatis, 104–144 (plurimis 117–123)×6–8μ; paraphysibus uncinatis, brunneis, septatis.

Type: on ground in woods, Shishan, Kunming, August 9, 1938, F. L. Tai and H. S. Yao, 5095; 5091, 5092, 6363 from same locality.

This species differs from *T. Walteri* mainly by its longer spores.

Trichoglossum yunnanense sp. nov.

Figs. 6, 29

Ascomatibus 3.5–7.5 cm. altis; clavula elliptica v. subglobosa, compressa, atra; stipite 4.5–7 cm. longo, 2–3 mm. crasso, tereti, flexuoso, atro; ascis cylindraceo-clavatis, 4- raro 2 v. 8-sporis, 237–294×19–22μ; sporidiis clavato-cylindraceis, 15- (raro 16)-septatis, brunneis, 143–187×6–7μ; paraphysibus brunneis, septatis, clavatis, sursum curvatis.

Type: on ground in woods, Chichushan, September 18, 1938, C. C. Cheo, 5393; also deposited in the Plant Pathology Herbarium, Cornell University as No. 27985.

This species is very close to *T. longisporum* except that the number of spores per ascus is eight in the latter. It differs from *T. tetrasporum* by its longer and narrower asci, longer ascospores and by the shape of the spores.

Dr. W. L. White of Cornell University, who has kindly compared this plant with the type specimen of *T. tetrasporum*, considers it as a form of *T. hirsutum* from which it is, however, distinct by 2- or 4-spored longer asci and spores.

Trichoglossum Persoonii sp. nov.

Figs. 14, 25

Ascomatibus 2.5–4 cm. altis; clavula abrupte subglobosa v. ovata, rotundata, 5–9 mm. alta, 3–8 mm. lata, atra; stipite tereti, 1–3 cm. longo, 1–2 mm. crasso, atro-brunneo; ascis clavatis, 225–275×18–23μ, 8-sporis; sporidiis clavato-cylindraceis, 13–20-septatis, plurimis 15–19, gracilibus, 162–200×5–6μ, brunneis, rectis v. curvatis, paraphysibus clavatis, brunneolis, septatis, sursum incrassatis, rectis v. curvatis, apicibus non v. cohaerentibus, supra ascos epithecium brunneum formantibus.

Type: on ground in woods, Cheli, August, 1939, H. S. Yao, 8067; 8068, 8070, 8075, 8096, 8071 from same locality.

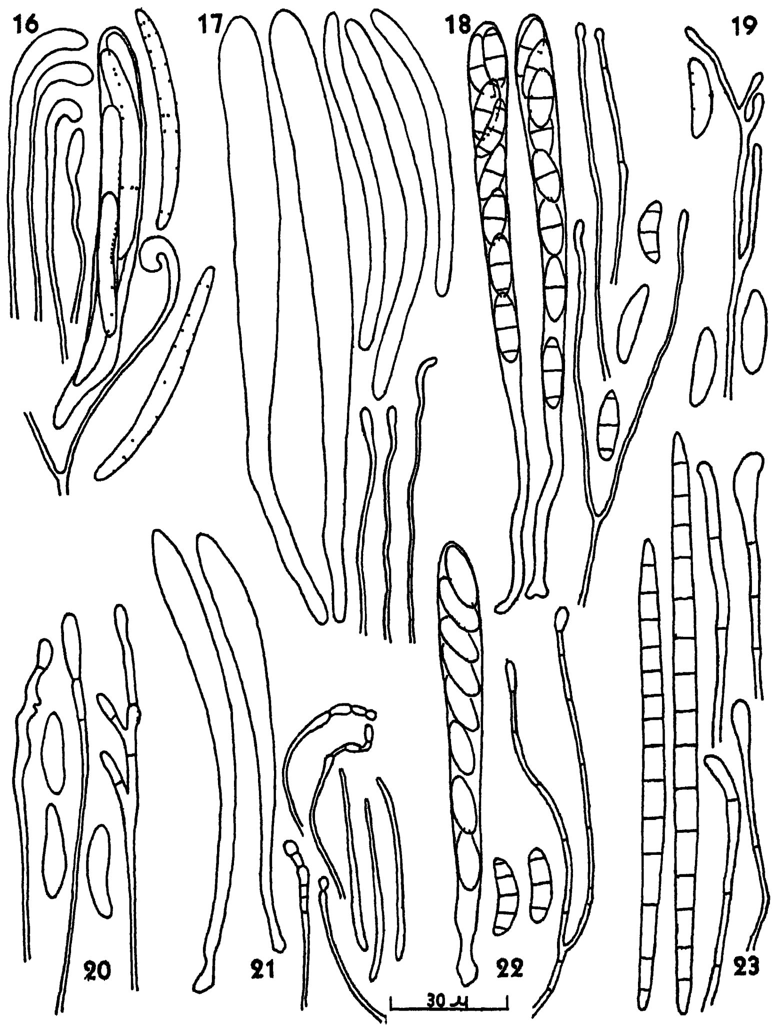

PLATE 2. 16 *Microglossum tetrasporum* 17. *Microglossum capitatum.* 18. *Leotia kunmingensis*, note long and slender stipe of ascus. 19. *Leotia atro-virens*, note branching of paraphyses. 20 *Leotia gracilis*, note variability of paraphyses. 21. *Cudonia helvelloides.* 22. *Leotia portentosa.* 23. *Geoglossum pusillum.*

This species is distinct from *T. gracile* by its longer and broader asci, and longer spores, and from *T. longisporum* by narrower spores, and from both by its sharply pointed spores.

The paraphyses are not always agglutinated. Agglutination of the paraphyses is variable and apparently not a dependable character for differentiating species.

In appearance this plant with its abruptly subglobose fertile portion resembles very much those illustrated by Lloyd under the name of *Geoglossum capitatum* (see his "The Geoglossaceae," 1916, fig. 794). But since no detailed description was given, it could not be ascertained that Lloyd's plant is identical with ours.

This species is distinct from all species of *Trichoglossum* by its sharply pointed spores and agglutinated paraphyses. It might be identical with *G. capitatum* Pers., but in the absence of authentic specimens and in view of the incomplete description Persoon's species is poorly known. It seems best to describe this Chinese plant as a new species.

Teng's *T. hirsutum* var. *capitatum* (l.c.) should be included in *T. hirsutum*, since it differs only by its subglobose ascigerous portion.

Trichoglossum sinicum sp. nov.

Figs 9, 27

Ascomatibus clavatis, 5.5–7 cm. altis; clavula lanceolata, compressa, atra, 2.5-3 cm. longa, 0.8-1 cm. crassa; stipite tereti, saepe parum compresso et sulcato, 3–4 cm. longo, 3.5–5 mm. crasso, "wood rose sorghum brown" (M. & P. 6B9); ascis clavato-cylindraceis, 237-281×21-26μ, octosporis, raro 4-sporis; sporidiis cylindraceo-clavatis, 7-15-septatis, plurimis 15, 147–175×6–7μ, brunneis; paraphysibus clavatis, septatis, apicibus brunneis.

Type: Cheli, August, 1939, H. S. Yao, 5315.

The size and color recorded above are based on the colored drawings and notes made by Mr. H. S. Yao. The setae of the plant are unusually slender and short, mostly shorter than the asci, not or hardly projecting above the hymenium, 6–7μ wide. The number of the septa of the spore varies from 7 to 15, but is mostly 15. This species is distinct from all other species of *Trichoglossum* in its robust, light colored stipe. It is close to *T. longisporum*, but differs by its robust, nonvelvety light colored stipe and shorter spores. It is also distinct from *T. hirsutum* by its longer and broader asci, slightly longer spores and different stipe.

Trichoglossum longisporum sp. nov.

Figs. 8, 30

Ascomatibus 5.5–10 cm. altis; clavula elliptica v. subglobosa, 1–2 cm. alta, 5–12 mm. crassa, parum et irregulariter compressa, atra; stipite tereti, flexuoso, 1.5–3 mm. crasso, atro, hirsuto; ascis clavato-cylindraceis, 237-281×19–25μ, 8-sporis, sporidiis clavato-cylindraceis, 156–190×6–7μ, 15 (raro 7 v. 13)-septatis, brunneis; paraphysibus pallide brunneis, uncinatis, septatis.

Type: Chichushan, September 18, 1938, C. C. Cheo, 5089.

This species differs from *T. hirsutum* by its longer and broader asci and spores. It is very close to *T. yunnanense* except that the asci are regularly 8-spored.

Trichoglossum tetrasporum Sind. & Fitzpatr., var. **brevisporum** var. nov.

Fig. 28

A typo sporidiis 117–136μ longis differt.

Ascomata 2–3 cm. high; ascigerous portion subrotund, separated abruptly from the stem, about $\frac{1}{4}$ of the total length, dull black; stipe terete, about 1 mm. broad, densely velvety, black. Asci cylindrical-clavate, 206–219×19–24μ, 4-spored, rarely 2; spores cylindrical-clavate, straight or slightly curved, brown, 15-septate, 117–136×6–7μ; paraphyses slightly thickened at apex, septate, pale brown, curved; setae projecting $\frac{1}{4}$ to $\frac{1}{3}$ of its length above the hymenium, 10–11μ wide.

Type: Chunghosze, Tali, August 24, 1938, H. S. Yao, 5085.

This plant is close to *T. tetrasporum* except that its spores are shorter. The asci are usually 4-spored, but 2-spored asci in the type of *T. tetrasporum*, a fragment of which was kindly sent by Dr. W. L. White.

TRICHOGLOSSUM VELUTIPES (Pk.) Dur. Ann. Myc. **6**: 434, 1908.

Ascomata 4–4.5 cm. high; ascigerous portion lanceolate or elliptical, distinct from the stipe, $\frac{1}{5}$–$\frac{1}{4}$ of the total length, simple or furcate, 0.7–1 cm. long, 0.6–1 cm. thick, more or less compressed, black; stipe terete, more or less flexuous, 3.0–3.2 cm. long, 2–4 mm. wide, tapering below, velvety, black; asci clavate, somewhat narrowed at apex, very short-stiped, 188–224×17–22μ, 4-spored; spores narrowed each way from the middle, 7–12, mostly 10–11-septate, 106–154×5.5–6.5μ, olivaceous brown; paraphyses variable in shape, clavate, slightly curved or uncinate at apex, brownish, hyaline below, septate; setae 117–157×6–7μ (broadest part).

Cheli: 8061, 8063.

LEOTIA Pers.

Leotia aurantipes (Imai) stat. nov.

Fig. 7

L. lubrica f. *aurantipes* Imai, Bot. Mag. Tokyo **50**: 9–16, 1936.

Plants solitary or gregarious, 2–8.5 cm. high, somewhat viscid-gelatinous; ascigerous portion pileate, convex, irregularly furrowed, 4–6.5 mm. high, 4–12 mm. broad, dark green (M. & P. 16H3), olivaceous green (M. & P. 23C1), yellowish olivaceous green (M. & P. 21B1) or brown (M. & P. 12L10); stipe terete when young or just beneath the ascigerous portion, usually compressed below, hollow, yellow (M. & P. 12L7) or orange yellow (M. & P. 11G5 or 11L8), usually slightly tapering above, more or less enlarged at the lower half and then slightly tapering towards the base, longitudinally furrowed, rarely branched at the tip, sometimes twisted, with minute inconspicuous greenish granules, 3–8 cm. long, 1.5–3.0 mm. wide above, 3–5 mm. wide below; asci clavate-cylindrical, slightly narrowed at the apex, 119–162×8.6–12μ; spores 8, biseriate above, uniseriate below, fusoid, with obtuse or subacute ends, straight or slightly curved, hyaline, becoming 3–7-septate, 17–23×5.0–6.4μ; paraphyses filiform, branched at the base, hyaline, septate, apices clavate or abruptly piriform or globose, straight or somewhat curved.

On ground in woods, Kunming: 7430, 7431, 7432, 7436, 7461, 7840, Chichushan: 7433, 7434, 7435, 7429.

L. aurantipes is easily distinguished from the other species of *Leotia* by its dark green, olivaceous green or somewhat ochraceous yellow head and orange yellow stipe. It is the most common species around Kunming. Kawamura gave an excellent colored illustration of this species in his "Japanese Fungi" (fig. 4, 1929) under the name of *L. lubrica.*

Since the type of *L. lubrica* does not exist, this species has been variously interpreted by different authors. Thus, Massee (Brit. Fung. Fl. **4**: 471, figs. 25–27, 1895) and Durand (Ann. Myc. **6**: 446, figs. 106, 213, 1908) consider the entirely olivaceous, ochraceous-yellow plants as *L. lubrica*, while according to others, notably Gillet (Disc. Fr. p. 23, pl. 102, 1879), Rehm (Disc. p. 1165, figs. 1–4, 1896 as *L. gelatinosa*) and Bresadola (Icon. Myc. **24**: T. 1187, 1932), the latter should have a yellowish green or olivaceous brown ascigerous portion and a yellow stipe. Imai (Bot. Mag. Tokyo **50**: 9–16, 1936) maintains that it is more reasonable to designate the gelatinous *Leotiae* which have mainly an ochraceous olive or green tint throughout or in part as the *lubrica* group, and to treat some of the species of *Leotia* as forms of *L. lubrica* rather than to recognize them as distinct species.

On the basis of his field and laboratory study of the forms of Imai's *lubrica* group in Yunnan for the past few seasons, the writer is of the opinion that well marked species can be distinguished in that group and that many of Imai's forms should be raised to specific rank. It is true that these fungi are variable in color, size and form. But when all observable characters and the limits of their variation are taken into consideration, little difficulty would be met in their identification.

Since it is impossible to determine what typical *L. lubrica* is, it is preferable to give new names to the entirely olivaceous ochraceous-yellow plants of Durand and to those with yellowish green or olivaceous brown heads and yellow stipes of Gillet and others, after they have been studied again and compared in fresh condition, rather than to refer them to the old and poorly known *L. lubrica.*

Macroscopically *L. aurantipes* resembles closely *L. lubrica*, as described by Gillet and others, but differs in having usually a compressed stipe and slightly narrower and shorter asci. Whether or not the Kunming plant is identical with that of Gillet could not be determined. But the Kunming plant is undoubtedly identical with the Japanese one designated by Imai

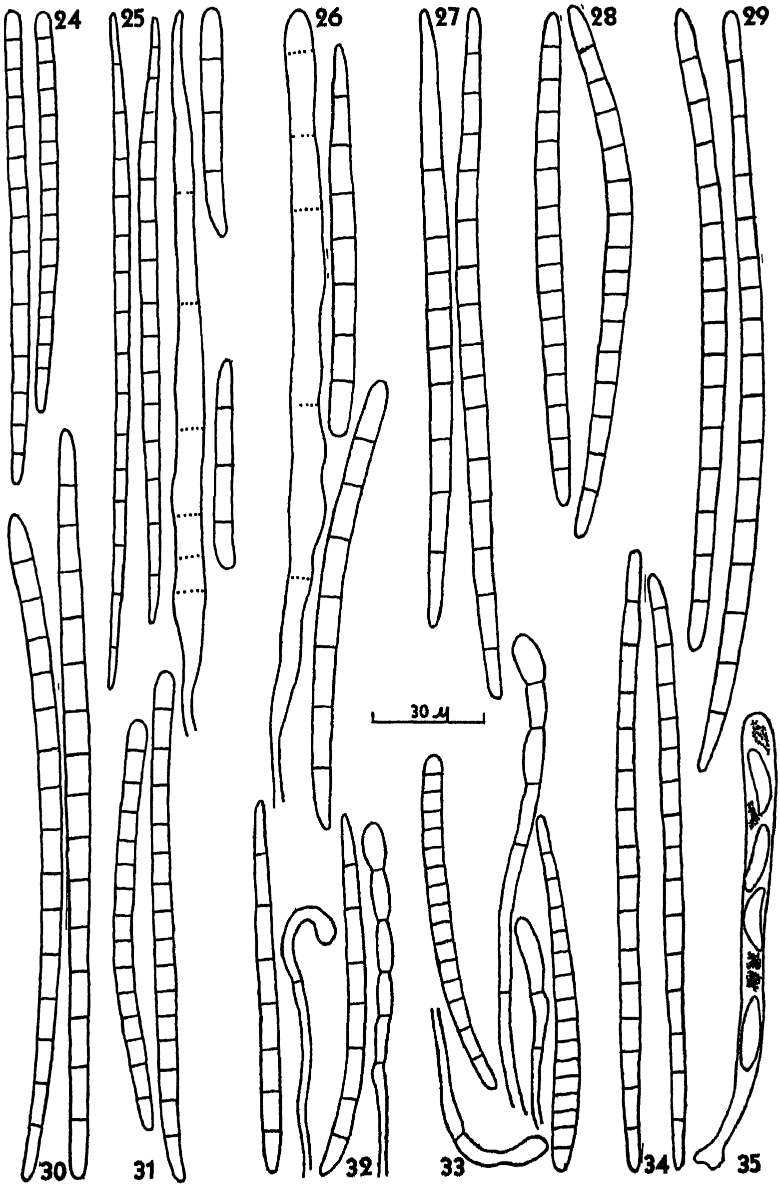

PLATE 3.—24. *Trichoglossum cheliense*, note shape of spore. 25. *Trichoglossum Persoonii*, note sharply pointed ends of spore. 26. *Trichoglossum kunmingense*, note small abnormal spores. 27. *Trichoglossum sinicum*. 28. *Trichoglossum tetrasporum* var. *brevisporum*. 29. *Trichoglossum yunnanense*. 30. *Trichoglossum longisporum*. 31. *Trichoglossum Durandii*. 32. *Geoglossum elongatum*. 33. *Geoglossum subpumilum*. 34. *Trichoglossum gracile*. 35. *Leotia chlorocephala*, note disintegration of four of the eight spores.

as *L. lubrica* f. *aurantipes*, to which it is here referred. Even if it were found to be identical with the European form described by Gillet and others, it should nevertheless have a new name for the above reasons.

Leotia kunmingensis sp. nov.

Figs. 3, 18

Ascomatibus gregariis, viscidulis, 4.5–5.5 cm. altis, atro-viridibus; parte ascigerante convexa, irregulariter sulcata, 0.5–1 cm. lata, 1.5–5 mm. alta, atro-viridi (M. & P. 24H5); stipite compresso, longitudinaliter sulcata, plus minusve contorto, 4–5 cm. longo, aequali v. deorsum incrassato, 2–4.5 mm. lato, glabro, concolore sed paullo dilutiore (M. & P. 23E6), firmo; ascis angustate clavatis, longe pedicellatis, 137–166×8–11μ, octosporis; sporidiis elliptico-fusiformibus, hyalinis, rectis v. leniter curvatis, primo continuis, demum 3-septatis, 16–20×5.3–6.4μ; paraphysibus filiformibus, deorsum ramosis, rectis, viridulis, septatis, apice subclavatis aut nodulosis, 2μ crassis.

Type: on ground in woods, Shishan, Kunming, August 28, 1938, F. L. Tai, 7452.

In the locality, where the above specimens were collected, abundant material of *L. aurantipes* was also gathered. The dark green plant is evidently not an environmental variation of *L. aurantipes*. *L. atro-virens* is smaller in size and lighter in color, has a non-furrowed and furfuraceous stipe, and paraphyses which are branched near the apex. It is also distinct from *L. chlorocephala* by its darker color, and the firm, compressed and non-furfuraceous stipe.

Leotia portentosa (Imai et Minak) stat. nov.

Figs. 5, 22

L. lubrica f. *portentosa* Imai et Minak, Bot. Mag. Tokyo 50: 9, 1936.

Plants clustered, 9–13 cm. high, entirely bluish-green to olivaceous green (M. & P. 23L1 or 30B7); ascigerous portion convex, smooth or furrowed, often ramose-lobate, lobes sometimes subtubercular, margin incurved, 1–2.4 cm. broad; stipe terete or more or less compressed, often branched at the tip, 7.5–11 cm. long, 3–7 mm. wide, equal or enlarged at the middle, furfuraceous with green granules, longitudinally furrowed and often twisted, firm. Asci clavate to clavate-cylindrical, apex rounded or slightly narrowed, 103–130×8.6–11μ; spores 8, subbiseriate above, uniseriate below, elliptical-fusiform with blunt or subacute ends, hyaline, straight or curved, continuous at first, becoming 5–7-septate, 15–20×5.3–5.7μ; paraphyses filiform, hyaline with greenish tint, the apices piriform or clavate, septate, branched near the base, green.

On ground in woods, Chichushan, September 11, 1938, C. C. Cheo, 5194.

Its large size, ramose-lobate clavule and greenish color are the distinguishing characteristics of this species.

LEOTIA CHLOROCEPHALA Schw. ex Durand, Ann. Myc. 6: 450, 1

Fig. 35

On ground in woods, Chichushan, 7427, 7428. Tsangshan 7453.

Imai (l.c.) regarded *L. chlorocephala* as one of the forms of his *L. lubrica*, but proposed a new name for it, *chlorosoma*, rejecting *L. chlorocephala* which had been imperfectly described in the original diagnosis. Since Durand studied the type specimen of Schweinitz and redescribed it, there seems to be no more doubt about its identity.

LEOTIA ATRO-VIRENS Pers. Myc. Eur. 1: 202, pl. 9, figs. 1–3, 1822.

Figs. 13, 19

Plants 1.3–2.5 cm. high (rarely up to 5 cm. high); ascigerous portion convex, somewhat convoluted, margin incurved, dark green (M. & P. 24C10), 6–11 mm. broad; stipe terete, more or less compressed at the lower two-third, straight, yellowish green (M. & P. 23L2), densely furfuraceous with green granules, almost equal in diameter, sometimes tapering at the lower end, 1–2 cm. long (rarely 4.8 cm.), 2–3 mm. wide. Asci narrowly clavate, shortly stipitate, occasionally with a long and slender stipe, 109–147×6–10μ; spores 8, subbiseriate above, uniseriate below, or uniseriate, elliptical or fusiform-elliptical, hyaline (greenish in mass), straight or curved, continuous at first, becoming 5-septate, 14–24×5.4–6.1μ; paraphyses slightly thickened at apex, straight or flexuous, indistinctly septate, branched near the apex or at the base, hyaline.

On ground in woods, Kunming, 7536, 7538. Meitan, Kweichow, Chekiang University Plant Pathological Herbarium No. 691 (7800).

Among the plants collected by Mr. Chiu on November 12, 1941 (7536), there is one which is 5 cm. high, whose ascigerous portion is 11 mm. in diameter and whose stipe is 4.8 cm. long and 2.5 mm. wide. The stipe is, however, bent and its lower two-thirds lie prostrate on the ground, whereas the above ground portion is only 2 cm. long. Its microscopic characters and color do not differ from the other plants.

Leotia gracilis sp. nov.

Figs. 15, 20

Ascomatibus gregariis, viscidulis, 1.0–4.5 cm. altis, atro-viridibus; parte ascigerante convexa, convoluta, margine incurvata, atro-viridi (M. & P. 24A7), 5–9 mm. lata, laxe granulata; stipite tereto, deorsum plus minusve compresso et interdum incrassato (2 mm.), firmo, furfuraceo, atro-viridi (M. & P. 24A8), 0.8–4 cm. longo, 1–1.5 mm. lato; ascis angustate clavatis, 116–139×9–11μ, octosporis, raro 6; sporidiis elliptico-fusiformibus, hyalinis, rectis v. curvatis, primo continuis, demum 5-septatis, 17–24×5.7–6.4μ; paraphysibus hyalinis, non v. sursum ramosis, septatis, apice clavatis v. irregulariter incrassatis.

Type: on mossy slope, Tienfungan, Kunming, November 11, 1941, W. F. Chiu, 7537.

This species differs from *L. atro-virens* by its slender form and darker color. In addition, the stipe is sometimes enlarged at the basal part, and the spores are more tapering towards the ends than those of the other species. It differs from *L. chlorocephala* by its slender form, darker color, and by its paraphyses which are sometimes branched near the apex.

SPATHULARIA Pers.

SPATHULARIA CLAVATA (Schaeff.) Sacc. Mich. **2**: 77, 1882.

On ground in woods, Tsangshan, Tali, 5194.

CUDONIA Fr.

CUDONIA HELVELLOIDES S. Ito et Imai, Trans. Sapporo Nat. Hist. Soc. **13**: 18, figs. 32–35, 1934.

Figs. 4, 21

Ascomata 4–6 cm. high, pileate, pinkish cinnamon (M. & P. 12C6); ascigerous portion depressed-convex or saddle-shaped, slightly depressed at the center, somewhat furrowed, margin incurved, 6–9 mm. high, 1 2.5 cm. broad; stipe flexuous, concolorous with the pileus, terete or more or less compressed, slightly enlarged towards the base, 3.5-5 cm. long, 2-3 mm. thick, longitudinally furrowed. Asci clavate, much attenuated below, apex slightly narrowed, 121–144×8.6–10µ; spores 8, biseriate, clavate-filiform, hyaline, straight or curved, indistinctly septate (7?), 43-63×1.7-2.1µ; paraphyses filiform, hyaline, closely septate above, the terminal cells elliptical or globose thickened, slightly or strongly curved.

On ground in bamboo groves, Tsangshan, Tali, August 20, 1938, collected by a workman, 7426.

This collection is referred to *C. helvelloides* with some hesitation, because no authentic specimen of this species has been seen. Spore measurements and other characters agree well with those of the Japanese species except the irregular swelling of the apex of the paraphyses which was not mentioned in the original description of that species.

SUMMARY

This paper records the results of a study of twenty nine species and four varieties of Geoglossaceae found in Yunnan (except one species from Kiangsi), of which twelve species and three varieties are described as new. Intergrading forms between *Geoglossum glabrum* and *G. nigritum* were found. Two of Imai's forms of *Leotia lubrica*, *aurantipes* and *portentosa*, are raised to specific rank. It is suggested that *L. lubrica* be rejected because it has been variously interpreted by different authors.

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New and Interesting Cortinarii from North America

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INTRODUCTION

Although species collected in various regions of North America are included in this report, by far the majority were found in the Olympic National Park on the Olympic Peninsula of the state of Washington. Most of the collections were made during the fall of 1941 while the writer was carrying on a survey of the agaric flora of western United States.[1] Most of the collections were made in the vicinity of Olympic Hot Springs, a station in the mountains a short distance south of Lake Crescent, but many interesting species were also found at Heart O'Hills on the slopes of Mt. Angeles. Both stations are on the north side of the Olympic Peninsula.

There were two outstanding features of the Cortinarius-flora of the Olympics in 1941. The first was the surprising number of previously undescribed Cortinarii encountered and the second was the abundance of carpophores produced by both the new and previously known species. Since Cortinarius unquestionably dominated the agaric flora during that season, it appeared desirable to compare the number of species found in the Olympics in 1941 with the number included in the most complete work yet published on the genus for North America, that of Kauffman (1932). In this monograph Kauffman included 202 species for North America. The total number collected and either identified or described as new from the Olympics in 1941 is 101 species.

When considering these figures, however, it should be kept in mind that, as of the time this paper is published, considerably more than 202 Cortinarii are known from North America. However, this is balanced in part by the fact that not all the Cortinarii collected in the Olympic area in 1941 were either identified or described. The majority of the collections were made within a period of five weeks, and in that time species of many other

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[1] The field work was made possible by a grant from the Horace H. Rackham School of Graduate Studies of the University of Michigan.

genera also demanded attention. In the following summary, the species (of Cortinarius) are arranged according to subgenera.

MYXACIUM. New species and varieties: *C. castaneicolor*, *C. griseo-violaceus*, *C. luteo-brunnescens* and *C. collinitus* var. *olympianus*. Previously described species: *C. pseudo-salor* Lange, *C. emunctus* Fr., *C. citrinifolius* Smith. *C. elatior* Fr., *C. mucigineus* Peck, *C. pallidifolius* Smith, *C. salor* Fr. and *C. vibratilis* Fr. Total: 12 species and varieties. Kauffman included only 15 for North America.

BULBOPODIUM. New species: *C. albescens*, *C. pseudo-arquatus*, and *C. subolivascens*. Previously described species: *C. calochrous* Fr., *C. cedretorum* Maire, *C. glaucopus* Fr., *C. metarius* Kauff., *C. montanus* Kauff. *C. multiformis* Fr., *C. olympianus* Smith, *C. orichalceus* Fr., *C. Parksianus* Smith, *C. prasinus* Fr., *C. purpurascens* Fr., *C. rapaceus* Fr., *C. scaurus* Fr. and *C. subpurpurascens* Fr. Total: 17 species. Smith (1942) included 48 species in his key. Kauffman, 1932, included 34.

PHLEGMACIUM. New species: *C. mutabilis*, *C. subfoetidus* and *C. superbus*. Previously described species: *C. anfractus* Fr., *C. balteato-cumatilis* Henry, *C. cliduchus* Fr., *C. crassus* Fr., *C. latus* Fr., *C. percomis* Fr., *C. substriatus* Kauff., *C. turmalis* Fr., *C. variicolor* Fr. and *C. varius* Fr. Total: 13 species. Kauffman recognized 29 from North America.

INOLOMA. New species: *C. fragrans*. Previously described species: *C. caesiifolius* Smith, *C. callisteus* Fr., *C. cotoneus* Fr., *C. pinetorum* (Fr.) Kauff., *C. pseudo-bolaris* Maire, *C. pyriodorus* Kauff. *C. turgidus* Fr. and *C. violaceus* Fr. Total: 9 species. Kauffman recognized 31 from North America.

DERMOCYBE. No new species. Previously described species: *C. anomalus* Fr., *C. cinnamomeus* Fr., *C. croceifolius* Pk., *C. malicorius* Fr., *C. phoeniceus* var. *occidentalis* Smith, *C. sanguineus* Fr., and *C. semisanguineus* Fr. *C. phoenicius* var. *occidentalis* was very rare in 1941 in the same places where it was abundant in 1935. Total: 7 species. Kauffman recognized 22 species.

TELAMONIA. New species and varieties: *C. angelesianus*, *C. bouldercnsis*, *C. mucicola*, *C. subcuspidatus*, *C. subpurpureus*, *C. distans* var. *olympianus*, *C. hemitrichus* var. *americanus*, *C. nigrellus* var. *occidentalis*. Previously described species: *C. adustus* Pk., *C. bibulus* Quél., *C. brunneus* Fr., *C. deceptivus* Kauff., *C. flexipes* Fr., *C. gentilis* Fr., *C. glandicolor* var. *curtus* Lange, *C. haematochelis* sensu Bres., *C. helvolus* Fr., *C. impennis* Fr., *C. incisus* Fr., *C. laniger* Fr., *C. Morrisii* Pk., *C. plumiger* Fr., *C. punctatus* Fr., *C. rigidus* Fr. and *C. stemmatus* Fr. Total: 25 species and varieties. Kauffman reported 39.

HYDROCYBE: New species: *C. cacao-color*, *C. fusco-discus*, *C. subacutus*. Previously described species: *C. acutus* Fr., *C. colus* Fr., *C. cypriacus* Fr., *C. dilutus* Fr., *C. erythrinus* Fr., *C. fasciatus* Fr., *C. firmus* Fr., *C. germanus*

Fr., *C. illuminus* Fr., *C. irregularis* Fr., *C. miniatopus* Lange, *C. privignus* Fr., *C. pulcher* Peck, *C. scandens* Fr. and *C. uraceus* Fr. Total: 18 species as compared to 34 reported by Kauffman.

MYXACIUM

Cortinarius castaneicolor sp. nov.

Plate 1

Pileus 4–9 cm. latus, convexus vel subplanus, glutinosus, fibrillosus, castaneo-rufus, ad marginem pallide alutaceus; lamellae caesiae dein pallidae, angustae, confertae; stipes 8–11 cm. longus, 10–15 (20) mm. crassus, clavatus, pallidus, sursum sericeus, deorsum zonatus; sporae 8–10×4.5–5.5μ.—Specimen typicum A. H. Smith n. 17,926, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 15, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 4–9 cm. broad, broadly convex with an inrolled margin, becoming plane or nearly so, glutinous when wet, ordinarily merely viscid, more or less appressed fibrillose beneath the gluten, the disc soon covered with minute patch-like scales, merely fibrillose streaked toward the margin, "hazel" on disc, "pinkish buff" toward the margin, finally becoming "chestnut" on disc and "cinnamon-buff" along the margin (disc dark chestnut-reddish, the margin buff to alutaceous); flesh 10–18 mm. thick at the stipe and tapered more or less abruptly to the margin, tinged caesious at very first but soon near "pale pinkish buff" (yellowish) or darker if water-soaked, unchanging when bruised, odor none, taste mild; lamellae "pallid purple-drab" (dull caesious) before the buttons open but soon becoming pallid and finally near "Sayal brown" (dull cinnamon), narrow (5–7 mm.), equal, adnate and toothed or adnexed, close, ±81 reach the stipe, 2 tiers of lamellulae, edges even; stipe 8–11 cm. long, 10–15 (20) mm. at apex, narrowly clavate, bulb 20–25 mm. thick, solid, pallid to pale watery buff within, surface white to whitish, apical region appressed silky, cortina white and scanty, lower portion decorated with scattered remnants of a universal veil, the remnants pale tawny and drying dull vinaceous brown, outer surface of the veil slightly gelatinous at first but all traces of viscidity soon lost.

Spores 8–10×4.5–5.5μ, slightly inequilateral, dull tawny under the microscope, the exospore slightly wrinkled; basidia four-spored; cheilocystidia if present no larger than basidia; gill trama subparallel, nearly hyaline in KOH; pileus trama homogeneous beneath a gelatinous pellicle of dull vinaceous brown hyphae (when revived in KOH), tramal body nearly hyaline when revived.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 11, 1941, Stuntz and Smith 17,780a; Oct. 15, Smith 17,926-type.

PLATE 1.—*Cortinarius castaneicolor* Smith, ×1.

Observations: Very good button stages were obtained in the type collection and a thin gelatinous sheath was found to extend from the margin of the pileus over the clavate portion of the bulb. Beneath this thin coating occurred the colored fibrils which leave the pale tawny remains mentioned in the description. In drying these become similar in color to the gelatinous hyphae forming the pellicle of the pileus. The remains of the viscid veil are quite easily washed away in prolonged wet weather with the result that one would not think of searching in Myxacium for the species. In stature the carpophores are similar to *C. pallidifolius*, but differ markedly in the color of the pileus, smaller spores and in having an almost dry stipe at maturity. *C. maculipes* Pk., a species of Phlegmacium, from its description appears to be quite similar to *C. castaneicolor*. I have examined its spores but have no notes on the appearance of the type. The spores of the two are alike, but from the description, it appears unlikely that my species can be referred to Peck's. The pileus of *C. castaneicolor* becomes darker in age instead of paler, a difference which appears significant. Peck compared the spots on the stem of *C. maculipes* to those of *Armillaria megalopus* Bres. In *C. castaneicolor* they are not that conspicuous. Peck did not mention caesious tints in either the flesh or gills of his species, and described the flesh as whitish. In *C. castaneicolor* the flesh when not caesious was distinctly yellowish. These differences in addition to the subviscid stipe appear sufficient to distinguish the latter.

Cortinarius griseo-violaceus sp. nov.

Plate 2

Pileus 3–6 cm. latus, convexus vel umbonatus, viscidus dein siccus, fibrillosus, griseo-violaceus; lamellae pallide violaceo-griseae, confertae, latae; stipes 6–10 cm. longus, 10–15 mm. crassus, aequalis vel subclavatus, pallide violaceus, deorsum viscidus et demum maculatus; sporae 7–9 (10) ×5–6μ, subellipsoideae.—Specimen typicum A. H. Smith n. 17,228, legit prope Heart O' Hills, Mt. Angeles, Olympic Mts., Wash., Sept. 24, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 3–6 cm. broad, convex, becoming broadly umbonate or nearly plane, the margin inrolled, surface viscid at first but soon dry and appearing appressed fibrillose, color "pale olive-gray" to "Quaker drab" when fresh (pale grayish violaceous), in age silvery violaceous, the margin sometimes "pallid neutral gray," often with sordid olivaceous-brown spotlike scales around the disc from the dried gluten; flesh "pale neutral gray" (pale violaceous gray) and watery, thick on the disc, abruptly tapered toward the margin, fading to "pale vinaceous-fawn" (pallid with a vinaceous tinge), brittle, taste mild, odor faintly fragrant; lamellae "ecru drab" (pallid violaceous gray) young, nearly "wood brown" at maturity, adnate or becoming adnexed, close, 62–66 reach the stipe, 1–2 tiers of

PLATE 2.—*Cortinarius griseo violaceus* Smith, ×1

lamellulae, moderately broad, edges even or somewhat eroded, stipe 6–10 cm long, 10–15 mm. thick at the apex, clavate when young, nearly equal in age, solid, pale violaceous within, fading to whitish, surface at first coated with appressed white fibrils up to the evanescent zone left by the ruptured cortina, silky near the apex, pale violaceous above, pallid to grayish violaceous below, at first the clavate portion covered by a very thin gelatinous sheath which soon becomes ruptured and discolors to form sordid brownish zones or patches, in wet weather the gluten sometimes becoming completely washed away.

Spores subellipsoid 7–9(10) × 5–6 μ, rusty brown in KOH, roughened; basidia four-spored; cheilocystidia inconspicuous and basidia-like or smaller; gill trama subparallel, nearly hyaline or slightly brownish in KOH; pileus trama with a pellicle of subgelatinous hyphae 3–5 μ thick, beneath it a region of somewhat inflated hyphal cells, the remainder filamentose, pallid to somewhat brownish in KOH.

Cespitose to gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Sept. 22, 1941 (17,151); Mt. Angeles, Olympics, Wash., Sept. 24 (17,228-type), Sept. 26 (17,306); Oct. 20 (18,067).

Observations: This species presented one of the most curious problems yet encountered in my study of Cortinarii. The fungus closely resembles *C. alboviolaceus* of the subgenus Inoloma in practically all characters with the exception of the viscid pileus and stipe. Both have a similar cuticle over the pileus, and in both the upper layer of slender hyphae appears to be at least subgelatinous in KOH. At the time coll. 17,151 was made I could not be sure of the subgenus, whether to place it in Myxacium, Phlegmacium or Inoloma, even though the material at hand was in perfect condition. Later, in no. 17,228 careful observations were made in the field on over one hundred fruiting bodies and a thin evenly distributed gelatinous universal veil was found to cover the button stages. This soon broke up into patches or zones as the carpophores expanded. These observations were verified a second time (coll. 17,306) two days later. Hence the species is placed in Myxacium in spite of the resemblance to *C. alboviolaceus*. Prolonged wet weather may cause some species of Inoloma to become viscid to the touch, see Smith (1939), but it could not produce the gelatinous universal veil described above. In truly viscid species the only effect produced by prolonged wet weather is to wash off the remains of the veil thus leaving the stipe merely moist. *C. alboviolaceus* was not encountered in the Olympics in 1941, but fresh material has been studied from Michigan (Kauffman and Smith 1933), and Nova Scotia (Smith and Wehmeyer, 1936). *Phlegmacium cumatilis* (Fr.) Ricken is apparently a more robust species with spores 10–12 × 5–6 μ, and with quite different stipe-characters. *Phlegmacium croceocaeruleum* sensu Ricken has a very slimy-viscid pileus and a dry stipe, see Smith (1939) (as Cortinarius).

C. Lebretonii Quél. is described as slightly viscid but is apparently a form of *C. spilomeus*, see Konrad and Maublanc (1924–32). *C. griseo-violaceus* does not have any highly colored veil remnants. The discoloration observed was caused by drying gluten. Consequently, although the descriptions may seem to indicate some similarity, there appears to be no close relationship. *C. epipolius* Fr. is said to lack violaceous tints in the gills. Rea (1926) has given the spores as 8–9×6–7μ and subglobose. He described the stipe as whitish, but becoming violet, and made no mention of discolored zones from the gluten. All of these characters taken together indicate that *C. griseo-violaceus* is distinct. Such typical species of Myxacium as *C. iodioides* and *C. iodes* have very glutinous stipes and pilei, and *C. oregonensis* differs sharply in the color of its gills and in the pileus becoming yellowish on the disc. *C. griseo-lilacinus* Britz. appears to be closest to the Olympic species. The reddish ring on its stipe as described may not be significant. It probably represents the color of the fibrillose zone left by the cortina after large numbers of spores have accumulated upon it. However, if one disregards this character, it appears that *C. griseo-lilacinus* is indistinguishable from *C. iodes*, and I am inclined to consider it a synonym of the latter. *C. griseo-violaceus* differs apparently, in having a very thin gelatinous veil that leaves discolored zones on the stipe, and apparently in having dull violet gray instead of lilac colors throughout the pileus, gills and stipe

Cortinarius luteo-brunnescens sp. nov.

Plate 3

Pileus 4–6 cm. latus, convexus, glaber, viscidus, flavidus; caro pallide lilacina demum pallida; lamellae caesiae, confertae, latae; stipes 7–9 cm. longus, 10–15 mm. crassus, clavatus, sursum lilacinus vel caesius, deorsum pallidus, viscidus, demum luteo-balteatus; sporae 7–9×4.5–5.5μ, subamygdaliformes.—Specimen typicum Stuntz and Smith n. 17,785, prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 11, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 4–6 cm. broad, convex, becoming broadly convex, surface glabrous and glutinous when fresh, soon appearing appressed fibrillose beneath the gluten and the disc breaking up into minute patchlike scales, becoming fibrillose-streaked near the margin, color "antimony yellow" to "warm buff" on the disc (bright to dull yellow), "straw yellow" on the margin, in age "chamois" (paler and duller) over the disc and "cream buff" (dull yellowish) along the margin, when dried "Verona brown" (dull vinaceous brown) over the disc and only slightly paler outward, the margin sometimes fibrillose when the center has become spotted with scales; flesh 8–12 mm. thick, tapered to the margin, tinged "pallid vinaceous drab" (pale dull lilac) when young, soon whitish, odor none, taste mild, no color change when cut; lamellae "pale Quaker drab" (dull violet) in partly expanded pilei, soon "avellaneous" and finally pale cinnamon brown, close, 72–76 reach the stipe, 2 tiers of lamellulae, broad (5–7 mm.) edges even or crisped;

PLATE 3.—*Cortinarius luteo-brunnescens* Smith, ×1

stipe 7–9 cm. long, 10–15 mm. at apex, clavate, solid, becoming hollow, apex concolorous with young gills and like them quickly fading, surface whitish, lower half stained with concentric zones of "antimony yellow" gluten, universal veil thin and gelatinous, at first evenly distributed over the lower part of the stipe.

Spores $7–9 \times 4.5–5.5\,\mu$, subalmond-shaped, slightly roughened, rusty brown under the microscope, basidia four-spored, cheilo- and pleurocystidia not differentiated; gill trama nearly hyaline in KOH, slightly interwoven; pileus trama homogeneous beneath a gelatinous pellicle, nearly hyaline in KOH.

Gregarious to scattered under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 11, 1941, Stuntz and Smith no. 17,785-type and on Oct. 15, Smith (17,925).

Observations: When they were discovered I mistook the carpophores for *C. delibutus*. The spores at once distinguish fresh material, however, and dried specimens can be readily separated by their colors. Those of *C. delibutus* are yellow when dried whereas those of *C. luteo-brunnescens* are dull brown to almost vinaceous brown. Since the manner in which Cortinarii dry is very distinctive for many of the highly colored species, *C. luteo-brunnescens* appears to be more than just a variety of *C. delibutus*. *Phlegmacium decolorans* as described by Ricken is said to have a shiny stipe when dry. However, even old specimens of *C. luteo-brunnescens* in which the gluten on the stipe had dried, could be readily distinguished from it by their small spores.

Henry (1938c) has given a detailed account of *C. delibutus* in which he commented on the extreme variability of the species and the inconstancy of such characters as the color of the pileus, gills and stipe and also the sporadic presence of cheilocystidia. Among the species he placed in synonymy with *C. delibutus* is *C. sphaerosporus* Pk. In a previous paper (Smith, 1939) the latter was reported from western United States. However, I am now convinced that Peck's species is nothing more than a slight color variation of *C. delibutus*. Both have the characteristic yellow color in the pileus when dried. A curious feature of some variable species of agarics such as this one is that, although the colors of fresh carpophores may be quite different, when dried they are all nearly identical in color. This is also true for such agarics as *Hygrophorus laetus* Fr. Dried carpophores of *C. delibutus* show some variation in the intensity of yellow present if young caps are compared with old ones, and, of course, allowances for this variation must be made when comparing different collections.

C. Berlesianus Sacc. and Cub. (*C. tricolor* Pk. nec Mont.) has the spores of *C. delibutus* and very likely is a synonym of that species (Henry, 1938c). I have examined the spores of the type but did not actually compare dried specimens of both. *C. illibatus* Fr. is said to have reddish dots on the stipe. Its spore size appears to be an open question, but neither that of Massee (15–16×6–7μ) nor that of Bataille (7–9μ subglobose) fits my collections. *C. subglutinosus* Karst. is said to have spores 10–13 ×6–8μ and lacks lilac or violaceous tints in any part. No information on its color change (if any) undergone in drying appears to be available so no comparison can be made on that point.

CORTINARIUS COLLINITUS Fr., Syst. Myc. 1: 248. 1821. var. TYPICUS

Plate 4

Pileus 5–7 cm. broad, convex to plane or with the margin turned up in age, glabrous and very glutinous, when young "antimony yellow" on the disc and tinged pale caesious toward the margin, disc becoming darker and orange-rust color in age; flesh watery yellowish buff, odor none, taste not recorded; lamellae "pale lobelia violet" when nearly mature, paler violaceous when young, finally "Verona brown" (dull reddish brown), close, adnate with a tooth, moderately broad; stipe 10–12 cm. long, 10–15 mm. thick, equal or slightly tapered at the base, solid, flesh white or pallid, not lutescent in age or when bruised, the lower two thirds covered by a thick pale violaceous glutinous sheath, the lower portion becoming ruptured into more or less concentric violaceous to pallid bands or patches made up in part by the dense white fibrillose layer beneath the gluten and the other part by the gluten itself, the inner white-fibrillose layer terminating in a broad silky-fibrillose apical zone.

Spores 12–15 × 7–8μ, broadly almond-shaped, rusty brown under the microscope (in KOH) and with a distinctly roughened or wrinkled exospore: basidia 30–36 × 9–11μ, four-spored; pleurocystidia not differentiated; cheilocystidia basidia-like (and very likely merely immature basidia); pileus trama with a thick hyaline gelatinous pellicle.

Scattered under ponderosa pine, Cave Junction, Ore., Nov. 29, 1937 (8190), and Kerby, Ore., Nov. 26 (9095).

Observations: Since agaric nomenclature officially starts with Fries' Systema Mycologicum, vol. 1, 1821, controversial names such as *C. collinitus* should either be abandoned or interpreted in a manner consistent with the official description. Fries' (1821) diagnosis reads as follows:

"pileo carnoso laevi aurantio-fulva, lamellis purpurascentibus, dein ferrugineis, stipite transversim in squamas coerulescentes getinosus rupto" ("getinosus" is apparently a misprint for gelatinosus).

It is evident from this that the important characters of the species are the bluish transverse scales of the stipe and the color of the gills and pileus. Since the above collections corresponded very well in these respects they are here regarded as typical for the species. To judge from the literature as well as my own field experience, the typical variety is seldom encountered. On the other hand, certain of the varieties are very common and it is no wonder that different investigators have disagreed on the exact characters of the species. Henry (1938c) has recognized *C. collinitus* as a composite species made up of a series of slightly differentiated populations which he has designated in part at least as varieties. His concept is consistent with the original Friesian description, consistent with general usage and in line with the conditions set down by the International Rules of Nomenclature for determining the choice of names. Kauffman's concept of *C. collinitus*

PLATE 4 —*Cortinarius collinitus* var *typicus* Fr , ×1

cannot justifiably be maintained since the species to which he applied the name does not have the essential character called for in Fries' original description.

Henry, however, considers *Cortinarius trivialis* Lange as the typical form of *C. collinitus*. This is not consistent with Fries' original description. *C. trivialis* (*C. mucifluus* Fr. sensu Kauff. in part at least) lacks the violaceous color in the gills and stipe. The specimens here described as var. *typicus* possess these colors. I have collected *C. trivialis* on many occasions and now consider it a variety of *C. collinitus* (**C. collinitus** var. **trivialis** (Lange) comb. nov. = *C. trivialis* Lange "Studies," pt. 10: 24. 1935), distinguished by its pallid gills, smaller spores and the sordid brownish to yellowish brown color assumed by the lower part of the stipe in age. The fungus described by Henry (1938c) as having amethyst gills at first and slightly violaceous tints in the gluten of the stipe also occurs near Ann Arbor. It comes up regularly in an aspen-juniper grove during late August or early September. It also has the small spores and is here considered to represent a form of var. *trivialis*. (**C. collinitus** var. **trivialis** f. **repandus** (Ricken) comb. nov. = *C. collinitus* var. *repandus* Ricken, "Blätterpilze" p. 124, 1911). Ricken characterized the variety as macroscopically similar to *C. collinitus* but differing in having smaller spores (11–13×6–7μ). He characterized the latter as having "blau odor violettlich" gills and the stipe as "blaulich odor blass." Lange has described a form of var. *typicus* (under the name *C. collinitus*) with the large spores but pallid gills, and a somewhat lutescent or brunnescent stipe. Lange reports his *C. collinitus* from North America, in addition to Denmark, and describes the gill edge as devoid of cheilocystidia. This fungus is here designated as **C. collinitus** var. **typicus** f. **caeruliipes** f. nov. (*C. collinitus* Fries sensu Lange, Flora Agaricina Danica, pl. 88, fig. B.)

Still another variety has been found in the conifer forests around Olympic Hot Springs in the Olympic National Park. The description follows:

Cortinarius collinitus var. **olympianus** var. nov.

Pileus 3–6 cm. latus, glutinosus, pallide alutaceus demum subpallidus; lamellae pallidae; stipes 7–10 cm. longus, 9–12 mm. crassus, glutinosus, pallidus; sporae 12–14.5×6–7.5μ.—Specimen typicum A. H. Smith n. 17,437, legit prope Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 3–6 cm. broad, obtuse, expanding to broadly convex or plane, the margin sometimes broadly uplifted making the disc appear depressed, surface very glutinous, the margin somewhat plicate-striate beneath the gluten, "clay color" when young (dull yellowish brown) but soon becoming "pinkish buff" (buff) at least along the margin and finally pallid more or less overall; flesh 10 mm. ± in the disc, tapered abruptly to the margin, soft, pallid brownish to whitish, odor none, taste mild; lamellae pallid when young (not clear white), soon "clay color" and in age nearly ochraceous tawny, broad (8 mm. ±), adnate but developing a slight decurrent tooth and becoming adnexed, moderately close (52–58 reach the stipe, 2 tiers of lamellulae), edges uneven; stipe 7–10 cm. long, 9–12 mm. at the apex, equal or very slightly and evenly enlarged downward, pallid within, solid, surface glutinous and whitish, a thick white cottony layer of appressed fibrils from the partial veil present beneath the gluten, as the gluten dries this layer becoming broken up into relatively few (3–5) pallid broad subannular zones, upper half merely appressed silky.

Spores almond shaped, 12–14.5×6–7.5μ, rusty brown, with a wrinkled exospore; basidia four-spored; cheilocystidia not differentiated; pleurocystidia none seen, gill trama nearly pallid in KOH, somewhat interwoven; pileus trama with a thick layer of slender hyaline gelatinous hyphae over the surface, beneath it a layer of enlarged hyphae (pseudo-parenchymatic in tangential section), the remainder floccose and more or less filamentose.

Gregarious under fir, Olympic Hot Springs, Olympic National Park, Wash. Sept. 30, 1941 (17,437).

Observations: This variety differs from *C. elatior*, in company with which it was growing, in having pale colors over all in age and in lacking cheilocystidia as well as violaceous tints. It appears very close to *C. mucifluus* sensu Lange but lacks cheilocystidia. It is separated from the other varieties of *C. collinitus* by the pale colors in age, the less scaly stipe, and lack of violaceous tints on the gills and stipe when young.

The following key is given to aid in recognizing the forms and varieties of *C. collinitus*. *C. collinitus* var. *pumilis* sensu Henry is more appropriately attached to *C. mucifluus* as a variety because of its large cheilocystidia.

A. Spores 12–15μ long.
  1. Both gills and stipe lilac to violaceous.................................Var. *typicus*
  2. Gills pallid, stipe violaceous...............................Var. *typicus* f. *caeruliipes*
  3. Gills pallid, stipe pallid, cap very pale in age.........................Var. *olympianus*

B. Spores 10–13μ long.
  1. Gills pallid to yellowish, stipe brunnescent below.......................var. *trivialis*
  2. Gills and stipe tinged violaceous at first......................Var. *trivialis* f. *repandus*

CORTINARIUS CYLINDRIPES Kauff., Bull. Torr. Bot. Club 32: 321. 1905.

The collection designated by Kauffman as the type of the species is the one from which his published description was drawn and the one from which his published photograph was taken. It was found under hemlock near Ithaca, New York in 1904. In his material now in the University of Michigan Herbarium are several additional collections from the same locality. The type consists of two fruiting bodies in rather poor condition. They were fairly well dried, but apparently rather badly damaged during the process by insect larvae. However, good sections of the gill edges were obtained and mature spores were abundant. No differentiated cheilocystidia were found, although basidia, both mature and immature, covered the edges of the gills. The immature basidia might possibly be mistaken for small cheilocystidia by an inexperienced observer. The spores measure 13–17×5–7.5μ. Kauffman described them as 12–15μ long, and in his notes on the collection remarked that spores from gills which were still violaceous measured 1- 1.5μ shorter but were typical as to shape and color. Several of Kauffman's Ithaca collections were examined and all were observed to have the same microscopic characters.

When studying agarics under Kauffman in 1929, *C. cylindripes* was the first Cortinarius I identified. The specimens studied *had* spores 12–15×6–8μ as per Kauffman's description, and he verified the identification stating that the material was typical in every respect. Since then this particular fungus has been found repeatedly in the vicinity of Ann Arbor. It grows in low open oak woods under brush at the edges of wet depressions, swamps or bogs. The gill edges are characterized by numerous inflated "balloon-shaped" cystidia. These are so abundant that the gill edge is practically sterile and "heteromorphic." The spores from deposits consistently measure 12–15×6–8μ. This fungus is clearly distinct from the type of *C. cylindripes* by its shorter spores and abundant cheilocystidia. The species reported as *C. cylindripes* from Nova Scotia by Smith and Wehmeyer (1936) is apparently the same as the type. The single preserved specimen is very young, and no cheilocystidia are present. The spores are only 15μ long, but this, more than likely, is due to the immaturity of the carpophore, and is in line with Kauffman's observations on the size of spores taken from young gills.

In his comments on *C. cylindripes*, Kauffman (1918, p. 331), stated that he considered a similar European species having spores 14–18μ long to be the original *C. collinitus* of Fries. An examination of the fruiting bodies he collected when he was in Sweden in 1908 and identified as *C. collinitus* shows that they have spores 13–17×5–7.5μ and that they lack cheilocystidia. In fact, these carpophores appear to be identical with his Ithaca collections in every respect. When spores of the type were compared with those of the Stockholm collection, no significant differences could be found. Pale, long and nearly smooth spores (apparently abnormal) are more frequent in the Swedish collection than in the type of *C. cylindripes* but they can be found in both. Since this study has removed the only difference which Kauffman himself found between the two, I have no hesitation in referring all the collections concerned to *C. cylindripes*. Since the type is definitely not a mixture of species, and since his description was taken from it, the published spore size must be considered an error of observation. His statement in the original description that the basidia are 10μ long, is a typographical error. The basidia are about 30×10μ.

The question of what names to apply to these two species must now be considered. The name *C. collinitus* must be ruled out of consideration here if one adheres to the International Rules of Nomenclature. Rightly or wrongly we must start from vol. 1 of Systema Mycologicum, and, as already pointed out (see discussion of *C. collinitus*) the name "collinitus" must be applied to a Cortinarius with the transverse scales or zones over the base of the stipe. In many instances in which the descriptions in Systema are very brief and general it appears logical to place the greater emphasis on the later more detailed accounts by Fries. However, when the description in Systema does contain the key character, it does not appear justifiable to try to establish under a given name a plant *without* that key character. Thus the name "collinitus" must be applied to a fungus having the transverse zones over the lower part of the stipe, and cannot be applied to *C. cylindripes*. *C. cylindripes*, then, is a species of conifer regions both in North America and Scandinavia characterized by its large spores, violaceous colors throughout in the very young stages and lack of cheilocystidia.

Lange (1938) has apparently described the other species under the name *C. pseudo-salor*. The spores and cheilocystidia appear to be identical. His description of the macroscopic characters, however, was apparently based on limited material (he states that he found it but once), and so such characters as the bluish violet edge of the gills, their transversely veined surfaces, and flush of light violaceous blue in the stipe must be interpreted with some latitude. The following is a description of *C. pseudo-salor* as I have found it in southern Michigan:

CORTINARIUS PSEUDO-SALOR Lange

Pileus 3–9 (10) cm. broad, convex to gibbous, becoming plane or umbonate, surface very glutinous, appearing as if varnished in dry weather, glabrous, or with veil remnants along the margin, color lavender to dull violaceous over all when young, sometimes becoming "army brown" (dull reddish brown) over all except the violaceous margin, usually becoming paler and yellowish, sometimes violaceous umber at first, margin often translucent striate when moist and frequently sulcate to longitudinally wrinkled; flesh thick on the disc, violaceous but soon pallid, odor and taste not distinctive, lamellae dull violet to lavender when young, slowly becoming cinnamon brown, emarginate or at first bluntly adnate, moderately broad (5–8 mm.), rather close, edges white floccose and often uneven, sometimes crisped, faces smooth to rather strongly veined; stipe 7–12 cm. long, 6–15 mm. thick, covered with a thick gelatinous sheath to near the apex, equal, solid, dull violaceous to lavender, gradually fading to pallid, apex silky to appressed fibrillose, sheath not breaking up into transverse zones as in *C. collinitus*, often with an apical fibrillose zone from the broken cortina.

Spores $12–15 \times 6.5–8\mu$, broadly almond-shaped, roughened, dark rusty in KOH; basidia four-spored, $28–36 \times 9–11\mu$; cheilocystidia very abundant, $24–32 \times 10–18\mu$, ballloon-shaped, thin walled, occupying the entire gill edge. Pileus with a gelatinous pellicle.

Common under oaks in low open woods and under brush at edges of bogs, July and August.

A single specimen was found under conifers on Mt. Angeles, Olympic Mts., Wash., Oct. 7, 1941 (17,612) which apparently belongs here. The pileus was "cinnamon-buff" (yellowish) on the disc and "pale grayish vinaceous" toward the margin. The flesh was pale grayish vinaceous near the gill margin and "dull lavender" elsewhere. The lamellae were "pale vinaceous lilac" before the spores obscured the original color. The stipe was 12 cm. long, 15 mm. thick at the apex and nearly equal. It was "dull lavender" in the cortex near the apex but paler below, and the glutinous sheath was lavender. The spores measure 11–14×6.5–8μ, and the cheilocystidia were found to be only slightly inflated (6–12μ).

Although not quite typical in its cheilocystidia, this find corresponds better with Lange's plate than many of the Michigan collections, and is particularly interesting because of its habitat. Apparently both *C. cylindripes* and *C. pseudo-salor* do occur under conifers. *C. elatior*, the most closely related species, lacks the pronounced violet colors of both *C. cylindripes* and *C. pseudo-salor*.

CORTINARIUS EMUNCTUS Fr., Epicrisis Syst. Myc., p. 275. 1838.

Pileus (4) 7 -9 (12) cm. broad, convex to obtuse with an inrolled margin, becoming broadly convex or more or less umbonate, surface covered by a thick layer of gluten, dull lilac (more or less "pale purple-drab") over all when young, becoming very pale violaceous gray ("pallid mouse gray") or tinged olive-yellow over the disc, in age the entire surface usually changing to "olive-ochre" (olive-yellow) because of the changing gluten, appearing somewhat fibrillose-streaked beneath the gluten; flesh thick, soft, tapered abruptly away from the disc, pallid but soon tinged buff ("cinnamon-buff"), odor and taste not distinctive; lamellae pallid brownish young, near cinnamon brown at maturity, close, broad, adnate but becoming adnexed, edges slightly eroded; stipe 9–14 cm. long, 10–25 mm. at the apex, clavate and up to 4 cm. thick at the base at times, usually tapered to a point below the thickest portion, solid, pallid within except for a faint lilac tinge in the apex, apical third dry and silky fibrillose, tinged violaceous, glutinous over lower two thirds and also pallid violaceous gray, soon stained olive-yellow like the cap (at least near the base) from the drying gluten.

Spores broadly ellipsoid to subglobose, 6–7.5×4.5–6μ, slightly roughened; basidia four-spored; cheilo- and pleurocystidia not differentiated; gill trama nearly hyaline in KOH, somewhat interwoven; pileus trama homogeneous beneath a thick gelatinous pellicle.

Scattered to gregarious under mixed conifers, Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, (17,449); Oct. 15 (17,924); and Oct. 17, 1941 (17,990).

Observations: This species varies greatly in stature. The carpophores of coll. 17,449 were very similar in stature and color to the illustrations of *C. emunctus* (Fries, 1877). The outstanding feature of the Olympic collections was the change in color to olive-yellow in age or after being collected and wrapped in waxed paper. The change takes place in the gluten of the pileus and stipe, and in dried material the pileus is about the same shade of yellow as that of *C. delibutus* (a dull or bright ochre yellow). Although the above collections showed differences in the amount of yellow assumed before collecting, after being properly dried the colors are the same. Since all the specimens were collected during a period of extremely wet weather, no information is available on the degree of color change taking place under more normal conditions. Neither is there any information available on the color of dried specimens of *C. emunctus* from Europe. Fries, however, did indicate that *C. emunctus* assumed yellowish and finally grayish alutaceous tints. Although the color in age according to Fries is obviously different from that observed in the Olympic collections and may well be significant, still it is close enough to lead one to suspect that it is only a variation. It appears best to identify my collection as the Friesian species at least until more information on the latter is available. *C. salor*, a species with the same appearance, can be readily distinguished by its violaceous gills, and *C. livido-ochraceus* Berk. is separated by its larger spores.

BULBOPODIUM

Cortinarius albescens sp. nov.

Pileus 4–9 cm. latus, obtusus vel subumbonatus, glutinosus, violaceo-griseus dein pallidus; sapor amarus; lamellae griseo-lilacinae, confertae, angustae, adnatae dein secedenti-liberae; stipes 6–12 cm. longus, 9–12 mm. crassus, deorsum marginato-bulbosus, sursum aequalis, obscure lilaceus demum pallidus; sporae 7–9 (10) × 5–6μ.—Specimen typicum A. H. Smith n. 17,522, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 1941; in Herb. Univ. of Mich. conservatum.

Pileus 4–9 cm. broad, obtuse with an incurved margin, in age the margin spreading, the disc slightly umbonate at first, umbo diappearing, surface glutinous and streaked with violaceous gray ("pale ecru drab") when young, quickly fading to whitish ("tilleul buff") but sometimes the disc becoming tinged "cinnamon-buff" (buff color), glabrous or with whitish fibrils from the universal veil; flesh thick in the umbo, abruptly thinner elsewhere, pallid, odor none, taste distinctly bitter; lamellae "grayish lavender" (dull lavender) young, becoming "Sayal brown" (dull cinnamon) at maturity, sometimes retaining a dull lavender hue, close to crowded, narrow, adnate, readily seceding, edges eroded; stipe 6–12 cm. long, 9–12 mm. thick, solid, equal, the base slightly bulbous and the upper edge of the bulb marginate at first, the marginate condition soon disappearing (as in *C. corrugatus*), flesh pale dull lavender throughout but soon pallid, unchanging when bruised, surface at first concolorous with the young gills but soon whitish, thinly fibrillose from scattered veil remnants, glabrescent, universal veil scanty, remnants usually distributed around the bulb or lower part of the stipe.

Spores broadly almond shaped, 7–9 (10) × 5–6μ, roughened, dark tawny under the microscope; basidia four-spored; pleuro- and cheilocystidia none seen; gill trama parallel, hyaline or nearly so in KOH; pileus trama with a thick gelatinous pellicle, pallid brownish in the tramal body.

Singly or in groups of three or four under conifers, Olympic Hot Springs, Olympic National Park, Oct. 2, 1941 (17,522-type; 17,523 and 17,567); Oct. 8 (17,706); Oct. 11 (17,770); Oct. 15 (17,913); Storm King Mt. also in the Park, Oct. 16 (17,976); Olympic Hot Springs, Oct. 17 (18,008).

Observations: The dried pilei are pale to dark buff colored or have retained an avellaneous cast near the margin. Although related to *C. glaucopus* this species differs in its bitter taste, long white stipe at maturity, the violaceous gray pileus which fades to whitish, and in its manner of fruiting. *C. arcifolius* Henry is very close but differs in having a mild taste, larger spores, slightly different colors in the pileus, and in not having adnate-seceding gills. *C. elotus* Fr. is said to have an acrid taste (in Hymen. Europaei), but its gills apparently are not lavender at first. In many respects *C. elotus* of Fries seems to fall into the series of olivaceous forms around *C. glaucopus* commented upon previously (Smith, 1939). *C. albescens* does not have the variable colors attributed to *C. elotus* by Fries and does not fit into the above series. The above mentioned forms of *C. glaucopus* are very distinct from *C. albescens*. *C. canolilacinus* Britz. may be close to *C. albescens*, but judging from its description, it differs in not having violaceous gills. *C. intermedius* Rea should also be considered here, but is distinct by its almost entire lack of bluish tints. More than likely *C. intermedius* will be found to be identical with *C. albidus* Pk.

Cortinarius pseudo-arquatus sp. nov.

Pileus 5–11 cm. latus, convexus vel planus, viscidus, alutaceus vel fulvus; lamellae griseo-caeruleae, confertae, angustae vel sublatae, stipes 6–12 cm. longus, 10–25 mm. crassus, marginato-bulbosus, sursum griseo-caeruleus, deorsum pallidus, demum pallide alutaceus; sporae 11–14 × 6–8μ, subellipsoideae.—Specimen typicum A. H. Smith n. 17,141, legit prope Olympic Hot Springs, Olympic National Park, Wash., Sept. 22, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 5–11 cm. broad, hemispheric with an inrolled margin at first, expanding to broadly convex or obtuse, the margin long remaining inrolled, when finally expanded the margin often either wavy or sinuate, surface glabrous or usually with patches of fibrils adhering along the margin, viscid, buttons "Sayal brown" over all except the "cinnamon-buff" margin (dull cinnamon on the disc, dull pale alutaceous along the margin), finally becoming more or less ochraceous tawny over the disc and the margin tinged avellaneous, in some the disc sometimes becoming "clay color"; flesh very thick and firm (up to 18 mm.), tapered abruptly, "tilleul buff" at first (pallid), hardly changing but in age finally yellowish buff, unchanging when bruised, odor and taste not distinctive; lamellae "endive blue" becoming "light Quaker drab" and finally more or less "tawny-olive" (pale grayish blue or rich caesious, slowly becoming brown), close to crowded 115 ± reach the stipe, 2 tiers of lamellulae, narrow to moderately broad (8 mm. ±), bluntly adnate, becoming shallowly adnexed and developing a decurrent tooth, edges becoming eroded; stipe 6–12 cm. long, 10–25 mm. thick at apex, equal down to a broad flanged (not depressed) bulb 3.5–5 cm. in dia., base of bulb subconic and solid, interior of stipe pale violaceous in upper portion but soon pallid throughout and finally sordid brownish, surface tinged bluish gray at apex but soon sordid yellowish to brownish, pallid below when young, silky, veil remnants soon disappearing, sometimes leaving a faint fringe around the limb of the bulb but not volva-like; veil faintly caesious at first, soon whitish.

Spores 11–14 × 6.5–8μ, broadly subellipsoid, nearly smooth, very pale tawny under the microscope; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama subregular; pileus trama homogeneous beneath a thick gelatinous pellicle.

Gregarious to scattered under conifers, Olympic Hot Springs, Olympic National Park, Wash., Sept. 22, 1941 (17,141-type). Also material collected in the same locality in 1935 and reported as *C. arquatus* (Smith, 1939).

Observations: This species was originally identified as *C. arquatus* but as a result of additional data obtained in 1941 it appears best to consider it a distinct but closely related species. Since *C. arquatus* is not too well known in Europe, I have adopted the concept of Kauffman which is clearly in line with the Friesian descriptions. There is a distinct and constant difference between the spores of the above collections and Kauffman's material. In the latter they are amygdaliform, dark rusty under the microscope, and distinctly roughened. In *C. pseudo-arquatus* they are nearly ellipsoid, very pale brown in KOH under high magnification and nearly smooth. The colors of the pilei are also distinct, as can be readily ascertained by comparing the descriptions. In *C. pseudo-arquatus* the tendency for the flesh in the pileus and stipe to become yellowish is much less pronounced, in fact, it is almost lacking. This species is one of the larger Bulbopodia. It was observed in the woods around Olympic Hot Springs during late September and early October in 1941, and had more or less disappeared at the time the majority of the Cortinarii were at the peak of their fruiting cycle.

Cortinarius cyanopus is also very close to *C. pseudo-arquatus*. Henry (1935) has given a detailed account of the former in which the pellicle is described as bitter, the spores as 9–11 × 6μ, the odor as fragrant, the color of the cap as pale creamy olivaceous and the gill edges as heteromorphic owing to the presence of numerous sterile cells (cheilocystidia). *C. pseudo-arquatus* does not correspond in any of these characters. My (1939) report of *C. cyanopus* from the Siskiyou Mts. of northern California was based on Kauffman's (1932) concept of the species. Its spore characters separate it from *C. pseudo-arquatus*, but it is properly placed in Bulbopodium.

Cortinarius subolivascens sp. nov.

Pileus (3) 4–7.5 cm. latus, late convexus dein planus, viscidus, obscure violaceo-griseus, demum subolivaceo- vel griseo-violaceus, glaber; lamellae caeruleae, confertae; stipes 3–5.5 cm. longus, 1–2 cm. crassus, marginato-bulbosus, subcaeruleus; sporae 9–11 (12) × 5–6μ.—Specimen typicum A. H. Smith n. 14,311, legit prope Deer Lake, Olympic National Park, Wash. June 13, 1939; in Herb. Univ. of Mich. conservatum.

Pileus (3) 4–7.5 cm. broad, plane with a decurved and inrolled margin, becoming broadly convex to nearly plane in age, viscid, color more or less "deep Quaker drab" (deep violaceous gray) and mottled with watery streaks when fresh, fading slowly and becoming olivaceous gray to pale purplish gray, the disc not fading in some (colors very difficult to describe, olive, purple and drab in varying proportions); flesh pallid olivaceous gray in cap and apex of stipe (slightly violaceous in the cortex at the apex of the stipe when young), odor none, taste not recorded; lamellae "light dull bluish violet" (bluish) to "light purple-drab" (dull purplish) before becoming pale cinnamon-brown, adnate but rounded slightly, narrow to moderately broad (5–7 mm.), crowded, 125 ± reach the stipe, not staining when bruised; stipe 3–5.5 cm. long, 1–2 cm. thick at apex, equal to the flaring marginate base (as in *C. glaucopus*), tapered to a point at the base, surface covered by "light dull bluish violet" fibrils from the remains of the veil, pallid beneath the fibrils or "light dull bluish violet" at apex.

Spores 9–11 (12) × 5–6μ, almond-shaped, roughened, dark rusty brown under the microscope; basidia four-spored; gill trama parallel, hyaline in KOH; pileus trama homogeneous beneath a gelatinous pellicle, tawny brown just beneath the pellicle in KOH.

Gregarious to subcespitose, under conifers, Deer Lake Trail, near Deer Lake, Olympic National Park, Wash., June 13, 1939 (14,311-type); Lake Angeles, Mt. Angeles, Olympics, Wash., June 25, 1939 (14,634).

Observations: This species is "cinnamon-buff" when dried (buff color). The change in color in drying, the violaceous gills and flanged base of the stipe indicate a close relationship to *C. glaucopus*, and enables dried specimens to be readily distinguished from those of *C. Parksianus*. *C. subolivaceus* differs from *C. glaucopus* in not becoming rusty brown while still fresh and in its larger spores. Typical *C. glaucopus* is very abundant during

September and October in this same area, and has been reported on previously, Smith (1939). Henry (1935) described *C. glaucopus* as having spores 8–11×6–6.5μ, but as not having a violaceous pileus. Typical *C. glaucopus* was examined in great quantity in the region around Olympic Hot Springs again during the season of 1941 and found to check exactly with the material described earlier Smith (1939). The small spores are distinctive but the colors of the pileus are very confusing. It is apparent that in Europe as well as in North America there are a number of slightly differentiated populations that may be regarded as either forms or varieties. Henry mentions three varieties of *C. glaucopus*, and I have observed several here in the United States. Because of the vernal fruiting habit of *C. subolivaceus*, its large spores and the dominant violaceous color of the pileus it is described here as a species. *C. glaucopoides* Kauffman appears to be a comparable species related to *C. glaucopus* but differs in the almost entire lack of violaceous tints.

Cortinarius orichalceus var. **olympianus** var. nov., f. **typicus**

Pileus 6–10 cm. latus, convexus vel planus, viscidus, olivaceo-luteus dein sordide vinaceo-brunneus; odor nullus; lamellae olivaceo-luteae, confertae, angustae; stipes 5–10 cm. longus, 1–2 crassus, pallide olivaceus; sporae 9–11×5-6.5μ.—Specimen typicum A. H. Smith n. 17,513, legit prope Olympic Hot Springs, Olympic National Park, Wash. Oct., 2, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 6–10 mm. broad, convex with an incurved margin, becoming broadly convex to nearly plane, very glutinous at least when young, disc soon broken up into areolate crustlike patches, appearing somewhat appressed fibrillose beneath the gluten along the margin, button stages "dark olive-buff" (pale olivaceous gray), sometimes almost entirely dark vinaceous brown in age; flesh thick, soft, pallid but soon becoming "deep olive-buff" (dark olivaceous) and when cut developing a pale lilac cast ("pale quaker drab") in the apex of the stipe and near the surface of the pileus, with a watery green line above the gills, odor none, taste not distinctive; lamellae "ecru olive" (fairly bright olive-green), becoming sordid rusty olivaceous in age, sometimes with a "pale Quaker drab" (dull lilac) tint near the cap margin, crowded, narrow, adnate, edges uneven to eroded; stipe 5–10 cm. long, 1–2 cm. thick at apex, solid, pallid within at first, then olivaceous gray and developing a faint lilac tint in some when cut, surface pale olivaceous and densely fibrillose from remains of the pale olivaceous veil, veil remnants becoming pallid, base with an abrupt marginate non-depressed bulb up to 4 cm. in dia. bulb conic to rounded below, soon staining dark reddish brown where handled.

Spores 9–11×5–6.5μ, somewhat almond-shaped, rusty brown in KOH, with a distinctly wrinkled exospore; basidia four-spored, hyaline or with a faint purplish tinge in KOH; hymenium filled with basidia-like bodies having a fuscous-purplish opaque amorphous content; cheilocystidia not differentiated; gill trama parallel, hyaline to faintly purplish in KOH; pileus trama with a thick, gelatinous pellicle, homogeneous and nearly hyaline in KOH or irregularly staining dull purple.

Gregarious to scattered under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 2, 1941 (17,513).

Observations: Several market baskets full of carpophores were collected Oct. 2. At that time it was the most abundant Bulbopodium in the region. The carpophores dried a dull sordid brown but after standing in contact with napthalene for several months their color was "seal brown" on the disc of the pileus and near "deep livid brown" (deep purple) on the bulb, stipe and margin of the cap. This change in color may have been caused by contact with the napthalene used as an insect repellant. The fungus described here is the *C. orichalceus* of Kauffman, and is distinct from the typical variety of the species in lacking a characteristic odor and in apparently having slightly smaller spores. Bresadola described the spores as 10–13 × 6–7 μ and the flesh as having the odor of anise.

Cortinarius orichalceus var. **olympianus** f. **luteifolius** f. nov.

Pileus 5–9 cm. latus, convexus, olivaceo-luteus dein sordide cinnamomeus; lamellae pallide luteae; stipes non violaceus; sporae 9–11 × 6–7 μ. —Specimen typicum A. H. Smith n. 16,970, legit prope Lake Angeles, Olympic Mts., Wash., Sept. 19, 1914; in Herb. Univ. of Mich. conservatum.

Pileus 5–9 cm. broad, broadly convex becoming nearly plane, the margin usually somewhat decurved and long remaining inrolled, very glutinous in wet weather, color "chamois" to "honey-yellow" over all at first (rich dull yellow or yellow tinged with olive), gradually becoming "Sayal brown" (dull cinnamon) on the disc, glabrous or appearing fibrillose-streaked beneath the gluten, disc developing small patchlike scales as the gluten dries; flesh thick, whitish but with a watery greenish line along the gills, odor none, taste perfectly mild; lamellae "deep colonial buff" (dull rather clear yellow), becoming "honey-yellow" (more of an olive-yellow) and finally dull rusty from the spores, close to crowded, 2 tiers of lamellulae, narrow (6–7 mm.), bluntly adnate and nearly equal, edges somewhat eroded; stipe 5–7 cm. long, 2–2.5 cm. thick at the apex, with a flanged nondepressed bulb up to 4 cm. broad, solid and pallid within but becoming pale olivaceous, surface more or less fibrillose from remains of the pale greenish yellow cortina, surface "marguerite yellow" (pale bright yellow) or paler, base sordid yellow and somewhat pointed, with numerous "marguerite yellow" rhizomorphs.

Spores 9–11.5×6–7µ, subalmond-shaped, rusty brown under the microscope, with a wrinkled exospore; basidia four-spored; basidia-like cells with amorphous purple-fuscous content rather rare; cheilocystidia none seen; gill trama hyaline but gradually becoming dull purplish red in KOH, subparallel; pileus trama homogeneous beneath a thick gelatinous pellicle, tramal body becoming purplish red in KOH at least in some places.

Observations: This form differs from the typical form in lacking the faint lilac tint in the apex of the stipe, in the pileus not becoming dark vinaceous red but instead merely dull cinnamon brown when fresh, and in the brighter yellow lamellae. The pilei of herbarium specimens are also paler, but the bulb is deep purplish as in typical material of the variety. The spores are also the same.

Cortinarius orichalceus var. **xanthocephalus** var. nov.

Pileus 4–6 cm. latus, convexus, viscidus, laete aurantio-brunneus; caro pallide caesia; lamellae olivaceo-ochraceae; sporae 8–10×6–7µ.—Specimen typicum A. H. Smith n. 17,514, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 2, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 4–7 cm. broad, (all young), convex with an inrolled margin, disc near "Xanthine-orange" (bright orange-brown), margin "amber-yellow" (clear full yellow), disc covered by minute crust-like scales beneath the thick gluten, margin at first fibrillose from the veil remnants; flesh thick, soft, "pallid mouse gray" (pale violaceous gray) or "pale mouse gray" in apex of stipe after being cut, pallid at very first, odor and taste not distinctive; lamellae bright "olive-ochre" (olivaceous yellow) but soon rusty greenish yellow, close but not crowded, adnexed, moderately broad, edges eroded; stipe 6–8 cm. long, 10–12 mm. thick at apex, solid, pallid when cut but then developing a lilac tinge in the cortex, surface "seafoam yellow" (pale yellow) and densely fibrillose from the veil remnants, veil faintly olivaceous yellow, bulb cylindric, the upper margin abruptly margined but not depressed, rusty yellow below and with pale yellow rhizomorphs.

Spores 8–10×6–7µ, somewhat almond-shaped, exospore wrinkled, rusty brown under microscope; basidia four-spored; hymenium with basidia-like bodies filled with dark amorphous contents; pleurocystidia not seen; cheilocystidia basidia-like; gill trama regular, hyaline to purplish in KOH; pileus homogeneous beneath a gelatinous pellicle which usually becomes dark purplish in KOH, tramal body also purplish in places when revived in KOH.

Cespitose in small clusters, Olympic Hot Springs, Olympic National Park, Wash., Oct. 2, 1941 (17,514).

Observations: The base of the bulb is deep purplish in the dried specimens, but the pilei have a somewhat ferruginous rather than fuscous-purple tint. The bright colors when fresh readily distinguish this variety from var. *olympiana* f. *typica* and the small spores and more ferruginous pilei distinguish the dried specimens. Form *luteifolius* of var. *olympianus* appears to be somewhat intermediate, but lacks the faint lilac tint in the apex of the stipe and in addition has larger spores. Because of the color assumed by the bulb after drying, var. *xanthocephalus* cannot be referred to the series of Bulbopodia of which *C. fulgens* is the central species.

PHLEGMACIUM

Cortinarius caesiellus sp. nov.

Plate 5

Pileus 4–7 cm. latus, convexus vel obtusus dein planus vel umbonatus, viscidus, pallide alutaceus; lamellae pallide caeruleae demum griseocaeruleae, confertae; stipes (4) 6–10 cm. longus, 8–15 mm. crassus, solidus, sursum caesius, deorsum pallidus et cum zonis subaurantiis 1–3 cinctus; sporae 7–9×6–8μ.—Specimen typicum A. H. Smith n. 18,823, legit prope Ann Arbor, Mich., Oct. 1, 1942; in Herb. Univ. of Mich. conservatum.

Pileus 4–7 cm. broad, convex or obtuse when young, in age plane or with a low umbo, the margin often remaining decurved and somewhat undulating, surface viscid when wet, glabrous or fringed with fibrils along the margin, color evenly "pinkish buff" (pale buff) or the disc slightly darker and pale alutaceous ("cinnamon-buff"); flesh thick, white, firm, odor and taste not distinctive; lamellae "light Payne's gray" (pale blue) becoming "pale drab-gray" and finally "clay color" (more or less alutaceous), adnate with a decurrent tooth, becoming slightly adnexed, moderately broad (6–8 mm.) equal, close; stipe (4) 6–10 cm. long, 8–15 mm. thick at the apex, solid, pale bluish drab in the apex when fresh, equal to somewhat clavate, dry, lower half with "orange-buff" (pale orange) zones or patches of fibrils, universal veil remnants sometimes disappearing in age, whitish and silky above, mycelium white.

Spores 7–9×6 8μ, broadly ovate to subglobose, roughened, dark rusty brown under the microscope; basidia four-spored, hyaline to pallid yellowish in KOH; cheilocystidia basidia-like or slender (only 3–5μ broad); pleurocystidia not differentiated; gill trama hyaline in KOH, of parallel hyphae; pileus trama with a thin gelatinous pellicle of narrow (2–3.4μ) hyphae, beneath it the hyphae rather compactly arranged and more or less pseudo-parenchymatous in tangential section, remainder filamentose and floccose, hyaline to pale brownish in KOH.

Subcespitose on boggy ground, Ann Arbor, Mich., Sept. 27, 1940 (15,476), and Oct. 1, 1942 (18,823-type).

Observations: This is the fungus previously referred to (Smith, 1942) as being close to *C. triumphans*. It is amply distinguished from that species and *C. luteo-armillatus* by its broadly ovate to subglobose spores. The colors of the pilei are much paler than in typical *triumphans*, and the pale bluish

PLATE 5 —*Cortinarius caesiellus* Smith ×1

gills furnish a field character by which it can be distinguished from *C. luteo-armillatus*. Both collections were found in the same boggy depression and in almost the same spot. Two species of Vaccinium, various oaks, one species of ash and scattered trees of shagbark hickory and ironwood make up the forest cover.

Cortinarius Riederi (Wienm.) Fr. is said to have tawny fibrils on the stipe. Ricken, however, placed this species in the group in which no universal veil is present and gave the spore size as $15-17 \times 8-10\mu$. Cooke's figure of *C. Riederi* depicts a fungus with the stature but not the colors of *C. caesiellus*, and no universal veil remnants are shown.

C. decoloratus Fr. sensu Kauffman is identical with *C. caesiellus*. However the name *decoloratus* cannot be used legitimately for a species with a universal veil resembling that of *C. triumphans*. Kauffman left only one collection of four small fruiting bodies, and from this it is apparent that his acquaintance with the species was limited. *C. albidipes* Pk. is identical with *C. caesiellus* in all characters except the presence of the universal veil. Peck's figures clearly show, and the description clearly emphasizes the white zoneless stipe. The only colored zone mentioned is the one formed by the spores becoming lodged in the fibrils left by the broken cortina. It is possible that *C. decoloratus* Fr. and *C. albidus* Pk. are synonyms. However, there appears to be some difference of opinion in regard to the spore size of the Friesian species.

Cortinarius corrugis sp. nov.

Pileus 6–12 cm. latus, obtusus demum late convexus vel subumbonatus, glutinosus, demum corrugatus, laete incarnato-cinnamomeus vel subtestaceus; lamellae pallide luteae demum alutaceae, confertae, angustae; stipes 6–9 cm. longus, 1.5–2 cm. crassus, aequalis, pallidus demum sordide brunneus; sporae 7–9 (10) $\times 3.5-4.5\mu$, laevae.—Specimen typicum A. H. Smith n. 16,842, legit prope Anderson Lookout, Baker National Forest, Wash., Sept. 11, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 6–12 cm. broad, obtuse with an incurved margin when young, becoming broadly convex or subumbonate in age, some merely remaining obtusely subcampanulate, surface glutinous when wet, glabrous or with scattered fibrillose patches along the margin, smooth at first but soon radially wrinkled to more or less corrugated, color "orange-cinnamon" on disc, "light pinkish cinnamon" toward the margin (bright to pale cinnamon), when water-soaked nearly "Verona brown" (dull somewhat vinaceous brown) not hygrophanous; flesh thick, firm, pallid (tilleul buff) but soon sordid brown around the wormholes, odor and taste none; lamellae "pinkish buff" (buff color) becoming "clay color" (pale yellow-brown) close to crowded (130–138 reach the stipe, 2–3 tiers of lamellulae, adnexed, relatively narrow (5–6 mm.), equal in width, very thin; stipe 6–9 cm. long, 1.5–2 cm. thick, solid and fibrous within, pallid brownish, equal, in age dark sordid brown at the base or over all, coated with a thin covering of pallid appressed fibrils, apex silky and pallid to brownish.

Spores 7–9 (10) × 3.5–4.5μ, appearing smooth under ordinary magnifications but under oil immersion lens very finely punctate, narrow and inequilateral, pale tawny under the microscope; basidia four-spored; gill trama parallel, hyaline in KOH; pileus trama with a thick gelatinous pellicle, beneath it a pseudoparenchymatous layer of greatly enlarged cells (as seen in a section tangential to pileus) with rusty brown walls, the remainder floccose and nearly hyaline.

Subcespitose under conifers, elev. 4,000 ft., Ermine Creek Trail, below Anderson Lookout, Baker Lake, Wash., Sept. 11, 1941 (16,842-type).

Observations: Many of the specimens had a viscid zone at the base of the stipe, but I could not determine for certain whether the gluten represented the remains of a gelatinous veil or whether it had dripped from the pileus. The specimens developed during very wet weather. No buttons with the veil intact were found. Because of the similarity of this species to *C. corruscans* sensu Kauffman it is place beside the latter in Phlegmacium. Kauffman described the spores of *C. corruscans* as smooth, but an examination of all the carpophores in his Tennessee collection reveals that the spores are slightly wrinkled as in most Cortinarii. The spores of *C. corrugis* appear almost smooth even under an oil immersion lense. However, if one focuses on the surface of the spore, minute depressions can be observed in the spore wall. When mounts of both of these species are compared under the microscope the difference is very striking.

C. vespertinus Fr. is said to have spores 4–5 × 3–4μ and more yellowish rather than cinnamon colors. *C. liratus* Fr. appears to be rather close but little information about it is available. In my collection of *C. corrugis* the stipe was solid and homogeneous, the pileus not hygrophanous, and the surface of the stipe brunnescent at least at the base. These differences should distinguish it from *C. liratus*.

Cortinarius mutabilis sp. nov.

Plate 6

Pileus 4–8 cm. latus, convexus demum late convexus vel planus, glaber, viscidus, sordide violaceus; caro tactu purpurascens; lamellae violaceae, latae, confertae, confrictis purpureo-maculatae; stipes clavatus, 6–8 cm. longus, 10–15 mm. crassus, farctus, pallide lilacinus, tactu purpurascens; sporae 7–9 × 4.5–5μ.—Specimen typicum A. H. Smith n. 17,451, legit prope Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 4–8 cm. broad, convex with an inrolled margin, becoming plane or broadly umbonate, margin remaining incurved for a long time, glabrous or nearly so, the margin often fringed from remains of the veil, surface glutinous and somewhat streaked beneath the gluten, color "dark plumbago gray" to "light plumbago gray" over all (dull violet-gray with a vinaceous tint); flesh thick and soft, more or less concolorous with the surface but soon pallid, odor and taste not distinctive, when cut or bruised changing slowly to near "aconite violet" (violaceous purple); lamellae concolorous with pileus when young, in age pale cinnamon brown from the spores but with a persistent violaceous cast, adnexed, broad (1 cm. ±), 64 ± reach the stipe, 2 tiers of lamellulae, close, changing to "purplish lilac" when bruised or finally concolorous with the flesh of the stipe, edges even; stipe clavate, 6–8 cm. long, 10–15 mm. thick at apex, 2–3 cm. at base, stuffed, pale lilac within and staining bright purple when cut or bruised, surface concolor with the cap or a brighter lilac, fibrillose with the pallid veil remnants, staining purplish when handled.

Spores $7–9 \times 4.5–5\mu$, ellipsoid, faintly tuberculate, pale rusty brown under the microscope; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama regular or nearly so; pileus trama homogeneous beneath a thick gelatinous pellicle.

Gregarious under conifers, pine, Douglas fir and mountain hemlock Olympic Hot Springs, Sept. 30, 1941 (17,451-type); Oct. 2, (17,494); Oct. 8 (17,696); and Oct. 11, 1941, Stuntz and Smith no. 17,772.

Observations: Because of the similarity in spore size, color and color change, I was at first inclined to regard this species as a form of *C. occidentalis* Smith. A careful study of developmental stages, however, showed that it was a typical Phlegmacium and hence it must be regarded as a distinct species because of the difference in the manner of its development. Abundant young stages were found on four occasions, and large quantities of material were observed in the field. It was encountered on nearly all collecting trips to Olympic Hot Springs from late September to late October. In Phlegmacium it appears to be related to *C. porphyropus*, but differs in spore size and in the color of the pileus. *C. euchrous* Henry is somewhat similarly colored, but is said to have an aggreeable fruity odor and lacks the color change of *C. mutabilis*. Two collections, one from a sphagnum bog on Mt. Baker, Wash. (16,717) and one at the edge of a bog, Lake Angeles, Olympic Mts., Wash. (16,972) that may belong in *C. euchrous* were found in 1941. However, the stipes did not become yellowish in the lower half and the odor though pungent was slightly disagreeable and was noticeable only when the flesh was cut or broken. No cheilocystidia were observed. This form needs further study.

Cortinarius subfoetidus sp. nov.

Pileus (3) 4–10 cm. latus, obtusus dein planus, glutinosus, laete lilacinus demum pallidus; odor graveolens; lamellae lilacinae demum cinnamomeae,

PLATE 6.—*Cortinarius mutabilis* Smith, ×1

confertae, latae, subdecurrentes; stipes 5–8 cm. longus, 10–20 mm. crassus aequalis, solidus, lilacinus dein pallidus, fibrillosus; sporae 7–9(10)×5–5.5μ.—Specimen typicum A. H. Smith n. 17778, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 11, 1941; in Herb. Univ. of Mich. conservatum.

Pileus (3) 4 10 cm. broad, obtusely umbonate to plane, in age the margin becoming lacerated, surface glutinous, appressed fibrillose beneath the gluten, "bluish lavender" to "light lavender violet" (lilac) over all at first, fading to buff or pallid ("pale pinkish buff" or "tilleul buff") on the disc, margin retaining its lilac color; flesh thick (2 cm. in dia.) "bluish lavender" or brighter at first but soon becoming pallid, not changing when cut, taste mild, odor very heavy-aromatic to subfoetid (somewhat sweetish and nauseous); lamellae concolorous with the pileus young, near "Sayal brown" at maturity, close, 2 tiers of lamellulae, moderately broad (5–8 mm.), broadest in the middle, adnexed to subdecurrent; stipe 5–8 cm. long, 10–20 mm. thick at the apex, equal and solid, flesh concolorous with pileus at first and quickly becoming pallid, surface with a "bluish lavender" fibrillose sheath terminating in a median lavender fibrillose zone, color of sheath fading soon and leaving only the colored zone, apex silky, fibrillose from pale lavender fibrils, when old whitish over all, not changing color when handled.

Spores subellipsoid to slightly inequilateral, 7–9 (10)×5–5.5μ, rusty brown in KOH, outer wall wrinkled; basidia four-spored; pleuro- and cheilocystidia not seen, gill trama hyaline and parallel; pileus trama homogeneous and hyaline beneath a somewhat differentiated pellicle of narrow subgelatinous hyphae, a delicate pinkish lilac tint diffused throughout the pellicle when the latter is revived in KOH.

Scattered under conifers, Mt. Angeles, Olympics, Wash., Oct. 7, 1941 (17,613); Olympic Hot Springs, Olympic National Park, Wash., Oct. 11, 1941, (17,778-type) Stuntz and Smith; same locality, Oct. 15 (Smith, 17,907).

Observations: The outstanding features of the species are the sickening-sweetish heavy aromatic odor, bright lilac colors of all parts, and the viscid pileus. The smaller spores, which rarely measure 10μ long, distinguish it from *C. balteato-cumatilis* Henry and its North American forms. Collection 17,438 (Olympic Hot Springs) of the latter had an odor like that of *C. pyriodorus*. Its spores measure 8–11×4.5–6μ. The stems were 10–12 cm. long, 2–4 cm. thick at the apex and 3–6 cm. at the base. The caps measured up to 30 cm. broad. The colors, however, were very similar to those of *C. subfoetidus* and the appearance of the dried specimens is also similar. Both are rather bright lilac at least near the margins of the pilei. *C. euchrous* Henry appears to be very similar to *C. subfoetidus* in many respects but has creamy white flesh and abundant cheilocystidia. It is described as having an agreeable fruity odor. *C. nemorosus* Henry differs in

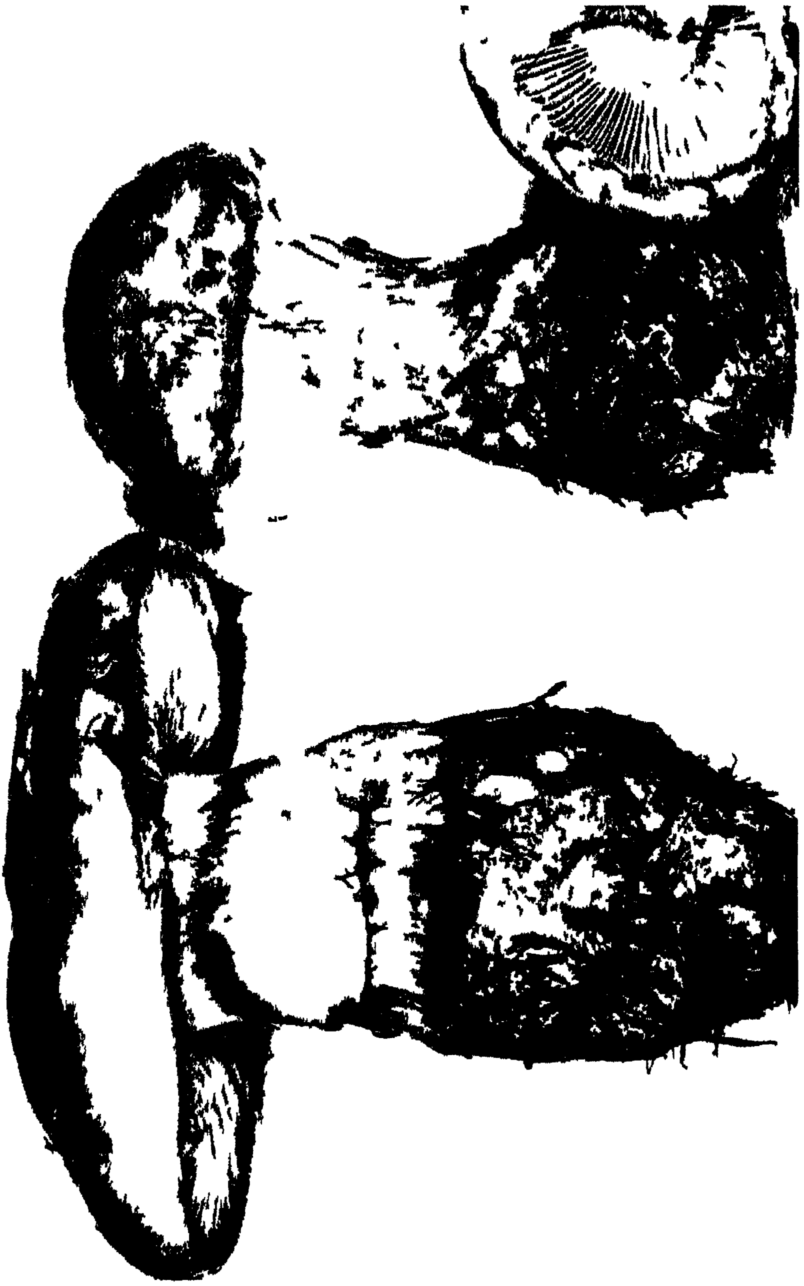

PLATE 7 —*Cortinarius superbus* Smith ×1

its much larger spores (13–14×6.5μ), bulbous and lutescent to brunnescent stipe, bitterish taste and fruity instead of a sickening, heavy, sweetish odor.

Cortinarius superbus sp. nov.

Plate 7

Pileus (4) 6–12 (15) cm. latus, convexus demum late convexus vel planus, glutinosus, fibrillosus, pallide olivaceo-luteus, testaceo-brunnescens; odor valde distinctus; lamellae subsulphureae dein fulvae, confertae, latae; stipes 6–9(15) cm. longus, sursum 1–2.5 cm. crassus, deorsum 3–4.5 cm., clavatus, valde fibrillosus, subsulphureus, deorsum testaceo-brunnescens; sporae 11–13×5.5–7.5μ.—Specimen typicum A. H. Smith n. 17,680, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941; in Herb. Univ. of Mich. conservatum.

Pileus (4) 6–12 (15) cm. broad, convex with an inrolled margin finally becoming broadly convex to plane, surface glutinous in wet weather, sometimes merely viscid after prolonged rain, the gluten often accumulating and drying on the disc in the form of spotlike scales and often dripping from the margin onto the base of the stipe, more or less fibrillose streaked beneath the gluten, pale yellowish when young ("cartridge buff") or with an olivaceous cast over all, soon becoming more or less vinaceous brown ("Mikado brown" to "Verona brown") or a brighter reddish brown over the disc, the margin usually remaining yellowish or olivaceous; flesh thick and firm (up to 2 cm. thick in the disc), tapered abruptly near the margin, pale yellow ("straw yellow" to "Barium yellow"), "Chartreuse yellow" in the apex of the stipe, soon becoming sordid brownish where cut or bruised (particularly in the base of the stipe), taste not distinctive, odor rather strong and very distinctive, reminding one somewhat of the odor of fresh green corn; lamellae "straw yellow" when young, gradually becoming rusty yellow-brown, close, 107 ± reach the stipe, 2 tiers of lamellulae, adnexed, broad (7–9–15 mm.), equal, horizontal, sometimes crisped, edges slightly uneven to serrate; stipe 6–9 (12) cm. long, 1–2.5 cm. thick at the apex, clavate, up to 4.5 cm. at the base, solid, yellow within but soon brownish when cut, surface densely fibrillose from the remnants of the copious yellow cortina, surface and fibrils more or less olive-yellow ("pale chalcedony yellow"), soon becoming dark sordid brown at the base or where handled and usually with an agglutinated dark basal zone of fibrils (apparently caused by gluten dripping from the cap or by a rudimentary gelatinous outer veil).

Spores 11–13×5.5–7.5μ, slightly roughened, somewhat almond-shaped, dark rusty brown under the microscope in KOH; basidia four-spored; cheilocystidia none; pleurocystidia absent but in revived mounts scattered basidia-like cells present having an amorphous reddish to purplish content in KOH; gill trama more or less regular to interwoven; pileus trama slightly purplish in KOH, surface covered by a thick gelatinous pellicle.

Scattered to gregarious on steep mountain slopes, Olympic Hot Spings Olympic National Park, Wash., Sept. 30, 1941 (17,443); Oct. 2, (17,492); Storm King Mt., Oct. 5 (17,580); Mt. Angeles, Olympics, Wash., Oct. 7 (17,645); Olympic Hot Springs, Oct. 8 (17,680-type); Lost Creek, Ore., Oct. 30, 1941 (18,162).

Observations: It is difficult to decide the subgeneric position of this species. At times it appeared to be a Myxacium and at other times a Phlegmacium. The gelatinous sheath, if present, is very thin and present only on very young carpophores. It soon is evident only as a discolored somewhat varnished-appearing band around the clavate base of the stipe. In many instances this band appeared to be caused by gluten that had dripped from the pileus, but in many others it was distributed in such a manner as to be clearly the remains of a gelatinous sheath. At the time the type collection was made about six market baskets of specimens were collected and no definite subgeneric disposition could be arrived at. The gluten from the cap often drips onto the base of the stipe before the veil breaks and such buttons lead one to place the fungus in Myxacium. However, since the species appears to be closely related to *C. percomis* of Phlegmacium, it is referred to that subgenus.

The outstanding characters of this species are the color and color change of the flesh of the pileus and stipe, the massive stem, copious cortina and odor. It appears to be closest to *C. nanciensis* Maire and *C. percomis* Fr. *Phlegmacium russum* (Fr.) Ricken is also close, but Ricken's fungus can hardly be *C. russus* Fr. since the flesh of the latter is pallid at first, not sulphur yellow, and should have a very disagreeable taste. It is also doubtful if Ricken's fungus with is odor of *Tricholoma lascivum* and white base of its stipe can be referred to *C. superbus*. *C. nanciensis* differs in having a universal veil with grayish lilac to brownish lilac tints, and in lacking a characteristic odor. There is apparently a difference in size and also in the attachment of the lamellae, but these are more likely to be variable characters. Although the change in color of the pileus is suggestive of *C. orichalceus*, and dried specimens of the two are similar in color when first dried, they can be easily distinguished after standing for a time (several weeks to a month) in the presence of napthalene. Those of *C. orichalceus* become deep purplish whereas those of *C. superbus* retain their olive brown colors. *C. Friesii* Bres. & Schulz. apparently has a similar odor, but has totally different colors.

CORTINARIUS CLIDUCHUS Fr., Epicrisis Syst. Myc., p. 260. 1838.

Pileus (5) 7–14 cm. broad, obtuse to broadly convex, becoming plane or with a slightly depressed disc, margin at times somewhat elevated in age, surface glutinous when wet, appearing fibrillose-streaked beneath the gluten, color dominantly "cinnamon-buff" over all at first, (yellowish), disc soon yellowish tawny ("ochraceous tawny"), in age sometimes more or less tawny over all; flesh very thick and firm in the disc, tapering abruptly toward the margin, pallid yellowish or when water-soaked with a greenish tint, odor none, taste mild; lamellae close, broad, shallowly adnexed or merely slightly depressed, becoming short decurrent, whitish to "pale pinkish buff" (yellowish) young, in age more or less "ochraceous tawny" intermediate stages sometimes nearly avellaneous, edges even or eroded; stipe 6–12 cm. long, 10–20 mm. thick at apex, clavate to nearly equal, solid but becoming hollow, pale watery yellowish within, surface whitish from a thin coating of appressed silky fibrils, glabrescent and yellowish in age, the cortina leaving a slight or rather distinct fibrillose zone.

Spores 9–11 × 5–6μ, slightly inequilateral to subalmond-shaped, roughened, rusty brown under the microscope; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama parallel to subparallel, hyaline in KOH; pileus trama homogeneous beneath a gelatinous pellicle, region next to the pellicle tawny in KOH.

Gregarious to subcespitose under alder along the trail to Lake Angeles, Mt. Angeles, Olympic Mts., Wash., Sept. 19, 1941 (16,971).

Observations: Kauffman (1932) apparently described material of this species from Washington under the name *C. saginus* Fr. Among his collections only one so labelled has been located. It has dried a dark mineral red and appears to belong in *C. orichalceus* instead. It was collected at Lake Cushman, also in the Olympics, in 1915, and was one of several specimens collected at different intervals. Apparently it was not used in making up his notes, however, since there is nothing in his published account of *C. saginus* to indicate *C. orichalceus*. The additional specimens must have been lost or spoiled in drying. Henry (1939) has placed a species obviously very closely related to the one Kauffman described but with spores 8- 9 × 6.5–8μ under the name *C. saginus*. He pointed out that Ricken's concept of *C. saginus* was not consistent with the Friesian descriptions and that Rea (1922) had translated the Friesian description and added Ricken's spore measurements thus creating a confused concept. Lange and Bresadola did not include *C. saginus* in their Icones. Henry accepts Cooke's illustration although R. Maire, Quélet, and Rea believed the latter represents *C. triumphans* (see Pearson, 1935). My material of *C. triumphans* and *C. cliduchus* does not compare well with Cooke's plate of *C. saginus*. In order to stabilize the nomenclature, Henry's concept of *C. saginus* rather than Kauffman's is recognized, and the American collections are placed in *C. cliduchus*. *C. cliduchus*, sensu Konrad and Maublanc, however, is characterized by yellowish bands over the lower part of the stipe. Such bands were not present in my material and are not indicated in the Friesian descriptions. *Phlegmacium cliduchus* of Ricken, characterized by a strong odor and yellow fibrillose bands on the stipe has been referred to *C. cephalixus* Secr. by Henry (1936). My material apparently differs slightly from the Friesian descriptions in having paler gills and in growing under alder in the mountains instead of in beech woods.

CORTINARIUS CRYSTALLINUS Fr. sensu Bresadola and Lange.

Pileus 3–5 cm. broad, obtuse with an inrolled margin, becoming broadly umbonate to nearly plane, surface glabrous and glutinous (all had been exposed to continuous rain for several days), "tilleul buff" (whitish) with "pinkish buff" to "cinnamon-buff" watery streaks or spots, entire disc gradually becoming "cinnamon-buff" (buff color); flesh thick (5–8 mm. in the disc), tapered abruptly, watery punctate, "pinkish buff" or more yellowish and very pale buff in age, very soft and fragile, taste of pellicle very bitter (like *Mycena fellea*), odor not distinctive; lamellae "tilleul buff" (pallid) young, becoming "pinkish buff" (pale buff) at maturity, very pale at all stages and drying more or less "ochraceous tawny," narrow (up to 5 mm.), bluntly adnate, close, 81–86 reach the stipe, 2–3 tiers of lamellulae, edges slightly wavy; stipe equal to slightly clavate, 4–8 cm. long, 9–15 mm. at apex, 15–20 mm. thick at base, tapered below the enlarged portion to a rootlike projection, solid but becoming hollow, pale buff within ("pinkish buff"), surface whitish and covered by a thin coating of appressed dry fibrils, soon glabrescent and appearing watery and more or less concolorous with the pileus.

Spores 5.5–7 (8) $\times$ 3.5–4μ, nearly ellipsoid, slightly roughened, pale yellowish in KOH; basidia four-spored; cheilo- and pleurocystidia not differentiated; gill trama hyaline in KOH, of parallel hyphae; pileus trama homogeneous or nearly so beneath a gelatinous pellicle, floccose tramal body slightly yellowish in KOH next to the gelatinous layer.

Scattered to gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 11, 1941, Stuntz and Smith 17,779.

Observations: An outstanding species because of the very bitter pellicle, very small spores and pallid to pale yellow-buff color. Henry (1936) has described a very similar species under the name *C. causticus*. It differs from the Olympic material chiefly in having a slight gelatinous veil on the stipe at first. Lange (1938) has described *C. crystallinus* as having a dry stipe, but otherwise there are few if any characters to distinguish between the two. Lange placed *C. crystallinus* in Myxacium because of its relationship to *C. vibratilis* and the other bitter species of Myxacium. His accounts of both *C. crystallinus* and *C. emollitus* appear to apply to the same fungus. It may well be that *C. causticus* should be included here also. However, in view of the difficulty encountered in deciding whether a species belonged in Phlegmacium or Myxacium in certain other cases, and the lack of any doubt in this species, I have used the name *crystallinus* which is consistent with the characters of the fungus.

Peck reported *C. crystallinus* for New York in 1878 but I have not examined his specimens. Kauffman (1932) did not recognize the species as occurring in North America but apparently did not account for Peck's report.

CORTINARIUS LATUS Fr., Epicrisis Syst. Myc., p. 260. 1836.

Pileus 5–10 cm. broad, very broadly convex with an inrolled margin, expanding to plane or with a low broad umbo, surface very glutinous when wet but soon dry, glabrous or more or less appressed-fibrillose beneath the gluten, color evenly "light pinkish cinnamon" to "pinkish cinnamon" young (pale cinnamon with a pinkish tinge), becoming "pinkish buff" (pale buff) on the margin and pale cinnamon-tan on the disc, always with a clean fresh appearance, occasionally the margin with a faint lilac tinge; flesh thick, white, firm (1.5 cm. in umbo), tapered abruptly, unchanging when cut or bruised, odor and taste mild; lamellae close to crowded, rather narrow (5-6 mm.), equal ±, adnate but becoming slightly adnexed, very pale buff or pallid (nearly white when young), sometimes developing a faint lilac tint before becoming pale cinnamon, finally dull cinnamon ("Sayal brown"), edges even; stipe 7–10 cm. long, 10–15 mm. thick, usually with an abrupt flanged bulb but sometimes clavate and bulb-margin obsolete, nearly equal in age, becoming hollow, white throughout and unchanging, cortina scant to copious, lower portion of stipe at first white fibrillose from its remains, glabrescent, with occasional patches of gluten from the pileus but lacking a gelatinous universal veil.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 2, 1941 (17,506); Oct. 8 (17,683 and 17,711); Oct. 11 (17,773).

Observations: In collection no. 17,711 the pilei developed a lilac tinge in the margin, and the gills, though white at first, also became faintly lilac in partly expanded buttons. The development of this tint appeared to be secondary. Because of the typically pallid gills and pale cinnamon cap the species appears closely related to *C. multiformis* and *C. Bouderi*. Since usuage has clearly established the name *C. latus* for a Phlegmacium, there is no need to discard it simply because the plant was not placed in that subgenus in Systema vol. 1. My collections appear to represent the species as Fries described it in his later works. It is doubtful if Ricken's *Phleg. latum* with its somewhat yellowish flesh and stipe is typical. The clear white flesh was an outstanding character of my material. Bresadola's (1929) illustration is excellent. He described the pileus as subviscid. My collections differed in being very glutinous but the gluten was thin and soon dried out to give the usual shiny appearance to the pilei.

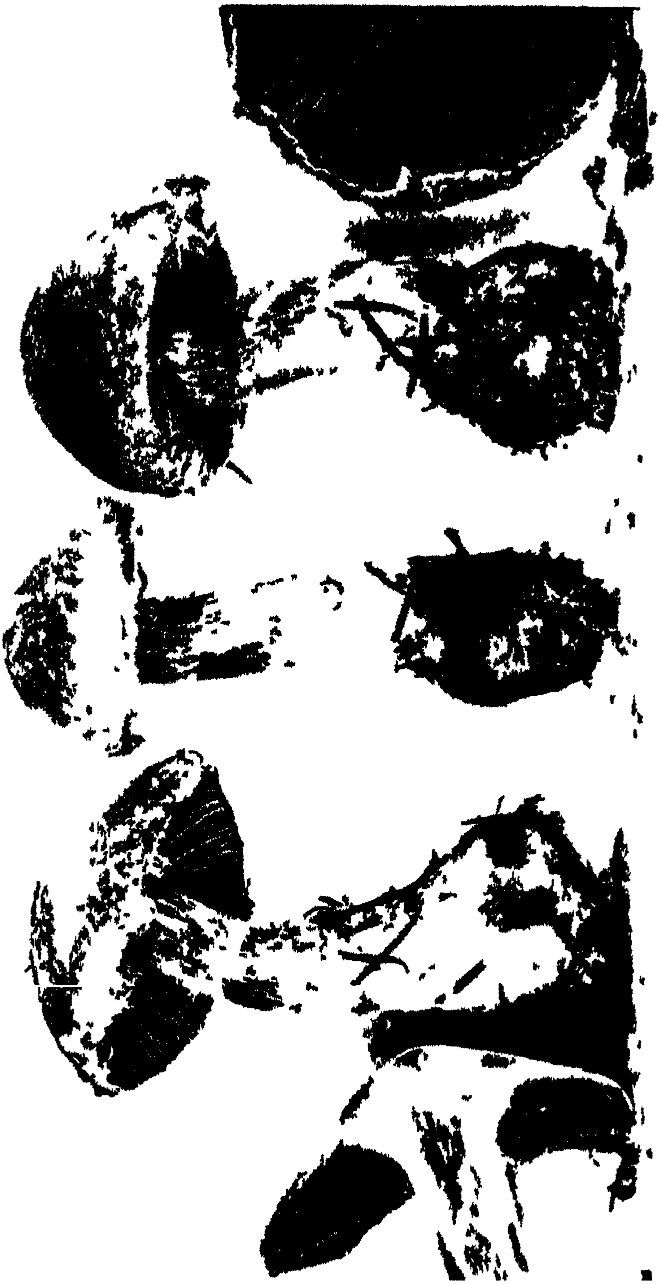

PLATE 8.—*Cortinarius fragrans* Smith ×1

INOLOMA and DERMOCYBE

Cortinarius fragrans sp. nov.

Plate 8

Pileus (2) 3-6 (9) cm. latus, campanulatus, siccus, fibrillosus, pallide lilacino-vinaceus demum ligno-brunneus; odor fragrans; lamellae subdistantes, latae, adnatae vel subdistantes, pallide lilacinae dein cinnamomeae; stipes 5–10 cm. longus, (4) 6–8 (11) mm. crassus, subaequalis, sursum lilacinus, deorsum lilacino-avellaneus; fibrillosus vel fibrilloso-zonatus; sporae 8–10×4–5.5μ.—Specimen typicum A. H. Smith n. 17,713, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941; in Herb Univ. of Mich. conservatum.

Pileus (2) 3–6 (9) cm. broad, obtusely conic with an incurved margin, becoming campanulate to subplane with a low obtuse conic umbo, surface dry and innately fibrillose, pallid when young but tinged lilac ("pale vinaceous fawn"), slowly becoming darker, some tinged "light vinaceous cinnamon" toward the margin and more or less wood brown over the disc, sometimes with more of a vinaceous tinge; flesh thin, tapered abruptly away from the disc, pallid but tinged lilac when young, in age lilac-buff or nearly white, taste mild, odor very distinctive, fruity (as in *C. pyriodorus*); lamellae subdistant, 33± reach the stipe, 2 tiers of lamellulae, broad (5 mm. ±), equal and horizontal in age, adnate and developing a short decurrent tooth, seceding in some, pale dull lilac to "light vinaceous cinnamon" (pale pinkish cinnamon with barely a tinge of lilac) young, becoming dull cinnamon at maturity ("Sayal brown" or darker); stipe 5–10 cm. long, (4) 6–8 (11) mm. thick, equal or merely subbulbous at the base, stuffed, the pith pallid, cortex "lavender" at least above but throughout in vigorous specimens, surface scurfy near the apex, very ragged-fibrillose below from veil remnants, usually more or less zoned, veil remnants lilac fading to pallid, bright lavender above, duller toward the pallid base which finally becomes slightly brownish ("avellaneous" in the base in age).

Spores 8–10×4–5.5μ, ellipsoid, roughened, dark dull rusty brown in KOH; basidia four-spored, pale sordid yellowish brown in KOH; pleuro- and cheilocystidia not found; gill trama regular, pallid; pileus trama with slightly larger cells near the surface, dull brown in KOH near or at the surface, tramal body nearly hyaline.

Scattered to gregarious, under conifers, Olympic Hot Springs, O'ympic National Park, Wash., Sept. 30, 1941 (17,454); Oct. 2 (17,552); Oct. 8 (17,713-type); Oct. 15 (17,900) and Mt. Angeles, Olympics, Wash., Oct. 4 (17,558), and Oct. 7 (17,635), 1941.

Observations: This is a small to medium sized species related to *C. pyriodorus* Kauffman by its odor and colors but it differs in its duller lilac tints, smaller size, slender and nearly equal stipe, and more distant lamellae. It is close to *C. myrtillinus* in some respects but possesses a copious universal veil and has somewhat different colors. *C. myrtillinus* is not described as having a characteristic fruity odor. *C. subtabularis* is quite similar but lacks a universal veil, has an abruptly bulbous stipe, close gills and has no characteristic odor. *C. fragrans* is a common species in the vicinity of Olympic Hot Springs and very constant in the characters emphasized.

CORTINARIUS TURGIDUS Fr. Epicrisis Syst. Myc., p. 278. 1836.

Pileus 3–6 cm. broad, very broadly convex when young, becoming plane or with a low obtuse umbo, the margin usually decurved but finally spreading or raised up slightly, surface dry and appressed fibrillose, nearly pallid to "pinkish buff" (pale buff) young, becoming "cinnamon-buff" to "clay color" (pale alutaceous), somewhat streaked in age; flesh more or less watery-punctate and pallid, watery avellaneous along the gills, thick (6 mm. ±) at the stipe, tapered evenly, soft and fragile, odor faintly fragrant, taste mild; lamellae pallid to very pale brownish when young, soon yellowish ("warm buff") and finally pale ochraceous tawny, broadly adnate, becoming short decurrent, broad (8 mm. ±), close, 67 ± reach the stipe, 2 tiers of lamellulae, edges becoming slightly uneven; stipe clavate, 6–10 cm. long, 8–12 mm. at apex, bulb 1.5–3 cm. thick, solid and pallid within, soft and fragile, surface concolorous with the pileus and thinly fibrillose, somewhat glabrescent, becoming a brighter pale yellowish brown in age.

Spores 8–9.5 (10) × 5–6μ, ellipsoid or nearly so, roughened, tawny in KOH under the microscope; pleuro- and cheilocystidia none; gill trama regular, hyaline in KOH; pileus trama with a thin pellicle of slender non-gelatinous hyphae, beneath this a region of enlarged cells with tawny walls (in KOH), the remainder hyaline and floccose.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, 1941 (17,458); Oct. 15 (17,902).

Observations: When dried the specimens are a pale rather bright cinnamon. The relationship to *C. argentatus* is quite striking, but lilac colors, of course, are not present. *C. turgidus* is practically dull white and silky-shining at first, but gradually assumes yellowish and finally alutaceous hues as the carpophores age. *C. argutus* differs in having an almost root-like projection below the bulb, subdistant gills and large spores, but appears to be similar in most other characters. The cuticle of the stipe in *C. turgidus* is somewhat cartilaginous but in my collections it did not become rimose. The latter is a character not likely to develop well in very wet weather.

CORTINARIUS ORELLANUS Fr., Epicrisis Syst. Myc., p. 288. 1836.

Pileus 2–4.5 cm. broad, obtuse with an incurved margin, becoming obtusely campanulate or nearly plane with an obtuse umbo, surface innately fibrillose to slightly fibrillose-furfuraceous, margin opaque, disc "chestnut brown," "russet" to "tawny" toward the margin, near "walnut brown" over all in age (dark rusty brown to chestnut brown at first, dull testaceous in age), not hygrophanous, flesh thin, near chestnut brown moist, odor none, taste mild; lamellae "tawny" but soon "ochraceous tawny" (dark tawny young, more yellowish at maturity), sinuate, nearly subdistant, 35 ± reach the stipe, 2 tiers of lamellulae, broad (4–5 mm.), becoming ventricose, edges uneven, intervenose; stipe 3.5–5 cm. long, 4–7 mm. thick, hollow or becoming so, equal, thinly fibrillose toward the base with pallid fibrils from the remains of the cortina, when young pallid buff over all from veil fibrils (yellowish), becoming tawny or sordid tawny in the base, paler brown and silky toward the apex.

Spores 9–11 × 5–6μ, narrowly subellipsoid, roughened, pale tawny in KOH under the microscope; pleuro- and cheilocystidia not seen; gill trama parallel, pale tawny in KOH; pileus trama with a surface layer several cells thick of slightly enlarged hyphae with yellowish walls (in KOH).

Gregarious on moss beds in an alpine meadow, Anderson Lookout, Baker National Forest, Wash., Sept. 13, 1941 (16,907).

Observations: The illustrations of this species by Konrad and Maublanc (1924–32) picture my specimens exceptionally well; the smaller figures in particular. At first I was inclined to place my material in *C. croceoconus* Fr. Kauffman (1918) gave a description of material he collected in Sweden, but his specimens could not be located for a critical comparison. The only collection among his Cortinarii bearing this name is the one he (1921) reported for Colorado. His notes on the label of the latter state that the fruiting body was overheated in drying. Since Kauffman did not recognize *C. croceoconus* in his monograph (1932) it is assumed that he later entertained some doubt over the identity of his Colorado collection. Fries has emphasized that *C. croceoconus* has an acute persistent umbo and that the cap is not squamulose. These two characters prevent my no. 16,907 from being identified as that species and seem to place it in *C. orellanus*. *C. subcinnamomeus* Cleland[2] (Smith, 1935) has somewhat similar spores but the two species are quite different in other respects, particularly in the much more pronounced olive colors of the latter. Its scales are caused by the cuticle and upper layer of the flesh together becoming broken up whereas in *C. orellanus* the very minute scales are caused by the recurved or upright threads of the cuticle and are present from the beginning instead of developing at maturity or later.

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[2] Since the name *Cortinarius subcinnamomeus* Karsten antedates that of Cleland, the name **Cortinarius Clelandii** nom. nov. is given to the Australian species.

CORTINARIUS ULIGINOSUS Berk. sensu Lange, Flora Agaricina Danica 3: 34. Pl. 95, fig. A. 1938.

Pileus 1.5–5 cm. broad, obtuse or obtusely conic when young, the margin incurved, becoming campanulate, obtusely umbonate or nearly plane, the margin spreading or remaining decurved, surface dry and appressed fibrillose, sometimes appearing slightly furfuraceous but not scaly, color "vinaceous rufous" over all (bright rusty red) or the disc "burnt Sienna" (a bit more orange), "Kaiser brown" at times, gradually becoming paler especially along the margin ("apricot buff") and occasionally splashed sordid greenish; flesh thin, rather pliant, "aniline yellow" (rich yellow with an olive cast) and in age distinctly greenish brown, odor of radish, taste very strongly raphanoid but also having a bitter aftertaste; lamellae "aniline yellow" young, finally "ochraceous tawny" but frequently remaining "ochraceous buff" (dull yellowish buff instead of pale tawny), moderately close, 26–37 reach the stipe, 2–3 tiers of lamellulae, moderately broad (4–5 mm. ±), depressed adnate to sinuate, seceding, edges slightly eroded; stipe 4–9 cm. long, 3–6 mm. thick, equal, hollow, cortex watery orange, interior tinged yellowish green, surface with "English red" fibrils on a "Salmon orange" ground color, in age fading to straw yellow near the apex and sordid orange toward the base, veil scanty and "Kaiser brown" fading to "orange-buff."

Spores ellipsoid, 7–9 (10)×4–5μ, slightly tuberculate; basidia four-spored; pleurocystidia present only as metallic-appearing basidia-like bodies that are greenish in fresh material and brownish in KOH; cheilocystidia saccate, 26–30×9–12μ, numerous to scattered, hyaline; gill trama regular, with pockets of amorphous pigment which are greenish in fresh material but reddish when revived in KOH; pileus trama homogeneous beneath a surface layer of hyphae filled with cinnabar red contents.

Gregarious on soil under alder and willow on marshy ground, Joyce, Washington (Olympic Peninsula), July 5, 1939 (14,784), and Park Creek, Mt. Baker, Washington, in beds of Polytrichum on poorly drained ground Sept. 10, 1941 (16,807 and 16,808).

Observations: After collecting the carpophores from Joyce, I visited the type locality of *Inocybe ferruginosa* but failed to get any specimens. The type locality was visited again in 1941 with the same result. These two species have almost exactly the same appearance, and their microscopic characters are also practically identical. They differ in the spermatic odor of the Inocybe, its nauseating taste and whitish flesh when young. Since the latter has spores with a somewhat wrinkled wall it appears more logical to place it in Cortinarius in spite of its odor and Inocybe-like stature. Because of its resemblance to *Cortinarius uliginosus* in all basic characters, it appears best to make it a variety of that species, and the new name **C.**

uliginosus var. **nauseosus** nom. nov. is proposed. The name *ferruginosus* is inappropriate as a varietal name (syn. *Inocybe ferruginosa* Smith, Papers Mich. Acad., Sci., Arts and Letters, **24**: 93, Pl. II, fig. 3; Pl. III, figs. 15-16. 1939).

Peck reported *C. uliginosus* from New York, but I have not made a critical study of his specimens. Kauffman did not recognize Peck's report in either his Agaricaceae of Michigan or in the North American Flora.

TELAMONIA

Cortinarius angelesianus sp. nov.

Pileus 1–2.5 cm. latus, conicus vel campanulatus, sordide alutaceo-squamulosus, umbrinus, hygrophanus, demum avellaneus; lamellae obscure ferruginae dein testaceae, confertae vel subdistantes, latae, adnatae vel subdecurrentes; stipes 3–6 cm. longus, 4–6 mm. crassus, aequalis vel deorsum attenuatus, subfulvus, deorsum fuscus; fibrillosus; sporae 7–8 × 4–5μ.—Specimen typicum A. H. Smith n. 17,629, legit prope Mt. Angeles, Olympic Mts., Wash., Oct. 7, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 1-2.5 cm. broad, conic when young, the margin incurved against the gills, becoming conic-campanulate or plane with a small umbo, surface covered from disc to margin with a dense coating of "snuff brown" (dull yellowish brown) fibrils which become aggregated into numerous small recurved fibrillose scales, not glabrescent, moist and hygrophanous beneath the fibrillose coating, ground color "bister" (dark umber brown) but this generally obscured by the scales, fading very slowly to dull dark avellaneous; flesh thick on the disc, abruptly tapered and thin over remainder of pileus, nearly "russet" (deep reddish brown) moist, dull grayish brown faded, odor and taste not distinctive; lamellae "russet" to "cinnamon-brown" young, remaining so or becoming dull cocoa-brown in age (very dark at all times) moderately close to subdistant, 23–30 reach the stipe, 2–3 tiers of lamellulae, moderately broad, adnate and with a slight decurrent tooth, edges even but a bit wavy; stipe 3–6 cm. long, 4–6 mm. at apex, equal or tapered to a pointed base, solid, cinnamon-brown within, darker (near bister) at the base, surface covered with a thin coating of appressed fibrils concolorous with those on the pileus, cortina buff colored and very scanty, universal veil remnants lacking or as small inconspicuous patches of brownish fibrils around the base, these soon evanescent.

Spores 7–8 × 4–5μ, broadly subellipsoid, slightly roughened, pale tawny under the microscope; basidia four-spored, the walls very slightly colored pale testaceous (in KOH) and many that are more or less collapsed dark testaceous in color; gill trama subregular, the hyphae with an abundant incrusting pigment causing the trama to be dark brown with a vinaceous or testaceous tinge when revived in KOH (the color very distinctive);

pileus trama more or less homogeneous and colored like the gill trama (very dark), the surface with fascicles of fibrils projecting to form the scales.

Scattered to singly on very decayed conifer wood, Olympic Hot Springs, Olympic National Park, Wash., Sept. 22, 1941 (18,822); Mt. Angeles, Olympics, Wash., Sept. 26 (17,292); Sept. 28 (17,379) and Oct. 7, 1941 (17,629-type).

Observations: This species has much the stature of small specimens of *C. flexipes* and the scales on the pileus also remind one of that species. It differs, of course, in the color of the scales and lack of any violaceous hues. The gills of dried specimens are dull chocolate color and aid in distinguishing herbarium specimens. It is difficult to be sure of the subgeneric position of this species. The lack of any appreciable veil remnants on the stipe at maturity may cause some to search for it in Hydrocybe near *C. acutus.* It appears to be most closely related to *C. helvelloides,* however. The latter is distinguished by larger spores and violaceous gills. *C. Cookei* Quél. appears to be practically identical with *C. helvelloides,* but may possibly be distinguished by its smaller spores. *C. lacorum* Smith is a true Dermocybe. Lange has reduced it to synonymy with *C. helvelloides,* but the question needs further study.

C. angelesianus, in spite of its brown universal veil does not appear to be even closely related to *C. psammocephalus* and its forms. The reaction of the gill and pileus trama in KOH distinguishes dried material from the latter group, and the very dark rusty gills and generally darker duller colors separate fresh specimens. *C. flavornatus* Singer can be readily distinguished by its much larger spores (7–11 × 7–8μ) and apparently by the brighter olive to yellow colors of the fresh pilei.

Cortinarius boulderensis sp. nov.

Plate 9

Pileus 2–4 cm. latus, conicus dein campanulatus, striatus, subtestaceus, ad marginem subviolaceus, demum cinnamomeus; lamellae griseo-lilacinae dein cinnamomeae, confertae, latae; stipes 5–8 cm. longus, 4–7 mm. crassus, sursum subpurpureus, deorsum pallide brunneus et vinaceo-fibrillosus vel zonatus; sporae 7–8 (9) × 4–5.5μ.—Specimen typicum A. H. Smith n. 17,461, legit prope Olympic Hot Springs (Boulder Creek), Olympic National Park, Wash., Sept. 30, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 2–4 cm. broad, obtusely conic and with an almost straight margin when young, becoming campanulate to plane or retaining a low obtusely conic umbo, surface moist and glabrous but appearing silky when faded, color "bone brown" to "warm sepia" or with a violaceous brown cast at first (dark dull reddish brown to chocolate brown), becoming "Rood's brown" (deep vinaceous brown), and faintly striatulate on the margin,

PLATE 9.—*Cortinarius boulderensis* Smith, ×1

hygrophanous, fading to "Sayal brown" (dark cinnamon)' the margin sometimes plicate-crenate in age; flesh thin and fragile, concolor with surface and fading to sordid vinaceous buff, odor and taste not distinctive; lamellae "light vinaceous drab" when young, becoming "Sayal brown" in age (grayish lilac at first, dull cinnamon in age), moderately close, 39–44 reach the stipe, 2 tiers of lamellulae, broad (5 mm. ±), adnate with a decurrent tooth, edges slightly uneven; stipe 5–8 cm. long, 4–7 mm. thick at the apex, base slightly bulbous, hollow and fragile, cortex "pale purple-drab" above, pallid brownish toward the base, surface "pale purple-drab" at the apex and appressed silky, brownish below, with a median "vinaceous fawn" (testaceous) annular band from universal veil remnants, usually with scattered patches of vinaceous fibrils lower down, occasionally sheathed with testaceous fibrils over the lower third.

Spores 7–8 (9) $\times 4$–5.5μ, ellipsoid, slightly roughened, rusty brown under the microscope; basidia four-spored, not purplish when revived in KOH; gill trama regular to subregular, hyaline to pale brownish in KOH; pileus trama homogeneous, dull brownish in KOH.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, 1941 (17,461-type).

Observations: This is a very characteristic Cortinarius of the *C. armillatus-C. haematochelis* series but differing from both in the grayish lilac gills and dull violet color of the apex of the stipe. It is smaller than either of the above. From descriptions it is most likely to be confused with *C. paragaudis* (Smith, 1939). Dried material of *C. paragaudis* has "deep livid brown" (almost haematite red) mycelium at the base of the stipe, and the dried specimens are tinged strongly with the same color. When mounted in KOH the gill and cap trama becomes deep purple and this pigment diffuses throughout the mount. No such changes take place in *C. boulderensis*. There is, of course, a corresponding difference in fresh specimens. Those of the latter species are pallid brownish in the base of the stipe and in *C. paragaudis* the color is deep purplish. From *C. subtestaceus* Smith *C. boulderensis* differs in its smaller spores, glabrous pileus, smaller size, habitat and color of both the young gills and apex of the stipe. *C. boulderensis* differs from *C. spilomeus* in its moist translucent-striate pileus and narrower spores (6–9 $\times$ 6–7μ in *C. spilomeus* as compared with 7–9 $\times$ 4–5.5μ). However, it is very likely closely related to *C. spilomeus*, in fact it may eventually be desirable to group *C. spilomeus*, *C. boulderensis*, *C. armillatus*, *C. haematochelis* and *C. subtestaceus* together in a subgroup or stirps of Telamonia.

Cortinarius mucicola sp. nov.

Pileus 1.5–3.5 cm. latus, conicus dein umbonatus, cinnamomeo-brunneus, striatus, dein avellaneus, glaber dein sericeus; lamellae lilacinae, dein cinnamomeae, latae, subventricosae, confertae; stipes 5–6 cm. longus, 3–6 mm. crassus, aequalis, deorsum albo-fibrillosus vel zonatus; sporae 7–9 × 4–5μ.—Specimen typicum A. H. Smith n. 17,455, legit prope Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 1.5–3.5 cm broad, obtusely conic with an incurved margin young, becoming plane with a conic or obtuse umbo in age, the margin spreading and often wavy, surface glabrous, moist, hygrophanous, "cinnamon-brown" or slightly paler moist, either evenly colored or the umbo darker, translucent striate along the margin, fading to nearly avellaneous on the margin and then appearing somewhat appressed fibrillose, in age appearing faintly fibrillose over all; flesh 4–5 mm. in the umbo but abruptly thinner toward the margin, watery "snuff brown" moist, dull dirty buff color faded, odor and taste not distinctive; lamellae "dull lavender" (pale lavender) when young but quickly changing to pale or dark cinnamon-brown with no trace of lavender remaining, close, 34–37 reach the stipe, 1–2 tiers of lamellulae, moderately broad (4 mm. ±)., becoming slightly ventricose, adnate but becoming depressed adnate, edges a bit uneven; stipe 5–8 cm. long, 3–6 mm. thick at apex, equal or slightly narrowed below, pale dull brown, paler above, darker below, lower portion with bands of concentric patches of white fibrils from the universal veil, glabrescent at times.

Spores 7–9 × 4–5μ, ellipsoid, slightly roughened, pale ochraceous tawny under the microscope; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama regular, dark brownish in KOH; pileus trama similarly colored, surface layer made up mostly of inflated cells 10–30μ in dia. and 25–80μ long.

Gregarious under conifers, in deep moss, Olympic Hot Springs, Olympics, Wash., Sept. 30, 1941 (17,455) and (17,456).

Observations: The only difference between the two collections was that the universal veil remnants of 17,456 were very conspicuous. *C. musicola* is quite close to *C. flexipes* but differs markedly in the clear pale dull lavender gills which very soon loose all traces of their original color, in the lack of superficial fibrillose scales over the pileus, and lack of violaceous flesh in either the pileus or stipe at any time. I have collected *C. flexipes* on several occasions and find the colors to be as described by Ricken (1915). The only truly cinnamon brown individuals I have seen were partly faded. The collections cited above are perhaps even closer to *C. microcyclus* Fr. but differ in having close instead of distant gills, a brown instead of a white stipe, and very likely in the color of the pileus although from the information available this difference may not be great. If Herpell's spore measurements are accepted (as has been done by Rea and Ricken) then there is also a distinct difference in spore size. In view of these discrepancies, my material has been described as new.

Cortinarius subcuspidatus sp. nov.

Pileus 3–5 (7) cm. latus, conicus vel subcuspidatus, dein campanulatus vel conico-umbonatus, sericeus dein glaber, subfulvus vel subargilaceus; lamellae cinnamomeae demum fulvae, confertae; stipes 7–12 cm. longus, 4–8 mm. crassus, albosericeus vel fibrillosus, deorsum luteo-zonatus, sporae 7–9×4.5–6μ.—Specimen typicum A. H. Smith n. 17,447, legit prope Olympic Hot Springs, Olympic National Park., Wash., Sept. 30, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 3–5(7) cm. broad, prominently conic when young, soon conic campanulate or conic-umbonate with a spreading margin, seldom merely subumbonate, surface glabrous and moist on the disc, silky fibrillose toward the margin, color "snuff brown" (dull cinnamon-brown) or near "avellaneous" on the disc, more nearly "avellaneous" toward the margin hygrophanous and fading to "cinnamon-buff" (pale buff) over all and then appearing densely appressed fibrillose; flesh brittle, concolorous with the surface when moist or faded, thick under the disc but abruptly thinner toward the margin, odor none, taste mild; lamellae "Sayal brown" young, (dark cinnamon) becoming "ochraceous tawny," close, 40–44 reach the stipe, 3 tiers of lamellulae, moderately broad and becoming somewhat ventricose (5–6 mm.), bluntly adnate or developing a slight tooth, edges even or slightly eroded, stipe 7–12 cm. long, 4–8 mm. thick at apex, clavate or only slightly enlarged downward, solid but becoming hollow, sordid brown within, pallid from a dense coating of appressed silky fibrils which extends to the apex, lower portion with one to several zones of pale buff ("cinnamon-buff") universal veil remnants, these sometimes evanescent, cortina whitish.

Spores ochraceous tawny under the microscope in KOH, 7-9×4.5–6μ, ellipsoid, very slightly roughened; basidia four-spored; pleurocystidia not seen; cheilocystidia rare to absent, slightly larger than the basidia and sometimes irregular in outline, 8–12 μ broad; gill trama subparallel to interwoven, the cells enlarged, pallid tawny in KOH; pileus trama pallid tawny in KOH, the cuticle composed of a mixture of slender filamentous hyphae and others with inflated hyphal cells up to 15–20μ in dia.

Gregarious on or around rotten conifer logs, Lake Angeles Trail, Mt Angeles, Olympics, Wash., Sept. 19, 1941 (16,969): Mt. Angeles, Sept. 24 (17,205); Sept. 26 (17,303); Sept. 28 (17,375); Olympic Hot Springs, Sept. 30 (17,447-type); Mt. Angeles, Oct. 7 (17,624) and Olympic Hot Springs, Oct. 11 (17,771).

Observations: This species is very characteristic in both the fresh and dried condition, When fresh the almost cuspidate pileus, yellowish remains of the universal veil, and the dark cinnamon gills which become tawny are its outstanding characters. It is not closely related to *C. gentilis* or *C. distans*. When dry the stipe is pallid and glistening from the appressed fibrils.

The universal veil remnants become alutaceous in drying. It is close to *C. mammosus* Kauff. but differs in usually having a sharper umbo, in the color of the gills both when young and mature, and apparently in the color of the universal veil. Although well dried, the fruiting bodies in the type of *C. mammosus* have dark dull-brown stipes, a decided contrast to those of *C. cuspidatus*.

Cortinarius subpurpureus sp. nov.

Pileus 3–5 cm. latus conicus vel convexus dein planus vel umbonatus glaber, saepe striatulatus, hygrophanus, griseo-purpureus dein ligno-brunneus; lamellae unbrino-purpureae dein fulvae, confertae; stipes 5–11 cm. longus, 8–10 mm. crassus, subclavatus, sursum purpureo-griseus, deorsum brunnescens, fibrillosus, zonis alutaceis 1–3 deorsum cinctus; sporae 7.5–9 ×5–6μ.—Specimen typicum Stuntz and Smith n. 17,781, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 11, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 3–5 cm. broad, conic to convex when young, the margin appressed against the stipe or curved in slightly, becoming broadly convex to plane or retaining an obtuse or conic umbo, silky fibrillose over all or along the margin only, but soon glabrescent, moist, translucent striate on the margin, hygrophanous, "dark vinaceous drab" (dull grayish purple) or "purple-drab," becoming "Verona brown" to "Rood's brown" (dull testaceous) and finally fading to "wood brown" (dark avellaneous) with a purplish tinge; flesh thick under the umbo or disc (5–8 mm.) but abruptly thinner away from the stipe and very watery, concolorous with the cap and fading with it, odor none, taste slight; lamellae "dark purple-drab" (deep grayish purple) but soon becoming "Rood's brown" (dull testaceous) and finally "ochraceous tawny," close, 2 tiers of lamellulae, bluntly adnate, ascending or horizontal, seceding, moderately broad (5 mm. ±); stipe 5–11 cm. long, 8–10 mm. thick, at the apex, narrowly clavate, solid but becoming hollow, "purple-drab" over all but soon sordid brown below and over all in age, lower half densely white fibrillose and with "cinnamon-buff" (dull yellowish buff) zones of universal veil tissue, appressed silky above, sometimes coarsely silky fibrillose from remains of the cortina.

Spores 7.5–9×5–6μ, dark rusty brown under the microscope, slightly roughened, broadly ellipsoid to subovoid; basidia four-spored; cheilocystidia and pleurocystidia not differentiated; gill trama regular to subregular, dull tawny in KOH, subhymenium somewhat cellular; pileus trama very distinctive, tramal body composed of interwoven hyphae with brownish walls when revived in KOH, cuticle composed of two layers of hyaline cells (revived in KOH), those over the surface slender (3–6μ) and radially arranged in an indefinite layer several cells (more or less) thick, between this layer and the brownish hyphae of the tramal body is found a layer of inflated hyaline cells (more or less barrel-shaped) 30–60×20–40μ. thin walled and radially arranged, the layer 2–3 cells thick.

Gregarious under conifers, Olympic Hot Springs, Olympics, Wash., Sept. 30, 1941 (17,462); same place and locality (17,463-convex form), Oct. 8 (17,712); Oct. 11 (Stuntz and Smith 17,781-type); Oct. 15 (17,915) Oct. 17 (18,001).

Observations: This was a common and easily recognized species in the field, and appears to be close to *C. pericelis*. The latter, however, is said to have pallid instead of violaceous gills. There should also be a distinct difference in stature, the Friesian species being much more slender than *C. subpurpureus*. In Kauffman's (1932) key it seems to be closest to *C. injuncundus* by virtue of its colored veil and violaceous gills, but differs in the color of the pileus and stipe, and in the organization of the trama of the pileus.

Cortinarius distans var. **olympianus** var. nov.

Pileus 3–6 cm. latus, conicus dein campanulatus, substriatus, furfuraceus, rufo-fulvus demum pallide fulvus; lamellae subtestaceae dein fulvae, latae, subdistantes, adnatae demum secedentes; stipes (5) 8–12 (14) cm. longus, 8–11 (15) mm. crassus, subaequalis, subfulvus; sporae 7–9×5–6μ. —Specimen typicum A. H. Smith n. 17,523, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 2, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 3–6 cm. broad, broadly conic when young, conic campanulate or subexpanded with a sharp conic umbo in age, surface moist and hygrophanous, minutely furfuraceous over all in either moist or faded condition, faintly striatulate on the margin, color "russet" to "hazel" over all when moist (dark to bright rusty brown), becoming "tawny" at least along the margin before fading, "ochraceous tawny" over all when faded; flesh thin, concolorous in either moist or faded condition, taste mild, odor strong of radishes; lamellae "Verona brown" (dull cinnamon), "tawny" at maturity, broad (6–8 mm.), broadest at attachment and tapered to the margin, subdistant, 23–26 reach the stipe, 2 tiers of lamellulae, adnate but becoming slightly adnexed and with a decurrent tooth, soon seceding; stipe (5) 8–12 (14) cm. long, 8–11 (15) mm. thick at apex, equal or gradually enlarged downward, hollow, dark yellowish brown over all (more or less concolorous with the pileus), with a median or superior rusty yellow fibrillose ring, silky above, becoming dark rusty brown and glabrescent where handled, mycelium whitish.

Spores very broadly ellipsoid and dark rusty brown under the microscope, 7–9×5–6μ, tuberculate roughened; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama regular; pileus trama homogeneous, the surface layer of compact radially arranged hyphae, the walls dark rusty brown from incrusting pigment.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 2, 1941 (17,523-type) and again Oct. 11 (17,803).

Observations: Pilei of the variety dry a more reddish brown ("carob-brown" to "liver brown") than typical material which is "cinnamon-buff" to "clay-color" when dried. This difference along with the rusty yellow fibrillose ring, the subdistant rather than distant gills, and the discoloration of the stipe when handled distinguishes the variety from typical material. Kauffman emphasized that the universal veil in the typical variety was concolorous with the carpophore but that when it broke the ring left on the stipe was whitish. In my own collections of typical material from both Michigan and Oregon this observation has been verified. Thus the difference in color of the veil remnants appears greatest in mature carpophores. *C. helvolus* is apparently very close but is characterized by thickish gills and lack of a raphanoid odor. In fact, var. *olympianus* seems to be intermediate between these two. It has the colored fibrillose zone of *C. helvolus* as well as the fusco-ferruginescent flesh in the base of the stipe. It is difficult to determine from the information at hand whether or not there really is much difference in the colors of the pileus between *C. distans* and *C. helvolus*. *C. distans* belongs to the series of bright colored Cortinarii around *C. gentilis* and is totally distinct from *C. brunneus* and other similar species. *C. croceo-fulvus* Fr. appears to be very close also, but is not described as either striate or furfuraceous.

Cortinarius hemitrichus var. **americanus** var. nov.

Pileus (2.5) 3–6 cm. latus, campanulatus dein umbonato-expansus, fibrillosus vel squamulosus demum glaber, rufo-fulvus dein helvolus; lamellae cinnamomeae, confertae, latae; stipes 5–8 cm. longus, (4) 6–10 mm. crassus, aequalis, albo-peronatus; sporae 5.5–7.5×4–5.5μ, late ellipsoideae. –Specimen typicum A. H. Smith n. 17,669, legit prope Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941; in Herb. Univ. of Mich. conservatum.

Pileus (2.5) 3-6 cm. broad, conic with an inrolled margin, becoming conic campanulate, in age plane with a conic umbo or the margin finally broadly recurved, surface covered by a thin coating of white fibrils which become more or less aggregated into appressed scales before weathering away, glabrescent, smooth, moist, hygrophanous, margin opaque, "russet", (rusty brown) when young, "Sayal brown" (dark cinnamon) at maturity and fading to near "cinnamon" (cinnamon color or paler) and eventually sordid tan; flesh thick in the umbo, tapered abruptly away from it (1.5–2 mm. near the stipe), moderately firm and rigid, concolorous with the surface, odor none, taste mild; lamellae "Sayal brown" when young (dark cinnamon) becoming more or less ochraceous tawny in age, adnate to depressed adnate, moderately broad, (5–7 mm.), broadest near the stipe, moderately close, 41–46 reach the stipe, 2–3 tiers of lamellulae, intervenose at times, edges even, sometimes spotted or stained dark brown; stipe 5–8 cm. long, (4) 6–10 mm. thick, equal, pale brown within and soon hollowed, surface peronate over lower half with a white sheath of universal veil remnants, sheath terminating in a median fibrillose zone, thinly appressed white-fibrillose above and soon glabrescent, becoming more brownish over all in age but not darkening any more in the base than elsewhere.

Spores $5.5–7.5 \times 4–5.5\mu$, broadly ellipsoid, nearly smooth, pale rusty brown under the microscope; basidia four-spored; cheilocystidia scattered to clustered, clavate, thin walled, hyaline, $26–38 \times 7–10\mu$; pleurocystidia not seen; gill trama regular, pallid brownish in KOH; pileus trama homogeneous, brownish in KOH; surface hyphae radially arranged into a compact cuticle, the hyphae more or less the same diameter as those of the tramal body.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 8, 1941 (17,669).

Observations: The variety appears to be very abundant in the Olympics whereas typical material was not found. Scattered groups of mature fruiting bodies were repeatedly observed in the region around Olympic Hot Springs, but coll. 17,669 was the only one encountered in which young material was abundant. The variety is distinguished by the small broadly ellipsoid spores and apparently by slightly different colors. It is close to *C. rigidus* sensu Ricken in certain respects. However, the lack of an odor, the presence of copious universal veil remnants over the pileus and generally more robust stature exclude *C. rigidus* from consideration. *C. stemmatus* has darker and redder colors, a not so conspicuously fibrillose pileus and distinctly larger spores. My specimens were compared with *C. hemitrichus* collected in Sweden by Kauffman. The spores of the latter are larger and more almond-shaped. Judging from the descriptions of various authors, who nearly all disagree in regard to minor characters of *C. rigidus* and *C. hemitrichus*, there are numerous local forms and varieties of these species, Kauffman's (1932) description of *C. hemitrichus* reads as though it were taken from a pale form of var. *americanus* rather than from his Swedish collection. *C. hemitrichus* sensu Henry (1934) has spores like Kauffman's Swedish collection. Consequently his account is accepted as applying to the typical variety. The spore size given in Saccardo very likely indicates that var. *americanus* also occurs in Europe.

Cortinarius nigrellus var. **occidentalis** var. nov.

Pileus 1–3 cm. latus, obtusus vel convexus, sericeus dein glaber, umbrino-castaneus demum testaceus; lamellae argillaceae vel cinnamomeae, confertae, latae, adnatae; stipes 4–7 cm. longus, 3–5 mm. crassus, subaequalis, vinaceo-annulatus, sursum pallidus dein brunneus, deorsum subfuscus; sporae 7–8 × 5- 6μ.—Specimen typicum A. H. Smith n. 17,304, legit prope Olympic Hot Springs, Olympic National Park, Wash., Sept. 26, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 1- 3 cm. broad, obtusely conic with an incurved margin when young, becoming convex to obtusely umbonate, surface silky fibrillose and more or less radially wrinkled in some, "carob brown" to "liver brown" over all when moist (deep chestnut to testaceous), the margin sometimes a paler deep reddish brown, hygrophanous, fading to "cameo brown" or "cacao brown" (cocoa-color), margin for a time appendiculate with veil fragments; flesh thick on the disc, thin on the margin, more or less dull yellowish brown ("snuff brown") moist or with a reddish tinge, fading to "clay color" (paler yellowish brown), odor and taste not distinctive; lamellae "clay color" young, becoming nearly "Sayal brown" at maturity, not staining, moderately close, 43–48 reach the stipe, 1–2 tiers of lamellulae, broad (4 mm. ±), adnate but becoming adnexed, edges even; stipe 4–7 cm. long, 3–5 mm. thick at the apex, slightly enlarged downward, stuffed, pith "clay color," cortex pallid, surface more or less pallid and fibrillose, cortina whitish, universal veil dull vinaceous red and leaving a vinaceous median fibrillose zone, apex silky and becoming pale sordid brownish.

Spores pale ochraceous tawny under the microscope, 7–8 × 5–6μ, broadly ellipsoid to subglobose, roughened; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama subregular; pileus trama homogeneous, the surface hyphae compactly and radially arranged.

Gregarious under conifers, Mt. Angeles, Olympic Mts., Wash., Sept. 24, 1941 (17,193) and Sept. 26 (17,304-type).

Observations: The color of the universal veil is almost identical with that of the typical variety. In the dried specimens it is more or less "fawn color" rather than bright reddish as in *C. haematochelis*. Var. *occidentalis* differs from typical material in the more reddish brown pileus, more yellowish brown gills, and slightly shorter and broader as well as paler spores. The difference in the color of the spores under the microscope is very striking. The difference between "avellaneous" to "fawn color" in the young gills of typical material and "clay color" in the variety is also important. Neither *C. nigrellus* nor the variety *occidentalis* can be referred to synonymy under *C. rigidus* because of their vinaceous universal veils.

CORTINARIUS ADUSTUS Pk. Ann. Rep. N. Y. State Mus. 42: 22. 1889.

Pileus 3–7 cm. broad, obtuse or with a flattened disc and an inrolled margin, becoming broadly umbonate or nearly plane and sometimes with a wavy margin, surface glabrous and moist, with watery streaks toward the margin, color "Brownish drab" to "light brownish drab" (dull violaceous brown), becoming "army brown" on the disc (deep vinaceous brown), scarcely fading; flesh thick, more or less purplish young ("pale purple-drab"), sordid dull watery brown in age and watery punctate, odor none, taste mild; lamellae "pale purple-drab" or more lilaceous when young, "Rood's brown" at maturity (deep vinaceous brown), close, 65-72 reach the stipe, 2 tiers of lamellulae, narrow to moderately broad and more or less ventricose (5–7 mm.), sharply and deeply adnexed, edges uneven; stipe 7–10 cm. long, 9–18 mm. thick at apex, narrowly clavate (occasionally 30 mm. at base), some nearly equal, solid, apex silky-fibrillose and concolorous with the young gills, lower portion covered by a white or pallid sheath of universal veil fibrils, glabrescent, more or less concolorous with the pileus, interior pallid vinaceous brown in the base, in the apex dull lilac at first.

Spores 7–9×4–5μ, ellipsoid, slightly roughened, dull bister under the microscope in KOH; basidia four-spored; pleuro- and cheilocystidia not differentiated; basidia and gill trama dull brown in KOH; pileus trama dull brown and with scattered enlarged cells near the surface or a more or less distinct cellular layer (in tangential section) present, the cells 8–20μ in dia.

Gregarious under conifers, Olympic Hot Springs, Oct. 11, 1941, Stuntz and Smith (17,776).

Observations: This species is very similar to *C. torvus* in color and in the way the fruiting bodies dry, but can best be distinguished by the lack of an annulus. The veil remnants form only an evanescent zone. Peck in his description of *C. adustus* gave the spore size as up to 10μ (.0004 inch) long. Kauffman separated Peck's species from *C. scutulatus* Fr. chiefly on the basis of spore size. He ascribed spores 7–8×4–4.5μ to the Friesian species and spores 8–10×5.5–6.5μ to that of Peck. The type of Peck's species has been examined and the spores found to be 7–8 (9)×5–5.5μ. Henry (1938 b) has recently described what he considers to be typical *C. scutulatus* with spores 9–11×6.5μ. Thus it now appears that the spore measurements given in the North American Flora for these species should be reversed. However, it is also evident that *C. scutulatus* is amply distinguished from *C. adustus* by the copious universal veil fragments left on the stipe as the sheath breaks up. Since this character goes back to the Friesian descriptions, whereas spore size does not, it should be given the most emphasis in determining which of the two should be regarded as *C. scutulatus*. This leaves *C. adustus* with few characters to really distinguish it from C *impennis* Fr., a fungus with much the same colors and only a slightly developed universal veil. *C. impennis* has distant gills, *C. adustus* as described has subdistant gills, and in the Olympic collections they were close. Consequently the latter are placed in *C. adustus*. However, a fungus I have identified as *C. impennis* has also been collected in the Olympics. Its slightly smaller spores and more distant gills appeared distinctive, but not all authors are agreed that *C. impennis* has small spores. For additional comments see *C. impennis*, page 223.

CORTINARIUS BIBULUS Quélet Champ. Jura et Vosges, Suppl. 10, p. 666. 1880.

Cortinarius americanus Smith, Ann. Myc. 22: 471 1934.

Lange (1938) placed *C. americanus* in synonymy with *C. pulchellus*, a species he had previously described. More recently Singer (1937) referred both *C. pulchellus* and *C. americanus* to *C. insignis* Britz. (in the revised sense of the latter author). Killerman (1928) however, placed *C.* (*Hydrocybe*) *insignis* in synonymy with *Inocybe geophylla*, a rather plausible disposition of it if one considers the lilac form of the latter. It is questionable whether *C. insignis* Britz. can be recognized as a valid name. Obviously the large fungus originally described under that name is distinct from the small species of the Revision (1899). If the concept established in the "Revision" is accepted, it is still questionable whether either *C. pulchellus* or *C. americanus* can be legitimately referred to it. *C. insignis* was described as lilac-flesh colored, whereas the other two species as I know them from fresh material are a dull violet with little or no vinaceous tints evident. Consequently it appears best to either discard the name *insignis* or accept Killerman's disposition of it. In regard to *C. pulchellus* and *C. americanus* the only significant difference appears to be in the development of the universal veil. However, in my collections of both the difference appeared to be constant and since the character is used to distinguish the subgenera Telamonia and Hydrocybe it is logical to accept it as sufficient evidence to separate the two species in question. Further studies, however, convinced me that *C. americanus* is not specifically distinct from *C. bibulus* Quél. The latter was overlooked in my first study of *C. americanus*. Although I have not seen material of *C. bibulus* the plate and description are convincing enough. The spores of *C. bibulus* may be slightly smaller than in the American material, and the veil remnants on the stipe more copious but these differences do not appear to be distinctive. In *C. americanus* the universal veil remnants usually form a single distinct fibrillose zone with only a few flecks of fibrils toward the base of the stipe or the latter is merely silky downward. The cortina is very scanty and collapses on the stipe above the remains of the universal veil. Actually the American Telamonia is intermediate in its veil characters between the fungus shown in Quélet's plate and that of Lange. This situation brings into focus the difficulties of trying to establish natural relationships in the genus Cortinarius. All along the dividing line between Telamonia and Hydrocybe one finds examples of two or more obviously closely related species being placed in separate subgenera. The study of such groups has interested me for some time, but it is greatly complicated by the duplication of stature and color throughout all the subgenera of the genus, and can be carried out satisfactorily only on fresh material.

CORTINARIUS BOVINUS Fr., Epicrisis Syst. Myc., p. 297. 1838.

Pileus 4–8 cm. broad, obtuse when young, becoming nearly plane or broadly umbonate at maturity, surface appearing dry from appressed fibrils especially near the margin which is more or less fringed with "clay color" to pallid fascicles of fibrils, colors dull brown to dull tan (near "cinnamon-brown" on the disc, margin near "clay color"); flesh thick, brittle, watery-brown, fading to near "wood brown" (hygrophanous), odor and taste not distinctive; lamellae subdistant, 3 tiers of lamellulae, broad, adnexed, "avellaneous" (grayish brown) or darker when young, pale cinnamon-brown in age, edges fimbriate; stipe 5–8 cm. long, 1–2 cm. thick at apex, 2–3 cm. at base, solid, watery-punctate and pale dull brown within (near "wood brown"), lower portion belted with pale buff ("cinnamon-buff") fibrillose rings from the universal veil, coarsely silky fibrillose and more or less avellaneous over all beneath the universal veil remnants.

Spores 8–10 × 6–7μ, very broadly ellipsoid, tuberculate roughened, dark rusty brown in KOH under the microscope; basidia four-spored; pleuro- and cheilocystidia not differentiated; gill trama regular; pileus trama homogeneous, hyphae of cuticle not particularly enlarged.

Gregarious to subcespitose, under hemlock, Timberline Camp, Mt. Baker, Wash., Aug. 24, 1941 (16,348).

Observations: Lange described the universal veil remnants as forming a white band on the stipe, a character not in accord with the Friesian descriptions. In my material the universal veil was "clay-color" (alutaceous) and hence possibly even more brownish than indicated by the descriptions of Fries and Rea. The difference, however, does not appear significant in view of the wide range of color included under the term fuscous by Fries and later mycologists. My specimens also appeared to have a denser fibrillose covering over the pilei than is usually indicated in the European manuals. Here again, however, considerable variation can be reasonably allowed.

CORTINARIUS BRUNNEUS Fr., Epicrisis Syst. Myc., p. 298. 1838.

Pileus 3–6 cm. broad, obtusely conic with an incurved margin when young, becoming broadly conic-campanulate or with a broad obtuse umbo and spreading margin, surface white-silky fibrillose along the margin but less so toward the disc, moist and hygrophanous but margin opaque, evenly "walnut brown" (dull testaceous), fading slowly (on the disc first) to dull tawny, the whitish fibrils more conspicuous in faded plants; flesh thick on the disc, tapered abruptly and thin over the remainder, dull walnut brown moist, fading to whitish, odor and taste not distinctive;

lamellae dull brown with a tinge of purplish at first, paler and more cinnamon brown in age, subdistant, 47–53 reach the stipe, 3 tiers of lamellulae, broad (6-8 mm.), broadest at base and tapered to the margin, rather deeply adnexed and toothed, the edges nearly even; stipe short, 4–6 (7) cm. long, 9-13 mm. thick at apex, clavate or nearly equal, solid or becoming hollow, lower portion whitish from the sheath left by the universal veil remnants, sheath terminating in a median fibrillose zone which soon discolors slightly, apex appressed silky and pallid, interior of apex "vinaceous brown" or with a distinct violet tinge causing the surface to appear obscurely violet-brown beneath the silky fibrils, dull sordid brown within toward the base and in age dull brown over all including the veil remnants.

Spores $7–9 \times 5–6\mu$, broadly subellipsoid, dull rusty brown under the microscope, slightly roughened; basidia four-spored; pleuro- and cheilocystidia none seen; gill trama regular, brownish in KOH; pileus trama with a surface layer of more or less enlarged cells ($9–25\mu$) in tangential section, otherwise homogeneous.

Gregarious under second growth Douglas fir, Mt. Angeles, Olympic Mts., Wash., Sept. 24, 1941 (17,198).

Observations: The color of the veil changes from whitish to pallid dull brownish as the carpophores age. Hence it is not surprising to find some descriptions giving its color as white (Lange) and others (Kauffman) fuscous. Fries (1874) described it as "fusco-albo." The purplish to violaceous brown tinge in the gills and apex of the stipe is obscured and a bit confusing but hardly pronounced enough to cause one to search for the species among those having truly violaceous or lilac gills. *C. brunneus* and *C. bovinus* according to the material I have seen can be separated by the distinctly colored universal veil of the latter in young stages, lack of testaceous tints in the fruiting body and by the homogeneous pileus.

CORTINARIUS GLANDICOLOR var. CURTUS Fr., sensu Lange, Flora Agaricina Danica 3: 40, Pl. 97, fig. D. 1938.

Pileus 10–25 mm. broad, obtuse, becoming plane or slightly umbonate, margin incurved slightly, surface covered by a thin coating of more or less appressed white fibrils, margin whitish from veil remnants, color beneath the fibrils "bone brown," "dusky brown" or "blackish brown (1)" (very dark blackish brown with only a tinge of testaceous, fading slowly to a grayer brown, about "wood brown"); flesh concolorous with surface but paler grayish when faded, rather firm and rigid, tapered abruptly off the disc and very thin, odor and taste not distinctive; lamellae "bister" to "Hay's brown" (very dark dull brown with a testaceous cast when partly mature), becoming "cinnamon-brown" at maturity but remaining rather dark for a long time, more or less subdistant, 21 ± reach the stipe, 2 tiers of lamellulae, some forked, moderately broad and becoming ventricose, thickish, edges even; stipe 3–5.5 cm. long, 2.5–3.5 mm. thick, equal, tubular, concolorous with the pileus beneath a dense white fibrillose coating, usually with a distinct white fibrillose zone around the mid-portion from the universal veil remnants, glabrescent, blackish within.

Spores 7–9×4–5 μ, ellipsoid, very slightly roughened, pale ochraceous tawny under the microscope; basidia four-spored; pleurocystidia none or present only as basidia-like cells with a dark brownish amorphous content; cheilocystidia none; gill trama regular, very dark brown in KOH (dark to light bister); pileus trama also dark brown, the surface layer indefinite and composed of inflated cells 20–40×30–90μ, many narrower and longer cells intermixed, the hyphae radially arranged.

Gregarious under second growth Douglas fir, Mt. Angeles, Olympics, Wash., Sept. 24, 1941 (17,201); Joyce, Wash., Sept. 29, 1941 (17,393).

Observations: Only the two small collections were made. My material was a little slenderer in stature than that described by Lange, but all other characters are in agreement. Lange did not give information of the trama of the pileus so no comparison can be made on that character. He cited the authority as "Fr. sensu Rea" but since Rea (1922) did not give the spore size it is not desirable to base a concept on his description, at least not one in which the spore size of the variety is different from that given in Rea's description of the species. The obscure violaceous tone usually present is quite confusing and sometimes might lead one to place his collection in *C. flexipes*. However, the latter is distinctly violaceous at first. *C. rigidus* is also close, but is readily distinguished by the paler gills when young and paler more reddish brown pilei. In many respects, this variety could be referred to *C. stemmatus*. It differs in the less conspicuous universal veil remnants on the stipe.

CORTINARIUS HAEMATOCHELIS Bull. ex Fr., sensu Bres., Icon. Myc. 14: pl. 652. 1930.

Pileus 3–6 (8) cm. broad, obtuse with a somewhat incurved margin when young, becoming partly expanded, usually with a broad somewhat flattened umbo and a more or less decurved margin, sometimes merely broadly convex to plane, surface slightly moist but not typically hygrophanous, "Mikado brown" on the disc and with a paler margin (toned with avellaneous) the vinaceous brown gradually giving way to fuscous shades (nearly "hair brown" when dried), glabrous or fibrillose streaked, in age the disc sometimes with spotlike scales; flesh thick on the disc (6 mm. ±), abruptly thinner away from the stipe, watery punctate and pale brown moist, ("wood brown") fading to pallid with a vinaceous tinge ("vinaceous buff"), odor and taste not distinctive; lamellae pale cinnamon brown ("Sayal brown") young, dark cinnamon brown in age, adnate, depressed–adnate or in age adnexed, broad (7 mm. ±), broadest in mid-portion but edges more or less horizontal, close, 42 ± reach the stipe, 2 tiers of lamellulae, edges slightly eroded; stipe clavate, 5–8 (10) cm. long, 5–9 (12) mm. thick at apex, base 15–25 mm., pallid over all from a silky-fibrillose coating in part at least from the remains of the cortina, with 1–2 belts of vinaceous brown ("Pecan brown" to "vinaceous tawny") universal veil remnants.

Scattered under conifers, Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, 1941 (17,457); Oct. 2 (17,530); Mt. Angeles, Olympic Mts., Wash., Oct. 4, (17,562); Sol Duc Hot Springs Olympic National Park, Oct. 6 (17,597); Olympic Hot Springs, Oct. 8 (17,659) and 17,709); same locality Oct. 11 (17,767) and Oct. 15, 1941 (17,909).

Observations: *C. haematochelis* has been considered a synonym of *C. armillatus* by some investigators, but Bresadola has recognized it as a distinct species because of the small spores. Bulliard's original plate does not help much in identifying either *C. armillatus* or *C. haematochelis* since the colors do not match those of either species. Hence there is nothing to be gained by comparing specimens with his illustrations. The same may be said for the descriptions. This, however, can be attributed to the similarity in the appearance of the two species. The question, then, is not whether Bulliard's fungus is distinct from *C. armillatus*, but instead is purely nomenclatorial. Should a new name be given to the species Bresadola placed in Bulliard's species, or should Bresadola's use of the name *C. haematochelis* be followed? In order to avoid multiplication of names in an already very large genus the latter choice is followed here.

I have collected *C. armillatus* in great quantities in northern Michigan and in smaller amounts in Ontario, Nova Scotia, New York and Tennessee, but have not encountered it along the west coast. Kauffman (1932) reported it from "New England and Canada to Pennsylvania and Minnesota." Its absence in the Olympics in 1941 was noticed particularly since I desired to make a comparison of fresh specimens of both species.

CORTINARIUS HELVOLUS Fr. sensu Bres., Icon. Myc. 14: pl. 653. 1930.

Pileus 3–4.5 cm. broad, broadly conic when young, becoming plane with a broad low but conic umbo, surface with a thin white-fibrillose silky coating (which is very inconspicuous), moist and hygrophanous, faintly striate, "chestnut" (deep reddish brown) but soon becoming "amber brown" (bright yellowish brown); the disc usually darker than the margin fading to "ochraceous tawny" or more or less pale tawny; flesh thin and fragile, nearly equal or tapered gradually to the margin, "amber-brown" fading to "warm buff" (yellowish) odor and taste not distinctive; lamellae "amber-brown" young, becoming "ochraceous tawny" (none were very old), bluntly adnate to slightly depressed, subdistant, 28 ± reach the stipe, 2 tiers of lamellulae, narrow to broad (6 mm. ± in the largest cap), somewhat ventricose, edges even; stipe 4–7 cm. long, 6–9 mm. at apex, equal or slightly enlarged to the base, hollow, fragile, readily splitting, "clay color" within (dull yellowish brown), surface at first with a thin coating of pallid fibrils over all and a submedian faint fibrillose zone, glabrescent and then more or less concolorous with the pileus.

Spores 6–8 × 3.5–4.5μ, narrowly ellipsoid to slightly ventricose, almost smooth, pale brown under the microscope; basidia four-spored; gill and pileus trama dark cocoa-color (very deep testaceous near the surface of the pileus); pileus trama practically homogeneous.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Sept. 30, 1941 (17,463).

Observations: In the field this species impressed me as being closely related to *C. gentilis*, but it dries a deep dull fuscous brown somewhat like *C. uraceus*. The spores are very distinctive and separate it at once both from *C. rubricosus* and *C. gentillis*. The universal veil is so thin that one is likely to seek first in Hydrocybe when identifying specimens. As a rule most Cortinarii with distinctly yellowish colors dry a pale brown or a decidedly yellowish brown. Concepts of *C. helvolus* differ somewhat. Ricken described it as having large spores, and Rea as having a ferruginous fibrillose zone on the stipe. Bresadola illustrates a pallid zone although he indicated in his description that the fibrils are yellowish at times.

CORTINARIUS IMPENNIS Fr., Epicrisis Syst. Myc., p. 293. 1836.

Pileus 3–6 (8) cm. broad, convex with an inrolled margin, becoming broadly convex to nearly plane, sometimes broadly umbonate, surface glabrous and variegated with watery streaks, when moist and fresh "Ecru drab" to "light cinnamon-drab" (pale to dark purplish umber), soon developing dull testaceous shades ("Vandyke brown" on the disc to "Rood's brown" toward the margin when still moist), fading to near "Sayal brown" or dull "cinnamon buff" (pale dark cinnamon with a prevading violaceous gray tone), the margin often fringed with violaceous-gray fibrils; flesh thick in the disc, thinner toward the margin, watery punctate before fading, purple to dull violet young, becoming grayish-purplish to "pale brownish drab," finally dull testaceous ("army brown") before fading to avellaneous, odor none, taste mild; lamellae "purple-drab" to "light purple-drab" and becoming "army brown" (deep dull testaceous-purple brown), broad (up to 1 cm.) bluntly adnate then becoming adnexed, distant, 28–35 (41) reach the stipe, 3 tiers of lamellulae, intervenose, edges even or crenulate, solid, when young dark purple to purplish umber throughout (concolorous with young gills), soon dull brownish below and in age pallid dull violaceous-vinaceous, surface more or less appressed fibrillose, usually with an evanescent median fibrillose to submembranous zone from the veil, part or all of veil remnants may adhere to the margin of the pileus.

Spores 8 10.5×5 6.5μ, broadly ellipsoid, dark rusty under the microscope, roughened; basidia four-spored; pleurocystidia not differentiated or merely as basidia-like cells with dull brown content when revived in KOH, cheilocystidia clustered, thin walled, saccate to mucronate, 18–30×6–12μ; gill trama regular, faintly vinaceous brown in KOH; pileus trama homogeneous and colored like the gill trama in KOH.

Gregarious under conifers, Olympic Hot Springs, Olympic National Park, Wash., Oct. 11, 1941 (Stuntz and Smith 17,780); Oct. 15 (Smith 17,923) and Oct. 17 (18,010).

Observations: *C. impennis*, *C. torvus* and *C. adustus* appear to be very closely related. *C. torvus* is readily distinguishable by its stature and membranous annulus, but is similar in spore size and in having the vinaceous reaction of the gills and pileus trama to KOH. Apparently the homogeneous pileus and cheilocystidia along with the distant gills distinguish *C. impennis* from *C. adustus*, but the type of the latter was not studied with these characters in mind, and since the cheilocystidia appear to be sporadic in their appearance in *C. impennis* they might not be present on the type specimens of *C. adustus* even though the two species were actually identical.

CORTINARIUS MORRISII Pk., Bull. Torr. Bot. Club **32**: 79. 1905.

Gregarious under hemlock, Boulder Creek Trail, Mt. Baker, Wash., Aug. 24, 1941 (16,347); Sandy Creek Trail, Mt. Baker, Wash., Aug. 30 (16,472); Olympic Hot Springs, Olympic National Park, Wash., Sept. 22, 1941 (17,168).

Observations: This is a characteristic Cortinarius in the same series as *C. gentilis* and *C. distans* but larger than either when well developed. It differs from *C. distans* var. *olympianus* in having "honey yellow" rather than "Verona brown" (pale yellow in contrast to dark dull brown) gills when young and in the pileus not being furfuraceous. Sometimes one is very likely to seek for *C. Morrissii* in the subgenus Hydrocybe because of the lack of universal veil remnants on the stipe in even rather young carpophores. When present the universal veil remnants are in the form of an inferior zone of scattered yellowish to tawny flecks. The pilei are "Sanfords brown" to "tawny" when moist and sometimes become "hazel" in age. The spores measure 8–10×5.5–6μ. *C. croceofulvus* as illustrated by Cooke (Illus. no. 1191, t. 1193) is very similar and may be identical. It is said to have spores the size of those of *C. Morrissii*, but no mention is made of its taste. *C. confusus* Kauff. and Smith is also very close but has smaller spores (7–8μ long), and lacks the radish-like taste of *C. Morrissii*.

CORTINARIUS RUSTICUS Karst., Symb. Myc. Fenn. 9: p. 45. 1883.

Pileus 5–8 cm. broad, convex, becoming broadly convex, margin inrolled at first, surface moist and hygrophanous, at first with a thin coating of grayish fibrils, opaque at all stages, "Sayal brown" (dark cinnamon) moist or appearing "wood brown" or "cinnamon-buff" (pale buff) margin for a time appendiculate with shreds of the cortina, flesh thick, watery punctate and dull brown, pale buff when faded, odor none, taste mild; lamellae "avellaneous" (dull grayish brown) young, "Sayal brown" at maturity (concolorous with the pileus), adnexed, moderately broad, 4–6 mm., subdistant to close, lamellulae often crisped, 66± reach the stipe, 3 tiers of lamellulae, edges even; stipe short, 3–6 cm. long, 1–2 cm. thick at apex, clavate, solid, watery brown within, apex silky and pale brownish, whitish below at first from the thin universal veil, brownish as the fibrils disappear, with an inferior white-fibrillose zone of universal veil remnants.

Spores 9–11×5–6.5μ, subamygdaliform, dark rusty brown under the microscope in KOH, tuberculate roughened; basidia four-spored; cheilocystidia and pleurocystidia not differentiated; gill trama subregular; pileus trama practically homogeneous, the surface cells only slightly enlarged.

Gregarious under spruce, near Lick Creek Summit, Idaho National Forest, Idaho, Elev. 6500 ft. ±, Aug. 3, 1941 (15,963 and 15,982).

Observations: This species is dull dark cinnamon over all. In drying, carpophores of 15,982 became blackish much after the manner of *C impennis* and *C. torvus*. It appears to be very similar to *C. injucundus* but differs in the color of the gills and their spacing and in having a white instead of a colored universal veil. *Telamonia iliopodia* sensu Ricken differs in its hollow stipe, smaller spores and yellower gills. From *T. bivela* sensu Ricken *C. rusticus* differs in its paler and duller gills and decidedly hygrophamous pileus. Fries' illustration (1877) of *C. bivelus* apparently depicts faded specimens. *C. rusticus* is described as having pallid cinnamon gills at first. This apparently is more of a cinnamon color than that observed on the youngest specimens in my collections but on the other hand it is exactly the color the gills assume as they mature, and hence no significance is attached to the difference. Apparently the universal veil is better developed in the material Karsten described, but this difference also appears to be of little significance taxonomically. The species may be only a variety of *C. bivelus* Fr. *C. Hillieri* Henry should be readily distinguishable by its characteristic odor although in its other characters it is apparently very similar to both *C. bivelus* and *C. rusticus*.

CORTINARIUS STEMMATUS Fr., Epicrisis Syst. Myc., p. 309. 1836.

Pileus 3–5 cm. broad, obtusely campanulate when young, becoming broadly conic campanulate or in age nearly plane with an obtuse umbo, margin incurved when young and usually remaining decurved, surface coated thinly with whitish fibrils over the disc, margin conspicuously white-fibrillose, appearing "benzo-brown" when young because of the fibrils, "bone brown" (very dark dull brown) when the fibrils are removed, fading slowly to "chestnut brown" or "Rood's brown" (becoming redder as it fades), streaked when fading but not striate; flesh more or less concolorous with the surface but fading to "pale pinkish buff" (pale buff), thick in the disc and tapered abruptly, odor none, taste mild; lamellae "seal brown" in buttons (vinaceous umber), becoming "wood brown" (dark avellaneous) and finally "Sayal brown" (dark cinnamon) from the spores, moderately close, 40–44 reach the stipe, 2–3 tiers of lamellulae, horizontal, moderately broad, (6–7 mm.), sharply adnexed, edges wavy; stipe 5-8 cm. long, 4-9 mm. thick, equal, solid but hollowed by grubs, near "benzo brown" (dull violaceous brown) within but fading like the pileus, surface pallid from a dense coating of appressed white fibrils, lower half shaggy-fibrillose or with zones or patches of white fibrils from the universal veil, apex silky.

Spores 7–9 (10)$\times$4-5.5μ, subamygdaliform, dull tawny under the microscope; basidia four-spored, pleuro- and cheilocystidia not seen; gill trama regular, very pale brown in KOH; pileus trama pale brown except for the surface layer of slightly enlarged cells (9–15μ).

Densely gregarious under alder and Douglas fir, Mt. Angeles, Olympics, Wash., Sept. 21, 1941 (17,125 and 17,126).

Observations: This fungus, very common in the Olympics and with slightly redder and paler colors than *C. palaceus* must be *C. stemmatus* Fr. The colors fade very slowly and change remarkably in tone. One group of about fifty fruiting bodies near my laboratory was observed for a week. When first found the pilei were just developing and were nearly fuscous. This shade remained constant for several days and then very gradually faded to dull testaceous and then to a paler reddish cinnamon-color. The close gills distinguish it from *C. glandicolor*. The latter is generally described as having a single zone of fibrils on the stipe from the ruptured universal veil. *C. stemmatus* either has a very shaggy-fibrillose stipe or the veil remnants are aggregated into several zones. *C. palaceus* as I know the latter can be readily recognized by its smaller ellipsoid spores and more pronounced fibrillose veil remnants on the cap. *C. washingtonensis* Smith is readily distinguished by it violaceous tints in the stipe, by the gills staining blackish when bruised and by its smaller spores. Henry (1937) points out that the apex of the stipe has an obscure violet reflection in *C. stemmatus*. The same was noted on my collections but is difficult to match in any color chart. The colors of the very young gills in my collections also had the same obscure violaceous cast but this was soon lost.

C. castaneoides Pk. appears to be very closely related but is distinguished by its smaller (6–7.5 × 3.5–4.5μ) spores and yellowish gills.

HYDROCYBE

Cortinarius boreasensis sp. nov.

Pileus 3–7 cm. latus, obtusus dein umbonatus, vel convexus, rufo-fulvus vel subtestaceus demum cinereo-cinnamomeus; odor distinctissimus, fragrans; lamellae subumbrino-violaceae dein ferrugineae, subdistantes, angustae vel sublatae, stipes 2–7 cm. longus, 4–8 mm. crassus, subclavatus, sordide brunneus, sericeo-fibrillosus; sporae 8–9 (10) × 5–6μ.—Specimen typicum A. H. Smith n. 970, legit prope Boreas River, New York, Sept. 19, 1934; in Herb. Univ. of Mich. conservatum.

Pileus 3–7 cm. broad, obtuse with an inrolled margin at first, expanding to umbonate, campanulate or broadly convex, sometimes nearly plane, the margin sometimes lacerated and recurved in age, surface smooth, moist and glabrous except for a few scattered fibrils along the margin, color "walnut brown" to "Mars brown" (dull testaceous to dark brown), hygrophanous and fading to an ashy cinnamon brown; flesh thin and fairly brittle, concolorous with surface or paler when faded; taste slightly and somewhat fruity or spicy, odor very strong and distinctive, sharp but sweet and somewhat fruity (but totally different from that of *C. pyriodorus*); lamellae dark dull violaceous when young, very dark rusty brown in age, subdistant, narrow to moderately broad, intervenose; stipe 2–7 cm. long, 4–8 mm. at apex, clavate to nearly equal, solid, flesh violet in apex, pallid to brownish progressively downward, surface pallid wood brown from appressed fibrils, becoming dull brown over all in age, cortina scanty and pallid.

Spores 8–9 (10) × 5–6μ, ellipsoid, roughened, dull rusty brown under the microscope; basidia four-spored, dull brown in KOH; pleuro- and cheilocystidia none, gill trama parallel, rusty brown in KOH; pileus trama rusty brown in KOH, the surface region composed of compactly arranged greatly enlarged hyphal cells (10–30 × 18–60μ).

Gregarious under conifers along the Boreas River, New York, Sept. 19, 1934 (970) and Bear Island, Lake Timagami, Ont., coll. Miss. Biggs, Sept. 4, 1936 (Smith 4524).

Observations: The odor of this species is very distinctive and pronounced but difficult to describe. The violaceous colors in the gills and the apex of the stipe are dark and dull. They could not be matched in Ridgway. The species is apparently closely related to *C. privignus* Fr. *C. Brosselini* Joachim (1938) is a much smaller Cortinarius with larger spores. It has a fragrant odor and apparently somewhat similar colors.

Cortinarius cacao-color sp. nov.

Plate 10

Pileus 5–10 cm. latus, obtusus dein convexus vel subplanus, glaber et udus, umbrino-testaceus dein pallide testaceus et furfuraceus, hygrophanus; lamellae testaceae, latae, adnatae, subdistantes; stipes 8–15 cm. longus, 1–2 cm. crassus, aequalis vel ventricosus et deorsum attenuatus, umbrino-testaceus, sericeus; sporae $7–8 \times 5–6.5\mu$.—Specimen typicum A. H. Smith n. 17,194, legit prope Mt. Angeles, Olympic Mts. Wash. Sept. 24, 1941: In Herb. Univ. of Mich. conservatum.

Pileus 5–10 cm. broad, obtuse to nearly convex when young, the margin incurved, becoming broadly umbonate with a decurved margin, glabrous when young, moist and hygrophanous, variegated between dark and pale "sorghum brown" (dark to pale reddish cocoa-brown), variously streaked when fading, "fawn color" to "army brown" faded and then the cuticle breaking up into minute, lacerate, fibrillose scales or merely becoming furfuraceous over all, the margin always somewhat fibrillose-tomentose; flesh thick on the disc (15 mm.) tapered abruptly away from the stipe and hence thin and fragile for the most part, watery and concolorous with surface when either moist or faded (but with a little less red than in "fawn color"), odor faint but sharp and soon vanishing, taste more or less mild; lamellae "cameo brown" young, "walnut brown" in age, hardly changing color (dark cocoa-color), broad, at times up to 15 mm., adnate but becoming slightly adnexed, subdistant, 41–44 reach the stipe, 2–3 tiers of lamellulae, edges becoming eroded; stipe 8–15 cm. long, 1–2 cm. thick at apex, subfusiform and up to 3.5 cm. thick in the midportion and tapered to an almost rooting base, sometimes equal or nearly so, solid, fleshy, concolorous with pileus but at first hoary from appressed silky fibrils and appearing pallid, with a very thin evanescent apical fibrillose zone from the cortina, the fibrils a very dull vinaceous gray, apex silky, the stipe and margin of the pileus almost identical in color.

Spores broadly ellipsoid to ovate-pointed, $7–8 \times 5–6.5\mu$, very dark sordid brown under the microscope, with a large central refractive body, slightly roughened; basidia four-spored, brownish in KOH; gill trama regular, pale brownish in KOH; pileus trama homogeneous, the surface hyphae radially arranged and forming a rather compact layer, brownish in KOH.

Singly to scattered under conifers, Mt. Angeles, Olympics, Wash. Sept. 24, 1941 (17,194-type), Sept. 26 (17,302); Olympic Hot Springs Olympic National Park, Sept. 30 (17,477); Mt. Angeles, Oct. 4 (17,551); Olympic Hot Springs, Oct. 2 (17,568); Sol Duc Falls, Olympic National Park, Oct. 6 (17,605); Olympic Hot Springs, Oct. 8 (17,718); Mt. Angeles, Olympic Mts., Wash. Oct. 20, 1941 (18,070).

Observations: *C. cacao-color* is practically identical in stature and color with *C. privignus* Fr. sensu Kauffman. The important difference between

PLATE 10—*Cortinarius cacao color* Smith, ×1

them is in spore size and shape. During the season of 1941 one collection, no. 18,005, of the latter was found The pilei measured 10–15 cm broad, the spores $8–10 \times 5–6\mu$, the stipes 10 cm. long and 3 cm thick at the apex Their odor was not pronounced. No matter how carefully the fruiting bodies are dried, they darken and become fuscous to blackish over the surface of the pileus and stipe. The same is true for all of my collections of *C. cacao-color.* The micaceous or silky appearance of *C. privignus* as described by Kauffman is caused by the loosening of the fibrils forming the cuticle of the cap as the latter fades. In *C. cacao-color* this change progresses to the point of causing the pileus to appear finely fibrillose scaly or furfuraceous. This condition is an important macroscopic character for both species. There is also a difference in the color of the cortina between these two, but the veil is so evanescent that the character is little help in identification. *C. rubricosus* Fr. apparently is also somewhat similar in appearance but is never described as becoming furfuraceous. *C. saturninus* Fr. sensu Henry (1938a) is described as becoming furfuraceous but it has grayish violet gills and large spores (11–12×6.5μ). Since Kauffman's concept of *C. privignus* did not include an appreciable odor and taste, it may represent a distinct American variety of the species.

Cortinarius fuscodiscus sp. nov.

Pileus 1.5–4 cm. latus, conicus vel campanulatus, striatus, glaber, ad discum umbrinus, ad marginem subalutaceus, hygrophanus; lamellae alutaceae, confertae vel subdistantes, angustae, subarcuatae; stipes 6–9 cm. longus, 3–5 mm. crassus, aequalis, sericeo-fibrillosus, pallide brunneus; sporae 8–10×5–6μ.—Specimen typicum A. H. Smith n. 17,589, legit prope Sol Duc Falls, Olympic National Park, Wash. Oct. 6, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 1.5–4 cm. broad, conic with the margin either straight or bent in slightly, becoming campanulate or the margin spreading and the disc with a sharp conic umbo, the margin frequently splitting, surface moist and hygrophanous, faintly translucent striate fresh but opaque when faded, "bister" on the disc and "snuff brown" toward the margin (dark dull yellowish brown), fading to "wood brown" at least on the margin (dark avellaneous), the disc remaining dark; flesh thin except in the umbo, dark watery brown, fragile, odor and taste none; lamellae "clay color" (alutaceous) young, dull pale ochraceous tawny at maturity, close to subdistant, 26–32 reach the stipe, 2 tiers of lamellulae, narrow (3–3.5 mm.), tapered toward the margin, subarcuate to depressed-adnate; stipe 6–9 cm. long, 3–5 mm. thick at apex, equal or slightly larger below, pallid brownish within, surface with a thin coating of appressed fibrils, glabrescent, pallid at first from the fibrils, sordid fuscous brown in the basal portion and over all in age, cortina white and scanty, no universal veil remnants present at any stage.

Spores 8–10×5–6μ, broadly ellipsoid, ochraceous tawny under the microscope, roughened; basidia four-spored; gill trama somewhat interwoven, somewhat cocoa-colored in KOH; pileus trama with a surface layer of enlarged hyphae, the cells 9–25μ in dia. and 10–60μ long, narrow binding hyphae quite numerous, the remainder of the trama cocoa-brown in KOH.

Observations: This species appears to be quite close to *C. acutoides* Pk., but differs in lacking chestnut colors and in having a fuscescent stipe. *C. nigricans* Vel. differs in its spore characters. Two collections from a sphagnum bog on Mt. Baker, Wash. appear to belong in *C. acutoides*. The notes from no. 16,721 are as follows: Pileus "russet" over all at first, gradually fading to near tawny, Lamellae "ochraceous tawny" at first and "tawny" in age. Stipe 9–13 cm. long (growing in sphagnum), 2.5–3 mm. thick above, pallid from a thin coating of fibrils, brownish but not fuscescent within. Spores 8–10.5×5–6μ. The specimens of *C. fuscodiscus* are much darker when dried than those of *C. acutoides*. *C. finitimus* Britz. appears to be close but is described as having spores 6–7×2.3μ.

Cortinarius subacutus sp. nov.

Pileus 1–2 cm. latus, conicus dein campanulatus vel umbonatus, glaber, hygrophanus, subtestaceus vel ad discum subniger; lamellae subtestaceae vel purpureo-tinctae, confertae, angustae, adnatae vel subdecurrentes; stipes 3–6 cm. longus, 2.5–3.5 mm. crassus, aequalis, griseo-fibrillosus, deorsum lutescens; sporae 7–9×4–5μ.—Specimen typicum A. H. Smith n. 17,360; legit prope Mt. Angeles, Olympic Mts. Wash. Sept. 28, 1941; in Herb. Univ. of Mich. conservatum.

Pileus 1–2 cm. broad, conic with an appressed margin when young, becoming conic campanulate to expanded umbonate, the umbo conic, glabrous, the margin opaque when moist, "Verona brown" over all at first (very deep brown with a tinge of vinaceous), the disc blackish in some, hygrophanous and fading to near "avellaneous" or more sordid, appearing appressed fibrillose part way to disc when faded; flesh thick under the umbo, abruptly thinner toward the margin, dark "Verona brown" moist, sordid "cinnamon-buff" faded, odor and taste not distinctive; lamellae "Hay's brown" to "sorghum brown" (deep purplish brown), becoming dull cinnamon brown, close, 28–30 reach the stipe, 2 tiers of lamellulae, moderately narrow, 2.5 mm. ±, adnate to subdecurrent, tapered to the margin, edges even; stipe 3–6 cm. long, 2.5–3.5 mm. thick above, equal or slightly narrowed below, becoming hollow, surface appressed fibrillose and pale sordid grayish brown up to the apex or apical region even paler, becoming sordid yellowish below in age, no universal veil remnants present.

Spores 7–9×4–5μ, narrowly inequilateral, dull rusty under the microscope, slightly roughened; basidia four-spored; pleuro- and cheilocystidia not seen; gill trama deep rusty-vinaceous when revived in KOH, incrusting plates of pigment small but conspicuous; pileus trama dark fuscous to vinaceous-fuscous in KOH, incrusting plates of pigment readily visible, the cuticle scarcely differentiated from the tramal body, both of somewhat enlarged cells.

Gregarious under conifers, Mt. Angeles, Olympics, Wash. Sept. 28, 1941, Stuntz and Smith no. 17,360.

Observations: This species is similar in many respects to *C. germanus* sensu Kauffman, but is readily distinguished by the narrow inequilateral spores as well as lacking the conspicuous vinaceous shades in the pileus described by Kauffman for *C. germanus*. *C. Romagnesii* differs in having pallid gills and larger spores. *C. fistularis* Britz. also appears to be quite similar but its stipe is said to be concolorous with the pileus, hence dark reddish brown and not lutescent. Its gills are described as distant instead of close but they are apparently about the same color in both species. The gills of *C. subacutus* have a very distinctive color, and the vinaceous-fuscous color of the pileus and gill trama, when mounted in KOH, aids greatly in identifying dried material. The very deep purplish brown gills and hygrophanous pileus distinguish *C. subacutus* from *C. castanellus* Pk.

CORTINARIUS CYPRIACUS Fr. Episcrisis Syst. Myc., p. 307. 1838.

Pileus 4–8 cm. broad, with a sharp conic umbo and an inrolled margin when young, broadly campanulate to expanded umbonate in age, umbo sometimes obsolete, the margin often arched, glabrous except for a faint grayish fibrillose fringe along the margin from the cortina, hygrophanous, near "Seal brown" (dark purplish umber) moist, fading to a darker grayish brown, becoming "wood brown" or drab, not striate but often splitting radially in age; flesh 2–3 mm. thick away from the disc, tapered gradually, scissile, watery purplish umber, fading to dark avellaneous, odor and taste slightly but distinctly raphanoid; lamellae "purple-drab" (dull purplish) young, "Rood's brown" to "Vandyke brown" at maturity (dark testaceous), distant to subdistant, 25–30 reach the stipe, 2 tiers of lamellulae, bluntly adnate, very broad (10–15 mm.), edges even; stipe 7–9 cm. long. 8-12 mm. thick at apex, slightly enlarged downward and then tapered to the tip of the base, solid, the apex dull purplish (like the gills), also purplish in the cortex, duller in the central portion, surface purplish gray above, base sordid purplish brown, thinly fibrillose from grayish fibrils, cortina scanty and grayish, sometimes leaving a faint apical zone, with a matted sordid purplish mycelium around the base.

Spores $8–10 \times 5–6.5\mu$, broadly ellipsoid, roughened, fuscous brown in KOH; basidia four-spored, content pale fuscous brown in KOH; pleuro- and cheilocystidia not seen; gill trama regular, walls with an incrusted fuscous brown pigment; pileus trama with the cells of the upper region slightly enlarged, all with dull fuscous brown incrusting pigment.

Gregarious under spruce, Forks, Wash. June 18, 1939 (14,425).

Observations: This species is very similar to *C. adustus* in appearance, but lacks a universal veil and no purplish tints were noticed in the trama of the gills or pileus when mounts were made in KOH. Quélet (1873) and Ricken very appropriately compared *C. cypriacus* to *C. impennis*. The similarity is striking. In several characters collection 14,425 differs somewhat from *C. cypriacus* as described in most European manuals. There is a matted sordid purple mycelium around the base of the stipe, the gills are more distant, and the spores slightly smaller. In fact my collection appears to be intermediate between *C. saturninus* and *C. cypriacus* sensu Ricken. *C. saturninus* Fr. sensu Henry (1938a) differs in its more convex pileus, the presence of clusters of cheilocystidia on the gills, slightly larger spores and habitat. Henry has given the name *C. subsaturninus* to the species Kauffman recognized as *C. saturninus*.

CORTINARIUS FASCIATUS Fr. sensu Lange, Flora Agaricina Danica 3: 50. Pl. 104. fig. D. 1938.

Pileus 10–20 mm. broad, sharply conic to cuspidate young, becoming conic campanulate to nearly plane but retaining a sharp conic umbo, surface glabrous or with a few fibrils along the margin from the cortina, glabrous and hygrophanous, color "auburn" (dull chestnut brown) over all, the margin translucent-striate, fading to "clay color" (sordid yellowish brown but pale); flesh thin, concolor with pileus, odor none, taste not recorded; lamellae "auburn" when young, becoming paler and near ochraceous tawny at maturity (paler and more yellowish), rather broad (2.5 mm.), ascending adnate to hooked, close to subdistant, edges even; stipe 2–3 cm. long, 1.5–3 mm. thick, equal, with a few scattered fibrils from the cortina but soon glabrescent, concolorous with the pileus (dull chestnut brown) or apex paler.

Spores 7–9(10)×4.5–5μ, slightly inequilateral, pale yellowish brown under the microscope, roughened; basidia four-spored, purplish-fuscous in KOH; gill trama of enlarged cells the walls with purplish fuscous incrusting pigment; pileus trama homogeneous, all cells greatly enlarged, their walls with a purplish fuscous incrusting pigment (when revived in KOH).

Gregarious to subcespitose on soil in the trail up Mt. Angeles, Olympic Mts. Wash. Sept. 29, 1941 (17,432).

Observations: This species appears merely unpolished when faded instead of distinctly fibrillose as in *C. acutus* and has much darker colors in all parts. The two are very easily distinguished in the herbarium by the color of the gill and pileus trama when revived in KOH.

CORTINARIUS IRREGULARIS Fr., Epicrisis Syst. Myc., p. 310. 1836.

Pileus 4–10 cm. broad, obtuse to convex, in age umbonate to plane, the margin inrolled at first, the disc slightly depressed in some, surface with patches of grayish fibrils near the margin, moist but opaque, hygrophanous, evenly "liver brown" (deep reddish brown) young, fading slowly to "Kaiser brown" (deep ferruginous); flesh thick on disc (1–2 cm.), tapered abruptly near the margin, dark watery brown moist, dull buff when faded, odor none, taste mild; lamellae "avellaneous" or a bit duller and darker when young, becoming "cinnamon-brown" at maturity, broad (10–12 mm.), adnexed, relatively close, 3 tiers of lamellulae, edges even; stipe 4–6 cm. long, 10–15 mm. thick at apex, equal or slightly enlarged upward, solid and dull watery brown within, fading to a paler brownish buff, surface with a thin fibrillose coating, soon glabrous, silky at apex, dull watery brown but with pallid streaks.

Spores $8\text{-}10 \times 4.5\text{-}5.5\mu$, subellipsoid (slightly inequilateral) ochraceous tawny under the microscope; basidia four-spored; gill trama regular, pallid brownish in KOH; pileus trama homogeneous, pale sordid brown in KOH.

Gregarious under spruce, near Payette Lakes, Idaho, Aug. 6, 1941 (16,035).

Observations: This species can be distinguished from *C. glabrellus* Kauff. by its larger spores and habitat under conifers. The dark ferruginous pilei are in strong contrast to the color of the young gills. It appears to be close to *C. duracinus* sensu Rea but differs markedly in the characters of its stipe. *Hydrocybe pateriformis* (Fr.) Ricken is also close but is characterized by deep saffron yellow gills and smaller spores. *H. tortuosa* (Fr.) Ricken is a smaller fungus with lilac tints in the apex of the stipe. It is supposed to have gills which stain red when bruised, but Ricken had not observed such a change. *C. irregularis* is said to have a reddish or brick red stipe (beneath the fibrils). My material differed in this respect, but the remainder of the characters appear to place it here. Ricken describes the habitat as in dry mountain conifer forests, a very appropriate description of the habitat of the Idaho collection.

CORTINARIUS PULCHER Pk., Ann. Rep. N. Y. State Mus. **26**: 63. 1874.

Hydrocybe nana Killerman, Denkschrift. Bayer Bot. Ges. Regensburg, Neue Folge, **18**: 67. 1928.

Pileus 10–15 mm. broad, sharply conic campanulate young, plane with a sharp conic umbo in age, the margin exceeding the gills and connivent to the stipe at first, surface glabrous, polished and lubricous but lacking a gelatinous pellicle, translucent striate, evenly "tawny" to "ochraceous tawny" or the margin a little paler, hygrophanous and fading to pale ochraceous; flesh thickish in the umbo, elsewhere membranous, yellowish brown and watery, odor and taste not distinctive; lamellae "ochraceous tawny" or with a more rusty cast in age, close, 21–24 reach the stipe, 1–2 tiers of lamellulae, broad (3 mm. ±), tapered to the margin, bluntly adnate but readily seceding; stipe short, 3–3.5 cm. long, 2–2.5 mm. thick, equal, solid, fragile, concolorous with pileus, at first with a faint superior evanescent fibrillose zone from the remains of the thin white cortina, soon entirely glabrous and polished.

Spores 6–7.5×4–4.5μ, very slightly roughened, ellipsoid, rusty brown under the microscope; basidia four-spored, pale rusty brown in KOH; pleuro- and cheilocystidia none seen; gill trama parallel or nearly so, rusty brown in KOH; pileus trama also rusty in KOH; made up almost entirely of inflated cells.

Gregarious under brush, Mt. Angeles, Olympics, Wash. Oct. 10, 1941 (17,757).

Observations: The lack of cheilocystidia distinguished this species from the various members of Naucoria and Galerina as well as certain small Cortinarii. *C. Junghuni* appears to be closest but most authors describe its stipe as thicker, and Rea indicates that its cap is quite reddish. Lange described *C. Junghuni* as having cheilocystidia and lacking striations on the pileus. My material has narrower spores than indicated by Ricken in addition to a polished glabrous pileus. *C. pulcher* appears to be closest to *C. acutus* but the latter is distinguished by its larger spores and silkier pileus when faded. Kauffman (1932) excluded *C. pulcher* on the basis that it probably belonged in the genus Naucoria. My sections of the type did not show cheilocystidia and the spores were typical of Cortinarius. The sections were revived in Lactophenol. The color of the stipe as described by Peck is "whitish or pale ochraceous." However, this discrepancy does not appear significant. The stipe may appear whitish at first from the remains of the cortina.

Hydrocybe nana Killerman apparently is very similar if not identical with Peck's species. It is described as having a reddish brown cap and a weak odor whereas Peck's species is said to be ochraceous and become pale ochraceous and no odor is mentioned. Killerman referred to Saccardo (1894) pl. no. 31 as representing the color of *H. nana*. When this is compared with "tawny" of Ridgway, it becomes apparent at once that the colors of Killerman's specimens and my collection instead of being different are strikingly similar. It is impossible to make an accurate interpretation of Peck's use of the term ochraceous, but we can make a comparison. Peck described *C. sphaerosporus* in the same article, and stated that its cap was pale ochraceous. By Ridgway's system this is somewhere between "straw yellow" and "antimony yellow" and very close to the faded colors of my specimens. The term ochraceous as commonly used refers to a yellower color than ochraceous tawny but the difference in this instance hardly appears sufficient to justify recognizing a species with it as the deciding character. It appears much more likely that Killerman's material was not faded when collected and that Peck's was at least partly faded.

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Vanilla: Its History, Cultivation and Importance

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The most important and famous flavoring substance, or spice, which the Americas have contributed to the world is vanilla. This is, today, the favorite flavoring material in the United States, where normally about one million pounds of vanilla beans are consumed annually. Since vanilla is a tropical crop, the United States is entirely dependent upon other regions for this natural product. Climatic and edaphic conditions in Puerto Rico, however, are congenial to the vanilla plant, and experience there has shown that the island is potentially capable of supplying most, if not all, of this essential flavoring substance for our domestic needs.

THE PRODUCT AND ITS SOURCE

Vanilla is obtained primarily from the fully grown, but unripened, fruits of a climbing orchid, *Vanilla planifolia* Andrews (*V. fragrans* (Salisb.) Ames), which have been subjected to a fermentation-curing process to produce the characteristic aroma which makes this flavoring so valuable. The finished product is an extract from vanilla fruits (beans), blended with alcohol, pure water, some glycerin and, in some cases, sugar.

The substance chiefly responsible for the peculiar fragrance and flavor of the vanilla bean is *vanillin* ($C_8H_8O_3$). This was first isolated from vanilla by Gobley in 1858. He found that the so-called "givre" of vanilla was due to vanillin crystals and not to benzoic acid as was then believed to be the case (5). Vanillin is a relatively simple substance which has been synthesized on a commercial scale from coniferin, eugenol and other sources. The cured vanilla beans, however, have an aroma and flavor not fully duplicated in synthetic vanillin, and the occurrence of other subsidiary substances, including at least one strongly aromatic ester (16), is the decisive factor in favor of the use of natural vanilla as a flavoring.

Free vanillin is not present in the beans when they are harvested. It is developed as a result of enzyme action on several glucosides, either during the natural ripening of the beans on the vines, or by a curing process. White needle-shaped crystals of vanillin accumulate on the outside of the beans when they are stored in bundles after curing. The crystals are 0.5 to 1 cm. in length. Additional vanillin occurs dissolved in a dark brown oleo-resinous secretion surrounding the seeds in the center of the bean (16). The vanillin content of the beans has been found to vary according

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to where they are grown, from 1.5% in Mexico to 2.7% in Java. First quality Bourbon beans contain about 2.3% vanillin.

The percentage of vanillin content, however is not necessarily proportional to the quality of the beans and does not determine their ultimate value, nor are the most strongly aromatic beans always those with the highest vanillin content. As noted above, the subsidiary substances inherent in the fruit influence greatly the aroma of vanilla. Besides vanillin, the beans are known to contain vanillic acid, which is odorless, about 11% of a fixed oil, 2.3% of a soft resin, sugar, gum and oxalate of lime (7), as well as some wax, fat, coloring matter and mineral constituents. The composition of vanilla is not yet completely understood, vanillin being the only constituent whose chemistry has been thoroughly investigated.

Vanilla is a tropical genus of the family Orchidaceae. About fifty species have been described, only three of which (*V. planifolia* Andrews, *V. pompona* Schiede and *V. tahitensis* J. W. Moore) are of commercial importance as sources of vanilla. With the exception of those orchids grown and sold in the floral industry for the beauty and singularity of their flowers, these species of *Vanilla* are the only orchids of any real economic importance.

Vanilla planifolia, the principal source of vanilla, is a coarse vine that, in nature, climbs to the top of tall trees. The plant may be briefly described as follows: Stem simple or branched, long, flexuous, succulent, green, producing opposite the leaves twining adventitious aerial roots by which it clings to trees and other supports; leaves succulent, nearly sessile, oblong-elliptic to narrowly lanceolate, acute to acuminate, 9 to 23 cm. long, 2 to 8 cm. wide; racemes axillary, consisting of as many as twenty or more flowers which are greenish yellow and inconspicuous; flowers composed of three sepals, three petals and a central organ known as the column (the united stamen and pistil), with one of the petals modified and enlarged to form the lip; sepals and petals almost linear to oblong-oblanceolate, obtuse to subacute, 4 to 7 cm. long, 1 to 1.5 cm. wide; lip trumpet-shaped, attached almost to the apex of the column which it envelops, somewhat 3-lobed above, 4 to 5 cm. long, 1.5 to 3 cm. wide at the widest point, with longitudinal verrucose lines or papillae on the disc and a tuft of hairs about the middle of the disc, retuse at the apex and irregularly fringed on the revolute margin; column hairy on the inner surface, about 3 cm. long; fruit a capsule (commercially known as a "bean"), narrowly cylindrical, 1 to 2.5 dm. long, 8 to 14 mm. in diameter.

This species, the true vanilla of commerce, is now thought to be indigenous to southeastern Mexico, Guatemala, British Honduras, Honduras, Nicaragua, Costa Rica, El Salvador, Panama, the West Indies, Colombia, Venezuela, Surinam, British Guiana, French Guiana, Ecuador, Peru and Bolivia. It occurs as a non-persistent waif in Florida and probably in most of the tropics and subtropics of the world. It is widely cultivated.

Vanilla pompona is a less important source of natural vanilla. It is known as vanillon, South American, West Indian or pompona vanilla and produces shorter, thicker beans. It resembles *V. planifolia* except that its leaves are larger, being 15 to 28 cm. long and 4 to 11.5 cm. wide. The green-yellow flowers are larger and more fleshy, and the lip has a tuft of imbricating scales, instead of hairs, in the center of the disc. The beans are cylindrical and more fleshy-thickened, being 15 to 17.5 cm. long and 2.5 to 3.3 cm. in diameter. They are inferior in quality and, consequently, command a lower price.

This species is indigenous to southeastern Mexico, Central America, Trinidad and northern South America. It is cultivated primarily in Guadeloupe, Dominica and Martinique. Attempts to cultivate it have been made in other parts of the world, but little is known regarding the results.

Vanilla tahitensis, the Tahiti Vanilla, differs from *V. planifolia* in having more slender stems, narrower leaves, longer perianth segments, a lip that is shorter than the sepals and shorter pods. The reddish-brown beans are 12 to 14 cm. long, up to 9 mm. in width, broad in the middle and tapering toward either end.

This species is indigenous to Tahiti. It is cultivated there and in Hawaii.

Several other species of Vanilla, concerning which there is little information available, have possibilities of producing vanilla for commerce. According to Rolfe (15), Gardner commented in collecting *V. Gardneri* Rolfe, "This is the plant which yields the Vanilla (Banilha of the Brazilians) in Brazil." This species is thought to be the source, to some extent, of what is known in commerce as "South American Vanilla."

The fruits of *V. appendiculata* Rolfe, from British Guiana, are said to retain a distinct aromatic odor for twenty-five years or more after having been collected (15), and the beans of *V. phaeantha* Reichb. f., which has been cultivated in some places in the West Indies, possesses some perfume. Presl, in describing *V. odorata*, from northern South America, noted that although the fruits had been collected thirty-six years previously, they still retained their aromatic fragrance. Rio vanilla, said to be obtained from *V. palmarum* Lindl., in the province of Rio de Janeiro, Brazil, and Guiana vanilla, said to be obtained from *V. guianensis* Splitgerber, are, at most, products of inferior quality. It is quite possible that these poorly known and apparently less valuable vanillas are used as adulterants of the true Mexican vanilla, *V. planifolia*. The vanillon, *V. pompona*, is commonly used for this purpose. In Mexico, the Indians are said to eat the fruits of a wild vanilla, known to them as "vanilla plátano," which is reported to be a smaller plant with larger leaves than *V. planifolia* (6). The botanical identity of this plant is unknown.

HISTORY AND DISTRIBUTION

The history of vanilla is replete with adventure and romance. Bernal Diaz, a Spanish officer under Cortez, was perhaps the first white man to take note of this spice when he observed Montezuma, the intrepid Aztec emperor, drink "Chocolatl," a drink prepared from the pulverized seeds of the cacao tree, flavored with ground vanilla beans, which the Aztecs call "tlilxochitl," derived from *tlilli*, meaning "black" and *xochitl*, interpreted here as meaning "pod."* Vanilla beans were considered to be among the rarer tributes paid to the Aztec emperor by his subject tribes. Cortez was subsequently introduced by Montezuma to his first cup of chocolate, served according to legend in golden goblets, with spoons of the same metal; but the Aztecs jealously guarded their secret—the flavoring principle of the drink. After the vanilla ingredient was finally discovered the Spaniards imported vanilla beans into Spain about 1510, where factories were established as early as the second half of the sixteenth century for the manufacture of chocolate, flavored with vanilla. Thus, vanilla may be considered a by-product of the Spanish Conquistadors' search for the hidden wealth of the Americas; a by-product which is today one of the most important of the minor extractive industries in Mexico.

Bernardino de Sahagun, a Franciscan friar, who arrived in Mexico in 1529, was perhaps the first to write about vanilla when he stated that the Aztecs used "tlilxochitl" in cacao, sweetened with honey, and that they sold vanilla spice in their markets. His work, "Historia General de las Cosas de Nueva España," originally written in the Aztec language, was not published until 1829–30, in Mexico—three hundred years after Sahagun's arrival in that country. The first observation of botanical interest was made by Carolus Clusius, in 1605, in his "Exoticorum Libri Decem," (p. 72), where he described and gave the name *Lobus oblongus aromaticus* to some dried vanilla beans which he had received, in 1602, from Hugh Morgan, apothecary to Queen Elizabeth. These beans were considered to be fruits of *V. planifolia*, the true Mexican vanilla, although nothing seems to have been known of their native country or uses. This same Morgan was the first European to suggest vanilla as a flavoring in its own right, a fact already known to the Aztecs.

In 1571–77, Francisco Hernandez was sent on a mission to Mexico by Philip II, of Spain. While in Mexico, Hernandez became an authority on vanilla and in his work noted above, first published in Rome in 1651, he not only described and named the plant, *Araco aromatico*, but he figured a vanilla branch with leaves and two beans growing upon it (p. 38). He

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* In the 1651 edition of Hernandez' work (Rerum Medicarum Novae Hispaniae Thesaurus) this name was correctly interpreted to mean "black flowers." The flowers of this species, however, are greenish yellow in color. This fallacy concerning the color of the vanilla flowers remained in literature for many years.

also recorded its native name as "tlilxochitl" and noted that it was held in high esteem by the Mexicans, not only for its pleasant taste and aroma, but because of its supposed healing qualities. A few years later, in 1658, Willem Piso wrote that, because of their fragrance, the Spaniards used the beans, which they called "vaynilla," meaning "little pod," as an ingredient in the manufacture of chocolate (Historiae Naturalis et Medicae Indiae Orientalis, p. 200). This is supposed to have been the first use of the word "vaynilla," from which the scientific name of the genus is derived. Francesco Redi, in 1675, studied some dried fruits of vanilla under a microscope and described the fruit and seeds (10). William Dampier, in his "A New Voyage Round the World," gave some valuable information about vanilla plants which he had observed growing, in 1676, on the Bay of Campeche, in southern Mexico, and, in 1681, at Boca-toro, in Costa Rica. He stated that the beans were collected by the Indians who sold them to the Spaniards. He also described the method of curing the fruit.

The generic name, Vanilla, was first used in 1703, when Plumier (Nova Plantarum Americanarum Genera, p. 25, pl. 28) enumerated three species from the West Indies, but failed to include the Mexican plant, *V. planifolia*. The genus, Vanilla, was not definitely accepted until 1799 when Swartz distinguished two species, *V. aromatica* and *V. claviculata*.

The nomenclatural status of the vanilla of commerce has never been definitely settled to the satisfaction of all botanists. According to Rolfe (15), the monographer of the genus, "The Mexican *Vanilla* had been introduced to cultivation prior to 1739,* when the second edition of Miller's 'Gardener's Dictionary' was published, but appears to have been again lost. It was, however, re-introduced by the Marquis of Blandford and flowered in the collection of the Right Hon. Charles Greville, at Paddington, prior to 1807, in which year a flowering specimen was figured and described by Salisbury under the name of *Myobroma fragrans* (Parad. Lond., 't. 82), and a year later Andrews published another figure as *Vanilla planifolia* ('Bot. Rep.,' viii. t. 538). Both of these authors wrongly identified the plant with a West Indian species, and both equally failed to recognise in it the true Mexican *Vanilla* of commerce, whose flowers were now figured for the first time."

It is interesting to note that the same plant which flowered in 1807 also produced fruits, at which time Bauer, the famous illustrator, prepared a drawing of the plant showing a fresh fruit. This is the first record of a vanilla fruit having been produced in Europe. How the flower was pollinated and became fertilized is not known.

Among the principal early authors who described vanilla in its native

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* The second edition of Miller's "Gardener's Dictionary" was published in 1733.

habitat may be mentioned Fusée Aublet who, in 1775 (Histoire des plantes de la Guiane Françoise 2, Mém. 4, pp. 77–85), not only recorded the methods of cultivation and curing of the fruits, but gave an account of three kinds of vanilla, typified by large, small and long beans, found in the vicinity of Cayenne, French Guiana. Humboldt, in 1811 (Voyage de Humboldt et Bonpland 2, pt. 3, p. 437), also gave an interesting account of the culture and preparation of vanilla in the State of Veracruz, Mexico.

Although Vanilla as an article of commerce was introduced into Europe as early as 1510, it did not appear permanently in horticulture until the beginning of the nineteenth century when, as noted above, in 1807, it gained attention after having flowered and fruited in the collection of Charles Greville.

For more than two centuries Mexico and other regions where *V. planifolia* is indigenous were the only commercial sources of vanilla since only in these regions was it possible to obtain fruits. Because of the unique adaptation of the flowers of orchids to insect pollination, only the bees in the regions where the plant grew naturally were apparently able or inclined to pollinate the flowers effectively. The dependence upon, and lack of, such specific pollinating agents retarded for some time the introduction of the plant as a plantation crop into other regions of the world congenial for its growth.

An effort was made to establish vanilla in Java in 1819 when two plants were dispatched to Buitenzorg from the Botanic Garden at Antwerp. Only one of these plants, however, survived the voyage and subsequently, in 1825, produced flowers, but no fruits. Later, in 1846, vanilla cultivation on a systematic plantation basis was established in Java.

In 1836, Charles Morren, of Liége, established the identity of the true vanilla of commerce as *V. planifolia*, and obtained two large crops of vanilla beans by pollinating the flowers artificially by hand. He attributed the failure of the plants to produce fruit in the eastern hemisphere to the absence of the particular insect or insects which pollinated the vanilla flowers in their native regions. In 1838, Morren's achievement was repeated by Neumann of the Muséum d'Histoire Naturelle in Paris, and several years later, in 1841, a former slave, Edmond Albius, in Réunion, discovered a practical method of artificial pollination which is used to this day.

This discovery of a method of artificially pollinating the flowers of vanilla, combined with the possibility of propagating the plants by cuttings, opened the way for its cultivation as a plantation crop on a large scale in the eastern tropics. Madagascar, which normally produces one half or more of the supply of vanilla beans grown in the world, is the most important area. Vanilla is also grown successfully, to a greater or lesser degree, in Réunion (Bourbon), Mauritius, the Seychelles Islands, Zanzibar, French Congo, Congo Independent State, Cameroons, Sierra Leone, Lagos, San Thomé, Comoro Islands, Ceylon, Java, the Society Islands and the Fiji Islands. It has not been too successful in Hawaii, the Philippine Islands, India, Cochin-China or the Malay Peninsula.

The history of the gradual but universal spread of the vanilla of commerce throughout the tropics of the world is meagre and, for the most part, unreliable. According to Ridley (14), vanilla was first introduced into Réunion in 1793, but its cultivation did not become important until after the sugar cane-failure between 1849 and 1856, and did not attain large proportions until about 1874. From Réunion, the plant was introduced into Mauritius, and, about 1840, into Madagascar.

Vanilla was introduced into India in 1835, but it was allowed to die out after flowering. Some years later it was again brought to India where it produced fruit, but its cultivation has never progressed in that country. Vanilla is said to have been introduced from Manila to the island of Tahiti by Admiral Hamelin in 1848 and it soon developed into a major industry. An unsuccessful attempt was made in 1852 to introduce the plant into the French Congo. It was successfully reintroduced in 1873, but its cultivation has not spread very rapidly. Vanilla growing was started in the Seychelles Islands about 1890, and cultivation in the Comoro Islands was begun in 1893 and very soon spread throughout these islands. By 1886, vanilla production was greater in the Mascarene Islands (Réunion, Mauritius, Rodriguez) and Java than in Mexico (11).

As may be noted from the above, the French, more than any other nation, have developed the vanilla industry in their overseas possessions. Soon after its introduction into Spain, vanilla was replaced by cinnamon as a flavoring for chocolate. In France, however, it remained the favorite and eventually it came to be used in perfumes, confections and ices. In recent years the French Colonies have produced approximately three fourths of the vanilla beans of commerce, and more than 20,000 persons are said to be engaged in this occupation.

Vanilla planifolia is also cultivated extensively in the western tropics, and some wild beans are harvested in regions where the plants are indigenous. Mexico and the French West Indies are important producing areas, and Puerto Rico shows great promise for future expansion of the industry.

According to Mallory *et al.* (11), the Totonoco Indians of Mexico, one of the three tribes who were supposed to grow vanilla for the Aztecs, were among the first to pledge allegience to Cortez and consequently were left undisturbed in the private ownership of their individual tracts. Today vanilla culture in Mexico is carried on almost entirely within their lands. This area lies for the most part on the first rising ground on the coastal plan of the Gulf of Mexico in southeastern Mexico. About 10,000 Indians in this region are said to produce most of the vanilla exported from Mexico. The skill and thrift of the Totonoco Indian make him a prime factor in the Mexican vanilla industry. He is a good bargainer and demands payment in silver which he may bury in the ground (11). He is also said to control the production of the beans, increasing or reducing his crops with the rise and fall in prices. The beans are generally sold to the larger export houses or to their traveling agents.

The most important vanilleries (vanilla plantations) in Mexico are in the states of Veracruz and Puebla. In Veracruz, the most productive ones are located in the vicinity of Papantla, Misantla and Jalacingo, south of Tuxpân, which is the principal port of embarkation. In Puebla, the vanilleries are located primarily at Tetela and Ocampo. These two states produce about 98% of the vanilla in Mexico. The rich volcanic soils and the climatological factors combine to make this area perhaps the ideal region in the world for vanilla culture. Most of the plantations are at an altitude of about 1,000 feet above sea level.

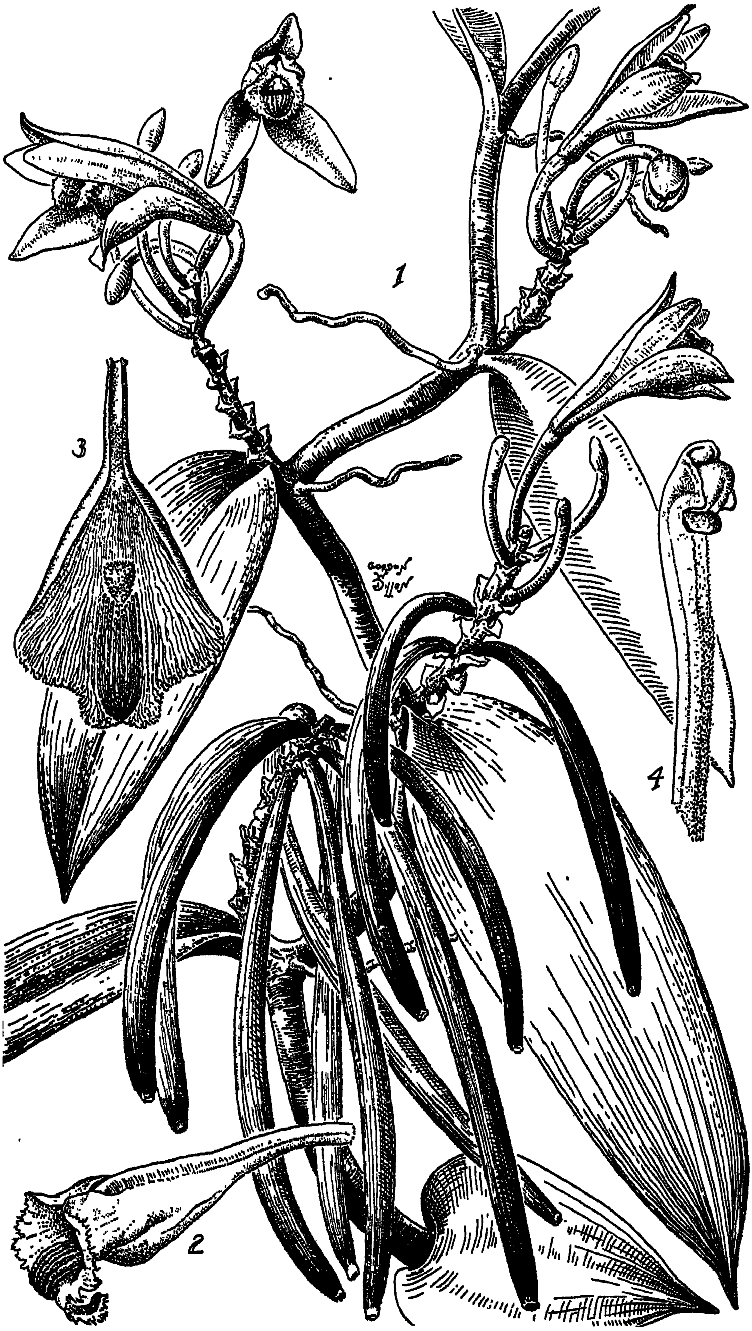
Other vanilleries of minor importance are found in the states of Chiapas, San Luis Potosi, Oaxaca, Tabasco and Michoacan. In 1920, it was estimated that more than 50,000 persons were employed in Mexico in the cultivation, handling and extraction of vanilla.

In Guatemala, the Indians of Vera Paz are said to collect some wild vanilla in the woods along the banks of the Polochia River, and in the forests northwest of Cobân (7).

USE AND ECONOMIC IMPORTANCE

Vanilla is today one of the world's most important flavoring materials. Since its early advent into Europe about the year 1510 (15), it has competed strongly and successfully with other spices in the world's markets, and as late as 1908 at least three times as much vanilla as all other flavoring materials was said to be consumed annually (13).

Vanilla beans, as mentioned above, were used by the ancient Aztecs of Mexico and Central America for flavoring chocolate long before the arrival of the Spanish conquerors. When first introduced into Europe, vanilla was used primarily as a flavoring for chocolate or as a tobacco perfume. Early explorers of tropical America, however, extolled its medicinal virtues and vanilla soon became an important drug, its reputation as an aphrodisiac being widespread. Belief in the medicinal properties of vanilla was strong during the sixteenth century; as early as the beginning of the seventeenth century it was given a place in the German pharmacopoeia, and in 1721 it had a place in the London Pharmacopoeia (16). The use of vanilla as a medicine waned during the latter part of the eighteenth century, and by the end of the nineteenth century, for all practical purposes, it was eliminated as a drug. It is still used to some extent, however, in



FIGS. 1–4. *Vanilla planifolia.* 1, habit, ×½; 2, lip, in natural position, side-front view, ×1; 3, lip, spread open, ×1; 4, column, side-front view, ×2. Drawn by Gordon W. Dillon.

medicine mainly to flavor otherwise distasteful elixirs and certain medicinal solutions.

It is interesting to note that at the height of its exploitation as a drug, physicians propounded various theories concerning the supposed therapeutic effects of vanilla which today seem ridiculous. One medical flora stated that " . . . vanilla exercises a powerful action on the animal economy, and justifies the attributes of tonic, stimulant, and comforting, which are accorded it. The truly active and strong impression which it makes on the nervous system by its fragrant aroma, and on the stomach when taken internally, is rapidly and sympathetically transmitted to all the organs, the functions of which it more or less accelerates. Hence, when the system is lowered, vanilla facilitates digestion and nutrition, augments the cutaneous transpiration or the secretion of urine, and acts as a tonic in various other ways. It is recommended in cases of dyspepsia, melancholy, hypochondria, and chlorosis, where the digestive functions are sluggish or torpid." (7)

On the continent of Europe, vanilla was also at one time used in hysteria, low fevers, impotency and rheumatism, and was thought to prevent sleep and "increase the energy of the muscular system." It was used by Spanish physicians in America to cure various maladies, being considered a strong stimulant and stomachic, and as an antidote to poison and to the bite of venomous animals (1).

In Mexico, home of the vanilla, very few of the natives who work in the industry are said to taste vanilla, because they have developed the impression that it possesses properties which cause it to act injuriously upon the nervous system (7). In fact, only a very small amount of the natural product is used in Mexico. Instead, artificial vanilla, which costs only a fraction of the price of pure vanilla, is imported for national consumption. This condition is doubtless, at least in part, the result of vanilla being a highly remunerative crop for export and not necessarily because of any antipathy to the bean.

Since vanilla beans yield a fine brown color, they were at one time thought to be a possible source of dye. During the last century the Germans unsuccessfully experimented with the beans for this purpose.

Vanilla is by far the most popular flavor at the present time in the ice cream, baking and chocolate industries of the United States. It is chiefly used as a flavoring of chocolate, beverages, confections, cakes, custards, puddings, ices, ice cream, and in the manufacture of soaps, perfumes and sachet powders. When added to the heavy oriental varieties of perfume, vanilla extract makes the odor more delicate. Vanilla is ordinarily used in the form of an extract from the beans. In the manufacture of chocolate, however, the beans are usually ground finely with sugar and included with the chocolate. One bean is considered sufficient to flavor 1½ pounds of chocolate. Some chefs still insist on using the bean, itself, in the food to be flavored instead of using the extract. Since the vanilla essence is known to be more volatile at high temperatures, there is perhaps some justification for this rather expensive practice.

The statistical data concerning vanilla are not too satisfactory or reliable, whether they concern the amount of vanilla grown throughout the world, consumed *in situ* or exported, or the proportions utilized in the manufacture of various products. The United States normally imports about four fifths of its vanilla beans from sources outside the western hemisphere, principally from France and its colonies. In 1939, the United States imported more than one million pounds, valued at one and one half million dollars. Three fourths of these imports came from France or directly from Madagascar and other French colonies. In recent years, vanilla beans have been second only to coffee in export value from Madagascar. Mexico, the source of beans of best quality, provided 270,000 pounds. Imports into the United States in 1940 exceeded those of 1939, but since that time the source of supply has been cut off, the importation of vanilla beans has been greatly reduced, and the stock pile of beans has been greatly diminished.

In 1920, Cunningham (6) wrote, "Because of the fact that the United States buys most of the vanilla of Mexico the dollar is the basis of price, both for buying and selling. The price paid at the plantation varies from $2.50 to $3 per pound, while the price in Vera Cruz is about $3.50 per pound. The New York price is about $4.50 per pound, with duty paid. Mexico levies an export duty of 1 peso per kilo plus a surtax of 10 per cent. These have been the ruling prices for 40 years."

However true the above may be, the price of vanilla beans apparently remains in a state of flux, not only in Mexico but also in other regions. In 1900, Mexican beans sold for about $9.00 per pound (13), and in 1939 they sold for approximately $4.00 per pound. Because of its overwhelming production of good quality beans, Madagascar sets the price of this product during normal times. In 1942, Madagascar was said to have had a two years' supply of beans in storage for shipment to foreign markets. As much as $250.00 per pound is supposed to have been paid for vanilla beans at one time (7). There are so many factors which influence prices that they can not be considered a true index of quality.

In 1942, Mallory *et al.* (11) wrote concerning Mexican beans, "In 1941, vanilla returned to its value in the days of the Spanish Conquest when it nearly equaled its weight in silver. In January 1941 it was $9.25 a pound; today it is $16." During the same year Madagascar beans, when obtainable, were selling at $13.00 and $14.00 per pound. In the meantime, the prices have been lowered and stabilized. Today, Mexican, West Indian and Bourbon first quality beans sell for $10.00 and $11.00 per pound in the markets of the United States.

HORTICULTURE

The horticultural technique of growing vanilla is essentially the same wherever the plant is cultivated. The usual procedure is to select a suitable location, clear the land of all trees and shrubs except such as may be desirable supports for the vanilla plants to climb upon, prepare the soil, plant or erect mechanical supports for the plants to grow upon, plant shade trees and arrange a wind-break if this is necessary, obtain and plant the vanilla cuttings, train the plants over the supports used, keep the vines and living supports properly trimmed, watch for parasites and destructive diseases, see that the flowers are correctly pollinated at the right time, select and retain only the desired number of fruits to be allowed to mature, and finally harvest the crop which then has to be cured. A great amount of individual attention has to be given the plants. Consequently, this will limit the size of the plantation which can be maintained at a highly productive and profitable level. Since vanilla is a crop that requires constant attention, everything possible should be done to facilitate the work. If the plantation is at the start planned and set out in an orderly manner many unnecessary future expenses, as well as loss of time and labor, will be avoided.

In nature, *V. planifolia* is commonly found climbing on trees in swamps, wet thickets and in mixed forests in low country. It seems to do well from sea level up to about 2,000 feet altitude and may even be found at 3,500 feet in Mexico. To thrive and be most productive, the plant requires a hot, moist tropical climate with frequent but not excessive rains. Arid conditions and violent winds are detrimental to the plant. Like so many other spices, vanilla is most successfully grown on islands or in littoral regions having an island climate, and with the exception of those in Mexico, all of the larger plantings are to be found on islands. A climate like that found in southeastern Mexico, the Mascarene and Seychelles Islands, the West Indies, Tahiti and Fiji has proved to be ideal for the cultivation of vanilla. In these regions the temperature varies from about 70° to 90° Fahrenheit, with an average temperature of about 80°. The annual rainfall is approximately 80 to 100 inches and is more or less evenly distributed throughout the year, with the atmospheric humidity always high. The ideal situation concerning precipitation is to have an even distribution of rainfall through ten months of the year for continuous luxuriant growth of the plants and the production of large fruits, with the remaining two months relatively dry so as to check vegetative growth and bring the vines into flower. Regularity of the proper climate is a most important point to be considered in the cultivation of vanilla, since temperature and humidity, and various other ecological factors, are thought to affect the quality of vanilla—its aroma and potency.

If climatic conditions are suitable for growing vanilla, other factors which must be considered in developing a vanillery are the terrain and soil. Level land which allowed stagnation of water about the vanilla roots should be avoided. Likewise, too steep a site should not be selected since erosion may seriously affect the plants, and such a location will also add to the difficulty of attending to the plants. If the only available land slopes steeply it should be terraced before the vanillery is planted. The ideal site, as noted above, is a gently sloping hill which allows adequate but not excessive drainage, permits the maintenance of a leaf mulch at all seasons, and will not interfere with the cultivation of the vanillery. Any soil which is light, porous and friable, easily penetrated by the roots of the plant, and abundantly supplied with decaying vegetable matter appears to be suitable for vanilla.

Since the roots of vanilla are mostly confined to the surface or humus layer, it is a good practice to maintain a thick layer of humus. In a test, McClelland (13) found that root development was 85% greater in leaf-mold than in soil. Also, the new vine growth was found to be considerably greater in leaf-mold than in soil. This emphasizes the necessity of keeping the vines continually supplied with a heavy vegetable mulch. In clearing the site all bulky debris should be chopped up and left to decay. This should not be burned over. As is the case with all orchids, animal manures are harmful and should not be used, and since the different vegetative organs of vanilla have been found to contain an exceptional amount of potash and lime, these chemicals should be present (5). The practice of adding burnt earth, lime and vegetable debris to the soil supplements to some extent these chemicals which may already be present. To help prevent erosion and avoid exposing the vanilla roots to the sun and elements, excessive weeding should not be done. Weeds are also an annual source of mulch for the plantation.

When originally developed as a plantation crop, vanilla plants were grown close together with the plants greatly entangled. This intensive culture produced enormous crops and was widely practiced until fungus diseases attacked the vanilleries in Reúnion and other parts of the world. With the vines entwined as they were, it was a hopeless task to extricate the diseased plants from the healthy ones, and many vanilleries were completely wiped out or the plants devitalized to such an extent that they were essentially worthless. Although the yield is less and the cost of maintenance is more per acre, the usual practice today is to place the supports or supporting trees about nine feet apart and grow only one vanilla plant upon each support. In this method there are only 537 vines to the acre and a diseased plant may be easily removed from the vanillery without disturbing the healthy plants. Also, the plantation is easily worked when the plants are grown so far apart. Other methods are to grow the vines five feet apart in rows ten feet apart, giving 871 vines to the acre, or four feet apart in rows eight feet apart, giving 1,361 vines to the acre (13). These closer plantings give a larger early return, but the close spacing of the plants is inconvenient for the workers and the plants are more susceptible to contagious diseases.

In nature, vanilla grows in forests or shrubby land where it has filtered light or partial shade and a support upon which to climb. These conditions should be simulated in the vanillery for best results. However, instead of allowing the vines to grow to great length as they do in the wild state, they must be trained to grow within easy reach of the workers so that the flowers may be pollinated, the vines pruned and the fruits harvested. Various experiments have shown that vanilla plants grown under a light shade are more healthy and produce a larger mass of sturdy vines than those grown in full sunlight or heavy shade. Heavily shaded vines are typically etiolated and spindly, whereas those grown in direct sunlight are yellowish and often burned.

There is no complete agreement among growers as to which is the best support for the vanilla: a living tree, trellises, lattice-work, posts and wire or bars.

Posts are subject to decay and to the ravages of termites, necessitating their being replaced at frequent intervals. In the case of wire or bar supports the tender succulent vines may be easily broken over so thin a support, especially in a strong wind. Where supports other than small trees are used it is always necessary to supply some form of partial shade for the vanilla plants. This is usually accomplished by planting tall, widely spaced trees or banana plants.

Although the type of support depends somewhat on the region where the vanillery is established, the most satisfactory supports are unquestionably small trees. The selection of the tree to be used depends largely on local conditions. In general, however, small-leaved species which permit checkered sunlight to filter through are considered most desirable. Most growers prefer species which grow rapidly in full sunlight and which produce branches sufficiently low (from five to seven feet from the ground) for the vines to hang within easy reach of the workers. The tree should be strong enough to support the vanilla vine even in a strong wind, and should never become entirely defoliated. It should also be possible to propagate it from large cuttings so that the young tree will grow rapidly from the beginning. If possible the trees should be planted a year or more before the vanilla cuttings are set out so that they will have had sufficient time to produce adequate support for the more rapidly growing vines.

The physic nut, *Jatropha curcas* L., a common and widespread small tree, which may be propagated from cuttings, is used extensively as a vanilla support. It also grows rapidly from seeds. In the Seychelles Islands, *Pandanus hornei* Balf. f. and several species of figs, *Ficus spp.*, are commonly used. Some planters in the Seychelles make the soil do double duty by growing vanilla vines on coffee trees. In Mexico, the calabash, *Crescentia cujete* L., and the coral tree, *Erythrina sp.*, are frequently used. The croton-oil plant, *Croton tiglium* L., is used by some growers and is said to be able to withstand winds of hurricane velocity. According to Ridley (14), in the Singapore Botanic Gardens, vanilla was successfully grown on the African oil palm, *Elaeis guineensis* Jacq. This being the case, it may be possible to grow these two tropical crops together since their cultural requirements are similar. In Puerto Rico, bucare, *Erythrina corallodendron* L., and the coral-tree, *E. berteroana* Urban, are well adapted for this purpose and have been widely used. Also, *Bauhinia purpurea* L. and the anatto-tree, *Bixa orellana* L., have been used for supports. Some other trees used in various regions for vanilla supports are the horse-radish tree, *Moringa oleifera* Lam., common screwpine, *Pandanus utilis* Bory, *Dracaena marginata* Lam., dragon's blood, *Dracaena draco* L., yellow mombin, *Spondias mombin* L., coral-tree *Erythrina variegata* Stickm., madura. *Gliricidia sepium* (Jacq.) Kunth, lebbeck-tree, *Albizzia lebbeck* (L). Benth, horsetail-tree, *Casuarina equisetifolia* Stickm., avocado, *Persea ameriana* Mill., India rubber tree, *Ficus elastica* Roxb., cotton tree, *Bombax malabaricum* DC., mango, *Mangifera indica* L., padouk, *Pterocarpus indicus* Willd , *Lagerstroemia floribunda* Jack, jackfruit, *Artocarpus integra* (Thunb.) Skeels, loquat, *Eriobotrya japonica* (Thunb.) Lindl., and cassava, *Manihot esculenta* Crantz. The use of leguminous trees is advisable in that they will help to improve the soil, especially if the land has been depleted by some previous crop.

Although the supporting trees usually provide sufficient protection from sun and wind, they are often inadequate for these purposes before the vines become mature. Tall, quick-growing, wide-spreading varieties of banana are commonly used to provide shade. In Mexico, maize is often grown to shade the young vines. The vines and leaves are succulent and heavy and, if exposed directly to violent winds, they are often badly damaged. If planted on an open hill or along the coast in a region susceptible to strong winds a wind-break of some kind should be planted on the windward side. According to Ridley (14), red hibiscus has been recommended as a hedge for this protection. Any strong, thickly branched, wind-resistant shrub or small tree should be suitable for this purpose.

Although vanilla can be grown from seeds, it is always propagated on plantations by means of cuttings. Various lengths of cuttings are used, the length having a decided influence on the development of the vine. In all cases, the cuttings should be taken from vigorous healthy plants. In Mexico, it is a common practice to use cuttings one foot in length, but cuttings of three or four feet length are often used. In some regions cuttings of six to twelve feet are set out so that the free end may hang over the support. If possible, long cuttings with twelve to twenty-four internodes should be used. The longer cuttings, if planted at the beginning of the rainy season, maintain a continued growth and bear flowers and fruits in one or two years. The short cuttings do not bear flowers and fruits until the third or fourth year. In the Seychelles Islands, during good growing weather—warm, still and moist—growth is rapid and some plants have been observed to grow as much as an inch a day (8). Experiments have shown that growth made by the shorter cuttings is greater in proportion to that made by the longer cuttings. McClelland (13) found that in a twelve months period cuttings with two internodes grew 4.7 feet, with four internodes 7.7 feet, with eight internodes 10.7 feet, and with twelve internodes 16.7 feet. Nevertheless, since the longer cuttings come into bearing much sooner than do the shorter ones it is more economical and profitable, when material is available, to plant long cuttings.

After the surface of the ground has been leveled around the base of the support and a heavy application of vegetable mulch has been added, several nodes of the cuttings are covered by soil or leaf-mold at the base of the support. At least two nodes are left above ground and this portion is trained to the support by being tied in several places to prevent swinging. If the free end is longer it is hung over the supporting branches and tied. Within several weeks the vine lengthens and sends out adventitious aerial roots which cling to the support. If necessary, cuttings may be started in a nursery and removed to the plantation. It is best, however, to start them in the plantations so as to avoid the possibility of disturbing the roots when the plants are moved. According to McClelland (13), it seems to make little difference whether the cuttings are planted immediately or allowed to wilt for twelve or fifteen days. Sometimes the covered portion of the vine will rot away or become diseased, especially the injured basal tip. It has been observed that if the leaves are left on the cuttings to avoid injury by removal and the basal tip of the vine is left exposed to the air to heal over, the cutting usually escapes rot and diseases. In some regions, as Dominica, the vine is merely laid on the surface of the soil and lightly covered with wilted grass after having been secured with two crotched pegs (13). It is advisable to use this method if rotting is prevalent in the plantation.

Once established, a plantation has to be given constant attention. It should be gone over at least every other week so as to train the vines to grow at a convenient level, prune the growing vines and tree supports, watch for diseased plants and parasites, and to keep a mulch over the surface of the ground, especially over the roots of the plant. Cultivation of the ground is not feasible since the roots grow at or near the surface, and any disturbance of the soil would also disturb the roots of the plant. As long as the vine can climb upwards it will not flower. Hence, the tip of the vine is cut off about nine or ten months before the flowering season. The flowers are produced in the axils of the leaves on long, hanging branches. When the plants are in flower they need daily attention. The flowers have to be pollinated and the stalk of the inflorescence must be clipped just back of the remaining buds, or the buds, themselves, should be removed after the desired number of pods are set on each infloresence. This prevents the loss of the plant's vitality in the production of useless blossoms, avoids the pollination of too many blossoms, and saves the pollinator from having to examine superfluous flowers. All undesirable pods should also be removed. After flowering and fruiting, the old stems should be trimmed away. These will be replaced the following year with new and more productive stems. According to Ridley (14), heavy pruning of young stems is very productive, but it shortens the productive life of the plant to two or three years. After pruning, shoots will appear farther back and these are left for the next year's crop.

The vines are said to reach their maximum production about the seventh or eighth year and may, if given proper care, continue to produce for several more years. One author gives forty years as the maximum productive life of vanilla, but this seems unlikely. In Mexico, at the end of three years after planting, a small crop is gathered, and for four or five years the vines continue to increase in size and production. At the end of nine or ten years the vines have lost their commercial value and are abandoned.

To prolong the life of the vines, some growers divide their plantations into four equal parts and pollinate the flowers in only one section each year. This method gives smaller returns at first but a constant yield is maintained over a number of years because of the three years rest that each vine has between each crop. This rest period also tends to keep the vines in a vigorous condition and makes them more resistant to diseases.

Except in Mexico and other areas where the species is indigenous, all beans of *V. planifolia* are obtained by means of hand-pollination. In the regions where it is indigenous, *V. planifolia* is said to be pollinated by bees of the genus Melipona and also by humming-birds (14), which visit the fragrant flowers to obtain the honey secreted at the base of the lip. The insect-pollinated flowers, being cross-pollinated, produce seeds which will germinate and produce plants, whereas those flowers which are hand-pollinated, being self-pollinated, produce seeds which are sterile.

Since only a small percentage of beans set naturally, the Mexicans do not depend entirely upon insect-pollination, but also resort to hand-pollination. In this manner they are able to control the production of beans. "It is thought that families of French extraction living in Nautla introduced manual fertilization into Mexico about 1890 or 1895." (11).

Vanilla planifolia normally flowers but once a year, the flowers being produced in April and May in Mexico and as late as November in some regions. In Guadeloupe, *V. pompona* flowers twice a year, during July and again, during November and December. In some years the vanillon flowers almost constantly, being extremely vigorous.

Since the flowers last only a day, time is a most important factor in working a vanilla plantation. One to three flowers on the racemes open each day and remain open from early in the morning to late in the afternoon. The next morning the flowers are withered. A bright day following rain is considered the best time for pollinating the flowers, and a wet day or a period of extreme drought is not propitious for pollination. Nevertheless, there is no choice. The flowers must be pollinated the day they open. To insure the maximum yield of beans, the plantation should be gone over every day during the flowering season. In Mexico, the thousands of flowers which open must be pollinated within a period of about twenty days. Only those flowers attached to the lower side of the rachis should be pollinated since they will later hang perpendicularly toward the ground to form perfectly straight beans. Those flowers attached to the upper side of the rachis should not be pollinated since they will produce crooked beans of inferior quality and less value, which are also difficult to bundle and do not present an attractive appearance.

Hand-pollinating is a delicate procedure, although it is not a difficult operation and is rather easily learned by the most inexperienced worker. It is often the work of women and children who are quick with their hands, and is accomplished merely by placing the pollen masses in contact with the stigma. The only implement needed is a splinter of bamboo, a stem of stiff grass or a slender piece of wood the size and shape of a toothpick sharpened at both ends.

An average worker may pollinate from 1,000 to 2,000 or rarely as many as 3,000 flowers a day (14). Records as to the actual number of flowers pollinated on the various plantations are not available, but about two million flowers are known to have been pollinated in one vanillery during one season (16). If pollination, with consequent fertilization, has been successful the flowers will remain on the rachis; if not, the blossom drops off in two or three days. Consequently, the worker can observe within a few days the number of pods set and can thus discontinue pollinating when the desired number of pods have been obtained for a vine.

The number of fruits which are left to mature on the individual plants varies in different regions. According to Ridley (14), "A good strong vanilla plant in full vigour should produce as many as 200 bunches or racemes of flowers at a time. Each raceme carries from 15 to 20 flowers, or even more. . . . Thus under good conditions a plant can give 4,000 flowers." He recommended that, in some cases, ten fruits be allowed to ripen on each raceme, but in the case of weaker plants only two or three should be allowed to ripen. If ten fruits were permitted to ripen on each of 200 racemes the plant would produce 2,000 fruits! This seems incredible in view of the fact that a recent author advises that an average cultivated plant will produce upwards of 25 perfect beans, whereas the wild vines produce only an average of three beans (12). In the Seychelles, about thirty beans are usually left to mature on each vine (8). According to the best recent authority, about sixty beans is the maximum number which should be expected from a cultivated vine. Ridley also stated that *V. planifolia* should be made to produce fewer fruits than *V. pompona.* If a plant has been forced to produce an excessive number of beans in one season the beans produced the following season will be inferior and the vines left in a debilitated condition.

After fertilization takes place the ovary elongates rapidly, growing as much as an inch in a week, until the full length of the bean is attained in from four to eight weeks. Depending upon the region where the plants are grown, it takes from three to ten months for the beans to become fully mature. According to Ridley (14), the fruit matures in about four months in the Straits Settlements and Cochin-China, six months in Reúnion, and nine months in Trinidad. Vanilla is usually picked from early November to late in February in Mexico. However, because of the ever-present demand for the beans and also in order to circumvent the stealing of their crops (a general practice), some growers harvest their premature beans as early as October. This premature harvest is said to cause the loss of about one pound in every 1,000 beans (6), and the early harvest of 1940-41 is said to have caused the loss of at least 20% of cured vanilla (11). This economic evil persists and is growing in spite of the Mexican Government's efforts to curb it.

When mature and ready for harvesting, the beans are firm, thick, yellowish green in color and quite scentless. An indication of ripening is a slight yellowing of the whole bean which is more pronounced at the distal end. They must be gathered when fully mature, but before they are too ripe. If gathered too soon they are deficient in aroma and are more subject to attack by a fungus. Long beans are more desirable than short ones since they produce a superior extract, and an eight-inch bean weighs more than two six-inch beans or three five-inch beans (13).

"If left on the plant, the pod begins to turn yellow at the lower end and gives off an odour of bitter almonds. The pod begins to split into two unequal valves, and a small quantity of dark balsamic oil, of a brown or red colour, is produced. Gradually the pod darkens in colour from brown to black. The epidermis softens and the real vanilla odour develops. The oil, which is called 'balsam of vanilla,' then increases in quantity. This balsam is carefully collected by the planters in Peru and other parts of South

America, but not sent to Europe. The pods, ripening slowly upwards from the tip, take about a month to fully ripen. Eventually, if left, the pods become dry and black and brittle, and are then scentless." This excellent account of the ripening of the fruits of vanilla in nature is taken from Ridley (14).

Doubtless the most widespread and serious disease of vanilla is the anthracnose, *Calospora vanillae* Massee. The vegetative apex of the vine, the leaves, and aerial roots are attacked. The fungus is thought to secret a toxin in the soil which affects various parts of the plant when they come in contact with the soil. When plants which have been attacked are transplanted to uninfested soil they soon recover their vigor. This being the case, the vanillery should be established in soil that has never been used for vanilla culture. This disease has affected production of vanilla in the Mascarene, Comoro and Seychelles Islands, the West Indies, Tahiti and Colombia. Ridley (14) states that the disease was first noticed in the Seychelles in 1887 when it was observed that hundreds of the finest and plumpest beans were wilted. They were observed to turn back at the end or in the middle, and fall off in one or two days. It was found that if all dead or dying leaves of infected vanilla vines were destroyed by burning, the disease could be checked or even eradicated. Also, the presence of an excess of moisture in the leaves, prolonged rainy weather, insufficiently drained land, and too much shade were all found to favor the development of the fungus. Overcrowding and excessive moisture were thus conditions to be avoided.

Various other species of fungi have been observed to attack different parts of the vanilla plant. In Tahiti, *Colletotrichum vanillae* Scalia has been found attacking the leaves (14), and in Madagascar *Fusarium batatis* Wollenw. var. *vanillae* Tucker causes root-rot, *Phytophthora parasitica* Dast. causes fruit-rot, and *Glomerella vanillae* (Zimm.) Petch attacks the roots. Other fungi found to be parasitic on the leaves of vanilla in various parts of the world are: *Vermicularia vanilla* Delacr., in Mauritius; *Gloeosporium vanillae* Cooke, in Colombia, Mauritius, and Ceylon; *Uredo scabies* Cooke, in Colombia; *Guignardia traversi* (Cav.) Lind. (10) and *Bacterium briosianum* Pavar., in botanical gardens in Italy; *Macrophoma vanillae* Averna and *Pestalozzia vanillae* Averna, in Brazil; *Physalospora vanillae* Zimm., in Java; and *Atichea vanillae* (Pat.) V. Hoeh., in Tahiti.

In his chapter on vanilla Ridley (14) reviewed quite thoroughly the diseases and pests. A summary of the pests discussed follows. *Trioza litseae* (*Hemiptera*, *Psyllidae*), the bug most destructive to vanilla, is recorded from Réunion. It attacks the buds and flowers, puncturing them and producing spots of decay. The emerald bug, *Nezara smaragula* Fabr. (=*N. viridula* S.) which is less destructive than *Trioza*, lays its eggs on the leaves and stalks of vanilla, and the insects when hatched suck the sap of the flower-buds and stalks. The most destructive weevil, *Perissoderes ruficollis* Waterh., is found in Madagascar. A small lamellicorn beetle, *Hoplia retusa* Klug, and an ashy-grey weevil, *Cratopus punctum* Fabr., bite holes in the flowers and often destroy the column. Two moth caterpillars have caused some damage. *Conchylia vanillana* (=*Phalonia*) attacks the young fruits and either causes them to dry up or produces irregular marks on the beans, which spoil them or lower their value as a product. *Plusia aurifera* Hb. (=*Autographa orichalcea* Fabr.) eats the buds of the plant. It is common in Rèunion, Madagascar, continental Africa, Saint Helena, Teneriffe and southern Europe. The caterpillar of *Simplica inarcualis* Guen. is also supposed to attack vanilla on occasions.

In planning and establishing a plantation, additional factors to those discussed above have to be considered. Foremost of these is the selection of the location. The plantation, of necessity, should be located in a region where a sufficient supply of cheap and intelligent labor is available, because vanilla cultivation is an expensive operation at best. For this reason, as well as for climatic considerations, the largest vanilla plantations have been developed in the eastern hemisphere in comparatively isolated places with a large native population. The lack of abundant cheap labor in tropical America has been a major deterrent to the establishment of vanilla, as well as certain other tropical crops, on a large plantation basis in this hemisphere. Most of the commercial vanilla produced in tropical America is grown by small, independent "farmers" whose family, with possibly a few helpers, does all the work. Much vanilla is still gathered in the wild state.

Puerto Rico has available land in regions suitable for growing vanilla, especially in the coffee area, and a continued effort has been made to establish this industry on the island so as to supply the markets of the United States. Encouragement should also be given this crop in other suitable areas of tropical America. The Agricultural Experiment Station of Puerto Rico has been doing research on vanilla for a number of years, and the accumulated knowledge concerning this crop should be useful for all tropical America. McClelland (13), in 1919, strongly advocated the growing of this crop in Puerto Rico and more recently, in 1935 (4), the industry was again urged for this island. The disadvantages of growing the crop in Puerto Rico were found to be (4)—(a) lack of experience in curing and packing methods, (b) difficulty in financing the undertaking, (c) lack of an established reputation, (d) damage caused by root diseases (shared by all vanilla-producing countries), and (e) comparatively high cost of labor. There is little doubt that Puerto Rico can supply a large part of the vanilla beans needed in the United States if a well planned program can be developed and followed through in vanilla cultivation on the island.

HARVESTING, CURING AND PROCESSING THE BEANS

During the harvesting season the beans, which do not mature simultaneously, should be gathered every day. They should not be allowed to reach full maturity, and should be picked before reaching the stage of dehiscing on the vine since split beans are considered inferior to those which are not split. The beans are ready for cutting or picking when they become yellowish and develop a hard, black tip. They may be easily removed unbroken from the vines by a sidewise pressure of the thumb placed at the base. Twisting should be avoided so as not to break the bean. If any portion of the vine comes away with the fruit it should be cut away without injuring the base of the bean. On many plantations, instead of picking, the beans are cut from the vines with a sharp knife. After each day's gathering, for convenience in future sorting, the beans should be roughly divided into four classes: long, medium, short and split.

There are various artificial methods used in curing, or completing the ripening of vanilla fruits, foremost of which are the use of sun heat (Mexican process), of hot water (Bourbon process), or of stove heat. Although they may differ somewhat in technique, all the methods have the same purpose of obtaining as rapidly as possible uniformly cured, unsplit beans. Curing is a process of alternately sweating and drying the beans until they have lost most of their moisture, as much as 80% being lost in curing Mexican beans The curing process should begin within a week after the beans are harvested. In Mexico, the curing process is carried out during the dry season, which extends from November to May. The beans may be cured by the grower, but for the most part the green beans are brought by mule-train or men to trading centers and are sold direct to curer-exporters, who are not only specialists in this work but have adequate facilities for curing the beans. The curer's lot is full of problems. He buys the beans by weight, taking into consideration the odor, oil content, and time of harvest and, in turn, sells his finished product by weight.

In Mexico, where the best vanilla is grown, the beans are gathered and stored in sheds for a few days until they begin to shrivel. If the weather is fair they are then spread on woolen blankets in the sun for a few hours until too hot to hold in the bare hands, after which the blanket is folded over them for the rest of the day. At the end of the day the bundles of beans are removed to blanket-lined, air-tight containers where they sweat all night. This process, which may take as much as two weeks or longer, is repeated until the beans turn a dark chocolate brown color. In case of cloudy weather, the larger beans are wrapped in blankets, sprinkled with water, and are heated in an oven to 140°F. When the temperature has dropped to 113°F. the smaller ones are inserted (14). After twenty-four hours the small beans are removed and twelve hours later the large ones are taken out. During this process the beans have sweated and acquired the desired rich brown color.

After the sweating process, the beans are spread out on grass mats in the sun every day for about two months or longer, after which they are spread in a shelter until they are sufficiently dry and ready for market. Care should be taken not to over-expose the beans to the sun since this will cause them to be dry, less aromatic and of a reddish instead of deep brown color. In Mexico, it takes from five to six months to bring the beans to a state of perfection. In Rēunion, not only the above process is used, but often the sweating stage is preceded by one (15 to 20 seconds) or several shorter periods (3 to 4 seconds) of immersion in water heated to within a few degrees of the boiling point. This, the Bourbon process, takes about three months to bring the beans to a state of perfection, and they are never so dry as the Mexican beans. Modifications of the above methods are practiced throughout the tropics wherever vanilla is grown. In recent years research has been undertaken by the Mexican Government to improve and hasten the slow and expensive methods of curing the beans, but as yet no results have been published.

The so-called Guiana process consists of placing the beans in ashes until they shrivel, after which they are rubbed with olive oil, tied to prevent splitting, and hung in the open air until dry; the Peruvian process includes dipping the beans in boiling water, after which they are dried in the open air for three weeks and then lightly rubbed with castor oil (14). A nunber of other such primitive processes are used in various regions.

When properly cured and dried vanilla beans should be almost black and supple enough to be twisted round the finger without rupturing. Before being packed they are usually smoothed and straightened by being drawn repeatedly through the fingers. This massaging helps to bring out some of the oil which exudes during fermentation, and gives the beans their characteristic lustre. Some beans are said to be oiled with mahogany-oil to render them supple and to preserve them from insects (7). Usually the beans are covered with white needle-shaped crystals of vanillin, the presence of which is considered by some to be a criterion of quality.

"Apart from the attractive crystals on the outside, the main pocket-lens features of the vanilla pod lie inside. The pericarp or fruit-wall has about twenty conducting strands, and three dark lines marking the limits of the valves which normally open as only two, one single and flattish, the other double and curved in cross-section. The central cavity is packed with numerous small black seeds embedded in a gummy oleo-resinous matrix which is secreted by three bands of fine hairs occupying the corners of the more or less triangular cavity. The seeds are developed in twelve rows, on three pairs of placentae, each placental ridge having two lateral rows of seeds. These structural details are rather difficult to distinguish in a dry pod, but a cross-section shows some indications of strands and placentae in the pericarp, and also the mass of seeds and secretions in the center" (16).

Vanilla beans are subject to attacks from mildew, especially if they are improperly cured and have not been sufficiently dried. Once the beans become permeated with the odor of mold, it is practically impossible to eliminate it and the value of the bean is much reduced. The moldy portion is cut away and the remainder of the beans, known as "cuts," is sold for perfuming soaps, etc. In Mexico, these "cuts" normally average from 10 to 20 per cent of the crop, but when the demand for vanilla is heavy, especially early in the season, and the prices are good, the number of "cuts" increase (11). The time of curing is less and the packing for shipping is easier than for whole first quality beans. Not all the "cuts," however, are the result of mildew. Dealers in vanilla often try to remove the mildew by washing the beans in alcohol and rubbing them with glycerin, and try to prevent its reappearance by the use of formaldehyde, but the moldy odor will persist. Beans with more than 36% moisture content are considered to be subject to molding (14).

Vanilla beans are always marketable so long as they are well-cured, of sound keeping qualities, and possess a sweet flavor. They will keep indefinitely if properly cured and stored. The value of vanilla depends almost entirely upon the curing and packing of the beans. During the curing process the beans are continually under observation so that any which may be moldy or in any way defective can be removed. The same intensive care is given to sorting and packing the fruits.

The beans are sorted into several classes, primarily as to quality and length, before being packed. The best beans are without defects, being oily, smooth, strongly aromatic and essentially black. The second class beans are somewhat defective in that they are over-dried, less aromatic, have a rough exterior and are somewhat reddish in color. The split beans, which have lost some of their perfume, comprise the third class. The first class beans often weigh as much as twelve or more ounces each.

The vanilla beans of commerce have been divided for convenience into four principal geographic types—Mexican, Bourbon, South American (including vanillon, West Indian vanilla, and pompona) and Tahiti. Mexican beans come from Mexico only. Bourbon beans were originally from the Island of Rêunion (Bourbon) only, but they now include all beans grown in the Mascarene, Comoro and Seychelles Islands. The Bourbon crop is handled almost entirely through France. South American beans are grown mainly in the French West Indies, and Tahiti beans are an inferior vanilla grown in the French group of the Society Islands. The crops are large in Tahiti, but the beans are usually rank in flavor. Java beans, which may be considered a fifth type, are grown in the Netherlands Indies, the bulk of the crop going to Holland.

"In Mexico five classes of vanilla are known. The best is *primera*, the pods of which are 24 cm. long and proportionally thick; the second are called *chica prima*, the pods being shorter and two counting as one, the third is *sacate;* the fourth, *vesacate*, are still smaller, and are gathered before they are ripe; the fifth quality is *basura*, with small, spotted, and much broken pods." (14) The *sacate* is said to be a large bean which grows abundantly along the roadsides in the warm regions of Mexico, where formerly its fruit was considered to be without commercial value (6). The Mexican beans are usually larger and darker in color than those produced elsewhere.

After sorting, the beans are either sold in bulk or are tied in bundles of fifty to ninety each and packed in tin boxes containing as much as 85 pounds (14). After being soldered up three tins each are placed in wooden cases, preferably cedar, and are ready for shipment. The fruits of *V. pompona*, vanillon, are not mixed with those of *V. planifolia* and are packed separately or sold in bulk.

There are a number of methods for preparing vanilla extract, but percolation processes are the most widely used. The beans are first finely chopped and are then placed in a percolator, after which a thirty-five to sixty-five per cent solution of ethyl alcohol is poured over them. As this diluted alcohol drips through the beans it becomes saturated with the extractive and sinks to the bottom of the percolator where it is repeatedly drawn off and poured over the beans again until the maximum of vanillin removed. It is then allowed to age before being placed on the market. Another method which is essentially the same, but is more modern and mechanical, involves a circulatory percolation whereby the solvent is pumped from the bottom of the tank and allowed to repercolate. This steady circulation of the solvent through the chopped beans is continued until the concentration of vanillin is the same at the top and bottom of the tank, when the liquid is drawn off and allowed to age.

According to the United States food and drug laws, vanilla extract is the flavoring extract prepared from vanilla beans, with or without sugar or glycerin, and contains in 100 cubic centimeters the soluble matter from not less than ten grams of the vanilla bean. Based on this standard, it takes 13.34 ounces of beans to make one gallon of finished extract.

SUBSTITUTES AND MISCELLANEOUS INFORMATION

A number of related and unrelated plants have flowers, fruits or vegetative parts which emit the odor of vanilla. While some are of no apparent use, others have been used as a substitute for, or adulterant of, commercial vanilla. The long, cylindrical pods of "chica vanilla" (little vanilla), *Selenipedium chica* Reichb. f., are said to have been highly esteemed at one time by the inhabitants of the Isthmus of Panama. These pods were used for all purposes for which real vanilla is commonly used. The Faham or Bourbon tea leaves, of the Mascarene Islands, from the orchid *Angraecum fragrans* Thou., and the dried leaves of *Orchis fusca* Jacq., of Eurasia, are said to possess the odor of vanilla (7). The familiar fragrant ladies' tresses, *Spiranthes cernua* (L.) L. C. Rich. var. *odorata* (Nutt) Correll, of the eastern and southern United States, has flowers which are strongly fragrant of vanilla.

The attractive herb, *Trilisa odoratissima* (Walt.) Cass., or "vanilla-plant," found on the coastal plain of the southeastern United States, was at one time used as a vanilla substitute. The leaves contain a large amount of coumarin and were used primarily as a flavoring agent for tobacco. The plant was extensively gathered and, about 1875, one dealer at the trading center of Palatka, Florida, had an order to fill of 150,000 pounds (2). Although used to some extent in this country, a much larger quantity was shipped to Germany and France. It is still used for this purpose. The little orchid "herb vanilla," *Nigritella angustifolia* Rich., which grows in the mountains of Switzerland, is said to derive its common name from the fact that on hot days it emits a powerful odor similar to that of vanilla (7). The common sweet clovers, *Melilotus spp.*, contain coumarin and have the slight odor of vanilla.

The most widely used vegetable substitute and most notorious adulterant of vanilla is the tonka or "snuff bean," *Dipteryx odorata* (Aubl.) Willd., a leguminous tree native to northern South America and Trinidad. The latter place has a virtual monopoly of this product. The beans usually sell for approximately fifty cents a pound, and are chiefly sold in the United States, with a smaller market in Europe. They contain a high percentage of coumarin and are used mainly in the manufacture of tobacco and perfume, and to a lesser extent in confections and the flavoring of liqueurs. Another tonka bean, *D. oppositifolia* Willd., is also said to be used as a vanilla substitute. The vanilla-like odor of the tonka bean is attributed to the large amount of coumarin present. This substance, if taken in too large a quantity, is said to produce poisonous effects, thirty to sixty grains being sufficient to cause nausea, depression and drowsiness (7).

Some little known and less common wild vanillas are thought to be used as adulterants of the true vanilla of commerce. The vanillon, *V. pompona*, is the species commonly used for this purpose, but there are doubtless others. According to Small (16), manipulated vanilla beans which have been exhausted and redried or roasted are sometimes sprinkled with crystals of benzoic acid, which simulate crystals of vanillin, and are placed on the market. These benzoic acid crystals, however, do not yield the carmine-red color given by vanillin with phloroglucin and hydrochloric acid. Synthetic vanillin crystals are sometimes sprinkled over low grade or "treated" beans to improve their appearance. Heliotropine, cinnamic acid derivatives and various perfumes are also said to be used as adulterants of vanilla. Perhaps the most common method of adulterating vanilla extract, and the most difficult to detect, is the use of fewer beans than the standard requirements. Although not used as a flavoring, the expressed juice of the fruits of a species identified as *V. claviculata*, native to the West Indies, is said to be applied to recent wounds and is called "liana a blessure" by the French in Santo Domingo (1).

An unfortunate phase in the development of the vanilla industry is that relating to so-called "vanilla poisonings," which gained prominence during the last century, especially those following the eating of ice cream and vanilla ices. Foreign substances which were introduced through ignorance, accidentally or as adulterants in the vanilla beans and extract were found to be the source of most of the poisonings. Some instances of poisoning were thought to have been caused by the presence of *tyrotoxicon*, a poison found in milk which has undergone certain putrefactive changes, or perhaps to the presence of microscopic organisms in the vanilla, since the plantations are liable to the attack of *Bacterium putredinis* Weinberg *et al.* (7), etc. The presence of cardol, or the oil of the cashew nut, was also thought to cause some poisonings since this was occasionally used to improve the appearance of the vanilla bean. "These cases are distinct from those in which the poisoning has been caused by the admixture of dangerous metallic substances." (7). In no instance was it found that vanilla, as such, caused poisoning.

Persons employed in handling vanilla occasionally suffer from an ailment known as "vanillism." According to Ridley (14), "It takes the form of headache, gastric trouble, and urtication, or a kind of rash. The latter is perhaps caused by the crystals of oxalate of lime which are so abundant all through the plant. The juice of the leaves and stalks of some species at least is very irritating to the skin, and the leaf of the cultivated vanilla is used as a blistering agent in Réunion. That of the wild species of the Malay Peninsula, which produces a considerable amount of irritation on the softer part of the skin, is used by the Malays as a stimulant to the growth of the hair." Irritation of the skin is also thought to be caused by an *Acarus*, a mite, which sometimes occupies the end of the bean (7).

The chief competitor of natural vanilla and the product which is commonly used to fortify the pure extract is synthetic vanillin, or artificial vanilla. Methyl vanillin and ethyl vanillin are also sometimes utilized. All of these are many times stronger than the natural extract but do not match it in quality. Ethyl vanillin is said to be about three times as strong as methyl vanillin, and has a superior, stronger and more delicate odor which comes nearest to the peculiar aroma of Bourbon vanilla beans (9). Another material, vanillic acid ester of vanilla alcohol, is said to be at least twice as strong as vanillin and has been strongly advocated as a flavor (9), especially during the present emergency when shortages of containers and transportation facilities necessitate reduction and concentration of all products insofar as possible. A small amount of vanillic acid ester is equal in flavoring potency to a large bulk of natural vanilla extract and would, consequently, be more practical for overseas shipments.

These products, which cost only a fraction of that of pure vanilla extract, have not seriously affected vanilla culture, but have been an important factor in reducing the rather exhoribtant prices once paid for vanilla beans. Most vanilla beans grown today have a market before they are harvested. In fact, the total crop grown throughout the world is insufficient to satisfy the needs, and the steady demand for the natural flavoring would seem to warrant the development of additional plantations, especially in Puerto Rico and other regions near to the United States.

German chemists were the first to place synthetic vanillin on the market. It was " . . . first produced in 1874 by Tiemann, through a process of oxidation with Shromic Acid of the Glucoside Coniferin, which occurs in the cambium of various coniferous woods." (9). Later, in 1891, the French chemist, De Taire, extracted vanillin from eugenol, which occurs in oil of cloves. The latter is still the primary source of commercial "vanillin." Of late, however, vanillin has been produced in large quantities from wood pulp. This, the original Tiemann process, is that which is used in Germany today. Artificial vanillin has also been obtained by electrolysis from sugar, from asafoetida, *Ferula assa-foetida*, L., Siam benzoin, *Styrax tonkinensis* (Pierre) Craib, and from a coal tar product. "Other materials were used as a base to produce this important aromatic chemical, namely Guaiacel Orthe Anisidine." (9). Vanillin can also be produced from heliotropine, which, in turn, is made from safrol. "The latter can be made from Oil of Sassafras, which is a distillate of Sassafras Bark." (9). Since the sassafras, *Sassafras albidum* (Nutt.) Nees, grows rather extensively in the Carolinas, Kentucky and elsewhere in the eastern and central United States, this source of artificial vanillin should almost be sufficient if all other sources were made unavailable. "Vanillin does not appear to have any physiological action on human beings when taken in small doses, as much as 10 to 15 grains having been administered without noxious results. On small animals, however, such as frogs, it appears to act as a convulsive. It has been suggested as a stimulant of an excito-motor character in atonic dyspepsia." (7).

A number of imitation vanilla extracts, which may or may not contain a certain percentage of pure vanilla extract, have been placed on the market. A small amount of pure vanilla, as little as ten per cent, usually greatly improves the flavor of these imitation extracts. Extract of tonka beans and coumarin are the primary sources of these extracts, although a number of synthetic chemicals are used, as ethyl vanillin, piperonal, various perfumes and cinnamic acid derivatives. Other materials which have been used are raisin and prune juices, maple sugar, St. John's bread, *Ceratonia siliqua* L., and fenugreek, *Trigonella foenum-graecum* L.

Although science has devised substitutes for this popular flavoring material, vanilla, like so many other natural products which have been synthesized, should survive these encroachments. The delicate, ephemeral essence of the natural product, which leaves no unpleasant after-taste, has not been completely captured by the test tube. There will doubtless be a future market for all first quality beans which may be grown.

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Diagnoses of Hawaiian Species of Pelea (Rutaceae)
Hawaiian Plant Studies, 13[1]

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For a number of years the writer has investigated in the field and studied in herbaria the genus *Pelea.* He intends to publish a monograph of it. In response to demands to make his discoveries available in advance of the monograph, the following preliminary diagnoses of the new species and varieties and the new combinations are issued. Many of them are published jointly with a former student, Dr. Edward P. Hume of Cornell University. The abbreviations for herbaria are the standard ones from the International List by J. Lanjouw (Chron. Bot. 3: 345–349, 1937).

MICROCARPAE

Pelea clusiaefolia Gray var. **Cookeana** (Rock) St. John & Hume, comb. nov.

P. Cookeana Rock, Ind. Trees Haw. Ids. 216, 1913.
P. clusiaefolia Grayγ var. Hbd., Fl. Haw. Ids. 63, 1888.

P. clusiaefolia Gray var. **cuneata** St. John & Hume, var. nov.

Foliis obovatis cuneatis glabris vel ad costam pilosis, capsulis 12–14 mm. diametro glabris ½-lobatis.

Typus, Hawaii, Kipuka Puaulu, Kilauea, *J. F. Rock* 13,037, (Ho.).

P. clusiaefolia Gray var. **dumosa** (Rock) St. John & Hume, comb. nov.

P. sapotaefolia Mann var. *dumosa* Rock, Ind. Trees Haw. Ids. 218, 1913.

P. clusiaefolia Gray var. **ecuneata** St. John, var. nov.

Foliis glabris plerumque ad basim rotundatis.

Typus, Kauai, Hanapepe, Dec. 1909, *U. Faurie* 187, (BM.).

P. clusiaefolia Gray var. **Fauriei** (Lévl.) St. John & Hume, comb. nov.

P. Fauriei Lévl., Fedde Report. Sp. Nov. 10: 153, 1911.

P. clusiaefolia Gray var. **sapotaefolia** (Mann) St. John, comb. nov.

P. sapotaefolia Mann, Proc. Boston Soc. Nat. Hist. 10: 312–313, 1866.
P. microcarpa Heller, Minn. Bot. Stud. 1: 839–840, pl. 49, 1897.

P. clusiaefolia Gray var. **puberula** St. John, var. nov.

A var. *sapotaefolia* paginis inferioribus puberulis differt.

Typus, Oahu, Pupukea, Jan. 29, 1927, *L. H. MacDaniels* 545, (Ho.).

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[1] This is the thirteenth of a series of papers designed to present descriptions, revisions, and records of Hawaiian plants. The preceding papers have been published as Occ. Papers Bishop Mus. 10(4), 1933; 10(12), 1934; 11(14), 1935; 12(8), 1936; 14(8), 1938; 15(1), 1939; 15(2), 1939; 15(22), 1940; 15(28), 1940; and nos. 11 and 12 are in press.

P. descendens St. John, sp. nov.

Frutex (?), novelles sparse puberulis deinde glabratis, ramulis glabris, foliis oppositis, petiolis maturis glabris, laminis 3–9 cm. longis spatulato-ellipticis glabris ad apicem emarginatis, pedunculis 1-floriferis 17–19 mm. longis glabris, capsulis 13–17 mm. diametro ¾-lobatis glabris, lobis valde reflexis, endocarpio glabro.

Typus, Oahu, s. ridge, Kipapa Gulch, moist wooded ridge, el. 1,800 ft., Oct. 16, 1932, *E. Y. Hosaka* 820, (Ho.).

P. Hosakae St. John, sp. nov.

Arbor 8 m. alta, novellis cinereis puberulis, ramulis puberulis, foliis oppositis, petiolis puberulis vel glabratis, laminis 9–23 cm. longis ovalibus vel ellipticis subcoriaceis glabris sed infra costa puberulenta, cymis 5–11-floriferis puberulis, pedunculis 5–10 mm. longis pedicellis 7–10 mm. longis, capsulis 9–18 mm. diametro dense cinereo-puberulis ⅔-lobatis, lobis rotatis, endocarpio velutino.

Typus, Oahu, Kipapa Gulch, Waipio, el. 1,700 ft., May 6, 1933, *E. Y. Hosaka* 1,006, (Ho.).

P. olowaluensis St. John, sp. nov.

Arbor 3 m. alta, ramulis minute puberulis glabratis, foliis oppositis, petiolis glabris, laminis 2.8–8 cm. longis ovalibus subcoriaceis glabris, cymis trifloris glabris, pedunculo 9 mm. longo, capsulis glabris 16–20 mm. diametro 6 mm. altis ½-lobatis, endocarpiis glabris.

Typus, Maui, Olowalu Valley, central ridge, May 12, 1920, *C. N. Forbes* 2,326.M, (Ho.).

P. Pickeringii St. John, sp. nov.

Ramis glabris, foliis oppositis, petiolis adpressi-hirsutulis, laminis 5–7.7 cm. longis obovatis cuneatis glabratis subcoriaceis reticulatis glanduloso-punctatis, capsulis glabris coriaceis ¾-lobatis apicibus obtusis.

Typus, Sandwich Island, 1838–42, *Wilkes Expedition*, (Ca.-Gr.).

P. pluvialis St. John, sp. nov.

Arbor (?), novellis puberulis, ramulis glabratis, foliis oppositis, laminis 7–18 cm. longis ellipticis subcoriaceis glabris, cymis glabris 4–5-floriferis, pedunculis 6–12 mm. longis, capsulis glabris 16 mm. diametro 11 mm. alto ⅔-lobatis, endocarpiis glabris.

Typus, Kauai, Waialeale, Sept. 20, 1910, *J. F. Rock* 5,040, (Ho.).

P. puberula St. John, sp. nov.

Frutex (?), novellis pilosis, ramulis sparse pilosis, foliis oppositis, petiolis pilosis deinde glabratis, laminis 4.5–6 cm. longis ovalibus coriaceis supra glabris infra villosis ad apicem emarginatis, cymis 5-floriferis pilosis, pedunculis 8–15 mm. longis, pedicellis 8–9 mm. longis, capsulis 12–13 mm. diametro puberulis ½-lobatis, lobis rotatis inaequalibus, endocarpio sparse pilosulo.

Typus, Kauai, Alakai Swamp, near Puu o Kila, alt. 4,000 ft., July 21, 1937, *E. C. Zimmerman*, without number, (Ho.).

P. punctata St. John & Hume, sp. nov.

Ramis glabratis, foliis oppositis, petiolis glabratis, laminis obovatis glabratis, capsulis glabris 18 mm. diametro ¾-lobatis.

Typus, Kauai, Kahili Swamp, Wahiawa, Dec. 29, 1930, *H. St. John et al.* 10,852, (Ho.).

P. ukuleleensis St. John, sp. nov.

Ramulis hirsutulis, petiolis dense hirsutulis, laminis 4.5–8.5 cm. longis ellipticis vel ovalibus coriaceis infra glabratis, costa hirsuta, cymis hirsutulis 5–9-floriferis, capsulis glabris ⅔-lobatis, endocarpiis glabris.

Typus, Maui, Ukulele, July 1919, *C. N. Forbes* 749.M, (Ho.).

P. wahiawaensis St. John & Hume, sp. nov.

Ramis glabris, foliis oppositis, laminis ellipticis glabris, capsulis 16–18 mm. diametro ½-lobatis.

Typus, Kauai, Wahiawa Swamp, *C. N. Forbes* 282.K, (Ho.).

P. waipioensis St. John, sp. nov.

Arbor 7 m. alta, novellis adpressi-hirsutulis, ramulis hirsutulis demum glabratis, foliis oppositis, petiolis hirsutulis demum glabratis, laminis 4.5–9.5 cm. longis obovatis ad basim subcuneatis ad apicem emarginatis vel obtusis coriaceis supra glabris infra costa sparse adpressi-hirsutula glabrata, cymis 7-13-floriferis puberulis, pedunculis 4–6 mm. longis, pedicellis 3–6 mm. longis, capsulis 13–15 mm. diametro glabris ⅔-lobatis reticulatis, endocarpio sparse puberulo.

Typus, Oahu, Kipapa Gulch, Waipio, el. 2,200 ft., Feb. 10, 1935, *E. Y. Hosaka* 1,270, (Ho.).

P. waialeale Wawra var. **latior** St. John & Hume, var. nov.

Foliis 6.5–9.8 cm. longis, 2.5–4.1 cm. latis.

Typus, Kauai, n. w. end of Alakai Swamp, Dec. 27, 1930, *H. St. John et al.* 10,776, (Ho.).

MEGACARPAE

P. apoda St. John, sp. nov.

Arbor vel frutex, novellis hirsutis, internodiis ramulorum glabratis, ramis glabratis, foliis oppositis sessilibus, laminis 1.8–6.3 cm. longis ovalibus coriaceis ad apicem emarginatis ad basim cordatis supra glabris infra hirsutis ad basim et in nervo medio deinde subglabratis, cymis 3–5-floriferis in nodis hirsutis, pedunculis 2–8 mm. longis, pedicellis 2 cm. longis, capsulis 22–24 mm. diametro glabris ⅚-lobatis, lobis recurvatis, endocarpio glabro.

Typus, Hawaii, Volcano region, July–Aug., 1918, *J. F. Rock*, without number, (Ho.).

P. Christophersenii St. John, sp. nov.

Arbor (?), novellis adpressi-puberulis, ramis petiolisque glabratis, foliis oppositis cito glabratis 4.5–12 cm. longis ovalibus coriaceis infra valde rugoso-nervosis, cymis adpressi-puberulis 9–15-floriferis (?), capsulis ¾-lobatis 25–32 mm. diametro puberulis lobis rotatis, endocarpio puberulento.

Typus, Oahu, top of Kaala, May 10–15, 1931, *E. Christophersen & E. P. Hume* 1,804, (Ho.).

P. grandifolia (Hbd.) St. John & Hume, comb. nov.

P. volcanica Gray *β* var. *grandifolia* Hbd., Fl. Haw. Ids. 67, 1888.

P. grandifolia (Hbd.) St. John & Hume var. **ovalifolia** (Hbd.) St. John, comb. nov.

P. volcanica Gray var. *ovalifolia* Hbd., Fl. Haw. Ids. 67, 1888.

P. honoluluensis St. John, sp. nov.

P. sandwicensis sensu Rock, Ind. Trees Haw. Ids. 224, pl. 85, 1913, non (Gaud.) Gray vel (H. & A.) Gray.

Typus, Oahu, Konahuanui, *J. F. Rock* 10,215, (Ho.).

P. kaalaensis St. John, sp. nov.

Foliis oppositis, laminis ellipticis 7–22 cm. longis coriaceis infra villosis, petiolis adpressi-hirsutulis cinereis, pedicellis 4–7 mm. longis, capsulis 28–32 mm. diametro valde puberulis ½–⅔-lobatis, endocarpio pilosulo.

Typus, Oahu, Makaha Valley, Kaala Range, Feb. 12–19, 1909, *C. N. Forbes*, without number, (Ho.).

P. hualalaiensis St. John, sp. nov.

Frutex vel arbor (?), novellis ramulisque dense villosis, ramis villosis deinde glabratis, foliis oppositis, petiolis 5–23 mm. longis villosis, laminis 3–9.5 cm. longis ellipticis vel ovalibus coriaceis supra glabris sed nervo medio ad basim villoso infra ab initio villoso deinde sparse villosis sed nervo medio dense villoso, cymis 5-floriferis pilosis, pedunculis 10–15 mm. longis, pedicellis 10–13 mm. longis, capsulis 25–30 mm. diametro ¾-lobatis puberulis, lobis valde reflexis, endocarpio glabro.

Typus, Hawaii, Puu Hualalai, Puuwaawaa, 4,800 ft. alt., woods, Dec. 21, 1931, *H. St. John, J. W. Coulter, E. Y. Hashimoto, J. C. Lindsay, & D. D. Mitchell* 11,362, (Ho.).

P. kauaensis St. John, sp. nov.

Arbusculus, novellis hirsutis, ramulis sparse hirsutis, foliis oppositis, petiolis hirsutis, laminis 5.5–11 cm. longis ovalibus coriaceis infra reticulatis sparse hirsutis subglabratis costa sparse hirsuta, cymis 3–5-floriferis, pedunculis 5–9 mm. longis sparse puberulis, pedicellis 5 mm. longis, capsulis 30–38 mm. diametro puberulis ¾-lobatis lobis semireflexis reticulatis, endocarpio pilosulo.

Typus, Oahu, Puu Kaua, 2,000 ft., Nov. 6, 1932, *Amy Suehiro*, without number, (Ho.).

P. lanceolata St. John & Hume, sp. nov.

Ramis glabris, foliis oppositis, petiolis glabris, laminis lanceolatis 4.5–9.5 cm. longis glabris, capsulis 20–24 mm. diametro ¾-lobatis.

Typus, Hawaii, Kapapala (Puuaulu), Aug. 7, 1911, *C. N. Forbes* 399. H. partim (Ho.).

P. lucens (Hbd.) St. John, comb. nov.

P. sandwicensis [Gray] = (H. & A.) Gray var. *lucens* Hbd., Fl. Haw. Ids. 67, 1888.

P. Munroi St. John, sp. nov.

Frutex, novellis pilosis, internodiis glabratis, foliis oppositis, petiolis 2–9 mm. longis, laminis 5–12 cm. longis ovalibus vel suborbicularibus coriaceis glabratis vel nervo medio piloso, cymis 5–12-floriferis sparse puberulis, pedicellis 15–40 mm. longis, capsulis immaturis 18 mm. diametro glabris ⅔-lobatis, endocarpiis pilosis.

Typus, Lanai, Lanaihale, April 16, 1915, *G. C. Munro*, without number, (Ho.).

P. manukaensis St. John, sp. nov.

Frutex 6 m. alta, novellis cinereis puberulis, ramulis adpressi-puberulis, nodis puberulis hirsutulisque, ramis glabratis, foliis oppositis, petiolis 5–15 mm. longis adpressi-puberulis, laminis 3.5–14 cm. longis, ellipticis ovalibusve subtiliter coriaceis utrinque glabris sed nervo medio puberulo, cymis 3-floriferis adpressi-puberulis, pedunculis 4–8 mm. longis, pedicellis 7–12 mm. longis, capsulis 21–26 mm. diametro ¾-lobatis, lobis rotatis, endocarpio glabro.

Typus, Hawaii, Manuka Mauka, South Kona, 2,000 ft. alt., Dec. 24, 1931, *H. St. John, E. Y. Hashimoto, E. Y. Hosaka, J. C. Lindsay, & D. D. Mitchell* 11,289, (Ho.).

P. oblanceolata St. John, sp. nov.

Arbor vel frutex, novellis dense hirsutulis, ramulis sparse hirsutulis, ramis glabratis, foliis oppositis, petiolis 2–4 cm. longis canaliculatis glabratis, laminis 9–16 cm. longis oblanceo-ellipticis coriaceis obtusis vel emarginatis supra glabris infra hirsutulis glabratis nervo medio hirsutulo, cymis 1–3-floriferis infra hirsutulis supra glabratis, pedunculis 5–12 mm. longis, pedicellis 15 mm. longis, capsulis 30–37 mm. diametro glabris ¾-lobatis, lobis rotatis glabris, endocarpio glabro.

Typus, Hawaii, Kulani Forest, Aug. 1918, *J. F. Rock*, without number, (Ho.).

P. orbicularis Hbd. var. **tonsa** St. John & Hume, var. nov.

Foliis glabris, paniculis sparse pilosulis.

Typus, Maui, Iao Valley, *C. N. Forbes* 89.M, (Ho.).

P. paloloensis St. John, sp. nov.

Arbor parvus glabratus, novellis adpressi-puberulis, foliis 3–4-verticillatis petiolatis, laminis 8–13 cm. longis anguste ellipticis vel oblanceolatis subcoriaceis glabris, cymis sparse adpressi-puberulis circa 13-floriferis, pedunculis 16–30 mm. longis, pedicellis 2 11 mm. longis, capsulis 18–22 mm. diametro ⅔-lobatis glabris, basi concavo, endocarpiis glabris.

Typus, Oahu, between Palolo and Waialae Iki, Jan. 30, 1917, *C. N. Forbes* 2,404.O, (Ho.).

P. puauluensis St. John, sp. nov.

Arbor 7 m. alta, novellis dense hirsutulis, ramulis hirsutulis, ramis hirsutulis deinde glabratis, foliis oppositis, petiolis 7–13 mm. longis adpressi-hirsutulis, laminis 3–8 cm. longis late ovalibus coriaceis emarginatis supra glabris infra glabratis nervo medio hirsutulo, cymis 3–7-floriferis dense hirsutulis pedunculis 8–23 mm. longis, pedicellis 6–14 mm. longis, capsulis 25–32 mm. diametro glabris ¾-lobatis, lobis rotatis, endocarpio glabro.

Typus, Hawaii, Bird Park, Hawaii National Park, open woods, 4,000 ft. alt., Dec. 22, 1931, *H. St. John, R. S. Bean, & E. Y. Hosaka* 11,257, (Ho.).

P. radiata St. John, sp. nov.

Frutex 3 m. alta glabra, foliis oppositis, petiolis 3–9 mm. longis, laminis late ovalibus ad basim subcordatis coriaceis reticulatis 3–7.2 cm. longis, axillis unifloriferis, pedicellis 3–5 mm. longis, capsulis 30–32 mm. diametro glabris ⅘-lobatis, endocarpiis glabris.

Typus, Hawaii, Kapua, Nov. 16, 1926, *L. H. MacDaniels* 273, (Ho.).

P. reflexa St. John, sp. nov.

Ramulis hirsutis, foliis oppositis, petiolis hirsutulis 8–17 mm. longis, laminis 7–13 cm. longis ellipticis subcoriaceis infra sparse hirsutulis deinde glabratis, pedunculis 1-floriferis cum pedicellis 25–30 mm. longis glabratis, capsulis 28–33 mm. diametro glabris ¾-lobatis lobis reflexis.

Typus, Molokai, Wailau Pali, *J. F. Rock* 7,046, (Ho.).

P. **Rockii** St. John, sp. nov.

Frutex vel arbor, novellis adpressi-puberulis et squamosis, ramis glabratis, foliis oppositis, petiolis puberulis, laminis 3–18 cm. longis ellipticis coriaceis glabris, cymis 8–13-floriferis, pedicellis 3–15 mm. longis, capsulis 18–23 mm. diametro glabris ½-lobatis lobis rotatis, endocarpio glabro.

Typus, Oahu, ridge between Palolo and Waialae, March 23, 1910, *C. N. Forbes* 1,490, (Ho.).

P. **Rockii** St. John var. **pauciflora** St. John, var. nov.

A planta typica laminis ovalibus, cymis 3–7-floriferis differt.

Typus, Oahu, Kaukonahua gulch, May 15, 1909, *J. F. Rock* 3,046, (Ho.).

P. **semiternata** St. John, sp. nov.

Arbor, ramulis glabris, foliis ternatis vel oppositis glabris, petiolis 2–18 mm. longis, laminis ellipticis coriaceis subacutis ad basim auriculatis 4–9.5 cm. longis, cymis 1-floriferis cum pedicellis 15–35 mm. longis filiformibus glabris, floribus glabris, capsulis 20 mm. diametro glabris ⅔-lobatis.

Typus, Oahu, South Opaeula Gulch, Paalaa, 1,700 ft., Nov. 9, 1930, *H. St. John* 10, 638, (Ho.).

P. **stellata** St. John, sp. nov.

Frutex vel arbor, novellis adpressi-puberulis, ramulis subglabratis, ramis glabris, foliis oppositis, petiolis 10–28 mm. longis glabratis, laminis 5.5–11 cm. longis ovalibus coriaceis glabris, cymis 3–5-floriferis minute adpressi-puberulis, pedunculis 5–12 mm. longis, pedicellis 5–8 mm. longis, capsulis 21–25 mm. diametro subglabris ⅔-lobatis, lobis rotatis, endocarpio glabro.

Typus, Maui, Makawao, dense lower woods with *Ochrosia sandwicensis*, Oct. 18, 1910, *J. F. Rock* 8,597, (Ho.).

P. **Storeyana** St. John & Hume, sp. nov.

Foliis oppositis, laminis 9–14 cm. longis subcoriaceis ellipticis costa hirsutula, pedicellis 3 mm. longis, capsulis immaturis 12 mm. diametro ¾-lobatis.

Typus, Oahu, Mt. Kaala, Makaleha, or Waialua, Dec. 1870, [J. Lydgate], Herb. Hillebrand, (B.).

CUBICARPAE

P. **Brighami** St. John, sp. nov.

Ramulis puberulis, foliis oppositis, laminis 3.5–10 cm. longis glabris ovalibus apicibus emarginatis, capsulis 10–14 mm. diametro dense puberulis.

Typus, Maui, Makawao, *H. Mann & W. T. Brigham* 377, (Ho.).

P. elongata (Hbd.) St. John, comb. nov.
P. elliptica (Gray) Hbd. δ var *elongata* Hillebrand, Fl. Haw. Ids. 69–70, 1888.

P. Forbesii St. John & Hume, sp. nov.

Ramis glabris, foliis oppositis 7.5–9.5 cm. longis ovatis vel obovatis supra glabris, petiolis glabris, capsulis 20–25 mm. diametro glabris.
Typus, Kauai, Waimea drainage, *C. N. Forbes* 869.K, (Ho.).

P. Gaudichaudii St. John, sp. nov.

Foliis oppositis, petiolis hirsutulis, laminis 25–51 mm. longis ovalibus subcoriaceis infra costa hirsutula, capsulis 16–22 mm. diametro cinereo-pubercentibus.
Typus, Iles Sandwich, *Gaudichaud* (P.).

P. hawaiensis Wawra var. **pilosa** St. John, var. nov.

Ramulis petiolisque puberulis, laminis 5–8 cm. longis oblanceolatis vel lanceolatis cuneatis subcoriaceis subtus pilosis.
Typus, Lanai, July 1870, *W. Hillebrand*, (B.).

P. hawaiensis Wawra var. **racemiflora** (Rock) St. John, comb. nov
P. cinerea (Gray) Hbd. var. *racemiflora* Rock, Ind. Trees Haw. Ids. 241, 1913.

P. mucronulata St. John, sp. nov.

Ramulis et novellis pilosulis, petiolis pilosulis, laminis 6–11.5 cm. longis coriaceis infra pilosulis, pedunculis pedicellisque pilosulis, capsulis 24–28 mm. diametro glabris mucronulatis.
Typus, Maui, Pakiloi, south slope of Haleakala, March 23, 1920, *C. N. Forbes* 2,078.M, (Ho.).

P. niuensis St. John, sp. nov.

Arbor, ramis glabratis, foliis oppositis, petiolis glabratis, laminis coriaceis ellipticis glabris 6–12 cm. longis 22–48 mm. latis, inflorescentii 7–9-florifera, capsulis elobatis 21- 25 mm. diametro glabris.
Typus, Oahu, Niu, Oct. 13, 1940, *H. St. John* 20, 111, (Ho.).

P. obovata St. John, sp. nov.

Ramulis glabratis, foliis oppositis, laminis 9.5–10 cm. longis anguste obovatis chartaceis obtusis subcuneatis glabris, cymis circa 25-floriferis puberulis, capsulis 20–26 mm. diametro subglabris.
Typus, Maui or Lanai ?, *J. Lydgate* 109, (B.).

P. ovata St. John & Hume, sp. nov.

Ramis glabris, foliis oppositis, laminis 6–13 cm. longis ovatis acuminatis, fructibus 24 mm. diametro glabris.
Typus, Kauai, Kaholuamanu, March 3, 1909, *J. F. Rock* 1,979, (Ho.).

P. ovalis St. John, sp. nov.

Arbor 5 m. alta, novellis puberulis squamosisque glabratis, foliis oppositis, petiolis glabris validis, laminis 8–16 cm. longis late ovalibus coriaceis glabris, cymis 3–7-floriferis glabris, pedunculis 3–12 mm. longis, pedicellis 10–13 mm. longis, capsulis 12–14 mm. diametro subglobosis elobatis glabris, endocarpio glabro.

Typus, Maui, Mountains above Hana, July 5, 1920, *C. N. Forbes* 2,670. M, (Ho.).

P. paniculata St. John, sp. nov.

Arbor 15 m. alta, novellis minute squamosis et puberulis, foliis oppositis, petiolis 3–6 cm. longis glabratis, laminis 9.5–20 cm. longis ellipticis subcoriaceis marginibus revolutis infra costa minute puberula, paniculis 13–20 cm. longis multi-floriferis, pedicellis 2–5 mm. longis, sepalis petalisque glabris, capsulis immaturis 8–9 mm. diametro elobatis tetragonis glabris, endocarpio glabro.

Typus, Kauai, upper Lihue ditch trail, Feb. 21, 1927, *L. H. MacDaniels* 845, (Ho.).

P. quadrangularis St. John & Hume, sp. nov.

Ramulis puberulis, foliis oppositis, laminis 7–13.5 cm. longis ovalibus subcoriaceis supra glabris infra sparse pilosis pallidisque, capsulis elobatis 19–25 mm. diametro 12–14 mm. altis, axilla 8–9 mm. alta, exocarpiis sparse puberulis glabratis, endocarpio glabro.

Typus, Kauai, vicinity of Wahiawa Swamp, Aug. 1909, *C. N. Forbes* 273.K, (Ho.).

P. waimeaensis St. John, sp. nov.

P. sapotaefolia Mann β var. Hbd., Fl. Haw. Ids. 63, 1883.

Ramulis puberulis, foliis oppositis, laminis 12–19 cm. longis anguste elliptici-oblongis coriaceis subemarginatis cuneatis infra pilosis, capsulis 26–28 mm. diametro quadrangularibus elobatis.

Typus, Kauai, Mts. of Waimea, *Knudsen* 38, (B.).

P. Wawraeana Rock var. **pubens** St. John, var. nov.

A planta typica capsulis puberulis, endocarpio ad suturam plusminusve pilosulo differt.

Typus, Oahu, Kaaawa, el. 575 m., April 12, 1931, *E. P. Hume* 157, (Ho.).

P. Wawraeana Rock var. **tenuifolia** (Hbd. ex Rock) St. John & Hume, comb. nov.

P. sandwicensis (Gaud.) Gray var. *tenuifolia* Hbd. ex Rock, Bot. Gaz. 65: 265–266, 1918.

APOCARPAE

P. adscendens St. John & Hume, sp. nov.

Ramis cinereis, foliis glabris vel glabratis, laminis ovato-oblongis 4.5–7 cm. longis subcordatis, coccis 7 mm. longis glabris.

Typus, Maui, Auwalu, Haleakala, March 24, 1920, *C. N. Forbes* 2,100. M, (Ho.).

P. cinereops St. John, sp. nov.

Arbor, ramulis cinereis, foliis oppositis, petiolis cinereis, laminis ellipticis subcoriaceis 4–9 cm. longis infra valde velutinis, floribus paucis, folliculis 7–10 mm. longis dense pilosis, endocarpio dense villoso.

Typus, Oahu, Mt. Kaala, 1,600 ft., Aug. 14, 1927, *L. H. MacDaniels* 927, (Ho.).

P. elliptica (Gray) Hbd. var. **coccinea** St. John & Hume, var. nov.

Foliis cuneatis, sepalis pilosis persistentibus, capsulis pilosis coccineis.

Typus, Oahu, Makaha Valley, *H. St. John* 11,605, (Ho.).

P. elliptica (Gray) Hbd. var. **mauiensis** St. John, nom. nov.

P. elliptica (Gray) Hbd β var. Hbd., Fl. Haw. Ids. 69, 1888.

P. haupuensis St. John, sp. nov.

Arbor 8 m. alta, novellis adpressi-puberulis, petiolis 2–5 cm. longis adpressi-puberulis vel glabratis, laminis 4.5–9.5 cm. longis chartaceis glabris ovalibus vel ovatis ad basim rotundatis vel subemarginatis ad apicem rotundatis vel subacutis, cymis 7-floriferis adpressi-puberulis, pedunculis 2–7 mm. longis, pedicellis 1–2 mm. longis, sepalis et petalis adpressi-puberulis, coccis distinctis rotatis glabris 9–11 mm. longis, 6 mm. altis subellipsoideis acutis compressis, endocarpio glabro.

Typus, Kauai, Haupu, Feb. 16, 1927, *L. H. MacDaniels* 746, (Ho.).

P. Saint-Johnii Hume, sp. nov.

Folliis oppositis ternatisve ovato-ellipticis 6–16 cm. longis, cymis 3 7-floriferis, pedicellis 2–5 mm. longis pilosulis, fructibus 12- 16 mm. diametro, folliculis glabris aurantiacis.

Typus, Oahu, Mauna Kapu, *E. Christophersen, G. P. Wilder, & E. P. Hume* 1,591, (Ho.).

P. sulfurea (Rock) St. John & Hume, comb. nov.

P. cinerea (Gray) Hbd. var *sulfurea* Rock, Bot. Gaz. **65**: 265, 1918.

P. tomentosa St. John & Hume, sp. nov.

Foliis oppositis, laminis 7.5–13 cm. longis late ellipticis infra tomentosis, cymis 3–5-floriferis, fructibus 18–21 mm. diametro, folliculis glabris.

Typus, Maui, Auhi, Ulupalakua, *G. C. Munro* 391, (Ho.).

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A Revision of Lacmellea, and the Transfer of Zschokkea (Apocynaceae)[1]

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INTRODUCTION

Conspectus.—In the following preliminary study all the species hitherto placed in Zschokkea are referred to Lacmellea. Two new species and three new varieties are described in Lacmellea. *Zschokkea monosperma* is placed in synonymy under *L. arborescens,* and *Z. peruviana* is reduced to varietal rank under this species. 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 Lacmellea (=Zschokkea), besides that of Mueller Argoviensis (16) in Martius' Flora Brasiliensis. K. Schumann (23) gives some differential characters for four species under Zschokkea and emphasizes the distinction between Lacmellea and Zschokkea. J. Miers (15) states his reasons for accepting the validity of Zschokkea, lists seven species under this genus, and publishes a new combination with Lacmellea. H. Hallier (7) discusses the systematic position of Zschokkea as known to him only from literature. Standley and Steyermark (28) present interesting observations on the identity of *Zschokkea Standleyi,* its bud characters, and Lacmellea. H. Pittier's (19) notes following his original description of *Zschokkea armata* also deserve notice, as do Ducke's (5 & 6) field data given after the description of his two novelties. J. Smith (24) communicates a vivid narration of his first encounter with the Hya-Hya or Milk-Tree of Demerara. R. Christison (3) offers an analysis of its latex in the same journal. Short descriptions of the structure of the wood as found in the genus and four species are given by L. Williams (30), whereas a short generic wood description, with uses and common names of Zschokkea, appears in Record & Hess' (22) Timbers of the New World.

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

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 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; G—Gray Herbarium, Cambridge; 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; 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 to me by Mr. B. A. Krukoff and Mr. E. J. Alexander, Drs. H. A. Gleason and H. N. Moldenke.

SYSTEMATIC TREATMENT

LACMELLEA Karst., Linnaea **28:** 449. 1857.

Zschokkea Muell. Arg., Mart. Fl. Bras. 6(1): 20. Pls. 6, 7. 1860.

Tribe *Carisseae* (2); small trees up to 30 m. high, the trunk up to 30 cm. diam., columnar, unarmed or armed with deciduous conic spines up to 2 cm. long (giving the tree a *Fagara*-like appearance), the bark grey to brownish, slightly scabrous, about 0.5 cm. thick, the white latex abundant, non-poisonous, sweet or bitter, the crown usually dense; branchlets slender, 1.5–4 mm. diam., flattened to bluntly or sharply quadrangular, brown or becoming grey, glabrous or sparsely hirtellous with short spreading hairs, marked with an interpetiolar line, the pith white to brown; leaves opposite, spreading to ascending, more or less uniformly spaced, the internodal space 3–8 cm. long, the axillary buds inconspicuous, few-scaled, pointed; petioles 1–15 mm. long, canaliculate above and rounded beneath, usually with minute glands near base, decurrent as faint ridges down the branchlets; blades elliptic, ovate or oblanceolate, 5–20 cm. long and 1.5–8 cm. broad, cuneate to acuminate, rounded or rarely subcordate at base, usually acuminate at apex and blunt at tip, rarely rounded or slightly emarginate, chartaceous to rigidly coriaceous, the upper surface dull to shining, drying brownish or greyish, the under surface pale-ferrugineous or greenish, sometimes dotted with minute black points and often becoming minutely rugulose, completely glabrous or sparsely hirtellous along the principal nerves, the midrib impressed on upper side and prominent on under side, the secondaries (secondary or lateral veins) slightly raised to rather markedly impressed on upper side, on under side raised to almost immersed, the principal pairs 6–30, with an average distance of 4–12 mm. apart near middle, diverging from the midrib at right angles or curved upwards, straight or arcuate, usually joined near the margins, the minor secondaries in between present or absent, the reticulation open and inconspicuous, becoming obscured as the blade matures, the tissue with minute brown-resinous granules; INFLORESCENCES axillary, cymose, lax to densely crowded, 3(1)-30 flowered, the infl. axis 0.6–4 cm. long, the peduncle to first pair of bracts up to 15 mm. long or completely reduced, the infl. branches 1–10 mm. long, glabrous or hirtellous, ascending to spreading or reflexed, the bracts and bracteoles ovate-lanceolate to ovate, usually ciliate like the calyx-lobes and otherwise simulating them, the pedicels short; calyx 1.5–4 mm. diam. below lobes, turbinate to somewhat obtuse at base, the calyx-tube very short, sometimes sparsely pubescent outside or inside, the calyx-lobes quincuncial, ovate, 0.8–3.5 mm. long and usually a little broader than long, rounded to subacute at apex, faintly subcordate at base, usually ciliate, sometimes sparsely pubescent outside or at base inside, dorsally thickened or flattened or sometimes keeled, the margins thin and sometimes irregularly and obscurely denticulate, persistent, without glands or squamellae (sometimes with fugacious vestigial scales at sides of base within); COROLLA greenish-white, usually fleshy, the corolla-tube slender hypocrateriform, 1.2–4 cm. long and 0.5–3 mm. diam. near middle, swollen above calyx and at region of insertion of stamens where sometimes with protruding pockets, glabrous or puberulent-hirtellous outside, pilose inside above base up to insertion of filaments, the corolla-lobes sinistrorsely contorted (viewed externally), from inconspicuously short, ovate and erect, to one-half the length of the tube, ligulate-oblong and spreading, blunt at apex, sometimes faintly subcordate at base (seen from within), 1–10 mm. long and 1–4.5 mm. broad, glabrous (microscopically papillose) to densely puberulent outside and inside, sometimes pilose at base, eciliate or ciliate on margins; ANTHERS located at about ¾ up corolla-tube in mature flower, basally attached on short but distinct filament or sessile, linear-lanceolate, 3–8.5 mm. long, sagittate at base, the basal lobes ¼ to almost ½ length of anthers, often extending into short, sharp or obtuse points, the apex extending into a non-polleniferous acumen, the acumen setose-filamentose or reduced to a mere mucro, 0.16–1.1 mm. long, penicillate at tip or sparsely pilose or completely glabrous; OVARY syncarpous, superior, ovate-oblong, glabrous, without apparent disk,[2] unilocular, the placentas two, each in cross section in the shape of a T with the ovules at the ends and parietal-facing sides of the expansion or cross-arm and with these intruded expansions often practically touching at the center of ovary, giving it a 2-celled axile-placental appearance, or here actually connected making the ovary 2-celled,[3] the ovules numerous, in 3–5

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[2] Woodson & Moore (33) illustrate how a disk surrounding the ovary becomes completely fused with the walls of the ovary.

[3] The general form of placentation is excellently illustrated in the photomicrographs of transverse sections shown by Woodson & Moore (33).

series on each placental arm, seen in longitudinal view as irregular polygons arranged in honeycomb-like mosaics; STYLE 2 10 mm. long up to lanate portion, glabrous, grading into the ovary or bulbose-thickened at base, more or less fluted, sometimes conspicuously so, the lanate portion 0.8 2.5 mm. long, the dense wool developing at maturity and finally deciduous, the apical branches 0.15–1.35 mm. long, sharp or obtuse at tips, glabrous (microscopically papillose) or densely hirtellous, shallowly concave axially, applicate or somewhat spreading in age, in bud sometimes intertwined; FRUIT a yellow to orange (usually edible) berry, 1–3 cm. diam., globose to spheroid, smooth, usually armed at apex with persistent base of style, 1 or 2-celled; seeds 1 or 2, about 6–15 mm. long, somewhat orbicular to elliptic convex on both sides, or flattened or concave and umbonate on the axial side, brownish, minutely rugulose, the cotyledons very thin, elliptic, almost the length and width of seed, venation usually not marked, the radicle short (up to 2 mm. long), the endosperm surrounding cotyledons thick and corneous or hard-gumming on maturity.

Type species.—Lacmellea edulis, Karst.

Lacmellea,[4] with *L. edulis* as the type species, was described by Karsten in Linnaea in 1857; in 1865 the author characterized it more completely and illustrated the species in Florae Columbiae. These descriptions and plate form the sole basis of all subsequent published remarks up to and including those in the present treatment on this genus, neither the type nor any authenticated material of *L. edulis* having ever been available. In 1860 Mueller proposed the genus Zschokkea, excellently exemplifying it by two plates and descriptions of six species, of which several type collections may be easily obtained for examination. Mueller noted that Lacmellea differs from Zschokkea in the structure of the corolla, deciduous lobes, insertion of the stamens, and the radicle. Bentham placed Zschokkea in synonymy under Lacmellea, remarking that the position of the stamens near the base of the tube described in Lacmellea is merely a bud condition true also in Zschokkea. Miers called Zschokkea a valid genus with extremely short rounded corolla-segments, very long slender anthers bidentate at their base and inserted within the upper part of the corolla-tube, simple style, densely barbate stigma, and a smaller dry capsular fruit. Furthermore, the distinctions between the two genera were so clearly marked in his judgment, apparently, that he transferred *Tabernaemontana* (?) *lucida* H.B.K., known to him only from description, to Lacmellea (see discussion under Doubtful Species at the end of this paper). Schumann, expressing opposition to Bentham's merging of Zschokkea with Lacmellea,

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[4] Lacmellea is the original spelling. Bentham (Benth. & Hook. Gen. Pl 2(2) 694. 1876) spelled the genus Lacmellia; as did likewise many other authors, such as Schumann, Miers, Baillon, Lemée, Dalla Torre & Harms, Kuntze & Post, and it is so spelled in both Index Kewensis and Index Londinensis.

adduced as differential characters for maintaining Lacmellea as a separate genus the basal insertion of the stamens, the anthers merely pointed instead of extended at apex, and the corolla-tube deciduous so that the androecium remains forming a crown over the ovary. Pittier remarked upon the great vagueness in the definitions of Ambelania, Zschokkea, and Lacmellea, and it was only with hesitation that he placed his long corolla-lobed *Z. armata* (which at first he had suspected of being *Lacmellea edulis*) in Zschokkea. Woodson (31) believed the true identity of *Lacmellea edulis* was firmly established by its discovery in British Honduras and the position of the genus Lacmellea thus clarified. He analyzed the flower-buds of this plant which he compared with the mature flowers of his own new *Zschokkea panamensis* (which, in turn, had been reported as *Lacmellea edulis* by Standley in The Flora of Barro Colorado Island, Panama) and partly as a result of these observations gave Lacmellea and Zschokkea separate treatment in North American Flora. Shortly afterwards, Woodson (26) described another new species of Zschokkea, *Z. Standleyi*, from Guatemala. In the same year, however, Standley and Steyermark (28) published a statement of the identity of this species with the material from British Honduras known as "Lacmellea edulis." In the ensuing discussion on Lacmellea and Zschokkea they observed: "In the undeveloped corollas of the British Honduras tree the corolla tube is at first short, and the anthers *are* borne near its middle; but, when the corolla is ready to open, as shown by the Guatemalan specimens, the tube has become much longer, and the anthers, although they have actually maintained their former position, are now near the apex of the elongated tube." These authors added that they "will not be surprised if ultimately Lacmellea and Zschokkea prove to be congeneric."

In the original description in Linnaea the only obvious feature in which Lacmellea seems to differ from Zschokkea is in the insertion of the stamens near the base of the corolla-tube instead of near the throat. The radicle is described as fusiform, and the actual interpretation of "corolla . . . laciniis . . . deciduis" is doubtful. Karsten explicitly states that he examined only the bud of *Lacmellea edulis:* "alabastri unius subevoluti examen." As first noted by Bentham and recently plainly stated by Standley and Steyermark, the stamens in the flower buds of Zschokkea are inserted low in the corolla-tube; there is, then, no disparity between this feature as described in Lacmellea and as it is found in Zschokkea. In Florae Columbiae Karsten described and illustrated clearly the corolla-tube circumscissile above the insertion of the stamens, thus falling off together with the corolla-lobes and leaving the anthers protruding cone-fashion from the persistent base of the corolla. It is this feature which may have been originally meant in Linnaea by "laciniis . . . deciduis." The anthers are delineated in the analysis as short-pointed at the apex and without extensions at the base. The radicle is drawn about 1/7 the entire length of the embryo, and the venation on the cotyledons is more marked than it appears in most of the Zschokkea species I have examined (see illustration of cotyledon of *Z. arborescens* in Mart. Fl. Bras.). The habit sketch shows the corolla-lobes spreading while the tube is scarcely exserted from the calyx, a character that I have observed only in mature flowers with elongated corolla-tubes in Zschokkea; and the leaves have a marked reticulation which is common only in young leaves. The stigma is not clearly depicted in the figure nor satisfactorily described in the text. No mention is made as to whether or not the style and stigma are glabrous, nor could this feature be thoroughly trusted in the bud since in Zschokkea the style is at first glabrous, the dense barbation at the apex developing only later on. The anthers of *Lacmellea edulis*, as figured, are conformable with those of some species described in Zschokkea, the short tips and blunt bases being no more so than those shown, for example, in *Zschokkea utilis*, Hooker's Icones Pl. 2637. Long corolla-lobes are frequent in the genus, and the fruits are up to 3 cm. in diameter (they are described as large as a hazel nut in *Lacmellea edulis*), pulpy and edible. Circumscissile corollas, however, are not found in Zschokkea, nor in any other member of the Apocynaceae known to me. This anomaly is hardly credible. In Zschokkea the corolla-tube ruptures at the extreme base, not above the insertion of the stamens, and not in a clear-cut circumscissile dehiscence.

In my opinion Lacmellea and Zschokkea are congeneric. I have no doubt in the application of the genus Lacmellea to all the species described in Zschokkea. This conclusion is suggested forcibly by the habit sketch of *L. edulis*, the general characterization of both genus and species, description and illustrations, and even by the delineation of such minute details at the 10-costate style. Its original description in Linnaea is satisfactorily, if not fully, conformable with Zschokkea; and most of the additional information presented in Florae Columbiae is within the limits permissible for specific variations and inaccurate observation, the circumscissile corolla being the only inexplicable difficulty. Circumstantial evidence derived from several angles is also worth consideration in favor of the congenerity of Zschokkea and Lacmellea. Seventeen species have been described in Zschokkea, ranging from British Honduras in Central America to the state of Espirito Santo in Brazil, whereas in Lacmellea, only one from the original material collected at or near the center of distribution of Zschokkea. *Triana 1882* (cited under *L. edulis*) collected in the Ilano de San Martín, Colombia, a region which is probably near the type locality of Karsten's plant, is certainly a Zschokkea, if not conspecific with *L. edulis*. S. Cortes (4) writes of a tree which he names *L. edulis*, with edible fruits and a latex exhaling an aroma of vanilla, called "Lechemiel" in Villavicencio. The latex of *Zschokkea lactescens*, sometimes called "Vainillo," is known to have a vanilla odor. *Lacmellea edulis*, in its overall description, suggests a species very close to or possibly identical with *Zschokkea armata*.

The alternative decisions confronting the resolution of the generic problem here are: 1. Accept Lacmellea on priority and transfer all Zschokkea species to this genus. 2. Propose Zschokkea as a nomen conservandum. 3. Treat all the species except *Lacmellea edulis* under Zschokkea purely on the strength of their better agreement with this genus rather than with the literal description of Lacmellea. The third alternative is a disregard of fair evaluation, a lack of interpretation, and an evasion of the true problem; if this course is followed, Lacmellea may remain a never-to-be-rediscovered genus, an arborescent member of the Carisseae characterized by a low insertion of its stamens on a short circumscissile corolla-tube. The second choice has some weighty arguments in its favor. Taking recourse to such an act would eliminate the necessity of sixteen new transfers, would maintain a well known genus accurately described and amply represented by authentic material. I do not feel, however, that it is a safe practise to take advantage of a convenience when it involves the arbitrary suppression of a prior genus as satisfactorily, although far from perfectly, defined as Lacmellea.

Lacmellea is confined to the tropics of the Western Hemisphere. *L. Standleyi* has been collected in the Izabal region of Guatemala and in the adjacent Toledo district of British Honduras. A very close relative of this species, *L. panamensis*, is found in Panama, and from thence on other members of the genus are somewhat common in gregarious or scattered stands, generally along water courses, in British Guiana, Venezuela, the Amazon region of Colombia, Peru, probably Ecuador and Bolivia, and throughout the State of Amazonas in Brazil. The genus is abundantly represented in the State of Pará in Brazil, but then apparently skips the Maranhão-Goyaz region to be discovered again in Bahia and Espirito Santo. The distribution has a marked similarity to that of Couma (see Monachino, A Revision of Couma and Parahancornia. LLOYDIA 6: 231. 1943), except that there is in Lacmellea more regional or local specific segregation along the way. For example, the Longipetalae-hirtellistigmata (see below) group of Lacmellea is analogous to the single widespread *Couma macrocarpa* Barb. Rodr. in its northern area, while three members of the Longipetalae-glabristigmata, *L. grandiflora* and *L. floribunda* in Peru and western Amazonas on the one hand and *L. aculeata* in Pará and eastern Amazonas on the other represent it in the south. The apparent isolation of *L. pauciflora* in Espirito Santo (and Bahia?) recalls the similar geographical disjunction observed in *Couma rigida* Muell. Arg. of Bahia. The state of Amazonas in Brazil harbors at least 6 species; and the contiguous territory of Peru at least 4, while *L. Foxii* is reported from Putumayo. *L. arborescens* and *L. aculeata* are common in Pará. A variety of the latter species is found in

Dutch Guiana; *L. utilis* is confined to British Guiana and *L. guyanensis* to French Guiana.

Lacmellea is a distinctive genus belonging in the Couma-Parahancornia-Ambelania-Hancornia group of Carisseae. Although it might be best placed between Ambelania and Hancornia, it is not very closely related to any one particular member of the tribe.

The species of Lacmellea are all closely interrelated, no sectional classification being particularly desirable within the genus. The nearest approach to natural grouping might be designated thus.—A. *Longipetalae* group, with two subgroups, 1. *Longipetalae-hirtellistigmata;* 2. *Longipetalae-glabristigmata;* and B or 3 *Brevipetalae* group. 1. LONGIPETALAE-HIRTELLISTIGMATA are characterized by long patent corolla-lobes, style with densely hirtellous, short apical branches, and anthers with penicillate tips. Of the species in this group *L. Standleyi* and *L. panamensis* are most closely allied; *L. armata* and *L. edulis* (not seen by me) I suppose to be very closely related if not conspecific, and *L. lactescens* somewhat removed but still very near to *L. armata* and *L. utilis.* 2. LONGIPETALAE-GLABRISTIGMATA are characterized by long patent corolla-lobes, style with glabrous long apical branches, and anthers with glabrous (or sparsely pilose) tips. This group is transitional from group A to B. Of the entities in this group, *L. grandiflora* stands somewhat alone unless *L. pauciflora* (not seen by me) is found to be very close to it. *L. floribunda* and *L. aculeata* (with its varieties) comprise the other unit. 3. BREVIPETALAE are characterized by very short, erect corolla-lobes, style with glabrous apical branches and anthers with glabrous tips. It is the largest and most complex group in the genus. *L. Foxii* and *L. densifoliata* were not seen by me and my placing them next to *L. microcarpa* should be construed as an approximation; *L. utilis* and *L. arborescens* also belong with this relationship, while *L. guyanensis* has an indefinite position here. *L. arborescens* loses specific coherence in Peru where the var. *peruviana* replaces it. *L. Klugii* and *L. ramosissima* should be associated together, although the former species shows obviously close connections to forms of *L. arborescens* var. *peruviana. L. gracilis* is best placed with *L. Klugii* and *L. ramosissima,* somewhat removed and vaguely reminiscent of *L. arborescens.*

In general, minor characters in the species of Lacmellea are significant for the delimitation of entities. Besides the floral features identifying the groups as suggested above, the ciliate or eciliate condition of the corolla-lobes and the presence or lack of puberulence on their outsides have been found of some diagnostic value. The absence of distinct filament in *L. gracilis* is noteworthy. Minor variations in the lengths of corolla-tube and lobes, the style, its lanate portion or apical branches, the acumen at apex of anthers, the obtuse or apiculate shape of the anther bases, are generally not trustworthy. The inflorescence habit is fairly important. The calyx size is significant within broad limits; the apices of the corolla-lobes, however, are not reliable as to their shapes. The hazardous task of separating foliage samples of *L. arborescens* var. *peruviana* from the related *L. Klugii* or the unrelated *L. floribunda* exemplifies the difficulty in differentiating sterile material in Lacmellea. In general, the number of secondaries and their spacing on the blades, the luster on the upper surface of the leaves and the presence of black dots on the under side are characters of some importance; the shape of the blade at base is more important than at apex; the length of the petiole is helpful in several instances. The pubescence on the vegetative parts is of little if any value. The full importance of spines on the trunks is not clear at present, but too much stress on this habit should be regarded with suspicion, as the spines are deciduous and variable in number.

The local names of Lacmellea species, referable to the regions from which they are reported, are as follows:—BRITISH HONDURAS: *Cow-Tree* or *Palo de Vaca*, *Prickly Vaca*, *Vaca*. COLOMBIA: *Leche y Miel* (Rio Meta; Villavicencio), *Raya Caspi* or *Vainillo* (Caqueta). VENEZUELA: *Cabrahosca* (Perija). BRITISH GUIANA: *Cow-Tree*, *Hya-Hya*. DUTCH GUIANA: *Awaratalla*, *Boebocraballi*, *Pritijari*, *Schopsteelhout*. BRAZIL, PARÁ: *Cumahy*, *Guajará-y*, *Molongó* or *Mulungu*, *Pao de Colher*, *Sorva Branca*, *Sobrerinha*, *Tucuja* or *Tucupa*. BRAZIL, AMAZONAS: *Chicle* (the gum), *Chicle de Espinho*, *Chicle de Terra Firma*, *Condurú de Espinho*, *Pau de Chicle*, *Sorvinha* (Rio Madeira, Rio Solimões), *Tamanqueira de Leite* (Acre & Rio Madeira), *Pepino* (Manáos), *Yaquitaque* (São Gabriel). BRAZIL, BAHIA: *Xinemen* (Bôm Gosta, municip. Ilheos). BRAZIL, RIO DE JANEIRO: *Apui* or *Jacataca* (cultivated).

The principal use of Lacmellea is found in its latex which is used to a limited extent as a basic material in the manufacture of chewing gum. The latex is generally sweetly palatable, that of *L. utilis* being said to be indistinguishable from animal milk when used in tea. That of both *L. Klugii* and *L. armata* has been reported to be used in popular medicine (to cure disturbances of the digestive tracts). According to G. S. Jenman the latex of *L. utilis* contains a large proportion of rubber of good quality, and according to the collector, that of *L. Foxii* is used mixed with Hevea and Castilloa rubber. The gummy latex of *L. arborescens* is reported used in Obidos as bird-lime to catch small birds. The wood of Lacmellea is sometimes utilized for interior construction and for such articles as spade-handles. The fruits of the majority of the species are edible.

KEY TO THE SPECIES AND VARIETIES OF LACMELLEA

(Flowers not seen in species followed by asterisk)

1. Corolla-lobes more than 3.5 mm. long when mature, spreading 2
    2. Apical branches of style above lanate portion densely hirtellous; acumen of anthers penicillate at tip with a tuft of very short hairs 3

3. Corolla-tube about 2.5 cm. long when mature.................................4

    4. Calyx 3–4 mm. diam. below lobes, the calyx-lobes 2.5–3 mm. broad and 2–2.5 mm. long; corolla-lobes glabrous outside; principal secondaries with an average distance of 12 mm. apart near middle of blade. (Guatemala & British Honduras.).. 1. *L. Standleyi*

    4. Calyx 2–2.5 mm. diam. below lobes, the calyx-lobes 1.5–2 mm. broad and 1–1.6 mm. long; corolla-lobes minutely puberulent outside particularly toward base; principal secondaries with an average distance of 7 mm. apart near middle of blade. (Panama.)................................ 2. *L. panamensis*

3. Corolla-tube about 1.5 cm. long when mature. (South America.).......... 5

    5. Inflorescence-branches ascending; leaf-blades elliptic, cuneate at base, the principal secondaries 11–13 pairs with an average distance of 5–7 mm. apart near middle...6

        6. Corolla-lobes ciliate; anthers merely apiculate at apex. (Aff. *L. armata;* Rio Meta, Colombia.)..............................3. *L. edulis**

        6. Corolla-lobes not ciliate; anthers acuminate at apex.......4. *L. armata*

    5. Inflorescence-branches spreading to reflexed at maturity; leaf-blades lanceolate, rounded to broadly cuneate at base, the principal secondaries about 9 pairs with an average distance of 7 mm. apart near middle.........5. *L. lactescens*

2. Apical branches of style above lanate portion glabrous; tips of anthers sparsely pilose or glabrous; corolla-tube mostly over 2 cm. long at maturity. (?*L. pauciflora.*)..........7

    7. Petioles 3–10 mm. long; blades 5–10 cm. long and 1.5–3 cm. broad, dull on both surfaces, the principal secondaries about 20 pairs with an average distance of 4 mm. apart near middle, diverging from midrib at right angles or curved slightly upward; inflorescences with ascending branches, generally loosely 3-flowered............8

        8. Branchlets usually sharply quadrangular; corolla-tube sparsely hirtellous outside. (Peru.)..6. *L. grandiflora*

        8. Branchlets not sharply quadrangular; corolla-tube glabrous outside. (?Aff. *L. grandiflora;* state of Espirito Santo, Brazil.)................7. *L. pauciflora**

    7. Petioles 5–13 mm. long; blades 10–20 cm. long and 3–8 cm. broad; principal secondaries ascending-arcuate; inflorescences 3–7 flowered.................... 9

        9. Inflorescences lax, the infl. branches spreading to reflexed; leaf-blades shining on upper surface, the principal secondaries 17–20 pairs with an average distance of 5–7 mm. apart near middle...................... 8. *L. floribunda*

        9. Inflorescences not lax, the infl. branches ascending; leaf-blades dull on upper surface, the principal secondaries 10–12 pairs with an average distance of 10 mm. apart near middle...9a

            9a. Corolla-lobes minutely puberulent outside; calyx-lobes and bracts ciliate; trunk of tree armed with spines.......................9. *L. aculeata*

            9a. Corolla-lobes glabrous outside..................................9b

                9b. Calyx-lobes and bracts eciliate; trunks of tree without spines. (Brazil.)........................9a. *L. aculeata* var. *inermis*

                9b. Calyx-lobes and bracts ciliate. (Suriname.)..................... ....9b. *L. aculeata* var. *surinamensis*

1. Corolla-lobes less than 3 mm. long, erect; apical branches of style above lanate portion glabrous; anthers glabrous; corolla-tube about 1.5 cm. long..........................10

    10. Anthers with short but distinct filament.......................................11

        11. Corolla-lobes (about 1 mm. long) glabrous outside, obscurely ciliate, and leaf-blades dull on upper surface, the principal secondaries 13–16 pairs with an average distance of 7 mm. apart near middle. (British Guiana.)........10. *L. utilis*

        11. Corolla-lobes and leaf-blades not with the above combination of characters....12

            12. Corolla-lobes 1.3–2.5 mm. long, not ciliate.........................13

                13. Inflorescences lax; petioles 1–4 mm. long; blades obtuse at base, the principal secondaries 9–11 pairs. (?Aff. *L. utilis;* French Guiana.).. ....11. *L. guyanensis**

                13. Inflorescences not lax; petioles 4–9 mm. long..................14

                    14. Leaf-blades rounded or subcordate at base and roundish at apex, rigidly coriaceous, the secondaries 10–12 pairs. (Aff. *L. microcarpa;* state of Pará, Brazil.).......14. *L. densifoliata**

14. Leaf-blades rounded to acuminate at base and usually acuminate at apex, the principal secondaries 15–30 pairs........15
15. Under side of blades dotted with minute black points.16
16. Calyx about 1.6 mm. diam. below lobes, the calyx-lobes 1.3–1.4 mm. broad and 1–1.6 mm. long; corolla-lobes densely puberulent outside; leaf-blades rigidly coriaceous, the margins recurved, the secondaries slightly raised on upper side and often obscure on under side. (Upper Rio Negro.) ....12. *L. microcarpa*
16. Calyx 2.5 mm. long. (Aff. *L. microcarpa;* Putumayo Territory, Peru.)..........13. *L. Foxii**
15. Under side of blades not dotted; calyx 2.2–2.8 mm. diam. below lobes, the calyx-lobes 1.7–2.2 mm. broad. 15a
15a. Corolla-lobes densely puberulent outside; leaf-blades usually shining on upper surface. (Pará and Amazonas.).............15. *L. arborescens*
15a. Corolla-lobes glabrous or very sparsely puberulent, sometimes approaching the above; leaf-blades often dull on upper surface. (Peru.)........... ....15a. *L. arborescens* var. *peruviana*
12. Corolla-lobes 1–1.3 mm. long, dorsally thickened and with a spreading margin, ciliate, glabrous outside, short-pilose at base inside; calyx-lobes 1.2–1.4 mm. broad and 1 mm. long.......................................17
17. Principal secondaries 14–20 pairs with an average distance of 4–5 mm. apart near middle of leaf-blades; leaf-blades broadly to sharply cuneate at base, drying brownish on upper surface..16. *L. Klugii*
17. Principal secondaries 6–12 pairs with an average distance of 7–10 mm. apart near middle of leaf-blades, the fainter secondaries in between often clearly present; leaf-blades cuneate to acuminate at base, drying greyish on upper surface......................17a
17a. Corolla-tube glabrous or sparsely hirtellous outside........ ....17. *L. ramosissima*
17a. Corolla-tube moderately to densely hirtellous outside...... ....17a. *L. ramosissima* var. *hirtella*
10. Anthers sessile; leaf-blades rounded to broadly cuneate at base, the principal secondaries about 16 pairs with an average distance of about 3 mm. apart near middle, very fine; calyx-lobes 1–1.3 mm. broad and 1 mm. long; corolla-lobes 1–1.3 mm. long, densely pilose at base inside, otherwise essentially glabrous...............18. *L. gracilis*

1. **Lacmellea Standleyi** (Woodson) Monachino, comb. nov.

Zschokkea Standleyi Woodson, apud Standl., Field Mus. Pub. Bot. 22 (1): 44. 1940.

Petioles 0.5–1 cm. long; leaf-blades oblong-elliptic, usually broadest above middle, 11–16 cm. long and 4–6 cm. broad, rounded to obtuse at base, dull on both surfaces, the principal secondaries about 12 pairs with an average distance of 12 mm. apart near middle; inflorescences with ascending branches, rather loosely 3–6 flowered, the peduncle to first pair of bracts average 1 cm. long (up to 2 cm.), the infl. branches average 4–8 mm. long (up to 11 mm.); calyx about 3–4 mm. diam. below lobes, the calyx-lobes 2.5–3 mm. broad and 2–2.5 mm. long; corolla-tube 2.5 cm. long, glabrous outside, the corolla-lobes 8–10 mm. long and 3–4.5 mm. broad, spreading or reflexed at maturity, glabrous (microscopically papillose) both outside and inside, or very sparsely pilose near base within;

anthers 4.5-5.5 mm. long, the acumen 0.3-0.6 mm. long and penicillate at tip with a tuft of very short hairs; style up to woolly part 6 mm. long, the woolly portion 1.5-2.5 mm. long, the apical branches 0.2-0.3 mm. long and densely hirtellous.

Type.– "Guatemala: Entre Ríos, Dept. Izabal, Alt. ca. 18 m., common in pasture, April 30, 1939, *P. C. Standley 72587* (Herb. Missouri Bot. Garden, type; Her. Field Mus., duplicate)."

Illustration.—"Lacmellea edulis" (33); photomicrograph from transverse section of ovary.

Distribution.—Atlantic Guatemala and adjacent British Honduras, lowlands and higher altitudes; common near Entre Ríos.

Specimens examined.—Guatemala, dept. Izabal: *Standley 72587* (type coll.; Apr., fl.; F, M); *Steyermark 38886* (Apr., fl.). British Honduras, Toledo district: *Kinloch 11* (F, Y); *Schipp 1234* (Nov., fr.), *1326* (Feb., fl. immature), *s.n.* (M); *Stevenson 120* (Yale Ser. No. 14902; Y).

L. Standleyi was reported as *L. edulis* in Tropical Woods (31) and North American Flora (32). It is very closely allied to the next species, differing essentially from it only in quantitative characters; the larger leaves, calyx, corolla, and the greater development of puberulence on the corolla-lobes.

2. **Lacmellea panamensis** (Woodson) Monachino, comb. nov.

Zschokkea panamensis Woodson, Trop. Woods **44**: 22. 1935.

Petioles 0.4-1 cm. long; leaf-blades oblong-elliptic, broadest above, at or below middle, 8.5-12.5 cm. long and 2-4 cm. broad, rounded to obtuse at base, dull on both surfaces, the principal secondaries about 13 pairs with an average distance of 7 mm. apart near middle; inflorescences with ascending branches, rather loosely 3-9 flowered, the peduncle to first pair of bracts averages 4 mm. long (up to 7 mm.), the infl. branches average 2-5 mm. long (up to 8 mm.); calyx about 2-2.5 mm. diam. below lobes, the calyx-lobes 1.5-2 mm. broad, and 1-1.6 mm. long; corolla-tube 2.5 cm. long, glabrous outside, the corolla-lobes about 6-8 mm. long and 3 mm. broad, spreading or reflexed at maturity, puberulent outside particularly toward base, densely pubescent near base within; anthers about 4.5 mm. long, the acumen 0.5-0.65 mm. long and penicillate at tip with a tuft of very short hairs; style up to woolly part about 6.5 mm. long, the woolly portion 2 mm. long, the apical branches 0.4 mm. long and densely hirtellous.

Type.—"Panama: Canal Zone: Barro Colorado Island, Feb. 1932. *R. H. Woodworth & P. A. Vestal 639* (Herb. Missouri Bot. Garden, Type)."

Illustration.—*Zschokkea panamensis* (33); photomicrograph from transverse section of ovary.

Distribution.—*L. panamensis* is known only from Panama; it is apparently common on Barro Colorado Island in the Canal Zone.

Specimens examined.—Panama, Canal Zone, Barro Colorado Island: *Silvestre Aviles 88* (F);

C. L Wilson 98 (March, fr & fl , F), *R. H. Woodworth & P. A. Vestal 470* (Feb , fr ; A, F), *639* (type coll ; Feb , fl ; A, F, M), *J Zetek 3624* (M), *3818* (March, fl immature; F, M). Panama, above Penonome *R. S. Williams 587*.

L. panamensis was reported as *L. edulis* from Barro Colorado Island (25). Like *L. Standleyi*, it is clearly related to the three following species from which it differs most markedly in the proportions of length of corolla-tube to corolla-lobes.

3. LACMELLEA EDULIS Karst., Linnaea 28: 449. 1856.

Petioles about 5 mm. long; blades elliptic, 10 cm. long and 3–3.5 cm. broad, broadly cuneate at base, shining on upper surface (?), the principal secondaries 11–12 pairs with an average distance of 5–7 mm. apart near middle; inflorescences with ascending branches, loosely 3–8 flowered; corolla-lobes oblong, ciliate; anthers relatively short pointed at apex.

Type.—"littoribus Metae," Colombia. Miers gives the type locality as "about 70° 40′ W. & 60° 20′ N.," the figure 60° 20′ being possibly a typographical error for 6° 20′. Pittier locates it in "los llanos que median entre Venezuela y Colombia;" Woodson, in "the Colombia Andes." Consideration of Karsten's itinerary in Colombia suggests that the type was collected in the western headwaters of Rio Meta, probably in the Villavicencio-San Martín sector.

Illustration.—Type (11); branchlets with leaves, flowers and fruits, analysis of the flower buds, seeds with embryo.

Distribution.—Known from Rio Meta in Colombia, as originally reported; *Triana 1882* from the Llano de San Martín, Colombia, is of doubtful determination.

Specimen examined.— Colombia: *Triana 1882* (determination doubtful; Llano de San Martín, 240 m.; US).

This important collection, which is unfortunately sterile, probably represents true *L. edulis*. Vegetatively it has a very close resemblance to *L. armata*.

L. edulis is known definitely only from the two original descriptions. It is very similar to, if not identical with *L. armata*. For further remarks see discussion under genus.

4. **Lacmellea armata** (Pittier) Monachino, comb. nov.

Zschokkea armata Pittier, Bol. Cient. y Tecn. Mus. Com. Venez. 1: 68. 1925. Bol. Com. e Ind. 4: 40. 1923.—nom. seminudum.

Petioles 0.5–1 cm. long; leaf-blades oblong elliptic, broadest above, at or below middle, 6–10.5 cm. long and 2–3.5 cm. broad, obtusely cuneate at base, dull on both surfaces, the principal secondaries about 13 pairs with an average distance of 5 mm. apart near middle; inflorescences with ascending branches, rather loosely 3–9 flowered, the peduncle to first pair of bracts averages 5 mm. long (up to 7 mm.), the infl. branches average 3 mm. long; calyx about 2 mm. diam. below lobes, the calyx-lobes 1.5-1.8 mm. broad and 1.5-1.8 mm. long; corolla-tube about 1.6 cm. long, glabrous outside, the corolla-lobes about 8 mm. long and 2.2 mm. broad, spreading or reflexed at maturity, microscopically puberulent toward apex outside, sparsely pilose near base within; anthers about 4 mm. long, the acumen 0.3 mm. long and penicillate at tip with a tuft of very short hairs; style up to woolly part about 3.5 mm. long, the woolly portion 1.3–1.6 mm. long, the apical branches 0.4 mm. long and densely hirtellous.

Type.—"Zulia: Selvas del rio Lora, en la proximidad de los cursos de aqua; Dec. 18, 1922 (*Pittier 10987*)."

Distribution.—Authenticated *L. armata* is known only from the type collection reported from cleared areas in the forests of Lora River, where it is said to be apparently scarce.

Specimens examined.– Venezuela, Zulia: *Pittier 10987* (type coll; Dec., fl.; A, U).

L. armata may ultimately be proved to be identical with *L. edulis*. The latter, as illustrated, differs from it in the ciliate corolla-lobes and in the anthers merely apiculate at apex and obtuse at base.

5. **Lacmellea lactescens** (Kuhlm.) Monachino, comb. nov.

Zschokkea lactescens Kuhlm., Arch. Jard. Bot. Rio de Janeiro 5: 207. 1930.

Petioles 0.5–1 cm. long; leaf-blades lanceolate, usually broadest below the middle, 4–10 cm. long and 2–4 cm. broad, rounded to broadly cuneate at base, dull on both surfaces, the principal secondaries about 8–9 pairs with an average distance of 7 mm. apart near middle; inflorescences with branches spreading to reflexed at maturity, loosely 5–23 flowered, the peduncle to first pair of bracts 5–10 mm. long, the infl. branches average 3-4 mm. long; calyx about 2.2 mm. diam. below lobes, the calyx-lobes about 2 mm. broad and 1.2–1.8 mm. long; corolla-tube about 1.5 cm. long, glabrous outside, the corolla-lobes 4.5–7 mm. long and 2-3 mm. broad, spreading or reflexed at maturity, microscopically puberulent toward apex outside and obscurely sub-ciliate on the margins, otherwise glabrous; anthers 4–4.5 mm. long, the acumen about 0.3 mm. long and penicillate at tip with a tuft of very short hairs; style up to woolly part about 4 mm. long, the woolly portion 1.4–1.6 mm. long, the apical branches 0.16–0.23 mm. long and densely hirtellous.

Type.—"silvis margine fluminis Abuna, terr. Acre Brasiliae; Oct., 1923; *J. G Kuhlmann 709*."

Distribution.—Scattered throughout the Amazonas in Brazil and adjacent Peru, Colombia and probably in Venezuela; in lowlands of terra firma on varzea, restinga and igapó.

Specimens examined.—Brazil, Amazonas: *Adams 65a, 65b; ducke 20* (Yale Ser. No. 20701;

Oct.-Nov., fl.; F, Y); *Froes 97, 99* (June, fl.), *105* & *139-141* (June, fr.), *142, 243, 859* (April, fl. & fr.), *872* (May, fl.), *Krukoff 4634* (June, fr.), *6414* (Sept.-Oct., fr. immature), *8393* (Sept.-Oct., fl. & fr. immature); *C. W. Smith 12221; coll. undesignated 12620.* Peru, Loreto: *Ducke 22410* (Iquitos; "ad urbem culto"; July, fl.; U); *L. Williams 159* (Rio Masana; F). Colombia, Caqueta: *Wesselhoeft 12651* (Rio Caqueta).

6. **Lacmellea grandiflora** Monachino, sp. nov.

Arbor usque ad 15 m. alta; ramulis plerumque argute quadrangulatis; petiolis 3–6 mm. longis; laminis 5–9 cm. longis, 1.5–3 cm. latis, ad basin rotundatis vel late cuneatis, venis secundariis ca. 40; ramis inflorescentiarum adscendentibus ca. 3-floribus; tubo calycis 3–4 mm. diametro, lobis 3–3.5 mm. longis, 3 mm. latis; tubo corollae ca. 3.5 cm. longo, lobis 6 mm. longis et 3.5 mm. latis, glabris patentibus; antheris 5 mm. longis glabris vel ad apicem 1–3 pilis ornatis; cruribus stigmatis 0.5 mm. longis glabris.

Tree up to 15 m. high, the branchlets sharply quadrangular or flattened, minutely hirtellous, dark brown; petioles 0.3–0.6 cm. long, glabrous; blades chartacious, lanceolate to oblongish, 5–9 cm. long and 1.5–3 cm. broad, rounded to broadly cuneate at base and with an acumen at apex 0.5–1.5 cm. long, dull on both surfaces and pale on under side, hirtellous on nerves on under side or entirely glabrous, the midrib sunken on upper side and prominent on under side, the principal secondaries about 20 pairs with an average distance of 4 mm. apart near middle, diverging from midrib at right angles or curved slightly upwards, markedly sunken on upper side to hardly so and prominent on under side; inflorescences with ascending branches, generally rather loosely 3 flowered, the peduncle to first pair of bracts 2–4 mm. long or completely reduced, the infl. branches 3–6 mm. long, the bracts ovate to lanceolate, 1–3 mm. long, acute at apex, sparsely hirtellous on back to glabrous and ciliate; calyx about 3–4 mm. diam. below lobes, the calyx-lobes ovate, about 3 mm. broad and 3–3.5 mm. long, rounded to obtuse at apex, strongly ciliate; corolla-tube about 3.5 cm. long, sparsely hirtellous outside, with protruding pockets at region of insertion of anthers, the corolla-lobes oblong-lanceolate slightly auriculate at base, about 6 mm. long and 3.5 mm. broad, glabrous, spreading or reflexed at maturity; anthers inserted ¾ up the corolla-tube on obvious filaments, about 5 mm. long, the acumen about 0.5 mm. long, broadened with a membranous margin, erect, glabrous or beset with 1 to several minute bristles at tip; ovary 1-locular with the parietal placentae intruded and touching at center of cell, about 2 mm. long, the style fluted, slightly bulbose-constricted at base, 8–9 mm. long up to woolly part, the woolly portion 1.5–2 mm. long, the apical branches about 0.5 mm. long, glabrous.

Type.—*Klug 3014;* Peru, dept. Loreto, Balsapuerto, alt. about 220 m., forest; Apr. 1933. (Deposited in Britton Herb. NY)

Distribution.—Known only from dept. Loreto, Peru; high lands.

Specimens examined.—Peru, Loreto: *Klug 3014* (type coll.; A, G, M, NY, U); *Tessmann 4012* (mouth of Rio Santiago; fl.), *4739* (atypical; Puerto Melendez, below Pongo de Manseriche; fl. & fr. immature); *L. Williams 1738* (Pebas on the Amazons River; July, fl. immature; F, M).

L. grandiflora is a distinctive species easily separable from all the others examined. It has a marked similarity to the illustration of *L. pauciflora*, a species which is, however, reported from a region incongruous with that of our plant.

7. **Lacmellea pauciflora** (Kuhlm.) Monachino, comb. nov.

Zschokkea pauciflora Kuhlm., Archiv. Inst. Biol. Veg. Rio de Janeiro 3 (1): 47. Pl. 5. 1936.

Petioles 5–10 mm. long; blades elliptic-oblong, 6–10 cm. long and 1.5–3 cm. broad, broadly cuneate at base, the principal secondaries about 20 pairs with an average distance of 4–5 mm. apart near middle, diverging from midrib at right angles or curved slightly upwards; inflorescences 2–3 flowered, 5–6 mm. long, the infl. branches 4–5 mm. long; calyx 4–5 mm. long and 4 mm. diam.; corolla before anthesis 1 cm. long, the corolla-tube 3 mm. diam., the corolla-lobes 4.5 mm. long; anthers 4 mm. long; style up to woolly part 3 mm. long, the woolly portion and apical branches 2 mm. long.

Type.—"silvis non longe ad apidum Collatina, civ. Espirito Santo. Legit. *J. G. Kuhlmann 60* (26-*III*-1934); Jard. Bot. Rio 28902."

Illustration.—Type (12); branchlet with leaves and flower buds, analysis of flower bud, fruit, seed.

Distribution.—Reported from the state of Espirito Santo, Brazil; very probably in Bahia.

Specimen examined.—Brazil, Bahia: *Froes 1095* (basin of Rio Sta. Ana, municip. Ilheos, Bôm Gosta; March, immature fruits).

L. pauciflora was described from a plant with immature flowers. The illustration of the bud, nevertheless, shows clearly that it belongs to the Longipetalae. This tree represents the southernmost range of the genus.

Froes 1095 is probably of the species. Unfortunately, no flowers are present for examination; the leaves, however, are as illustrated for *Zschokkea pauciflora*. It is reported a tree 50 feet high and 10 inches in diameter, growing on highlands. The foliage is most like *L. grandiflora* of the known species, but the branchlets are like those of *L. lactescens*, not sharply quadrangular.

8. LACMELLEA FLORIBUNDA (Poepp.) Benth., Benth. & Hook. Gen. Pl. 2 (2): 694. 1876.

Hancornia floribunda Poepp., Nov. Gen. 3: 70. Pl. 279. 1845.
Zschokkea floribunda Muell. Arg., Mart. Fl. Bras. 6(1): 23. 1860.

Petioles 0.7–1.3 cm. long; blades lanceolate to elliptic, 10–15 cm. long and 3–7.5 cm. broad, rounded to broadly cuneate at base, usually shining on upper surface, the principal secondaries 17–20 pairs with an average distance of 5-7 mm. apart near middle; inflorescences lax, with spreading to reflexed branches, loosely 5–7 flowered, the peduncle to first pair of bracts 7–15 mm. long, the infl. branches 5–10 mm. long; calyx about 2.5–3.5 mm. diam. below lobes, the calyx-lobes 2.5–3 mm. broad and 1.5–2 mm. long; corolla-tube about 3.5 cm. long, glabrous outside, the corolla-lobes 3.5–4 mm. long and about 2.5 mm. broad, densely minutely puberulent outside and inside, spreading at maturity; anthers about 8.5 mm. long, the acumen 0.5–0.6 mm. long, apparently glabrous; style up to woolly part about 9 mm. long, the woolly portion 1.5–2.5 mm. long, the apical branches 0.9–1.3 mm. long, glabrous.

Type.—"sylvis circum Ega, *Poeppig 2723*."

Illustration.—Type (20); branch with leaves and flowers, analysis of flowers.

Distribution.—Western Amazonas in Brazil to Loreto, Peru, where frequent on high lands.

Specimens examined — Brazil, Amazonas *Poeppig 2723* (Type coll.; G, F; photo). Peru, Loreto: *Killip & Smith 27300* (Iquitos; Aug., fl.); *Klug 721* (Mishuyacu; Dec., fl.); *L. Williams 3739* (Iquitos; Oct., fl.; M).

The authorship of the 3d vol. of Nov. Gen. and the novelties described therein are often credited to Poeppig and Endlicher. The title page of vol. 3, however, unlike the title pages of vol. 1 and vol. 2, gives Poeppig as the sole author of this volume (20). Dr. Leon Croizat, who has investigated the problem (see Jour. Arnold Arb. 24: 170. 1943), in answer to my query affirms that Poeppig alone, and not Poepp. & Endl., is the proper authority for the new species proposed in the 3d vol. of Nov. Gen.

Krukoff 4690 and *Froes 69*, cited below, perhaps represent a species not yet described. They have a vegetative resemblance to *L. floribunda* and are for this reason only placed tentatively under this species; they may be found to have no close relationship whatsoever to it when their flowers are collected. Petioles 1-1.5 cm. long; blades elliptic, 9–14 cm. long and 5–7 cm. broad, short caudate at apex with the usually laterally curved tip about 1 cm. long, rounded to broadly wedge-shaped at base, glabrous on both sides or faintly minutely hirsutulous on under side along the costa and secondaries, the principal secondaries widely spaced and arcuate, about 15 pairs with an average distance of about 1 cm. apart near middle; peduncle to first pair of bracts 5–7 mm. long; the sepals about 3.5 mm. broad and 2.2 mm. long, rounded at apex, puberulent outside; fruits globose, about 3 cm. diam., seeds 1 or 2, about 1 cm. long, somewhat orbicular to elliptic, convex on one side, flattened or concave and umbonate on the axial side, dark brown, minutely rugulose. *Krukoff 4690*, Brazil, Amazonas, basin of Rio Jurua, near mouth of Rio Embira, tributary of Rio Tarauaca, lat. 70° 30′ S., long. 70° 15′ W.; June 6, 1933. (Deposited in NY) *Froes 69*, Brazil, Amazonas, basin of Rio Solimões, municip. Esperança, Colonia; May 28, 1941.

9. **Lacmellea aculeata** (Ducke) Monachino, comb. nov.

Zschokkea aculeata Ducke, Arch. Jard. Bot. Rio de Janeiro 3: 240. 1922.

Petioles 0.5–0.9 cm. long; blades elliptic, 11–20 cm. long and 4–8 cm. broad, mostly rounded or obtuse to cuneate at base, dull on both surfaces, the principal secondaries usually 10–12 pairs with an average distance of 10 mm. apart near middle; inflorescences with ascending branches, rather loosely 3–5 flowered, the peduncle to first pair of bracts 5–10 mm. long or completely reduced, the infl. branches 4–8 mm. long; calyx 3–4 mm. diam. below lobes, the calyx-lobes 2.8–3.3 mm. broad and 3–3.3 mm. long; corolla-tube about 3 cm. (up to 4 cm.) long, glabrous outside, the corolla-lobes about 6 mm. long and 2 mm. broad (up to 10 mm. long and 4.5 mm. broad), usually densely minutely puberulent outside and inside, spreading at maturity; anthers about 7.5 mm. long, the acumen 0.6–1 mm. long, beset with 1 to several minute bristles at tip or sometimes glabrous; style up to woolly part about 7 mm. long, the woolly portion 1.7–1.9 mm. long, the apical branches 1–1.3 mm. long, glabrous.

Cotypes.—"*J. Huber 1290*, *M. Guedes 2067* et *2134*, *R. Siqueira 2635*, *A. Ducke 15449* et *15744*; in regione viae ferreae inter Belém et Bragança prope Santa Izabel (n. *8221*) et Peixeboi (n. *8803*, *R. Siqueira*); in silvis inter flumina Cuminamirim et Ariramba confluentes fluminis Trombetas, n. *14972*."

Distribution.—Typical *L. aculeata* is known from the state of Pará in Brazil; frequent in uninundated lands near Belém.

Specimens examined.—Brazil, Pará: *R. C. Monteiro da Costa 286* (Jan., fr. immature; F, M), *1019* (F); *Ducke 14972* (Oct., fl., F, U), *15449* (Aug., fl.; F, U), *15744* (F), *17456* (July, fl. & fr. immature; U); *M. Guedes 2067* (May, fr. immature; F), *2134* (July, fl.; F, U); *Huber 505* (Oct., fl.; F), *1290* (Aug., fl.; F); *R. Siqueira 8803* (Oct., fl.; F, U), *2635* (May, fl. & fr. immature; F, U); *C. W. Smith 12510/16* (March, fr.); *coll. undesignated 8221* (Herb. Mus. Para.; May, fr. immature; F).

L. aculeata and its varieties are closely related to *L. floribunda*. Although they differ from it in characters generally considered of minor importance, they are nevertheless well defined segregates. Typical *L. aculeata*, however, is not so clearly separated from its varieties.

9a. **Lacmellea aculeata** var. **inermis** Monachino, var. nov.

Haec varietas inermis a forma typica speciei lobis corrolae extus glabris et lobis calycis bracteisque eciliatis recedit.

An unarmed var. differing from the species in the corolla-lobes being glabrous outside, and the calyx-lobes and the bracts being eciliate.

Type.—*Ducke 23875;* Brazil, Amazonas, Parintins, Lago Yosé-Assu, uninundated forest; Sept. 16, 1932. (US)

Distribution.—*L. aculeata* var. *inermis* is known only from the type.

Specimen examined.—*Ducke 23875* (type).

L. aculeata var. *inermis* is a minor variety scarcely worthy of a separate treatment from the species, except for convenience. The lack of spines is not a dependable feature; nor are the eciliate bracts and calyx-lobes and the glabrous corolla-lobes, which are merely the extremes of variable characters.

9b. **Lacmellea aculeata** var. **surinamensis** Monachino, var. nov.

Haec varietas a forma typica speciei lobis corollae glabris recedit.

Leaf-blades more oblong than in the species; calyx-lobes shorter, 2–3 mm. long; corolla-tube generally shorter (mature flowers not seen) and more carnose, the corolla-lobes glabrous or very sparsely and faintly ciliate at apex, not minutely puberulent outside, easily separated even in the bud; style up to woolly part 4 mm. long, the woolly portion 1–1.5 mm. long, the apical branches 0.6–1 mm. long.

Type.—*Forest Bureau 4393;* Dutch Guiana, Sectie O; Aug. 26, 1919. (Deposited in the Britton Herb. NY)

Distribution.—*L. aculeata* var. *surinamensis* is known from Dutch Guiana; reported "seldom in virgin forests" by Markgraf.

Specimens examined.—Dutch Guiana: *Forest Bureau 1562* (Zanderij I; Jan., fr. immature; U), *4288* (Watramiri; March, fr.), *4393* (Type), *4717* (Watramiri; July, fl.; U); *J. A. Samules 528* (Zanderij; July, fl.).

Unlike *L. aculeata* var. *inermis*, this variety deserves recognition, albeit its separation from the species is scarcely less difficult than that of the former.

10. **Lacmellea utilis** (Arn.) Monachino, comb. nov.

Tabernaemontana utilis Arn., Edinb. N. Phil. Journ. 8: 318. 1830.
Zschokkea utilis Hemsl., Hook. Ic. Pl. 27: Pl. 2637. 1900.

Petioles 0.8–1.2 cm. long; blades usually elliptic, 7–11.5 cm. long and 2–6 cm. broad, rounded to broadly cuneate at base, dull on both surfaces, often minutely black-dotted on under side, the principal secondaries 13–16 pairs with an average distance of about 7 mm. apart near middle; inflorescences with ascending branches, rather densely 3–15 flowered, the peduncle to first pair of bracts 2–5 mm. long, the infl. branches 2–4 mm. long; calyx 2.8 mm. diam. below lobes, the calyx-lobes about 2 mm. broad and 1.3–1.6 mm. long, rounded to acute at apex; corolla-tube about 1.5 cm. long, glabrous outside, the corolla-lobes about 1.5 mm. long and 1 mm. broad, glabrous (microscopically papillose) outside, puberulent inside, ciliate, erect or slightly spreading at maturity; anthers 4.5 mm. long, the acumen 0.16 mm. long, glabrous; style up to woolly part 2–2.7 mm. long, the woolly portion 1 mm. long, the apical branches 0.6–0.8 mm. long, glabrous.

Type.—*James Smith s.n.;* British Guiana, Demerara, near Byawadanny.

Illustration.—*Zschokkea utilis* (8); branch with leaves, flowers and fruits, and analysis of flowers and fruits.

Distribution.—British Guiana;[5] reported as not uncommon near the first rapids of Demerara.

Specimens examined.—British Guiana: *C. W. Anderson 150* (F); *For. Dept. Brit. Guiana 3446* (Field No. F710; Moraballi Creek, Essequibo Rv.; Oct., fl. & fr.; B), *3992* (Field No. F556; Makauria Creek; Oct., fl. & fr.; B); *Jenman 4275* (upper Demerara Rv.; Sept., fl.), *7491* (near Rockstone, Essequibo Rv.; May, fr.); *Sandwith 413* (near Bartica, Moraballi Creek, Essequibo Rv; Oct., fl.).

The description and illustration of *Zschokkea utilis* were based on the study of *Jenman 4275*, collected in the upper Demerara river, and *Jenman 7491*, collected near Rockstone, Essequibo river. There is no doubt about the specific identity of these plants with the material examined by Arnott.

Lacmellea utilis, known to the natives of the Demarara region of British Guiana as "Hya-Hya," was the first species of the genus to come to the observation of a naturalist. James Smith, in a letter to Professor Jameson in the latter part of 1829 or early 1830, recounts how he stopped at the little Indian settlement of Byawadanny, just below the first rapids of the Demerara, and there was told of a tree called by the Indians "Hya-Hya," which was by no means uncommon in the woods of the colony, and the milk of which was both potable and nutritious. He was then in company with Mr. Couchman, the superintendent of a wood-cutting establishment in the immediate vicinity. "We had sent a lad to search around for the tree, and he returned in a short time to tell us he had met with it. We followed him to the spot, and found that he had felled the tree. It had fallen across a little rivulet, the water of which, when we arrived, was completely whitened from its juice. On striking a knife into the bark, a copious stream of milk-like fluid immediately followed. Our guide drank of it, and Mr. Couchman and myself tasted it after him. It was thicker and richer than cow's milk, and destitute of all acrimony, leaving only a slight feeling of clamminess on the lips. I had already seen that it mixed freely with the water of the little stream, and as I slept that night near the spot, the next morning Mr. Couchman and myself drank it in warm coffee. With this it commingled equally well, and lost all the viscosity before perceptible in its pure state, so much so, as to appear to us incapable of being distinguished from animal milk." James Smith continues by extracting from his notebook a description of the Hya-Hya taken on the spot. "Trunk from 16 to

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[5] Cortes (4) reports it also from Venezuela and Colombia; but this distribution is not supported by any other evidence.

18 inches in diameter, 30 to 40 feet high, branching from the top; bark greyish colour, slightly scabrous, and about a quarter of an inch thick, between which and the wood the milk seemed to be secreted. The incision made by the stroke of a knife into it latitudinally, or diagonally, caused it to flow freely; but when the cut was made longitudinally, little or no milk exuded." He prepared two flowering specimens of the plant, together with wood and bark samples and also a small bottle of the latex, which he forwarded to Professor Jameson. The botanical specimens were transmitted to G. A. W. Arnott for study.

11. **Lacmellea guyanensis** (Muell. Arg.) Monachino, comb. nov.

Zschokkea guyanensis Muell. Arg., Linnaea 30: 391. 1860.[6]

Petioles 1–4 mm. long; blades elliptic, 8–12 cm. long and 3–4 cm. broad, obtuse at base, somewhat shining on upper surface, the principal secondaries 9–11 pairs with an average distance of 7 mm. apart near middle; inflorescence lax, the infl. axis 2 cm. long (ex descrip.), peduncle to first pair of bracts 5–8 mm. long; calyx below lobes 3.3 mm. diam., the calyx-lobes 2.7 mm. broad and 2 mm. long; corolla 15 mm. long (ex descrip.); style up to woolly part 2 mm. long(?).

Type.—"Guyana gallica (*Poiteau* in hb. Petropol.)."

Distribution.—Known only from type coll. and the specimen cited below, French Guiana.

Specimen examined.—French Guiana: *Wachenheim 223* (Maroni; U).

L. guyanensis is known to me only from a single collection of material lacking flowers. The original description is rather incomplete, and I therefore cannot place the species in its precise position.

12. **Lacmellea microcarpa** (Muell. Arg.)Monachino, comb. nov.

Zschokkea microcarpa Muell. Arg., Mart. Fl. Bras. 6(1): 23. 1860.
Hancornia microcarpa R. Spruce, ex Muell. Arg., loc. cit.

Petioles 0.5–0.8 cm. long; blades ovate to elliptic, 5–8 (10.5) cm. long and 3- 4.5 (6) cm. broad, broadly cuneate at base and decurrent on petiole, minutely black-dotted on under side, rigidly coriaceous and with the margins recurved, dull on both surfaces, the principal secondaries about 20 pairs with an average distance of 4 mm. apart near middle, somewhat raised on upper side as well as on under side, or sometimes obscure on under side; inflorescences with ascending branches, rather densely 5–13 flowered, the peduncle to first pair of bracts about 2 mm. long or completely reduced, the infl. branches 2–3 mm. long; calyx 1.6 mm. diam. below lobes, the calyx-lobes 1.3–1.4 mm. broad and 1–1.6 mm. long, obtuse to subacute

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[6] In July of the same year, 1860, Mueller (16, p. 23) published this name in Mart. Fl. Bras. in a footnote under *Z. floribunda.*

at apex; corolla-tube about 1.5 cm. long, puberulent toward the upper part outside, the corolla-lobes 2.2–2.5 mm. long and about 1 mm. broad, puberulent outside and inside; anthers 5 mm. long, the acumen 0.3–0.5 mm. long, glabrous; style up to woolly part about 2.7 mm. long, the woolly portion about 0.8 mm. long, the apical branches 1 mm. long, glabrous.

Type.—"ad flumen Rio Negro supra ostium fluminis Casiquiari: *R. Spruce 3537.*"

Distribution.—Known from the upper Rio Negro in Brazil, adjacent Vaupés in Colombia, and probably to be found in Amazonas in Venezuela.

Specimens examined.—Brazil, Amazonas: *Froes 510* & *875* (municip. São Gabriel, upper Rio Negro); *Weiss & Schmidt 48* (upper Rio Negro; fl.). Colombia, Vaupés: *Spruce 3537* (type coll.).

13. **Lacmellea Foxii** (Stapf) Monachino, comb. nov.

Zschokkea Foxii Stapf, Kew Bull. **1912**: 38. 1912.

Petioles 8–9 mm. long; blades elliptic, 4.5–7 cm. long and 2.2–3.5 cm. broad, shortly acute at base, minutely black-dotted on underside, coriacious, brownish on upper side, the secondaries 15–17 pairs, fine; inflorescences many flowered, the peduncles 4–5 mm. long, the infl. branches 3–4 mm. long; calyx 2.5 mm. long; corolla 15 mm. long, the corolla-lobes oblong, 2.5 mm. long; anthers about 5 mm. long; style up to woolly part 3 mm. long, the woolly portion and apical branches 2 mm. long.

Type.—"Peru. Putumayo Territory: Entre Rios and Sabana (about 72° W. long., 1° S. Lat.), *Fox 31.*"

Distribution.—Reported only from the type locality; "the tree is not very widely spread, and is becoming scarce owing to the methods of working" it for rubber (Kew Bull. **1912**: 74. 1912).

Without examining a specimen of *L. Foxii* I find it impossible to place it in its precise position. It belongs in the Brevipetalae group and the black dots described on the under sides of the coriaceous leaves suggest its close kinship to *L. microcarpa.*

14. **Lacmellea densifoliata** (Ducke) Monachino, comb. nov.

Zschokkea densifoliata Ducke, Arch. Jard. Bot. Rio de Janeiro **4**: 166. 1925.

Branchlets with leave suberect and densely disposed; petioles about 4 mm. long; blades 6–9 cm. long and 4–5 cm. broad, rounded or subcordate at base and rounded, rarely obtuse or a little retuse, at apex, shining on upper surface (?), rigidly coriaceous, the secondaries 10–12 pairs, fine and straight, obsolete near leaf apex; inflorescences subsessile, densely flowered; corolla 18 mm. long, strongly curved, etc. as in *L. arborescens.*

Type.—"regione Campos do Cupijó prope Cametá (civitate Pará), ad marginem silvulae paludosae. A. Ducke 22-7-1916; *Herb. Jard. Bot. Rio 17455.*"

Distribution.—Known only from the type locality; Ducke writes that he encountered only one individual on the border of a wooded islet in "une portie tourbeuse du campo."

Ducke states that *L. densifoliata* is allied to *L. microcarpa*, known to him only from literature. The leaf-blades are described as sometimes subcordate at base and rounded to retuse at apex, features very unusual in the genus.

15. **Lacmellea arborescens** (Muell. Arg.) Monachino, comb. nov.

Zschokkea arborescens Muell. Arg., Mart. Fl. Bras. 6(1): 22. 1860.
Hancornia arborescens R. Spruce, ex Muell. Arg., loc. cit.
Zschokkea monosperma Muell. Arg., loc. cit.
Hancornia monosperma R. Spruce, ex Muell. Arg., loc. cit.

Petioles 0.5–1.5 cm. long; blades usually elliptic, 7–15 cm. long and 3–6 cm. broad, broadly cuneate at base and decurrent on petiole, shining on upper surface, the principal secondaries 17–30 pairs with an average distance of 4–5 mm. apart near middle; inflorescences with ascending to spreading branches, from rather loosely to densely 5–20 flowered, the peduncle to first pair of bracts 4–15 mm. long or completely reduced, the infl. branches 2–9 mm. long; calyx 2.2–2.8 mm. diam. below lobes, the calyx-lobes 1.7–2.2 mm. broad and 1.3–2 mm. long; corolla-tube 1.2–1.7 cm. long, glabrous outside, the corolla-lobes 1.3–2.2 (up to 2.8) mm. long and about 1.3 mm. broad, densely minutely puberulent outside and inside, erect or slightly spreading at maturity; anthers 5–6 mm. long, the acumen 0.3–0.5 mm. long, glabrous; style up to woolly part 2.4–4 mm. long, the woolly portion 1.6–2 mm., the apical branches 0.8–1.4 mm. long, glabrous.

Cotypes.—"Habitat secus Rio Negro inter Barcellos at S. Isabel: *R. Spruce 1922;* et in vicinibus Barra ejusdem prov.: *R. Spruce 1001;* nec non in silvaticis umbrosis siccis prope Borba: *Riedel 1301.*"

Illustrations.—Cotype (16; pl. 6, fig. 3); embryo. *Zschokkea monosperma* (16; pl. 6, fig. 2); fruit, seeds.

Distribution.—Typical *L. arborescens* is frequent on terra firma in the eastern portion of Amazonas and in the state of Pará, extending into Matto Grosso, Brazil.

Specimens examined.—Brazil, Pará: *Capucho 467* (Bôa Vista; Sept., fl. immature; F), *528* (Bôa Vista; Dec., fr.; F); *R. Monteiro da Costa 72* (Bôa Vista; F, M); *Ducke 11400* (between Almeirim & Prainha; Oct , fl.; U), *21584* (Farro; June, fl. & fr. immature; U); *Krukoff 1209* (lower Cupary Rv.; Sept., fl.); *Spruce 679* (photo; cotype coll. *Zschokkea monosperma;* F). Brazil, Amazonas: *Ducke 190* (Manáos, Rio Negro; May, fl.), *7161* (Barcellos, Rio Negro; June, fl. & fr. immature; U); *Froes 326* (Manáos, Rio Negro); *Krukoff 5811A* (Maicy, Rio Madeira), *5966* (near Urucurituba, Rio Madeira; Sept., fl.), *6057* (near Santa Fe, Rio Madeira; Sept., fr. immature), *6835* (near Livramento, Rio Madeira; Oct., fr.), *8003* (Manáos, Rio Negro; Aug.-Sept., fr. immature); *Kuhlman 22413* (Santa Laura, Rio Madeira; Aug., fr.; U); *Spruce 1001* (photo; cotype coll.), *1922* (cotype coll.; Dec., fr. immature; G, NY); Brazil, Matto Grosso: *Krukoff 1327* (Near Tabajara, upper Machado Rv.; Nov.–Dec., fr. immature).

The cotypes of *Zschokkea monosperma* are *Spruce 679* and *Riedel 1607*, reported from "campis arenosis prope Santarem prov. Paraensis." Ducke (6) questions as to whether *Zschokkea monosperma* is anything more than an insignificant variety of *Z. arborescens*. He does not know it from Pará. Mueller writes in the original description that its flowers are like *Z. ramosissima* except for the calyx-lobes which are more rounded and obtuse at apex, that its inflorescence has bracts like in *Z. ramosissima* but are obtuse like in *Z. arborescens* which it further resembles in general aspect, calyx, corolla, stamens and style. The photo of the type of *Z. monosperma* does not show any character for its separation from *L. arborescens*.

15a. **Lacmellea arborescens** var. **peruviana** (van Heurck & Muell. Arg.) Monachino, stat. nov.

Zschokkea peruviana van Heurck & Muell. Arg., Observ. Bot. Descrip. Pl. Nov. Herb. van Heurck. 2: 148. 1871.

Type.—"Peruvia orientali prope Tarapoto: *R. Spruce 4934* (in herb. van Heurck)."

Distribution.—*L. arborescens* var. *peruviana* is known from the depts. of Loreto and San Martín in Peru; high lands.

Specimens examined.—Peru: *Klug 2764* (dept. San Martín, Pongo de Cainarachi; Sept.–Oct. fl.); *Spruce 4934* (Type coll.; F, G, NY); *L. Williams 3983* & *4384* & *4546* & *4678* (dept. Loreto, lower Rio Huallaga; Oct., fl. & fr.; F, M), *6535* & *6562* (Tarapota, dept. San Martín, upper Rio Huallaga; Dec., fl.; F, M, & F, M, U).

L. arborescens var. *peruviana* intergrades with the species in all particulars and is separated from it often with great difficulty. *Williams 3983*, or *4384* and *6562*, for example, are scarcely different from collections of typical *L. arborescens* from the state of Pará in Brazil; the corolla-lobes are somewhat less densely puberulent outside, but the leaves are as shining on their upper side, as thick, and have as many secondaries. It should be noted that its leaves sometimes display a confusing resemblance to those of *L. floribunda*, although the two species cannot possibly be confounded in the presence of inflorescences. This variety, furthermore, seems to have some puzzling relationship to the following species.

16. **Lacmellea Klugii** Monachino, sp. nov.

Folia foliis "*L. arborescens* var. *peruviana*" consimilia, laminis ellipticis 5.5–11 cm. longis, 2–2.5 cm. latis, ad basin late vel subanguste cuneatis, supra in siccitate brunnescentibus; inflorescentiis floribusque "*L. ramosissima*" consimilibus.

Petioles 0.5–0.7 cm. long; blades elliptic, 5.5–11 cm. long and 2–5.5 cm. broad, broadly to somewhat sharply cuneate at base, dull on both surfaces, drying brownish on upper surface, the principal secondaries 14–20 pairs with an average distance of 4–5 mm. apart near middle, straight, the fainter secondaries in between few or lacking; inflorescences with ascending to spreading branches, generally densely 8–30 flowered, the peduncle to first pair of bracts 2–3 mm. long or completely reduced, the infl. branches 1–2 mm. long; calyx about 2 mm. diam. below lobes, the calyx-lobes 1.2–1.4 mm. broad and 1 mm. long; corolla-tube about 1.5 cm. long, glabrous outside, usually strongly curved at maturity, the corolla-lobes 1–1.3 mm. long and 1 mm. broad, dorsally thickened and with a somewhat spreading wide thin margin, ciliate, glabrous outside, short-pilose at base inside, erect; anthers 4–4.5 mm. long, the acumen 0.16–0.3 mm. long, glabrous; style up to woolly part 2.5–3 mm. long, the woolly portion 1–1.5 mm. long, the apical branches 0.8–1 mm. long, glabrous.

Type.—*Klug 840;* Peru, dept. Loreto, Mishuyacu, near Iquitos, alt. 100 m., forest clearing; Jan. 1930. (Deposited in Britton Herb. NY)

Distribution.—*L. Klugii* is known from the dept. of Loreto, Peru; forests, high lands.

Specimens examined.—Peru, dept. Loreto· *Klug 388* & *402* (Mishuyacu, near Iquitos; Oct.–Nov., fl.), *840* (type coll.; NY, US); *L. Williams 676* (forest between Rio Nanay and Rio Napo; May, fl. & fr.; F, M).

L. Klugii is a puzzling entity. Its leaves are not distinguishable from some samples of *L. arborescens* var. *peruviana* and its flowers from those of *L. ramosissima*. As a species it is consistent within itself, forming perhaps a connecting link between these two, although the more important diagnostic characters ally it more closely to the latter.

17. **Lacmellea ramosissima** (Muell. Arg.) Monachino, comb. nov.

Zschokkea ramosissima Muell. Arg., Mart. Fl. Bras. 6(1): 21. Pl. 7 1860.
Hancornia ramosissima R. Spruce, ex Muell. Arg., loc. cit.

Petioles 0.3–0.6 cm. long; blades elliptic, 7–12 cm. long and 2.5–5 cm. broad, cuneate to acuminate at base and decurrent on petiole, dull on both surfaces or subnitidous on upper surface, generally drying greyish on upper surface, the principal secondaries 6–12 pairs with an average distance of 7–10 mm. apart near middle, arcuate, the fainter secondaries in between often clearly visible; inflorescence with ascending to spreading branches, densely to loosely 6–15 flowered, the peduncle to first pair of bracts 2–5 mm. long or completely reduced, the infl. branches 2–5 mm. long; calyx about 2–2.5 mm. diam. below lobes, the calyx-lobes 1.2–1.5 mm. broad and 0.9–1.3 mm. long, rounded to subacute at apex; corolla-tube about 1.5 cm. long, glabrous or sparsely puberulent outside (grading into a densely puberulent variety), usually strongly curved at maturity, the corolla-lobes 1–1.6 mm. long and 1 mm. broad, dorsally thickened and with a spreading wide thin margin, ciliate, glabrous to puberulent outside, usually with a pubescent line at base inside; anthers 4–4.5 mm. long, the acumen 0.16–0.34 mm. long, glabrous; style up to woolly part 2.5–3 mm. long, the woolly portion 0.6–1.3 mm. long, the apical branches 0.3–1 mm. long, glabrous.

Type.—"prov. Rio Negro prope Panuré ad flumen Uaupes: *R. Spruce 2628.*"

Illustration.—Type (16; pl. 7); branch with leaves and flowers, analysis of flowers.

Distribution.—Scattered throughout Amazonas in Brazil and probably in adjacent Colombia.

Specimens examined.—Brazil, Amazonas: *Ducke 21610* (Tonantins; Nov., fl.; U); *Froes 187* & *299* (municip. Sao Pãulo de Olivença, Rio Solimões), *12005/16* (Rio Negro; Apr., fr. immature); *Krukoff 6830* (near Livramento, Rio Madeira; Oct.-Nov., fl), *8752* & *8826* (municip. São Paulo de Olivença, Rio Solimões; Oct.–Dec., fl.); *Spruce 2628* (type coll.).

Williams 13210, collected on the island of El Ratón, terr. Amazonas, Venezuela, is of a very doubtful identity. Vegetatively it most resembles *L. ramosissima* of the species known, but without flowers I cannot place this Lacmellea with any assurance.

17a. **Lacmellea ramosissima** var. **hirtella** Monachino, var. nov.

Haec varietas a forma typica speciei tubo corollae extus parce vel dense hirtello recedit.

This variety differs from the species in the corolla-tube being sparsely to densely pubescent outside.

Type.—*Ducke 306;* Brazil, Amazonas, Rio Taruma, Manáos, silva non inundabili; Oct., 1936. (Deposited in Britton Herb. NY)

Distribution.—*L. ramosissima* var. *hirtella* is known only from the type coll.

Specimen examined.—Brazil, Amazonas: *Ducke 306* (type coll.).

L. ramosissima var. *hirtella* is a minor variety differing from the species merely in the presence of pubescence on the exterior of the corolla-tube, a character of little importance in itself and of a variable nature.

18. **Lacmellea gracilis** (Muell. Arg.) Monachino, comb. nov.

Zschokkea gracilis Muell. Arg., Mart. Fl. Bras. 6(1): 21. Pl. 6, fig. 1. 1860.
Hancornia gracilis R. Spruce, ex Muell. Arg., loc. cit.

Branchlets slender (about 1.5 mm. diam.); petioles 0.3-0.4 cm. long; blades ovate-lanceolate, 5–6 cm. long and 2–2.5 cm. broad, rounded to broadly cuneate at base and long acuminate at apex, dull (?) on both surfaces, the principal secondaries about 16 pairs with an average distance of about 3 mm. apart near middle, very fine, straight up to near leaf margins, diverging from midrib at almost right angles; inflorescences with ascending to somewhat spreading branches, loosely 3–5 flowered, the peduncle to first pair of bracts 2–3 mm. long, the infl. branches about 3 mm. long; calyx 1.7–2 mm. diam. below lobes, the calyx-lobes 1–1.3 mm. broad and 0.8–0.9 mm. long, rounded to obtuse at apex, moderately to sparsely ciliate; corolla-tube about 1.2 cm. long, glabrous outside, the corolla-lobes 1–1.3 mm. long and 1 mm. broad, glabrous or with a few hairs outside, densely pilose at base inside, the pubescence extending into upper part of corolla-tube; anthers sessile or without distinct filaments, 3 mm. long, the acumen 0.3 mm. long, glabrous; style up to woolly part 2 mm. long, the woolly portion 0.8–0.9 mm. long, the apical branches 0.3 mm. long, glabrous.

Cotypes.—"fruticetis subhumidis prov. de Alto Amazonas, in vicinia Barra do Rio Negro: *R. Spruce 1000, Riedel 1457;* prope Coari et alibi e.g. in silivis caednis prope Barra: *M.*"

Illustration.—Cotype (16; pl. 6, fig. 1); branch with leaves and flowers.

Distribution.—Known from Manáos & Coary, State of Amazonas, Brazil.

Specimen examined.—Brazil, Amazonas: *Ducke 22414* (Manáos, Rio Negro; Oct., fl.; U).

L. gracilis, a graceful and characteristic species with the most slender branchlets and smallest calyces in the genus, is unique in its sessile anthers.

DOUBTFUL SPECIES

Lacmellia lucida (H.B.K.) Miers, Apocyn. S. Am., 14. 1878.
Tabernaemontana (?) *lucida* H.B.K., Nov., Gen. & Sp. Pl. 7: 209. 1825.
Psychotria lucida Willd., in Roem. & Schultes, Syst. 4: 189. 1819, non H.B.K. (Fide H.B.K. loc. cit.)

Type of *Tabernaemontana* (?) *lucida.*—"aquis fluminis Pimichin (Missiones del Atabapo)."

Miers transferred H.B.K.'s *Tabernaemontana lucida* to Lacmellea merely from an examination of its description, no material of the species being available to him. No collection or photo of *T. lucida* has been seen by me. Its original diagnosis, in my opinion, is not sufficiently complete to determine the genus with any assurance. The fruit, as described, is very probably of the Carisseae and it answers quite well to Lacmellea; it is, however, questioned by H.B.K. whether truly belonging to *T. lucida: "an frutcus vere hujus plantae?"* Only fragments of the flowers were examined. The stigma was described as simple and the cymes (according to Bonpland) terminal, neither of which characters is true for Lacmellea in which the stigma is cleft (it might however be easily mistaken for simple) and the cymes axillary; the leaf-apex of *T. lucida,* described as obtuse or rounded, sometimes emarginate, is one rarely met with in Lacmellea.

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More Fungi from Florida

William A. Murrill

(*Herbarium, Florida Agricultural Experiment Station, Gainesville, Fla.*)

The specimens cited here are permanently deposited in the Station Herbarium. The nomenclature is that of "North American Flora," but at the close of the paper certain species are transferred to genera more familiar to those using Saccardo.

Clitocybe australis sp. nov.

Pileo infundibuliformi, caespitoso, 4–6 cm. lato, subtomentoso, atriisabellino, lobato, grato; lamellis decurrentibus, confertis, angustatis, pallidis; sporis ovoideis, levibus, 3×2μ; stipite subaequali, albo, pubescenti, 2–4×0.4–0.6 cm.

Pileus infundibuliform, cespitose, 4-6 cm. broad; surface dry, smooth, subtomentose under a lens, uniformly isabelline to ochraceous-fulvous, margin reflexed, lobed, even, concolorous; context thin, white, unchanging, odorless, mild; lamellae decurrent, inserted, close, narrow, entire, white to pallid, unchanging when bruised or dried; spores ovoid, smooth, hyaline, about 3×2μ; basidia 4-spored, cystidia none; stipe subequal, white, unchanging, solid, tough, nearly smooth, pubescent to mycelioid, 2–4×0.4–0.6 cm.

Type collected by W. A. Murrill in moist leaf-mold in thin frondose woods at Gainesville, Fla., Oct. 6, 1943 (*F 20118*). Suggesting *C. adirondackensis* but larger and densely cespitose.

Clitocybe Westii sp. nov.

Pileo convexo, 3 cm. lato, roseo-avellaneo; lamellis adnatis, albis, sporis ellipsoideis, 6×4μ; stipite albo, clavato, 4×0.6–0.8 cm.

Pileus convex, gibbous, not fully expanding, solitary, 3 cm. broad; surface dry, smooth, glabrous, shining, rosy-avellaneous, margin even, entire, incurved; context firm, rather thick, white, slightly fragrant, mild; lamellae adnate with decurrent tooth, close, arcuate, inserted, rather narrow, thin, entire, white; spores ellipsoid, smooth, hyaline, uniguttulate, obliquely apiculate, about 6×4μ; stipe white, pruinose at the apex, striate below, with clavate base, 4×0.6–0.8 cm.

Type collected by Erdman West and W. A. Murrill on the ground in Kelley's Hammock, ten miles northwest of Gainesville, Fla., August 3, 1938 (*F17969*). Near *C. subclavipes* Murrill but smaller and having crowded instead of distant gills.

Gymnopus caryophilus sp. nov.

Pileo convexo-plano, 1–2 cm. lato, glabro, fulvo, grato; lamellis adnexis, latis, confertis, pallidis; sporis ovoideis, 4–5×2.5–3µ; stipite glabro, fulvo, 1–1.5×.015–.03 cm.

Pileus convex to plane, gregarious or scattered, 1–2 cm. broad; surface smooth, not viscid, glabrous, fulvous, margin even, entire, upturned with age; context thin, pallid, with anise odor and mild flavor; lamellae adnexed, inserted, broad, crowded, entire, pallid; spores pipshaped, smooth, hyaline, 4–5×2.5–3µ; cystidia none; stipe equal, hollow, flexible, often laterally compressed, smooth, glabrous, concolorous, 1–1.5×.015–.03 cm.

Type collected by W. A. Murrill in short grass under a Florida hickory at Gainesville, Fla., April 24, 1943 (*F 19390*). Suggesting *G. dryophilus* but smaller, with smaller spores.

Hydrocybe Arnoldae sp. nov.

Pileo conico, 3 cm. lato, fulvo; lamellis adnatis, aurantiacis, sporis ellipsoideis, 5–6×4µ; stipite glabro, stramineo, apice albo, 5×0.6 cm.

Pileus conic to broad-conic, 3 cm. broad; surface smooth, glabrous, neither viscid nor striate, pale fulvous, fulvous on the disk, margin entire; context very thin, white, odorless, taste mawkish; lamellae adnate, distant, medium broad, inserted, entire, aurantiacous; spores broadly ellipsoid, obliquely apiculate, smooth, hyaline, granular, about 5–6×4µ; stipe equal above the tapering base, smooth, glabrous, hollow, stramineous, with a narrow white band at the apex, 5×0.6 cm.

Type collected by Lillian Arnold, Erdman West, and W. A. Murrill under evergreen oaks in Sugarfoot Hammock, near Gainesville, Fla., July 11, 1938 (*F 17809*). A pretty little species with conic, fulvous cap, orange gills, and pale-yellow stem, wearing a white collar at its throat.

Lactaria paradoxiformis sp. nov.

Pileo convexo-plano-depresso, 6–8 cm. lato, viscido, glabro, cremeo, subacrido; lamellis confertis, ochraceis, viridescentibus; sporis ellipsoideis, tuberculatis, 9×6µ; stipite concolori, 2–5×1–1.5 cm.

Pileus convex to plane with depressed center, gregarious, 6 8 cm. broad; surface viscid, smooth, glabrous, cremeous, becoming bluish-green in part or wholly, margin deflexed, even or striate over lamellae, entire to undulate, paler; context pallid above, ferruginous below, unchanging, slightly fragrant, slightly but distinctly acrid; latex not copious enough to form drops but stains orange to rusty; lamellae short-decurrent, inserted, arcuate, crowded or subcrowded, rather narrow, entire, ochraceous, becoming partly bluish-green with age; spores ellipsoid, minutely tuberculate, pale-brownish, about 9×6µ; stipe equal, smooth, glabrous, ochraceous, bluish-green where bruised, 2–5×1–1.5 cm.

Type collected by W. A. Murrill under red oak and hawthorn on Cherry Hill, south of Orange Lake, Marion Co., Dec. 7, 1941 (*F 19250*). Also collected by him the same day in red-oak woods seven miles west of Gainesville (*F 18540*), and in a hammock at Juniper Springs, Oct. 11, 1940 (*F 20018*). Suggesting *L. paradoxa* Beards. & Burl. and appearing at the same season, sometimes in abundance.

Lepiota aeruginea sp. nov.

Pileo conico ad convexo vel plano, umbonato, 2–2.5 cm. lato, aerugineo, striato, disco plumbeo; lamellis liberis, confertis, albis, fimbriatis; sporis ellipsoideis, 7–8×4–5μ; stipite bulboso, albo, 3×0.2–0.3 cm.; annulo amplo, albo, fimbriato.

Pileus conic to broadly convex or plane, umbonate, solitary, 2–2.5 cm. broad; surface dry, finely fibrillose, aerugineous, soon fading, cuticle striately-split to the rounded plumbeous entire umbo, margin striate, entire to somewhat ragged; context rather thin, white, unchanging, odorless; lamellae free, inserted, close, medium broad, white, unchanging, fimbriate; spores ellipsoid, smooth, hyaline, 1-guttulate, 7–8×4–5μ; cystidia none; stipe bulbous, stuffed, smooth, subfibrillose, white, unchanging, about 3×0.2–0.3 cm.; bulb white, ovoid, about 5 mm. or more thick; annulus fixed, median, ample, persistent, white, fimbriate.

Type collected by W. A. Murrill in dry oak-pine woods at Gainesville, Fla., July 6, 1939 (*F 19324*). Also collected in the vicinity under oak, July 26, 1939 (*F 19431*). Near *L. subfulvidisca* Murr. but color distinct and unusual, although rather evanescent.

Lepiota cretaceiformis sp. nov.

Pileo convexo-plano, 1.5–2 cm. lato, floccoso-farinaceo, flavo, striato, subumbonato; lamellis remotis, confertis, angustatis; sporis subovoideis, 12×7μ; stipite bulboso, 8–10×0.1 cm.; annulo amplo, persistenti.

Pileus convex to plane, solitary, 1.5–2 cm.; broad; surface dry, floccose and farinaceous, yellow, striate to the small glabrous reddish-brown umbo, margin becoming deflexed and ragged; context membranous, yellowish, odorless; lamellae free, remote, inserted, narrow, close, entire, yellow; spores subovoid, smooth, hyaline, 1-guttulate, about 12×7μ; stipe very long and slender, bulbous, floccose, pale-brownish when dry, 8–10×0.1 cm.; bulb ovoid, small, pallid; annulus ample, persistent, median, fixed, yellow, ragged on the edge.

Type collected by W. A. Murrill on leaf-mold in Kelley's Hammock, ten miles northwest of Gainesville, Fla., July 4, 1943 (*F 19352*). Also collected by the author on leaf-mold in a low hammock in Sugarfoot, southwest of Gainesville, Aug. 6, 1943 (*F 19935*). Related to *L. cretacea* but solitary, and to *L. flavescens* but having larger spores. Frequent in dense low hammocks about Gainesville.

Melanoleuca australis sp. nov.

Pileo convexo-subdepresso, 5–6 cm. lato, glabro, fuligineo, sapore grato; lamellis sinuatis, pallidis; sporis ellipsoideis, 4–5×3μ; stipite glabro, albo, 2×1–1.5 cm.

Pileus convex to slightly depressed, irregularly circular, gregarious to cespitose, 5–6 cm. broad; surface dull, glabrous, fuliginous, shining when dry, margin entire or lobed, even, concolorous; context thin, white, unchanging, odorless, mild; lamellae sinuate, medium broad, medium close, entire, pallid, darker with age; spores ellipsoid, smooth, hyaline, 1-guttulate, about 4–5×3μ; stipe short, often eccentric, solid, equal or tapering downward, glabrous, white, unchanging, about 2×1–1.5 cm.

Type collected by W. A. Murrill under a laurel oak in woods in Gainesville, Fla., Dec. 31, 1941 (*F 20072*). Also found nearby in a yard near a live-oak (*F 18010*), with stipe much longer than in the type. Suggesting certain color-forms of *M. terrea* but glabrous.

Melanoleuca ferruginescens sp. nov.

Pileo convexo-plano, 4–5 cm. lato, glabro, albo ad rubro-brunneo, grato; lamellis sinuatis, latis, albis ad ferrugineis; sporis ellipsoideis, levibus, 3×1.5μ; stipite glabro, albo ad ferrugineo, 2–4×1–1.5 cm.

Pileus convex to plane, gregarious, 4–5 cm. broad; surface smooth, glabrous, white or avellaneous, usually reddish-brown on the disk, margin pallid, even, entire; context thick, white, odorless, mild, ferruginous when bruised; lamellae sinuate, inserted, rather crowded, broad, entire, white, drying dirty-white, ferruginous when bruised; spores ellipsoid, smooth, hyaline, about 3×1.5μ; cystidia none; stipe short, equal, solid, radicate, smooth, glabrous, white, ferruginous when bruised, 2–4×1–1.5 cm.

Type collected by W. A. Murrill under live-oak west of Newnan's Lake, Alachua Co., Fla., Dec. 28, 1942 (*F 21691*). Suggesting *M. subsaponacea* (Pk.) Murr. because of its color when bruised but smaller, with smaller spores, and not bitter. Not found elsewhere.

Melanoleuca floridana sp. nov.

Pileo conico-convexo, 3.5 cm. lato, subtomentoso, isabellino; sporis ellipsoideis, 6–8×4μ, stipite cremeo, clavato, 5×0.8–1.3 cm.

Pileus conic-convex to subexpanded, cespitose, about 3.5 cm. broad; surface dry, smooth, subtomentose, isabelline, slightly darker on the disk, margin even, undulate to lobed; context pale isabelline, mild, odorless; lamellae sinuate, arcuate, narrow, medium distant, inserted, eroded, pallid with a rosy-isabelline tint; spores ellipsoid, smooth, hyaline, granular, about 6–8×4μ; stipe smooth, finely fibrillose, cremeous, fleshy, solid, with clavate base, 5×0.8–1.3 cm.

Type collected by West and Murrill in rich soil in Sanchez Hammock, eleven miles northwest of Gainesville, Fla., July 23, 1938 (*F 17965*). This hammock is located in the southern border of the old Sanchez Grant, a very interesting collecting ground.

Melanoleuca fulvidisca sp. nov.

Pileo convexo-subexpanso, 6–7 cm. lato, glabro, pallido, disco fulvo, farinaceo; lamellis latis, distantibus, subflavis; sporis subovoideis, levibus, 6–8×4–5μ; stipite glabro, pallido, 4–5×0.8–1 cm.

Pileus convex to subexpanded, 6–7 cm. broad; surface dry, smooth, glabrous, pallid with fulvous disk, margin even, entire; context thin, white, farinaceous, very slightly bitterish, odor unpleasant; lamellae sinuate, broad, distant, inserted, entire, pale-yellow; spores subovoid, smooth, hyaline, granular, 6–8×4–5μ; stipe equal or tapering downward, smooth, glabrous, pallid, 4–5×0.8–1 cm.

Type collected by W. A. Murrill southwest of Gainesville, Fla., on the ground in mixed woods, Feb. 9, 1941 (*F 17805*). Suggesting *M. equestris* but differing in several ways.

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.

Pileus 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*). 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. At first I referred it to *M. transmutans* Pk., because the gills became stained. See note by Singer in LLOYDIA 5: 116. 1942.

Melanoleuca hygrophorus sp. nov.

Pileo plano, avellaneo, viscido, striato, 4 cm. lato; lamellis sinuatis, latis, distantibus, albis; sporis ellipsoideis, 6–8×3–5μ; stipite albo, 4–5×0.7 cm.

Pileus plane with slight umbo, solitary, 4 cm. broad; surface uneven, slimy-viscid, glabrous, striate, avellaneous, blackening with age or on drying, margin irregular and slightly lobed; context membranous, odorless; lamellae sinuate-adnexed, distant, ventricose, inserted, very broad, pure-white, not darkening on drying, edges undulate; spores ellipsoid, smooth, hyaline, granular, 6–8×3 5μ; stipe equal, smooth, glabrous, not viscid, white, 4.5×0.7 cm.

Type collected by West and Murrill on the ground in Planera Hammock, ten miles northwest of Gainesville, Fla., July 20, 1938 (*F 17914*). A viscid species with gills just touching and sometimes almost free. The flesh was so very thin that no attempt was made to determine its taste. Some might place it in *Hygrophorus*.

Melanoleuca platyphylloides sp. nov.

Pileo plano, 4–5 cm. lato, avellaneo; lamellis sinuatis, albis, sporis albis, 5μ; stipite albo, glabro, 5×0.6–0.8 cm.

Pileus plane, solitary, 4–5 cm. broad; surface dry, finely hispid, slightly streaked, uniformly pale avellaneous, margin even, slightly lobed; context very thin, white, not changing, odorless, mild; lamellae sinuate, rather narrow, medium distant, inserted, pure-white, unchanging, edges entire; spores globose, smooth, white, granular, about 5μ; stipe curved, slightly tapering downward, smooth, glabrous, twisted on drying, white, 5×0.6–0.8 cm.

Type collected by West and Murrill in humus in Planera Hammock, eleven miles northwest of Gainesville, Fla., July 20, 1938 (*F 17915*). Suggesting *Collybia platyphylla*, but having narrow gills that are medium distant and a rather short stipe.

Monadelphus floridanus sp. nov.

Pileo infundibuliformi, caespitoso, 4–8 cm. lato, albo, lobato; lamellis praedecurrentibus, angulatis albis, sporis ovoideis, 3×2μ; stipite irregulari, albo, 1–3×0.3–0.8 cm.

Pileus irregular, deeply infundibuliform, cespitose, 4–8 cm. broad; surface smooth, glabrous, uniformly white, not changing; margin deflexed, even, lobed and splitting; context thin, white, sweet, odorless; lamellae long-decurrent, narrow, crowded, entire, white, yellowish with age; spores ovoid, smooth, hyaline, uninucleate, about 3×2μ; stipe irregular, uneven, finely subtomentose, solid, white, 1–3×0.3–0.8 cm.

Type collected by West and Murrill on dead oak wood in Kelley's Hammock, ten miles northwest of Gainesville, Fla., July 19, 1938 (*F 17905*). Like clusters of white lilies, irregular and somewhat torn. I first thought of *Hexagona daedalea* (Link) Murrill, and was surprised when I saw the gills.

Omphalina subfulviceps sp. nov.

Pileo convexo-expanso, umbilicato, ad 2.5 cm. lato, pallide fulvo, subglabro; lamellis subdecurrentibus, albis; sporis ellipsoideis, 7×4μ; stipite glabro, subfulvo, 1.5×0.1–0.2 cm.

Pileus convex to expanded, deeply umbilicate, scattered, reaching 2.5 cm. broad; surface dry, smooth, finely hispid at the center, uniformly pale-fulvous, margin even, subentire, incurved on drying; context very thin, white, odorless, slightly acid; lamellae short-decurrent, inserted, medium broad, medium close, entire, white, pale-isabelline when dry; spores ellipsoid, smooth, uniguttulate, about 7×4μ; cystidia none; stipe tapering downward, cartilaginous, smooth, glabrous, concolorous, about 1.5×0.1–0.2 cm.

Type collected by W. A. Murrill on the ground under a laurel oak 12 mi. southwest of Gainesville, Fla., July 19, 1940 (*F 19330*). Also collected by the author in an open field at Gainesville, June 8, 1940 (*F 19326*). Spores tinged with brownish-yellow but not dark enough for *Tubaria.*

Prunulus subpalustris sp. nov.

Pileo convexo-plano, 1.5–2 cm. lato, glabro, avellaneo, praestriato; lamellis adnatis, ventricosis, latis, pallidis; sporis 4×2μ; stipite glabro, avellaneo, 7×0.1–0.2 cm.

Pileus convex to plane, 1.5–2 cm. broad; surface dry, glabrous, pale-avellaneous to dark-avellaneous, closely striate to the small, slightly darker disk, margin entire, upturned with age; context membranous, pallid, odorless; lamellae narrowly adnate, inserted, ventricose, broad, medium distant, entire, pallid, very thin; spores elongate-ellipsoid, smooth, hyaline, about 4×2μ; stipe equal, hollow, smooth, glabrous, concolorous, about 7×0.1–0.2 cm.

Type collected by W. A. Murrill in sphagnum in low mixed woods near Hatchet Creek, east of Gainesville, Fla., Apr. 11, 1943 (*F 19325*). A delicate species, evidently rare.

Russula albimarginata sp. nov.

Pileo convexo-depresso, 5 cm. lato, viscido, glabro, vinoso, acrido; lamellis adnatis, angustatis, confertis, albis; sporis subglobosis, echinulatis, albis, 6μ; stipite glabro, albo, 5–6×1.3–1.6 cm.

Pileus convex to depressed, 5 cm. broad; surface viscid, smooth, glabrous, vinosous, margin pallid, not peeling, even, entire; context thin, firm, white, odorless, very acrid at once; lamellae adnate, plane, close, very narrow, not forked, entire, white; spores subglobose, roughly echinulate, white in mass, about 6μ; cystidia none; stipe equal, solid, smooth, glabrous, white, 5–6×1.3–1.6 cm.

Type collected by W. A. Murrill in good soil under hardwoods in the Ravine at Gold Head State Park, Fla., Jan. 26, 1941 (*F 19447*). Remarkable for its peculiar coloring and very narrow gills. In dried specimens the margin of the cap is white, separated by a bay zone from the dark-purple center.

Russula anisata sp. nov.

Pileo convexo-praedepresso, 6 cm. lato, glabro, rubro-incarnato, subacrido; lamellis adnatis, latis, albis; sporis globosis, echinulatis, albis, 6µ; stipite glabro, albo, 4.5×1.3-1.6µ.

Pileus convex to deeply depressed, scattered, reaching 6 cm. broad; surface slightly viscid when wet, glabrous, reddish-incarnate, fading or white-spotted with age, margin even, entire, at length undulate and upturned; context thin, white, unchanging, soon moderately acrid, with anise odor; lamellae adnate, few forked near the base, broad, ventricose, entire, white; spores globose, rough, white in mass, about 6µ; stipe tapering downward, solid, smooth, glabrous, white, unchanging, 4.5×1.3-1.6 cm.

Type collected by W. A. Murrill on a lawn shaded by frondose trees in Gainesville, Fla., June 29, 1942 (*F 22496*).

Russula brunneipes sp. nov.

Pileo convexo-depresso, 7 cm. lato, glabro, rosei- isabellino, pectinato, grato; lamellis adnexis, latis, albis; sporis ellipsoideis, echinulatis, albis, 8×6µ; stipite glabro, albo vel rosei-brunneo, 4–5×0.7–1 cm.

Pileus convex to depressed, gregarious, 7 cm. broad; surface slightly viscid, glabrous, uniformly rosy-isabelline, margin pectinate, not separable, entire; context thin, white, unchanging, odorless, mild; lamellae adnexed, very fragile, broad, ventricose, rather close, few forked, mostly equal, entire, white; spores broadly ellipsoid, strongly echinulate, white in mass, 8×6µ; stipe equal or tapering downward, smooth, glabrous, partly white but mostly pale-rosy-brown, 4–5×0.7–1 cm.

Type collected by W. A. Murrill under a live-oak in Sugarfoot, near Gainesville, Fla., Dec. 17, 1941 (*F 19537*).

Russula heterosporoides sp. nov.

Pileo convexo-subdepresso, 6–8 cm. lato, glabro, pallido, striato, grato; lamellis confertis, albis; sporis ovoideis, levibus, albis, 5×3µ; stipite albo, glabro, 6–8×1.5–2.5 cm.

Pileus convex to slightly depressed, scattered, 6–8 cm. broad; surface moist, smooth, glabrous, dull-white, slightly yellowish at the center, margin entire, striate-tuberculate, peeling; context thin, firm, white, unchanging, odorless, mild; lamellae adnexed, few inserted, not forked, crowded, medium broad, entire, white, unchanging; spores white, ovoid, smooth, about 5×3μ; stipe tapering downward, glabrous, white, unchanging, firm, solid, distinctly parallel grooved or lined, 6–8×1.5–2.5 cm.

Type collected by W. A. Murrill in dry soil under longleaf pine at Gainesville, Fla., Apr. 28, 1939 (*F 19110*). Suggesting *R. heterospora* Beards. and the indorous form of *R. chlorinosma* in the sense of Singer.

Russula inedulis sp. nov.

Pileo convexo-depresso, 7–8 cm. lato, viscido, glabro, roseo, grato; lamellis adnatis, latis, confertis; sporis globosis, tuberculatis, flavis, 6–7μ; stipite glabro, albo, 5×1.5–3 cm.

Pileus convex to depressed, 7–8 cm. broad; surface viscid when moist, smooth, glabrous, mostly roseous but with small white or yellowish areas, margin even, undulate, scarcely peeling; context thick, firm, white, unchanging, odorless, mild but of poor quality; lamellae adnate, broad, crowded, becoming deep-yellow; spores globose, rough, yellow, 6–7μ; stipe enlarged below, smooth, glabrous, white, unchanging, about 5×1.5–3 cm.

Type collected by W. A. Murrill on a grassy lawn near laurel oak and longleaf pine in Gainesville, Fla., Oct. 24, 1942 (*F 22465*). A large, attractive species.

Russula levyana sp. nov.

Pileo convexo-depresso, 4–5 cm. lato, subviscido, glabro, purpureorubro, grato; lamellis adnatis, latis, albis; sporis globosis, echinulatis, stramineis, 10μ; stipite glabro, albo, 3×1 cm.

Pileus convex to depressed, gregarious, 4–5 cm. broad; surface slightly viscid, smooth, glabrous, bright purplish-red, margin even, entire; context white, unchanging, odorless, sweet and nutty; lamellae adnate, many forked at the base, broad, ventricose, rather close, entire, white to slightly yellowish; spores globose, roughly echinulate, pale-stramineous in mass, about 10μ; cystidia none; stipe equal or tapering downward, smooth, glabrous, white, about 3×1 cm.

Type collected by W. A. Murrill under longleaf pine near Otter Creek, Levy Co., Fla., Jan. 14, 1940 (*F 15859*). In the dried specimens the gills are grayish and the stems slightly discolored. Related to *R. xerampelina* Fr. but without the disagreeable odor of that species.

Russula luteispora sp. nov.

Pileo convexo-depresso, 3.5 cm. lato, glabro, subincarnato, substriato; lamellis adnexis, confertis, pallidis; sporis ellipsoideis, echinulatis, luteis, 7×5μ; stipite glabro, albo, 2.5×0.7–0.9 cm.

Pileus convex to depressed, solitary, 3.5 cm. broad; surface slightly viscid, smooth, glabrous, uniformly pale-incarnate, margin slightly striate and slightly undulate; context very thin, white, unchanging, odorless;

lamellae adnexed, equal, plane, narrow, close, entire, pallid; spores broadly ellipsoid, rough, luteous in mass, about 7×5μ; cystidia none; stipe tapering downward, smooth, glabrous, white, 2.5×0.7–0.9 cm.

Type collected by W. A. Murrill in low ground under hardwoods at Gulf Hammock, Levy Co., Fla., Jan. 14, 1940 (*F 18537*). A pretty little species with deep-yellow spores.

Russula obscuriformis sp. nov.

Pileo convexo-subdepresso, 8 cm. lato, glabrescente, atriroseo, disco badio, grato; lamellis adnatis, latis, albis; sporis subglobosis, tuberculatis, stramineis, 8μ; stipite glabro, albo, 5×2 cm.

Pileus convex to slightly depressed, solitary, 8 cm. broad, surface dry, smooth, at length glabrous, dark-roseous with bay center, darker on drying, margin even or slightly striate, entire, peeling readily; context thin, white, discolored on drying, odorless, mild; lamellae adnate, mostly equal, few forked, broad, medium distant, entire, white; spores subglobose to broadly ellipsoid, finely tuberculate, stramineous in mass, about 8μ long; cystidia none; stipe equal, smooth, glabrous, white, 5×2 cm.

Type collected by W. A. Murrill under an oak at LaCrosse, Alachua Co., Fla., July 13, 1938 (*F 15536*). Suggesting *R. obscura* Romell but differing in color and spore color. The gills in dried specimens are distinctly gray.

Russula praecompacta sp. nov.

Pileo convexo-depresso, 4 cm. lato, subpulverulento, rubro, disco pallide, grato; lamellis adnatis, confertis; sporis globosis, echinulatis, albis, 6μ; stipite glabro, roseo, 3×0.8 cm.

Pileus convex to slightly depressed, solitary, 4 cm. broad; surface dry, smooth, minutely pulverulent, red with pallid disk, margin concolorous, even, entire, not peeling, becoming inflexed and slightly striate on drying; context very firm, white, unchanging, odorless, mild; lamellae adnate, plane, close, narrow, equal, entire; spores globose, strongly echinulate, white in mass, about 6μ; stipe slightly larger at the middle, smooth, glabrous, roseous, 3×0.8 cm.

Type collected by W. A. Murrill in low ground in mixed woods east of Weirsdale in Marion Co., Fla., Oct. 5, 1941 (*F 18493*). Characterized by its coloring and compactness, although of light weight when dry.

Russula pseudofoetens sp. nov.

Pileo convexo-depresso, 5.5–6.5 cm. lato, viscido, glabro, incarnato, acrido; lamellis adnatis, confertis, albis; sporis ellipsoideis, tuberculatis, subflavis, 8×6μ; stipite albo, 3–4×1.5 cm.

Pileus convex to slightly depressed, gregarious or scattered, 5.5–6.5 cm.

broad; surface viscid, smooth, glabrous, uniformly incarnate, margin even, entire, peeling with difficulty; context thin, firm, white, unchanging, odorless, decidedly acrid at once; lamellae adnate, close, rather narrow, entire, white to yellow; spores broadly ellipsoid, finely tuberculate and with a few interrupted ridges, slightly yellowish, about 8×6μ; cystidia none; stipe equal, smooth, glabrous, white, unchanging, 3–4×1.5 cm.

Type collected by W. A. Murrill in dry pine-oak woods at Gainesville, Fla., June 17, 1939 (*F 15552*). Resembling *R. foetens* in a dried condition.

Russula sericella sp. nov.

Pileo convexo-depresso, 5–7 lato, pruinoso, vinoso vel pallidevinoso, grato; lamellis adnatis, confertis, albis ad griseis; sporis globosis, tuberculatis, albis, 6–7μ; stipite albo ad subbrunneo, 5–7×1.5–2 cm.

Pileus convex to depressed, 5–7 cm. broad; surface dry, smooth, finely pruinose, vinosous on the disk, paler toward the margin, which is entire and very slightly striate at times; context white, unchanging, odorless, mild; lamellae adnate, many forked at the very base, few inserted, close, narrow, entire, white, gray when dried; spores globose or subglobose, plainly short-tuberculate, white in mass, 6–7μ; cystidia none; stipe usually equal, stuffed, smooth, glabrous, white, becoming pale-brownish when handled, 5–7×1.5–2 cm.

Type collected by W. A. Murrill under a live-oak in Gainesville, Fla., June 1, 1938 (*F 12075*). Also collected several times under frondose trees in Alachua Co. and once in Clay Co., Fla. Closely related to Kauffman's *R. sericonitens* but easily distinguished by the change in the color of the stipe. Spores tuberculate; not echinulate as in *R. xerampelina* Fr.

Russula subpruinosa sp. nov.

Pileo convexo-plano, 4 cm. lato, subpruinoso, purpureo, disco atropurpureo, grato; lamellis adnatis, confertis, albis, brunnescentibus; sporis ellipsoideis, tuberculatis, hyalinis, 8–9×6–7μ; stipite albo, brunnescente, 3×0.7 cm.

Pileus convex to plane, solitary, 4 cm. broad; surface dry, smooth, minutely pruinose, pale-purple, the large disk dark-purple, margin even, entire, peeling only slightly; context very firm, thick, white, unchanging, odorless, mild; lamellae adnate, many forked near the base, plane, narrow, close, entire, white, yellowish-brown where bruised; spores broadly ellipsoid or subglobose, minutely tuberculate, white in mass, 8–9×6–7μ; cystidia none; stipe equal, smooth, subglabrous, white, turning yellowish-brown where bruised, 3×0.7 cm.

Type collected by W. A. Murrill under oaks in Planera Hammock, eleven miles northwest of Gainesville, Fla., Oct. 30, 1938 (*F 15542*). Suggesting *R. praecompacta* Murr.

Russula subvariata sp. nov.

Pileo convexo-depresso, 6.5 cm. lato, viscido, glabro, subpurpureo, grato; lamellis adnatis, confertis, albis; sporis ellipsoideis, echinulatis, albis, 8×6μ; stipite glabro, albo, 4×1.3 cm.

Pileus convex to depressed, solitary, 6.5 cm. broad; surface viscid, smooth, glabrous, uniformly dull-purplish, margin even, slightly lobed, not peeling; context thin, white, mild, without characteristic odor; lamellae adnate, few inserted, close, medium broad, entire, white; spores broadly ellipsoid, roughly echinulate, white in mass, about 8×6μ; cystidia none; stipe equal, smooth, glabrous, white, browning where bruised, 4×1.3 cm.

Type collected under a laurel oak in Sugarfoot, near Gainesville, Fla., Feb. 12, 1941 (*F 18232*). Suggesting *R. variata* Bann. but differing in several important characters.

Venenarius anisatus sp. nov.

Pileo convexo-subexpanso, 6.5 cm. lato, albo, anisato; lamellis adnatis, decurrentibus, albis, sporis 10×6.5μ; stipite 5.5×1.2–1.8 cm., annulo magno, persistente.

Pileus convex to subexpanded, solitary, 6.5 cm. broad; surface uniformly white with a few flat volval fragments, margin entire, even; context white, unchanging, with a faint odor of anise; lamellae adnate, each with a long decurrent ridge on the stipe, broad, unequal, not very close, white, unchanging, the edges neither fimbriate nor eroded; spores ellipsoid or ovoid, smooth, hyaline, about 10×6.5μ; stipe slightly enlarged above, floccose below, white, unchanging, 5.5×1.2–1.8 cm.; bulb large, subglobose, 3×3 cm., not radicate, the volva limb mostly carried aloft in fragments of medium size; annulus skirt-like, large, white, membranous, persistent, attached 1.5 cm. from the apex.

Type collected by W. A. Murrill under a large pine in Gainesville, Fla., June 25, 1938 (*F 16364*). Also collected in Gainesville by the author twice during July, 1938 (*F 17255*, *F 17348*). Suggesting *V. abruptiformis* Murr., but having shorter spores and an anise-like odor.

Venenarius maculans sp. nov.

Pileo convexo-expanso, 3–4 cm. lato, albo vel subcitrino; lamellis adnatis, angustatis, confertis, denticulatis; sporis ellipsoideis, 8–10×5–6μ; stipite albo, rubescente, bulboso; annulo amplo, albo.

Pileus convex to expanded, often broadly umbonate, gregarious or scattered, usually 3–4 cm. broad, rarely 6 cm.; surface nearly smooth, glabrous, white or lemon-tinted, sometimes isabelline on the disk or in spots, margin even, entire; context thin, white, unchanging, odorless, mild; lamellae adnate, crowded, narrow, denticulate, white, unchanging; spores ellipsoid, smooth, hyaline, obliquely apiculate, 8–10×5–6μ; stipe equal above the bulb, furfuraceous at the apex, glabrous below, white, becoming reddish where bruised, usually 4–6×0.5–0.7 cm.; bulb as in *V. phalloides* with spreading volva and short limb, usually 1.5 cm. wide; annulus white, ample, like a bell-shaped skirt, fixed about 1.5 cm. from the apex of the stipe, slightly staining reddish at times.

Type collected by W. A. Murrill under scrub oaks on a river flat in Columbia Co., Fla., northwest of High Springs, Dec. 14, 1941 (*F 20157*). Found but once.

Venenarius parviformis sp. nov.

Pileo hemisphaerico, 2.5 cm. lato, glabro, albo; lamellis adnatis, confertis, albis; sporis ellipsoideis, levibus, 8–9×6μ; stipite inaequali, glabro, albo, 3×0.5–0.8 cm.; annulo brevi, amplo, albo, persistenti; volva alba, 2×1.5 cm.

Pileus hemispheric, not fully expanding, 2.5 cm. broad; surface slightly viscid when fresh, smooth, glabrous, subshining, white, unchanging, margin even, entire; context thin except at center, white, unchanging, odorless; lamellae adnate, crowded, medium broad, entire, white, unchanging; spores ellipsoid, smooth, about 8–9×6μ; cystidia none; basidia 4-spored; stipe enlarged downward, smooth, glabrous, white, unchanging when bruised, about 3×0.5–0.8 cm.; annulus fixed 1 cm. from apex, very short, skirtlike, grooved by the lamellae above, white, persistent; bulb ovoid, white, 2 cm. high, 1.5 cm. broad; volva neither appressed nor widely spreading, the edge either 3-lobed or ragged.

Type collected by W. A. Murrill in sandy soil in a high hammock at Gainesville, Fla., Oct. 4, 1943 (*F 19266*). About the size of *V. parvus* but spores entirely different. Very rare.

Venenarius vernellus sp. nov.

Pileo conico, 2.5 cm. lato, albo, glabro, subviscido; lamellis confertis, angustatis, albis, fimbriatis; sporis globosis, 6–7μ; stipite albo, fibrilloso, 5.5×0.4–0.6 cm.; annulo albo, persistenti; volva adpressa, 1.5×1 cm.

Pileus conic, not fully expanding, with pointed umbo, 2.5 cm. broad; surface slightly viscid, white, slightly stramineous at the center, subshining, glabrous, smooth, margin scarcely striate with age, entire, inflexed on drying; context very thin, white, unchanging, with unpleasant odor; lamellae very narrow, very close, white, unchanging, the edges fimbriate; spores globose, smooth, hyaline, about 6–7μ; cystidia none; basidia 4-spored; stipe subequal, white, unchanging, 5.5×0.4–0.6 cm., the apex smooth, glabrous, not grooved, below the annulus slightly rough with fibrils pointing upward; veil fixed 1 cm. from apex, white, delicate, skirtlike, persistent; bulb ovoid, white, 1.5 cm. high, 1 cm. thick, edge of volva appressed, ragged.

Type collected by W. A. Murrill in sandy soil in a high hammock at Gainesville, Fla., Oct. 4, 1943 (*F 20002*). Probably nearest to *V. vernus* but very small, with conic cap and rough stem. The pileus is not hygroscopic. Evidently very rare.

Venenarius Watsonianus sp. nov.

Pileo convexo-expanso, 12 cm. lato, albo, appendiculato, grato; lamellis adnatis, angustatis, fimbriatis, sporis 14×3.5μ; stipite albo, floccoso, 13 ×2.5–3 cm., annulo amplo, lacerato; volva alba, ampla, lacerata-lobata.

Pileus convex to expanded with elevated center, solitary, 12 cm. broad; surface uniformly white, unchanging, glabrous, with closely adhering soft volval fragments or patches, margin even, appendiculate; context white, unchanging, with faintly pleasant odor; lamellae adnate, narrow, crowded, white, unchanging, fimbriate; spores sausage-shaped, smooth, hyaline, about 14×3.5μ; stipe slightly tapering upward, white, unchanging, floccose, not lined above, 13×2.5–3 cm.; annulus basal, white, ample but thin and torn; bulb large, irregular, elongate, radicate, the volva irregularly torn, somewhat spreading, white, unchanging.

Type collected by W. A. Murrill in dry mixed woods at Camp O'Leno, Columbia Co., Fla., Oct. 19, 1941 (*F 21875*). Rare in Alachua Co.

Lepista Westii sp. nov.

Pileo umbonato vel plano, 5–6 cm. lato, avellaneo-isabellino; sapore dulci; lamellis sinuatis, pallidis; sporis ellipsoideis, roseo-ochraceis, 6–6.5 ×3.5–4μ; stipite albo, solido, 5×1 cm.

Pileus umbonate to plane, gregarious, 5–6 cm. broad; surface dry, glabrous, minutely rugulose, pale isabelline with an avellaneous tint, margin incurved; context white, sweet, nutty, odor not characteristic; lamellae sinuate, 4–5 times inserted, pallid to rosy-ochraceous; spores rosy-ochraceous in mass, smooth, ellipsoid, 6–6.5×3.5–4μ; stipe equal, often curved near the base, milk-white, solid, white within, about 5×1 cm.

Type collected by Erdman West and W. A. Murrill in humus in oak woods at Gainesville, Fla., Nov. 12, 1932 (*F 9752*). About forty specimens were collected, representing all stages.

Cortinaria atribadia sp. nov.

Pileo convexo-depresso, 7.5 cm. lato, viscido, glabro, atribadio; lamellis adnatis, latis, integris; sporis fusoideis, levibus, 11×5.5μ; stipite pallido, abruptibulboso, 3×1 cm.

Pileus convex to depressed, solitary, 7.5 cm. broad; surface viscid, smooth, glabrous, uniformly dark-bay, margin even, entire; context white, unchanging when cut, mild, with earthy odor; lamellae adnate, inserted, broad, close, entire, soon fulvous; spores short-fusoid, smooth, opaque, ferruginous, about 11×5.5μ; stipe short, striate, whitish, abruptly bulbous, about 3×1 cm.; bulb large, dark-violet when dry.

Type collected by W. A. Murrill on a shaded lawn in Gainesville, Fla., Dec. 31, 1940 (*F 20063*).

In 1939 (Jour. Elisha Mitchell Sci. Soc. **55**: 362–366) I gave a brief account of the genus *Cortinaria* as represented in Florida and described several new species. Those added in the present paper bring the number now known from the state to thirty-four. Further collecting may raise the total to fifty. The percentage of endemic species appears to be large. *Cortinaria*, adopted by S. F. Gray in 1821, may be considered simply a variant spelling and need not cause any change in current names except to make them feminine instead of masculine.

Cortinaria campestris sp. nov.

Pileo convexo-subexpanso, umbonato, 4 cm. lato, umbrino, innato-fibrilloso; lamellis adnatis, latis, integris; sporis ovoideis, levibus, 8×4μ; stipite subglabro, ferrugineo, 3.5×0.4 cm.

Pileus convex to subexpanded with broad umbo, gregarious, reaching 4 cm. broad; surface dry, uniformly umbrinous, innate-fibrillose, the tips of the fibrils recurved, margin even, undulate; context thin, brownish, odorless, mawkish; lamellae adnate, separating, plane, broad, medium distant, soon ferruginous, the edges entire, white; spores elongate-ovoid, smooth, opaque, ferruginous, about 8×4μ; stipe equal, curved, subglabrous, ferruginous, reaching 3.5×0.4 cm.

Type collected by W. A. Murrill in open grass in flatwoods soil southwest of Micanopy, Alachua Co., Fla., Mar. 17, 1940 (*F 19281*). Not found elsewhere.

Cortinaria deflexa sp. nov.

Pileo convexo-subexpanso, 6 cm. lato, glabro, isabellino, deflexo, grato; lamellis adnatis, latis, alboviolaceis; sporis ellipsoideis, levibus, 7–8×5μ; stipite subfibrilloso, alboviolaceo, 8×0.6–0.8 cm.

Pileus convex to subexpanded, 6 cm. broad; surface glabrous, uneven, uniformly dark-isabelline, margin even, entire, deflexed; context very thin, white, mild, odorless; lamellae adnate, broad behind, rather crowded, entire, pale-violet to fulvous; spores broadly ellipsoid, smooth, opaque, ferruginous, about 7–8×5μ; stipe subequal, smooth, shining, slightly fibrillose, pale-violet, white below, about 8×0.6–0.8 cm.

Type collected by W. A. Murrill in leaf-mold in low frondose woods at Gainesville, Fla., Feb. 10, 1939 (*F 19150*).

Cortinaria fimbriata sp. nov.

Pileo convexo-subexpanso, 5–7 cm. lato, subviscido, glabro, isabellino;

lamellis sinuatis, confertis, pallidis, fimbriatis; sporis subovoideis, levibus, 11×6μ; stipite glabro, albo, 4–6×0.8–1.3 cm.

Pileus convex to subexpanded, gregarious, 5–7 cm. broad; surface slightly viscid, smooth, glabrous, isabelline, margin paler, even, undulate; context white, odorless, mild or radish-like or bitter; lamellae sinuate, rather broad, close, inserted, pallid, white-fimbriate; spores subovoid, pointed, inequilateral, smooth, pale-ferruginous, about 11×6μ; stipe subequal, smooth, glabrous, white, fibrillose at the apex and sometimes with a bulbous base, 4–6×0.8–1.3 cm.

Type collected by W. A. Murrill on the ground in a live-oak hammock on the Old Micanopy Road, near Gainesville, Fla., Jan. 21, 1940 (*F 22504*). Also collected in the vicinity under laurel oak. The gills are beautifully fringed.

Cortinaria lacticeps sp. nov.

Pileo convexo-plano, 5–7 cm. lato, albo, glabro; lamellis subadnatis, latis, pallidis; sporis ellipsoideis, levibus, 9×5μ; stipite bulboso, glabro, albo, 2–4×1–3 cm.

Pileus convex to plane, cespitose or gregarious, 5–7 cm. broad; surface glabrous, white, margin incurved, even, entire, often becoming revolute and split; context thick at the center, white, odorless, becoming slightly mawkish; lamellae narrowly adnate, rounded behind, broad, ventricose, crowded, pallid when young, inserted, entire; spores ellipsoid, smooth, opaque, ferruginous, uniguttulate, about 9×5μ; cystidia none; stipe enlarged downward, bulbous, solid, smooth, glabrous, white, 2–4×1–3 cm.; cortina very delicate, white, evanescent; bulb large, distinctly marginate.

Type collected by W. A. Murrill under a hedge of laurel cherry in Gainesville, Fla., Jan. 2, 1943 (*F 19863*). Common at this season in the vicinity of Gainesville under hedges and evergreen oaks, often appearing in groups of thirty or more hymenophores.

Cortinaria oreades sp. nov.

Pileo convexo-subexpanso, 4–7 cm. lato, subviscido, glabro, isabellino vel ferrugineo-fulvo, amaro; lamellis sinuatis, latis, pallidis; sporis levibus, 8–11×4–5μ; stipite glabro, pallido, 4–6×1–1.5 cm.

Pileus convex to subexpanded, gregarious, 4–7 cm. broad; surface slightly viscid, glabrous, dark-isabelline or ferruginous-fulvous, margin pallid, even, undulate or lobed; context pallid, odorless, very bitter at once; lamellae sinuate, rounded behind, inserted, broad, crowded, entire, pallid to rusty; spores pipshaped, smooth, opaque, ferruginous, 8–11 ×4–5μ; stipe equal or tapering downward, smooth, glabrous, solid, pallid, 4–6×1–1.5 cm.; cortina slight, white, evanescent.

Type collected by Dr. G. F. Weber in his yard in Gainesville, Fla., Jan.

13, 1941 (*F 19301*). Also collected by the author in the vicinity. The type collection was part of a fairy ring 8 ft. in diameter.

Cortinaria privigniformis sp. nov.

Pileo conico-convexo, umbonato, 3 cm. lato, glabro, fulvo; lamellis sinuatis, confertis, integris; sporis ellipsoideis, tuberculatis, 8×5μ; stipite albo, glabro, 6×0.5–0.7 cm.

Pileus conic to convex with broad umbo, gregarious, reaching 3 cm. broad; surface dry, smooth, glabrous, shining, uniformly fulvous, margin deflexed and hoary at first, even, entire to somewhat split; context very thin, pallid; lamellae sinuate, plane, close, rather broad, entire, soon fulvous; spores ovoid or ellipsoid, inequilateral, tuberculate, uniguttulate, ferruginous, about 8×5μ; stipe tapering downward, not bulbous, smooth, white, glabrous, shining, 6×0.5–0.7 cm.

Type collected by W. A. Murrill in leaf-mold in Kelley's Hammock, 10 mi. northwest of Gainesville, Fla. Jan 22, 1943 (*F 18124*.)

Cortinaria pusilla sp. nov.

Pileo convexo-subexpanso, 2 cm. lato, glabro, alboviolaceo, grato; lamellis sinuatis, latis, integris; sporis subglobosis, tuberculatis, 6×5μ; stipite glabro, violaceo, bulboso, 3.5×0.2–0.4 cm.

Pileux convex to subexpanded, about 2 cm. broad; surface dry, smooth, glabrous, uniformly pale-violet, margin even, entire; context thin, dull-violet, mild; lamellae slightly sinuate, rather close, broad, entire, soon fulvous; spores broadly ellipsoid or subglobose, uniguttulate, deep-ferruginous, tuberculate, about 6×5μ; stipe tapering downward, smooth, glabrous, violet, bulbous, 3.5×2.0–0.4 cm.; cortina slight, evanescent.

Type collected by W. A. Murrill under a live-oak at Rochelle, near Gainesville, Fla., Sept. 28, 1941 (*F 22494*).

Cortinaria subglobispora sp. nov.

Pileo convexo-subdepresso, 4 cm. lato, glabro, avellaneo-isabellino, grato; lamellis adnatis, violaceis; sporis subglobosis, levibus, 7×5μ; stipite alboviolaceo, bulboso, 5–6×0.6–0.8 cm.

Pileus convex to slightly depressed, sometimes umbonate, gregarious, about 4 cm. broad; surface smooth, glabrous, shining, uniformly avellaneous-isabelline, margin even, entire; context firm, thin, white, mild, odorless; lamellae adnate, inserted, medium distant, medium broad, firm, entire, violet; spores broadly ellipsoid or subglobose, smooth, opaque, pale-ferruginous, about 7×5μ; stipe usually bulbous, almost solid, pale-violet, whitish at the base, 5–6×0.6–0.8 cm.; bulb globose to onion-shaped, not marginate.

Type collected by W. A. Murrill on the ground in frondose woods in

Planera Hammock, 11 mi. northwest of Gainesville, Fla., Jan. 16, 1940 (*F 22472*). Also collected by Watson and Murrill in deep leaf-mold in a moist high hammock on the Old Micanopy Road, near Gainesville, Fla., Jan. 21, 1940 (*F 22513*).

Cortinaria sublilacina sp. nov.

Pileo convexo-plano, 5–7 cm. lato, viscido, fibrilloso, subviolaceo, non grato; lamellis sinuatis, confertis, violaceis; sporis fusoideis, levibus, 9–10 ×5–6µ; stipite bulboso, violaceo, 2–5×1.5–2 cm.

Pileus convex to plane, gregarious, 5–7 cm. broad; surface viscid when wet, innate-fibrillose, pale-violet, with a ferruginous tint in places, margin even, entire, deflexed to straight; context firm, thick, pallid with yellowish and violet tints, taste mawkish, odor somewhat unpleasant; lamellae sinuate, inserted, medium broad, crowded, entire, violet; spores fusoid, smooth, uniguttulate, ferruginous, 9–10×5–6µ; stipe short, bulbous, striate, innate-fibrillose to subglabrous, violet, 2–5×1.5–2 cm.; bulb 3 cm. thick, cortina evanescent.

Type collected by W. A. Murrill on a lawn in Gainesville, Fla., Nov. 20, 1938 (*F 19211*).

Cortinaria viscibadia sp. nov.

Pileo convexo-subexpanso, 6 cm. lato, viscido, glabro, badio, grato; lamellis adnatis, confertis, integris; sporis ovoideis, levibus, 8–10×5µ; stipite glabro, violaceo, bulboso, 4×1.5–1.8 cm.

Pileus convex to subexpanded, solitary, 6 cm. broad; surface viscid, smooth, glabrous, uniformly bay, margin even, entire; context thick, white, odorless, mild; lamellae adnate, plane, close, rather broad, entire, soon fulvous; spores ovoid, pointed, smooth, opaque, pale-ferruginous, about 8–10×5µ; stipe tapering downward, bulbous, smooth, glabrous, shining, violet, 4×1.5–1.8 cm.; bulb white, 2.3 cm. thick; cortina copious, persisting on stipe.

Type collected by W. A. Murrill on the ground in high-pine woods at Gainesville, Fla., Jan. 12, 1940 (*F 22476*). Found but once. Suggesting *C. atribadia* Murr. but differing in several ways.

Cortinaria Watsonii sp. nov.

Pileo convexo-expanso, 6–10 cm. lato, glabro, cremeo, disco subfulvo, amaro; lamellis sinuatis, latis, pallidis; sporis subovoideis, levibus, 10–12×5–6µ; stipite abruptibulboso, 5–6×1–2 cm.

Pileus convex to expanded, gregarious, reaching 10 cm. broad; surface slightly viscid, smooth, glabrous, cremeous with pale-fulvous disk, margin even, entire to undulate; context firm, whitish, bitter and astringent; lamellae sinuate, ventricose, inserted, broad, entire, pallid to fulvous;

spores subovoid, inequilateral, smooth, granular, pale-ferruginous, 10–12×5–6μ; stipe subequal above the abrupt bulb, scurfy, pale-yellowish, solid, 5–6×1–2 cm.

Type collected by J. R. Watson and W. A. Murrill on the ground in a high hammock at Gainesville, Fla., Jan. 9, 1940 (*F 22510*). Common in Alachua Co., especially under live-oaks. Also collected in Columbia, Marion and Lake Counties. The odor varies from pleasant to disagreeable. Sometimes both taste and odor resemble that of radishes.

Cortinaria Weberi sp. nov.

Pileo convexo-subexpanso, 5–6 cm. lato, glabro, rosei-isabellino, grato; lamellis adnatis, integris; sporis ellipsoideis, levibus, 8×5μ; stipite bulboso, glabro, albo, 4×1–2 cm.

Pileus convex to subexpanded, gregarious, 5–6 cm. broad; surface smooth, dry, glabrous, rosy-isabelline; margin even, entire, often splitting with age; context thin, white, unchanging, mild, odorless; lamellae adnate or slightly sinuate, inserted, medium broad, rather close, entire, soon fulvous; spores ellipsoid, smooth, not guttulate, pale-ferruginous, about 8×5μ; stipe equal above the bulbous base, smooth, glabrous, satiny-white, about 4×1–2 cm.; bulb not margined.

Type collected by Dr. G. F. Weber among leaves in mixed woods at Hawthorn, Fla., Feb. 16, 1941 (*F 22459*). Very trim and neat. Not found elsewhere. The gills in mature dried hymenophores are often transversely banded, or rivulose.

Hebeloma floridanum sp. nov.

Pileo convexo-subexpanso, subumbonato, 4.5 cm. lato, glabro, viscido, rosei-isabellino, subamaro; lamellis sinuatis, subdistantibus, pallidis ad fulvis; sporis levibus, 8–10×4–5μ; stipite pallidi, subpruinoso, 5×0.7 cm.

Pileus convex to subexpanded, slightly umbonate, solitary, 4.5 cm. broad; surface viscid, smooth, glabrous, rosy-isabelline, isabelline on the disk, margin even, entire; context thin, dull, pallid, with pleasant odor and mawkish, slightly bitter taste; lamellae sinuate, plane, inserted, rather broad, rather distant, entire, pallid to fulvous; spores subpipshaped, obliquely apiculate, 1-guttulate, fuscous in mass but pale yellowish-brown under a microscope, smooth, 8–10×4–4.5μ; cystidia none; stipe tapering downward, smooth, whitish, finely pruinose, 5×0.7 cm.

Type collected by W. A. Murrill in leaf-mold in Sugarfoot Hammock, southwest of Gainesville, Fla., July 12, 1938 (*F 10452*). The gills are not so close as in most of our Florida species.

Hebeloma Weberi sp. nov.

Pileo convexo-depresso, 5–8 cm. lato, viscido, glabro, isabellino, disco fulvo, raphanico; lamellis sinuatis, pallidis; sporis subovoideis, levibus, 11×6μ; stipite pallido, 3–5×0.7–1 cm.

Pileus convex to depressed, gregarious, 5–8 cm. broad; surface viscid, smooth, glabrous, isabelline with fulvous disk, margin incurved, even, entire, often splitting with age; context thin, white, unchanging, odorless, tasting strongly of radishes; lamellae sinuate or adnexed, inserted, medium broad, medium close, pallid when young, finely fringed; spores subovoid, smooth, inequilateral, uniguttulate, about 11×6μ; cystidia none; stipe usually tapering downward, white or pallid, more or less white-chaffy, stuffed, 3–5×0.7–1 cm.

Type collected by Dr. G. F. Weber in shaded leaf-mold in Gainesville, Fla., Jan. 19, 1942 (*F. 19205*). Not found elsewhere.

Naucoria subcuspidata sp. nov.

Pileo hemisphaerico, gregario, 1 cm. lato, glabro, fulvo; lamellis sinuatis, latis, subfulvis, integris; sporis ferrugineis, 10×4μ; stipite equali, fulvo, subfibrilloso, 2×0.1 cm.

Pileus hemispheric with very small umbo, gregarious, about 1 cm. broad; surface smooth, glabrous, fulvous, the umbo dark-fulvous, margin even, entire; context very thin; lamellae sinuate, inserted, broad, medium distant, pale-fulvous, white on the edges; spores elongate-ellipsoid, slightly rough, ferruginous, about 10×4μ; cystidia none; stipe equal, crooked, concolorous, slightly fibrillose, about 2×0.1 cm.

Type collected by W. A. Murrill on dead hardwood in Kelley's Hammock, ten miles northwest of Gainesville, Fla., Aug. 15, 1943 (*F 18648*). A small fulvous species growing on dead wood and evidently rare. The margin is incurved in dried specimens and the colors are practically unchanged.

Agaricus cylindriceps sp. nov.

Pileo cylindrico-convexo, truncato, gregario, 5–8 cm. lato, squamuloso, albo, amygdalino; lamellis adnexis, confertis, sporis 5–6×3.5–4μ; stipite bulboso, ad 7.5×1.3 cm., albo, glabro; annulo amplo, albo.

Pileus cylindric to broadly convex and truncate, not fully expanding, gregarious, up to 8 cm. broad; surface dry, minutely squamulose, white or pale yellowish-white, the disk in old plants often rosy-avellaneous, margin even, entire; context white, sweet, with an amygdaline odor when young; lamellae adnexed, ventricose, crowded, inserted, entire, pale-pink, show in darkening; spores broadly ellipsoid, smooth, purplish-brown, 5–6×3.5–4μ; stipe tapering upward, up to 7.5×1.3 cm. above the large bulb, white, smooth, glabrous, solid; veil ample, white, forming a large, fixed, median annulus.

Type collected by W. A. Murrill in bare soil under a laurel oak on the campus of the University of Florida, in Gainesville, Aug. 13, 1937 (*F*

16050). Also collected many other times in and about Gainesville on shaded lawns, in oak woods, etc.

Coprinus subradiatus sp. nov.

Pileo convexo-plano, 2 cm. lato, isabellino, glabro, rimoso, membranaceo; lamellis adnexis, confertis, albis, fimbriatis; sporis ovoideis, 8–9×5μ; stipite albo, 5×0.05–0.15 cm.

Pileus convex to plane, solitary, 2 cm. broad; surface isabelline, glabrous, soon rimose to the small disk, margin entire, paler; context membranous, pallid; lamellae adnexed, rounded behind, narrow, close, inserted, fimbriate, white, becoming dirty-pallid on drying but not entirely dissolving: spores ovoid, smooth, purplish-brown, opaque, truncate, about 8–9×5μ; cystidia none; stipe white, enlarged and pubescent above and below, subglabrous in the middle, 5×0.05–0.15 cm.

Type collected by W. A. Murrill in a pile of charcoal in oak woods at Gainesville, Fla., July 26, 1939 (*F 16331*). Related to *C. radiatus* and *C. Spraguei.*

Stropharia australis sp. nov.

Pileo convexo-expanso-umbonato, 4.5 cm. lato, glabro, isabellino; lamellis adnexis, confertis, integris; sporis ovoideis, levibus, 10×6μ; stipite glabro, pallido, 10×0.4–0.6 cm.; annulo amplo, pallido.

Pileus convex to plane with small rounded umbo, solitary, 4.5 cm. broad; surface smooth, glabrous, isabelline, margin becoming striate and split with age; context thin, pallid; lamellae adnexed or just free, rounded behind, inserted, close, medium broad, entire, soon umbrinous; spores ovoid, smooth, opaque, rather pale, about 10×6μ; cystidia none; stipe long, slightly tapering upward from an enlarged base, smooth, glabrous, pallid, 10×0.4–0.6 cm.; annulus 2 cm. from apex, fixed, ample, membranous, pallid, persistent.

Type collected by W. A. Murrill in leaf-mold and trash in low frondose woods at Gulf Hammock, Levy Co., Fla., Jan. 14, 1940 (*F 12111*). Not found elsewhere.

Ceriomyces oliveisporus sp. nov.

Pileo convexo-subplano, 6 cm. lato, subtomentoso, badiofulvo, grato; tubulis parvis, viridiflavis, cyanescentibus; sporis oblongis, olivaceis, levibus, 12–14×3–4μ; stipite subglabro, isabellino vel avellaneo, 4×1 cm.

Pileus convex to nearly plane, solitary, about 6 cm. broad; surface dry, subtomentose, dark-fulvous tinged with bay, margin entire, concolorous, slightly projecting; context pallid, unchanging, reddish under the cuticle, 5–10 mm. thick, mild to slightly mawkish, with pleasant odor; tubes not depressed, 5–10 mm. long, bluing within when cut, mouths regular except near stipe, 2 per mm., not stuffed, pale greenish-yellow, bluing when wounded; spores olive in mass, oblong, smooth, about 12–14×3–4μ; stipe subequal, pinched at the base, solid, dry, subglabrous, minutely chaffy above, isabelline, avellaneous below, unchanging, about 4×1 cm.

Type collected by W A. Murrill on decayed stumps of slash pine in flatwoods west of Rochelle, Alachua County, Fla., August 1, 1943 (*F 17961*). It is not often that one finds boletes on dead wood. They are also rare in flatwoods.

Ceriomyces pallidiformis sp. nov.

Pileo convexo-subdepresso, 5 cm. lato, isabellino, grato; tubulis parvis, subviridibus; sporis levibus, ochraceis, 10–12×4–5μ; stipite brunneo, reticulato, 5×1–1.5 cm.

Pileus convex to slightly depressed, solitary, 5 cm. broad; surface dry, subglabrous, smooth, dark-isabelline, margin entire, fertile, concolorous; context about 1 cm. thick, very soft, mild, odorless, white, unchanging; tubes short, small, not depressed, mouths dull-greenish, brownish when bruised; spores fusiform, smooth, pale yellowish-brown, about 10–12×4–5μ; stipe enlarged above and below, dry, mottled with pallid and light-brown, shallowly reticulate, 5×1–1.5 cm.

Type collected by W. A. Murrill under oaks and pines on a dry hill near Planera Hammock, 11 mi. northwest of Gainesville, Fla., July 4, 1943 (*F 15610*). Suggesting *C. subpallidus* Murr., described from North Carolina, but having shorter tubes and a brownish stem.

Ceriomyces pseudoboletinus sp. nov.

Pileo convexo-subplano, 5–7 cm. lato, citrino, squamuloso, grato; tubulis viridiflavis, cyanescentibus, 1–2×1 mm.; sporis oblongis, levibus, 10–12×4–5μ; stipite glabro, subcitrino, 3×1–2.5 cm.

Pileus convex to subexpanded, solitary, 5–7 cm. broad; surface moist, citrinous, with minute pale reddish-brown imbricated scales, margin entire, fertile; context about 1 cm. thick, firm, citrinous, slightly bluing at times when cut, odorless, with a nutty flavor; hymenium ventricose, adnate, bright-flavous with a greenish tint, tubes about 1.5 cm. long, bluing when bruised, mouths large, about 1 per mm., radially elongated near the stipe; spores yellowish-brown, fusiform, smooth, 10–12×4–5μ; stipe much enlarged above, smooth, glabrous, pale-citrinous, solid, about 3×1–2.5 cm.

Type collected by W. A. Murrill on the ground in longleaf pine and turkey oak woods in Gainesville, Florida, Oct. 3, 1941 (*F. 17981*). Also collected by the author in dry pine woods several miles east of Gainesville (*F. 19589*) and at Lake Swan, Putnam Co. (*F. 19869*). The pores and surface suggest certain species of *Boletinus* but there is no trace of a veil.

Ceriomyces umbriniceps sp. nov.

Pileo convexo, 6 cm. lato, subtomentoso, umbrino, grato, anisato; tubulis 1 cm. longis, 2–3 per mm., cyanescentibus; sporis elongatis, ovoideis, 11.5×5μ; stipite roseo, radicato, subglabro, 2.5×1–1.3 cm.

Pileus convex, not fully expanding, solitary, 6 cm. broad; surface dry, soft, smooth, subtomentose, uniformly umbrinous, margin entire, fertile, concolorous; context about 5 mm. thick, very pale yellow, slowly slightly bluing when cut, with mild taste and strong anise odor; hymenium plane, scarcely depressed at the stipe, olivaceous at maturity, tubes angular, thin-walled, 2–3 per mm., about 1 cm. long, greenish-blue when bruised; spores elongate-ovoid, pale-yellowish-brown, about 11.5×5μ; stipe short, pink, enlarged below, solid, radicate, 2.5×1–1.3 cm. above the root, apex avellaneous and subglabrous, root tapering downward, brown, 2 cm. long.

Type collected by W. A. Murrill east of Gainesville, Fla., in humus on a rather dry bank under small laurel oaks, Aug. 27, 1943 (*F 21538*). Suggesting *C. subtomentosus* but different in color and odor and having a short, radicate stipe. In dried specimens the cap is fulvous and the stem pale-brownish.

Gyroporus albisulphureus sp. nov.

Pileo convexo, 5 cm. lato, glabro, albo, grato; tubulis sulphureis, 5–7 mm. longis, 2–3 per mm.; sporis oblongis, levibus, hyalinis, 12×3.5μ; stipite albo, glabro, 4×1.5–2 cm.

Pileus convex, not expanding, solitary, 5 cm. broad; surface smooth, glabrous, soft, milk-white, margin fertile, slightly lobed; context very soft, white, unchanging, about 1 cm. thick, odorless, mild; hymenium plane, adnate, sulfur-colored, tubes 5–7 mm. long, 2–3 per mm., sulfur-colored within, unchanging, mild; spores sausage-shaped, smooth, hyaline, about 12×3.5μ; stipe enlarged above, smooth, glabrous, milk-white, unchanging, 4×1.5–2 cm., with a yellow reticulum at the apex.

Type collected by W. A. Murrill in turkey-oak woods near Planera Hammock, 11 mi. northwest of Gainesville, Fla., Aug. 15, 1943 (*F 19636*). Very attractive with its soft white cap and yellow tubes.

Gyroporus biporus sp. nov.

Pileo convexo, 9 cm. lato, glabro, atri-avellaneo, purpureitincto, grato; tubulis flavis, 1 cm. longis, 1×1 mm. vel 2–2.5×1–1.5 mm.; sporis oblongis, hyalinis, 9×3μ; stipite pallido, praereticulato, 5×1.5 cm.

Pileus convex, not expanding, solitary, 9 cm. broad; surface slightly moist, smooth, glabrous, dark-avellaneous with purplish stains, margin slightly lobed, even, concolorous, scarcely projecting; context 1–2 cm. thick, firm, white, practically unchanged when cut, with agreeable odor and taste: hymenium plane, flavous, unchanging, dirty-yellow when dry; tubes reaching about 1 cm. long, flavous within, angular, entire, marginal ones about 1 mm. broad and long, those behind 2–2.5×1–1.5 mm., radially elongate, slightly decurrent; spores oblong, hyaline with a faint yellowish tint, usually 1-guttulate, about 9×3μ; stipe much enlarged upward, compressed, solid, crooked, white with a pale-yellowish tint and a few purplish stains, coarsely reticulate to within 1 cm. of the base, 5×1.5–3 cm.

Type collected by W. A. Murrill in thin young laurel-oak woods at Gainesville, Fla., Oct. 5, 1943 (*F 20062*). Suggesting at first sight *B. flavimarginatus* Murr. with a stipe like that of *B. illudens*. The tubes and adjacent context become very slightly greenish some time after being cut. About half of the tubes are isodiametric and the remainder as in *Hexagona daedalea*.

Ganoderma subtuberculosum sp. nov.

Pileo dimidiato, 15×30×6 cm., laccato, badio, lobato; tubulis 1–1.5 cm. longis, cremeis ad avellaneis; sporis ovoideis, verrucosis, brunneis, 10–12×7–8μ.

Pileus dimidiate, 15×30×6 cm.; surface laccate, shining, shallowly sulcate, bay to blackish; margin cremeous to fulvous, obtuse, 5 mm. thick, undulate to lobed; context soft-corky, castaneous, 1–2 cm. thick; tubes perennial, indistinctly stratified behind, 1–1.5 cm. long, avellaneous within, mouths circular, 4–5 to a mm., edges obtuse, cremeous, becoming darker and thinner; spores ovoid, distinctly verrucose, dark-fulvous under the microscope, 10–12×7–8μ.

Type collected by Don Plank on dead or dying *Casuarina Cunninghamiana* at South Bay, Palm Beach Co., Fla., Nov. 27, 1939 (*F 18722*). A large, thick, perennial hymenophore, dark and shining above and cream-colored beneath. The species is related to *G. tuberculosum* Murrill, described from British Honduras, but the surface is not tubercular and the spores are much larger.

NEW COMBINATIONS

For those using Saccardo's nomenclature the following species are recombined:

Ceriomyces oliveisporus = Boletus oliveisporus
Ceriomyces pallidiformis = Boletus pallidiformis
Ceriomyces pseudoboletinus = Boletus pseudoboletinus
Ceriomyces umbriniceps = Boletus umbriniceps
Gymnopus caryophilus = Collybia caryophila
Gyroporus albisulphureus = Boletus albisulphureus
Hydrocybe Arnoldae = Hygrophorus Arnoldae
Lepista Westii = Tricholoma Westii

Melanoleuca australis = Tricholoma australe
Melanoleuca ferruginescens = Tricholoma ferruginescens
Melanoleuca floridana = Tricholoma floridanum
Melanoleuca fulvidisca = Tricholoma fulvidiscum
Melanoleuca hygrophorus = Tricholoma hygrophorus
Melanoleuca platyphylloides = Tricholoma platyphylloides
Melanoleuca ustaliformis = Tricholoma ustaliforme
Monadelphus floridanus = Clitocybe floridana
Omphalina subfulviceps = Omphalia subfulviceps
Prunulus subpalustris = Mycena subpalustris
Venenarius anisatus = Amanita anisata
Venenarius maculans = Amanita maculans
Venenarius parviformis = Amanita parviformis
Venenarius vernellus = Amanita vernella
Venenarius Watsonianus = Amanita Watsoniana.

New Lagenidiaceous Parasites of Rotifers from Brazil

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Parasitism of protozoa, rotifers, nematodes, and other primitive animals by aquatic phycomycetous fungi is not uncommon in nature. This is particularly true of the parasitic chytrids which produce great numbers of actively motile zoospores. On the other hand, parasitism of rotifers by lagenidiaceous fungi is less common, and up to the present time only two parasites, *Lagenidium oophilum* and *Myzocytium zoophthorum*, of rotifer eggs, embryos, and adults have been reported. However, in the course of a study (1944a, 1944b) of the chytrids of Brazil, the author found three additional lagenidiaceous parasites of rotifers from various parts of the Amazon Valley.

These species occurred in soil and water samples collected in Matto Grosso and Amazonas in 1943, and developed in great abundance after the cultures had been transferred to Columbia University. A combination of soil, animal charcoal water, and bits of floating onion skin was used successfully to provide the food necessary for the growth of rotifers and thereby the hosts for the parasites. Under such conditions it has been possible to keep the cultures of host and parasite flourishing for more than six months, and an abundance of material for study has always been at hand. It was not uncommon to find as many as a hundred infected rotifers and eggs in a single microscopic mount.

The species which occurred in greatest abundance was collected in a soil sample at Flores Nabuco near Manaus in the state of Amazonas. It parasitizes only young and mature rotifers and is characterized primarily by minute zoospores. The latter are considerably smaller than those of any known species of *Lagenidium*, and for this reason the author regards the parasite as a new species and accordingly names it *L. microsporum*.

Lagenidium microsporum sp. nov.

Thallis frequenter unicellulosis, ovalibus, 5×6–15×25μ, pyriformibus aut oblongis et uniseptatis. Sporangiis sphaericis, 5–20μ, ovalibus, 5×7–10×18μ, in unum, 4×5–6×20μ, tubulum exeuntibus. Zoosporis ovalibus, reniformibus, 2.5–3.5μ. Oogoniis ovalibus, sphaericis, 12–18μ diam., utriformibus; antheridiis ovalibus, 5×7–7×11μ, fusiformibus, 5×9–6×10μ. Oosporis hyalinis, laevibus, sphaericis, 7–14μ, ovalibus, 7×9–10×14μ; germinatione ignota.

Thalli usually unicellular, up to 40 in a host, oval, 5–15×6–25μ, spherical, 6–20μ, pyriform or oblong and uniseptate. Sporangia usually of same size and shape as thalli with one broad, 4×5μ, or long, 6×20μ, exit tube.

Zoospores fully delimited in sporangium, forming a globular mass at exit orifice but soon swimming away without encysting; oval, 2.5×3.5μ, slightly flattened and bean-shaped, coming to rest intermittently and rounding up but apparently not withdrawing flagella and encysting; diplanetism doubtful. Oogonia oval and spherical, 12–18μ in diam., slightly utriform and pyriform; antheridia predominantly oval, 5–7×7–9μ, and broadly fusiform, 5–6×9–10μ. Oospores spherical, 7–14μ, oval, 7–9×10–11μ; content hyaline and granular with a large vacuole; wall hyaline and smooth, 1.5–2μ thick; germination unknown.

Parasitic in the bodies of *Distyla* sp. from a soil sample collected at Flores Nabuco near Manaus, Amazonas, Brazil.

The second species from Brazil was found in water and soil samples collected near the Campo Grande in Matto Grosso and is ubiquitous in host range. It parasitizes the eggs, embryos, and adults of rotifers, eggs of *Chaetonotus larus* and bodies of nematodes which have been caught by predacious fungi. It is distinguishable from *L. microsporum* by larger diplanetic zoospores and parthenogenetic resting spores or oospores. Accordingly, it is named *L. parthenosporum.*

Lagenidium parthenosporum sp. nov.

Thallis elongatis, oblongis, ovalibus, lobatis, frondosis, septatis aut non septatis; segmento, 8×12–20×90μ. Sporangiis ovalibus, 9×12–18×25μ, oblongis, 6×13–15×30μ, in unum vel duos tubulos exeuntibus, 3×5–5××18μ. Zoosporis reniformibus, 4–5×5.5–6.5μ; cystosporis 4.5–6μ. Oosporis hyalinis, rugosis, sphaericis, 8–16μ, ovalibus, 6×9–10×14μ, elongatis, 5×10–8×20μ; germinatione ignota.

Thallus consisting of 1 to 5 segments, larger thalli septate, elongate, 8–12×20–90μ, lobed, curved, occasionally branched, and usually constricted at septa; reduced thalli continuous, oval, 9–18×12–25μ, oblong, 6–15×13–50μ, and slightly irregular. Sporangia of same size and shape as segments and reduced thalli with one or two, 3–5μ broad by 5–18μ long exit tubes which extend beyond the surface of the host. Zoospore segments delimited completely in the sporangium, rounding up immediately upon emerging and forming a mass of cystospores near the exist orifice; cystospores spherical, 4.5–6μ, giving rise to slightly reniform, 4–5×5.5–6.5μ, diplanetic zoospores. Oospores or resting spores formed parthenogenetically by contraction and encystment of protoplasm in thallus segments; usually solitary, rarely double in segments; shape spherical, 8–16μ, oval, 6–10×9–14μ, elongate, 5–8×12–20μ, occasionally curved, irregular, lobed and dumbbell-shaped; wall 2.5–3μ thick, smooth at first, later becoming deeply wrinkled so as to make spores pointed or somewhat stellate in appearance; content hyaline and finely granular with a large central or excentric vacuole; germination unknown.

Parasitic in the eggs and bodies of *Distyla* sp. and *Philodina* sp., eggs of *Chaetonotus larus* and bodies of *Heterodera* sp. from a soil sample, Campo Grande, Matto Grosso, Brazil.

The third Brazilian species occurred in a water sample from Igarape Raimundo, collected near the point where it enters the Rio Negro at Amanaus, Amazonas. So far it has been found only in the eggs of a species of *Distyla*. It differs from the other species described above by its more elongate, tubular thalli, larger polyplanetic zoospores, and elongate antheridia. Inasmuch as it differs thus in several characters from other known members of *Lagenidium*, it is interpreted by the author as a new species, for which he proposes the name, *L. Distylae.*

Lagenidium Distylae sp. nov.

Thallis elongatis, irregularibus, lobatis, frondosis. Sporangiis ovalibus, oblongis elongatis, 6×30–9×40μ, in unum, 4×7–3×25μ, tubulum exeuntibus. Zoosporis reniformibus, 6×8μ, cystosporis sphaericis, 6.6–7μ. Oogoniis ovalibus, fusiformibus, 10×15–20×30μ; antheridiis elongatis, 5×20–8×30μ. Oosporis hyalinis, laevibus, sphaericis, 12–18μ, ovalibus, 8×12–12×15μ; germinatione ignota.

Thalli usually elongate, tubular, curved, irregular, lobed and occasionally branched, 6–10μ in diam., consisting of 2–8 segments, 6–9×30–40μ Sporangia of same size and shape as segments with one short 4×7μ, or long, 3×25μ, exit tube; content of sporangium emerging as a naked mass, becoming enveloped by a vesicular membrane, and undergoing cleavage zoospores. Zoospores reniform, 6×8μ, diplanetic; cystospores, 6.6–7μ. Oogonia and antheridia borne on same thallus; oogonia oval, broadly spindle-shaped and locally paunchy, up to 20μ in diam., and 30μ in length. Antheridium elongate, tubular, 5–8×20–30μ. Oospores hyaline, smooth, spherical, 12–18μ, oval, 8–10×12–15μ; content granular with a large vacuole; germination unknown.

Parasitic in the eggs of *Distyla* sp., Igarape Raimundo at Manaus, Amazonas, Brazil.

DEVELOPMENTAL CYCLE OF BRAZILIAN SPECIES

Since most species of *Lagenidium* occur only sporadically and in limited quantities, there is frequently but little opportunity to study their complete life cycle. Consequently, much remains to be learned about the variations in sporogenesis, the presence or absence of diplanetism, gametogenesis, sex determination, syngamy, and oospore development in this genus. Due primarily to an abundance of material, the author has been able to study many of these little known stages, and accordingly an account is presented herewith of the developmental cycle of the new Brazilian species with special emphasis on the lesser known phases.

Lagenidium microsporum.—The life history of this species is shown in figures 1 to 34. Although they appear to be limited in host rnage to the bodies of *Distyla* sp., the thalli of this species are very gregarious (fig. 1) so that up to forty parasites may occur in a single host. However, so far it has never been found in rotifer eggs. In spite of the general abundance of parasites in cultures and the greater numbers of zoospores produced, the author has not been able to determine the manner in which rotifers become infected. In most known species of *Lagenidium* the zoospores germinate on the host and develop a germ or penetration tube the tip of which enlarges and becomes the thallus, while the empty zoospore case remains attached on the outside for a considerable length of time. In *L. microsporum*, however, no germinating spores or attached cases have been observed, although thousands of embryonic, young, and mature rotifers have been carefully examined for such structures. It is not improbable that the minute zoospores are engulfed by the rotifers in feeding and germinate within the host.

The parasite first becomes visible in the rotifer as a minute, hyaline body with a small vacuole and one to several refractive bodies (fig. 2). This body increases rapidly in size, while the refractive bodies multiply in number (fig. 3, 4). At the same time, one or more vacuoles may appear in the cytoplasm. During these early developmental stages the protoplasm appears to be quite watery or hydrated, and within the vacuoles occur numerous darkly gleaming granules which undergo rapid Brownian movement. The vacuoles also may frequently change in size, shape, and position during the early phases. Figures 5 and 6 show later stages of the same thallus in which the number of refractive bodies has greatly increased and additional vacuoles have developed. The refringent granules may be oblong, elongate, and irregular, as well as spherical in shape and have a characteristic tinge of color. Following the stages shown in these figures, the refractive material gradually becomes dispersed as minute bodies so that the protoplasm becomes less refringent in appearance and more evenly granular and dense (fig. 7). Concurrently, the wall of the incipient sporangium thickens and an exit tube develops (fig. 8). Eventually the small vacuoles coalesce into one or more larger central ones (fig. 9), after which centrifugal cleavage begins (fig. 10). After the latter process has been completed, the well known homogeneous granular phase ensues during which the outlines of the cleavage segments disappear. This stage may last from 15 to 30 minutes, and then the zoospore initials gradually become visible again (fig. 11). Shortly thereafter the tip of the exit tube deliquesces, and most or sometimes all of the zoospores rapidly emerge from the sporangium.

It is thus obvious that the zoospores of *L. microsporum* are fully delimited within the sporangia, and as they emerge they form a loose mass at the exit orifice (fig. 12). No vesicular membrane is present around the mass

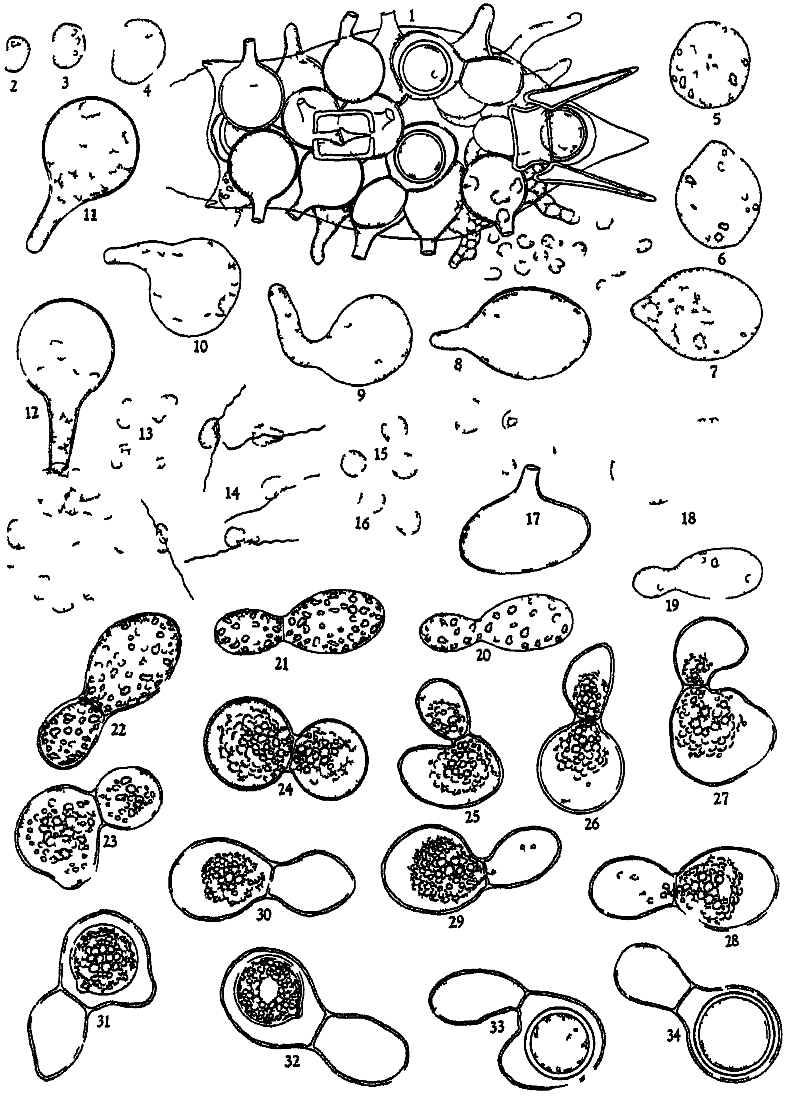

PLATE 1 Figs 1–34 —*Lagenidium microsporum* 1 Specimen of *Distyla* sp infected with 17 sporangia and 4 antheridia, oogonia, and oospores 2–8 Successive stages of the development of a unicellular thallus 9 Mature vacuolate sporangium 10 Centrifugal, progressive cleavage 11 Fully delimited zoospore segments in sporangium 12 Emergence of incipient zoospores 13 Elongation and maturation of zoospores 14 Motile zoospores 15, 16 Quiescent and germinating zoospores 17 Emerged unequal cleavage segments 18 Multivacuolate content of a sporangium which emerged and later developed numerous flagella 19–22 Successive stages of the development of an antheridium and oogonium 23, 24 Aggregation of denser refractive protoplasm in the center of gametangia 25 Vacuolation and contraction of protoplasm toward intervening cross wall 26–29 Stages of syngamy 30 Young naked zygote 31–34 Development of oospore wall and maturation stages of oospores

of zoospores, although they are not fully mature when they emerge. Within 20 to 40 seconds after the stage shown in figure 12, the individuals in the mass begin to rock back and forth slightly, indicating that the flagella are forming and beginning to beat slowly. At the same time the zoospore body elongates slightly, and a small oval depression appears on the ventral side (fig. 13). Shortly thereafter the flagella begin to beat more rapidly, and the zoospores soon swim away. Accordingly, from 60 to 90 seconds may elapse between the time the zoospores emerge and swim away.

Because of the minute size and rapid motility of the zoospores, it is difficult to determine their exact shape and the relative lengths of the two flagella inserted in the ventral depression. The spores appear to be slightly flattened and oval or pyriform with a pointed apex and rounded posterior end (fig. 14), and rotate on their axis in swimming. On some of the individuals which had temporarily come to rest, the flagella were approximately 7μ long, but the author is not absolutely certain that the pairs are equal in length. Cystospores in the true sense have not been observed. The zoospores may come to rest, round up (fig. 15), and remain totally inactive for a few seconds. Apparently, they do not encyst or retract their flagella, because they may dart off again quickly without germinating or undergoing any of the changes in shape and motion usually involved in diplanetism and cystospore germination. A few germinated spores have been observed in water (fig. 16), but they degenerated within a few hours.

The process of sporogenesis and zoospore behavior described above are normal for this species, but variations often occur. Frequently numerous zoospores remain in the sporangia where they become motile and continue to swarm for almost an hour with intermittent quiescent periods. Also, in many cases the zoospores degenerate shortly after emerging from the sporangia. In some sporangia cleavage may be abnormal and unequal with the result that segments of different sizes are formed and escape from the exit tubes (fig. 17). The larger segments shown in figure 17 developed from four to eight flagella without further cleavage and behaved like large abnormal zoospores. In one instance the entire content of a sporangium emerged as a multivacuolate mass (fig. 18) and underwent numerous changes in shape and position without cleaving into zoospores. It finally developed a large number of paired flagella and floated away.

The sporangium wall in this species is fairly thick and resistant, so that the sporangia retain their shape until long after the zoospores have been discharged. In a few cases they have been found to persist after the rotifer shell had disintegrated. Like the walls of the oogonia, antheridia and oospores, they show a positive cellulose reaction when tested with chloroiodide of zinc.

Oospores are formed in great abundance in *L. microsporum*, and the process of syngamy can be followed fairly clearly in living material. The thalli which are to become the antheridia and oogonia may be recognized when quite young by their elongate shape and denser, more refringent protoplasm. Figures 19 to 22 show successive stages of the development of an antheridium and oogonium. The former structure appears to grow out as a bud (fig. 19, 20) from an oval thallus, and is finally delimited by a cross wall (fig. 22), while the remainder of the thallus enlarges and becomes the oogonium. Obviously both gametangia originate from a single zoospore, so that sex is apparently determined phenotypically in this species. While these growth changes are taking place, the number of oval, elongate, irregular and spherical refringent bodies increases until the protoplasm becomes very dense and refractive.

Inasmuch as no sharply-defined and differentiated gametes are formed, an elaborate and complex process of gametogenesis is lacking in *L. microsporum*. However, certain changes do occur in the antheridia and oogonia before fusion which perhaps may be regarded as foreshadowing the evolution of gametogenesis and heterogamy in the higher oomycetes. The first visible change to be observed is the aggregation of the refractive bodies and denser material toward the center of the gametangia (fig. 23). This aggregation continues until a fairly well defined layer of hyaloplasm is visible around the denser material (fig. 24). The next pronounced change is a contraction of the protoplasts toward the intervening cross septum (fig. 25) whereby the hyaloplasmic layer beigns to draw away from the walls at the ends of the antheridia and oogonia. This aggregation and condensation of the protoplasm and slight contraction toward the antheridium are the only visible mass changes which might perhaps be interpreted as primitive stages in the evolution and differentiation of an oosphere in the oogonium before fusion. It is to be particularly noted, however, that no periplasm is formed in the oogonium.

As contraction continues, a pore is formed in the cross wall, and the protoplasm from the antheridium begins to flow into the oogonium (fig. 26). How the pore is formed and the extent of its diameter are not known, because it does not become visible until the protoplasm begins to pass through. Judging by the width of the protoplasmic stream passing through, it appears to be approximately 1.5 to 2μ in diameter. As the protoplasm from the antheridium flows in, small vacuoles may appear at the border of the hyaloplasm in the oogonium, and these have been observed to burst and disappear. Quite probably this is a means by which the incipient zygote gets rid of excess water as fusion progresses. Later stages of syngamy are shown in figures 28 and 29, and in figure 30 the process has been completed. As far as is now known, the whole process requires from 3 to 7 hours.

The young zygote shown in figure 30 is still naked and is made up of a central portion of denser granular and globular material surrounded by a thin layer of hyaloplasm. Particularly noteworthy is the small papilla which projects toward the fusion pore. When it lies closer to or in contact with the pore, it may often create the impression that a fertilization tube is present like in *L. pygmaeum* (Zopf, 1887) and *M. zoophthorum* (Sparrow, 1936). That no tube exists in *L. microsporum* is clearly evident when the spores lie away from the pore, as in figures 31 and 32. The young oospore becomes enveloped by a thin hyaline membrane (fig. 31) which seems to be formed by condensation or a phase change of the outer surface of the hyaloplasmic layer. With further maturation, the membrane thickens (fig. 32) and finally attains the structure of an oospore wall. Concurrent with these changes in the wall, a vacuole develops in the center of the oospore (fig. 32), while the refractive globular and granular material gradually disperses until the protoplasm as a whole becomes evenly granular (fig. 33, 34).

As to relationships with other members of the Lagenidiaceae, *L. microsporum* resembles most closely *L. pygmaeum* and *M. zoophthorum* in type of sexual reproduction. In both of the latter species the sexual thalli are bicellular so that the antheridia and oogonia occur adjacently. However, in these two species a distinct fusion tube is formed by the antheridium—a structure which is lacking in *L. microsporum*. It differs in other respects also by its minute zoospores which are fully delimited in the sporangium.

In its effect on the host, *L. microsporum* is not instantly lethal to rotifers. They do not seem to suffer much discomfiture when the parasites are small and may continue to feed actively. However, by the time the parasites are one-third to half grown, the rotifer becomes sluggish in movement, ceases to feed, and soon dies. The host protoplasm becomes aggregated around the developing thalli and is eventually absorbed, so that in the mature stages of the parasite, the rotifer is usually empty except for the sporangia (fig. 1).

Lagenidium parthenosporum.—This species is ubiquitous and may parasitize several species of rotifers and their eggs, eggs of *Chaetonotus larus*, and nematodes. However, it is most commonly found in the eggs of *Distyla* sp. and *Philodina* sp. Unlike that of *L. microsporum*, its thallus is usually multicellular and deeply constricted at the septa, elongate, lobed, and sometimes branched, as is shown in figure 35 of a heavily infected rotifer. The method of infection can be easily determined in this species because the empty zoospore cases and germ tubes persist for a long time after the thalli have begun to develop (fig. 35–41). As many as 20 zoospore cases have often been found attached to a single rotifer egg. As soon as the germ tube enters the host, its tip begins to expand and elongate (fig. 36) and gradually develops into the thallus. Figures 38–41 show successive stages in the development of an elongate thallus from the end of the germ tube. It is to be noted in these figures that the protoplasm has a similar appearance

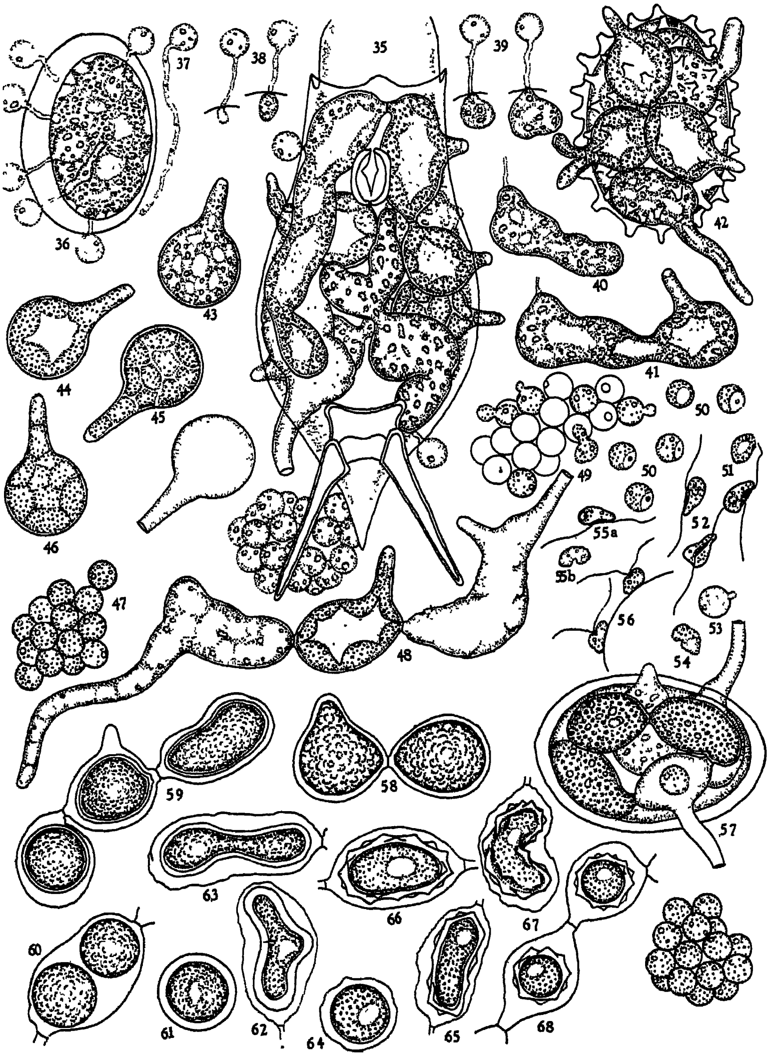

PLATE 2. Figs. 35–68.—*L. parthenosporum*. 35. Heavily infected specimen of *Distyla* sp. 36. Infection of rotifer egg. 37. Germinated zoospore in water adjacent to rotifer egg. 38–41. Stages of the development of an elongate thallus from the end of a germ tube. 42. Heavily infected egg of *Chaetonotus larus*. 43–46. Maturation stages, cleavage, and sporogenesis in a pyriform sporangium. 47. Discharged cleavage segments which have rounded up and formed a cluster of cystospores. 48. Elongate constricted thallus consisting of three sporangia. Sporangium at left highly vacuolate with an abnormally long exit canal; central sporangium undergoing cleavage; sporangium at right empty and wrinkled. 49. Germination of primary cystospores. 50. Newly emerged incipient zoospores. 51. Elongation of zoospore initial. 52. Primary zoospores. 53. Secondary germinating cystospore. 54. Newly emerged secondary zoospore. 55a, 55b. Side and cross-section views, respectively, of secondary zoospores. 56. Secondary zoospores creeping on surface of rotifer egg. 57. Curved thallus, three segments of which are filled with dense protoplasm and will form resting spores. 58. Contraction and encystment of protoplasm in resting spore development. 59. Thickening of resting spore wall and beginning dispersal of refractive globules and granules. 60. Thallus segment with two incipient resting spores. 61–63. Young spherical, elongate, constricted and irregular thick-walled resting spores. 64. Beginning of localized shrinking and wrinkling of hyaline wall. 65–68. Mature resting spores or parthenogenetic oospores of various sizes and shapes.

to and undergoes the same fundamental changes in development as that of *L. microsporum* described above, so that it is not necessary to describe these changes again.

The effect on the rotifer host also is very similar. Rotifers may continue to feed normally while the parasites are small, but by the time they are one-third to half grown the host ceases feeding, contracts its mouth parts, undergoes spasmodic movements, and soon dies. As in the case of infection by *L. microsporum*, the content of the rotifer may be completely absorbed (fig. 35). In rotifer eggs the first visible effect on the host protoplasm is an increase in optical heterogeneity, followed by vacuolation (fig. 36) and contraction around the developing thalli. Here also the entire content of the egg is usually absorbed by the parasites. Their effect on living nematodes is not known, because only two infected specimens were observed, and these had previously been captured by a predacious fungus, *Dactyella* sp.

The process of sporogenesis in *L. parthenosporum* also is similar to that of the previously described species. In preparation for spore formation the refractive material becomes highly dispersed and gives the protoplasm a greyish-granular appearance, while the small vacuoles fuse into one or more larger ones, as is shown in figures 43 and 44 of a small pyriform sporangium. Cleavage takes place within the sporangium in this species also (fig. 45) and is followed by the granular homogeneous stage. The transition from the stage shown in figure 45 to the homogeneous phase is very rapid and may take place in 5 to 10 seconds. However, during the latter stage, which may last for 30 minutes, the outlines of the cleavage segments do not disappear completely, as Scherffel (1925) described for *Ectrogella bacillariacearum*. As the tip of the exit papilla or tube deliquesces, the cleavage segments escape very quickly with sufficient force to carry them considerably away from the exit orifice (fig. 35, 47, 57). The individual segments round up in a few seconds and form an irregular mass of spherical cystospores without any evidence of a surrounding vesicular membrane, flagella, or motility. The sporangium and thallus wall in this species is thinner than that of *L. microsporum*, and within a short time after the cleavage segments have emerged, it becomes wrinkled (fig. 49) and eventually collapses. Like the wall of the cystospores and resting spores, it shows a positive cellulose reaction when tested with chloro-iodide of zinc.

The cystospores soon develop a thin hyaline wall and may persist from several hours to days without undergoing any fundamental change. In one instance they perisisted for four days before degenerating. During the persistent stage some of the minute granules usually coalesce to form one or more small globules, as Scherffel has described for species of *Ectrogella*. In normal cases the cystospores persist from three to fifteen hours, after which their content emerges leaving a hyaline vesicle behind (fig. 49). The emerged protoplasts round up (fig. 50) and develop a small vacuole in which lies a small body. Shortly afterward they elongate slightly (fig. 51) and develop into motile zoospores (fig. 52). In so doing, they undergo the same initial rocking movement, which increases in intensity with the beating of the flagella, as has been described for *L. microsporum.*

The zoospores of *L. parthenosporum* are larger than those of the previous species and reniform in shape with a more conspicuous ventral groove (fig. 52) The anterior end tapers, while the posterior one is rounded. In side view, however, the spores appear flattened. The flagella arise in the ventral groove and extend in opposite directions, while the spores are motile. Whether they are equal or unequal in length is not absolutely certain, but the author is of the opinion that the zoospores are isocont. The primary swarmers may remain motile for 30 to 80 minutes after which they come to rest and form secondary cystospores. After 2 to 6 hours these give rise in turn to secondary swarmers (fig. 53–55), which, following a brief motile period, come to rest on the host (fig. 56) and germinate. No tertiary swarmers have been observed. Nevertheless, it is obvious that the zoospores of *L. parthenosporum* are distinctly diplanetic.

As was noted earlier, the resting spores or oospores are formed asexually in the segments of the thallus. The process consists essentially of a contraction and encystment of the protoplasm without the involvement of syngamy. The first indication that durable spores are to develop is an increase in density of the protoplasm and the development of numerous globules and granules in the thallus segments. Figure 57 shows three segments of a curved thallus in which these changes are visible. Following this stage, the protoplasm condenses and contracts away from the wall of the segments (fig. 59) and becomes enveloped by a definite membrane. The content of the incipient oospores is globular, coarsely granular and uneven, but as development proceeds, the discrete elements apparently fragment and become dispersed so that the protoplasm takes on a more evenly granular appearance. At the same time, the membrane thickens into a definite spore wall (fig. 59). In rare cases the content of the segments may constrict and divide, forming two spores in one cell (fig. 60). The wall of the young spores is quite thick (fig. 61–63), hyaline and smooth at first, but as they age it begins to shrink and wrinkle (fig. 64) in localized regions, leaving numerous definite and bluntly tapering points on the periphery (fig. 66–68). As a result, the mature spores become multi-pointed and sometimes almost stellate in outline (fig. 68). While these changes are taking place in the wall, the protoplasm becomes more evenly granular and develops a relatively small oval or spherical vacuole Inasmuch as the thallus segments vary considerably in size and shape, the oospores also are highly variable. As is shown in figures 60 to 68, they may be spherical, oval, irregular, elongate, and slightly curved.

Lagenidium parthenosporum differs markedly from *L. oophilum* and *M. zoophthorum*, the other two rotifer parasites described by Sparrow (1936, 1939). Its zoospores are smaller than those of either species and distinctly diplanetic. It is, furthermore, distinguished by its asexual or parthenogenetic oospores, and does not appear to be closely related to any of the species which inhabit rotifers.

Lagenidium Distylae.—The thallus of this species is usually slenderer, more elongate, and branched than those of the two previously described lagenids. Furthermore, its large zoospores are delimited outside of the sporangia and may swarm several times. They are reniform in shape, pointed at the anterior and rounded at the posterior end with a conspicuous ventral groove in which the two equal flagella are inserted (fig. 69, 70). After a motile period of from 30 to 90 minutes, they come to rest, round up, and become cystospores. Some of the latter may germinate within one-half to two hours in water and form long germ tubes (fig. 72–76) the tips of which enlarge like small incipient thalli. Such spores, however, degenerate within a day or so without further development. In other primary cystospores the contents emerge (fig. 77–82) and develop into secondary swarmers. Quite often the contents of cystospores which have already formed long germ tubes may retract and emerge (fig. 83). After a short motile period which may last from 15 to 30 minutes, the secondary zoospores also round up and form secondary cystospores (fig. 84). These usually germinate with long tubes in water or infect the host, but if they are chilled overnight, they may give rise to tertiary swarmers (fig. 85, 86). Whether or not a fourth swarming period can be induced has not been determined, but it is nevertheless evident that the zoospores of *L. Distylae* under varying environmental conditions may become polyplanetic like those of the higher Phycomycetes.

After infecting the host, the empty zoospore case and part of the germ tube persist on the outside (fig. 87, 89), while the intramatrical tip of the tube enlarges, elongates, and gives rise to the thallus as in *L. parthenosporum*. The young thalli are usually elongate, tubular, lobed, or branched (fig. 88), but as they reach the walls of the host cell they become curved and frequently double back on themselves. They soon become transversely septate, and as the segments increase in diameter the thallus becomes constricted at the cross walls (fig. 89). The segments eventually develop into either sporangia, antheridia, or oogonia. In becoming sporangia, the protoplasm in the segments undergoes the same changes described for *L. microsporum* and *L. parthenosporum*, while a short, broad, or an elongate exit tube develops and grows out beyond the surface of the host cell (fig. 89–91). When the sporangium is mature, the tip of the tube deliquesces, and the entire protoplasmic mass with its vacuole flows out and forms a large globule (fig. 92–95) at the exit orifice. This mass is at first naked, but as cleavage begins a thin hyaline vesicular membrane develops at its periph-

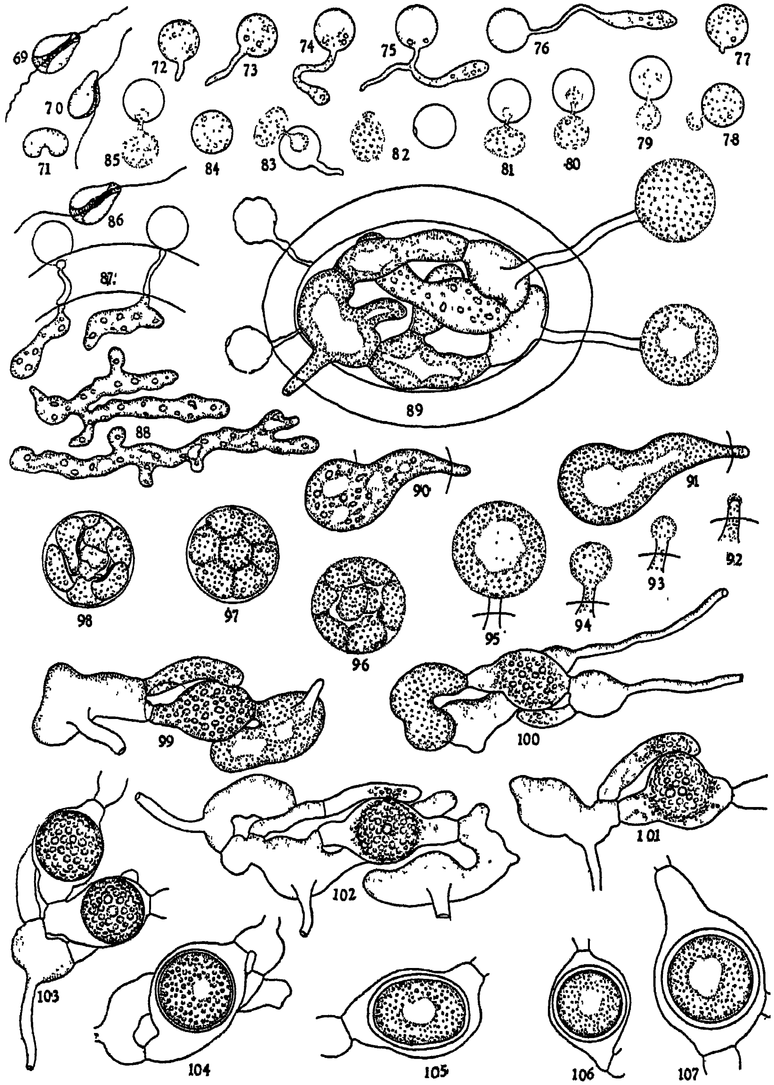

PLATE 3. Figs. 69–107.—*L. Distylae.* 69–71. Ventral, side, and cross-section views, respectively, of primary zoospores. 72–76. Germination stages of primary cystospores in water. 77–82. Successive stages in the formation of secondary zoospores from primary cystospores. 83. Content of germinated primary cystospore emerging to form secondary zoospore. 84, 85. Secondary cystospore and emergence of content to form tertiary zoospore. 86. Ventral view of tertiary zoospore. 87. Infection of rotifer egg. 88. Young elongate, branched and lobed thalli. 89. Rotifer egg with curved, lobed thallus; contents of two sporangia have emerged as globular naked masses of protoplasm. 90, 91. Late maturation stages of an elongate pyriform sporangium. 92–95. Deliquescence of exit papilla of same and stages of the emergence of the protoplasm. 96, 97. Cleavage stages in extramatrical vesicle. 98. Zoospores swarming in vesicle. 99. Thallus with an elongate antheridium and a broadly fusiform oogonium. 100, 102. Contraction of protoplasm in gametangia prior to fusion. 102. Syngamy. 103. Two incipient oospores. 104–107. Maturation of oospores.

ery. The subsequent changes—namely, cleavage, motion of the mass, flagellar development, beginning of motility, etc.—which occur are fundamentally similar to those which have often been described for other species of *Lagenidium*, *Lagena* and *Pythium* and need not be repeated here. The fully formed zoospores swarm actively in the extramatrical vesicle (fig. 98) for 20 to 50 minutes and escape as the membrane ruptures.

Sexual reproduction and oospore development are very similar to those described by Zopf (1884) for *L. rabenhorstii*. The antheridium is generally tubular and elongate and occurs on the same thallus as the oogonium (fig. 99–102). It can usually be recognized from the earliest stages on by its elongate shape, but the oogonium, on the other hand, does not differ very much from the zoosporangia. Later, however, the protoplasm becomes denser with numerous suspended granules and refractive globules (fig. 99) so that both gametangia may be readily recognized by this character. The protoplasm in each structure later contracts as the granular and globular material aggregates toward the center (fig. 100), in much the same manner as has been described above for *L. microsporum*. Following the stage shown in figure 100 the protoplasmic masses move slightly toward the point where the gametangia are in contact (fig. 101), with the result that the ends of both structures become vacuolate and almost empty. No well defined fusion canal, which extends into the oogonium as in *L. rabenhorstii*, has been observed, and it appears as if the walls of the antheridium and oogonium break down at the point of contact. Howsoever the union is formed, the protoplasm in the antheridium, nevertheless, flows slowly into the oogonium and fuses with the ooplasm (fig. 102). The young zygote soon becomes enveloped by a thin hyaline membrane (fig. 103) which thickens and develops into the definitive oospore wall (fig. 104–107). In the meantime, the granular and globular refractive material becomes dispersed as a central vacuole develops, so that the protoplasm of the mature spore has an evenly granular appearance (fig. 105–107).

It is to be noted in this species also that although gametangia and sexuality are well defined, no marked differentiation of specialized gametes occurs. The contraction and aggregation of the ooplasm toward the point of contact with the antheridium is the only change which might be interpreted as a differentiation of an egg cell. However, no periplasm is formed. It is not improbable that marked nuclear changes may occur in the ooplasm prior to fusion, but they are not visible in living material.

SUMMARY

Three new lagenidiaceous fungi, *Lagenidium microsporum*, *L. parthenosporum*, and *L. Distylae*, which parasitize rotifers have been found in water and soil samples collected in various parts of the Amazon Valley in Brazil. The first of these species is characterized by minute zoospores and well-

defined sexuality. In *L. parthenosporum*, on the other hand, the resting spores or oospores are developed parthenogenetically in the segments of the thallus. The third species, *L. Distylae*, is distinguished by large polyplanetic zoospores which are formed by cleavage in an extramatrical vesicle. All species eventually kill their hosts and absorb most if not all of the protoplasm.

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INDEX*

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* New genera, species, etc. are indicated by italics.

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(Continued on back cover)

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A Quarterly Journal of Biological Science

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CONTENTS

No. 1, March, 1945

No. 2, June, 1945

No. 3, September, 1945

No. 4, December, 1945

Dates of Publication

Volume 8, 1945

Number 1, March	June 21, 1945
Number 2, June	August 17, 1945
Number 3, September	November 6, 1945
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LLOYDIA

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The Genus Chlorotettix (Homoptera-Cicadellidae) in Mexico

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Several species of Chlorotettix have been described from Mexican and Central American material, but no attempt has previously been made to bring together the species occurring in that country and to examine the 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*, *lobatus*, *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*

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* 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*.

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

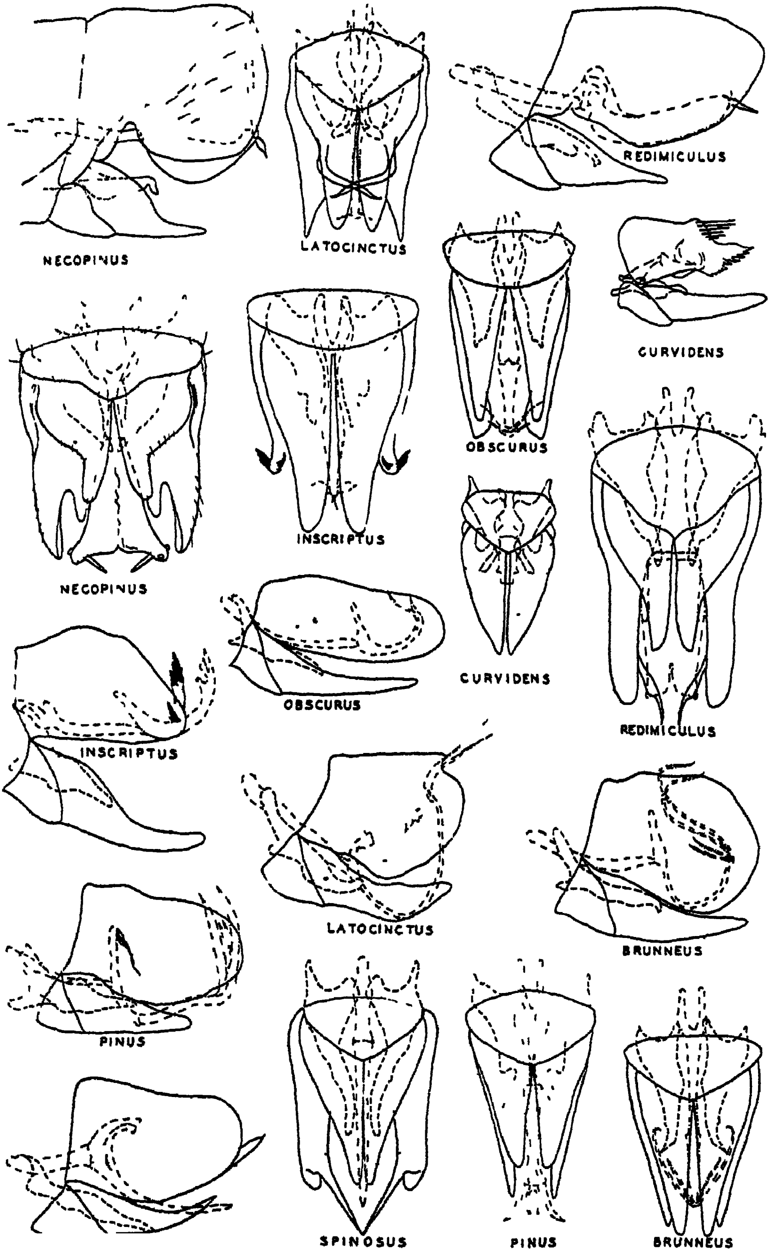

PLATE 1.—Lateral and ventral views of male genital structures in normal position, of species as labeled.

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

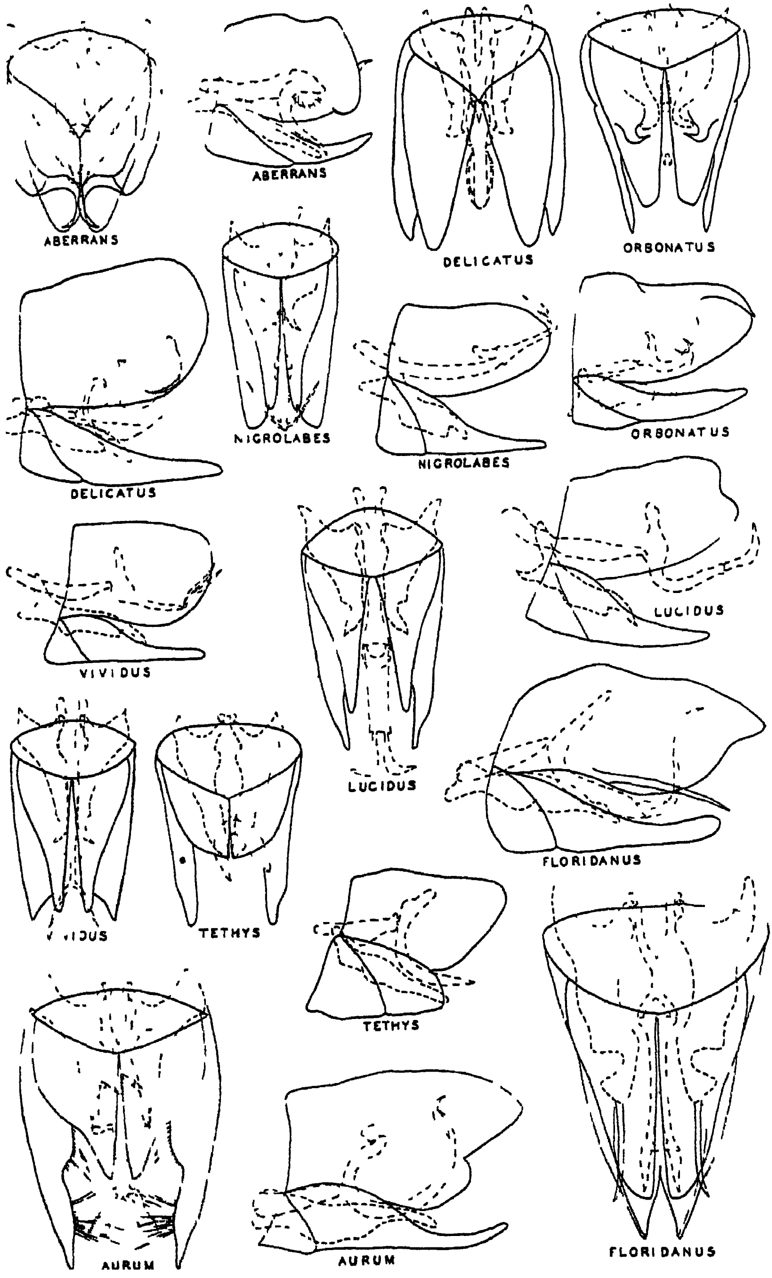

PLATE 2.—Lateral and ventral views of male genital structures in normal position, of species as labeled.

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.

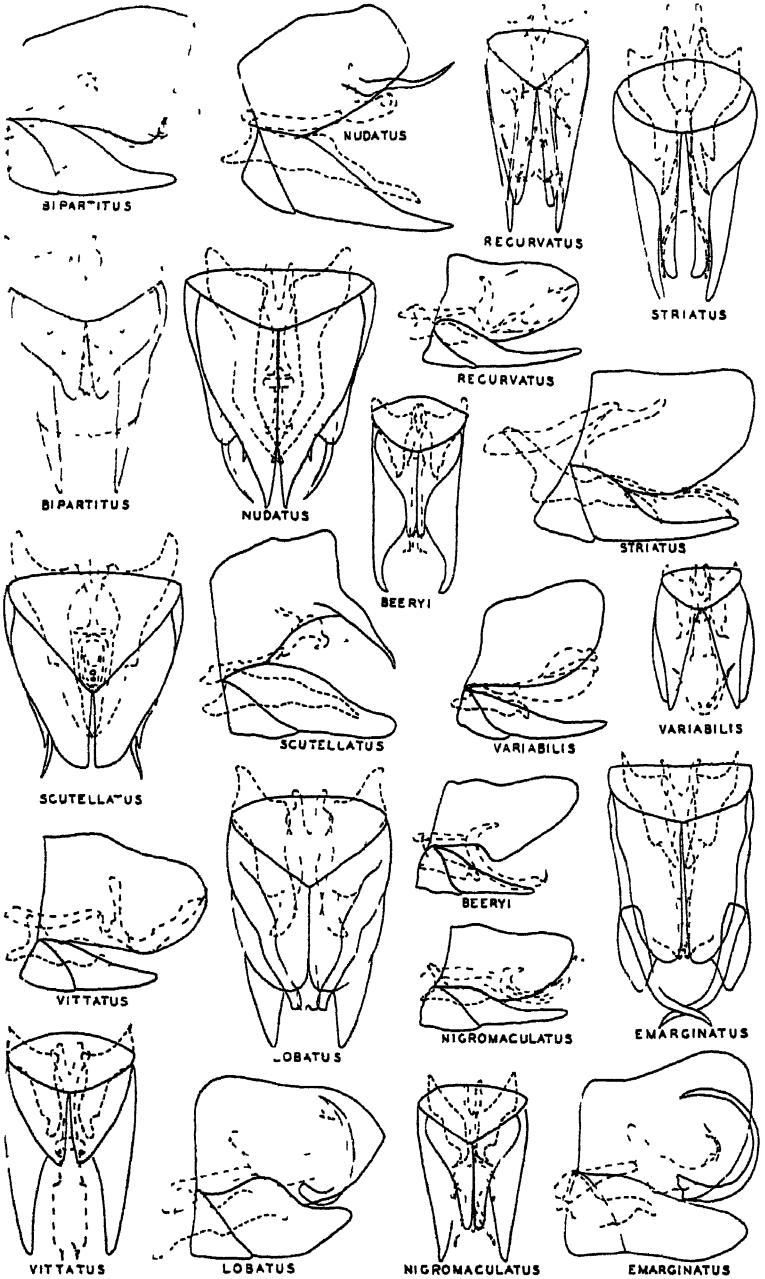

PLATE 3.—Lateral and ventral views of male genital structures in normal position, of species as labeled.

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.

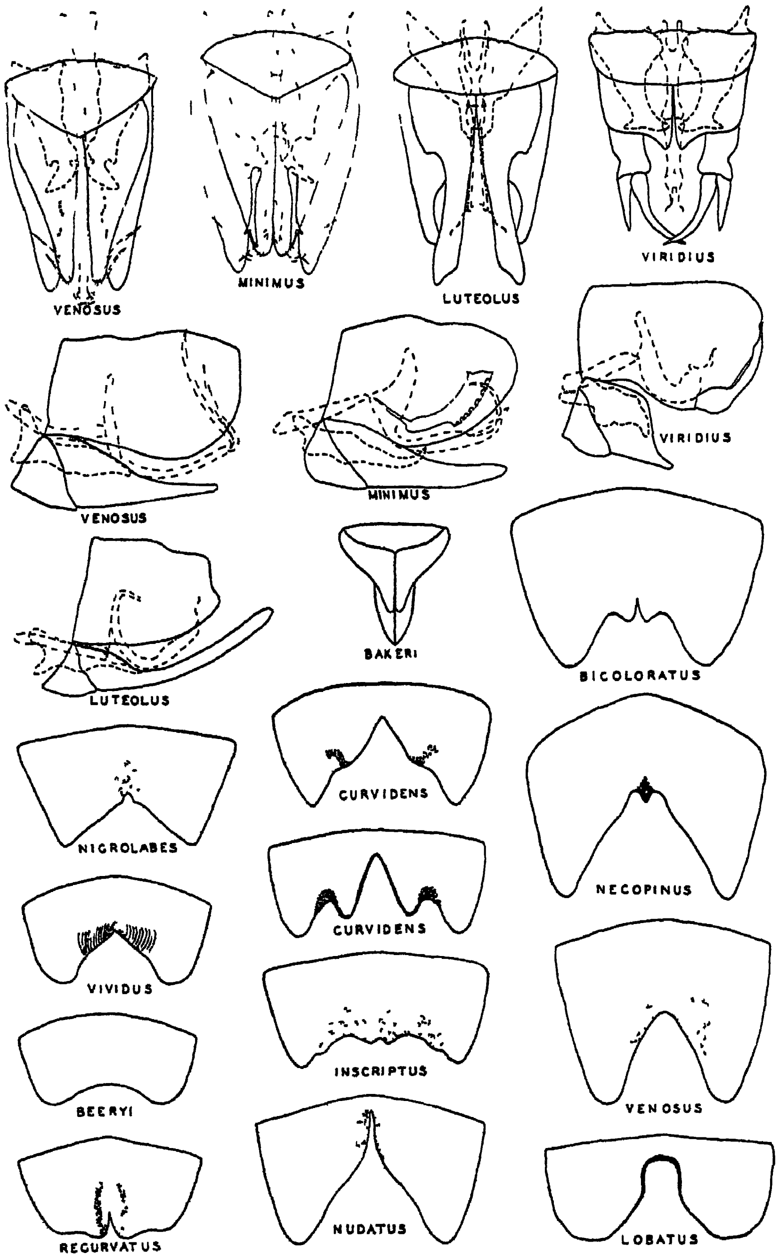

PLATE 4.—Upper portion—lateral and ventral views of male genital structures in normal position, of species as labeled. (Central figure of bakeri is ventral view of external male plates.) Lower portion—ventral views of last ventral segments of females as labeled.

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

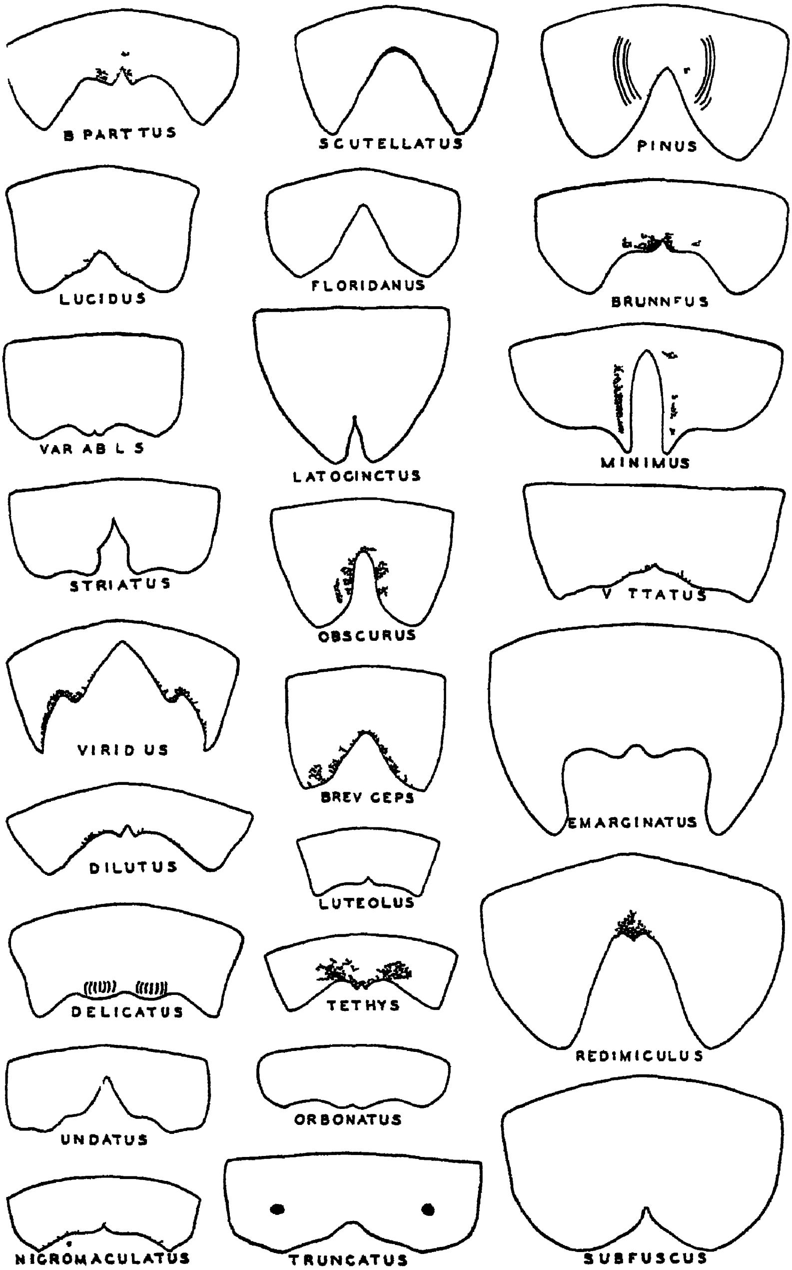

PLATE 5 —Ventral views of last ventral segments of females as labeled

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,

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[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.

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[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.

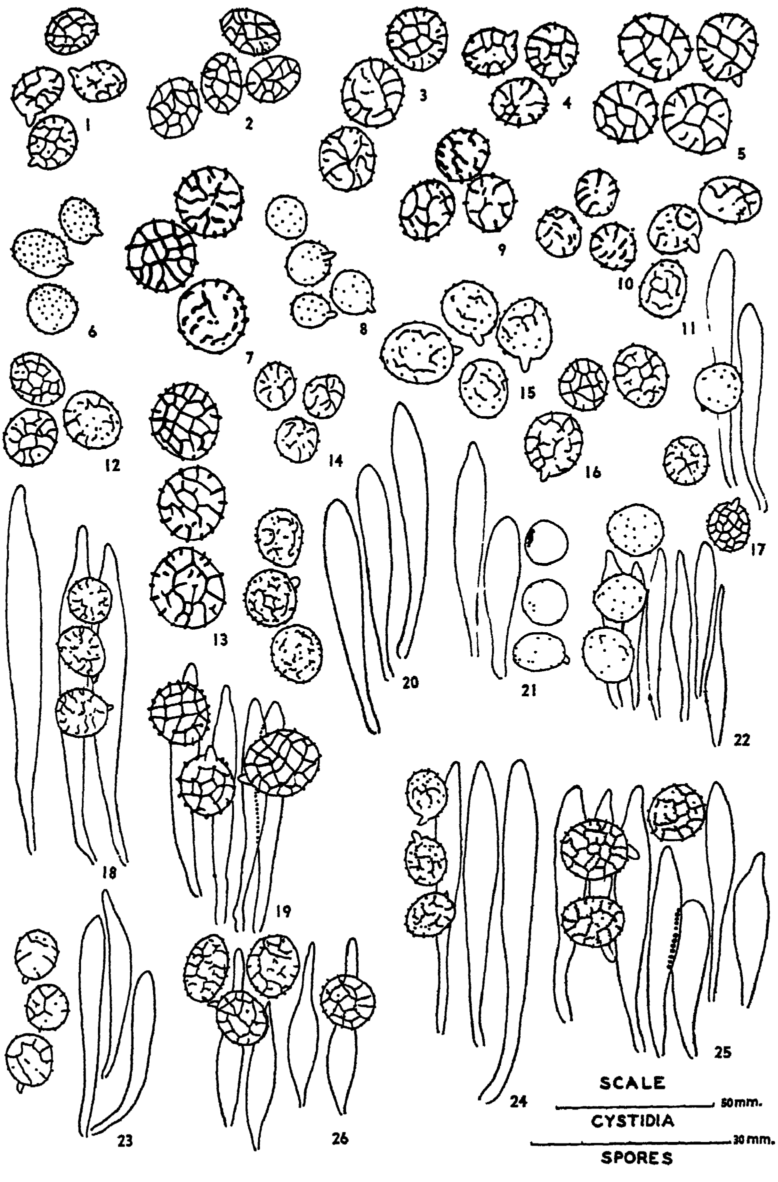

PLATE 1.—1. *Lactarius deliciosus* (L.) Fr., spores. 2. *L. zonarius* (Bull.) Fr., spores. 3. *L. zonarius* var. *insulus* (Fr.) Rom., spores. 4. *L. cinereus* Peck, spores. 5. *L. castaneus* sp. nov., spores. 6. *L. subvellereus* Peck, spores. 7. *L. lignyotus* Fr. f. *gracilis* Bres., spores. 8. *L. 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* (Bann. 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. uncialis* 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.

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[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-

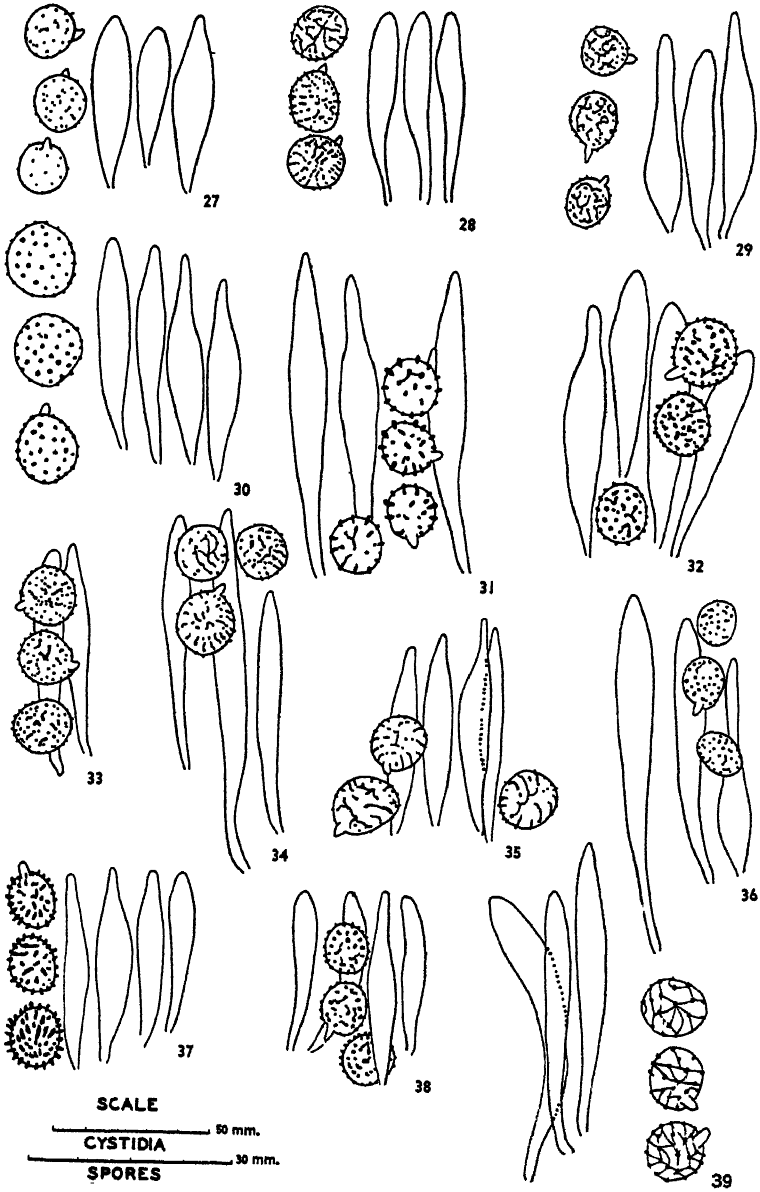

PLATE 2.—27. *R. taliensis* sp. nov., spores and cystidia. 28. *R. azurea* Bres., spores and cystidia. 29. *R. pseudolepida* Sing., spores and cystidia. 30. *R. purpurina* Pk. ap. Kauffm., spores and cystidia. 31. *R. humidicola* Burl., spores and cystidia. 32. *R. integra* (L.) Fr., spores and cystidia. 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, Shishan, 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 purement 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 grayish, 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.

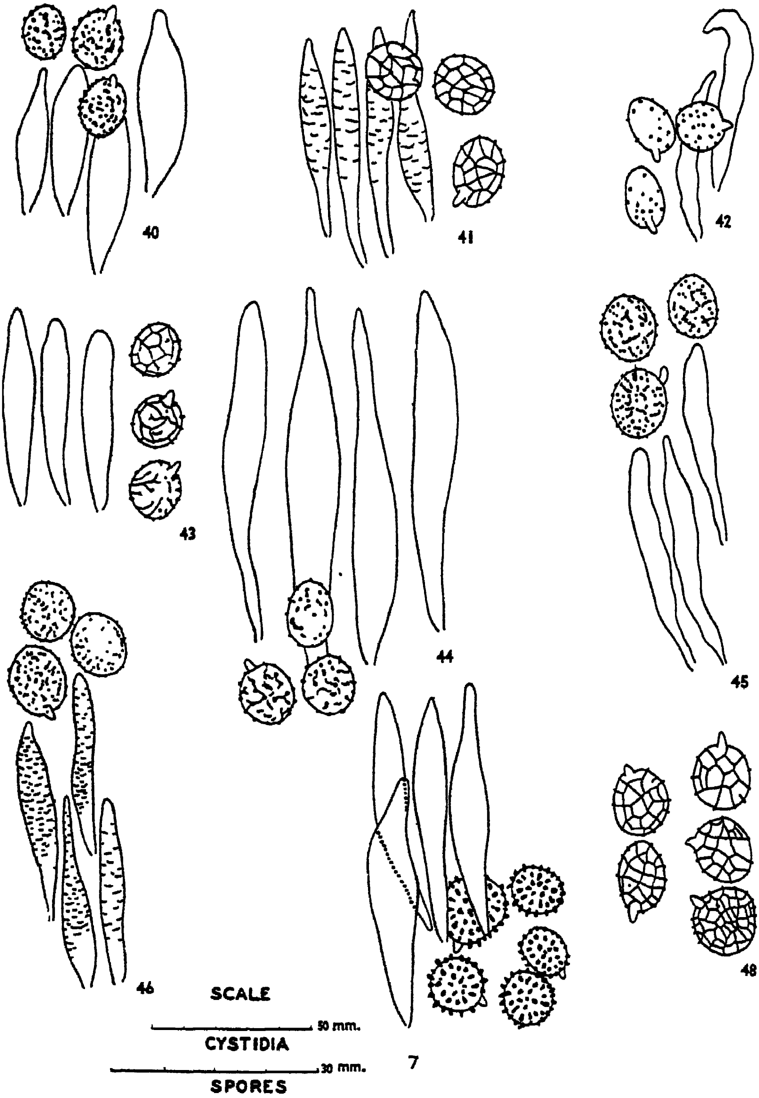

PLATE 3.—40. *R. corallina* Burl., spores and cystidia. 41. *R. fragilis* (Secr.) Fr., spores and cystidia. 42. *R. viscosa* P. Henn., spores and cystidia. 43. *R. punicea* sp. nov., spores and cystidia. 44. *R. chichuensis* sp. nov., spores and cystidia. 45. *R. sanguinea* (Bull.) Fr., spores and cystidia. 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 $MgCl_2\ 6H_2O$, 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-

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* 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 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.

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	10.0	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)		.	..	.	..

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. *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.

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			

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 secreted 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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SYMPOSIUM

on

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

CONTENTS

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.

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[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 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

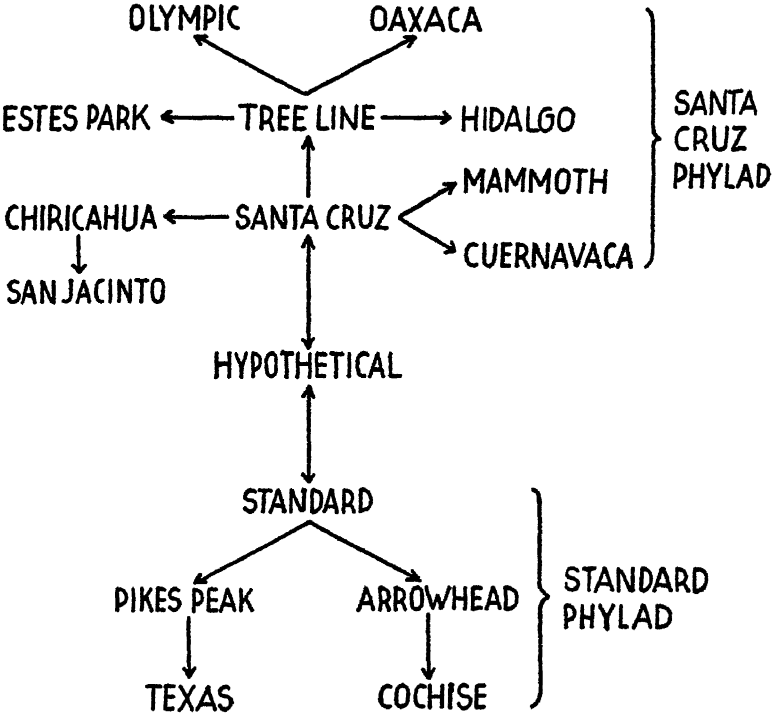

FIG. 1

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 arietinum*, *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 subspecifically 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 periods, 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 distance 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

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[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

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[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

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[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

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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

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[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 ⅓ 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

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[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-

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[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:

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[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, Manâos, 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 Manâos, growing on terra firma.

Specimens examined.—Brazil, Amazonas: *Ducke 451* (*H.J.B.R. 35153;* Manâos; 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 Manâos, 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 Panurê (S. Jeranimo) on the Rio Vaupês, 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).

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[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 ⅔ its length from throat, the corolla-lobes about 8 mm. long; stamens inserted at base of pilose ring.

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[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 Arirambá; 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 cocerning 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 other 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. Hypnosporae 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. Coun. 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

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* 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, parvulis, 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).

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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. Crayi*), 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 wintered 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 Starchy %	Embryos Oily %	Albumen Starchy %	Albumen Oily %	General Contents 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-

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[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 dicotyledons 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 belonging 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 Auricularias 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 varariotecta* 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 between 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

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* 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 ellipsoid 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, $7–10.5 \times 2.8–3.2\mu$; basidia clavate, not very thick and medium long, with four straight and rather long sterigmas, $35–39 \times 6–6.5\mu$; 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 $2–3\mu$ 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 roughening 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 lamellae 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. 2^{me} 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. Buttneri* 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 statements 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 nct 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 dedepression, 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 sessile carpophores of the other Favolaschias; besides, the red color, of course, makes this slight similarity seem more striking.

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.

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-

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* 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. varariotecta* 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 varariotecta 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 communicantibus; 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 *Varariae* 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,

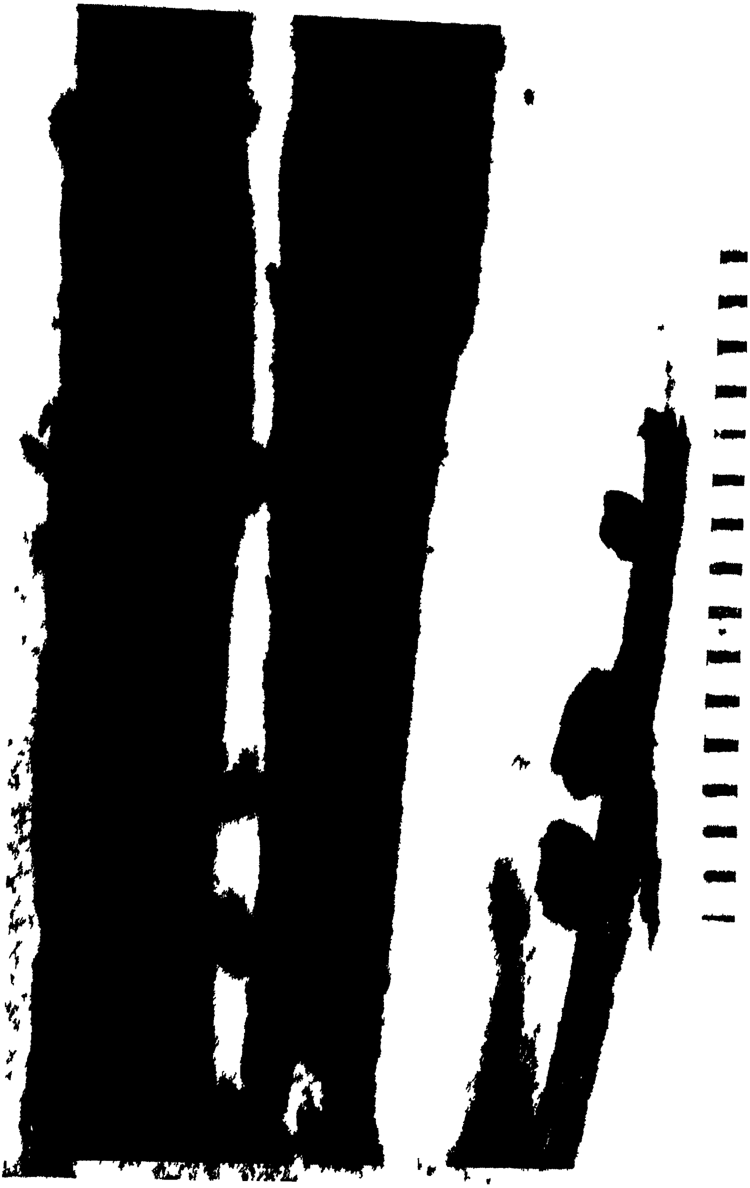

PLATE 2.—*Favolaschia cinnabarina* (B. & C.) Pat. Material from British Guiana, on its natural habitat. Phot. D. H. Linder. The millimeter scale at the right side of the plate is enlarged exactly as much as the specimens.

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

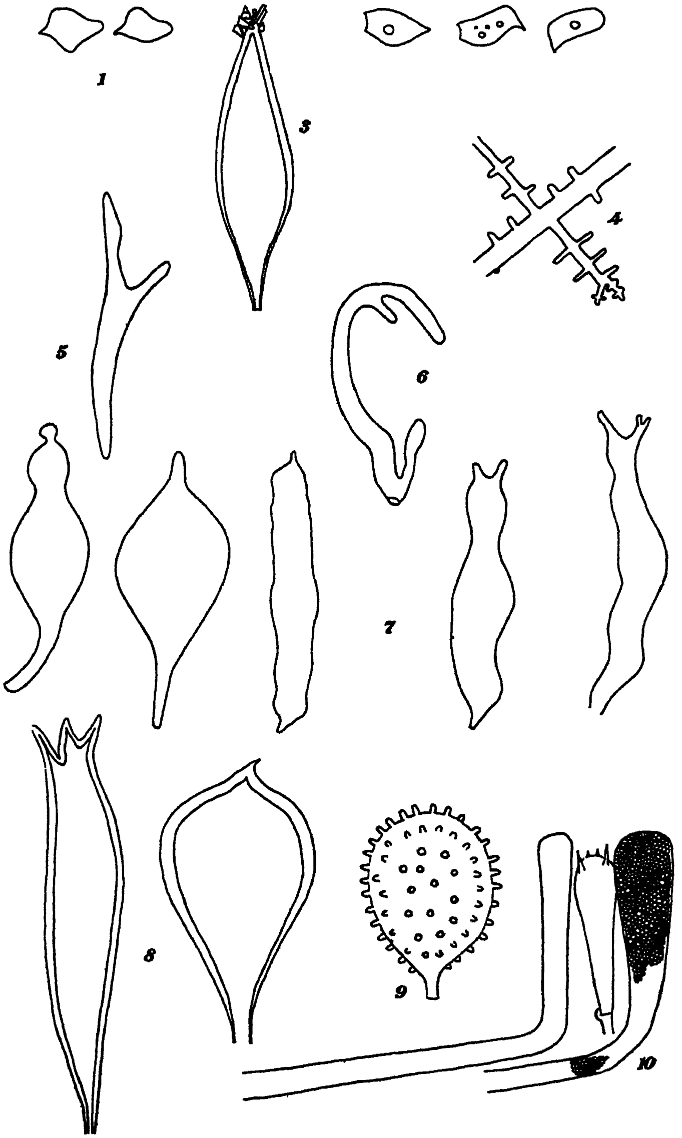

PLATE 3.—Fig. 1. *Campanella alba* (B. & C.) Sing. Spores, seen frontally (left) and in profile (right); ×1000.—Fig. 2. *Campanella simulans* (Pat.) Sing. Cystidium; ×1000.—Fig. 3. *Campanella simulans* (Pat.) Sing. Spores; ×1000.—Fig. 4. *Campanella simulans* (Pat.) Sing. Dendrophysis of the sterile 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, nonamyloid; 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 considerably 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, $10-60 \times 1-2$ (4) mm.

Spores $5.5-7 \times 4-5.3 \mu$, 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 varety 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, $6–7 \times 3\mu$. 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 ($6.3–7 \times 3.2\mu$) 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 accurring 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 $50 \times 5.5\mu$), 24 $51 \times 5.5-14\mu$ 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 asterostromelloid 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. 3^{me} sér. **2**: 195. 1844.
Polyporus pusillus Pers. ex Lloyd, Myc. Mot. **7**: 1238. 1924, non al.
Polyporus Rhipidium var. *pusillus* Kobayasi, Bull. Biogeogr. Soc. Jap. **7**: 3, pl. 2. 1937.
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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INDEX TO GENERA

INDEX TO SPECIES

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

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2

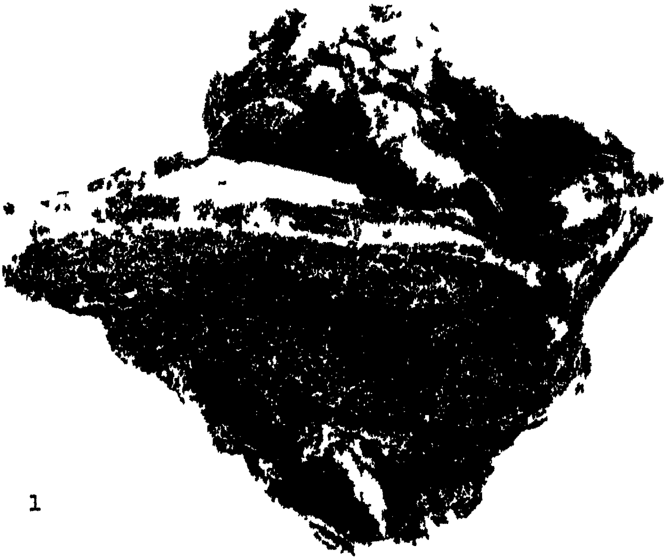
1

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

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[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 catclaw 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 33070, 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. 21099, 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. Soccoro 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 mississippiensis*, 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 are leaky water mains and hydrants. This moss is shown even in Lloyd's photograph of the type

FIG. 4. *Polyporus farlowii*, photograph of type at Kew by C. G. Lloyd

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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LLOYDIA

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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 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.

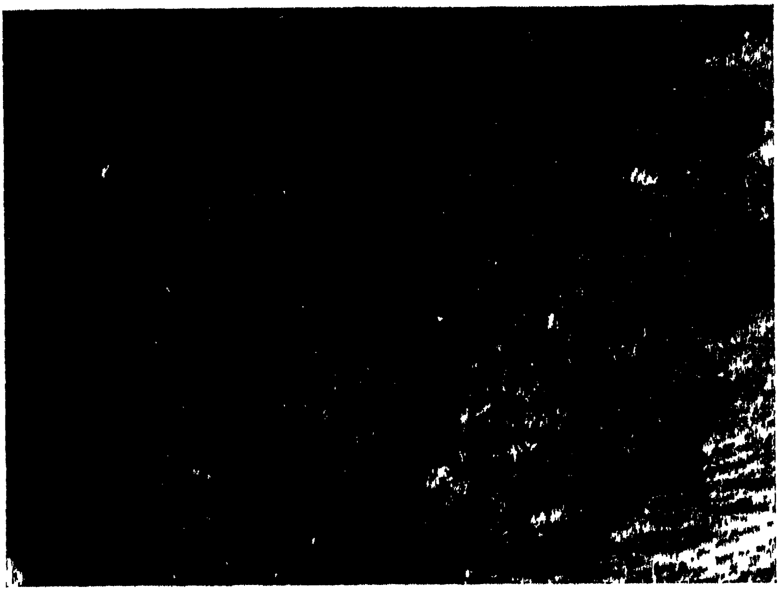

FIG. 1. *Hypoxylon aeneum*. A portion of the type collection in the Nitschke herbarium. ×12.

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. 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.

FIG. 2. *Hypoxylon annulatum.* Schweinitz' original illustration of his *Sphaeria annulata* in Jour Phil. Acad. Sci. 5, pl. II, fig. 8.

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 apparently 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 to an authentic specimen this is *H. marginatum* in its scattered condition.

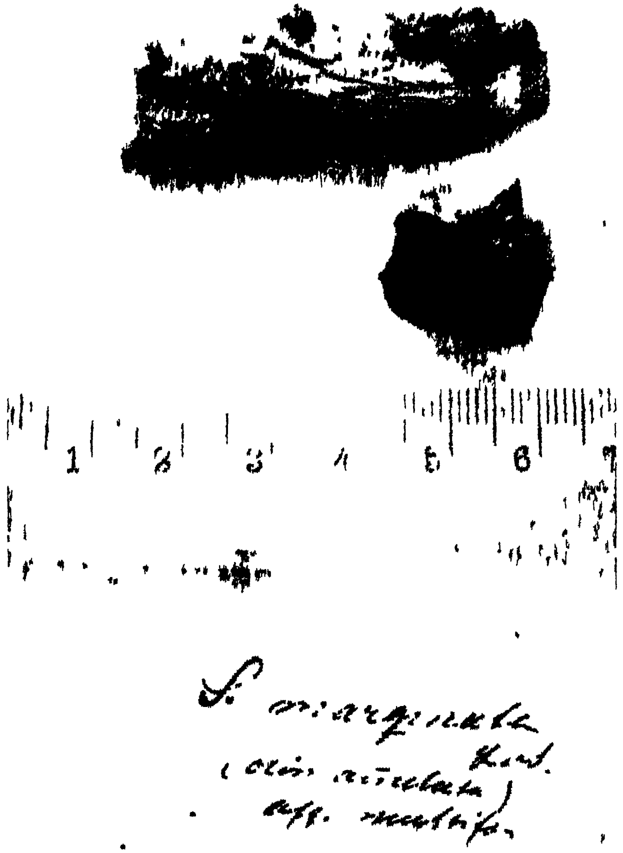

FIG. 4. *Hypoxylon marginatum*. Photograph by Nannfeldt of specimen sent by Schweinitz to Fries.

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 ×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 8–10×3–4µ 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 9–10×3.5µ) 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 21–27×9–11µ, 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. trunculata*."

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 Herbarium 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. Nac. 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 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.

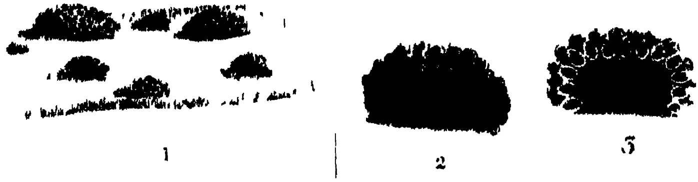

FIG. 5 *Hypoxylon argillaceum*. From Persoon's Icones pictae specierum rariorum fungorum, pl. 3, figs., 1, 2, 3.

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 measurements 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 ¼ 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 14–15×3.5μ. 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 7–10×3–5μ. 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, $8.5 \times 6.5\mu$; 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, conspicuously 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, echinulalatis, 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, projecting 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, 1930 (*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 in Gainesville, 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 Gainesville, 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.

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[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: *Lickapatoe, Sokko-Sokko.* FRENCH GUIANA: *Macoube.* BRAZIL: *Macucú* (fide Saldanha da Gama), *Molongó* (fide Record). BRAZIL, PARÁ: *Amapá Dôce, Sorva* (confusion with Couma?). BRAZIL, AMAZONAS: *Amapá* (São Gabriel; Humaytá), *Amapá Branco & Gogo de Guariba* (São Gabriel). BRAZIL, MARANHÃO: *Amapá.* BRAZIL, BAHIA: *Pequiá, Virole Brabo.* PERU, LORETO:[2] *Chicle* (fide Williams), *Huapu-Caspi.*

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[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-

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[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.[1] 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.

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[1] 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 Mucugê (*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 036* (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), *2030* (Brownsberg; Oct., fl.), *3591* (Sectie o), *5503* (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. 31054; Manáos, Pensador; Aug., fl.), *21604* (Manáos, prope cataractas fluminis Tarumá; Oct., fl., US); *Krukoff 7021* (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

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[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]

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[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. 1780. 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

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[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 "Landolphiées," 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-

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[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,

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[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: 260 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 inflorescences; 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

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[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.[11] 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,

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[11] 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. 9311*)."

Distribution.—Known only from Pará, Brazil.

Specimens examined Brazil, Belém: *Ducke 16187* (June 1916, fl.; US); *Huber 9311* (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.- "*Cascaria punctata** . . . Portoricco." Urban (Symb. Ant. Fl. Ind. Occ. 4 (3): 422. 1910) places this name in synonymy under *Cascaria 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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INDEX*

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* New genera, species, etc. are indicated by italics.