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A preliminary study of the operculate cup-fungi of Costa Rica*

by

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The fruiting bodies of some of the operculate cup-fungi (Class Ascomycetes, Order Pezizales) are among the largest and most brilliantly colored produced by any group of fungi. They commonly attract the admiration and curiosity of amateur and professional naturalist alike. The orange goblets of *Cookeina sulcipes,* for example, are a familiar sight to residents of moist, lowland, tropical countries. Other species, smaller in size or of duller coloration, are known only to those with the patience to seek them out. The thirty-two species of operculate cup-fungi presently known to occur in Costa Rica probably represent only a small fraction of the total number that grow there. It is hoped that the publication of this preliminary account will stimulate further collection and study of these interesting and attractive fungi.

This paper is based upon specimens collected By Dr. C. W. Dodge and his companions during the period 1929-1936, as well as upon specimens collected by the author in June 1962. Duplicates of most of the specimens have been deposited in the Museo Nacional de Costa Rica. Another set of Dodge's collections it at the New York Botanical Garden and a complete set of the author's collections is available at Cornell University.

MORPHOLOGY AND SYSTEMATIC POSITION

The cup-fungi (discomycetes) are placed in the class Ascomycetes, a group of fungi in which the reproductive spores are produced in elongate micro-

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scopic sacs (asci) from which they are shot, or otherwise released, at maturity. The operculate cup-fungi are among those Ascomycetes which bear their asci in a tightly packed layer (hymenium) lining a cup-shaped fruiting body (apothecium). In addition to the asci, this layer commonly contains a number of slender, sterile elements (paraphyses). Technically, the operculate discomycetes are distinguished from other Ascomycetes with cup-shaped fruiting bodies by the way in which the ascus opens to discharge its spores. The tip of the ascus opens by means of a small lid (operculum) which often remains attached to one side of the opening. The operculum is usually visible on empty, discharged asci when they are examined under the microscope. Other cup-fungi (Helotiales, Ostropales, Phacidiales, and Lecanorales) have asci which open by means of an apical pore or split. ALEXOPOULOS (1), DENNIS (2), GAMUNDI (3), and SEAVER (8) illustrate and discuss the differences in mode of ascus dehiscence and other features of microscopic morphology of discomycetes.

In the field it is impractical to determine the mode of ascus dehiscence, and one must recognize a member of the Pezizales by the shape, size, coloration, and texture of its apothecia and by the substrate on which it is found growing. Although a majority of operculate discomycetes have apothecia which may be called cup-shaped, the "cups" of different species vary from deeply urn-shaped to discoid or button-shaped. Most of them pass through cupulate stages in youth and become increasingly flattened, or even convex, at maturity. Some of the smaller species, however, are discoid to top-shaped, or even subglobose, from earliest youth. In some species the apothecium lies directly upon the soil, wood, or other substrate; in others it is supported above the substrate on a stalk (stipe) of varying length and thickness.

Many operculate cup-fungi have fruiting bodies larger than those of their inoperculate relatives. Any cup-shaped to button-shaped fruiting body that is more than a centimeter in diameter almost certainly belongs to a member of the Pezizales. Some of the largest species are quite un-cup-like, and consist of a sponge-like *(Morchella)* or irregularly globose head *(Gyromitra)* supported on a stout stalk. Fruiting bodies of this kind may be ten or more centimeters in height. The smaller species, those ranging in size from a centemeter down to a few hundred microns in diameter, are rarely stalked.

The fruiting bodies of operculate discomycetes vary in texture from leathery to soft-fleshy. Many members of the family Pezizaceae have the brittle quality of a fresh, crisp vegetable and break sharply when bent between the fingers. None have the gelatinous, woody, or carbonaceous textures characteristic of related fungi, or of fungi with a superficial resemblance to the Pezizales.

Many operculate cup-fungi are brightly colored in shades of yellow, orange, or red; more are some shade of tan or brown; and a few are black, grey, or almost white. With the exception of immature specimens of the family Ascobolaceae, which are often yellow-green, apothecia of blue or green hues are rare in the Pezizales.

HABITAT

Operculate discomycetes occur wherever and whenever there is sufficient moisture for their development and a suitable substrate for their nutrition. They are most common in forested regions, especially in sheltered ravines, but are found even in dry climates where local conditions provide a moist environment. In dry cattle country, dung or soil inhabiting species are sometimes found in moist depressions adjacent to water holes or streams. At the other extreme are genera *(Pachyella, Psilopezia)* which are seldom found more than a meter or two away from running water and at times are found completely submerged. Although further information is needed before anyone can make firm statements about the seasonal occurrence of discomycetes in Costa Rica, experience with the Pezizales elsewhere suggests that they are probably most abundant during the wettest months of the year.

Operculate cup-fungi are saprophytes which grow in a variety of substrates including soil, wood, dung, and charcoal. Soil inhabiting species, chiefly members of the family Pezizaceae, are most frequently collected on shaded ground that is free of herbaceous vegetation. The ruts of infrequently traveled roads and steep, eroding earthen banks are common habitats. An especially suitable roadside bank may have three or more unrelated species fruiting on it in a space of twenty meters. Soil inhabiting species have not been found in Costa Rica at altitudes below 2,000 meters, but at higher altitudes they are quite common. It is probable that lateritic soils will not support the growth of these fungi.

Members of the family Sarcoscyphaceae are found on dead but undecomposed wood of all sizes from fine twigs to stout branches. Many species of the family Pezizaceae also grow on wood, but wood that is so thoroughly softened by decay that it may be pulled apart with the fingers. They are usually found on larger branches or logs and only rarely on twigs.

Most species of the family Ascobolaceae and many smaller Pezizaceae are found on dung. They appear most commonly on dung which is re-moistened after a period of complete desiccation. It is often possible to stimulate the development of apothecia in the laboratory by placing a piece of dried dung in a closed dish with a damp paper towel. Some of the smaller genera are so inconspicuous and ephemeral that this is the best way to collect them. Only the most dedicated mycologists become truly enthusiastic about dung inhabiting fungi and one who sets forth to collect them should be prepared to be treated with suspicion by anyone who encounters him at his task.

Several species of the family Pezizaceae are found only in areas which have been burned over, or on the remains of old wood fires. They appear either on charred wood or scorched soil, or on a combination of both. In wet climates apothecia are formed on open ground and on the exposed surfaces of logs, but where the air is dry it is well to separate the stones of fireplaces and turn over logs to find apothecia which have developed in damp crevices at the surface of the ground.

COLLECTION AND PRESERVATION

Operculate discomycetes are best preserved by drying. The author prefers to collect them directly into small brown paper bags of the sort used to package small items of hardware. Collection data are written on the bag in the field and later torn off and included with the specimen in an herbarium packet or box. Minimal field notes include: locality and date of collection, substrate, accurate descriptions of the colors of the interior and exterior of intact apothecia, and mention of any liquid exuded by, or color changes in, the flesh of broken apothecia. In warm, dry climates specimens dry out on the laboratory table but elsewhere some form of artificial heat is required. Specimens may be dried in their bags and stored therein until finally identified. Thoroughly dry specimens will keep indefinitely provided that they are fumigated with ethylene dichloride or a similar material to prevent destruction by beetles. Dried specimens shrink badly and lose most of their color, but they retain their microscopic features. They may be expanded to something very close to their original shape and size by soaking them in water or a weak solution of potassium hydroxide.

MICROTECHNIQUES

In order to use the keys which follow, one must have information about features which can only be seen with the aid of a compound microscope and, in some instances, an oil immersion objective. For most purposes a "crush mount" (i.e. a preparation made by mashing a bit of apothecium on a slide) serves admirably. Fresh apothecia may be crushed directly in the mounting medium; dried material must first be revived by soaking it in 1% potassium hydroxide or 10% ammonium hydroxide. For preliminary observations, either water or dilute glycerin may be used as a mounting medium but two other media are required in addition.

The first of these is Melzer's reagent, used to determine the iodine reaction of the tips of asci. It consists of:

potassium iodide	1.5 gm
iodine	0.5 gm
chloral hydrate	20.0 gm
distilled water	20.0 ml

Fresh or revived specimens are crushed in the reagent, covered, and examined. In some genera *(Peziza)* the tips of asci turn blue in this reagent. In an emergency other strong aqueous solutions of iodine may be used but the results are not always satisfactory.

The ascospores of many species are ornamented with warts, crests, or ridges of a callose-pectic material. Frequently these markings are visible only when stained with Cotton Blue (6). The preferred formula consists of:

Cotton Blue C4B	0.05 gm
lactic acid	30.0 ml

The dye is dissolved in the acid and allowed to stand for at least an hour. The solution is then filtered to remove any particles of undissolved dye. A small portion of the hymenium of a fresh or revived specimen is crushed in a drop of the stain on a slide and covered. Gentle heating at just below the boiling point of the acid hastens the staining. Callose-pectic markings stain a deep blue. Preparations made in this way may be sealed with fingernail lacquer and kept for some time but the spores gradually overstain. For critical studies it is best to use a fresh preparation.

TAXONOMIC SPECIES

Eleven of the species described herein are listed as numbered "taxonomic species" under the appropriate genera. This indicates that the author has been unable to find published names for the collections so labeled. It is anticipated that continued study of the literature and examination of future collections will establish that a majority of them are new species. A few may prove variants of known species or be described in works the author has not yet seen. It should be noted that taxonomic species are not accompanied by latin diagnoses, nor are they labeled, "new species". It is the author's intent that they be treated as *not validly published* under the provisions of the International Code of Botanical Nomenclature (4) and that their publication here not be taken into consideration for purposes of establishing nomenclatural priority.

KEY TO GENERA

1. Apothecia deep cup-shaped to saucer-shaped, usually stipitate; texture tough, leathery to subgelatinous or corky; saprophytes or weak parasites on woody materials in early stages of decay; hymenium bright colored, red to yellow; asci suboperculate ..... (5). FAMILY SARCOSCYPHACEAE. ..... 2.

1. Apothecia cup-shaped to discoid, convex, or variously shaped, if cup-shaped then lacking a stipe; texture soft-fleshy to crisp-fleshed, easily broken; saprophytes on soil, well-rotted wood, dung, or charcoal; hymenium variously colored; asci operculate. ..... 4.

2. Apothecia soft, subgelatinous, translucent, glabrous; hymenium deep purplish-red, having the texture and color of raw beef; exterior whitish to pinkish, watery; stipe stout or absent ..... PHILLIPSIA

2. Apothecia not as above; texture leathery; hymenium orange to scarlet; exterior whitish to pale orange or pink, often hairy; stipe slender, resembling the stem of a globet. ..... 3.

3. Bases of asci constricted, crooked, resembling pig's tails; apothecial hairs in fascicles. ..... COOKEINA

3. Bases of asci tapered gradually; apothecial hairs, where present, single..... SARCOSCYPHA

4. Ascospores with purple to brown markings; asci protruding from the hymenium at maturity; apothecia small, less than 1 cm broad, usually on dung ..... FAMILY ASCOBOLACEAE. ..... 5.

4. Ascospores hyaline to pale yellow, rarely smoky, with or without hyaline warts, spines, crest, or ridges; asci not protruding from the hymenium at maturity; apothecia large or small; on a variety of substrates. FAMILY PEZIZACEAE 6.

5. Ascospores separating from each other in the ascus, discharged separately. ... ASCOBOLUS

5. Ascospores clinging together in the ascus, discharged as a group. ..... SACCOBOLUS

6. Apothecium consisting of a pileus or cap supported by a distinct stipe or stalk. ..... 7.

6. Apothecium sessile, or nearly so. ..... 9.

7. Pileus conical; hymenium costate, divided by a network of anastomosing ribs, sponge-like ..... MORCHELLA

7. Pileus subglobose or irregular; hymenium smooth or slightly wrinkled. ..... 8.

8. Pileus gyrose-contorted, roughly spherical; stipe stout. ..... GYROMITRA

8. Pileus mitre-shaped to saddle-shaped or cupulate; stipe slender. ..... HELVELLA

9. Apothecia fringed with hairs or bristles. ..... 10.

9. Apothecia without hairs. ..... 13.

10. Apothecia remaining cup shaped at maturity; hymenium whitish; on soil. ..... HUMARIA

10. Apothecia becoming saucer-shaped at maturity or topshaped to subglobose from the start; hymenium red, orange, or yellow. ..... 11.

11. Hairs unseptate; apothecia minute, up to 1 mm broad; on dung. ..... LASIOBOLUS

11. Hairs septate; apothecia 3-25 mm broad. ..... 12.

12. Apothecia on dung; ascospores, smooth, without internal oil drops. CHEILYMENIA

12. Apothecia on rotting wood or soil, ascospores warted or smooth, with internal oil drops. ..... SCUTELLINIA

13. Hymenium bright-colored, orange or red; ascospores ellipsoid, ornamented with crests or ridges; on soil. ..... ALEURIA

13. Hymenium dull-colored, tan, brownish, yellowish, purplish, or blackish; ascospores ellipsoid to spherical, ornamented or smooth; on a variety of substrates. ..... 14.

14. Apothecia small, less than 3 mm broad; on dung. ..... ASCOPHANUS

14. Apothecia medium-sized to large, more than 3 mm broad; on soil, wood, or charcoal. ..... 15.

15. Ascospores spherical; apothecia on charred wood. ..... 16.

15. Ascospores ellipsoid; apothecia on soil, wood, or charcoal. ..... 17.

16. Apothecia cup-shaped to saucer-shaped, more than 1 cm broad; tips of asci turning blue in iodine. ..... PEZIZA (Subgenus *Plicaria*)

16. Apothecia discoid, less than 1 cm broad; tips of asci not turning blue in iodine. ..... BARLAEINA

17. Apothecia cup-shaped to discoid, the margin free of the substrate; on soil, wood, or charcoal, not submerged in water; tips of asci bluing in iodine. ..... PEZIZA

17. Apothecia discoid, the margin often adherent to the substrate; on water-soaked wood in streams, often partly to completely submerged. ..... 18.

18. Apothecia medium-sized, 20-30 mm broad; hymenium dark brown; the entire ascus turning blue in iodine. ..... PACHYELLA

18. Apothecia smaller, 5-20 mm broad; hymenium brownish, yellowish, or blackish, often surrounded by a halo of lighter colored, sterile tissue; asci not turning blue in iodine. ..... PSILOPEZIA

FAMILY SARCOSCYPHACEAE

1. COOKEINA Kuntze

Apothecia scattered or in clusters, medium-sized to large, 1-5 cm broad, goblet-shaped with a slender stem, thin-fleshed; texture resembling fine kid leather; exterior puberulous to hispid, ivory to apricot in color; hymenium bright-colored, orange to scarlet, fading with age or on drying; hairs light-colored, whitish, composed of bundles of parallel, cylindrical, septate hyphae of unequal length; asci suboperculate (5), not turning blue in iodine, thick-walled, cylindrical, large, up to 20 μ broad and 300 μ long, with a blunt, rounded base which connects to the sterile tissue of the apothecium by a slender, crooked stalk resembling a pig's tail; ascospores ellipsoid, large, 20-40 μ long, smooth or ornamented with fine longitudinal wrinkles or striae, containing one or two large oil drops; paraphyses slender, with numerous septa, freely branching and anastomosing, cylindrical, or slightly constricted at the septa; on wood; tropical to subtropical.

TYPE SPECIES: *Cookeina tricholoma* (Mont.) Kuntze.

Cookeina sulcipes (Berk.) Kuntze (Fig. 1).

Apothecia large, up to 4 cm broad, apparently glabrous but with fine hairs on the exterior of cup and stipe; ascospores cylindrical-ellipsoid, 14-18 ×

HABITAT: on sticks lying on the ground in tropical wet forest.

SPECIMENS EXAMINED: *Denison et al. 1902,* Finca La Selva, Puerto Viejo, Heredia Prov., 100 meters, 11 June 1962; *Dodge & Goerger 9482,* forest near farmhouse, Finca Castilla, Limón Prov., 30 meters, 29 July 1936; *Dodge & Goerger 9973,* flood plain of Río Sándalo, Península de Osa, Puntarenas Prov., 1-10

meters, 22 August 1936; *Denison, Jiménez, et al. 1978,* 8 kilometers north of Dominical, San José Prov., 300 meters, 24 June 1962.

NOTE: An albino variety, differing only in its pure ivory-white color, was collected with the colored variety at Finca La Selva.

Cookeina tricholoma (Mont.) Kuntze (Fig. 2)

Apothecia medium-sized, up to 2 cm broad, externally clothed with numerous long, shining, white hairs; margin commonly remaining inrolled at maturity; ascospores pointed-ellipsoid, 14-17 × 28-35 μ.

HABITAT: on wood or bark in tropical wet forest.

SPECIMENS EXAMINED: *Dodge & Thomas 4424,* south bank of Río Pejivalle, Cartago Prov., 650-800 meters, 26 September 1929; *Berkeley & Woodward 1950,* Finca La Selva, Puerto Viejo, Heredia Prov., 100 meters, 20 June 1962; *Denison et al. 1947,* Standard Fruit Co. Plantation, Pandora, Limón Prov., 35 meters, 20 June 1962; *Dodge & Goerger 10307,* hills above Quebrada Huaca, Península de Osa, Puntarenas Prov., 10-30 meters, 28 August 1936; *Denison, Jiménez, et al. 1977,* 8 kilometers north of Dominical, San José Prov., 300 meters, 24 June 1962.

2. PHILLIPSIA Berk.

Apothecia solitary or in groups of two or three, medium-sized to large, 1-4 cm broad, shallow cup-shaped to subdiscoid with a stout stipe, rather thick-fleshed; texture subgelatinous; stipe highly variable in length but usually less than 1 cm; hymenium deep purplish red to orange, fading and cracking on drying; exterior glabrous, subtranslucent, whitish to pinkish; asci suboperculate (5), not turning blue in iodine, cylindrical, gradually tapered below; ascospores ellipsoid, or, more often, unequal-sized, moderate-sized to large, 18-30 μ long, containing two or more medium-sized oil drops, smooth or with longitudinal striae; paraphyses filiform, 1.5-2.0 μ broad at their apices, containing bright red pigment granules; on wood; tropical to subtropical.

TYPE SPECIES: *Phillipsia domingensis* Berk.

NOTE: Mme. LE GAL has published an extensive study of this genus (7).

Phillipsia domingensis Berk. (Fig. 3).

Apothecia 1.5-3.0 cm broad; hymenium dark red; asci 8-spored; ascospore unequal-sided ellipsoid, 10-15 × 20-25 μ, ornamented with longitudinal bands or ridges, containing two medium-sized oil drops and several smaller ones.

HABITAT: on wood or bark in the tropics.

SPECIMENS EXAMINED: *Dodge & Thomas 4655,* cañon of Río Reventazón, Cartago Prov., 15 October 1929; *Dodge, Catt, & Thomas 5770,* margin of Bonilla Lakes above Tunnel Camp, 13 December 1929.

Phillipsia taxonomic species 1. (Fig. 4)

Apothecia 1-2 cm broad; hymenium dark red, meat-colored; asci 8-spored, ascospores ellipsoid, symmetrical, 12-14 × 21-26 μ smooth, containing several small oil drops.

HABITAT: on sticks in wet forest above 2,500 meters.

SPECIMENS EXAMINED: *Campbell & Carroll 1955,* along road from Coronado to Volcán Irazú, Cartago, Prov., 2,600 meters, 22 June 1962; *Denison, Jiménez, et al. 1974,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,800 meters, 23 June 1962.

3. SARCOSCYPHA (Fr.) Boud.

Apothecia solitary to clustered, small to large, 3 mm to 3 cm broad, saucer-shaped to cup-shaped, with a slender stipe of varying length; texture resembling soft leather; hymenium bright-colored, scarlet to orange; exterior whitish to pale pink, buff, or orange, glabrescent to tomentose; hairs, where present, hypha-like, flexuous, septate; asci suboperculate (5), iodine negative, cylindrical, gradually tapered below; ascospores ellipsoid to oblong, moderate-sized to large, 18-40 μ long, smooth, with two or more medium-sized oil drops; paraphyses filiform to subclavate, forked or sparingly branched, on twigs, sticks, or woody debris; temperate to tropical.

TYPE SPECIES: *Sarcoscypha coccinea* (Fr.) Lambotte.

Sarcoscypha tetraspora (Seaver) Denison comb. nov. (Fig. 5)

= *Cookeina tetraspora* Seaver, *Mycologia,* 17: 45, 1925.
= *Phillipsia tetraspora* (Seaver) Le Gal

Apothecia 3-5 mm broad; hymenium orange; asci 4-spored; ascospores narrow ellipsoid, sometimes unequal-sided, 11-14 × 24-36 μ.

HABITAT: on twigs or small bits of woody debris in damp places at middle altitudes.

SPECIMENS EXAMINED: *Denison 1901,* Villa Aseptina, Coronado, San José, Prov., 1,450 meters, 11 June 1962; *Denison et al. 1914,* La Paz, Heredia Prov., 1,000 meters, 13 June 1962.

NOTE: This small species differs from members of the genus *Cookeina* in which it was originally placed in two important respects: 1) its asci do not have "pig's tail" bases and 2) it has a different arrangement of excipular tissues. The author feels that this species, and the one following, are more closely allied to the smaller species of *Sarcoscypha,* e. g. *S. occidentalis,* than to the genus *Phillipsia.* It is possible that they deserve a new genus of their own.

Sarcoscypha taxonomic species 2. (Fig. 6)

Apothecia small, 5-10 mm broad; hymenium bright red; asci 8-spored; ascospores ellipsoid, symmetrical, 11-12 × 21-23 μ.

HABITAT: on twigs at middle to high altitudes.

SPECIMEN EXAMINED: *Denison et al. 1956,* on road from Coronado to Volcán Irazú, San José Prov., 2,600 meters, 22 June 1962.

Family ASCOBOLACEAE

4. ASCOBOLUS Pers. ex Fr.

Apothecia clustered to gregarious, small, 1-15 mm broad, saucer-shaped to turbinate, sessile or partially buried in the substrate; texture soft, fleshy to waxy; hymenium at first pale yellow, brown, or whitish, often with a yellow-green cast, becoming dark brown or blackish as the spores mature, at maturity dotted with the tips of protruding asci; exterior similar in color but paler, smooth to pulverulent; asci operculate, iodine positive, broad, clavate to subcylindrical; ascospores ellipsoid, large, 18-50 μ or more in length, at maturity covered with a purple to blackish layer (epispore) which becomes divided by cracks and fissures to form a pattern characteristic of each species; paraphyses slender, often adhering together; occurring on dung, less often on charred wood or soil; rather common in the temperate zone.

TYPE SPECIES: *Ascobolus stercorarius* (Bull.) Schroet.

Ascobolus immersus Pers. ex Fr.

= *Dasyobolus immersus* (Pers. ex Fr.) Sacc.

Apothecia minute, 0.5-2.0 mm broad, partially buried in the substrate, the margin fringed with fascicles of hairs, greenish-yellow becoming brown; ascospores ellipsoid, very large, 20-35 × 50-70 μ.

NOTE: The only Costarican material known developed on some dried cow dung collected by Mr. George Carroll on Volcán Irazú. The writer has not seen this material. It was identified by Mr. Henry Dissing, Institut for Sporeplanter, Copenhagen. Unfortunately the specimens have been lost.

5. SACCOBOLUS Boud.

Apothecia scattered, small, less than 1 mm broad, globose to turbinate or cup-shaped, sessile, white to ochraceous, becoming brown as the spores mature, subtransparent, soft, fleshy; asci operculate, iodine positive, very broadly clavate; ascospores ellipsoid to cylindrical or unequal-sided, becoming dark brown to purplish, smooth or covered with fine granules, medium-sized to large, 30-35 μ long, 4 or 8 per ascus, adhering together in the ascus and discharged as a group; paraphyses cylindrical to clavate, slender; occurring on dung, rarely on old sacking or debris; world wide.

TYPE SPECIES: *Saccobolus kerverni* (Crouan) Boud.

Saccobolus taxonomic species 3. (Fig. 7)

Apothecia globose to subturbinate, minute, 0.1-0.3 mm broad; asci 30-40 × 85-125 μ, 8-spored; ascospores fusiform-ellipsoid, unequal-sided, 8-9 × 20-23 μ, becoming dark brown, the epispore with a few cracks of the type seen in spores of *Ascobolus,* covered with granules of dark brown material.

HABITAT: on cow dung.

SPECIMENS EXAMINED: *George Carroll 1836,* meadow below crater of Volcán Poás, Alajuela Prov., 2,750 meters, 15 June 1962.

NOTE: The apothecia of this fungus developed in the laboratory in a moist chamber. The author is indebted to Mr. George Carroll for sending him mature apothecia and to Mr. Henry Dissing of the Institut for Sporeplanter, Copenhagen, for the initial identification and for pointing out the cracked epispore.

Family PEZIZACEAE

6. ALEURIA Fuckel

Apothecia scattered to gregarious or caespitose, small to large, 0.5-7.5 cm broad, deep cup-shaped becoming saucer-shaped, discoid or irregular, sessile or subsessile, crisp-fleshed, easily broken; hymenium bright-colored, red to orange; exterior similar in color but paler, smooth or tomentulose; hairs, when present, inconspicuous, hypha-like; asci operculate, iodine negative, cylindrical, moderate-sized, 10-15 × 150-250 μ; ascospores ellipsoid, moderate-sized, 12-18 μ long exclusive of ornamentation, ornamented with conspicuous ridges or crests 1 μ or more in height, which may or may not anastomose to form a reticulum, containing one or two large oil drops; paraphyses clavate to subcapitate, containing granules of red pigment which turns green in iodine; on bare soil, world wide.

TYPE SPECIES: *Aleuria aurantia* (Fr.) Fuckel

Aleuria aurantia (Fr.) Fuckel (Fig. 8)

Apothecia medium-sized to large, 2-7 cm broad, cup-shaped to saucer-shaped or irregular; hymenium orange-peel orange; ascospores 7-9 × 14-16 μ exclusive of their ornamentation, ornamentation of thin-edged ridges which form a reticulum and protrude at each pole to form an apiculus.

HABITAT: on bare soil throughout the temperate zone and at higher altitudes in the tropics.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1976, 1986, 1993,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,400 meters, 25 June 1962.

Aleuria rubra Batra (Fig. 9)

Apothecia saucer-shaped to discoid, medium-sized, 1-3 cm broad; hymenium blood red; ascospores 7-8 × 14-15 μ exclusive of ornamentation, orna-

mentation of thick, rounded ridges which anastomose to form a coarse reticulum, usually without apiculi at the poles.

HABITAT: on bare soil at high altitudes in the tropics.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1987, 1992,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,360 meters, 25 June 1962.

NOTES: The specific status of this fungus deserves further consideration. One collection *(1992)* was found growing intermixed with *Aleuria aurantia* on a bank of earth which also supported two species of *Peziza.* No apothecia of intermediate color were found. There was an excellent correlation between red hymenial color and discoid shape, and between orange color and cupulate shape. Both the red and orange forms were found elsewhere growing by themselves under very nearly identical conditions. It seems unlikely, therefore, that the two forms reflect either different stages of maturity or different conditions of the environment. The possibility remains, however, that they represent merely color phases of the same species, comparable to the black and cinnamon phases of the American black bear or the luminescent and nonluminescent forms of *Panus stypticus.* If this is indeed the case it is curious that the red form should be confined to the tropics.

SEAVER (8) refers a collection of what appears to be *A. rubra* from Costa Rica to *Aleuria aurantia.*

Aleuria taxonomic species 4. (Fig. 10)

Apothecia saucer-shaped, small, up to 1 cm broad; hymenium orange-peel orange; ascospores broadly ellipsoid, 8-9 × 11-23 μ exclusive of ornamentation consisting of sharp-edged crests which do not anastomose to form a reticulum.

HABITAT: on bare soil, known only from a single collection.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1971,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,360 meters, 23 June 1962.

7. ASCOPHANUS Boud.

Apothecia scattered to gregarious, small, 0.5-3.0 mm broad, saucer- shaped to discoid or convex, sessile, soft, fleshy to waxy; hymenium reddish-brown to dull yellow, the color fading with age; asci operculate, iodine negative or with a diffuse reaction of the entire ascus, cylindrical to clavate; ascospores ellipsoid, medium-sized to small, 10-25 μ long, smooth or warted; paraphyses filiform to clavate or subcapitate; on dung; world wide.

TYPE SPECIES: *Ascophanus carneus* (Pers. ex Fr.) Boud.

NOTE: This genus is under revision by Dr. R. P. Korf, Cornell Univ., Ithaca, N. Y., and his students. Those species with iodine positive asci will probably be retained in the genus *Ascophanus* and the others dispersed elsewhere.

Ascophanus carneus (Pers. ex Fr.) Boud. (Fig. 11)

Apothecia 0.5-1.0 mm broad, crowded, discoid to subhemispheric; hymenium rust-brown to orange; asci bluing weakly or not at all in iodine; ascospores ellipsoid, 11-12 × 20-21 μ, ornamented with peg-shaped warts; paraphyses filiform.

HABITAT: on cow dung, probably world wide.

SPECIMENS EXAMINED: *Denison et al. 1928,* crater of Volcán Irazú, Cartago Prov., 3,400 meters, 17 June 1962.

NOTE: Mr. George Carroll and Mr. Henry Dissing have furnished information about a group of apothecia which developed on cow dung from the same locality. Their specimens, identified as *Ascophanus carneus* have iodine positive asci but those the author collected do not.

Ascophanus taxonomic species 5. (Fig. 12)

Apothecia 2-3 mm broad, saucer-shaped, hymenium dull yellow; asci iodine negative; ascospores ellipsoid, small, 5-6 × 12-15 μ, smooth, without oil drops; paraphyses stout, with bulbous apices.

HABITAT: on cow dung; known only from a single collection.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1973,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,400 meters 23 June 1962.

8. BARLAEINA Sacc. emend. Le Gal

Apothecia solitary to gregarious, small, 1-15 mm broad, discoid to saucer-shaped, sessile or subsessile, soft-fleshed; hymenium dull colored, brownish, purplish, or greyish; exterior similar in color, smooth or nearly so; asci operculate, iodine negative, cylindrical, medium-sized, 10-15 × 100-200 μ; ascospores spherical, small, 5-12 μ in diameter, smooth or sculptured, containing one or more oil drops; paraphyses filiform, their apices subclavate and often somewhat curved, often united by superficial, dark-colored material; on soil, dung, or charcoal.

TYPE SPECIES: *Barlaeina amethystina* (Quel.) Sacc. & Trav.

Barlaeina taxonomic species 6. (Fig. 13)

Apothecia discoid, 4-10 mm broad; hymenium watery, olivaceous grey; ascospores spherical, small, 5-6 μ in diameter exclusive of sculpturing, covered with large, rounded warts, containing a single oil drop; paraphyses slightly curved at their apices, stuck together at their tips by dark, amorphous matter.

HABITAT: on charcoal, known only from a single collection.

SPECIMENS EXAMINED: *Denison, Jiménez et al. 1985,* along Pan American Highway 18 kilometers north of San Isidro, San José Prov., 1,640 meters, 25 June 1962.

9. CHEILYMENIA Boud.

Apothecia gregarious to scattered, small, 0.5-10.0 mm broad, saucer-shaped to discoid or subturbinate, soft, fleshy; hymenium red-orange to yellow; exterior clothed with brownish hairs; hairs pale yellow to dark brown, stiff, bristle-like, tapering to a point, in some species the lower hairs stellate, otherwise rarely branched, septate; asci operculate, iodine negative, cylindrical, 10-15 × 150-250 μ; ascospores ellipsoid, medium-sized, 15-22 μ long, smooth, without oil drops; paraphyses slender, with subclavate apices, septate, infrequently branched, containing granules of red to yellow pigment; on dung of various kinds; world wide.

TYPE SPECIES: *Cheilymenia stercorea* (Pers.) Boud.

Cheilymenia coprinaria (Cooke) Boud. (Fig. 16)

= *Patella coprinaria* (Cooke) Seaver

Apothecia saucer-shaped, 3-10 mm broad; hymenium yellow to red-orange; hairs dark brown, thick-walled, originating within the tissues of the excipulum, unbranched, 3-7-septate, up to 20 μ broad and 700 μ long; ascospores ellipsoid, smooth, 7-10 × 14-17 μ.

HABITAT: on cow dung; common and probably world wide.

SPECIMENS EXAMINED: *Denison et al. 1921,* meadow just below crater of Volcán Poás, Alajuela Prov., 2,600 meters, 15 June 1962; *Denison et al. 1932,* along road between Coronado and Volcán Irazú, Cartago Prov., 2,600 meters, 17 June 1962; *Campbell 1944,* along Pan American Highway 32 kilometers south of Cartago, San José Prov., 2,800 meters, 19 June 1962; *Denison, Jiménez, et al. 1961, 1955,* Cerro de la Muerte, 3,100 meters, 23 June 1962.

Cheilymenia theleboloides (Alb. & Schw. ex Fr.) Boud. (Fig. 17)

= *Patella theleboloides* (Alb. & Schw. ex Fr.) Seaver

Apothecia small, about 1 mm broad, saucer-shaped to discoid; hymenium orange to yellow; hairs yellow to brownish; originating from superficial cells of the excipulum, 0-3-septate, up to 200 μ long; ascospores ellipsoid, 10-11 × 16-19 μ, smooth, without oil drops.

HABITAT: on cow dung. possibly on other substances: world wide.

SPECIMENS EXAMINED: *Denison et al. 1929,* inside crater of Volcán Irazú, Cartago Prov., 3.400 meters, 17 June 1962; *Dodge & Goerger 10646,* roadside north of Finca Guayabillos, San José, Prov., 9 July 1936.

10. GYROMITRA Fr.

Apothecia solitary or scattered, large, 3-8 cm or more broad and 4-10 cm high, composed of an irregular, subglobose, lobed, or contorted cap and a sup-

porting stalk, crisp-fleshed, easily broken; hymenium red-brown to grey; stipe stout, 1-3 cm or more broad, whitish, grey, or brownish, smooth to floccose or pulverulent; asci operculate, iodine negative; ascospores ellipsoid, moderate-sized, 16-24 μ long, smooth, containing two yellow to brownish oil drops; paraphyses cylindrical with subclavate to capitate apices; on soil or rotten wood; widely distributed in the temperate zone.

TYPE SPECIES: *Gyromitra esculenta* (Pers.) Fr.

Gyromitra taxonomic species 7. (Fig. 15)

Apothecia up to 4 cm broad and 8 cm high; cap reddish-brown to greyish; stipe smooth, color similar to cap but paler, up to 2 cm thick; ascospores ellipsoid, symmetrical to slightly unequal-sided, 7-8 × 16-19 μ smooth, containing two oil drops; paraphyses subcapitate.

HABITAT: on very rotten woods, at higher altitudes.

SPECIMENS EXAMINED: *Campbell 1951,* along road from Cartago to Volcán Irazú, Cartago Prov., 2,100 meters, 22 June 1962; *Denison, Jiménez, et al. 1966,* along Pan American Highway 6 kilometers south of Cerro de la Muerte, San José Prov., 2,820 meters, 23 June 1962.

11. HELVELLA L. ex Hooker

Apothecia solitary or scattered, medium-sized to large, 1-8 cm broad and 1-10 cm tall, composed of a saddle-shaped to mitre-shaped, rarely cup-shaped, cap and a supporting stalk or stipe, crisp-fleshed, easily broken; hymenium dark brown to blackish or pale grey; stipe slender or stout, 0.2-3.0 cm thick and 1-7 cm long, terete to irregularly fluted, smooth to pulverulent or scurfy; asci operculate, iodine negative; ascospores ellipsoid, medium-sized, 18-25 μ long, smooth, containing one large central oil drop; paraphyses slender, subclavate; on soil or rotten wood; world wide.

TYPE SPECIES: *Helvella mitra* L. ex Fr.

Helvella atra Oed. ex Fr.

Hymenium saddle-shaped to mitrate, 1-3 cm broad, dark brown to black; stipe slender, 2-3 mm thick and 4-5 cm long, terete, blackish, pruinose; ascospores ellipsoid, 11-12 × 20-22 μ, smooth, containing one large oil drop.

HABITAT: on soil.

SPECIMENS EXAMINED: *Dodge & Thomas 5069,* potreros of Rancho Redondo, San José Prov., 9 November 1929; *Dodge & Thomas 5240,* potreros of Retes, El Alto de Cabeza de Vaca, San José Prov., 13 November 1929.

12. HUMARIA Fuckel emend. Denison

Apothecia scattered to gregarious, medium-sized, 1-3 cm broad, cup-shaped, margin fringed with dark brown hairs; hymenium white or faintly

yellowish; exterior brown; furry; hairs up to 1.5 mm long, dark brown, septate, tapering to a point, arising in tufts; asci operculate, iodine negative, cylindrical, 15-18 × 250-300 μ; ascospores oblong-ellipsoid, 20-26 μ long, ornamented with irregular warts or crests, containing two oil drops; paraphyses slender, clavate, septate; on soil; world wide.

TYPE SPECIES: *Humaria hemispherica* (Wiggers ex Fr.) Fuckel.

Humaria hemispherica (Wiggers ex Fr.) Fuckel (Fig. 14)

= *Patella albida* sensu Seaver

Apothecia remaining cup-shaped at maturity; exterior covered with brown pustules surmounted by tufts of hairs; marginal hairs 800-1,500 μ long, lower ones much shorter, 100-500 μ; ascospores oblong-ellipsoid, 12-13 × 23-25 μ, covered with low warts of irregular shape.

HABITAT: on soil, rather common in the temperate zone, apparently rare in the tropics.

SPECIMENS EXAMINED: *Dodge & Thomas 5056,* potreros of Rancho Redondo, San José Prov., 2,220-2,600 meters, 11 November 1929.

13. LASIOBOLUS Sacc.

Apothecia gregarious, small, less than 1 mm broad, turbinate to subglobose, soft-fleshed, orange to rust-red, sessile, sides clothed with hairs; hairs white, stiff, bristle-like, pointed, up to 800 μ long, non-septate; asci operculate, iodine negative, cylindrical to cylindro-clavate; ascospores cylindrical to ellipsoid, medium-sized, 18-28 μ long, smooth, not containing oil drops; paraphyses filiform, sparingly branched; on dung of various kinds; world wide.

TYPE SPECIES: *Lasiobolus papillatus* (Pers. ex Fr.) Sacc.

Lasiobolus ciliatus (Schmidt ex Fr.) Boud. (Fig. 18)

Apothecia turbinate, 0.5-0.9 mm broad, rust-red; hairs up to 500 μ long; ascospores ellipsoid, 11-12 × 20-23 μ, smooth, not containing oil drops; paraphyses 2-3 μ thick, containing granules of red pigment.

HABITAT: on dung, world wide.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1964,* Cerro de la Muerte, Cartago Prov., 3,100 meters, 23 June 1962; *Denison et al. 1929,* inside crater of Volcán Irazú, Cartago Prov., 3,400 meters, 17 June 1962.

14. MORCHELLA Dill. ex Hook.

Fruiting bodies scattered to solitary, large, 2-10 cm broad and 4-20 cm tall, composed of a conical to cylindrical or subglobose cap and a supporting stalk; cap consisting of hymenial pits separated by sterile ridges, dark grey to pale buff; stipe cylindrical to subconical, hollow, paler than the cap, smooth

to coarsely pulverulent; asci operculate, iodine negative, cylindrical; ascospores ellipsoid, medium-sized, 18-25 μ long, smooth, not containing oil drops but often with several small oil drops clustered about each end; paraphyses cylindrical, stout, 9-11 μ thick; on soil, often in open grassy woodland; widely distributed in the temperate zone, very seasonal.

TYPE SPECIES: *Morchella esculenta* Pers. ex St. Ammans

Morchella elata Fr.

Fruiting body 3-5 cm broad and 13-17 cm high, dark brownish-grey; ribs lighter, running parallel up and down the cap; stipe pale buff, finely pulverulent; ascospores ellipsoid, 11-13 × 18-22 μ, smooth, not containing oil drops.

HABITAT: on soil.

SPECIMEN EXAMINED: *Mary Alt 1931,* wooded pasture along road from Cartago to Volcán Irazú, Cartago Prov., 2,600 meters, 17 June 1962.

15. PACHYELLA Boud. emend. Le Gal

Apothecia scattered to gregarious, medium-sized, 1-3 cm broad, discoid to shallow saucer-shaped, sessile and attached to the substrate to the extreme margin of the apothecium, or with a stout, gradually tapered base; hymenium dark brown to reddish brown, plane or slightly convex, often with irregular, shallow depressions; exterior, when visible, whitish; asci operculate, iodine positive, the entire ascus bluing, cylindrical; ascospore ellipsoid, large, 25-35 μ long, smooth or with faint sculpturing, containing one or two oil drops; paraphyses clavate, 7-8 μ thick; on very rotten, water-soaked wood at the margins of streams.

TYPE SPECIES: *Pachyella clypeata* (Schw.) Boud.

Pachyella taxonomic species 8. (Fig. 19)

Apothecia discoid, with a watery, translucent, obconic base, 1-2 cm broad; hymenium dark brown; base whitish, subgelationus, shrinking greatly on drying; ascospores ellipsoid, large, 13-15 × 24-28 μ smooth or with obscure, low, irregular warts, containing two oil drops which fuse to form one large central one.

HABITAT: on rotten wood in running water, known only from one collection.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1984,* along Pan American Highway 12 kilometers north of San Isidro, San José, Prov., 1,420 meters, 25 June 1962.

16. PEZIZA L. ex Hooker

Apothecia solitary to gregarious, medium-sized to large, 1-10 cm broad, cup-shaped to discoid, or becoming repand with age, sessile to substipitate, crisp-

fleshed, easily broken; hymenium usually some shade of brown, varying from black to pale buff, sometimes with overtones of yellow, green, blue, or purple; exterior usually paler, glabrous to pulverulent; asci operculate, iodine positive, their tips turning blue in iodine, cylindrical; ascospores ellipsoid to spherical, medium-sized to small, 10-22 μ long, smooth or sculptured, with or without oil drops; paraphyses filiform to clavate; on soil, wood, charcoal, and infrequently other substrates.

TYPE SPECIES: *Peziza vesiculosa* Bull. ex Fr.

Peziza trachycarpa Currey (Fig. 20)

= *Plicaria trachycarpa* (Currey) Boud.

Apothecia solitary to scattered, cup-shaped, up to 5 cm broad, dark purple-brown; ascospores spherical, 9-12 μ in diameter, covered with flat-topped warts, containing a single oil drop; paraphyses clavate to subcapitate.

HABITAT: on charcoal or burnt soil, world wide.

SPECIMENS EXAMINED: *Denison et al. 1920,* meadow near top of Volcán Poás, Alajuela Prov., 2,600 meters, 15 June 1962.

Peziza atrovinosa Cooke & Gerard (Fig. 22)

= *Aleurina atrovinosa* (Cooke & Gerard) Seaver

Apothecia scattered, shallow cup-shaped, up to 2 cm broad, dark brown to blackish; ascospores ellipsoid, 6-8 × 10-10 μ, covered with a network of anastomosing ridges, containing one or two oil drops; paraphyses slender, cylindro-clavate.

HABITAT: on charred wood or burnt soil, probably world wide.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1981,* along Pan American Highway 12 kilometers north of San Isidro, San José Prov., 1,420 meters, 25 June 1962.

Peziza taxonomic species 9. (Fig. 21)

Apothecia solitary to scattered, shallow cup-shaped, up to 3 cm broad; hymenium pale brown with orange tints; asci iodine positive, the tips bluing in iodine; ascospores ellipsoid, 10-11 × 21-24 μ, covered with flat-topped warts, with a larger, rounded wart or apiculus at each pole, containing one large oil drop; paraphyses slender, filiform, sinuous.

HABITAT: on rotten log, known only from a single collection.

SPECIMENS EXAMINED: *Campbell 1959,* along road from Cartago to Volcán Irazú, Cartago Prov., 2,600 meters, 22 June 1962.

Peziza taxonomic species 10. (Fig. 23)

Apothecia scattered, discoid to saucer-shaped, up to 5 cm broad; hyme-

nium pale brownish-grey; asci iodine positive; ascospores ellipsoid, 6-8 × 12-15 μ, covered with low, rounded warts, containing two oil drops; paraphyses straight, subclavate, containing fine granular material in their tips.

HABITAT: on a roadside bank.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1989, 1990,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,400 meters, 25 June 1962.

NOTE: This species resembles *Peziza praetervisa* Bres. in many respects, but differs in its straight paraphyses and in the substrate on which it grows.

Peziza taxonomic species 11. (Fig. 24)

Apothecia scattered, up to 2 cm broad, discoid, thick-fleshed; hymenium dark brown to black; asci iodine positive; ascospores ellipsoid, 10-11 × 18-20 μ, smooth, not containing oil drops; paraphyses subclavate, straight or slightly curved at their tips, with fragments of dark-colored material adhering to the tips.

HABITAT: on soil, known only from a single collection.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1991,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,300 meters, 25 June 1962.

NOTE: This collection is similar to *Peziza sepiatra* Cooke, a species known to the author only from published descriptions.

17. PSILOPEZIA Berk. emend. Le Gal

Apothecia solitary to scattered, medium-sized, 3-35 mm broad, discoid to slightly convex, adherent to the substrate to the extreme margin of the apothecium, often surrounded by a halo of light-colored hyphae, firm-fleshed to subgelatinous; hymenium brown to black or greyish; asci operculate, iodine negative, cylindrical, 15-25 × 300-400 μ; ascospores ellipsoid to oblong-ellipsoid, 18-25 μ long, smooth, containing two oil drops; paraphyses clavate, stout, up to 10 μ broad at their apices; occurring on wet, rotting wood, rarely on adjacent soil or stones, usually near streams and often partly submerged in water; world wide.

TYPE SPECIES: *Psilopezia nummularia* Berk.

Psilopezia nummularia Berk. (Fig. 25)

Apothecia 1-3 cm broad, firm-fleshed; hymenium dark brown to black; ascospores pointed-ellipsoid, 11-13 × 23-27 μ, smooth, containing 2-3 oil drops.

HABITAT: on rotten, water-soaked wood, world wide.

SPECIMENS EXAMINED: *Mary Alt 1907,* Finca La Selva, Puerto Viejo, Heredia Prov., 100 meters, 11 June 1962; *Dodge & Catt 5725,* tributary of Rio Siquirres, Limón Prov., 70-170 meters, 4 December 1929; *Dodge & Goerger*

10014, flood plain of Río Sándalo, Península de Osa, Puntarenas Prov., 1-10 meters, 22 August 1936.

Psilopezia babingtonii (Berk.) Berk. (Fig. 26)

Apothecia up to 1 cm broad, subgelatinous; hymenium pale buff to reddish brown; ascospores ellipsoid, 10-13 × 19-23 μ, smooth, containing one or two oil drops.

HABITAT: on rotten, water-soaked wood, world wide.

SPECIMENS EXAMINED: *Denison et al. 1936,* along road from Cartago to Volcán Irazú, Cartago Prov., 2,600 meters, 17 June 1962; *Denison, Jiménez, et al. 1970,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,360 meters, 23 June 1962.

18. SCUTELLINIA (Cooke) Lambotte

Apothecia solitary to gregarious, small to medium-sized, 1-25 mm broad, saucer-shaped to discoid or slightly convex, sessile, externally clothed with dark, bristle-like hairs; hymenium red to orange, rarely almost yellow, fading to white or buff when dry; hairs dark brown, stiff, pointed, heavy-walled, septate, 75-2,500 μ long, straight, unbranched, forked once to several times at the base and deeply rooted at several points in the underlying tissue; asci iodine negative, operculate, cylindrical, 10-30 × 200-300 μ; ascospores ellipsoid to spherical, medium-sized, 15-30 μ long, smooth or sculptured, containing one or two oil drops; paraphyses filiform to narrow-clavate, containing granules of orange pigment; occurring on rotting wood, bark, soil, charcoal, or dung; cosmopolitan.

TYPE SPECIES: *Scutellinia scutellata* (L. ex Fr.) Lambotte.

NOTE: This genus is represented in Costa Rica by a large number of species and varieties. Those treated below are among the more easily recognized, but there are many more. Most of the described species differ from one another chiefly in subtle differences in spore shape and sculpturing.

Scutellinia scutellata (L. ex Fr.) Lambotte (Fig. 27)

= *Patella scutellata* (L. ex Fr.) Morgan

Apothecia scattered to gregarious, 2-13 mm broad, saucer-shaped to discoid; hymenium scarlet to red-orange; hairs 200-900 μ, the longest ones at the margin of the hymenium, ascopores ellipsoid, 10-15 × 19-23 μ, covered with low anastomosing warts, containing one or more large oil drops.

HABITAT: usually on rotten wood, less often on soil or other substrates; cosmopolitan.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1994,* along Pan American Highway 75 kilometers north of San Isidro, San José Prov., 2,650 meters, 25 June 1962; *Denison, Jiménez, et al. 1967,* along Pan American Highway 30 kilometers north of San Isidro, San José Prov., 2,360 meters, 23 June 1962.

Scutellinia erinaceus (Schw.) Kuntze (Fig. 28)

= *Patella erinaceus* (Schw.) Morgan
= *Patella setosa* sensu Seaver

Apothecia gregarious to crowded, small, 2-3 mm broad, discoid to slightly concave; hymenium dull orange with overtones of yellow or brown rather than red; hairs 400-600 μ long; ascospores ellipsoid to cylindro-ellipsoid, 10-14 $\times$ 18-22 μ, smooth, containing one or two oil drops.

HABITAT: on rotten wood, temperate and tropical America.

SPECIMENS EXAMINED: *Denison, Jiménez, et al. 1979,* 8 kilometers north of Dominical, San José Prov., 300 meters, 24 June 1962.

Scutellinia asperrima (Seaver) Le Gal (Fig. 29)

= *Melastiza asperrima* (Ell. & Ev.) ex Seaver

Apothecia scattered to gregarious, 1-5 mm broad, discoid or slightly concave; hymenium orange-red to cinnamon; hairs scattered, 250-1,500 μ long; ascospores pointed-ellipsoid, often unequal-sided, 12-16 $\times$ 21-27 μ, covered with a network of anastomosing ridges which project at each end to form apiculi.

HABITAT: on rotten wood, Central America and Caribbean islands.

SPECIMENS EXAMINED: *Dodge & Thomas 4348,* above Río Cacao at Pejivalle Farm, Cartago Prov., 24 September 1929; *Dodge & Catt 5652,* west bank of Río Pacuare, Limón Prov., 10 October 1929.

RESUMEN

Se presenta un estudio preliminar de los ascomicetes operculados de Costa Rica, conocidos hasta la fecha abarcando las colecciones de Dodge y compañeros de 1929 a 1936 y las del autor y su grupo en 1962, con un comentario sobre métodos de recolección y estudio y una clave analítica para los géneros.

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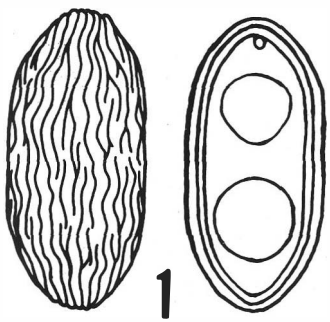
Figs. 1-6. Ascospores drawn from material mounted in Cotton Blue in lactic acid. Two spores of each species are shown; one in surface view, one in optical section. All drawings are at 1,500 ×. Fig. 1. *Cookeina sulcipes,* Fig. 2. *Cookeina tricholoma,* Fig. 3. *Phillipsia domingensis,* Fig. 4. *Phillipsia* tax. sp. 1., Fig. 5. *Sarcoscypha tetraspora,* Fig. 6. *Sarcoscypha* tax. sp. 2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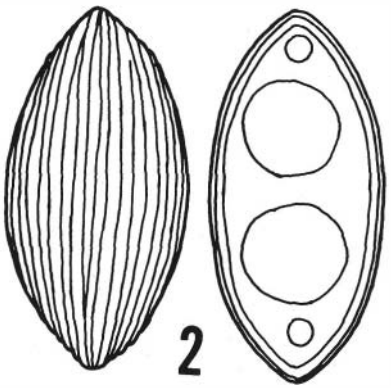
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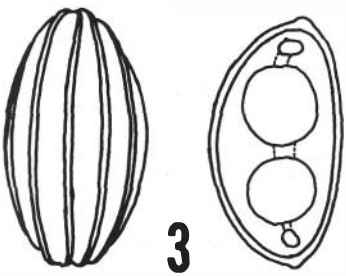
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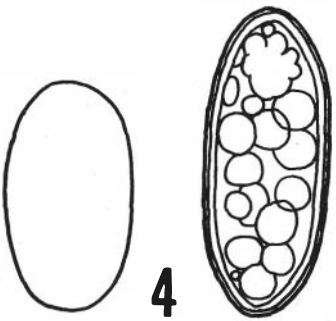
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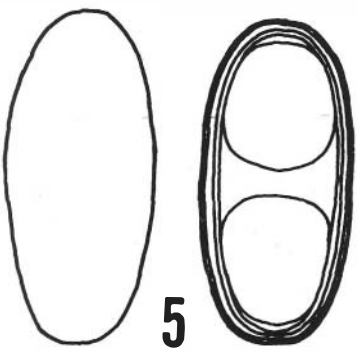
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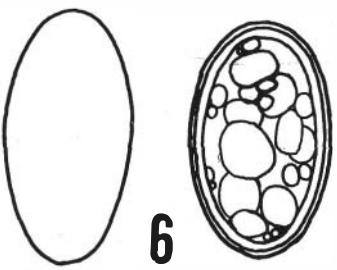
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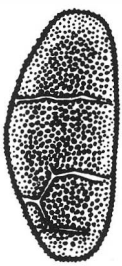
Figs. 7-12. Ascospores drawn from material mounted in Cotton Blue in lactic acid. Two spores of each species are shown; one in surface view, one in optical section. All drawings are at 1,500 ×. Fig. 7. *Saccobolus* tax sp. 3., Fig. 8. *Aleuria aurantia,* Fig. 9. *Aleuria rubra,* Fig. 10. *Aleuria* tax. sp. 4., Fig 11. *Ascophanus carneus,* Fig. 12. *Ascophanus* tax. sp. 5.



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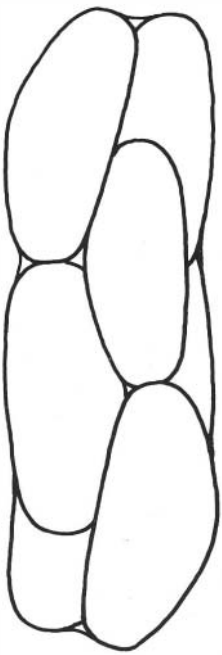

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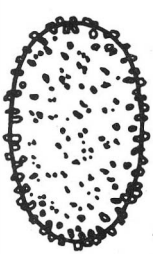

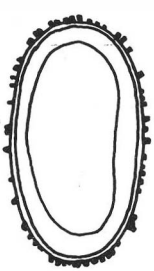

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Figs. 13-19. Ascospores drawn from material monted in Cotton Blue in lactic acid. Two spores of each species are shown; one in surface view, one in optical section. All drawings are at 1,500 ×. Fig. 13. *Barlaeina* tax. sp. 6., Fig. 14. *Humaria hemispherica,* Fig. 15. *Gyromitra* tax. sp 7., Fig. 16. *Cheilymenia coprinaria,* Fig. 17. *Cheilymenia theleboloides,* Fig. 18. *Lasiobolus ciliatus,* Fig. 19. *Pachyella* tax. sp 8.

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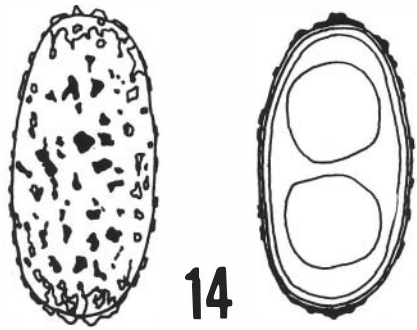

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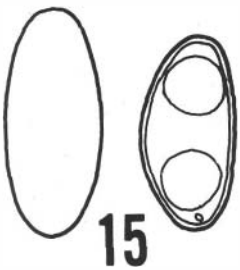

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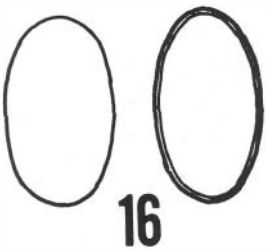

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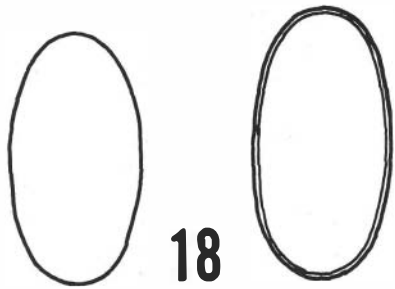

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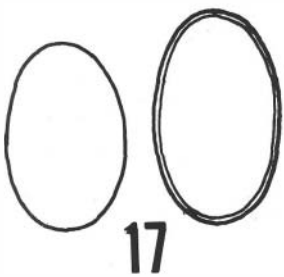

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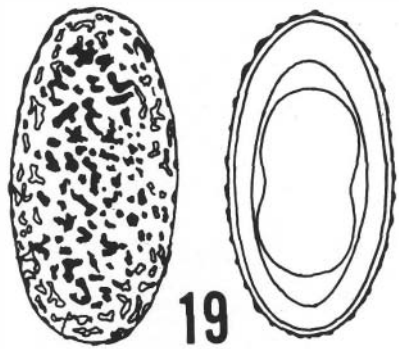
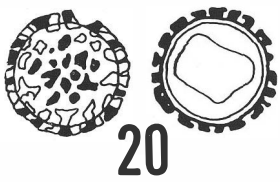


19

Figs. 20-26. Ascospores drawn from material mounted in Cotton Blue in lactic acid. Two spores of each species are shown; one in surface view, one in optical section. All drawings are at 1,500 ×. Fig. 20 *Peziza trachycarpa,* Fig. 21. *Peziza* tax. sp. 9., Fig. 22. *Peziza atrovinosa.* Fig. 23. *Peziza* tax. sp. 10., Fig. 24. *Peziza* tax. sp. 11., Fig. 25 *Psilopezia nummularia,* Fig. 26. *Psilopezia babingtonii.*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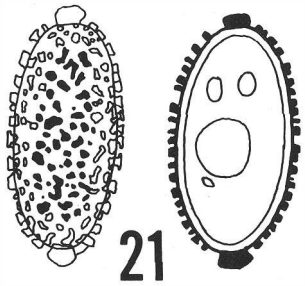
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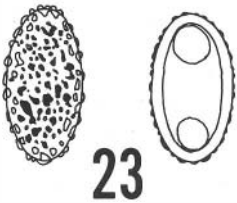
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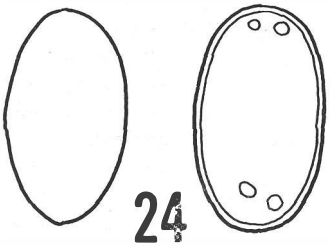
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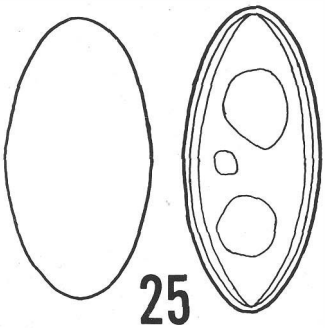
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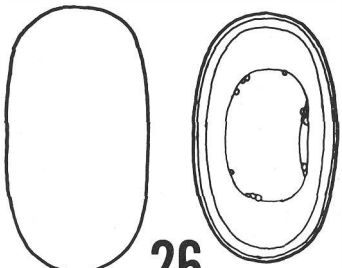
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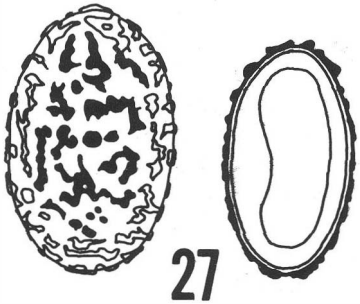
Figs. 27-29. Ascospores drawn from material mounted in Cotton Blue in lactic acid. Two spores of each species are shown; one in surface view, one in optical section. All drawings are at 1,500 ×. Fig. 27. *Scutellinia scutellata,* Fig. 28. *Scutellinia erinaceus,* Fig. 29. *Scutellinia asperrima.*



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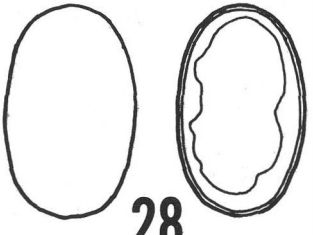

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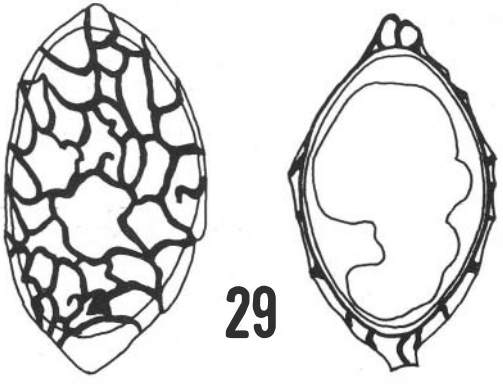

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