

STUDIES ON SECOTIACEOUS FUNGI IX THE ASTROGASTRACEOUS SERIES

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STUDIES ON SECOTIACEOUS FUNGI IX THE ASTROGASTRACEOUS SERIES

By

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CONTENTS

	PAGE
Introduction	1
Key to Genera	2
Hydnangium	3
Octavianina	7
Zelleromyces	18
Martellia	24
Gymnomyces	47
Elasmomyces	56
Cystangium	67
Arcangeliella	70
Macowanites	75
Discussion	94
Species Excluded	103
Literature Cited	105
Figures	106

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ROLF SINGER AND ALEXANDER H. SMITH*

The "Astrogastraceous Series" of genera consists of a number of Secotiaceae and related gastromycetous genera which Malençon (1931) has presented as a gradually degraded series starting from the Russulaceae (Agaricales) and becoming progressively less agaricoid at the hymenogastraceous level. As one reads the literature on these fungi one becomes aware of the fact that since the species and genera were originally described, very little has been added by way of new information on them that might lead to a clearer and more accurate classification of the taxa involved.

It was with the idea of attempting to get new information on the species of this group, that we took up the study of this series. We believed that the application of the methods now used so widely on *Lactarius* and *Russula*, if applied to the members of the series under consideration, would reveal much new information of real value in ascertaining relationships of the species involved and also enable the species to be more readily and accurately identified.

We wish it clearly understood that the treatment of the group presented in this paper is not offered as a monographic treatment. We have simply studied as many species as we could in the two years we have been collaborating on the problem of secotiaceous fungi in general. We do believe, however, that the series of species studied, over seventy in number, is large enough to clearly delimit the principal genera involved and also large enough to clearly indicate the trend of evolution in the group. As our investigation progressed it became abundantly clear that previous gastromycete specialists, such as Zeller and Dodge, by not using the characters considered important in *Russula* and *Lactarius*, missed much that was significant in the material they studied.

The results have exceeded our expectations. At the beginning of our study of the Secotiaceae we held opposite views on the direction of evolution and on the manner of origin of the Agaricales. Smith was inclined to the view that the Secotiaceae were derived from the agarics, a theory which has had rather wide spread acceptance in recent years. Singer held tenaciously to the theory that the Agaricales were derived from the Gas-

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teromyces. As a result of our different opinions on the trend of evolution, in our previous papers, (Singer & Smith 1958 a, b & c, 1959 a, b), we merely presented data on the genera and species involved. It was through Smith's persistence in the study of the species of *Arcangeliiella* and *Hydnangium*, particularly in working over the collections in the herbarium of S. M. Zeller, which are now at the New York Botanical Garden, that the data to recharacterize many of the species and genera presented here was obtained.

The data he obtained from this study convinced him that it is impossible to logically defend the thesis that the Astrogastreaeous Series is an evolutionary series leading from the agaric genera *Lactarius* and *Russula* to the Gastromycetes. Hence, in the discussion at the end of the presentation of our taxonomic data in the present paper, we have presented our opinions on the evolution of the Astrogastreaeous Series.

Many of the specimens reported on in this paper were collected in the field by Smith during his expeditions to collect Agaricales in the western United States. For financial support in this work he wishes to acknowledge help from the National Science Foundation, the Faculty Research Fund of the University of Michigan, and the field expedition fund of the University of Michigan Herbarium. Also, funds from the National Science Foundation and the publication fund of the University of Michigan Herbarium have helped to defray the cost of publication.

Definition of the Astrogastreaeous Series: As we define the genera which belong here they are characterized primarily by the context of the carpophore being composed of heteromerous tissue, and by the spores having typically an amyloid material covering all or part of the spore ornamentation. This definition holds until the *Hydnangium-Octavianina* level is reached. Here we begin to find examples in which the context of the gastrocarp contains only scattered sphaerocysts rather than the latter occurring in bunches, and the spore ornamentation is seen to become progressively less amyloid until species are encountered with inamyloid spore-ornamentation and scarcely any sphaerocysts in the tissues. At this level clamp connections finally occur, and similarities to other lines of agarics, such as *Laccaria* become apparent.

KEY TO THE GENERA OF THE ASTROGASTRACEOUS SERIES

1. Spore deposit not obtainable, the spores not forcibly discharged from the sterigmata 2
1. Spore deposit readily obtained as in most Hymenomycetes 10
 2. Spore ornamentation inamyloid 3
 2. Spore ornamentation amyloid at least in some part 4
3. Clamp connections present; spore ornamentation in the form of warts and spines with free tips *Hydnangium*
3. Clamp connections absent; latex present or absent *Octavianina*

4. Stipe-columella absent as such, the sterile column reduced to a basal area of tissue with branches extending into the gleba from it (these may or may not reach the peridium); or no interior sterile structures present other than tramal plates..... 5
4. Stipe-columella well defined; gleba usually exposed at base of peridium (at the margin and on under side) and in age often separating from columella 7
5. Fresh specimens exuding a latex when cut..... *Zelleromyces* 6
5. Latex absent..... 6
6. Mediostratum of tramal plates containing sphaerocysts..... *Gymnomyces*
6. Mediostratum of tramal plates lacking sphaerocysts..... *Martellia*
7. Latex present in fresh specimens..... *Arcangeliiella*
7. Latex absent..... 8
8. Mediostratum of tramal plates lacking sphaerocysts..... *Elastomyces*
8. Mediostratum with at least scattered sphaerocysts..... 9
9. Cuticle of peridium of large pseudoparenchyma-like cells; leptocystidia typically present in hymenium..... *Cystangium*
9. Cuticle of peridium various and hymenial cystidia mostly of the pseudocystidial and macrocystidial types (as in *Russula*)..... *Macowanites*
10. Latex present..... *Lactarius*
10. Latex absent..... *Russula*

HYDNANGIUM Wallroth

In Dietr. Flor. Boruss. [Flor. Königr. Preuss.] VII p. 465. 1839.

Gastrocarp globose to irregular, lacking a columella and or a sterile base; gleba chambered; latex absent; spores inamyloid; hyphae with clamp connections; sphaerocysts present or absent.

Type species. *Hydnangium carneum* Wallr.

This is to be regarded as the most primitive genus in the Astrogasteraceous Series, because of the clamped hyphae and essentially non-amyloid spores. In checking the amyloid reaction on the spore ornamentation a lens of 1.3 N.A. was used, with, of course, the condenser immersed. The objective was a B. & L. apochromatic lens. With this system no amyloid reactions were visible on isolated spines in the mount, but only faintly on spines in place on the spores where it was difficult to exclude a slight shadow effect.

There has obviously been confusion in regard to species concepts and we are not in a position at present to even guess as to how many species may actually be hidden under the name *H. carneum*, but there have been more than one. All we can do now, as far as the genus is concerned is to present our studies as far as we have been able to carry them to date. As of this writing we believe we can recognize four species in the genus. The following redescriptions are based on a study of authentic material, as indicated, as far as such was available.

KEY TO SPECIES

1. Spores pseudo-amyloid..... 1. *H. nigricans*
1. Spores hyaline to yellowish in Melzer's reagent..... 2
2. Context of peridium showing scattered sphaerocysts..... 2. *H. soderstroemii*
2. Context of peridium lacking sphaerocysts..... 3
3. Oleiferous hyphae present..... 3. *H. roseum*
3. Oleiferous hyphae none..... 4. *H. carneum*

1. *HYDNANGIUM NIGRICANS* Kalchrenner, Grevillea 10:107. 1882.

Figs. 1-2.

Gastrocarps 15×20 mm, depressed-globose, smooth, black when dried; gleba ochraceous tawny, pale cinnamon as dried, cavities small and filled with spores; columella and sterile base lacking as far as known.

Spores $12-19 \mu$, globose, pale tawny to pale ochraceous in KOH (pigment fading somewhat on standing), rusty-brown (pseudo-amyloid) in Melzer's reagent; ornamentation in the form of broad cones about $1.5-2 \times 1-2 \mu$; so closely arranged as to touch each other on all sides but not fused, their walls either not at all or only very inconspicuously striate; plage area not differentiated; sterigmal appendage seldom showing.

Hymenium. Very poorly revived in material available for study. "... Basidia $30 \times 11 \mu$ "—Dodge and Zeller (1936) p. 592.

Hyphal layers. Subhymenium gelatinous—disintegrating, hyaline; mediostratum apparently of broad ($7-11 \mu$) interwoven hyphae which also disintegrate readily. Oleiferous hyphae $8-12$ (15) μ broad present and staining brightly in phloxine. Epicutis of peridium of rusty brown thin-walled hyphae more or less interwoven and progressively with less pigment interiorly, the cut ends giving a cellular appearance. Context of interwoven hyaline hyphae and oleiferous hyphae. *Clamp connections present.*

Under Acacia, grassy area, near Somerset, East C.R.S. Feb. 1876. leg. Macowan (type) (Zeller Herb., NY).

In the portion of the type in the Zeller collections at New York only the oleiferous hyphae, the presence of clamps, and the spores could be critically studied. The spores are paler in color than those of *Octavianina nigrescens* but of the same tone and in addition are pseudoamyloid. *H. nigricans* appears to be a species closely related to *O. nigrescens* but differs in the presence of clamp connections.

2. *HYDNANGIUM SODERSTROEMII* Lagerheim in Patouillard et Lagerheim, Bull. Soc. Myc. France 9:142. 1893.

Fig. 3.

Gastrocarp 3-4 cm broad; globose to subglobose, strongly gibbous, rounded above, flattened below, base attenuate, short; peridium thin, evanescent, flesh-reddish; gleba pallid whitish-incarnate; chambers sinuous, small 0.25 mm long, empty, tramal plates somewhat thickened, radiating from the base. Basidia $70 \times 8-10 \mu$, 2-spored, subcylindric, cystidia none; spores globose, $12-15 \mu$ in diam., echinate, warts obtuse, short, thickish.

A portion of the type in the Zeller Herbarium was studied and the following data are here reported.

Spores $10-15 \mu$ in diam., globose, wall $1.5-2 \mu$ thick, ornamentation about 2μ high in the form of cones 2μ broad at base, wall and cones not amyloid (possibly with a slight amyloid reaction around the base of the spines); elements of ornamentation readily deciduous; sterigmal appendage conspicuous as a broken filament with undulating walls.

Hymenium. Basidia 1-, 3-, but mostly 2-spored, $45-66 \times 9-11 \mu$ without sterigmata, mostly remaining partly collapsed but sterigmata clearly evident. Cystidia absent or if present resembling 1-spored basidia, rare.

Hyphal layers. Tramal plates of interwoven hyphae, some sphaerocysts observed in slightly crushed sections; subhymenium remaining indistinct (apparently of compactly interwoven hyphae). Epicutis of peridium of interwoven appressed hyphae. Context of interwoven hyphae and some sphaerocysts. Clamp connections present.

A study of the type of *Octaviania stillingeri* Lloyd gave data identical to that of the type of *H. soderstroemii* except for the shorter basidia ($30\text{--}40 \times 9\text{--}11\ \mu$). We believe that *H. stillingeri* is properly placed in synonymy with *H. soderstroemii* as has been proposed by other authors. The difference in the length of the basidia might possibly be significant, but this would have to be established by studies of ample specimens in the fresh state. The pale incarnate tint to the gleba indicates a close relationship to *H. carneum*, but the presence of sphaerocysts in the context of the peridium indicates a slight progression toward the more clearly defined portion of the *Astrogastraceus* Series.

We are recognizing *H. soderstroemii* as a distinct species from *H. carneum* because of confusion as to the true concept of *H. carneum* and the fact that we have actually studied the type of *H. soderstroemii* and demonstrated the important characters as these are given in this work. If indeed the true *H. carneum* does have sphaerocysts in the peridium, the question of whether *H. soderstroemii* is a synonym will have to be reviewed again, but as of this writing we would assign all the collections as indicated in our key. Hesse's account of the anatomy of the peridium of *H. carneum* did not indicate the presence of sphaerocysts, which, again, is in line with the data taken from Murrill's collection of the latter.

3. *HYDNANGIUM roseum* (Harkness) Singer & Smith comb. nov.

Octaviania rosea, Harkness, Bull. Cal. Acad. Sci. 1:29. 1884.

Arcangeliiella rosea (Hark.) Zeller & Dodge, in Dodge, Ann.

Mo. Bot. Gard. 18:462. 1931.

Fig. 4.

"Gregarious, peridium fibrillo-rugose, irregularly lobed, 1-3 cm in diam., with distinct absorbing base, pale rose color, deepening within; basidia 1-, 2-spored; sterigmata filiform, capitate, as long as the diameter of the spore; spores globose, hyaline, pale, epispore covered with short, obtuse spines, 14-17 μ ."

"Under shrubby oaks, at Golden Gate Park, San Francisco, Calif. January" (quoted from Harkness, p. 252, 1899).

The specimen studied was collected by Harkness at San Francisco and distributed as No. 3238 in Rabenhorst-Winter, *Fungi Europei*. The following data were obtained from it:

Spores globose, 10-15 μ ; sterigmal appendage a short or long (depending on where the sterigma breaks) filament, with parallel walls that are thin, hyaline and non-amyloid; spore wall 1.5(2) μ thick, inamyloid (yellow in Melzer's reagent), ornamentation essentially inamyloid, consisting of pointed cones 1.3-1.8(2) $\times$ 1.3-2 μ , cones separate but closely spaced, after standing in Melzer's reagent for about a half hour a slight darker spot, almost shadow-like could be seen on some cones near apex, (so there is a possibility of a very slight amyloid reaction there).

Hymenium. Basidia $26-24 \times 10-13 \mu$, almost oval when young, 2-spored (rarely 1-spored), readily collapsing; sterigmata conic before spore forms, then the wall parallel in upper part and base enlarged, $9-12 \mu$ long overall and $2-3 \mu$ wide at base. Basidioles $18-20 \times 10 \mu$, basidia project strongly above them when sporulating. Cystidia none unless some 1-spored basidia actually remain sterile.

Hyphal layers. Tramal plates of interwoven filaments $4-11 \mu$ diam. and with hyaline walls; no sphaerocysts found (sections revived very well); subhymenium appearing cellular from broad ends of cut hyphae—about the diameter of the base of the young basidium; no true sphaerocysts seen in the layer. Epicutis of peridium of appressed-interwoven, hyaline, hyphae not sharply differentiated from the filamentous context; clamp connections present; no sphaerocysts or laticiferous hyphae seen; oleiferous hyphae present.

We here maintain Harkness's species as distinct from *Hydnangium soderstroemii* because of the lack of sphaerocysts in the peridium and tramal plates, and the shorter broader basidia. There is no question but that the two species are very closely related, but lacking critical studies of fresh gastrocarps, we cannot be sure at present that there are not other differences, not now apparent. It is clear from the material in the Zeller Herbarium (NY) that more than one species was included under the name *Arcangeliiella rosea*.

4. *HYDNANGIUM CARNEUM* Wallr. in Dietr. Flor. Boruss. [Fl. Königr. Preuss.] VII p. 465. 1839.

Fig. 5.

Gastrocarp $10-25$ mm broad, occasionally larger (± 35 mm), globose to depressed or variously irregular, dull reddish when young, later shining and flesh-color; with a rather strong basal attachment of mycelium, rhizomorphs not present. Gleba at first fragile becoming fleshy; dull reddish young, later flesh-colored, chambers rather spacious and, especially in the center, quite irregular in form; columella none, sterile base present as a mycelial tissue-like pad at point of attachment.

Spores $11-15 \mu$ diam., globose, hyaline in KOH, pale yellow in Melzer's reagent and ornamentation inamyloid; ornamentation in the form of pointed cones $1.7-2.2 \mu$ high and $1-1.7 \mu$ at base, separate but often touching at their bases; spore wall $0.8-1.3 \mu$ thick; sterigmal appendage short and inconspicuous; plage area not different from remainder of surface.

Hymenium. Basidia 2-spored, $40-52(65) \times 10-13 \mu$, narrowly clavate to subcylindric, thin-walled, readily collapsing, basidioles also readily collapsing. Cystidia none. Pseudoparaphyses none.

Hyphal layers. Subhymenium of hyphae $5-10 \mu$ broad, compactly arranged but thin-walled and delicate, collapsing readily, giving a cellular appearance in sections but basic arrangement not clear from dried material; mediostrium of interwoven hyaline smooth, thin-walled hyphae $6-12 \mu$ diam., the cells somewhat inflated and readily collapsing, no sphaerocysts seen. Epicutis of pileus of thin-walled hyaline hyphae $3-8 \mu$ diam. and readily collapsing, the zone not distinctly separated from context. Context of interwoven hyaline hyphae $5-12 \mu$ diam., very delicate and readily

collapsing; sphaerocysts none; oleiferous hyphae none. Clamp connections present.

Jamaica, Dec. 25, Jan. 8, 1908-09, W. A. Murrill. (NY).

The above is a composite description of macroscopic characters taken from Hesse's account of the species in Europe and microscopic data taken from Murrill's collection. This was done because all the available data on microscopic characters as given by Hesse also checked with those of the Murrill collection—in other words, as near as we can tell, the latter is correctly identified. Murrill's material was abundant, well dried and is in a good state of preservation at present. No. 109, *Octaviania carnea*, of de Thümen, Mycolthea universalis, leg. L. Becker, Breslau, 1873 has spores exactly as in Murrill's collection but there was not enough peridium present for a critical study. Hence we used Murrill's collection.

We suspect that this species is not referable to the Astrogastreaeous Series, or if so, it is at a level where several lines traceable up to the agarics diverge. On the sum total of all its characters including the color of the tramal plates when fresh, the hyaline non-amyloid, strongly echinate spores, long basidia and broad hyphae of the mediostratum of the tramal plates, this species resembles what one would expect to find in a gastroid *Laccaria* and a true relationship, in our estimation, is highly probable.

H. roseum is not really very distinct from *H. carneum*, but for the time being we recognize both on the presence or absence of oleiferous (or laticiferous?) hyphae, the character which Zeller and Dodge used to place *H. roseum* in *Arcangeliiella*.

OCTAVIANINA O. Kuntze

Rev. Gen. Pl. 3²:501. 1898.

Gastrocarp globose to irregular, usually less than 5 cm broad; peridium typically unpolished, thin, tissue with or without sphaerocysts, epicutis not clearly defined; gleba chambered; columella reduced to a sterile base or none; spores non-amyloid or essentially so, usually pseudo-amyloid, ornamentation typically coarse; clamp connections absent; latex present or absent.

Type species. *Octavianina asterosperma* (Vitt.) O. Kuntze.

We are inclined to agree with Zeller and Dodge (1936) that since Vittadini indicated that *Octaviania asterosperma* is aberrant in his genus *Octaviania*, it is undesirable to regard it as the type species for that genus. Following the proposal of Zeller and Dodge to consider *O. variegata* Vitt. as the type of *Octaviania*, and this appears to be the most logical procedure, the name *Octaviania* goes into synonymy under *Melanogaster*. By selecting *Octavianina asterosperma* as the type of Kuntze's genus, the latter becomes meaningful as a genus near the gastromycete end of the Astrogastreaeous Series.

It is in this group of species that we believe the two lines, one leading to *Russula* and the other to *Lactarius*, diverge. It is significant that at this stage the spores for all practical purposes are inamyloid but that sphaerocysts are present in the mediostratum of the tramal plates and in the peridium of some species. Thus *Hydnangium* is to be regarded as

even more primitive, since, in addition to the reduction in sphaerocysts, clamp connections are present.

In this group of species, based largely on the coarse ornamentation of the spores, their pseudoamyloid reaction, and the absence of clamp connections on the hyphae of the gastrocarp, we note the primitive nature of the heteromerous tissue—sphaerocysts present in the peridial context in *some* of the species but these elements not in nests or groups—and the first demonstratable signs of the presence of amylaceous material on the spore ornamentation. Also the spore color in KOH is generally darker than found in the Russulaceae—usually cinnamon buff to pale tawny. A feature we believe is very important from the standpoint of evolution. A further feature of the spores of a number of the species is the presence of longitudinal striations on the elements of the ornamentation. In *O. nigrescens* the warts are of a primitive (relatively generalized) type with conspicuous striations whereas in species with more perfectly formed warts and spines, the striations are less conspicuous.

A second interesting feature is the number of species which show significant color changes when bruised. Agaric specialists have, of course, long been cognizant of the importance of these color changes in the recognition of species, but in the gastromycete literature such changes have not had the attention they deserve. This, again, re-emphasizes the need to study critically hypogeous gastromycetes in the fresh condition just as is now generally done with species of the Agaricales.

The absence of clamp connections on the hyphae of the gastrocarp is the deciding character separating *Octavianina* from *Hydnangium*. Thus *H. nigricans* appears to be a borderline species, since it has the pseudoamyloid spores of *Octavianina*, but is placed in *Hydnangium* because of the clamp connections. It is also interesting to note that in this group, where the diagnostic characters of the Russulaceae are found in a primitive, generalized state, that the peridium shows consistently a relatively undifferentiated type of structure, namely the lack of a specialized epicutis.

KEY TO SPECIES.

1. Spores $17-23 \times 12-15 \mu$, ornamentation as spines $1-1.5 \times 0.5 \mu$, yellowish in Melzer's reagent..... 5. *O. macrospora*
1. Spores smaller and globose to subglobose..... 2
2. Spore ornamentation in the form of both ridges and warts..... 6. *O. flava*
2. Spore ornamentation as distinct warts and spines..... 3
3. Gastrocarps white when fresh, soon blackening where handled or bruised..... 4
3. Gastrocarps not blackening as above..... 5
4. Context of peridium containing sphaerocysts.... 7. *O. asterosperma* var. *potteri*
4. Context of peridium entirely of filamentose hyphae..... 8. *O. nigrescens*
5. Cystidia present in the hymenium..... 6
5. Cystidia absent from hymenium..... 7
6. Latex absent..... 9. *O. rogersii*
6. Latex present..... 10. *O. papyracea*
7. Gastrocarp warty to uneven, white, becoming yellow where handled 11. *O. tuberculata*
7. Not as above..... 8
8. Pseudoparaphyses with thickened walls; gastrocarp white, becoming red when injured..... 12. *O. lutea*

8. Not as above..... 9-
 9. Surface of gastrocarp loosely fibrillose and yellowish white; peridium breaking up into small patches..... 13. *O. lanigera*
 9. Gastrocarp smooth and silky, continuous, whitish but slowly becoming brownish..... 14. *O. laevis*

5. OCTAVIANINA **macrospora** Singer & Smith sp. nov.

Fig. 6

Carpophoris circa 1 cm latis, subalbis, glabris; gleba pallida, locellis minutis irregularibusque; sporis $17-23 \times 12-16 \mu$, ellipsosideis, subochraceis, inamyloideis, echinatis. Specimen typicum legit prope "Twin Bridges Forest Camp" Clackamas Co., Oregon. August 9, 1937, D. P. Rogers (NY).

Gastrocarp about 1 cm diam. white when fresh, gray as preserved in liquid, glabrous; gleba of open chambers, presumably white when fresh; sterile base present and concolor with gleba as preserved.

Spores $17-23 \times 12-16 \mu$, broadly ellipsoid, inner wall $1.5-2 \mu$ thick; pale buff in KOH and pale ochraceous in Melzer's reagent; sterigmal appendage sometimes conspicuous, often slightly irregular in outline, hyaline-yellowish in Melzer's sol.; ornamentation in the form of short spines $1-1.5 (2.5) \times 0.5 \mu$ entirely non-amyloid (pale yellowish throughout in Melzer's solution), the elements distinct but often touching at their bases.

Hymenium. Basidia 1-, and 2-spored, $29-37 \times 10-13 \mu$, clavate, thin-walled, content granular and ochraceous in KOH. Basidioles numerous. Cystidia none.

Hyphal layers. Subhymenium appearing cellular in section from the cut ends of hyphal branches, hyphae about the diameter of the base of the basidium, 1-2 cells below the cross wall cutting off the basidium the cells enlarging in age to sphaerocyst proportions; mediostratum filamentous, the cells of the filaments scarcely enlarged, walls thin and hyaline, no sphaerocysts present. Epicutis of peridium a collapsed turf of clavate to cystidioid cells $18-27 \times 4-8 \mu$ or $20-30 \times 3-5 \mu$ if fusoid. Context of hyaline interwoven subgelatinous (in KOH) hyphae $3-6 \mu$ diam., no sphaerocysts or oleiferous hyphae in the layer. Clamp connections none.

Under hemlock, Twin Bridges Forest Camp, Clackamas County, Oregon, August 9, 1937. Coll. D. P. Rogers. Identified questionably as *Hydnangium album* by Zeller (Zeller Herb., NY).

The spores remind one of those of *Martellia ellipsospora* but have thicker walls and are completely inamyloid. The turf of cystidioid elements as the epicutis of the gastrocarp of *O. macrospora* is a further important distinguishing character.

6. OCTAVIANINA **flava** (Rodway) Singer & Smith comb. nov.

Gymnomycetes flavus Rodway, Papers & Proc. Royal Soc. Tasmania 1917:110. 1918.

Fig. 14.

Gastrocrops 1-2 cm diam., drying dull buff (near "pinkish buff"), surface unpolished (as dried) and with bits of imbedded debris, surface showing the outline of the glebal chambers—hence peridium very thin; gleba chambered, chambers irregular in shape and almost filled, near-

cinnamon buff in color, no columella or veins visible in the specimen studied.

Spores 9-12(14) μ (less ornamentation), yellowish-hyaline in KOH, pale orange-brown in Melzer's reagent (*not* dark brown), ornamentation in the form of short, broad, ridges and crests often irregular in outline and with some isolated warts, height of large warts 1-2.3 μ high, 1-2 μ broad at base, ridges about 1 μ thick and 5-10 μ long, typically inamyloid but some shadow-like local areas seen along the crest of some ridges or near the apex of some warts (usually only on one side); sterigmal appendage inconspicuous.

Hymenium. Basidia 26-33 $\times$ 10-15 μ clavate, none seen with sterigmata, thin-walled, readily collapsing. Cystidia rare, clavate to narrowly fusoid ventricose, 34-48 $\times$ 7-12 μ , content homogeneous or with some refractive material.

Hyphal layers. Subhymenium of filaments 7-10 μ broad, many-septate (hence subhymenium appearing cellular in section). Mediostratum of heteromorous tissue, mostly of large sphaerocysts. Peridium of heteromorous tissue; epicutis not clearly revived but apparently filamentous; laticiferous hyphae none. Clamp connections none found after careful observation.

Material studied. Rodway No. 1276, Wedge Bay, Tasmania, and No. 090 (Lloyd colls.) by L. Rodway, Hobart, Tasmania. Both from the Zeller Collections (NY).

We regard this at present as a valid *Octavianina* because of the clearly heteromorous tissue and essentially non-amyloid spore ornamentation. As far as could be ascertained the epicuticular zone is not cellular. The specimen used in our study could by no means be construed as young, except for its size. All the elements of the sterile tissues were completely expanded, and the collapsed basidia and abundant spores are additional evidence for judging the specimen as past maturity.

Our macroscopic data are taken from the specimen studied, except for size, because there is always the chance that the type collection contained several species. There is no doubt in our minds as to the desirability of removing this species from *Arcangeliella*, and we feel confident it is not synonymous with *Arcangeliella tasmanica*. If the type of the latter is actually lost the name should be discarded.

We place this species along side of *O. asterosperma* because of basic similarities in the spore ornamentation and structure of the peridium.

7. OCTAVIANINA ASTEROSPERMA (Vitt.) O. Kuntze, Rev. Gen. Pl. 3²:501. 1898. var. *potteri* Singer & Smith var. nov.

Fig. 9.

Sporis inamyloideis; latice nullis. Specimen typicum legit prope Ithaca, Mich. Sept. 17, 1949, V. Potter 8898 (MICH.).

Gastrocarp 1-3.5 cm diam., roughly ellipsoid to globular in shape, surface glabrous, unpolished and dull grayish brown in darker areas, paler to pallid elsewhere as dried, white when fresh, blackening when handled; gleba watery white, drying rusty brown, chambers somewhat radially arranged; columella present as a pulvinate sterile base; attached by a small padlike stem.

Spores 12-16(18) μ in diam., including ornamentation, ornamented with large conic to blunt warts $2.5-3.5 \times 2-3 \mu$, their walls yellowish in KOH and tawny to red-brown in Melzer's reagent, no distinct amyloid spot or area anywhere; sterigmal appendage a filament 4-8 μ long, 3 μ wide and thin-walled.

Hymenium. Basidia 26-34 $\times$ 11-16 μ , clavate, sterigmata short, 2-, or 3-spored (possibly some 4-spored). Cystidia or conidiophores (36-) 44-66 (-80) $\times$ 8-15 μ , the long ones are the narrowest, ventricose at base and with a long neck often irregular in outline, thin-walled, hyaline in KOH.

Hyphal layers. Mediostratum of tramal plates a broad band of sub-parallel to slightly interwoven hyphae 6-10 μ diam. and with sphaerocysts up to 25 μ scattered in it especially where plates branch; hymenopodium about 2 strands of parallel hyphae which are hyaline and thin-walled and give rise to diverging branches 2-3 cells long (the subhymenium) with the basidium arising as the terminal cell. Peridium as revived in KOH with ochraceous-walled filaments forming a thin epicutis of appressed hyphae; context of hyaline heteromerous tissue. Clamp connections absent.

On exposed soil along a logging road in rich heavy soil (mud), Ithaca, Michigan, Sept. 17, 1949, Victor Potter 8898, (MICH).

The elements of the spore ornamentation do not show any truly distinct amyloid spot at or near their apices. The elements are actually readily deciduous and with a little pressure on the cover glass can be broken off and studied in detail. The wall is pseudoamyloid clear to the apex in most warts and spines, and in others the intensity of the color diminished to yellowish, but in no case was a bluish spot or zone present. In observations on spores with the ornamentation in place, shadows occasionally give the effect of a dark spot, and at first these were regarded as possible amyloid areas.

The basidia with sterigmata showed small, rather narrow sterigmata, much narrower than the "sterigmal appendage" seen on many spores. This posed a question: Were some of the spores actually conidia instead of basidiospores? We suspect this to be true but were unable to demonstrate a spore attached to the apex of one of the "cystidia" or any other hymenial element. We consider it significant, however, that the width of the neck of the cystidia seen, and the thickness of the wall, corresponds to the same characters as observed on the sterigmal appendage of the spores.

Zeller & Dodge indicate a latex for *Arcangeliella asterosperma* var. *asterosperma*, but the Potter collections did not show one. This character and the completely inamyloid spores are the characters by which variety *potteri* is recognized.

8. OCTAVIANINA **nigrescens** (Zeller) Singer & Smith comb. nov.

Hydnangium nigrescens Zeller. Mycologia 40:641. 1948.

Fig. 8.

Gastrocarp 25-40 $\times$ 10-30 mm, subglobose to oblong or irregular, attached by a single rhizomorph, surface soft, glabrous, with some innate veins especially below, white, soon blackening, drying fuscous brown; gleba cinnamon brown, drying a slightly darker brown but remaining distinctly cinnamon, cavities distinct, "empty", columella and sterile base none.

Spores $12-16.5 \times 10-14 \mu$, globose to broadly ellipsoid, with a thick inner wall (about 2μ thick) which is *tawny* in KOH and Melzer's; exterior to this is a second layer which is also colored (pale tawny to ochraceous-tawny in KOH and Melzer's) and which is irregularly areolate-cracked into a number of large irregular warts with numerous fine striations; plage area not distinctive; sterigmal appendage short and typhal-like.

Hymenium continuous. Basidia $20-24 \times 10-14 \mu$, short-clavate, hyaline, thin-walled, readily collapsing, 2-, 3-, and 4-spored; sterigmata straight, irregular and often hyphal-like, (typically gastroid); spores borne acropetally. Pseudoparaphyses numerous, $12-18 \times 10-15 \mu$, hyaline, thin-walled. Cystidia none.

Hyphal layers. Subhymenium of branched filaments $4-7 \mu$ diam. and subgelatinous as revived in KOH, hyaline and thin-walled; mediostratum of subparallel-interwoven non-gelatinous hyphae with thin smooth walls and hyphal cells equal in diameter or slightly inflated ($3-12 \mu$ diam.), no sphaerocysts present. Epicutis of peridium of appressed rusty brown hyphae (in KOH) $3-7 \mu$ diam. rather closely interwoven. Context of interwoven hyaline hyphae about like those of the mediostratum of the tramal plates. Clamp connections none. Laticiferous or oleiferous hyphae none.

Partially exposed, on ground in mixed woods. Near Ithaca, New York, Tompkins County. Rogerson 1615, type (NY).

The type has been studied and appears to us to be an extreme spore-type in the genus *Octavianina*. The fine striae on the elements of the ornamentation in this species find their counterpart on the spores of such species as *O. lutea*, *O. laevis*, and *O. lanigera*. The color change of the fresh peridium is not out of line with that of *O. asterosperma*, and the color of the dried gleba is typical for the genus. The most interesting feature is the high degree of pigment development in the spores. If one has not studied the spores of the other species of the genus, he is likely to insist that by spore color this species is more properly referred to the series of *gastromycetes* connected to the *Cortinariaceae* of the *Agaricales*, but the structure of the outer wall is anomalous for this group. Actually, the spore color is merely a darker tone of the same type as observed for most others of the genus in which the tint ranges from hyaline to cinnamon buff in the darkest spores.

9. *OCTAVIANINA rogersii* Singer & Smith sp. nov.

Figs. 7 & 22.

Carpophoris $1-2.5$ cm latis, subglobosis, albidis, impolitis, demum areolatis; gleba cinnamomeo-alutacea, locellis minutis; sporis $14-19 \mu$, subglobosis; pseudocystidis $60-80 \times 7-11 \mu$. Specimen typicum legit prope Woods Creek, Benton Co. Oregon, U.S.A., 24 Mai 1939, D. P. Rogers (NY).

Gastrocarp $1-2.5$ cm broad, globose to subglobose, flattened or quite irregular in outline, white when fresh and drying whitish to pale buff, surface unpolished as dried; peridium continuous or at times breaking into a number of lobes and gleba exposed above (not at base in any specimens seen so far). Gleba of minute chambers and drying nearly

"cinnamon buff", not of a gelatinous consistency. Columella as seen in dried material rudimentary to lacking, when present consisting merely of thin short lines of sterile tissue and not percurrent. Stipe absent.

Spores subglobose, 14-19 μ diam., wall about 2 μ thick and pale orange-yellow in Melzer's reagent; sterigmal appendage absent to very inconspicuous and its walls thin and parallel (hyphal-like); ornamentation in the form of distinct rods and spines 1.5-3 $\times$ 0.6-1 μ , typically *pale yellow* in Melzer's reagent (spores from dried specimens) but a few seen with a distinct small bluish spot in upper half or at apex (for taxonomic purposes non-amyloid), the spines closely arranged but separate, no distinct plage area showing.

Hymenium. Basidia 42-56 $\times$ 10-15 μ , clavate, 1-spored, thin-walled, hyaline. Basidioles numerous, 30-38 $\times$ 9-11 μ . Pseudoparaphyses present as broadly inflated basidioles (10-15 μ broad), thin-walled, hyaline, readily collapsing. Cystidia scattered, 60-80 $\times$ 7-11 μ , narrowly clavate to narrowly fusoid, some with refringent rods and granules in interior, arising from oleiferous hyphae, thin-walled, hyaline in KOH.

Hyphal layers. Subhymenium of slightly enlarged to sphaerocyst-like cells, hyaline, thin-walled; mediostratum of filamentose hyphae with some oleiferous hyphae and some scattered sphaerocysts, all hyaline in KOH. Epicutis of peridium continuous with context and of appressed-interwoven narrow (2-4 μ) hyaline thin-walled smooth hyphae. Context mostly of interwoven filamentous hyphae but some sphaerocysts present near subhymenium. Clamp connections absent.

Under Douglas fir, Woods Creek road, Western Benton County, Oregon, May 24, 1939. Coll. D. P. Rogers.

This collection reminds one strongly of *Martellia monticola* but is at once distinguished by the essentially non-amyloid spores. The large 1-spored basidia are an outstanding feature, but one possibly not too reliable as a taxonomic character. The cystidia are *Russula-like* (pseudocystidia ?) and are a good character for the species. In gross morphology, in spore characters, and in the reduction in the number of sphaerocysts this species is to be regarded as below the level of *Martellia* in the evolutionary series. In the exceedingly weak amyloid reaction of the spores, it is, however, reminiscent of that genus. This reaction was noted on dried material revived in Melzer's reagent but did not show on material preserved in liquid and mounted in Melzer's fluid.

10. OCTAVIANINA *papyracea* Singer & Smith sp. nov.

Fig. 15.

Carpophoris 1-4 cm latis, subglobosis, albidis; gleba alutacea, locellis minutis; peridio papyraceo; latice cremoricolor; viscoso; sporis 14-17 μ , globosis, inamyloideis; sphaerocystibus in tramate nullis; hyphis defibulatis. Specimen typicum legit prope Trinidad, Calif. Nov. 21, 1939. H. E. Parks 6347 (NY).

Gastrocarp 1 cm diam., brownish, hard, globose, unchanging, color creamy; gleba of minute chambers, near pinkish-buff as dried and when moistened with alcohol orange-tan, with an abundant cream colored latex fresh, taste mild; columella lacking; peridium as dried almost like a

thin nut shell, the exterior surface dull cinnamon is some places and near cinnamon-buff in others.

Spores 14-17 μ , globose to subglobose, sterigmal appendage inconspicuous, spore wall thick (1 μ or more), in Melzer's reagent orange-yellow; ornamentation in the form of spines 2-3 μ long and 0.5-1 μ at the base, densely covering the surface but not fused, yellowish in Melzer's or nearly hyaline at tip; spore wall hyaline to yellowish in KOH.

Hymenium. Basidia 20-32 $\times$ 9-13 μ , thin-walled and readily collapsing, hyaline or nearly so in KOH, 1-, and 2-spored, sterigmata 10 μ or more long; cystidia a few seen, 46-60 $\times$ 10-13 μ , thin-walled, hyaline, soon "empty", subcylindric to enlarged near apex and with an apical mucro.

Hyphal layers. Mediostratum of tramal plates of interwoven, hyaline subgelatinous hyphae with slightly thickened walls, no sphaeroeysts present; subhymenium of cells 10-13 μ in diam. in rows of 2-3 and rows terminated by a basidium or basidiole, all tramal tissues yellowish hyaline in Melzer's reagent. Epicutis of peridium a layer of appressed, ochraceous hyphae (in KOH) with some free hyphal ends at surface as a rudimentary turf; hyphal ends 3-4 μ diam.; context of hyaline subgelatinous hyphae with slightly thickened walls (similar to those of the tramal plates), interwoven; laticiferous hyphae present; sphaerocysts none; clamp connections none.

Under *Sequoia* debris but not buried in the soil, Spruce Cove, Trinidad, Calif. Nov. 21, 1939. H. E. Parks. The specimen is No. 6347 in the Zeller Collections (NY).

Parks (No. 5702) made a second collection which appears to be the above species, on Nov. 28, 1935 at Trinidad, Calif. It was hypogeous in an old road and under alder leaves but *Sequoia* was present in the vicinity also. The following data were recorded for this collection.

Gastrocarp 2-4 cm diam. globose or neary so; peridium creamy to ivory when fresh, becoming rufous at base where exposed, drying tawny; gleba slightly lighter in color, exuding a thick sticky cream colored latex when fresh and cut open. As dried the gleba is about cinnamon buff and the peridium nearly russet. No evidence of a columella was seen on cut specimens.

Spores 13-16 μ , globose, pale ochraceous in KOH, darker ochraceous in Melzer's reagent (but not pseudoamyloid), sterigmal appendage short and inconspicuous; ornamentation in the form of cones 1-2 μ high and 0.5 μ at base, non-amyloid or with faint "shadows" near apex in some; wall thickened somewhat.

Hymenium. Basidia 25-32 $\times$ 9-12 μ , clavate, hyaline in KOH, a few seen with 4-6 very fine sterigmata. Cystidia about 50-65 $\times$ 10-16 μ and pointed but very badly collapsed, rare (but probably more numerous than the observations indicate).

Hyphal layers. Tramal plates with interwoven hyaline hyphae and large laticiferous hyphae, no sphaerocysts found; subhymenium of divergent hyphae with basidia at the ends but divided below the basidium into 2-3 short cells which enlarge to 8-13 μ . Epicutis of pileus a narrow ochraceous (in KOH) layer of appressed subgelatinous hyphae, context of

hyaline glassy (in KOH) hyphae 5-8 μ in diam., and laticifers but no sphaerocysts. Clamp connections none.

The latex-bearing and non-latex bearing species are so closely related in their other characters that at this level we have been unable to convince ourselves that they should be placed in separate genera. The papy-fragile peridium is distinctive of the holotype and undoubtedly is a good "herbarium" character.

11. OCTAVIANINA TUBERCULATA (Hesse) O. Kuntze, Rev. Gen. Pl. 3²:501. 1899.

Hydnangium tuberculatum (Hesse) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:373. 1935.

Octaviania tuberculata Hesse Hypog. Deutsch. 1:75-77. 1891. Fig. 10.

Gastrocarp 13 $\times$ 20 mm, subglobose, more or less warty and uneven and also furrowed, white at first, yellow where handled, finally brownish; gleba marbled, tramal plates showing pallid against the cavities which are filled with dark brown spores; columella and sterile base none. Odorless.

Spores 12-16 μ , globose, covered with broad cones 2-3.5 $\times$ 2-3 μ , dark reddish brown in Melzer's reagent, the wall of the cones usually with at least a few longitudinal striations or creases, color in KOH near ochraceous tawny; plage area not different from remainder; sterigmal appendage usually not visible. Not amyloid in any part; inner wall thick and pale tawny.

Hymenium continuous. Basidia 18-22 $\times$ 10-14 μ , broadly clavate, thin-walled, readily collapsing (3-4-spored, Zeller & Dodge). Basidioles present; pseudoparaphyses ellipsoid, 12-15 μ broad. Cystidia none seen.

Hyphal layers. Subhymenium of inflated sphaerocyst-like cells, hyaline, thin-walled; mediostratum of hyaline slightly interwoven filaments. No sphaerocysts seen in the layer but some slightly inflated cells present, all hyphae thin-walled and smooth. Epicutis not differentiated from context, entire peridium of interwoven filaments 8-13 μ in diam., hyaline, thin-walled and no true sphaerocysts present. Clamp connections none.

Under *Fagus sylvatica*, Hessen-Nassau, Germany, September and October, 1888. Specimen collected and identified by Hesse (Zeller Herbarium, NY).

The warty surface of the gastrocarp appears to be a good field character, at least it has been found constant in other genera in this series. The staining to yellow of the injured surface should be a second distinctive character and helps to separate it from the other species described by Hesse.

12. OCTAVIANINA lutea (Hesse) Singer & Smith comb. nov.

Octaviania lutea Hesse. Pringsh. Jahrb. f.w. Bot. 16:255. 1885.

Hydnangium luteum (Hesse) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:372. 1935.

Fig. 11.

Gastrocarp 2.5-3 cm thick, subglobose to irregular, snow white when young and fresh, gradually becoming dingy but retaining white patches, when handled or injured turning red, finally cherry red. Gleba when first sectioned (young specimen) snow white, but soon changing to red-

dish, in old specimens when cut the surface shiny and golden yellow. Sterile base rudimentary in young specimens, obsolete in age. Odorless.

Spores 14-19 μ , globose, ornamented with broad pyramids $2.5-3 \times 2-2.5 \mu$, spores yellowish in KOH, dark rusty brown in Melzer's sol. thick-walled (the *O. asterosperma* - type).

Hymenium. Basidia short-clavate, $23-27 \times 10-15 \mu$, 2-, 3-, 4-spored, hyaline, thin-walled, readily collapsing. Pseudoparaphyses clavate, those observed by Smith more broadly clavate, about $20 \times 9 \mu$, with *slightly thickened walls* (as illustrated by Hesse). Cystidia none.

Hyphal layers. Subhymenium filamentous, of broad cells (6-10 μ). Mediostratum of filamentous hyphae mostly rather broad (7-10 μ), and some of the cells appreciably inflated (sphaerocysts ?) all hyphae hyaline in KOH and readily disintegrating under pressure. Epicutis of appressed filamentous hyphae nearly hyaline in KOH and 3-8 μ in diam. Context of hyaline thin-walled hyphae of both narrow and broad types (3-10 μ diam.). Presence of sphaerocysts doubtful; clamp connections none observed but conclusion not final.

The specimen studied was collected by Hesse under birch at Altmorschen, Hessen, Nassau, Germany, September 1889. (Zeller Herbarium, NY).

The peridium remained pallid on drying and easily sloughs off. The gleba is cinnamon as dried. The white peridium which stains cherry red on handling and the golden yellow gleba at maturity appear distinctive.

13. OCTAVIANINA LANIGERA (Hesse) O. Kuntze, Rev. Gen. Pl. 3²:501. 1898.

Octaviania lanigera Hesse, Hypog. Deutschl. 1:79-80. 1891.

Hydnangium lanigerum (Hesse) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:372. 1935.

Fig. 12.

Gastrocarp irregular in shape, roughly 1-2.5 cm diam., often with a constriction dividing it into two lobes, or in some one of the lobes further divided, with a mycelial attachment in (at base of) the primary furrow, color yellowish white from a loosely fibrillose outer layer; peridium nearly 1 mm thick and not separable from the gleba but at maturity breaking up into small patches. Gleba golden yellow, of cavities of appreciable size partly filled with spores, pale cinnamon as dried; columella (none evident in specimen examined), sterile base very inconspicuous in dried specimen. No appreciable odor.

Spores 11-16 μ ; globose, of coarse spines and warts about $2-3 \times 2-2.5 \mu$, ornamentation non-amyloid; spore rusty brown in Melzer's, ochraceous in KOH (obviously the *O. asterosperma* type).

Hymenium of very delicate-walled elements all readily collapsing. Basidia 4-spored, $20-22 \times 10-12 \mu$, thin-walled, hyaline, Cystidia none observed. Basidioles numerous. (Hesse, fig. 7 l.c. shows some thick-walled, 2-celled elements in the hymenium about the size of basidioles).

Hyphal layers. Tramal plates of interwoven hyaline subgelatinous hyphae 5-11 μ in diam. and readily disintegrating when revived; a few cells observed which might be interpreted as sphaerocysts; subhymenium of filamentous-hyphae about like those of the mediostratum. Epicutis of gastrocarp of hyaline to pale yellowish interwoven thin-walled hyphae 8-

11 μ diam. Context of loosely interwoven hyphae about like those of the outer layer but some sphaerocysts possibly present ("holes" in the inner context may mark the occurrence of collapsed sphaerocysts). Clamp connections, none observed after considerable study. Oleiferous hyphae rare.

The specimen studied was collected by Hesse under *Betula*, Altmorschen, Hessen-Nassau, Germany, Sept. 1901. (Zeller Herb. NY).

This species is congeneric with *O. asterosperma* and *O. laevis* by its spore characters, but distinct from both by the characters of the peridium.

14. OCTAVIANINA LAEVIS (Hesse) Kuntze. Rev. Gen. Pl. 3²:501. 1898.

Octaviana laevis Hesse, Hypog. Deutschl. 1:80-81. 1891.

Arcangeliiella laevis (Hesse) Dodge, Ann. Mo. Bot. Gard. 22:368. 1935.

Hydnangium laeve (Hesse) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:372. 1935.

Fig. 13.

Gastrocarp 1-2 cm in diam., globose to slightly irregular in shape, surface smooth and silky-fibrillose, whitish, gradually becoming brownish, and when dried dark rusty brown; gleba whitish becoming yellow and when dried pale cinnamon, chambers extremely minute (scarcely visible to unaided eye); columella none; sterile tissue none; odorless.

Spores globose 13-18(20) μ in diam.; strongly ornamented with cones $2.3 \times 2.2.5 \mu$; non-amyloid to pseudo-amyloid, (rusty brown in oldest or largest spores in Melzer's reagent), walls of cones rusty brown below, yellow near apex, cones so closely spaced as to touch each other at base; spore color in KOH pale ochraceous.

Hymenium of very delicate-walled elements readily collapsing. Basidia about 10-12 μ broad, nearly globose, 2-, and 4-spored, walls *very* thin and hyaline. Basidioles present but remaining badly collapsed; cystidia none.

Hyphal layers. Tramal plates of interwoven gelatinous narrow (2-3 μ) hyaline hyphae; no sphaerocysts found; subhymenium scarcely distinct in revived mounts—apparently of the same type of subgelatinous hyphae composing the mediostratum. No oleiferous or laticiferous hyphae seen. Epicutis of peridium of filamentous, appressed, interwoven hyphae with rusty brown pigment in the layer but individual hyphae as isolated have merely slightly ochraceous walls. Context of peridium of subgelatinous interwoven hyphae hyaline in KOH; a few inflated cells seen which could be interpreted as sphaerocysts. Clamp connections none found.

The description is taken from the original by Hesse, and the microscopic data are from a Hesse collection made at Altmorschen, Hessen-Nassau, Germany, July 1888 by Hesse himself.

This is a species closely related to and congeneric with *O. asterosperma* (the spores are almost identical) but differs in the greater reduction of sphaerocysts in the context of the peridium, in different color changes when fresh specimens are handled, and in having more of a tendency for the hyphae of the tramal plates to gelatinize. Zeller's collection from Salem, Oregon, April, 1935 is correctly identified. It was found under *Opulaster* and *Corylus* (hazel). The Thaxter collection "B₂ H" from Burbank, Tenn. August 1896 is also correctly determined. Thus it is likely that Thaxters (B216) collection from North Carolina is correctly identified

also but we have not examined it. The distribution of the species in North America is thus widespread.

Zelleromyces gen. nov.

Carpophoris globosis, *elongatis vel irregularibus*; *sporis ornamentatis atque amyloideis*; *columellas manifesta*; *latice copioso*; *sphaerocystibus in peridio praesentibus*.

Gastrocarp consisting of peridium, gleba and usually a well defined columella, the gleba chambered and cavities only partly filled with spores; spores with amyloid material over at least part of the basic ornamentation or ornamentation entirely amylaceous; peridium well developed, the epicuticular layer distinctive by virtue of being a trichodermium or at least with numerous dermatocystidia, usually the trichodermial elements arranged compactly so as to form an almost cellular epicutis; heteromerous tissue present at least at the junction of the tramal plates with the peridium; latex present in fresh material.

Type species. *Zelleromyces cinnabarina* Singer & Smith.

In its gross morphology this genus corresponds to *Martellia* but anatomically a greater range of characters is allowed. The spore ornamentation varies from only partly amyloid to the heaviest reaction we have seen in the whole series. There is also a wide range in the types of epicutis present on the peridium.

Since the presence or absence of sphaerocysts in the mediostratum of the tramal plates has been considered important at the generic level in *Macowanites* and *Elasmomyces* in the *Russula* branch of the Astrogasteraceous Series, some comment on the situation as described here for *Zelleromyces*, is pertinent. *Z. cinnabarinus* and *Z. oregonensis* lack this character, whereas it is present to some degree in the remaining species. In fact, the genus might well be divided into sections on this character. We hesitate, however, to recognize two separate genera for these two groups because throughout the whole *Lactarius* branch of the Astrogasteraceous Series, in fact in *Lactarius* itself, there is a general tendency for the mediostratum to lack sphaerocysts. In this particular situation we believe that the combination of lack of clamp connections, presence of amyloid spore ornamentation and presence of a latex is the best index of close relationship.

KEY TO SPECIES

1. Spores typically elliptic in profile view; sphaerocysts absent from mediostratum of tramal plates..... 2
1. Spores globose, or sphaerocysts present in mediostratum..... 3
 2. Peridium cinnabar red fresh; spores $14-17 \times 11-13 \mu$ 15. *Z. cinnabarinus*
 2. Peridium pale cream color to pale clay color fresh; spores $10-13 \times 8-11 \mu$ 16. *Z. oregonensis*
3. Peridium with a medial gelatinous layer with heteromerous tissue to the interior of it..... 17. *Z. ravenelii*
3. Not as above, i.e., no heteromerous tissue present in the peridium, if a peridium is present..... 4
4. Spores globose $10-15(16) \mu$, ornamentation in form of spines with the apex amyloid..... 18. *Z. gilkeyae*

4. Spores globose 9-12 μ diam., ornamentation of broad warts entirely covered by amylaceous material.....19. *Z. glabrellus*
 4. Spores broadly ellipsoid 9-12.5 $\times$ 6.5-8.5 μ ornamentation in the form of ridges and crests.....20. *Z. gardneri*

15. *Zelleromyces cinnabarinus* Singer & Smith sp. nov. Fig. 16.

Carpophoris 1-4 cm latis, globosis, cinnabarinis; latice albido; sporis 14-17 $\times$ 11-13 μ , ellipsoideis; reticulatis, amyloideis; cystidiis 26-30 $\times$ 9-13 μ rarisusculis. Specimen typicum legit prope Jackson, Louisiana. U.S.A., 26 Dec. 1931. A. H. Smith & C. A. Brown (MICH).

Gastrocarps 1-4 cm in diam., globose, flattened or somewhat irregular in outline, sessile but attached by a mycelial pad, dull cinnabar red when fresh, drying dark reddish brown; gleba pale cinnamon to dull cinnamon-buff, chambered, chambers empty, irregular in shape but generally radiating out to peridium in an obscure pattern (most noticeable near point of attachment); columella rudimentary to absent, branched and branches radiating from the slight sterile base; when cut exuding a white latex.

Spores 14-17 $\times$ 11-13 μ , ellipsoid, ornamentation strongly amylaceous, forming a knotty reticulum, prominences about 1 μ high, bands of amyloid material 0.6-1 μ wide; spore wall hyaline or nearly so in Melzer's reagent, with an irregular sterigmal appendage 2-4 μ long with some amylaceous material on it.

Hymenium. Basidia 20-26 $\times$ 9-12 μ , mostly 2-spored, hyaline, thin-walled, collapsing. Cystidia 26-30 $\times$ 9-13 μ , broadly fusoid to ovate-pointed and some with refractive content, rather rare.

Hyphal layers. Tramal plates of interwoven filaments and laticiferous hyphae; subhymenium appearing cellular in section (but actually of compactly interwoven filaments with cross walls so numerous as to produce isodiametric cells), giving off branches on which the basidia and basidioles occur, these branches having one or two short cells below the hymenial element. Epicutis of peridium a tangled layer of clavate cells, enlarged hyphal cells and some filaments all subgelatinous in KOH and difficult to revive. Laticiferous hyphae present. Sphaerocysts in context scattered, hence context weakly heteromerous. Clamp connections absent.

Under young pine, Jackson, Louisiana, (near Baton Rouge), Dec. 26, 1931, A. H. Smith and C. A. Brown.

This species was at first identified as *Arcangeliiella ravenelii* but is readily distinguished by its distinctly ellipsoid spores and cinnabar-red peridia. As preserved the gastrocarps are a darker redder brown than those of *Z. ravenelii*.

16. *Zelleromyces oregonensis* Singer & Smith sp. nov.

Fig. 17.

Carpophoris 10-30 mm latis, globosis, pallide alutaceis; latice albido; sporae 10-13 $\times$ 8-11 μ , echinulatis, amyloideis; cystidiis 46-48 $\times$ 9-11 μ . Specimen typicum legit. prope. Comstock, Ore. U.S.A., 23 Oct. 1937, S. M. Zeller, N. 8333 (NY).

Gastrocarp 10-30 mm broad, globose, cinnamon-buff to dingy pale tawny as dried, surface unpolished; columella dendroid, branches pale buff; gleba "marbled with hygrophanous translucent areas"—Zeller. Chambers small

but labyrinthiform, cinnamon buff to pale ochraceous tawny (as dried); peridium thin, not opening to expose the gleba; "milk clear, whitish"—Zeller.

Spores $10-13 \times 8-11 \mu$, subglobose to broadly elliptic, sterigmal appendage inconspicuous, about $2.5-3 \mu$ long, ornamentation in the form of closely set but unconnected rods $1-1.25 \times 0.4-0.5 \mu$; in some spores the rods arranged in crescents or in chains and touching or almost touching each other, amyloid over all or just over the upper two thirds, the rods rather readily deciduous, plage area ornamented but the elements reduced merely to amyloid granules; spore wall only slightly thickened and hyaline in Melzer's reagent.

Hymenium. Basidia $32-44 \times 9-14 \mu$, 4-spored, clavate-pedicellate, thin-walled, collapsing readily; cystidia $46-48 \times 9-11 \mu$, fusoid-ventricose to subcylindric or narrowly clavate, apex obtuse, rare to scattered and content protoplasmic, evenly refractive as revived in KOH (not macrocystidia).

Hyphal layers. Tramal plates with a mediostrium of interwoven hyaline (in KOH) hyphae $5-12 \mu$ in diam.; the subhymenium cellular, 1-2 cells deep and elements up to 18μ broad (sphaerocysts?). Epicutis of peridium a turf of dermatocystidia, the elements $28-45 \times 4-9 \mu$, narrowly subfusoid to filamentose, the walls slightly thickened in some, hyaline to yellowish in KOH, smooth, rarely with refractive content of amorphous material; context of interwoven filaments, sphaerocysts rare and present near the subhymenium in groups of 2-3, hypodermal layer yellow in KOH, the pigment in the hyphal walls, this zone of more compactly arranged hyphae than that making up the body of the context; laticiferous hyphae present but very scattered; clamp connections absent.

Under incense cedar, Comstock, Oregon, Oct. 23, 1937, S. M. Zeller, 8333.

This was identified as *Arcangeliella cremea* by Zeller, but differs from that species in the characters of the epicutis of the peridium, the shape of the cystidia, and in the more uniform elements of the spore ornamentation. Zeller specifically mentioned the latex (milk) for this collection. The absence of a latex in the type of *A. cremea* is inferred because it was not mentioned in the original description. This could be an erroneous assumption but we doubt if it is. Sprague, who collected the type of *A. cremea* at Corvallis, Oregon, no doubt gave the fresh material to Zeller, who then, as was his habit, sectioned it and thus would have observed a latex if one had been present.

17. *Zelleromyces ravenelii* (B. & C.) Singer & Smith comb. nov.

Octaviania stephensii var. *ravenelii* Berk. & Curt. in Tulasne, Fung. Hypog. xvii. 1851.

Hydnangium stephensii var. *ravenelii* Berkeley, Grevillea 2:33. 1873.

Octaviania ravenelii Lloyd, Myc. Notes 67:1140. 1922.

Arcangeliella ravenelii (B. & C.) Dodge, Ann. Mo. Bot. Gard. 18:463. 1931.

Fig. 18.

Gastrocarps 25-40 mm in diameter, subspherical to pyriform, drying light fawn to nearly pallid; sterile base not prominent; columella slender, percurrent; with laticiferous ducts which exude a white aromatic latex.

Spores 12-16(17) μ , globose or nearly so, ornamented, blackish violet under oil-immersion in Melzer's reagent because of a heavy ornamentation in the form of a small-meshed reticulum of ridges about 1 μ wide connected by finer amyloid lines or chains of granules, main ridges 1-1.5 μ high and secondaries about 0.25 μ high; sterigmal appendage inconspicuous.

Hymenium. Basidia 2-spored, a few 1-spored with an elongated sterigma or intermediate (one long and one aborted), basidia $36-45 \times 10-13 \mu$, sterigmata on two-spored basidia 9-12 μ long and 2 μ wide at base, conic. Basidioles numerous. Cystidia 48-60 $\times 10-15 \mu$, clavate with an apical mucro but mostly larger than 1-spored basidia.

Hyphal layers. Subhymenium cellular but not from sphaerocysts, merely of short cells more or less isodiametric because of numerous cross walls; hyphae of the tramal plates interwoven and hyaline with scattered sphaerocysts. Peridium a thick (about 200 μ) layer of hyaline subgelatinous hyphae 4-11 μ in diam. with laticiferous hyphae interspersed, covering the surface sparsely are small dermatocystidia 18-26 $\times 3-7 \mu$, these are irregular in outline. Clamp connections absent.

Material studied. Ravenel, Fungi Amer. N.16, Ellis, N.A.F. no. 1211.

The white latex with an aromatic odor in combination with the heavy reticulum of the globose spores furnishes a good combination of characters by which to recognize this species. In fact it is exceptionally well characterized. The Zeller collections from Oregon have a peridium reminding one of a *Scleroderma*, but the large dark, amyloid spores with their heavy reticulum are like those of the Ravenel collections.

18. *Zelleromyces gilkeyae* Singer & Smith sp. nov.

Fig. 19.

Gastrocarpis 20-35 mm latis, rugulosis, rubro-brunneis; gleba pallide alutacea, molli; latice albo. Sporis 10-15(16) μ , globosis; cystidiis 46-62 $\times 10-14 \mu$. Specimen Typicum in Herb. "N.Y." conservatum est. legit prope Reedsport, Ore., 22 Oct. 1938. Sub *Acer circinatum*, Helen Gilkey, Zeller 8498. (NY).

Gastrocarps 20-35 mm broad and about 2 cm deep, surface pale reddish brown and wrinkled; gleba cinnamon-buff; consistency rather punky and gleba readily attacked by insects in the herbarium; no stipe or columella visible (data on dried material). Miss Gilkey reported a columella when fresh and a white latex.

Spores globose, 10-15(16) μ , ornamentation in the form of rods and spines $2-3 \times 0.7-1 \mu$ (long and narrow), and these slightly amyloid near or at the apex, and also in most spores with a darker amyloid reaction around the base or near it, spines closely arranged but no connecting ridges between them, and the wall of the spore between them merely yellowish in Melzer's reagent and in KOH merely yellowish-hyaline.

Hymenium. Basidia 2-spored, $30-37 \times 9-12 \mu$, (possibly a few 4-spored); basidioles $20-35 \times 9-11 \mu$. Pseudoparaphyses none. Cystidia abundant, $46-62 \times 10-14 \mu$, elongate-mucronate, thin-walled, hyaline in

KOH or with scattered refractive amorphous particles within, or content reticulate.

Hyphal layers. Subhymenium cellular, mediostratum of interwoven filaments and laticiferous hyphae, scattered sphaerocysts also present. Peridium with an outer layer in the form of a trichodermium with the elements so closely packed together as to form a cellular layer, the end-cells ochraceous brown in KOH; beneath this layer is one of interwoven subgelatinous hyphae (no sphaerocysts reliably observed); clamp connections none but false clamps occasionally present.

Under *Acer circinatum* in deep mixed woods, near Reedsport, Oregon, October 22, 1938. Zeller 8498, collected by Dr. Helen Gilkey.

In the Zeller collections this number was filed as *Arcangeliella occidentalis*. We do not question that a columella was present in at least most of the specimens. Miss Gilkey's notes leave no doubt on that score, but it does not show in the cut specimens available for study. This we explain as an artifact and would point out that Smith has noted the same thing happening in some of his collections in this group.

This species is distinct because of the large spores with localized amyloid material on the main spines of the ornamentation, the large cystidia of the macrocystidium type, and the structure of the epicutis of the peridium. We strongly doubt if this is the fungus Harkness described as *Octaviania occidentalis* from under oak in California. McMurphy No. 272, March 23, 1919, also labeled *A. occidentalis* in the Zeller collections is still a different species having a thick gelatinous layer over the exterior of the peridium, and it lacks cystidia, among other characters.

The localized amylaceous material on the spines of the spore ornamentation, the almost cellular epicuticular trichodermium, and the cystidia remind one of *Martellia*, but the presence of a latex excludes that genus.

19. *Zelleromyces glabrellus* (Zeller & Dodge) Singer & Smith comb. nov.
Arcangeliella glabrella Zeller & Dodge, Ann. Mo. Bot. Gard. 22:368. 1935.

Fig. 20.

Gastrocarps 10-15 mm in diam., drying to 5-10 mm, subglobose to depressed-globose, smooth, white to brownish, drying sordid white to buckthorn-brown; columella percurrent; gleba white, drying ivory-yellow to cream-buff, cavities nearly sphaerical; latex present.

Spores globose, 9-12(13) μ , so strongly amyloid as to be blackish violet and opaque in Melzer's reagent and the ornamentation difficult to measure (but about 1-1.5(2) μ high and each element almost as broad at the base as it is high), in the form of warts and obtuse cones; sterigmal appendage inconspicuous to absent.

Hymenium. Basidia 4-spored, clavate, 36-45 $\times$ 10-13 μ , sterigmata straight, 4-5 $\times$ 2 μ ; pseudoparaphyses present, 12-16 μ broad, thin-walled and readily collapsing. Cystidia abundant and voluminous, 50-70 $\times$ 14-20 μ , broadly fusoid, thin-walled, content homogeneous in KOH, smooth, readily collapsing, rarely some slender cystidia with amorphous contents (pseudocystidia) in KOH also present.

Hyphal layers. Tissue of the tramal plates heteromerous, sphaerocysts rare in the thin plates, and a few in the cellular subhymenium. Peridium

with an epicutis of the type found in *Lacrymaria* of *Psathyrella* in the Coprinaceae (Agaricales), i.e., cellular and 2-4 cells deep with filaments projecting between the cellular elements, all parts hyaline in KOH and thin-walled; beneath the epicutis is a layer of filamentous hyphae 4-8 μ in diameter but no sphaerocysts were seen (the layer revived poorly), no true laticiferous hyphae were seen (the structures observed were more like oleiferous hyphae in morphology, but apparently carried a latex). Clamp connections none.

This species is based on a collection from Tasmania by Rodway (his number 1111).

Among the Zeller collections is a portion of the type collection consisting of two gastrocarps, one slightly smaller than the other. We have selected as the lectotype the specimen which is small and would have been the one referred to as a young fruiting body. It shows cystidia and was apparently the element in the collection seen to have the latex. This makes the type consistent with the outstanding diagnostic characters as given in the original description.

The second (the larger) specimen we have not as yet identified. In it the peridium shows obvious heteromerous tissue, it has no obviously differentiated epicutis, the spores are globose to ellipsoid, 9-11 $\times$ 8-10 μ , and with ornamentation 0.25 μ high consisting of scattered warts, granules and some crests which are mostly unconnected. The basidia are 2-, 3-, and 4-spored, 26-33(44) $\times$ 9-11 μ , and pseudoparaphyses 12-18 μ broad are present but cystidia are lacking. Sphaerocysts are present in at least the thicker tramal plates but these structures revived poorly. Clamp connections are absent.

It was obvious when working with the specimens that each was fully expanded and mature. Hence the characters are comparable. It should also be pointed out that the spores in neither of the gastrocarps correspond in size with the measurements given by Zeller & Dodge. Is there still another species hiding in Rodway 1111? As we have typified *Z. glabrellus* it is readily recognized by the extremely dark amyloid reaction of the heavy spore ornamentation, the cystidia and the structure of the epicutis. It is placed in *Zelleromyces* on the assumption that it was this element in the collection which exuded a latex. From the fact that the original description calls for a latex in the "young specimens" we question whether the other elements of the collection however many these are, actually had a latex.

20. *Zelleromyces gardneri* (Zeller & Dodge) Singer & Smith comb. nov.
Gymnomyces gardneri Zeller & Dodge, Ann. Mo. Bot. Gard.
6:54-55. 1919.
Arcangeliiella gardneri (Zeller & Dodge) Zeller & Dodge, Ann.
Mo. Bot. Gard. 22:367. 1935.

Fig. 21.

Gastrocarp subglobose to irregular, depressed, 25 $\times$ 15 $\times$ 15 mm drying out to 14 $\times$ 8 $\times$ 8 mm, cream colored to yellow ochre in alcohol, drying tawny olive; columella dendroid, resembling much thickened septa; gleba cream color to clay color dried, cavities small, isodiametric to irregular; latex white.

Spores $9-12.5(15) \times 6.5-8.5(-10) \mu$, broadly ellipsoid to subglobose, ornamentation strongly amyloid, $0.25-0.5 \mu$ high and in the pattern of crooked ridges, warts fused into crests and these connected to give the effect of a broken reticulum; nearly hyaline in KOH; sterigmal appendage very inconspicuous (about 2μ long.)

Hymenium. Basidia 4-spored, $26-37 \times 7-9 \mu$, clavate, thin-walled and readily collapsing, sterigmata very fine and straight-conic. Pseudoparaphyses clavate, $20-25 \times 10-12 \mu$ (basidioles ?) cystidia $24-35 \times 10-16 \mu$, ellipsoid-mucronate, thin-walled, readily collapsing, content homogeneous or nearly so, (hence not chrysoecystidia).

Hyphal layers. Tramal plates with hyphae reviving poorly but some sphaerocysts clearly demonstrated in the mediostratum—hence the tissue at least weakly heteromerous. Subhymenium cellular, cells about the width of the base of the basidium. Peridium (very little present, the surface being alveolate as in *Gautieria*), all that was evident under the microscope was a thin layer of appressed filaments of non-gelatinous hyphae. Laticiferous hyphae present. Clamp connections none.

Under leaves of *Quercus agrifolia*, California. December.

Material studied. The part of the type collection in the Zeller Herbarium (NY).

Among the Zeller Collections are the following identified as the above species. Parks No. Z-11. This is not the same as the type, but we are not prepared to identify it or describe it at present. Zeller No. 16 (Parks Z-2) is immature but apparently represents another species. Parks Z-348 represents a fourth species in which the prominent elements of the spore ornamentation are only partly amyloid. Murphy No. 271 by virtue of its cheese-like consistency when dried and small ellipsoid spores is still another species, but his 267 is possibly the same as his 271 though the spores are globose. Parks 943 appears to be the same as the type. It lacks a peridium, the surface as dried is somewhat alveolate, and the spores check reasonably well. We found no cystidia but are not inclined to emphasize this as a character at present. Zeller 1728, by H. P. Barss from Corvallis, Oregon, also appears to be correctly identified. Hence, *Z. gardneri* is known from 3 different localities, and the thin evanescent peridium appears to be constant. It is to be noted that in this species the spore ornamentation is very similar to that found in *Lactarius*.

MARTELLIA Mattirola

Malpighia 14:78-82. 1900.

Tissue of peridium entirely of filamentous hyphae or with scattered sphaerocysts or truly heteromerous in at least the inner layer; epicutis of peridium various, consisting of a turf of dermatocystidia, or in the form of a cellular epicutis, or epicutis not clearly differentiated from the context; tramal plates with a distinct filamentose mediostratum lacking sphaerocysts; subhymenium typically of enlarged sphaerocyst-like cells; spores ornamented and the ornamentation amyloid over all or, for many species, only over a portion of the ornamentation; columella present or absent, if present often arising from a sterile base; latex absent and

laticiferous hyphae typically absent; oleiferous hyphae sometimes present. Clamp connections absent.

Type species. *Martellia mistiformis* Mattiolo.

As we have defined the genus it differs from *Hydnangium* in lacking clamps on the hyphae and in having some part of the spore ornamentation distinctly amyloid. The genus can readily be divided into three sections. Section *Protocystangium* characterized by a cellular peridial epicutis and a lack of sphaerocysts in the tissue of the peridium; section *Martellia* with sphaerocysts in the context of the peridium, and Section *Martelliella* in which sphaerocysts are not present in the peridial context and the epicutis of the peridium is relatively undifferentiated or present only as a turf of dermatocystidia.

Martellia in the sense that we have presented it here shows three interesting trends in development. First, the degree of development of sphaerocysts in the context of the peridium. The type of the genus is actually intermediate in this respect and in a way connects the group of species lacking these structures in the peridial context to the group which possess them. In the latter group occur species with scattered sphaerocysts and one in which these structures appear in pockets but are not greatly enlarged. In view of the highly developed heteromerous tissue in *Lactarius* and *Russula*, the degree to which sphaerocysts occur in the peridial context of *Martellia* is of the greatest interest.

The second line of development is in the extent of the coating of amylaceous material over the elements of the spore ornamentation. The smallest indications of this character were observed in *Octavianina rogersii*, but we have not described that species in *Martellia* because for all practical purposes the spores are inamyloid. In *Martellia* it is possible to arrange a series of species starting from those with weakly developed or spotty amylaceous material on the elements of the spore ornamentation, as in *M. maculata*, to those evenly coated, but in those entirely covered by amylaceous material there are some in which the element of ornamentation is deeper blue at the apex than elsewhere. It is also significant in this genus that as a genus the spores show many of the basic types of ornamentation described in the Singer (1951) system. Thus the development in the amyloidity of the spore ornamentation parallels roughly the development of the sphaerocysts.

The third line of development is in the epicutis of the peridium. In its most specialized form this layer occurs as a cellular epithelium reminding one of that of *Cystangium*. Indeed, if one is forced to postulate an origin for *Cystangium* it would be from this group of species. *M. idahoensis* has a peridium in which the epicutis approaches the type found in *Cystangium* and is to be regarded as an intermediate stage between a turf of dermatocystidia and a truly cellular type. In a number of species very little differentiation of the epicutis is found, a situation common in *Octavianina*. Thus, in all the major cellular and anatomical characters save one (sphaerocysts in the mediostratum of the tramal plates) leading to the Russulaceae we find them in a rudimentary condition in *Martellia* as well as stages showing considerable evolutionary progress in their specialization.

KEY TO SPECIES

1. Sphaerocysts absent from tissue of peridium..... 2
1. Sphaerocysts (or irregularly enlarge cells in *M. mistiformis*) present to some extent—often merely scattered—in the tissue of the peridium..... 15
 2. Epicutis a layer of vesiculose cells 1-several deep..... 3
 2. Epicutis a turf of dermatocystidia or not differentiated from context..... 6
3. Cystidia present in hymenium, fusoid..... 21. *M. oregonensis*
3. Cystidia absent..... 4
 4. Spore ornamentation in the form of warts, spines, ridges, crescents, or irregular “knotty” lines (all types present on a single spore)..... 22. *M. variabilispora*
 4. Element of spore ornamentation not fused in above patterns, occurring as discrete warts and spines..... 5
5. Gastrocarp soon stained brown; spore ornamentation conspicuously spotty in its amyloid reaction (spore not evenly violaceous in Melzer’s)..... 23. *M. maculata*
5. Gastrocarp white(gray as preserved in liquid); spore ornamentation evenly amyloid or sufficiently so to give the reaction an even appearance under ordinary magnifications..... 24. *M. vesiculosa*
6. Spores mostly over 12 μ wide or if 9-12 μ wide then 10-14 μ long..... 7
6. Spores mostly less than 12 μ wide..... 11
7. Spores ellipsoid and 15-23 $\times$ 12-16 μ 25. *M. ellipsospora*
7. Spores not as above..... 8
 8. Spores ochraceous tawny in KOH but ornamentation amylaceous..... 26. *M. soehneri*
 8. Not with above combination of characters..... 9
9. Elements of spore ornamentation 1-2.5 μ broad at base, in the form of simple or forked spines or truncated cones 3.5-5 μ high..... 27. *M. gilkeyae*
9. Not as above..... 10
 10. Cystidia abundant in hymenium; gleba yellowish, dried..... 39. *M. scissilis*
 10. Cystidia absent in hymenium, gleba cinnamon brown as dried..... 28. *M. parksii*
11. Basidia with distinct yellow, to orange or brown content in KOH..... 12
11. Basidia hyaline or nearly so in KOH..... 14
 12. Ornamentation with elements 0.25-0.5 μ high..... 29. *M. californica*
 12. Ornamentation with elements higher than above..... 13
13. Cystidia present in hymenium; resembling chrysocystidia as revived in KOH..... 30. *M. fallax*
13. Cystidia absent..... 31. *M. subfulva*
14. Cystidia present in hymenium, of the type termed Macrocystidia..... 32. *M. foetens*
14. Cystidia none, setalike dermatocystidia present..... 33. *M. brunnescens*
14. No dermatocystidia present..... 34. *M. albella*
15. Spore ornamentation mainly in the form of a broken reticulum..... 16
15. Spore ornamentation as discrete elements or 1-2 united into an irregular isolated ridge..... 17
 16. Peridial surface plush-like; cystidia present in hymenium..... 35. *M. setigera*
 16. Peridial surface silky to unpolished; cystidia absent..... 36. *M. monticola*
 16. Pleuro cystidia present, surface of gastrocarp subgelatinous..... 36a. *M. alba*
17. Epicutis of pileus a thick layer of appressed gelatinous hyphae..... 37. *M. occidentalis*
17. Not as above..... 18
 18. Epicutis of peridium of a compacted trichodermium; gastrocarp wrinkled when fresh..... 38. *M. idahoensis*
 18. Epicutis of peridium of appressed filaments..... 19
19. Odor of fresh specimens strong of witch hazel; spines of spore ornamentation amyloid only at the tip..... 39. *M. scissilis*
19. Odor not distinctive; spore ornamentation heavily amyloid..... 40. *M. cremea*
19. Odor not distinctive; spore ornamentation only partly covered with amylaceous material..... 41. *M. mistiformis*

Section **Proto-cystangium** sec. nov.

Peridio in parte exteriore cellulis vesiculososis efformato.

Species typica. *Martellia vesiculosa* S. & S.

21. **MARTELLIA oregonensis** (Zeller) Singer & Smith comb. nov.

Hydnangium oregonense Zeller, Mycologia 33:200. 1941.

Fig. 23.

Gastrocarp 10-20 mm broad, depressed globose, smooth, white, becoming marbled with light and dark brownish spots; gleba white becoming flesh-pink, then brownish-vinaceous, cavities small; columella and sterile base none, odor farinaceous.

Spores $15-18 \times 10-15 \mu$ (minus ornamentation), ellipsoid to globose; ornamentation of spines $4-7 \times 1.5-2.5 \mu$ amyloid in some manner, either with a thin amylaceous coating over all, with a more heavily amylaceous jacket over lower half and apex nearly hyaline, or upper part even or more irregularly coated with amylaceous material than the lower part; elements closely spaced (but not fused) to somewhat separated; plage area and sterigmal appendage not distinct.

Hymenium continuous. Basidia (30) $35-46(54) \times 10-13 \mu$, clavate, 1-spored, yellowish-hyaline, thin-walled. Cystidia fusoid, scattered to rare, $42-54 \times 7-11 \mu$, thin-walled, hyaline. Basidioles clavate, thin-walled.

Hyphal layers. Subhymenium of inflated cells (sphaerocysts), 2-3 cells deep; mediostratum of interwoven filamentose hyaline thin-walled hyphae $3-6 \mu$ diam. and lacking sphaerocysts; a few subparallel strands forming a rudimentary hymenopodium on each side of mediostratum. Epicutis of peridium a cellular zone 3-6 cells deep, the elements $8-20 \mu$ broad and with thin smooth hyaline walls, from the surface of this layer project numerous small dermatocystidia $15-22 \times 4-8 \mu$, some fusoid ventricose, some clavate, and all with hyaline walls. Context of interwoven hyaline hyphae $3-5 \mu$ diam. and cells scarcely inflated; no sphaerocysts or inflated cells present.

Under duff in mixed woods, Roaring River Fish Hatchery, Linn County, Oregon, April 30, 1938. S. M. Zeller, 8487-type. (NY).

As Zeller pointed out, this is a most interesting fungus. Its unusual characters are the cellular epicutis of the peridium with the small dermatocystidia, lack of sphaerocysts in the context of the peridium, the large spores with their tremendously large spines irregularly coated with amylaceous material, the white color of fresh specimens and the vernal fruiting habit. Zeller 8200, from the above locality on March 20, 1934 is the same. It was identified as *Hydnangium gilkeyae* by Zeller. In it some of the large spines appeared tubular with amylaceous material lining the tubule. Zeller 8459 is a third collection. It was from under incense cedar at Comstock, Oregon, June 15, 1937 and was also identified by Zeller as *Hydnangium gilkeyae*.

22. **MARTELIA variabilispora** Singer & Smith sp. nov.

Fig. 24.

Carpophoris 15 mm latis, globosis; candidis, gleba alba dein cinnamomeo-alutecae, loculata; sporis $11-14 \times 9.5-12 \mu$, amyloidesis, subreticulatis. Specimen typicum in Herbarium "NY" conservatum, F. H.

Smith, 4 Oct. 1948, prope "Mary's Peak", Benton County, Oregon, U.S.A.

Gastrocarp 15 mm broad as dried, subglobose, pure white throughout, drying alutaceous; the gleba white at first, drying cinnamon buff; center of gastrocarp cavernous; columella and sterile base none present.

Spores $11-14 \times 9.5-12 \mu$, broadly ellipsoid to subglobose, sterigmal appendage inconspicuous or up to 2.5μ long, usually with an amyloid basal jacket; ornamentation strongly amyloid, or on larger elements strongly amyloid only at the tip, prominences $0.7-1.5 \mu$ high, in the form of warts and small spines, the elements isolated to grouped into ridges, crescents, or irregular "knotty" short lines (all types usually present on a single spore), very closely arranged but the pale yellowish spore wall visible between elements or groups of elements; plage area not distinctive; hyaline revived in KOH.

Hymenium continuous. Basidia $24-32 \times 9-11 \mu$, 1-spored, clavate, thin-walled, hyaline in KOH. Basidioles numerous. Pseudoparaphyses $10-15 \mu$ broad, clavate, scarcely distinct from basidioles. Cystidia none observed but basidia with sterigma beginning to form remind one of mucronate leptocystidia.

Hyphal layers. Subhymenium cellular and in age the cells enlarged and sphaerocyst-like, hyaline, thin-walled; mediostratum of thin-walled hyaline, smooth, interwoven filaments, not gelatinous in KOH; no sphaerocysts and no oleiferous hyphae present. Epicutis of peridium a cellular layer 4-6 cells deep of hyaline smooth-walled hyphal cells, some clavate end-cells projecting from surface. Context of hyaline interwoven filaments $3-5 \mu$ diam., non-gelatinous and lacking incrustations; no sphaerocysts present and no oleiferous hyphae seen. Clamp connections none.

Under conifers, Mary's Peak, Benton County, Oregon. Coll. Dr. F. H. Smith. October 4, 1948.

This collection was identified by Zeller as *Hydnangium gilkeyae* but the spores readily separate the two, and the epicutis of the peridium is also different. It appears to be related to *Martellia ellipsospora* by spore characters.

23. MARTELLIA maculata Singer & Smith sp. nov.

Fig. 26.

Carpophoris 1-2 cm latis, globosis, pallidis, brunescens; gleba pallida; sporis $10-15 \times 8.5-11 \mu$, subglobosis, echinatis; aculeolis ad apicem amyloideis; cystidiis nullis. Specimen typicum legit, S. M. Zeller. (8349) 6 Nov. 1947, sub "incense cedar", prope Comstock, Oregon, U.S.A. (NY).

Gastrocarp 1-2 cm thick, globose, surface uneven to alveolate, pallid, with brown stains in places; gleba pallid but also with brown stains in places; columella and sterile base absent.

Spores $10-15 \times 8.5-11 \mu$, subglobose to ellipsoid, wall about $1-1.5 \mu$ thick, pale orange to orange buff in Melzer's and nearer cinnamon-buff in KOH; sterigmal appendage inconspicuous; ornamentation in the form of spines up to 1μ high and 0.5μ broad which are amyloid only at the tip or on one side near the tip, smaller amyloid granules also present on the spore surface but for the most part all elements unconnected; plage area not different from remainder of surface.

Hymenium. Basidia clavate, $20-24 \times 10-12 \mu$, yellowish in KOH, 2- and 4-spored. Basidioles numerous, content yellowish in KOH. Cystidia none seen.

Hyphal layers. Subhymenium gelatinous, hyaline in KOH, the cells badly collapsed but short and $\pm$ isodiametric; mediostratum subgelatinous, hyphae only slightly inflated, hyaline in KOH, thin-walled; no sphaerocysts present. Epicutis an epithelium several cells deep, the walls hyaline to yellowish, smooth, not gelatinous. Context of interwoven hyaline subgelatinous filaments, no sphaerocysts present. Clamps none.

In the Zeller Collections at New York under the name *Hydnangium compactum* Harkness, No. 8349, under incense Cedar, Nov. 6, 1937.

The amyloid reaction of the spore ornamentation is such that the reaction appears spotty under the microscope; some warts show it and some do not, but when present it is clearly evident. The cellular epicutis of the peridium, spore characters and lack of cystidia are distinctive.

24. *MARTELLIA vesiculosa* Singer & Smith sp. nov.

Figs. 27-28.

Carpophoris 1-2 cm latis, globosis, candidis; gleba pallida, loculata; columella nulla; sporis $10-14 \times 8-11 \mu$, echinatis, aculeis integris amyloideis; cystidiis nullis. Specimen typicum legit prope Comstock, Ore. U.S.A. Oct. 20, 1937. S. M. Zeller 8323, (NY).

Gastrocarp 10-20 mm thick, globose, pure white, gray as preserved in fluid; gleba creamy and unchanging (gray as preserved in fluid) chambers small and irregular; columella and sterile base none evident.

Spores ellipsoid to subglobose $10-14 \times 8-11 \mu$, wall pale yellow in Melzer's and about 1μ thick; sterigmal appendage short and inconspicuous; plage area not distinctive except for slightly more irregular ornamentation; ornamentation amyloid, of separate rods and warts up to 1.3μ high, these closely grouped in some areas but not fused, very easily deciduous hence many "glabrous" spores in most mounts.

Hymenium. Basidia short-clavate, $23-28 \times 9-12 \mu$, mostly 2-spored, hyaline, thin-walled, readily collapsing. Basidioles numerous. Cystidia, none present.

Hyphal layers. Subhymenium "cellular" in structure, the cells enlarging to $\pm 15 \mu$ diam. (sphaerocyst-like); mediostratum of interwoven hyaline subgelatinous filaments $3-7 \mu$ diam., no sphaerocysts present. Oleiferous hyphae absent. Epicutis of peridium an epithelium of large inflated cells ($18-52 \mu$ diam.) with yellowish non-gelatinous smooth walls. Context of narrow ($3-5 \mu$) uninflated non-gelatinous hyphae intricately interwoven and hyphal cells unenlarged; no sphaerocysts present except in subhymenium. Oleiferous hyphae none. Clamp connections none.

In the Zeller collections (NY) under *Hydnangium monticola*, Zeller 8323. Found under incense Cedar, Comstock, Oregon, Oct. 20, 1937. S. M. Zeller.

The tendency for the spines of the spores to slough off in revived material is rather striking. The species is distinguished by the evenly amyloid elements of the spore ornamentation, the fact that the elements are not fused at their bases, and the vesiculose cells of the epicutis.

Section *Martelliella* sec. nov.

Peridio in parte exteriore hyphis filamentosis efformato vel cum pilocystidiis.

Species typica. *Martellia ellipsospora*.

25. MARTELLIA *ellipsospora* (Zeller) Singer & Smith comb. nov.

Hydnangium ellipsosporum Zeller, Mycologia 31:13. 1939.

Figs. 30-31.

Gastrocarp 1-2 cm tall, 1-1.3 cm broad, subglobose, usually taller than broad, smooth but outer layer flaking off in age at times, white to pale ochraceous-buff, occasionally with large white rhizomorphs adhering to surface; gleba cream-color, becoming ochraceous-buff, cavities medium size, "empty"; columella none and no stipe or sterile base present.

Spores 15-20(23) $\times$ 12-15(16) μ , broadly ellipsoid, ochraceous in dilute KOH, thin-walled and wall nearly hyaline in Melzer's reagent; sterigmal appendage prominent in some of the smaller spores, usually inconspicuous in larger ones; ornamentation of irregular warts, short ridges and spines and 1.8-2.5(3) $\times$ 0.4-1 μ , strongly amyloid or amylaceous material denser over the elements of the ornamentation in some places than in others and usually darkest at or near the apex, sometimes strongly amyloid on one side of a wart and not on the other, the long narrow elements often bent or crooked, *many fine lines* and granules of amylaceous material present and connecting the major elements of the ornamentation; plage area covered with amyloid ornamentation in the form of lines and granules.

Hymenium. Basidia 30-42 $\times$ 11-15 μ , mostly 1-spored rarely 2-spored, broadly clavate, thin-walled, hyaline in KOH; those with a sterigmata resembling mucronate cystidia. Cystidia none. Basidioles present, clavate to ellipsoid. Pseudoparaphyses resembling inflated basidioles.

Hyphal layers. Subhymenium cellular, cells sphaerocyst-like and in age quite inflated (10-20 μ); mediostratum a narrow band of interwoven hyaline, branched filaments 4-7 μ in diam., hyphal cells of equal (or nearly so) diameter throughout. Epicutis of peridium as described by Zeller—an outer compactly interwoven layer of narrow hyphal filaments 3-6 μ in diam., the walls thin to slightly thickened but not at all gelatinous. Context of more loosely interwoven hyaline hyphae 5-8 μ in diam., no sphaerocysts found; clamp connections none.

Under conifers, Benton and Clackamas Counties, Oregon, June to August. The type was from under Douglas fir, Alsea Mt. Oregon, June, 1937. Coll. D. P. Rogers. (NY).

By virtue of the giant spores with their peculiar heterogeneous type of ornamentation both as to the amyloid reaction and the shape and size of the elements of the ornamentation themselves, the species is readily distinguished. The lack of sphaerocysts is significant. Zeller's illustration (fig. 19, l.c.) does not show the filamentous structure of the mediostratum as distinctly as Smith observed it on the type, but his indications of its existence are clear. Consequently we have no hesitation in transferring the species to *Martellia*.

26. **MARTELLIA soehneri** (Zeller & Dodge) Singer & Smith comb. nov.
Hydnangium soehneri Zeller & Dodge, Ann. Mo. Bot. bard. 22:
372. 1935.

Fig. 29.

Gastrocarp 6-9 mm diam. globose to reniform, very dark brown to black, surface unpolished; gleba "Sudan brown", cavities relatively large, empty; columella and sterile base none present on specimens examined.

Spores $15-19 \times 12-15 \mu$ excluding sterigmal appendage; ellipsoid to subglobose sterigmal appendage $4-7 \mu$ long and with a basal jacket of amyloid material; wall about 1μ thick and pale ochraceous tawny in KOH, merely hyaline-yellowish in Melzer's; ornamentation amyloid and in the form of rods and warts often fused into irregular short ridges, crescents or octopus-like configurations, isolated small warts and granules also present and frequently these connected by fine lines or merely with "tails", prominences $1-1.5 \mu$ high; plage area not distinctive.

Hymenium. Basidia 1-spored, $42-50 \times 9-11 \mu$, narrowly clavate, wall rigid and pale ochraceous, content when present dark ochraceous to brownish yellow, basidia appearing somewhat staggered in the hymenium, and basidiospores also caught in the layer (basidia growing up around them and these spores eventually covered by walls of old collapsed basidia). Basidioles colored and with walls similar to basidia, often septate $15-20 \mu$ back from apex. Cystidia none.

Hyphal layers. Subhymenium of compactly interwoven broad filamentous much-branched thin-walled hyphae pale ochraceous in KOH and with granular protoplasmic content, darker in color as the dark orange-brown hymenium is approached; mediostratum of interwoven more or less ochraceous filaments with slightly thickened and slightly gelatinous walls, occasional dark rusty brown laticiferous-like hyphae also present. No sphaerocysts present anywhere in tramal plates. Epicutis of pileus basically a turf of compactly arranged crooked, branched hyphae yellow to pale orange-ochraceous in KOH and Melzer's, with some free hyphal ends at surface or these grouped into fascicles. Context of yellowish crooked, subgelatinous hyphae with granular content; conspicuous dark rusty brown laticiferous-like hyphae also present; sphaerocysts absent. Clamp connections absent.

Part of the type studied; Pupplinger Heide bei Wolfratshausen, Führenwald. Bayern, Germany. C. Soehner. (NY).

This is a most incongruous hypogeous species. The large ochraceous (in KOH), ellipsoid spores with their amyloid ornamentation, and the dark orange brown hymenium with imbedded spores are a most unusual set of characters. Actually, as far as we can judge from the material at hand, the hymenium thickens much as one observes it in many of the Clavariae. This, the generally strong tendency to produce ochraceous orange pigment and the subgelatinous tissues as revived in KOH all add to the unusual aspect. The conspicuous deposits of orange-brown wall material in the hymenium are most unusual.

27. *MARTELLIA gilkeyae* (Z. & D.) Singer & Smith comb. nov.

Hydnangium gilkeyae Zeller & Dodge, Ann. Mo. Bot. Gard. 22: 371. 1935.

Fig. 25.

Gastrocarp oblong to subglobose, $45 \times 30 \times 30$ mm, brittle, surface glabrous, with innate reticulate veins, buff with brownish stains, pale tawny when dried and then the wrinkles more pronounced; gleba white becoming slightly creamy when fresh, drying "pinkish-buff" to "warm-buff", cavities open and medium sized; columella and sterile base none.

Spores $12-16 \times 12-15 \mu$ (excluding spines), ornamented with prominent simple to forked spines or truncated cones $3.5-5 \mu$ high and $1-2.5 \mu$ broad at base, ornamentation amyloid (denser at apex and around base in many spines), the elements varying greatly in size and not fused at the bases (in fact seldom connected); sterigmal appendage collapsed and inconspicuous; plage area not distinctive.

Hymenium continuous. Basidia $30-37 \times 10-14 \mu$, 1-spored, clavate, thin-walled, hyaline in KOH. Basidioles numerous. Cystidia none but basidia on which the sterigma are developing resemble mucronate leptocystidia morphologically; rarely one sees a pseudocystidial-like filament in the hymenium.

Hyphal layers. Subhymenium of densely ramose-interwoven filaments $3-6 \mu$ in diam., no sphaerocysts present; mediostratum of interwoven narrow ($2-4 \mu$) thin-walled, hyaline non-gelatinous hyphae; no sphaerocysts present. Epicutis of peridium a loose tangled turf of narrow ($2-4 \mu$) clavate to subcylindric hyphal end-cells $12-30 \mu$ long and mostly pale ochraceous and with granular content, much debris adhering in this layer. Context of loosely interwoven hyaline thin-walled smooth non-gelatinous hyphae; sphaerocysts absent; oleiferous hyphae very rare. Clamp connections none.

Hypogaeous under *Corylus californicus*, May, Oregon, legit. Helen Gilkey. (Zeller 2334-type). Also April 27, 1935, R. Sprague at Roaring Creek Fish Hatchery.

This species, by its spore characters, is more closely related to *M. oregonensis* than to any other species, but the two differ in the structure of the epicutis of the peridium, in the color of the fresh peridium, and in the cystidia of *M. oregonensis*.

28. *MARTELLIA parksii* Singer & Smith sp. nov.

Fig. 35.

Carpophoris 10 mm latis, globosis, impolitis, rugulosis, cinnamomeo-brunneis (in sicc.); gleba cinnamomea, loculata; columella nulla; sporis $10-14(18) \times 9-12(14) \mu$, echinatis; magis amyloideis in apicibus aculeolorumquam in parte inferiore; cystidiis nullis; Specimen typicum legit. prope Comstock, Ore. 6 Nov. 1937, S. M. Zeller 8362 (NY).

Gastrocarp about 10 mm diam. globose, surface uneven to wrinkled and unpolished (when dried out). Near dull cinnamon brown; gleba dull cinnamon-brown, chambers minute; columella and sterile base lacking; consistency rubbery-tough (from material preserved in liquid).

Spores $10-14(18) \times 9-12(14) \mu$, ellipsoid to subglobose, sterigmal appendage $2-3 \mu$ (in addition to above length), with a basal amyloid jacket; ornamentation amyloid and in the form of warts and rods single or in groups but not fused to form distinct lines or ridges, prominences $0.5-1.0 \mu$ high and more heavily amyloid at apex than at base; spore wall merely yellowish in Melzer's sol. about 1μ thick; plage area not distinct as such; pale buff (about "pinkish-buff") in KOH under microscope.

Hymenium. Basidia 2-spored (only a few with sterigmata seen), $22-28 \times 10-13 \mu$, broadly clavate, thin-walled, readily collapsing. Pseudoparaphyses resembling broad basidioles. Cystidia none found.

Hyphal layers. Subhymenium cellular, the cells $6-10 \mu$ in diam.; mediostratum of interwoven hyaline gelatinous hyphae mostly $2.5-6 \mu$ diam., no sphaerocysts and no oleiferous hyphae in the layer. Epicutis of pileus a turf of minute cells, clavate to filamentous, encrusted with much amorphous material, the clavate cells $4-8 \times 3-6 \mu$ and the filaments $4-12 \times 1.5-3 \mu$, various intergrading types present also. Context of narrow ($1.5-4 \mu$) hyaline gelatinous hyphae interwoven and with thin walls; no sphaerocysts present and no oleiferous hyphae. Clamp connections absent.

The type collection was found among those of *Hydnangium parksii* in the Zeller Collections. It is close to the Doty collection of May 31, 1939, but the elements of the epicutis are quite different, the spores are larger, and we doubt if the gastrocarps ever were white.

29. *MARTELLIA californica* Singer & Smith sp. nov.

Fig. 32.

Carpophoris 3 cm latis, irregularibus, impolitis; luteocinnamomeis; columella ramosa; gleba cinnamomea, loculata; sporis $9-12 \times 7.5-9 \mu$, in KOH aurantii-ochraceis, verrucosis, verrucis superne tantum amyloideis; cystidiis $36-52 \times 8-13 \mu$. Specimen typicum legit. prope Guadeloupe, Calif. 9 April 1919, H. E. Parks 524 (NY).

Gastrocarp about 3 cm broad, tuberlike and lobed to irregular in outline, surface unpolished and with much foreign material adhering to it, dull croceus to dull cinnamon; columella apparently dendroid, as judged by streaks of sterile tissue in the gleba; gleba cinnamon, chambered, the chambers small and more or less circular (data all from dried specimen).

Spores $9-12 \times 7.5-9 \mu$, subglobose with a prominent sterigmal appendage, in KOH with an orange-ochraceous content when mature (like the content of the basidia) but when immature hyaline or nearly so, finally thick-walled ($0.5-1 \mu$); ornamentation in the form of low warts $0.25-0.5 \mu$ high and these often amyloid only in upper part, usually separate but on well-ornamented spores some grouped into irregular short lines; plage area not distinct.

Hymenium. Basidia $34-42 \times 10-13 \mu$, 2-, and 4-spored, clavate, hyaline at first but at maturity (sporulating) filled with an orange-ochraceous to orange-brown content. Basidioles hyaline, clavate, thin-walled, $10-15 \mu$ broad. Cystidia scattered (most numerous in cavities near the peridium), fusoid to fusoid-ventricose, $36-52 \times 8-13 \mu$, hyaline in KOH, "empty", thin-walled, originating in the subhymenium (hence of the type known as leptocystidia).

Hyphal layers. Tramal plates with a mediostratum of narrow (3-6 μ) uninflated hyaline hyphae strongly interwoven and subgelatinous in KOH; subhymenium basically of compactly interwoven filaments of very short uninflated cells (but appearing cellular in sections). Epicutis of peridium ochraceous to orange-brown in KOH, basically a turf but elements extremely crooked and interwoven, and the walls often with short out-growths making the layer difficult to dissect, much debris adhering over the surface; context of densely interwoven filaments 3-8 μ diam., the walls slightly thickened and subgelatinous, no incrustations found, no sphaerocysts present. No laticiferous hyphae seen; clamp connections absent.

In forest duff, Guadeloupe, California, April 9, 1919. H. E. Parks, 524. Identified as *Arcangeliiella pilosa* by Zeller and then apparently he changed his mind and placed it on the same sheet as *A. cremea*.

This is a most unusual species and one on which adequate color notes would be highly desirable. It differs sharply from *M. cremea* in the highly pigmented basidia and in the ornamentation of the spores, even if one were to discount the epicutis of the peridium. Accurate data on the spore color when fresh are also needed as we believe it will be found to be a valuable species character. The lack of sphaerocysts in the peridium is important also. Since the tissues revive well, the absence of these structures was clearly determined as far as the type specimen is concerned. When this species can be re-described from fresh material in all stages of development, it may be found desirable to erect a genus for it and *M. fallax*.

30. *MARTELLIA fallax* Singer & Smith sp. nov.

Figs. 33-34.

Carpophoris 1-2 cm latis, albidis, brunescens; gleba pallide flava vel pallida; sporis 9-12 $\times$ 8-10 μ , subglobose, in "KOH" luteis; verruculosis; aculeae irregulariter amyloideae; cystidiis 38-50 $\times$ 12-17 μ , intus (in "KOH") luteis. Specimen typicum, legit prope Guadeloupe Mines, Calif. H. E. Parks. Z-253 (NY).

Gastrocarp 1-2 cm in diam., white, turning rusty brown in spots, gleba very pale yellow-cream color to nearly white; odor earthy (notes by Parks).

Spores 9-12 $\times$ 8-10 μ , subglobose to globose, sterigmal appendage 2-3 μ long, 1-1.8 μ thick and not amyloid; spore wall up to $\pm$ 1 μ thick and yellowish-hyaline in Melzer's sol.; ornamentation in the form of warts and spines 0.5-0.8 μ high and almost as broad, with amyloid material covering the smaller elements but on the larger ones covering only the apex or one side of the wart below the apex, plage area ornamented but the particles there less amyloid and smaller than elsewhere on the spore; spores pale ochraceous to hyaline in KOH.

Hymenium. Basidia 36-44 $\times$ 9-11 μ , 2-spored mostly, rarely 4-spored, thin-walled, readily collapsing, many with yellow content in KOH; sterigmata straight and conic. Pseudoparaphyses 10-14 μ broad, ellipsoid. Cystidia 38-50 $\times$ 12-17 μ , ventricose-mucronate or apex obtuse, thin-walled, hyaline in KOH or with refractive content as in chrysocystidia.

Hyphal layers. Tramal plates of interwoven, filamentous, subgelatinous hyphae somewhat transparent in KOH, hyaline, with slightly thickened walls, cells uninflated, 4-9 μ diam., no sphaerocysts present; subhymenium of similar hyphae but the cells shorter. Epicutis of peridium of interwoven hyphae hyaline to yellowish in KOH, walls thickened and "glassy" in KOH, surface with scattered dermatocystidia or these present as fascicles; the cystidia subfusoid, 4-8 μ thick and 20-30(40) μ long, hyaline and with walls slightly thickened; context of interwoven filaments; sphaerocysts absent. Clamp connections absent. Laticiferous hyphae absent.

Guadaloupe Mines, Calif., in adobe soil under *Quercus agrifolia*, a thick mat of rotting leaves present, Parkers Z-253. No date given. This was identified as *Arcangeliiella socialis* in the Zeller Herbarium.

As a species, the limited extent to which amylaceous material covers the larger elements of the ornamentation is important as is also the lower height of the prominences. But the cystidia are curious. In KOH the hymenium appears yellow from their content and that of the basidia. We do not class the cystidia as "true" chrysocystidia because the same content may also be found in young basidia or even those with sterigmata. These are, rather, leptocystidia in the usual sense but with a colored content. The field characters are practically the same as for *M. ferruginascens*.

31. **MARTELLIA subfulva** Singer & Smith sp. nov.

Fig. 36.

Carporphoris 8-15 mm latis, pallide fulvis, glabris, gleba loculata, cinnamomea; columella nulla; sporis 9-12 $\times$ 8-11 μ , pallide cinnamomeis (in "KOH"), amyloideis; cystidiis nullis. Specimen, legit prope Trout Creek, Molalla River, Oregon, U.S.A. 16 June, 1939. Beulah and Helen Gilkey (NY).

Gastrocarp pale rusty brown, 8-15 mm diam. $\pm$ globose to irregular, surface glabrous but with some adhering debris; gleba chambered with very fine chambers, dull cinnamon; columella none. Sterile base indistinct in preserved material but a definite point of attachment present.

Spores 9-12 $\times$ 8-11 μ , subglobose to globose, pale cinnamon in KOH, wall yellowish in Melzer's; ornamentation strongly amyloid, in the form of rods and spines 0.75-1.5 μ long and 0.3-0.7 μ thick, *more strongly* amyloid at apex than at base, irregular in outline (as focused on from above) or 2-3 fused into an irregular formation but no sign of a reticulum, (the individual groups unconnected but some elements showing fine tails); sterigmal appendage inconspicuous and with a basal amyloid jacket.

Hymenium. Pale cinnamon-yellowish in KOH. Basidia 23-28 $\times$ 10-12 μ , clavate, content pale yellowish cinnamon in KOH (preserved material), 2-spored mostly, thin-walled and soon collapsing. Pseudoparaphyses scattered 10-15 μ diam. almost globose at times. Basidioles scattered. Cystidia none found.

Hyphal layers. Subhymenium a layer of large sphaerocysts 2-4 cells deep; mediostratum a narrow layer of filamentose elements hyaline in KOH and not gelatinous, only moderately interwoven. Epicutis of peridium a turf ending in clavate to fusoid cells with ochraceous content, and smaller cylindric to pointed cells with slightly thickened walls. Context

beneath this area ochraceous in KOH and of interwoven narrow hyphae; context near subhymenium nearly hyaline but hyphae also narrow and interwoven; sphaerocysts and oleiferous hyphae none.

In conifer duff along Trout Creek, tributary to Molalla River, Clackamas County, Oregon. 16 June, 1939. Coll. by Beulah and Helen Gilkey.

The above data were from the specimen preserved in fluid. In the dried specimens of the same collection the gastrocarps are dull brown and the gleba dark cinnamon. Revived in KOH the turf forming the epicutis of the peridium is very distinct and the hyphae beneath it rusty brown rather than ochraceous but most of the context shows some ochraceous tone. The spores are pale cinnamon in KOH but strongly amyloid in Melzer's. Also the basidia are more strongly cinnamon in sections from dried material revived in KOH.

This species is most closely related to *Martellia fallax* in color reactions in KOH, the turf of dermatocystidia of the epicutis, and the amyloid spores. It differs in lacking cystidia and in the paler gleba and paler spores in KOH.

32. *MARTELLIA foetens* Singer & Smith sp. nov.

Fig. 37.

Gastrocarpio 30 mm lato, plus minusve globoso; peridio arrhizomorphica, obscure fulvo; gleba loculata, sicca, pallida, cinnamomeo-fuscata ubi laesa, KOH ope flavescens; columella stipiteque nullis. Sporis 9-12 $\times$ (7)8-10(10.5) μ , globosis vel subglobosis, pallide ochraceis, spinulis interdum seriatis vel confluentibus superne substantia amylacea obtectis; macrocystidiis paucis nec conspicuis; peridio simplici ex hyphis tangentialibus repentibus prope superficiem brunnescentibus vel fulvescentibus et hyphis nonnullis superficialibus interdum cystidioideis ascendentibus formato, plus minusve 150 μ crasso. Specimen typicum legit prope Secesh Summit, Idaho County, Idaho, 10 August 1958. Smith 59864 (MICH).

Gastrocarp 30 mm broad, irregular in outline but roughly globose; peridium glabrous, smooth, without rhizomorphs, dull tawny when collected and drying more or less cinnamon brown; gleba loculate, dry, pallid at first, stained dull cinnamon-brown around worm holes; columella and stipe none (no definite point of attachment); odor when fresh pungent, reminiscent of *Russula foetens*; taste slightly disagreeable.

Spores 8-11 $\times$ 7-9 μ , globose or subglobose, ornamentation projecting 1-1.5 μ (rarely 2 μ), spinules 1-1.5 μ broad at base, consisting of heavily amyloid warts and spinules closely spaced and some connected to form chains, others fused into an irregular grouping of ridges or crests but the groups essentially unconnected to other groups, sterigmatal appendage often oblique, relatively inconspicuous (2-3 μ long; in dilute KOH the spore pale to dingy ochraceous, the wall typically less than 1 μ thick).

Hymenium. Basidia 27-42 $\times$ (6.5)8-12 μ , clavate or nearly so, 4-spored or occasionally 1-, 2-, or 3-spored; sterigmata more often straight than curved, if curved not truly half-sickle-shaped as in agarics, vertical to oblique. Macrocystidia rare to scattered, with banded or granular contents or some hyaline throughout, yellow, becoming blackish in sulfobenzaldehyde, not conspicuously connected with conducting elements (but occasional oleiferous hyphae present in subhymenium or trama), 30-40

$\times 3.5\text{--}8.2\ \mu$, variable in shape, cylindric, clavate, fusoid-ventricose or dumbbell-shaped, smooth and thin-walled.

Hyphal layers. Subhymenium a moderately thick layer of subisodiametric cells $8\text{--}15\ \mu$ diam. which at times may enlarge considerably to the size and shape of sphaerocystis ($20\ \mu$); mediostratum of uninflated hyphae $3\text{--}6\ \mu$ diam. extending in the direction of the tramal plate ("regular"), interwoven, not or only slightly gelatinizing in 2.5 percent KOH. Peridium about $150\ \mu$ thick, consisting of a rather uniform layer of tangentially arranged filamentous hyphae which are repent (extending parallel with surface of peridium) but are strongly interwoven, near the surface often strongly colored fulvous brown and with occasional hyphae or cystidioid terminal cells ascending somewhat as in *M. ferruginascens*; the hyphae slightly gelatinous revived in KOH, inamyloid and without clamp connections.

Chemical reactions. KOH causing a yellow stain in the gleba, the pigment dissolving in the medium when mounted on a slide.

Solitary under *Pinus contorta*, Secesh Summit, Idaho County, Idaho, August 10, 1958. Smith-59864-type (MICH).

This species may be easily mistaken for a *Rhizopogon* in the field. The yellow reaction in KOH is an interesting field character, but does not show on revived material. *M. foetens* is close to *M. ferruginascens*, but the odor is distinct, and we believe important, especially in view of the connection to the Russulaceae. In addition there are true sphaerocysts in pockets in the tramal plates of *M. ferruginascens*, i.e., the trama is heteromerous at least to a slight extent.

33. **MARTELLIA brunnescens** Singer & Smith sp. nov.

Fig. 38.

Carpophoris $10\text{--}25\ \text{mm}$ latis, globosis, albis, glabris, subtriticulatis demum alveolatis, brunnescentibus; gleba alba demum brunnea; columella nulla; sporis $8\text{--}11 \times 8\text{--}9\ \mu$, echinulatis, aculeis amyloideis; cystidiis nullis. Specimen typicum, legit prope Roaring River Fish Hatchery, Linn County, Oregon, U.S.A., 31 Mai, 1939; Max Doty (NY).

Gastrocarp $10\text{--}25\ \text{mm}$ broad, globose or nearly so, white, glabrous, surface uneven to tuberculate and in some specimens finally alveolate, older specimens brownish as if stained; columella and sterile base none; gleba white staining brown, the chambers minute.

Spores $8\text{--}11 \times 8\text{--}9\ \mu$, broadly ellipsoid to subglobose, sterigmal appendage inconspicuous; ornamentation in the form of short spines and warts in groups or evenly distributed but mostly unconnected, the prominences $0.8\text{--}1.3\ \mu$ high, generally strongly amyloid, especially at apex of the spines; plage area not distinctive or merely with less prominent ornamentation.

Hymenium. Basidia 4-spored and 2-spored, $26\text{--}34 \times 10\text{--}12\ \mu$, clavate, thin-walled, content protoplasmic. Basidioles numerous. Cystidia none.

Hyphal layers. Subhymenium appearing cellular because the hyphae diverging from the mediostratum are cut up by cross walls to produce more or less isodiametric cells; mediostratum of interwoven hyaline gelatinous hyphae $3\text{--}5\ \mu$ in diam. and no sphaerocysts or oleiferous hyphae present in the layer. Epicutis a turf of seta-like dermatocystidia $22\text{--}36$

$\times 3-7 \mu$, fusoid in shape, and walls thin to thickened and yellowish hyaline in KOH, often with patches of amorphous incrustation around them. Context of gelatinous interwoven hyphae $2-4 \mu$ in diameter, hyaline and smooth. No sphaerocysts or oleiferous hyphae present. Clamp connections none.

Type collected at Roaring River Fish Hatchery, Linn County, Oregon, May 31, 1939, Max Doty. Filed under *Hydnangium parksii* in the Zeller Collections (NY).

The above data are all taken from the material preserved in alcohol in the Zeller Herbarium. Apparently none of the material was dried. The distinctive features are the turf of dermatocystidia and amyloid spores with isolated to grouped but unconnected elements of the ornamentation of only moderate height.

A collection by Helen Gilkey at Alsea Mt., Benton County, Oregon. June 2, 1944 was 3 cm in diameter and was identified by Zeller as *H. parksii*. It is the same as the Doty collection, but in it setae resembling the dermatocystidia also occur in the hymenium of the cavities near the context of the peridium. The same brownish stains on the gastrocarp are present in both.

34. MARTELLIA *albella* Singer & Smith, sp. nov.

Carpophoris 10-16 mm latis, subglobosis, albellis, glabris, saepae ochraceo-maculatis; gleba albella, loculata; sporae $11-12 \times 9.5-12 \mu$, subglobosis; cystidiis nullis. Specimen typicum legit prope Puerto Blest, Rio Negro, Argentina, 17 Feb. 1960, R. Singer M-3024 (LIL).

Gastrocarp irregularly globose or potato-shaped, 10-16 mm broad and around 16 mm high, permanently closed and lacking both a stipe and well developed sterile base. Peridium 0.1 mm thick, or a little more (very thin), not breaking up or separable from the gleba when fresh, pallid white, glabrous, smooth, naked, not viscid, sometimes ochraceous spotted in age but not changing color when bruised. Gleba whitish, in age dingy pallid, minutely loculate, tramal plates not lamellate in form but instead irregular and much branched to produce the small chambers which are 0.3-0.7 mm in diameter. Context fleshy, white, unchanging, taste mild, inodorous.

Spores $11-12 \times 9.5-12 \mu$, subglobose, hyaline to pale yellowish; ornamentation projecting 0.7-1.2 μ , of type II (a broken reticulum of coarse crests which are sometimes forked and accompanied by isolate warts and spines, entirely amylaceous).

Hymenium. Basidia $33-58 \times 8-12 \mu$, hyaline, 2-spored (a few 1-spored), cylindric-clavate to clavate, sterigmata straight to curved. Cystidia and pseudocystidia none seen (sulfobenzaldehyde mounts of freshly dried material showed no brown-black discolorations in hymenial layer).

Hyphal layers: Tramal plates. Hyphae of the mediostratum forming a relatively broad, layer of interwoven filaments or in places subparallel in arrangement, rarely with scattered oleiferous hyphae intermixed, not gelatinized, hyaline; subhymenium variable in thickness and intermittent of intricately interwoven elements with short almost sphaerical cells (up to 10 μ in diam.), all hyaline and from it extend short multiseptate hyphae

extending to the basidia. Peridium consisting of a broad inner layer (the context) and an outer one (the cutis). Both layers of periclinal (appressed) filamentous hyphae, and oleiferous hyphae the latter yellowish and 4-8 μ thick and very numerous in the context; the primordial hyphae mostly yellow and granular on outside (turning brown or fuscous in sulfobenzaldehyde). At the surface the hyphae 3.5-7 μ broad, with rounded tips and occasionally the ends ascendant or erect to form a sparse rudimentary turf. All hyphae lacking clamp connections.

On earth, virtually epigeous, under *Nothofagus dombeyi* Puerto Blest, Rio Negro, Argentina. Feb. 17, 1960, R. Singer M-3024 (LIL), holotypus.

This species is distinguished readily from *M. brunnescens* by the lack of dermatocystidia and by a different pattern of spore ornamentation.

Section MARTELLIA

Epicutis of gastrocarp non-cellular, formed of repent hyphae or a trichodermium of cystidia or hyphal ends.

Type species. *Martellia mistiformis*.

35. MARTELLIA *setigera* (Zeller) Singer & Smith comb. nov.

Hydnangium setigerum Zeller, Mycologia 31:150. 1939.

Fig. 39.

Gastrocarp 5-15 mm diam., subglobose, attached by a single rhizomorph, surface unpolished to plush-like, white to light brown; gleba creamy white, changing to light brown, cavities small, irregular. Columella and sterile base none.

Spores 8-10(11) μ , globose nearly hyaline as revived in KOH; sterigmal appendage $\pm 2.5 \times 2 \mu$ and with an amyloid jacket around the base; ornamentation in the form of irregular knotty ridges connected to form a broken reticulum and in addition with both small warts and granules with tails, or very fine lines connecting to coarser elements, the prominences about 0.25 μ high (very low), all elements of ornamentation strongly amyloid; spore wall pale yellowish in Melzer's and about 0.5-0.75 μ thick; plage area not differently marked than remainder of surface.

Hymenium. Basidia 30-42 $\times$ 10-12 μ , clavate, yellowish as revived in KOH; 1-, 2-, and 4-spored (Zeller), very few seen sporulating in Smith's sections and those seen were 4-spored. Basidioles numerous. Pseudoparaphyses scattered 36-40 $\times$ 15-20 μ (resembling giant basidia but none observed bearing sterigmata). Cystidia numerous, 34-52 $\times$ 7-11 μ , basically fusoid but near apex usually with a series of constrictions, apices acute, hyaline, content protoplasmic, often seen to connect to oleiferous hyphae; filamentous "pseudocystidia" 30-40 $\times$ 3-5 μ and with obtuse apices also present.

Hyphal layers. Subhymenium in the form of diverging hyphae 4-8 μ diam. which are 2-3 septate and in age the cells becoming sphaerocyst-like (up to 15 μ); mediostratum of filamentose-inter-woven hyaline hyphae 4-8 μ in diam. and at junction points some cells barrel-like and up to 12-15 μ broad but no true sphaerocysts present; oleiferous hyphae scattered. Epicutis a trichodermium of thin-walled yellowish to hyaline hyphae with numerous cross-walls and the cells of irregular shape making the layer difficult to interpret, proliferated at the tips into versiform dermatocystidia (10)15-30 $\times$ (3)5-8(10) μ , clavate, subfusoid, seta-like or con-

torted-filamentose, if seta-like the cell walls thickened slightly but hyaline in KOH. Context of interwoven narrow (3-4 μ) hyphae with hyaline walls, some barrel-shaped cells scattered through it near subhymenium and a few intercalary sphaerocysts present. Clamp connections none. Oleiferous hyphae present.

Under moss in dense coniferous woods, Roaring River Fish Hatchery, Linn County, Oregon, March 20, 1934. S. M. Zeller 8202-type.

The type was preserved in liquid and this may have affected the color of the setae as these structures were described by Zeller. The above description gives the microscopic data as we obtained them from the type. The species is a *Martellia* even though the spore ornamentation is strongly amyloid. The lack of true sphaerocysts in the mediostratum is the deciding character in this instance. When this species is again encountered, specimens should be dried in the usual manner and sections of such specimens then revived in KOH to get the typical color reactions. We suspect that the basidia in such sections will show a colored content and that the setae may then show as Zeller described them. The structures Smith observed which could be interpreted as endocystidia were oleiferous hyphae.

36. *MARTELLIA monticola* (Hark.) Singer & Smith comb. nov.

Octaviania monticola Harkness, Proc. Calif. Acad. Sci. Bot. III. 1:254. 1899.

Hydnangium monticola (Hark.) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:372. 1935

Fig. 40 and pl. 2, lower figure.

Gastrocarp 10-35 mm broad, globose or nearly so, irregular at times; peridium white but dingy from adhering dirt, at times pinkish-buff in age, outer layer readily separable and often peeled back, much as in *Scleroderma flavidum* Ell. & Ev., inner layer after exposure soon rimose, often so deeply as to expose the gleba; gleba when young, becoming "pale pinkish buff" of slightly paler than "light pinkish cinnamon", loculate, the chambers small; columella a white strip of sterile tissue which branches laterally and is percurrent in some specimens and in others almost lacking, base often with a conspicuous fleshy thickening; odor mild; taste not recorded; context of peridium white and unchanging when cut.

Spores 10-12.5 $\times$ 9.5-12 μ , subglobose to globose, hyaline to very pale yellowish in dilute bases; apiculus small and inconspicuous, either straight or oblique; ornamentation in the form of a heavily amyloid broken reticulum with the prominences 0.5-1.1 μ high, rarely with numerous short irregular ridges only partly connected and with isolated warts also present.

Hymenium. Basidia 26-40 $\times$ 7.5-12 μ , hyaline, clavate, 2-, or 4-spored, thin-walled and readily collapsing; sterigmata mostly straight, vertical or less frequently oblique. No cystidia of any kind found.

Hyphal layers. Subhymenium broad, consisting of isodiametric cells some enlarged to resemble sphaerocysts, filaments rarely present; mediostratum narrow, consisting of filamentous hyphae relatively frequently septate and somewhat interwoven, lacking sphaerocysts except where tramal plates merge with peridial inner layer; lactiferous hyphae none; oleiferous hyphae occasional. Peridium three layered; with an epicutic-

ular layer consisting mainly of hyphal ends and cystidioid terminal elements not forming a palisade but irregularly ascending and often tangled, the terminal cells cylindric, $24-41 \times 4.5-8.5 \mu$, ampullaceous, subcapitate, clavate, fusoid, etc., apices obtuse to subacute, walls thin to slightly thickened; intermediate layer consisting of tangentially repent filamentous hyphae rarely with slightly swollen cells (to 10μ diam.), usually $2-4.5 \mu$ broad, hyaline, subparallel to interwoven, not gelatinized, when peridium splits this layer often adheres to the epicuticular layer; inner layer of hyaline heteromerous tissue, sphaerocysts large and abundant; all hyphae inamyloid and lacking clamp connections.

Scattered under *Abies lasiocarpa*.

Material studied. Idaho, Kinney Point, Hell's Canyon, Aug. 20, 1958, coll. T. Westerdale, Smith-60297 (MICH).

This species can be recognized in the field by the manner in which the two outer layers of the peridium split open, giving somewhat the aspect of *Scleroderma flavida*. The spore ornamentation separates it readily from *M. cremea*.

36a. *MARTELLIA alba* (Harkness) Singer & Smith, comb. nov.

Hydnangium album Harkness, Proc. Cal. Acad. Sc. Bot. III, 1.251. 1899.

Gastrocarp about 1 cm thick, subglobose, with a basal point of attachment, pale cinnamon brown and unpolished as preserved in liquid (no dried material); Gleba of small chambers evenly distributed about concolorous with pileus as preserved; no columella or sterile base seen.

Spores globose, $11-13 \mu$, wall yellowish in Melzer's and pale buff in KOH, $1-1.5 \mu$ thick; ornamentation in the form of chains of warts connected by fine lines to produce a broken reticulum, or the warts grouped into short ridges very irregular in outline and with fine lines radiating but not connected to form a reticulum, isolated warts few, when present typically with tails, prominences $0.4-0.8$ (1μ) high (mostly relatively low ornamentation); sterigmal appendage short, inconspicuous, centrally attached; plage area not distinguishable.

Hymenium continuous, basidia 1- 2-spored, $30-40 \times 10-15 \mu$, clavate, hyaline in KOH (isolated), thin-walled and readily collapsing. Pleurocystidia $20-40 \times 10-13 \mu$, cylindric to clavate or tapered to a blunt apex, content evenly highly refractive (not granulose), scattered to rare, imbedded in the hymenium and also present as endocystidia in subhymenium and trama.

Hyphal layers. Subhymenium of interwoven filaments $5-9 \mu$, giving rise to inflated cells near base of basidium and these $10-15 \mu$ diam. Mediostratum of interwoven hyphae with enlarged hyphal cells up to 15μ diam. and scattered laticiferous or oleiferous hyphae with refractive granular content, $5-12 \mu$ in diam., groups of inflated cells sometimes present at junctions of tramal plates and where plates join the peridium. Peridium of a thick ($100 \mu +$) layer of hyaline hypha $2-4(6) \mu$ in diam. appearing near the outer surface to be loosely interwoven and somewhat "glassy" in KOH as though gelatinous originally, this layer extending

to the subhymenium but more compactly interwoven inward. Clamp connections none.

In the forest, California, spring.

Through the courtesy of Dr. Ira Wiggins, at the Dudley Herbarium, Stanford, University. Smith has been able to examine the "co-type," which, as we read the number on it, reads 174 instead of 178, but the numeral following the 7 is not too clear. Smith's data do not check well with that given by Zeller and Dodge (1936) as to dark brown bodies resembling latex organs, and the short sharp spines of the spores, and the basidia which they give as $20 \times 6 \mu$. Our measurements are based on basidia with sterigmata, but the sterigmata are not included in the measurements. The hyphae of the mediostratum are "physalomitie," and if one interprets the largest elements as sphaerocysts then these may be said to be scattered. In this character the layer resembles that forming the interior context in the peridium of *M. mistiformis* and a close relationship to that species is not at all improbable. It would appear however, that in *M. alba* the inner (context) layer of the peridium was so reduced as to be evident only in areas where the tramal plates meet the peridium. Although we place this species in *Martellia* we recognize it as one which is borderline and could with some justification be referred to *Gymnomyces*.

37. *MARTELLIA occidentalis* Singer & Smith sp. nov.

Fig. 41.

Carpophoris circa 1 cm latis, subglobosis, in siccati atro reticulatis, duris; columella percurrente; gleba loculata, avellanea; sporis 11-14(17) $\times$ 10-13(15) μ , tenuicatis, globosis; subspinulosis, aculeis amyloideis. Specimen typicum, legit prope Saratoga, Calif. 23 March, 1919. J. McMurphy 272 (NY).

Gastrocarp up; to 1 cm diam. subglobose; peridium blackish, wrinkled and hard; columella percurrent as a blackish line of sterile tissue; gleba of chambers about 0.5 mm in diam. round or nearly so and filled with "avellaneous" material (spores). Above data taken from dried specimen.

Spores 11-14(17) $\times$ 10-13(15) μ , globose to subglobose, wall thin, many spores remaining collapsed in Melzer's reagent, ornamented with warts and spines 1-1.5(2) $\times$ 1 μ , ornamentation *strongly* amyloid, elements closely arranged but mostly separate (2-3 fused on some spores in places), spaces between the elements non-amyloid, spore in KOH yellowish-hyaline; sterigmal appendage inconspicuous and lacking any coating of amylaceous material.

Hymenium. Basidia 4-spored, 36-44 $\times$ 10-17 μ , clavate, sterigmata very fine, conic, about 4 $\times$ 1 μ . Pseudoparaphyses 30-36 $\times$ 16-24 μ almost ellipsoid, thin-walled, hyaline (in KOH). Cystidia none.

Hyphal layers. Tramal plates of interwoven "glassy" hyphae in KOH, about 5-6 μ in diam. and with hyaline walls, no sphaerocysts or laticiferous hyphae seen; subhymenium of cellular elements at times considerably enlarged (sphaerocysts). Epicutis of pileus a thick gelatinous layer about 200 μ thick or more and with slightly less gelatinous tissue forming the body of the context, all hyaline in KOH and yellowish hyaline in Melzer's reagent. Sphaerocysts rare and mostly near the subhymenium of the outer glebal cavities. Clamp connections none. Laticiferous hyphae rare.

Under oak, Saratoga, Calif. Coll. J. McMurphy, No. 272. March 23, 1919. Identified as *Arcangeliella occidentalis* in the Zeller Herbarium.

The name *Octaviania occidentalis* should perhaps be discarded as a nomen confusum. Harkness in his original account did not mention a latex, and if we interpret his language correctly, the gastrocarps have a sterile base from which branches of sterile tissue extended into the gleba as a dendroid columella. We quote: "Large, 2.5 cm in diam. color white, turning brown, semiglobose; common integument flakey; absorbent base firm, terminating in branching fibrillae; gleba cells white; cells oblong or subrotund, basidia 4-spored; spores briefly stipitate, white, globose, echinulate, having about twenty blunt projections on the circumference 14 μ diam." Whether one interprets the statement about the sterile base as we do or as terminating downward and there giving rise to fibrils, it is evident that Harkness did not say anything about a percurrent columella. These two characters Zeller and Dodge must have obtained from the co-type, and this causes us to wonder if the original collection was a mixture of species.

In any event, the species Harkness described and the one McMurphy collected (as No. 272) are two different fungi. The outstanding features of the McMurphy collection are the broad basidia (10-17 μ) the absence of cystidia, and very likely the presence of gelatinous tramal tissues. The McMurphy collection, in addition had filled glebal chambers, but the importance or meaning of this character needs further study.

38. *MARTELLIA idahoensis* Singer & Smith sp. nov.

Figs. 42, 45-46 and pl. 2, center figure.

Gastrocarpio 8-40 mm lato, globoso-depresso vel irregulari; peridio cristulis irregularibus ornato, albo, duplici; gleba alba, demum cinnamomeo-alutacea minute loculata, sicca; columella a basi sterili exigua dendroidee extensa, lineari, manifeste percurrente, in siccis facile praetervisa; carne alba, immutabili. Sporis 10.5-13 $\times$ 9.5-11.5 μ , globosis vel breviter ellipsoideis, aculeis longis echinatis iodi ope typi VI modo ornamentatis, partim amyloideis. Basidiis 2-4-sporis. Cystidiis pseudocystidiisque praesentibus. Peridio in parte interiore hyphoso ex hyphis filamentosis composito (parte interiore plus minusve 350 μ crassa); in parte exteriori (200 μ lata) e catenulis hypharum paucarum filamentosarum numerosissimorumque elementorum inflatorum sphaerocystiformium (e. gr. 26 $\times$ 15 μ) efformato, membris terminalibus catenularum hyphiformibus, clavatis (e. gr. 40 $\times$ 10 μ), irregularibus rarius cystidiformibus, ex toto haud gelatinoso. Specimen typicum, legit prope Squaw Meadows, Idaho County, Idaho, Aug. 1958, Smith 60161 (MICH.)

Gastrocarp 8-40(50) mm broad, globose-depressed, circular or quite irregular in outline; peridium uneven to ribbed with irregular ridges and grooves, more or less distinctly radiating from the base of the carpophore (point of attachment), at first merely wrinkled, with little or no dirt adhering to the surface, white to dead white when young, finally with a pale alutaceous tone in some areas, rarely over all, drying pallid, two-layered, the outer layer separable, thin (little more than half a millimeter thick when dried); gleba white, in age pale cinnamon buff, composed of minute, irregular empty chambers, dry in consistency when cut;

columella poorly developed, dendroid, in fresh material observable as a few white lines of sterile tissue extending out from a small basal tubercle of sterile tissue or a thickened basal portion of the interior layer of the peridium. Context of peridium white, unchanging, odor none, taste not recorded.

Spores $10-13 \times 9-11.5 \mu$, globose to broadly ellipsoid; sterigmal appendage very inconspicuous, straight or oblique, attached at geometric base of spore; ornamentation essentially echinate to verrucose, the prominences $1-1.5(-2) \mu$ high, elements unconnected or anastomosing to form compound warts which are also more or less unconnected to each other, very few anastomosing lines or ridges, amylaceous material denser at apex of the spines and warts.

Hymenium. Basidia $29-45 \times 11-16 \mu$, clavate, hyaline, (1-), 2-, 3-, and 4-spored; sterigmata $5-8 \mu$ long, narrowly conic, erect or slightly oblique, straight or nearly so, apical. Macrocystidia arising from deeper in the tramal tissue than the basidia, $40-50 \times 9-10 \mu$, with banded to granular pale yellowish content turning brown in sulfobenzaldehyde, clavate to subcylindric, obtuse, scattered. Leptocystidia (?) rare, $30-37 \times 12-15 \mu$, clavate-mucronate and with weakly refractive amorphous interior mass as revived in KOH: a second type ($76-90 \times 9-14 \mu$) present and narrowly clavate, found on fresh material but not demonstrated again from dried material, their content hyaline and homogeneous and the wall very slightly thickened.

Hyphal layers. Subhymenium broad, cellular, of large and small sphaerocysts; mediostratum of tramal plates relatively narrow, composed entirely of filamentous hyaline subparallel to slightly interwoven hyphae extending in the direction of the tramal plates; laticiferous hyphae rare (best seen in immature fruits), brown in KOH, crooked. Peridium consisting of an epicuticular layer over 200μ thick consisting of a staggard palisade of hyphae with enlarged cells and ending in clavate end-cells, or these showing irregular proliferations, rarely with narrow or branched elements in the palisade; interior to this layer is a layer of repent filamentose hyphae more or less interwoven and with pockets of slightly inflated cells (rudimentary sphaerocysts), not at all gelatinized. Clamp connections absent; all hyphae inamyloid.

Chemical characters. FeSO_4 , KOH and ethyl alcohol not showing any color reaction in or on the peridium or gleba.

Solitary to gregarious, beneath the duff under *Picea englemanni* and *Abies lasiocarpa*, common in the type locality.

Material studied. Idaho, Squaw Meadows, Valley County, Idaho, August 1958, Smith-60161, type (MICH); additional collections Smith-60260, 60272, 60361, 60363, 60367, 60597, (all paratypes, MICH).

This species, which grows along with *Gymnomyces ferruginascens*, can be distinguished from the latter by its clean wrinkled appearance. It does not become brown from handling. The leptocystidia are rare and neither of us has been able to demonstrate them on the dried material. It is clear to us that the only readily demonstrable type of cystidia in the hymenium is the macrocystidial type. Balloon-shaped pseudoparaphyses can be found here and there in the hymenium.

39. *MARTELLIA scissilis* (Zeller & Dodge) Singer & Smith comb. nov.
Arcangeliella scissilis Zeller & Dodge, Ann. Mo. Bot. Gard. 22:369.
1935.

Fig. 47.

Gastrocarp up to 3 cm broad, surface very smooth, yellowish drying tawny; columella thin, white, extending about half way to apex; gleba creamy, drying antimony-yellow, compact; odor strong of witch-hazel.

Spores 10-14 μ (minus ornamentation), globose to subglobose; sterigmal appendage prominent, 4-5 μ long; ornamentation in the form of fine spines and rods $0.7-1 \times 0.5 \mu$ which are amyloid only at the tips and are not connected to each other; the spore wall between the spines non-amyloid.

Hymenium. Basidia 4-spored, $20-25 \times 8-11 \mu$, short-clavate, thin-walled, sterigmata $3-4 \times 1 \mu$, short-conic; basidioles $15-23 \times 8-10 \mu$, clavate, thin-walled. Pseudoparaphyses none. Cystidia abundant, $40-55 \times 9-16 \mu$, obventricose-mucronate, thin-walled, readily collapsing, smooth, content hyaline and homogeneous (leptocystidia).

Hyphal layers. Subhymenium of cellular structure. Mediostratum of tramal plates interwoven, hyaline and with hyphae having walls 0.5-0.7 μ thick, glassy in KOH, no sphaerocysts demonstrated. Peridium a thick hard (as dried) layer of interwoven hyphae with "glassy" walls in KOH. Epicutis not differentiated but surface hyphae with ochraceous to brownish walls and apparently a sparse covering of narrowly clavate hyphal end-cells forming a sparse turf. Innermost layer apparently with scattered sphaerocysts (vesiculose "holes" seen in this area). Oleiferous hyphae rare. Clamp connections none.

Under conifers, Northern California, November. Material studied: H. E. Parks No. 4125.

The hard peridium, the difficulty in macerating the sections and the refractive character of the hyphae in the peridial wall are distinctive features. The almost pseudoamyloid spores with the slight amyloid reaction at the tips of the spines forming the ornamentation are also important characters. On the basis of such characters as these in addition to the odor of witch-hazel, there should be no difficulty in recognizing the species.

40. *MARTELLIA cremea* (Zeller & Dodge) Singer & Smith comb. nov.
Arcangeliella cremea Zeller & Dodge, Ann. Mo. Bot. Gard. 22:
367. 1935.

Figs. 43-44.

Gastrocarps $10 \times 20 \times 20$ mm, irregular in shape, drying subreniform, light buff to cinnamon-buff, marbled; columella precurrent, creamy white; gleba firm, cinnamon-buff. The type is pallid yellowish as dried.

Spores globose to broadly ellipsoid, $10-12(14) \times 9-12 \mu$, (without ornamentation), ornamentation of strongly amyloid, isolated spines closely set and generally of two sizes: 1) 1.2-2 μ high and 1.5-2 μ at base, conic; and 2) smaller warts or amyloid particles 0.5-1 μ in diam. and about as high, no connecting lines seen, the tips of the spines often with an amyloid plug, over the plage area of the spore usually a few fine amyloid lines present and connected to form a partial reticulum and the warts and

spines on that area greatly reduced in size, the ornamentation easily broken off and littering the mount.

Hymenium. Basidia $26-33 \times 8-12 \mu$, 2- and 4-spored, clavate, hyaline, thin-walled, sterigmata $6-8 \times 1.5 \mu$, conic and narrow; pseudoparaphyses subelliptic, $10-16 \mu$ in diam., thin-walled; cystidia scattered, $35-46 \times 12-17 \mu$, ventricose-mucronate, rarely with refractive, amorphous content (but when present not same type as in chrysocystidia), mostly remaining collapsed.

Hyphal layers. Hyphae of tramal plates interwoven, hyaline; subhymenium of sphaerocysts-like cells. Peridium with a thick (about 100μ) outer filamentose epicutis of hyphae $3-5 \mu$ in diam., hyaline interwoven, and not incrustated, inner layer heteromerous; clamp connections none. Oleiferous hyphae rare to scattered.

In duff, under oaks, Oregon, March. Zeller 7927-Type.

The distinctive features of the species are the mucronate cystidia and the great variability in the height of the spore ornamentation. The lack of a cellular outer (epicuticular) layer in the peridium and lack of a stipe-columella are all that keep this species out of *Cystangium*. The spines on the spores are covered with amylaceous material but the deposit is thicker near the spine-apex.

41. MARTELLIA MISTIFORMIS Mattiolo, Malphigia 14:78. 1900.

Hydnangium mistiforme (Mattiolo) Zeller & Dodge, Ann. Miss. Bot. Gard. 22:372. 1935.

Gastorcarp about 10 mm thick, subglobose, sterile base rudimentary; peridium smooth, easily separable from the gleba, variable in thickness, whitish olive; gleba lacunose, chambers small irregular, gyrose, irregularly arranged but tending to arise in rows mostly from the base (but not lamellate), color amber to chestnut, the tramal plates cottony-filamentous and often scissile at junctions.

Spores $11-13.5 \times 9.5-12.5 \mu$ varying from hyaline to brown, pigment localized in the wall when present, wall thin or up to 1.5μ thick; ornamentation $0.7-1.5 \mu$ high, hyaline to brownish hyaline (NH_4OH and KOH), consisting of a fundamental ornamentation of narrowly conic spines which are isolated (type VI), surface typically only partly covered with amylaceous material—only at the tip, or on one side, etc.; sterigmal appendage centrally or eccentrically attached.

Hymenium. Basidia 4-spored, sterigmata straight and conic, erect or oblique. Cystidia not demonstrated conclusively (one brown, somewhat projecting and deeper rooting element seen as well as one which was hyaline and mucronate).

Hyphal layers. Subhymenium very broad, cellular, consisting of voluminous sphaerocysts; mediostratum narrow to very narrow, distinctly regular and dense, not gelatinized. Peridium consisting of two layers, the epicutis very densely compacted of hyphae about 2μ thick, hyaline and mainly tangentially arranged but strongly interwoven, in some areas irregular in shape; context hyaline and similar to epicutis in structure but hyphae broader and even more strongly interlaced, with some very short and broad elements scattered through it but not typically heter-

omeroous since the shorter elements are not like the sphaerocysts of the subhymenium, they are smaller and irregular in shape. All hyphae in-amyloid and lacking clamp connections.

Subhypogeous or hypogeous under sugar oak (Quiercie de Sughero), May. Italy. Sardinia, Orune, leg. U. Martelli, type (F. H. Patouillard Herbarium).

Zeller and Dodge state that the peridium is composed of jellified compact hyphae, but the peridial tissue as observed on the type showed no tendency toward gelatinization even when subjected to pressure in warm 10% KOH. Either there was once a gelatinous outer layer which has been obliterated or, more probably, there never was such a layer over the peridium. Zeller & Dodge described the spores as umber and slightly echinate.

GYMNOMYCES Masee & Rodway

Bull. Miscel. Infor. Kew p. 125. 1898.

"Peridium haud distinctum vel nullum. Gleba carnosa, ad basin fertilis, extus intusque lacunosa, cellulis cavis ubique subaequalibus; septa haud scissilia. Basidia pleurumque 2-spora. Sporae globosae, hyalinae, echinulatae vel verrucosae."

Differs from *Gautieria* in the hyaline globose spores. Some species of *Octaviania*, in which the peridium is very delicate, bear some resemblance to the species included in the present genus, but are distinguished by the well developed sterile base and the tinted spores."

For our own interpretation and definition of this genus see *G. pallidus*.

Type species. *Gymnomyces pallidus* Masee & Rodway. 1.c.

KEY TO SPECIES

1. Peridium white, becoming rose-tinted; spores with a heavy amyloid deposit at the base of or partly surrounding the sterigmal appendage. 43. *G. roseomaculatus*
1. Not as above. 2
2. Basidia ochraceous tawny as revived in KOH. 44. *G. cinnamomeus*
2. Basidia hyaline or nearly so in KOH. 3
3. Spores with inamyloid spines and a low broken amyloid reticulum between them; gastrocarp with evanescent peridium. 45. *G. alveolatus*
3. Not as above. 4
4. Spores $7-9(11) \times 6-8 \mu$, ornamentation in the form of a broken reticulum, the prominences $0.25-0.4 \mu$ high. 42. *G. pallidus*
4. Not as above. 5
5. Epicutis of appressed, interwoven hyphae (scattered dermatocystidia may be present over surface). 6
5. Epicutis in the form of a distinct trichodermium. 7
6. Columella present and percurrent; gleba rose pink when fresh. 46. *G. socialis*
6. Columella none; gleba white at first. 47. *G. compactus*
7. spores $12-14(18) \times 9-12(15) \mu$; gastrocarp white changing to brown 48. *G. ferruginascens*
7. Spores $8-11 \times 7-9 \mu$; gastrocarp white and unchanging. 49. *G. parksii*

42. GYMNO MYCES PALLIDUS Masee & Rodway, Bull. Misc. Inf. Kew p. 125. 1898.

Fig. 48.

"Gleba globosa, irregularis, initio albida, dein sordida, cellulis majusculis irregularibus, sordide albidis; septa tenuia, albida, nec scissilia.

Sporeae globosae, 9-10 μ diam., hyalinae, verruculosae, saepe brevissime caudatae, in quoque basidio binae, sterigmatibus brevibus suffulatae."

"Underground, Rodway 299."

"Irregularly spherical, 2-4 cm in diameter, very fragile, no distinct peridium. Sterile base obsolete but in one specimen growing into a slender stem emerging from an umbilicus."

The original data are quoted above for the genus and the type species. We have studied Rodway 1277 marked Co-type in the Zeller Herbarium and obtained the following data.

Spores 7-9(11) $\times$ 6-8 μ , broadly ellipsoid to subglobose, ornamented, the ornamentation in the form of a broken reticulum, the elements 0.25-0.4 μ high and very "knotty" in appearance and coated with a strongly amylaceous material; spore wall thin; sterigmal appendage short and pointed.

Hymenium. Basidia 4-spored, clavate, 26-30 $\times$ 8-9 μ , hyaline in KOH and readily collapsing. Cystidia scattered to abundant, 30-40 $\times$ 5-8 μ , subcylindric-mucronate and with some hyaline refractive amorphous material in the interior, thin-walled, not encrusted.

Hyphal layers. Subhymenium of inflated cells but these not much broader than the diameter of the basidioles (not true sphaerocysts); hyphae of tramal plates interwoven and with occasional sphaerocysts, hyaline in KOH. Peridium with an outer layer (epicutis) of gelatinous interwoven hyphae 3-6 μ in diameter, hyaline in KOH or yellowish only at the surface; interior to the epicutis is a thin layer showing some sphaerocysts, hyaline in KOH; laticiferous hyphae present. Clamp connections absent.

In order to clearly establish the position of this genus the holotype must be studied. "Co-type" material showed an obvious peridium and 4-spored basidia. *G. pallidus* was placed in synonymy with "*Arcangelihella alveolata*" by Zeller & Dodge very likely on the basis of Rodway's collection 1277. This collection (designated packet 3 in the Zeller collections under the above name) is specifically different from the numerous other species found under that heading in the Zeller Herbarium.

The following is an account of our study of the material filed under the name *A. alveolata* in the Zeller Herbarium. The packets have now been numbered 1-7 and are reported on here in that order.

Packet 1. From under mixed shrubs near Peoria, Linn County, Oregon, coll. and det. S. M. Zeller, Oct. 1922. Part of one gastrocarp present. Spores 9-11 $\times$ 7-9(10) μ , globose to subglobose, ornamented by ridges and lines of granules coated with amylaceous material, the heavy lines extending clear around the spore and often approximately radiating from near the sterigmal appendage; wall between elements of ornamentation hyaline in Melzer's reagent; ornamentation about 0.5-1 μ high for heavy lines 0.25 μ for finer lines and particles.

Basidia 4-spored, 40-55 $\times$ 9-12 μ , narrowly clavate, sterigmata conic, straight, 5-6 $\times$ 1.5 μ ; basidioles numerous; cystidia absent or possibly as ends of laticiferous hyphae merely projecting into the hymenium (these demonstrated on crushed material). Tramal plates with mediostrium of heteromorous tissue; subhymenium of isodiametric cells about as broad

as the base of the basidia. Peridium with a thick outer layer of subgelatinous hyphae in KOH, 5-9 μ in diam., interwoven, and interspersed are many laticiferous hyphae, inner layer apparently with some sphaerocysts. Clamp connections none.

Conclusion. The spore characters alone clearly indicate that this material is not the same as Rodway 1277. See notes on packet 4.

Packet 2. Under Oak, Berkeley, Calif. coll. N. L. Gardner, Nov. 24, 1904. Spores 7-9(11) μ , globose to subglobose with an inconspicuous sterigmal appendage; ornamentation in the form of long ridges extending more than half way to entirely around the spore, some shorter ridges and granules present between the heavier ones, the heavy ones 0.25-0.5 μ high. Basidia 36-45 $\times$ 7-9 μ , ventricose below the apex, 4-spored; sterigmata conic, many curved, 4-5 $\times$ 2 μ (at base). Basidioles abundant. Cystidia none.

Subhymenium cellular, the cells the same diameter as the base of the basidioles but about isodiametric (no true sphaerocysts present); tissue of the trama plates heteromerous, filaments interwoven, hyaline in KOH and yellowish in Melzer's reagent. Laticiferous hyphae present. Peridium of interwoven hyaline hyphae 3-8 μ in diameter, no differentiation into an outer layer, subgelatinous in KOH; laticiferous hyphae present; sphaerocysts absent; clamp connections absent.

Conclusion. This material appears to be the same species as that in packet 1, though the ornamentation of the spores is slightly lower and the peridium as observed shows more reduction.

Packet 3. This is Rodway No. 1277, already described in this account.

Packet 4. L. Rodway No. 1280, from Cascades; "co-type" material of *Hydnangium glabrum*. (Fig. 49.) This material is the same as that in packet 1. No new combination is proposed because of the very real possibility that the holotype is different than Rodway 1280.

Packet 5. H. C. Parks 477 (Z-27). This is *G. parksii*, see that species.

Packet 6. Gardner No. 220. See *Macowanites gardneri* S. & S.

Packet 7. See *Gymnomyces cinnamomeus*.

Discussion. It is evident from an examination of the seven packets that "*Arcangeliella alveolata*" must be redescribed from an examination of the holotype in order to clarify and properly define its limits. There is nothing in the original account to indicate that *G. pallidus*, or the genus *Gymnomyces*, for that matter, is characterized by the presence of a latex. Thus we believe the genus belongs in the *Russula* series of the *Astrogastraceae* where the thin apparently transparent peridium, or the absence of a peridium, would be its chief claim to distinction, and it should be remembered that the reduced peridium was precisely the character emphasized by Masee and Rodway when they erected the genus. On the basis of the present data we would arrange the genus along with *Martellia* at a lower level than those with a well differentiated stipe-columella such as *Macowanites*. We have extended the concept of *Gymnomyces* here to include species with a well defined peridium, rather than describe a new genus. However, if it should be found that in the holotype of *G. pallidus* the mediostratum of the tramal plates does not contain sphaerocysts, then a new genus would be in order.

Revised description of Genus. Gastrocarp globose to subglobose; peridium varying from thin and evanescent to well-formed, the inner layer when more than one is present often containing sphaerocysts; gleba chambered, cavities empty or nearly so, tramal plates in sections showing at least scattered sphaerocysts; columella present or absent but not in the form of a percurrent stipe-columella. Spores ornamented and the ornamentation amyloid to partly amyloid.

43. *GYMNOMYCES roseomaculatus* Singer & Smith sp. nov.

Fig. 50.

Carpophoris 1-5 cm latis, globosis vel irregulare, rimosis, albis, dein roseo-maculatis; gleba alba demum alutacea; columella nulla; sporis 14-17 $\times$ 12-16 μ , subglobosis vel breviter ellipsoideis, echinatus ("Type VI, Singer system"); cystidiis 43-62 $\times$ 12-18 μ , hyalinis vel intus ochraceo-fulvis. Specimen typicum legit prope Saratoga, Santa Cruz Mts., California, (NY). U.S.A. March, 1919, H. E. Parks Z-19.

Gastrocarp 1-5 cm in diam, very irregular in shape, with a tendency to split or crack when mature; peridium thin but persistent, white but tinged or spotted with rose or bright red, gradually discoloring to brownish over all; gleba white, turning tan, chambers very small but not filled; columella none evident (Parks made no mention of it); odor very penetrating, resembling that of witch-hazel.

Spores 14-17 $\times$ 12-16 μ , subglobose to broadly ellipsoid, with a sterigmal appendage 3-4 $\times$ 2-3 μ , ornamentation in the form of closely set rods 1-1.5 $\times$ 0.6-1 μ , not fused even though bases may touch, strongly amyloid, typically with a large mass of amyloid material to one side of or partly around the sterigmal appendage, spore-wall thin and nearly hyaline in Melzer's reagent, yellowish-hyaline to pale dingy orange-ochraceous in KOH.

Hymenium. Basidia 30-35 $\times$ 12-14 μ , clavate, 2-spored, readily collapsing; pseudoparaphyses present, 25-30 $\times$ 15-20 μ ; cystidia 43-62 $\times$ 12-18 μ , ventricose-pedicellate, tapered evenly, also tapered to an obtuse or subacute apex, thin-walled, either empty (hyaline) or with golden ochraceous somewhat granular content in KOH (but not typical of chrysocystidia), walls thin and smooth.

Hyphal layers. Tramal plates of broad filaments and some sphaerocyst-like cells, filaments interwoven, pallid yellowish to hyaline in KOH; subhymenium of sphaerocyst-like cells 1-3 deep, hyaline, thin-walled. Epicutis of peridium of interwoven hyphae but some free ends present, hyphae 4-10 μ diam. and ochraceous in mass (in KOH), much debris adhering along hyphae in and over this layer; context heteromerous but sphaerocysts not abundant, filaments loosely arranged, clamp connections none; laticiferous hyphae very rare.

In an open field under grass near *Quercus*, Saratoga, Santa Cruz Mts., California. March 1919. H. E. Parks Z-19, type.

This species has more than its share of distinctive characters. The white peridium which develops rose colored spots or areas coupled with the pungent odor of witch-hazel should be a valuable combination of field characters. Under the microscope the heavy mass of amyloid material

beside or partially surrounding the sterigmal appendage is unusual, and in addition to this we have the large cystidia with their golden subgranular content in KOH.

44. *GYMNOMYCES cinnamomeus* Singer & Smith sp. nov.

Figs. 51-53.

Gastrocarpio 10-25 mm lato, subgloboso, glabro, in siccis cinnamomei-brunneo; gleba cinnamonei-brunnea, loculata; sporis 9-12 μ , globosis, praecipue in parte superiore aculeolorum amyloideis, echinatis; basidia in "KOH" ochraceo fulvis; cystidii nullis. Specimen typicum, legit prope Berkeley, Calif. 7 January 1905, N. L. Gardner (NY).

Gastrocarps as dried globose to subglobose, 10-25 mm broad, surface glabrous, cinnamon-brown; gleba chambered, pale cinnamon-brown, no columella showing; point of attachment not definite.

Spores 9-12 μ not including the sterigmal appendage, globose to subglobose, ornamentation amyloid and consisting of short spines up to 1 μ high and warts, the amyloid reaction limited mostly to the upper half of the spines and warts, some weakly amyloid ridges and connecting lines also present and often forming half crests or half circles; sterigmal appendage oblique and projecting about 3 μ , pointed.

Hymenium. Basidia 4-spored, 38-55 $\times$ 10-13 μ , clavate, readily collapsing, *ochraceous to tawny* as revived in KOH, sterigmata irregular in size 4-7 or 11 μ long on the same basidium, sometimes conic. Cystidia none found (hymenium revived fairly well). Pseudoparaphyses present, clavate to vesiculose.

Hyphal layers. Mediostrium of tramal plate heteromerous and some oleiferous hyphae present, subhymenium cellular, cells about same diameter as base of basidium. Peridium with a thick outer layer of narrow interwoven subgelatinous hyaline filaments 3-10 μ diam., sphaerocysts present in a thin poorly defined inner layer. Clamp connections none.

Hypogeous under *Quercus agrifolia*, Univ. of Calif. campus, Berkeley, Calif. Jan. 7, 1905, coll. N. L. Gardner.

Material studied. The collection designated as packet number 7 in the *Arcangeliella alveolata* collections of the Zeller Herbarium.

The spore ornamentation varies from true broad cones to crests or half-circles and some spores predominantly show the latter. As dried the specimens remind one of *Martellia foetens* and *G. ferruginascens* but the latter two definitely occur under conifers and the ornamentation of the spores appears to distinguish them further. The colored basidia in KOH also appear distinctive.

45. *GYMNOMYCES alveolatus* Singer & Smith sp. nov.

Figs. 54-56.

Gastrocarpio 3-5 cm lato, subgloboso; peridio papyraceo demum evanescente; gleba loculata; alutacea; columella tenui; sporis 9-12 μ , globosis, aculeolis in-amyloideis sed reticulatione basali partim amyloidea; cystidiis 30-37 $\times$ 4-8 μ , filamentosis vel subretriosis, curvulis. Specimen typicum, legit prope Corvallis, Oregon, 23 May 1929. S. M. Zeller 6862 (NY).

Gastrocarps 3-5 cm thick, globose to irregular in outline, pale dull ochraceous tawny as dried, with an inconspicuous basal attachment, (al-

most like a thick rhizomorph); peridium thin and at maturity evanescent, the glebal chambers showing as an alveolate pattern on outer surface; gleba chambered, chambers empty, color "cinnamon-buff" as dried; columella slight, as a few thin lines of sterile tissue penetrating through gleba to the surface, sterile base small and inconspicuous.

Spores 9-12 μ , globose; sterigmal appendage inconspicuous, non-amyloid; wall thin (0.5 μ) and pallid yellowish in Melzer's reagent, nearly hyaline in KOH; ornamentation of scattered warts about $1-1.5 \times 1 \mu$, and non-amyloid (hyaline in Melzer's), and a low broken reticulum of broad and narrow lines most of which are in part distinctly coated with amylaceous material but on some the non-amyloid basic ornamentation visible.

Hymenium. Basidia 2-spored, $26-33 \times 9-11 \mu$, clavate, thin-walled, hyaline in KOH; sterigmata 4-8 μ long, straight, conic, cystidia $30-37 \times 4-8 \mu$, as crooked filaments to somewhat ventricose and with a crooked neck, hyaline, thin-walled, rarely with refractive content. Pseudoparaphyses none, basidioles abundant.

Hyphal layers. Tramal plates of loosely interwoven hyaline smooth, thin-walled non-gelatinous hyphae 5-12 μ in diam. and occasional sphaerocysts up to 20 μ present, laticiferous hyphae rare; subhymenium of *loosely interwoven much-branched* filaments 3-9 μ diam. Peridium not differentiated into layers, in young specimens about 200 μ thick and of closely interwoven, hyaline non-gelatinous hyphae 4-10 μ in diam., laticiferous hyphae interspersed and sphaerocysts rare (to apparently absent in some sections); surface with a few projecting hyphal ends but no true turf or hypodermial layer present. Clamp connections none.

Solitary on soil under duff ($\pm 3''$ deep), under *Quercus garyana* north of Corvallis, Oregon. May 23, 1929. S. M. Zeller 6862.

Zeller had not identified this collection to his own satisfaction though he did place it on a sheet with other collections of *Arcangeliiella rosea*.

The smaller spores, their differences in ornamentation and the amyloid reaction of the elements in both species, and the habitat difference are all significant. But the subhymenial layer shows the most basic difference. The alveolate surface of the gastrocarps is not to be regarded lightly as a character though here we are lacking information as to just what actually happens to the peridium.

46. *GYMNOMYCES socialis* (Hark.) Singer & Smith comb. nov.

Octaviania socialis Harkness Proc. Acad. Sci. Bot. III 1:252. 1899.

Arcangeliiella socialis (Harkness) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:369. 1935.

Figs. 57-59.

Fructifications depressed globose, 10-20 mm diam. or cespitose and coalescing into irregular masses $20 \times 25 \times 40$ mm, surface smooth, cream color to pinkish, dingy ochraceous to clay color dried; sterile base distinct, stipitiform below, continued through the gleba as a slender percurrent columella of heteromerous tissue; gleba rose pink drying "pinkish buff", cavities medium sized and empty.

Spores $9-14 \times 8-10(11) \mu$, excluding ornamentation and apiculus, globose to broadly ellipsoid, ornamented with cones $1.2-2 (2.5) \mu$ high and $0.8-1.2 \mu$ broad, some small particles also present, all elements of ornamentation unconnected to each other or occasionally 2-3 cones fused, strongly amyloid; sterigmal appendage present and $3-4 \mu$ long.

Hymenium. Basidia 4-spored (rarely 2-spored), short and fat $24-28 (33) \times 11-14 \mu$, thin-walled, readily collapsing, sterigmata curved or straight, $7-9 \mu$ long, $\pm 2 \mu$ at base; pseudoparaphyses present, ellipsoid to globose, $18-25 \times 14-20 \mu$; cystidia rare, $26-38 \times 10-14 \mu$ fusoid-ventricose, thin-walled, smooth, content containing some refractive material.

Hyphal layers. Hyphae of tramal plates filamentous mixed with sphaerocysts (mostly sphaerocysts); subhymenium of filaments and cellular tissue interwoven into a tissue, laticiferous hyphae present; peridium with a filamentose-interwoven epicutis of hyaline hyphae, beneath this a zone of heteromerous tissue.

Hypogeous under *Eucalyptus*, *Pasania densiflora*, etc.

Material studied Parks. #979.

The specimen selected for study was ample, well dried, and checked in essential details with the description by Zeller & Dodge (1936, p. 623). We have not studied the co-type, so the concept established here is tentative. Harkness apparently did not describe a latex as being present and Parks, who usually indicated such a character if it were present, failed to mention its presence in his notes. Hence, we transfer the fungus to *Gymnomyces*.

47. *GYMNOMYCES compactus* Singer & Smith sp. nov.

Fig. 60.

Gastrocarpio 1-2 cm lato, globoso vel irregulari, albo, demum brunneo-maculato; gleba alba, dein brunnea; minute loculata; sporis $10-14 \times 9-12 \mu$, late ellipsoideis aculeolatis; aculeis amyloideis; cystidiis nullis. Specimen typicum legit prope Sandy, Oregon, 17 June 1937, S. M. Zeller 8286 (NY).

Gastrocarp 1-2 cm thick, globose to irregular, white with brownish spots, surface uneven to wrinkled; gleba white, stained brown in places, cavities small and partly empty; columella none; sterile base none.

Spores $10-14 \times 9-12 \mu$, broadly ellipsoid; sterigmal appendage inconspicuous; ornamentation heavily amyloid, in the form of warts closely arranged in lines or fused into groups of various shapes but no long ridges or unbroken lines present, prominences about 1μ high, very faint fine lines or streaks on spore wall also present but these scarcely visible under oil; spore wall about 0.5μ thick and yellowish-hyaline in Melzer's; plage area not distinctive.

Hymenium. Basidia $26-33 \times 9-12 \mu$, 4-spored: sterigmata short (-6μ) and fine, straight; basidial wall thin and hyaline, content hyaline and protoplasmic (material preserved in liquid). Basidioles numerous. Pseudoparaphyses none. Cystidia none.

Hyphal layers. Subhymenium cellular, the cells enlarging to sphaerocysts, thin-walled, hyaline in KOH; mediostratum of interwoven hyphae with some sphaerocysts mixed in especially at junction points, filamentose hyphae with somewhat enlarged hyphal cells with thin smooth hyaline

walls. Epicutis of peridium a thin decumbent turf of dermatocystidia $18-30 \times 4-7 \mu$, mostly narrowly fusoid to clavate (layer evident in young specimens) and with thin hyaline walls. Context (in age the entire peridium) of interwoven filamentous hyphae with subgelatinous walls which are smooth and hyaline, the hyphae $4-7 \mu$ diam. but near subhymenium scattered sphaerocysts occur. Oleiferous hyphae none. Clamp connections none.

This species was identified as *Hydnangium compactum* by Zeller.

According to Dodge & Zeller (1936) the "co-type" of *H. compactum* Harkness has spores $5-6 \mu$ in diameter and has a thick peridium of jellified hyphae. It probably does not belong in the Astrogastraceous Series.

48. *GYMNOMYCES ferruginascens* Singer & Smith sp. nov.

Fig. 61.

Gastrocarpio (7) 10-50 mm lato, globoso vel ellipsoideo; peridio opaco, calcei-albo dein ferruginascente, haud viscido; gleba alba, dein pallida, brunnescente maturitate, loculata; columella stipiteque nullis, e tuberculo mycelioso nascitur; carne KOH ope ferrugineo-brunneo fit, odore debili; sporis $11-14.5 \times 10-12.5 \mu$, hyalino-stramineis, echinatis; pseudocystidiis paucis; peridio duplici, in strato interno ex hyphis filiformibus tangentialiter dispositis constante, in strato externo ex hyphis palisadice dispositis efformato. Specimen typicum ligit prope McCall, Idaho, U.S.A. 18 Aug. 1958. Smith 60269 (MICH).

Gastrocarp (7) 10-50 mm in largest diam., globose to ellipsoid or if developing among roots irregular in outline, attached at base but only by a tubercle of mycelium; peridium dry and unpolished, dull white when young, gradually becoming rusty brown especially from handling; gleba white at first, becoming pallid and by maturity "tawny" to "russet" (rusty brown), loculate, chambers empty and lined by hymenium; columella and stipe none; odor faintly disagreeable in large collections.

Spores $12-16(18) \times 9-12(15) \mu$ excluding ornamentation, ellipsoid to subglobose, ornamented with amyloid spines and warts some of which are unconnected but others fused into groups or connected by fine lines, the prominent elements $1-1.5 \mu$ high; sterigmal appendage straight or oblique, attached centrally.

Hymenium. Basidia and basidioles forming a continuous hymenium, $35-60 \times 10-14 \mu$, clavate, rarely ventricose in midportion, 2-, and 4-spored, very rarely 1- or 3-spored, hyaline, thin-walled, readily collapsing; sterigmata mostly slightly curved; pseudocystidia very rare, imbedded in hymenium, tibiiform, up to 7.5μ broad.

Hyphal layers. Subhymenium strongly developed, cellular and with frequent large sphaerocysts, hyaline in well dried material or where unstained by natural color changes; mediostratum "regular" consisting of filamentose hyphae somewhat interwoven but extending in the direction of the tramal plates, not or at most only slightly gelatinized, rather loosely arranged at juncture of tramal plates and sphaerocysts evident in these areas; peridium with an epicuticular layer consisting of a palisade of versiform elements cylindric, subulate, ampullaceous, or clavate with tips varying from acute to broadly rounded, hyaline but becoming brown inside and out, with thin to thick (1.2μ) wall, the elements of the palisade

eventually decumbent; inner peridial layer of hyaline to brownish filaments, tangential-repent, scarcely gelatinized, with thin to slightly thickened walls and narrow protoplasmic content. Hyphae all inamyloid and lacking clamp connections.

Chemical characters. FeSO_4 pale olivaceous on the gleba; KOH, quickly rusty brown on peridium.

Solitary to scattered under *Picea engelmannii* and *Abies lasiocarpa*.

Material studied. Idaho, Squaw Meadows, Valley County, Aug. 18, 1958, Smith-60269, type (MICH); Smith-60271, 60272, 60370, 60371, 60372, 60373 and 60598 all from the same locality.

This species is a good example to demonstrate the necessity of obtaining accurate data on fresh material to properly characterize a species of this genus. The color change is the most obvious field character, but the chemical reactions are also very important. As pointed out previously, *M. foetens* is distinguished by its odor and lack of sphaerocysts. Since the mediostratum of the tramal plates does show some sphaerocysts in the zone where branches come off, *G. ferruginascens* may be regarded as belonging in *Gymnomyces* but extremely close to *Martellia*.

49. *GYMNOMYCES parksii* Singer & Smith sp. nov. Figs. 62-63.

Gastrocarpio 10-15 mm lato, basi stipiti formi cava praedito sed gleba columella haud perforata est, superficie alba; odore nullo; sporis 8-11 $\times$ 7-9 μ , subglobosis echinatis (echinulis 2-2.5 μ longis ad apices tantum amyloideis, reticulatione incompleta reunitis inter se). Cystidiis raris, contentu destitutis, tenui-tunicatis, subfusoides. Specimen typicum legit prope Los Gatos, Calif. Parks 477 (Z-27) (NY).

Fructifications 10-15 mm broad (estimated), with a hollow stipe-like base which does not penetrate the gleba but in places the gleba is exposed in the area between the margin of the peridium and the sterile base; white, odorless.

Spores 8-11 $\times$ 7-9 μ , subglobose to broadly ellipsoid, with a prominent pointed sterigmal appendage 3-4 μ long (not included in above measurement), ornamented with prominent spines 2-2.5 μ long which are amyloid only near the apex or over upper half, and strongly amyloid lines and particles forming almost a broken reticulum at times and about 0.5 μ high.

Hymenium. Basidia 33-44 $\times$ 9-11 μ , clavate, 2- and 4-spored; sterigmata 4-6 $\times$ 2 μ , straight, conic. Cystidia rare, about 50 $\times$ 11 μ subfusoid, thin-walled, lacking any distinctive content; pseudoparaphyses none.

Hyphal layers. Mediostratum of tramal plates mostly filamentous-interwoven but sphaerocysts present as plates approach the peridium; subhymenium cellular. Peridium with an epicutis in the form of a compact (almost indistinct) trichodermium of septate hyphae 6-11 μ diam.; interior to this occurs a layer of mostly filamentose hyphae but some sphaerocysts clearly seen; laticiferous hyphae rare; clamp connections none demonstrated on the hyphae anywhere.

In heavy clay soil under oaks, Los Gatos, Calif. Parks 477 (Z-27), type (NY).

We take pleasure in dedicating this very unusual species to the collector, Mr. Harold E. Parks, who has collected so many hypogeous fungi

in California. The most interesting feature to us is that from the standpoint of gross morphology we have here a level of evolution in the *Astrogastraceae* Series almost exactly comparable to the *Truncocolumella* level in the *Gastroboletus* series (see Smith & Singer, 1959). *M. parksii* compares readily in this respect with *Truncocolumella citrina* var. *separans* since in both the gleba is slightly exposed around the point of attachment at maturity.

In the Zeller collections this fungus was filed under *Arcangeliella alveolata* and is now marked as packet no. 5 on that folder. It is, of course, not the same as any of the other species filed there under that name.

ELASMOMYCES Cavara

Malpighia 11:426. 1879.

This genus is characterized by the absence of both a latex and true laticiferous hyphae, by a strong differentiation of a regular filamentous mediostratum lacking distinct sphaerocysts, by the absence of clamp connections, by having amyloid spore ornamentation, and by dermatocystidia often forming a turf as an epicutis, or the epicutis in the form of a trichodermium (but not as an epithelium); a stipe-columella is present at least in a reduced state, or only a columella is present and percurrent.

Type species. *E. mattirolanus* Cavara.

As defined here species with sphaerocysts in the mediostratum of the tramal plates are excluded. From the standpoint of a level of evolution this genus is, in general, slightly more reduced in the gross morphology of the fruiting body than *Macowanites*, and extends, morphologically to a lower level, i.e., to forms which do not ever open to expose the gleba and in which the columella is at least somewhat reduced from a stipe-like structure. The degree of reduction of the columella is the main character by which the genus *Martellia* is recognized. In the latter, the columella bears no resemblance to a stipe.

KEY TO SPECIES

- 1. Peridium not differentiated into a cuticular layer distinct from the context and no true turf of hyphal end-cells present over the surface..... 2
- 1. Cuticular layer differentiated or if not at least a distinct turf of dermatocystidia or a trichodermium present (check young specimens)..... 5
 - 2. Spores 15-20 × 12-15 μ, ellipsoid; odor when fresh of ethyl acetate..... 50. *E. odoratus*
 - 2. Spores smaller..... 3
- 3. Spores 8-11 × 7-9 μ (excluding sterigmal appendage); peridium and gleba salmon-colored fresh..... 51. *E. echinosporus*
- 3. Spores larger..... 4
 - 4. Context of peridium distinctly heteromerous..... 52. *E. rodwayi*
 - 4. Context of peridium with only an occasional spherical cell..... 53. *E. mattirolanus*
- 5. Hymenial cystidia present..... 6
- 5. Hymenial cystidia absent..... 7
 - 6. Spores 7-10 × 6.5-9 μ, ornamented with widely spaced bands of heavily amyloid material as well as with ridges and warts..... 54. *E. russuloides*
 - 6. Spores 13-16 × 12-14 μ..... 55. *E. zellerianus*
- 7. Spore ornamentation in the form of a broken reticulum; odor when dried resembling that of *Lactarius camphoratus*..... 56. *E. camphoratus*

7. Not as above 8
 8. Stipe-columella present and distinct, stipe base typically pale rose color dried 57. *E. roseipes*
 8. Sterile base present; columella in the form of a percurrent structure with branches 58. *E. pilosus*

50. *ELASMOMYCES odoratus* Singer & Smith sp. nov. Fig. 67.

Gastrocarpio 10-20 mm lato, concavo, impolito et albo; stipite-columella inconspicua; odor graveolens; sporis 15-20 $\times$ 12-15 μ , pallide alutaceis (in "KOH"), amyloideis; cystidiis nullis. Specimen typicum legit prope Tahoma Creek, Mt. Rainier National Park, Washington, U.S.A., 23 July 1948. A. H. Smith 29303 (MICH).

Gastrocarp 10-20 mm broad, depressed convex, whitish and unpolished; peridium not reaching the aborted stipe consistently. Stipe columella greatly reduced in proportion to size of peridium and columella not always percurrent; gleba chambered, pallid becoming pinkish cinnamon as spores mature. Odor strong of ethyl acetate.

Spores ellipsoid, 15-20 $\times$ 12-15 μ , (including ornamentation); pale cinnamon-buff in KOH, ornamentation strongly amyloid, in the form of rods or spines 1.5-2.3 μ long, thickness variable, generally amyloid over all but darker at apex or on one side as compared to the other, elements occurring in irregular ridges or lines not connected to each other except by very fine lines, isolated warts and ridges often with "tails", no true appearance of even a broken reticulum, spore wall thin and pale yellowish in Melzer's reagent where exposed; sterigmal appendage inconspicuous.

Hymenium. Basidia 1-, and 2-spored, 30-35 $\times$ 10-14 μ , clavate, readily collapsing. Basidioles numerous, with protoplasmic content. Cystidia none seen but 1-spored basidia without a spore attached resemble cystidia.

Hyphal layers. Subhymenium of vesiculose cells, 12-20 μ in diam. 1-2 cells deep. Mediostratum of filamentose-interwoven hyphae, no sphaerocysts seen. Epicutis of ochraceous hyphae 3-5 μ in diam., interwoven and appressed or at the surface with some ascending hyphal ends. Context of interwoven filaments, hyaline to yellowish, no sphaerocysts. Oleiferous hyphae none. Clamp connections none.

On humus under conifers and hardwoods, Lower Tahoma Creek, Mt. Rainier National Park, July 23, 1948. Smith 29303 type.

This species is very close to *Martellia ellipsospora* in spore characters and in its other anatomical characters but in gross morphology is quite different, being at a different level of evolution in the Astrogastraceous Series. At the present stage of our knowledge of this group it seems to us better to present the Mt. Rainier material as a new species, particularly in view of the lack of a columella in *Martellia ellipsospora*, and the fact that its gleba is not exposed, as far as we know at present.

51. *ELASMOMYCES ECHINOSPORUS* (Zeller & Dodge) Zeller & Dodge, Mo. Bot. Gard. 22:370. 1935.

Macowanites echinosporus Zeller & Dodge, Ann. Mo. Bot. Gard. 6:57-58. 1919.

Fig. 65.

Gastrocarp 10 $\times$ 15 mm, even, smooth, very delicate salmon-color, becoming tawny olive in alcohol; gleba covered above, exposed below, sinuate.

about the stipe, pale salmon color like the peridium, cavities minute, irregular; stipe-columella portion not percurrent (merely projecting up into the gleba as a conic projection).

Spores $8-11 \times 7-9 \mu$, subglobose to broadly ellipsoid; sterigmal appendage about 2μ long, inconspicuous, faintly amyloid over the basal portion; spore wall thickened slightly, not appreciably amyloid (hyaline in Melzer's reagent); ornamentation strongly amyloid, consisting of large to small *irregularly shaped* warts and short crooked ridges 1.2μ to 0.25μ high (very variable in size), many with "tails" and short side branches but *not connected to form even a partial reticulum*, often amyloid nodules arranged in crooked short chains; plage area only faintly amyloid and with only very inconspicuous ornamentation.

Hymenium continuous. Basidia clavate "2-, 4-spored, $5-8 \times 11-22$ " Z & D. Pseudoparaphyses $23-26 \times 10-13 \mu$, clavate, thin-walled. Cystidia "rare, clavate, apiculate, $9-10 \times 20-24 \mu$ " Z & D.

Hyphal layers. Subhymenium cellular, the cells enlarging to $10-18 \mu$ diam. (sphaerocyst-like), thin-walled; mediostratum of interwoven filamentous tissue (as far as could be ascertained from the portion of type available). Peridium not differentiated into layers but with some hyphal ends projecting from surface as a rudimentary type of dermatocystidia, heteromorous structure more evident to the interior and interwoven connective hyphae more abundant near surface; clamp connections, none found; oleiferous hyphae rare.

Hypogeous under *Quercus agrifolia*, East Oakland, Calif. coll. N. L. Gardner (Univ. Calif. Herb. 402).

The spore ornamentation distinguishes *E. echinosporus* from *E. roseipes*. In the former, in spite of its name, the ornamentation is frequently in the form of ridges and many individual elements are branched or show distinct tails. In *E. roseipes* the elements are not as variable in height and appear as separate spines. There is also a distinct difference in habitat.

52. ELASMO MYCES RODWAYI (Masse) Zeller, Mycologia 40:642. 1948.

Secotium rodwayi Masse, Kew Bull. Misc. Infor. 1901; 158. 1901. Fig. 68.

Gastrocarp 20-30 mm broad, depressed globose, ochraceous-white drying dull tawny; gleba brown, firm, cavities irregular, small, exposed and depressed around the stipe; peridium continuous over the upper surface but not continuing so as to connect to the stipe hence leaving a "ring hole"; stipe (as dried) 5 mm long and 2 mm thick, hollow, lower portion furfuraceous.

Spores ($7-8 \mu$ Masse) $11-15 \times 8.5-11 \mu$ including sterigmal appendage and ornamentation; sterigmal appendage prominent, $2-3 \mu$ long, base with a faintly amyloid jacket; ornamentation in the form of blunt cones or warts ranging in height from 1.5μ to less than 0.5μ , the large elements more heavily amyloid over the apex than on the sides, or some cones amyloid only at the apex, the fine amyloid particles irregularly dispersed, a few fine lines present but elements rarely connected to each other (type VI-Singer); spore wall hyaline in Melzer's reagent; plage area not different from rest of the spore surface.

Hymenium. Basidia (27)34-46 $\times$ 12-15 μ , 4-spored, clavate, becoming ventricose at or below middle when sporulating, hyaline, thin-walled. Basidioles numerous, clavate, 10-12 μ broad. Cystidia none.

Hyphal layers. Subhymenium of hyphae about the diameter of the base of the basidium, filamentose-branched but compactly interwoven, appearing cellular in sections; mediostratum of interwoven filaments 4-7 μ diam. and hyaline or nearly so in KOH, no encrusted pigment present. Epicutis of peridium poorly differentiated from context, of interwoven filamentous hyphae 3-5 μ in diam., some hyphal ends projecting at surface. Context heteromerous, sphaercoysts most abundant toward the subhymenium of the glebal cavities. Clamp connections none. Oleiferous hyphae rare.

Known only from Tasmania.

The above description is based on our study of the type, and the original description. The extent to which the stipe projects into the gleba is not too clear in the one specimen observed, but there is no evidence to indicate that it is percurrent. In this respect the species is apparently quite similar to *E. echinosporus*.

53. *ELASMOMYCES MATTIROLANUS* Cavara, *Malpigia* 11:426. 1897.

Secotium mattirolanum (Cavara) Fischer in Engler & Prantl, *Naturl. Pflanzenfam.* 1 (Abteil. 1**: 301-2. 1900.

Gastrocarp globose-depressed or angular, 10-29 mm broad, with thin acute or rounded margin which often becomes diffracted, closed when young (according to Cavara), eventually open below or margin continuing appressed against the stipe-columella. Peridium very thin, with rudimentary cuticular layer, smooth. Context white or whitish, fragile; odor and taste not recorded.

Gleba lacunose with minute and irregular chambers, at its lower surface showing ridges radiating from the stipe-columella and sometimes covering the entire lower portion of the columella (then there is no stipe as such), and reaching the margin of the gastrocarp, apparently sometimes covered with the peridium which then connects the margin with the stipe-columella (or columella) adapting itself to the hymenophoral sublamellar ridges of the lower portion of the gleba, showing a grooved surface (false lamellae, according to Cavara, a condition we have not observed in the single type specimen at our disposal); columella constant and percurrent, adnate to the gleba, relatively short, simple, white; volva none; partial veil none seen.

Spores 10-15 $\times$ 9.5-13.5 μ , subglobose or ellipsoid and 12 $\times$ 9 μ , with central or eccentric straight or oblique sterigmal appendage; with a wall 1-1.2 μ thick, distinctly ochraceous; ornamentation of type VI (isolated spines), (0.5-) 1.5-2.5 μ high, entirely amyloid (covered with amylaceous material).

Hymenium. Basidia 30-42 $\times$ 9.5-12.5 μ , ventricose to clavate, 2- and 4-spored, with variable sterigmata but more often straight than curved and rarely very long. Sterile bodies with more or less granular incrustation, cystidioid, and varying from short and narrow to long and well differentiated (clavate, vesiculose, or cylindric) and then 22-27 $\times$ 11-12

μ , sometimes more like primordial hyphae (especially if cylindric) many transitional forms observed. Metuloids and macrocystidia none.

Hyphal layers. Subhymenium well developed and consisting of elongated as well as globose elements; lateral stratum irregular-intermixed, consisting mainly of filamentous hyphae of 2.5-4 μ diam. extending in all directions and occasional sphaerocysts (?) or merely slightly swollen hyphae (e. gr. 5.5 μ diam., shaped as shown in Cavara's original drawing) present; the mediostratum regular, consisting of similar filamentous hyphae extending more or less parallel and axial but strongly interwoven, not intermixed with sphaerocysts although occasional hyphal enlargements occur. Peridium with no distinct epicutis, the hyphae being in more parallel arrangement than those in the interior; context hyphous but with occasional vesiculose cells and air spaces, slightly gelatinized (?). Tissue of the stipe heteromerous. Laticifers none, but there are numerous oleiferous hyphae and some are broad enough to be "empty" laticifers (diameter 2.7-5.5 μ), very long, yet there is no latex, no contents or incrustation. Surface layer of stipe of suberect elongated elements. Hyphae of all tissues inamyloid, without clamp connections.

Subhypogaeous under fallen needles of *Abies alba* at San Giovanni, Gualberto, Forest of Vallombroso, Tuscany, Italy. F. Cavara. Autumn 1896, type (NY).

This part of the type was sent to Zeller by Cravara. The rest of the type collection is said to be in the Instituto Botanico di Napoli. Mattioli's collection from Florence, Italy, authentic, is at the Farlow Herbarium.

Illustrations: Cavara 1c.pl. 7; Revue Mycol. 21: pl. 187, fig. 1-5; Engler & Prantl l. c. fig. 150, A-F, respectively fig. 84, A-D; Petri, Flora Ital. Cryptogama 15, fig. 6-7.

The macroscopic data were taken from the part of the type studied and supplemented by Cavara's original description. The microscopic characters were described entirely from our observations and do not coincide with Cavara's data, particularly as far as the interpretation of the hymenial elements are concerned. However, there can be no doubt but that the type collection was homogeneous and that Cavara described what he saw in his own interpretation.

54. ELASMOMYCES RUSSULOIDES Setchell, Journ. Mycol. 13:240. 1907. Figs. 66 and 69.

Gastrocarp 10-15 mm broad, 10-12 mm high, depressed-globose to depressed convex, glabrous, white to bright red; gleba white, free from stipe, cellular within, where exposed sublamellate; stipe-columella short, fairly robust, terete, percurrent, unpolished to pruinose where surface is exposed.

Spores 7-10 $\times$ 6.5-9 μ , sterigmal appendage 1.7-2 μ long in addition; globose to subglobose; nearly hyaline in KOH and in Melzer's with a strongly amyloid ornamentation over a yellowish hyaline spore wall; ornamentation in the form of widely spaced heavily amyloid bands which sometimes cross or fuse with each other but not forming a true reticulum, or only a broken reticulum, isolated warts and short ridges also present, some faintly amyloid fine lines also present, prominences about 1 μ high, plate area with lower more fused elements of the ornamentation.

Hymenium. Basidia 2-spored, $23-28 \times 9-11 \mu$ (2-, and 4-spored, Setchell), clavate, thin-walled, hyaline in KOH; basidioles numerous. Cystidia abundant in young specimens, clavate, $40-60 \times 10-12 \mu$, content subreticulate-refractive, hyaline in KOH, walls thin and smooth.

Hyphal layers. Subhymenium of narrow ($2-3 \mu$) branched hyaline filaments, cell at base of basidium $4-5 \mu$ broad, subgelatinous in KOH, (no sphaerocysts in subhymenium); mediostratum of tramal plates of interwoven hyaline thin-walled scarcely inflated hyphae subgelatinous in KOH, in this layer occur numerous large ($5-8 \mu$) oleiferous hyphae which connect to the hymenial cystidia; sphaerocysts not present in this layer. Epicutis of peridium a turf (decumbent in age) of dermatopseudocystidia up to 130μ long and 12μ broad, clavate (much like the hymenial cystidia but often much longer). Context of intricately interwoven hyphae—mostly intertangled near the surface and there also much-branched and the hyphal cells often irregular in shape, the hyphae $2-3 \mu$ in diam. or rarely thicker; toward the gleba the hyphae $4-5 \mu$ in diam., the cells larger and with less branching; oleiferous hyphae numerous. Sphaerocysts none. Clamp connections none. Tissue of stipe heteromerous. Dermatopseudocystidia present on stipe surface also.

Solitary to gregarious under leaves of *Hetermules arbutifoliae* and *Quercus agrifoliae*, Berkeley, Calif. N. L. Gardner et W. A. Setchell. (Type Setchell # 220). Type examined.

This is a most interesting *Elasmomyces*. It is more like *Macowanites* in gross morphology but the reduction in the occurrence of sphaerocysts in the tramal plates and peridium are the anatomical characters which place it in the genus where Setchell described it. It is a curious feature that this species, which shows such a striking resemblance to a young *Russula*, also shows this striking reduction in the presence of sphaerocysts. The color of the cap varies as it does in *Russula*, buttons are white at first, become bright red as the spores mature, and in age the pigment leaches out leaving a dingy variously tinted (red to yellowish) peridium. At least this is the situation which the type collection indicates and it is certainly a common occurrence in *Russula*. Also, in the type collection, some specimens are nearly sterile. In general, however, the highly colored fruit bodies even though very young in appearance have numerous spores.

This species and *E. roseipes* are very closely related but at once distinguished by the difference in the ornamentation of the spores, and the less specialized structure of the peridium. The habitat is probably significant also.

55. *ELASMOMYCES zellerianus* Singer & Smith sp. nov.

Fig. 70.

Gastorecarpio 15-25 mm lato; peridio luteo-albo, impolito; gleba pallide ochracea; stipite-columella manifestis; sporis $13-16.2 \times 12.6-14 \mu$, eichinatus; aculeolis $1.5-2.5 \mu$ longis, amyloideis; ab *E. mattirolano* praesentia dermatopseudocystidorum, superficiei peridii pruinosa differt. Specimen typicum, legit prope Lake Quinault, Washington, sub coniferis, 26 Oct. 1925. coll. C. A. Brown (MICH).

Gastorecarp 15-25 mm broad, depressed-globose, with undulate margin. Peridium 0.2 mm thick, yellowish white, pruinose. Gleba with large empty

cavities and thin (0.1 mm) tramal plates, light ochraceous, drying tawny-olive to wood-brown. Stipe-columella short, thick in the stipe part, percurrent in the columella part. Context white or whitish; odor and taste not reported.

Spores $13-16.2 \times 12.6-14 \mu$, subglobose, many yellowish, many hyaline (in KOH and ammonia), ornamentation of type VI (longspinose with isolated spines $1.5-2.5 \mu$, completely covered with amylaceous material; sterigmal appendage oblique as in *Russula puiggarii*).

Hymenium. Basidia $31-38 \times 12-15 \mu$, clavate, hyaline, with two sterigmata which are almost half-sickle shaped in most basidia. Cystidia on tymenium none seen with certainty.

Hyphal layers. Subhymenium very extensive and mainly cellular, more so than in *E. mattirolanus*, consisting of a thick layer of large sphaerocysts (larger than in *Macowanites* and *Russula*), and a few elongated hyphous elements, hyaline. Mediostratum relatively narrow, slightly gelatinized, subregular in arrangement, consisting of filamentous elements or occasionally very slightly enlarged hyphal elements but sphaerocysts not seen. Peridial trama consisting of hyphae extending in all directions with some air spaces between (loosely woven), slightly gelatinous, hyaline, covered by an epicutis-like outer layer which is very thin and consists of hyphal ends which are usually periclinal in their arrangement and their terminal members are sometimes cystidioid, these dermatocystidia versiform, e. gr. cylindric-capitate, ampullaceous, etc.; dermatopseudocystidia of the macrocystidium type also differentiated in the epicutis, about $54 \times 9 \mu$, with some loosely banded contents, long-clavate; primordial hyphae also present, granularly incrustated. Laticifers none seen. Oleiferous vessels not very prominent. Hyphae of all tissues without clamp connections and inamyloid.

Emergent under conifers, Pacific Coast States, U.S.A.

Material studied. Washington, Lake Quinault, C. A. Brown, October, 26, 1925. det. Zeller (as *E. mattirolanus*), type (MICH).

The other collection, cited by Zeller & Dodge (1936) from Waldport, Oregon, S. M. Zeller No. 7112 (NY), is probably the same as the above, but we have not studied it microscopically.

E. zellerianus is certainly closely related to *E. mattirolanus*, but nevertheless sufficiently different to be recognized. We describe it here in order to show that the type species of the genus has not as yet been found in the United States, and also in order to show that the sterile bodies in the hymenium and peridial surface are apt to come within the variability observed in *Russula* and *Macowanites*, but not *Cystangium*.

56. ELASMOYCES camphoratus Singer & Smith sp. nov.

Fig. 64.

Gastrocarpio 6-12 mm lato, subgloboso, subfulvo, glabro, impolito; odore ei *Lactarius camphoratus* simili; gleba subfulva, loculata; columella percurrente; sporis $7.5-11(12) \times 6.5-8(10) \mu$, globosis, subreticulatis; reticulatione amyloidea. Specimen typicum, legit prope Lake Quinault, Wash. 5 Nov. 1925, C. A. Brown (MICH).

Gastrocarps 6-12 mm diam. subglobose to globose-convoluted, pale to dark tan or rusty brown, glabrous and dull, odor strong and resembling

that of *Lactarius camphoratus* (all characters from dried specimens). Peridium distinct, almost papery but not readily separating. Gleba chambered, near cinnamon-buff, the chambers empty and more or less elongated approximately vertically, possibly separating slightly from the base of the columella. Columella present, colored like the peridium, percurrent and unbranched (1 good section available).

Spores $7.5-11(12) \times 6.5-8(10) \mu$, globose to subglobose, sterigmal appendage about $2-3 \mu$ long, oblique, not prominent, ornamentation consisting of fine lines $0.25-0.35 \mu$ wide, forming a broken network or system of branched and anastomosing lines with some isolated granules, major prominences rare and $0.8-1 \mu$ high, most prominences $0.25-0.3 \mu$ high, all elements of ornamentation strongly amyloid; the wall between the lines yellowish hyaline in Melzer's reagent.

Hymenium. Basidia $28-36 \times 8-9 \mu$, 1-, to 4-spored, hyaline in KOH, sterigmata about 2-spored basidia often $9-12 \mu$ long, typically straight and conic. Basidioles numerous. Cystidia $32-43 \times 9-13 \mu$, scattered, fusoid-ventricose or broadest near the obtuse apex, thin-walled, hyaline, content homogeneous or nearly so ("empty"); one-spored basidia may be mistaken for a second type of cystidium.

Hyphal layers. Tramal plates with a mediostratum of loosely interwoven non-gelatinous hyaline hyphae, $(4)8-12 \mu$ in diam., with thin walls, lacking incrustations; subhymenium of hyphae of about the same diameter but with cross walls frequent enough to make the cells nearly isodiametric; large $(9-12 \mu$ in diam.) somewhat hyaline, refractive laticiferous hyphae also present. Sphaerocysts none seen unless some of the more enlarged subhymenial elements be so interpreted. Epicutis of the peridium a compactly arranged trichodermium of non-gelatinous hyaline to yellowish thin-walled elements of various shapes: crooked-filamentous, clavate, fusoid, or simply variously irregular (the clavate elements may proliferate to produce fusoid cells, etc.). Context of interwoven hyaline thin-walled non-gelatinous hyphae with only an occasional sphaerocyst and these not grouped into nests. Laticiferous hyphae hyaline but distinct. Clamp connections absent.

In a path in a conifer forest, Lake Quinault, Washington, Nov. 5, 1925, C. A. Brown. Identified as *Arcangeliella stephensii* by S. M. Zeller.

The epicutis is difficult to interpret unless good thin sections are obtained. There is no information to the effect that a latex was present, and since C. A. Brown studied the spores from fresh material it is to be assumed that he cut up the fresh specimens. Hence it is likely that a latex was not present, or if it was, that it was watery as in some *Lactarii* related to *Lactarius camphoratus*. We are describing the species in *Elasmomyces* because of the extreme reduction in the number of sphaerocysts present and the filamentose-interwoven mediostratum of the tramal plates coupled with the fact that there are indications that the gleba loosened slightly from the base of the columella in the one longitudinal section available for study. It is tempting, in view of the odor, to postulate a relationship to *Lactarius camphoratus*, but we prefer to postpone seriously proposing such an affinity until more data from fresh collections becomes available. A number of questions remain unanswered.

57. *ELASMOMYCES roseipes* Singer & Smith sp. nov.

Figs. 71-72.

Gastrocarpio 18-40 mm lato, 12-20 mm alto, margine obtuse rotundato vel acuto. Peridio tri-stratoso, externe roseo, vel roseo-vinaceo, levi, haud viscoso. Stipite a columella vix separabili, $7-14 \times 3-8$ mm columella inclusa, albo, ad basin vel in tota parte inferna vinaceo-roseo punctato, sicco; volva nulla. Sporae echinatis, $8.8-12 \times 7.5-10 \mu$; pseudocystidiis paucis vel subnullis; tramate hymenophorali duplici, ex parte laterali subhymenii extensi pseudoparenchymosa latissima et mediostrato angustissimo regulari consistente; peridio strato externo palisadico ex membris terminalibus hypharum vix gelatinascentium cystidiformibus gaudente; strato intermedio hyphoso ex elementis filamentosis radiatim dispositis formato; tramate ipso peridii heteromero, sphaerocystibus numerosis agglomeratis cum hyphis filamentosis; hyphis primordialibus supra stratum externum peridii repentibus, flavidis, incrustatis, angustissimis, paucis internis. Hyphis omnium typorum defibulatis. Specimen typicum, legit prope Trinidad, Calif., Chas. A. White 171 (MICH).

Gastrocarp 18-40 mm broad, 12-20 mm high, semiglobate, then convex, often somewhat irregular, but not ordinarily applanate, usually umbilicate, with acute but often (mostly) so strongly recurved peridium that the margin appears broadly rounded and often somewhat furrowed on inner side (depressed along the interlamellar spaces of the outer-lower portion of the gleba).

Peridium 1-2 mm thick, thinner towards the margin, three-layered, surface pink, salmon color or rose-vinaceous, often diffracted-scaly, especially around and on the umbilicus, often with whitish areas (faded areas?), not glutinous, rather opaque, smooth except for marginal zone.

Gleba loculate to sublamellate, light ochraceous, forming lamella-like outer ridges which may become loose and free from the rest of the gleba but usually merely continue the more loculate internal portions, dehiscent from the columella and leaving a broad ring-hole around it, appressed to it only where the margin of the gastrocarp touches the stipe-columella, usually one side of the gastrocarp does not extend downward far enough to touch the stipe-columella and the gleba remains exposed unilaterally; gleba subfree or narrowly adnexed to the apex of the columella, 3-6 mm diam. at the thickest part.

Stipe-columella. "Stipe" not clearly distinguishable from "columella" at least when the gleba is not completely enclosed, relatively short and not (or scarcely) projecting beyond the lower level of the gastrocarp, remaining for the most part not only in the hole formed by the concave underside of the gastrocarp but above the point of real or theoretical attachment of the peridium to the "stipe" (which is at the base) hence no "true" stipe present, vinaceous pink, usually densely punctate with this color on a white background, smooth, glabrous or subglabrous, often eccentric because of the unilaterally attached peridium and then on the side that is more eccentric either attached to the gleba or gleba exposed. Both "stipe" and "columella" together about $7-15 \times 3-8$ mm, solid, then stuffed, equal or tapering upward. Context white, rather firm, heteromerous.

Spores $8.8-12 \times 7.5-10 \mu$, hyaline, in oldest specimens pale yellowish, subglobose to very short ellipsoid, sterigmal appendage more frequently attached to the geometrical base of the spore rather than eccentrically, and either straight or slightly oblique, ornamentation $0.7-1 \mu$, projecting, of type VI, i.e., with isolated spines, entirely amyloid.

Hymenium. Basidia $35-38 \times 11-14 \mu$, 4-spored, rarely 1-, 2-, or 3-spored, clavate, or ventricose, sterigmata either straight and conic-spinose, or slightly curved but rarely truly half-sickle-shaped. Pseudocystidia clavate to subcylindric, rare and not constantly occurring, representing the continuation of the laticiferous hyphae into the hymenium, $39-55 \times 5.5-10 \mu$; not gloeocystidial but with loose contents which appear to be short rods, externally even or uneven, internally yellowish or hyaline, not staining blue in sulfovanillin.

Hyphal layers. Subhymenium well developed, consisting of a thin layer of some globose and some elongate very small elements, but extended into an adjacent layer (lateral trama) of larger and smaller sphaerocysts interrupted only by a small number of filamentous elements and sparing little room for the central mediostratum which is extremely narrow and consists of regularly arranged filamentous hyaline elements. Peridium consisting of three layers, (1) the outermost, which is colored with a pink dissolved pigment (in ammonia and KOH) which soon fades, and is formed by a palisade of terminal cystidioid cells; these dermatocystidia hyaline, cylindric subampulaceous, clavate or capitate, sometimes with blunt protuberances or forked, $17-31 \times 3-9 \mu$, superimposed by scarce repent thin yellowish, strongly incrustated primordial hyphae, $2.5-8 \mu$ diam., all these elements only very rarely with some inconspicuous yellowish granular contents; below this outermost layer which is $50-60 \mu$ thick, follows (2) a cutis-like layer corresponding to the hypodermium of the Agaricales, consisting of subparallel to slightly interwoven repent filamentous elements slightly pinkish from dissolved pigment which soon fades, the layer about 100μ thick; interior to it (3) the peridial context which is truly heteromerous and hyaline. Surface layer of stipe with the same structure as the surface layer of the peridium. Oleiferous hyphae present in peridium and stipe-columella. Laticiferous elements not always present but when present inconspicuous, $2.5-5 \mu$ thick, their content similar to that of the pseudocystidia, distantly septate. Clamp connections absent. Hyphae all inamyloid, in cresyl blue some of the primordial hyphae staining deep blue. No macrocystidia of the type becoming blue in sulfovanillin present on surface of cap or stipe.

Embedded or partly erumpent in duff of spruce woods, gregarious, fruiting in July and August. California.

Material studied. California, Big Lagoon Park, Charles A. White, No. 171, type (MICH), 204 and 245, paratypes (MICH).

This species has somewhat the appearance of a *Russula* of section *Rigidae* (*Lepidinae*). The acute or obtuse margin, a very important character in *Russula* seems to have no importance here. The "veil" is perhaps not constant, and certainly not very conspicuous, but it seems to be present in some specimens connecting the upper part of the base of the stipe with the outer layer of the peridium (not seen in very young

specimens) and it may be that this indicates pseudoendocarpy, but more systematic studies on fresh or well preserved material of more different stages will be necessary to be certain.

The question of the presence or absence of laticifers vexed us for some time until we came to the conclusion that these elements are not constant in many species of the group containing *Elasmomyces* and *Arcangeliella*. There is certainly no latex in this species, and the laticifers seen by us may be merely somewhat modified oleiferous hyphae although occasionally they have quite the same appearance as they typically have in *Lactarius* or in *Arcangeliella*.

The particularly narrow mediostratum is very easy to overlook in sections where the tramal plates are not cut strictly perpendicularly. For that reason and also because of the macroscopical aspect of the fruiting bodies particularly the lamellar outer layer of the gleba in many carpophores, we have considered it practical to key out *E. roseipes* in *Macowanites* also.

58. *ELASMOMYCES pilosus* (Zeller & Dodge) Singer & Smith comb. nov.

Arcangeliella pilosa Ann. Mo. Bot. Gard. 22:368. 1935.

Figs. 73 and 74.

Gastrocarps 30-45 mm broad, 10-40 mm high, globose to depressed-pyriform, shrinking on drying, at first whitish, becoming reddish brown, drying citrine drab to light brownish olive or olive, unpolished to pubescent. Sterile base prominent, extended above into a branched or plate-like percurrent columella of loosely interwoven hyphae.

Spores (8) $9-11.5 \times 8-10 \mu$, globose to subglobose, ornamented, the ornamentation in the form of rods and narrow cones $1-1.5 \mu$ high and $0.7-1 \mu$ wide, spaced moderately far apart and unconnected with each other, readily deciduous; sterigmal appendage not conspicuous.

Hymenium. Basidia 4-spored, clavate, thin-walled; basidioles numerous; pseudoparaphyses none; cystidia abundant, aciculate, $35-50 \times 7-12 \mu$, hyaline, thin-walled, lacking incrustations.

Hyphal layers. Subhymenium of filamentous, "glassy" hyphae in KOH; hyphae of tramal plates narrow, interwoven and gelatinous, a few oleiferous hyphae present, sphaerocysts none. Peridium 2-layered, the epicutis a palisade of dermatocystidia $30-60 \times 6-9 \mu$, subclavate to subfusoid, with thin to slightly thickened walls (0.5μ), not gelatinous, as dried there is much amorphous material in the layer but when individual cystidia are isolated there is no incrustation on them; inner layer thick, of gelatinous hyphae $3-8 \mu$ in diam. and more or less interwoven; no sphaerocysts seen anywhere in the gastrocarp. Clamp connections none.

Hypogaeous under oak, California, February to April.

As near as we can ascertain there was no latex reported as being present when the type collection was found and apparently Zeller and Dodge placed the collection in *Arcangeliella* on the basis of hyphae they interpreted as lactifers. The dermatocystidia do not produce a true epithelium (cellular structure). However, they are an important diagnostic character of the species, as are the hymenial cystidia which, in revived preparations, are found most abundantly in the hymenium near the perid-

ium. Since the columella is a distinct percurrent structure, we place the species in *Elasmomyces*, but closely approaching *Martellia*.

In future collections we would expect some of the gastrocarps to show the gleba separating from the columella as in the case of *Truncocolumella citrina* var. *separabilis*. In *Gymnomyces parksii* the gleba does separate slightly but in that species the columella is not percurrent. It seems to us that the situation presented here is exactly what one would expect to find in any true natural series of genera or species—a few taxa which are clean-cut intermediates between genera and which must be arbitrarily assigned to a position in the classification.

Cystangium gen. nov.

Carpophoris macroscopice eis Macowanitis simillimus sed structura sua ad Setchelliogaster accedentes. Peridii strato externo epithelio efformato; tramate hymenophorali e mediostrato regulari sed sphaerocystibus intermixto et strato laterali in subhymenium transiente, cellulari, lato; cystidiis voluminosis praesentibus vel absentia. Hyphis efibulatis; sporis subglobosis, amyloideo-echinatis, flavidis.

Species typica: *Secotium sessile* Masee & Rodway ex Rodway.

Carpophore macroscopically as in *Macowanites* but structure of the peridium remaining one of *Setchelliogaster*, the outer layer being pseudo-parenchymatous; leptocystidia present or absent; mediostratum of tramal plates heteromerous; clamp connections absent; spores amyloid and ornamented as in the Russulaceae.

Macowanites, *Arcangeliella*, *Elasmomyces* and *Cystangium* form a group of genera containing species which in gross morphology are almost agaric-like and merge into those in which the gastrocarp remains closed and the stipe-columella is not developed, the sterile tissues being represented by a columella only. *Elasmomyces* and *Cystangium* are at a lower level in this scale than the other two. In fact *Cystangium* appears to be a side branch in the series because although it has basic agaric structure in the fruiting body, the type species has characters not combined in either of the agaric genera, *Russula* or *Lactarius*. It could have arisen easily from *Martellia* where the characters of the epicutis and the presence of leptocystidia occur but are not combined as they are in *C. sessile*.

KEY TO SPECIES

1. Leptocystidia rare to absent.....59. *C. depauperatum*
 1. Leptocystidia many and conspicuous.....60. *C. sessile*

59. **CYSTANGIUM sessile** (Masee & Rodway ex Rodway) Singer & Smith
 comb. nov. *Secotium sessile* Masee & Rodway, Proc. R. Soc.
 Tasmania 1911:31. 1912.

Elasmomyces sessilis (Mass. & Rod. ex Rodway) Rodway, Proc.
 R. Soc. Tasmania, 1924:8. 1925.

Gastrocarp up to 20 mm broad and 10 mm high, with umbilicate apex and excavate base, depressed-globose. Peridium 0.75-2 mm thick, smooth and polished, cream colored. Gleba sublamellar to labyrinthiform with radially elongated or convolute chambers, very fragile when dried, narrowly exposed between the short stipe and the lower margin, ochraceous.

Stipe-columella percurrent and scarcely expanded at apex, free from gleba, white or concolorous with the gleba; stipe portion 3.5×1.2 mm, scarcely protruding from below the excavation of the lower side of the gastrocarp, smooth, equal, hollow, context fragile when dry, white; odor and taste not recorded.

Spores $9.7\text{--}15 \times 9.2\text{--}13.7$ μ , subglobose to very short ellipsoid, pale yellow, contents blue in cresyl blue mounts, wall 1.2 μ thick, ornamentation projecting $0.8\text{--}2.2$ μ , of type VI (isolated spines), rarely spores with type IV-II, i.e., with short isolated ridges, the amylaceous matter usually but not always covering the entire spines, only in particularly long spines only the tip reacting with Melzer's reagent, sterigmal appendage rather large, usually oblique and much more often eccentric than centrally attached, no distinct amyloid smoother spot in the suprahilar region differentiated.

Hymenium. Basidia $28\text{--}31 \times 12\text{--}15$ μ , ventricose to clavate, (1-), 2-, 3-, (4-) spored, sterigmata $7.5\text{--}11$ μ long, of various shapes and sizes (half-sickle-shaped and curved inward and upward or thin-conic-spinulose and straight although oblique). Leptocystidia conspicuous and numerous, $77\text{--}115 \times 16\text{--}27$ μ , ventricose-ampullaceous, hyaline, "empty" or some partially granular on the outside (but very different from primordial hyphae), most with a pale melleous resinous incrustation around the apex, with rather thin to scarcely and irregularly thickened walls (walls $0.5\text{--}1.5$ μ thick, simple, hyaline), not metachromatic in cresyl blue mounts (walls lilac-violet as are those of the basidia, no colored contents), arising from a considerably lower level than the basidia, sometimes actually from the mediostratum, with rounded obtuse to more or less acute tip, strongly projecting beyond the basidia. Macrocytidia and primordial elements absent.

Hyphal layers. Subhymenium very broad and cellular, consisting mainly of sphaerocysts of variable size and often arranged in rows, continuations of the cystidial bases passing through the layer. Mediostratum relatively narrow, consisting of filamentous hyphae and some sphaerocysts over 19 μ diam., hyphae regularly arranged. Peridium consisting of a broad outer layer which is an epithelium and consists of vesiculose elements $20\text{--}45 \times 17\text{--}32$ μ , hyaline; inner layer heteromerous, its hyphae as in the mediostratum of the tramal plates. Laticifers none. Hyphae of all tissues inamyloid, without clamp connections.

Apparently in forested regions and subhypogaeous on Mt. Wellington, Hobart, L. Rodway, No. 647, type (NY, K).

The spore size indicated by Zeller & Dodge (1936) for *Arcangeliiella australiensis* (Berk. & Br.) Dodge makes it impossible to accept the contention of these authors regarding the identity of *S. sessile* with *A. australiensis*.

Some parts of the description of the microscopic characters are adapted from Cunningham (1942) who thinks that this species is a *Secotium* rather than an *Elasmomyces*. For illustrations, see Cunningham, l.c. pl. 9, fig. 3, and 34, fig. 24.

The structure of the tramal plates is more like that of *Macowanites* than *Elasmomyces*. The combination of a cellular epicutis and large

leptocystidia distinguishes the genus from *Macowanites* and the presence of sphaerocysts in the mediostratum of the tramal plates excludes it from *Elasmomyces* as we define that genus here.

We have not studied the type of *Hydnangium australiensis* and so must leave the final decision as to its relationship with *C. sessile* to later type studies, but we agree with Cunningham who insists that *Secotium sessile* is an autonomous species. Zeller in his herbarium indicated that it was identical with *Elasmomyces mattirolanus*, but as we show (see *Elasmomyces*) this disposition is unacceptable.

60. **CYSTANGIUM depauperatum** Singer & Smith sp. nov.

Gastrocarpio roseo, peridio externe maculato; columella frequenter tenui-percurrente; stipite tenui praesenti; sporis $9-13.7 \times 8.2-12.5 \mu$, echinatis; cystidiis perpauca, vix manifestis. Sub *Nothofagis*. Specimen typicum in Herbario Lilloano conservatum est; leg. Singer prope Peuella, Chile, M1921.

Gastrocarp 5-20 mm high, 9-15 mm broad, either higher than broad or broader than high, ovate to irregularly vertically compressed, rarely umbilicate, underside depressed around the stipe. Peridium up to 1 mm thick, smooth, unpolished and dry, surface with pink to rose-red areas on a white background. Gleba lacunose, in places sublamellar or entirely non-lamellar, chambers small, gleba fragile, pallid to pale cream color, usually exposed on one side between the short stipe and the margin of the gastrocarp. Columella vertical or oblique, thin (0.5-1 mm in section) white, percurrent or reaching only half way where it branches and becomes indistinct from the tramal plates, not expanded if percurrent; stipe 3-6 mm long, 2-3 mm thick, present as a short ventricose basal continuation of the columella and usually eccentric in the basal cavity of the gastrocarp and often adhering to one side of it, white on the exposed area, solid. Context of peridium and stipe-columella fragile and white, unchanging on exposure, taste mild, odor none.

Spores $9-13.7 \times 8.2-12.5 \mu$, globose to broadly ellipsoid, hyaline to pale stramineous in NH_4OH , wall at times appreciably thickened; ornamentation of isolated spines (type VI) $1-2 \mu$ high, the amylaceous matter covering the spinules completely and the latter either straight or curved, narrowly conic to rod-shaped; sterigmatal appendage typically eccentric, oblique.

Hymenium. Basidia $26-41 \times 11-16.5 \mu$, ventricose to clavate typically 4-spored but in some gastrocarps 1- and 2- and 4-spored. Cystidia absent or some inconspicuous clavate cystidioles scattered granular content (not discoloring in sulfobenzaldehyde when lacking granular content); no conspicuous leptocystidia or macrocystidia present.

Hyphal layers. Subhymenium cellular, but consisting of small, inflated, short, somewhat irregular elements with only rarely any large sphaerocysts intermixed, at first forming a rather broad layer but in age in places rather narrow. Mediostratum regular, basically filamentous, rather narrow, containing only here and there an occasional sphaerocyst. Peridium consisting of an inner tramal layer which occupies about half its diameter and consists of mostly filamentous hyphae with few sphaerocysts intermixed, or sphaerocysts at times more or less layered; and an

outer cuticular layer distinctly epithelial in structure, consisting of vesiculose elements 20 μ or more in diameter and scattered oleiferous hyphae, the cell walls forming the outer surface of the layer giving off hyphal outgrowth about 3.5 μ thick, with or without cross walls (the entire structure reminding one of the "virescens-structure" of *Russula virescens* and allied species). All hyphae inamyloid and without clamp connections.

Chemical characters: The rose colored spots 4-4-9, later becoming 6-4-4 Maerz & Paul, become "barberry" (M. & P.) when ammonia is applied.

In the Montane (Austro-Andine) and Valdivian type forests consisting mainly of *Nothofagus*, under *N. dombeyi*, subhypogaeous on soil banks at 400-800 mi. alt., in the fall. Argentina, Patagonia, Nahuel Huapi National Park, along the trail from Puerto Blest to Los Cóntrors, March 14, 1959, Singer *M1806* (LIL), paratype. Chile, Llanquihué, Lago Todos los Santos, above Peulla, March 20, 1959, Singer *M1921* (LIL), type.

This species is close to *Martellia idahoensis*, but differs in having a few sphaerocysts in the mediostratum of the tramal plates, in growing under *Nothofagus* instead of spruce and fir, as well as in having a stipe-columella. *Hydnangium thaxteri* can hardly be in the same as *C. depauperatum* in view of the peridial structure as described by Zeller & Dodge, and spores which are only 7-8 μ in diameter. In placing this species in *Cystangium* we are placing greatest emphasis on the epithelial type of peridial cutis and the partly exposed gleba. The aspect of the fruit body is that of an *Elasmomyces* but sphaerocysts do occur in the mediostratum of the tramal plates.

ARCANGELIELLA Cavares

Nuov. Giorn. Bot. Ital. N. S. 7:117-128. 1900.

Spores ornamented and amyloid as in the Russulaceae of the Agaricales; cystidia in the form of pseudocystidia and macrocystidia present in the hymenium; tissue of the peridium heteromerous; epicutis of the peridium typically differentiated in some manner such as a gelatinous layer or a trichodermium; laticiferous hyphae present in the tramal plates and in the context of the peridium; stipe-columella typically present; gleba chambered and the chambers empty to partially filled with spores; gastrocarp globose to irregular with the lower margin of the peridium not always extending to the stipe thus leaving the gleba exposed around the stipe-columella at maturity; latex present.

Type species. *Arcangeliella borziana* F. Cavares.

As defined here the genus is the counterpart of *Macowanites* in gross morphology, and also anatomically with the exception that typically there are relatively few sphaerocysts in the mediostratum of the tramal plates and laticiferous hyphae are abundant. The genus, as we define it here, approaches *Lactarius* so closely that one can easily mistake its species as being aborted states of the agaric genus.

KEY TO SPECIES

1. Spore ornamentation as distinct rods and cones.
 2. Cutis of peridium of appressed gelatinous filaments 1-3.5 μ in diam. 61. *A. densa*
 2. Cutis of peridium a distinct trichodermium of pseudocystidia and gelatinized hyphal tips. 62. *A. borziana*

1. Spore ornamentation more or less in the form of a reticulum.
3. Sphaerocysts of peridial tissue with refractive somewhat thickened walls
3. Sphaerocysts thin-walled. 63. *A. lactarioides*

61. *ARCHANGELIELLA densa* (Heim) Singer & Smith comb. nov.

3564, 1958,

Archangeliella densa Heim, Comptes rendus Ac. Sc. 246:3564.
1958.

Elasmomyces densa Heim, Rev. Mycol. Paris 24:93. 1959.

Fruit body 3-3.5 cm in widest dimension, 2.7-3 cm in narrowest dimension, 1.8-2 cm high, always ochraceous and zonate. Peridium about 1 mm thick, lubricous, viscid when wet, of filamentose septate hyphae 3-6 μ broad and lacking clamp connections; and in addition with pockets of sphaerocysts the latter measuring 30-70 μ in diam., also numerous laticiferous hyphae 5-12 μ broad, and sinuous, undulating or contorted. Cortex exuding a copious white latex very soon turning citrinous. Stipe 1-1.5 cm high, 4 mm thick, single or duplex, typically enlarged upward, solid, surface smooth, terete or creased. Columella percurrent, cylindric 5-7 mm broad. Gleba labyrinthiform, dingy flesh colored, cavities large, somewhat radiating from the columella as judged by the general orientation of the tramal plates. Flesh inodorous, after a couple of minutes the taste becoming acrid.

Basidia 35-62 $\times$ 10-12 μ , 4-, rarely 2- spored, narrowly clavate with undulating walls; sterigmata 9 $\times$ 3 μ , conic. Spores 8-9.6 $\times$ 7-8.9 μ (excl. orn.), 10-13 $\times$ 9.6-10 (with orn.), broadly ovate, scarcely asymmetric without a plage (suprahilar area ornamented much like the rest of the spore surface), ornamentation type VI (Singer system), of amyloid warts and spines isolated or with only a few fine connecting lines. Cystidia. none.

Solitary on ground in woods of *Dipterocarpus* Dai. Suteb. Cianegmoi, Thaïlande, alt. 100-1400, 3 et 5 XII. 1957. leg. R. Heim (Typus, M.N.H.N., Paris).

This species is a typical *Arcangeliella* and very close to the type of the genus, *A. borziana*. In *Lactarius* its closest relatives appear to be with the viscid glabrous species in which the latex changes to yellow on exposure to air. *L. delicatus* is an example. As far as Smith can tell from Heim's data and his own study of the type of *A. lactarioides*, there is no particularly close relationship to the latter, other than its general generic characters. The spore ornamentation of *A. lactarioides* is very different (a heavy amyloid reticulum), its peridium is innately fibrillose, and pseudocystidia are present in the hymenium. It is most unfortunate that Heim did not describe the detailed anatomical features of the tramal plates, or publish his Latin diagnosis with the original description in 1958.

62. *ARCHANGELIELLA BORZIANA* F. Cavara, Nuov. Giorn. Bot. Ital. N.S. 7:126. 1900.

Figs. 75, 76, 77, 78, 79.

Gastrocarp 6-8 $\times$ 15-30 mm, globose to irregular or oblong, often bilobed, smooth, fairly soft but drying hard, spotted with yellow, surface

smooth and viscid, peridium not always reaching the stipe-like base (thus exposing the gleba), exuding an abundant white mild latex; gleba light rose-colored, exuding a latex; with an attenuate stipe-like base (stipe-columella not present on the fragment of the type available for microscopic study).

Spores 9-15 μ , globose to subglobose, *thin-walled* (many remain partly collapsed in Melzer's reagent), usually not showing a distinct sterigmal appendage, ornamentation in the form of strongly amylaceous rods or narrow cones $1.1.3(2) \times 0.5 \mu$, closely spaced but unconnected, wall surface between elements of ornamentation not amyloid; spores *pale brown* in KOH.

Hymenium. Basidia 4-spored, $38-44 \times 10-13 \mu$, clavate, hyaline, thin-walled, sterigmata $4-6 \times 1.5 \mu$, conic, straight; pseudoparaphyses none; basidioles abundant; cystidia abundant, $40-60 \times 12-18 \mu$, fusoid-ventricose and thin-walled, a second type also present measuring $75-125 \times 10-14 \mu$, subfusoid to subclavate and with walls $1.2-1.7 \mu$ thick approximately, flexuous and undulating, hyaline in KOH, content homogeneous in age, protoplasmic when young, both types relatively abundant.

Hyphal layers. Hyphae of tramal plates narrow ($2-4 \mu$) and interwoven from branching, thickest plates are in the area near the peridium and these showing some sphaeroecysts. Peridium consisting of an epicutis of a more or less distinct trichodermium of dermatopseudocystidia and gelatinized hyphal tips; the context a thick (about 200μ) layer of narrow ($1.5-3 \mu$) hyphae strongly gelatinized and hyaline or nearly so, laticiferous hyphae present and abundant, the content of the gelatinous hyphae of hyaline granules (in KOH) which in Melzer's reagent become dull brown as in certain species of *Hygrophorous*, the cross walls of these hyphae thickened and highly refractive in KOH; innermost layer of peridium on heteromerous tissue with hyphae having granules as described above. All hyphae inamyloid. Clamp connections absent.

In fir forests, Italy, summer.

Material studied. The fragment of the type in the Zeller Herbarium (NY).

Since this is the type species of the genus great care was observed in the study of the microscopic characters, and the microscopic data given above were all obtained from the specimen cited. The data given in the section on macroscopic characters are taken from the specimen examined and the description as translated by Zeller and Dodge (1936). These data clearly indicate that the gross morphology of the fruitification of *A. borziana* is directly comparable to that of *Macowanites*. As dried the gastrocarp is hard and black, which is to be expected because of the thick gelatinous context. The thick-walled cystidia are best observed in crushed mounts since usually only the thinner-walled apical portion projects beyond the basidia. These are not pseudocystidia since they definitely originate from the narrow hyphae of the tramal plates not from the laticiferous hyphae. A second peculiar character is the presence of pseudo-amyloid granules in the hyphae.

The anatomical features as well as the gross morphology of the fruit body shows that *Arcangeliiella*, as characterized by the type species, clearly belongs in the Astrogastraceous Series, and that although comparable to

Macowanites in general features, differs in possessing a latex which exudes from the fresh specimens when they are cut, just as in *Lactarius*. In other words, *Arcangeliella* is to *Lactarius* what *Macowanites* is to *Russula*, either the final stage in the evolution of the agaric genus, or the first stage of degradation of an agaric to a *Gastromycete*. Thus the Astrogas-traceous Series contains two distinct lines, one connecting to *Russula* and one to *Lactarius*, but at all levels of evolution the comparable genera are extremely close to each other in all other characters.

The concept of *Arcangeliella* which we introduce here is important since it is much more restricted than that of Zeller and Dodge (1936). Particularly we exclude all species in which the presence of a latex is not indicated in the original description. Zeller and Dodge relied on the presence of laticiferous hyphae in their concept, and as we have pointed out in the detailed accounts of many of the species, these structures and the commonly occurring oleiferous hyphae in Basidiomycetes generally were confused under the one heading. It was undoubtedly this situation which led these authors to put such unrelated species as those with rusty brown spores of the *Cortinarius* and *Boletellus* types in the same genus as species with the spores of the Russulaceae. It is to Zeller's credit, however, that in his last years he realized the error but he did not live to correct it.

63. *ARCANGELIELLA LACTARIOIDES* Zeller, *Mycologia* 39:282. 1947.

Fig. 80.

Gastrocarp 25-30 mm broad, 15-20 mm high, subspherical becoming expanded, summit slightly depressed; peridium smooth, innately fibrillose, dry, pale yellowish, drying brownish, context thin especially below or at margin where it breaks away from the stipe-columella; columella percurrent, 4-6 mm broad, laticiferous hyphae present, "lactiferous" Zeller; gleba white, becoming creamy, drying brownish, exposed below, adnexed, very ventricose, cavities labyrinthiform, partly filled with spores.

Spores $8-11 \times 6-7 \mu$, ellipsoid, rather thin-walled, ornamentation in the form of a strongly amylaceous reticulum $0.3-0.5 \mu$ high; plage area nearly smooth, sterigmal appendage short-pointed.

Hymenium. Basidia 4-spored, $40-48 \times 9-12 \mu$, clavate, sterigmata $3-4 \times 1 \mu$, very short and conic; cystidia present as ends of laticiferous hyphae projecting into the hymenium (pseudocystidia).

Hyphal layers. Subhymenium cellular; true laticiferous hyphae abundant in tramal plates; remainder of elements in mediostratum filamentous and interwoven and with scattered sphaerocysts through this matrix. Peridium of heteromerous tissue; the epicutis a gelatinous layer with some dermatocystidia present in it but not reviving too well at the surface. Clamp connections none.

In fir woods below timberline (elev. 7500 ft.) Diller Canyon, Mt. Shasta, Calif. (Cooke 14666, type) (NY).

Material studied. Wm. B. Cooke 14666 (type).

As Zeller stated "This species is a clear connecting link between the Gasteromycetes and *Lactarius*" (l.c., p. 283). It is even closer to *Lactarius* than is *A. borizana*, as is indicated by the reticulum of the spores.

64. *ARCANGELIELLA crassa* Singer & Smith sp. nov.

Fig. 81.

Gastrocarpio circa 3.5 cm lato, convex-depresso, pallide alutaceo, glaber, impolito; stipite columellaque 1 cm altis, 5-8 mm crassis, pallidis; gleba sublamellata; spores 8-11 $\times$ 6.5-8 μ , reticulatis; reticulatione amyloidea; Specimen typicum, legit Cow Creek, Stanislaus National Forest, 25 Jul. 1931, Frank A. Patty (NY).

Gastrocarp (as dried) up to 3.5 cm broad, convex-depressed, pale pinkish buff (dried), glabrous but unpolished; stipe-columella 5-8 mm broad, about 1 cm high, becoming hollow in largest specimen, pallid, surface unpolished; gleba pale pinkish buff, varying lamellate to lacunose on same specimen; peridium up to 5 mm thick as dried, pale pinkish-buff within, margin remaining attached to the stipe (hence *gastrocarp* remaining closed, —condition shown in largest specimen) or not reaching the stipe in places thus exposing the gleba (younger specimens).

Spores ellipsoid, 8-11 $\times$ 6.5-8 μ (not including sterigmal appendage); sterigmal appendage oblique and prominent; with a nearly smooth but well marked plage with an amorphous mass of amyloid material on it; ornamentation in the form of a small-meshed reticulum or broken amyloid reticulum, prominences $\pm$ 0.25 μ high, spore wall slightly thickened and inamyloid.

Hymenium. Basidia 42-53 $\times$ 10-12 μ , pedicellate-clavate, 4-spored; sterigmata straight-conic, 4-7 μ long. Cystidia rare, pseudocystidial type, 52-65 $\times$ 7-12 μ , flexuous, often pointed at apex.

Hyphal layers. Subhymenium cellular, some cells enlarged to sphaerocyst size; hymenopodium of subparallel hyphae and 2-3 hyphae thick; yellowish in KOH; mediostratum interwoven, hyphae yellow to hyaline, enlarged cells (8-12 μ) seen in groups, but these may represent cut ends of hyphae; laticiferous hyphae abundant. Epicutis of pileus of appressed filamentose hyphae 3-6 μ broad, the outermost ochraceous in KOH but the walls smooth; context of interwoven hyaline hyphae with nests of large sphaerocysts with *refractive somewhat thickened* walls hyaline in KOH. Clamp connections none. Laticiferous hyphae very numerous.

Under duff in a coniferous forest, Stanislaus National Forest, Cow Creek, July 25, 1931. Coll. Frank A. Patty. Determined as *Arcangeliella alveolata* by Zeller & Dodge and as *Elasmomyces russuloides* by Lee Bonar.

This is a most distinctive species because of the sphaerocysts in the context having thickened somewhat refractive walls, because of the ellipsoid, reticulate spores, and because of the undifferentiated peridium—there is no layering to speak of. Although it stands out very distinct in the series as a species we have some reservations as to the proper genus in which to place it. Sections mounted in KOH give off a slightly whitish-milky dissolved substance when first mounted. This in addition to the very abundant laticiferous hyphae which resemble in content those of many species of *Lactarius* has led us to place the species in *Arcangeliella*. But there are no notes whatever with the specimen. The mediostratum of the tramal plates does not contain sphaerocysts like those found in the peridial context. Smith did note clusters of small cells which could have been the cut ends of large laticiferous hyphae. Hence, if it is ever found

that this species actually does not have a latex, it should be transferred to *Elasmomyces*.

MACOWANITES Kalchbrenner

Hedwigia 15:115. August 1876.

Macowania Kalchbrenner ex Berk. Gardner's Chronicle 5 (n.s.): 785. June 17, 1876.

Hypochoanum Kalchbrenner ex Berk. Gardner's Chronicle 6 (n.s.): 140. July 29, 1876, nom. nud.

Type species. *Macowania agaricina* Kalchbr. ex Berk.

Hymenophoral trama of the fully developed carpophore consisting of a broad layer of heteromerous tissue bordered by a normally narrow or inconspicuous subhymenium, or of a narrow layer of sphaerocysts (with some connective hyphae around them) bordered by a filamentous thin hymenopodium and a subcellular subhymenium. Pseudocystidia of a type similar to the macrocystidia of the *Russulae* present in the hymenium but not necessarily blackening in sulfobenzaldehyde (bluing in sulfovanillin), these also at times present in the tramal plates as endocystidia or, more often on the surface of the peridium or stipe-columella as dermatopseudocystidia; often showing transitions to primordial hyphae, especially on the peridial surface, both pseudocystidia and primordial hyphae numerous and easily demonstrable. Oleiferous hyphae present, laticiferous vessels absent. Spores hyaline to yellow under the microscope (in water) and accumulated in the chambers of the gleba showing practically the same range of colors as in *Russula* and these shades apparently constant in each species, mostly with oblique sterigmal appendage. Sterigmata very variable in shape. Spore ornamentation amylaceous and obviously of the same origin and composition as in *Russula*, covering completely all or most of the protuberances of the spore wall, more or less echinate, warty, etc., and often showing short ridges or connecting lines. Gleba frequently with a basically lamellar or sublamellar structure but strongly anastomosing or alveolar, more rarely merely loculate and irregular, without a geotropic growth thus not allowing for free spore fall; spore deposits not obtainable. Hyphae without clamp connections, inamyloid, not gelatinized except sometimes in the outer peridial layer. Columella percurrent and continued into a free stipe without a clear separation of columella and stipe, more rarely protruding below the lower margin of the gastrocarp to produce a relatively large and conspicuous free stipe. Growing in the neighborhood of trees, particularly conifers, and at first hypogeous (between the line formed by the mineral soil and the duff), often erumpent in wet weather.

There is some difficulty as far as the generic name *Macowanites* and its nomenclatorial validity is concerned. The name originally published for the genus was *Macowania* but this is a homonym of *Macowania* Oliver in Hooker's Icon. Plant. pl. 1062, 1870 (Compositae), antedating the fungus under this name by six years and dedicated to the same South African collector, MacOwan. Kalchbrenner realized this situation very soon after the publication in Gardner's Chronicle and in a letter to Berkeley, suggested *Hypochoanum* as a substitute. We doubt very much

that the substitution as published in Gardner's Chronicle one month later can be construed to be a valid *nomen novum*. It consists of one sentence: "We have received a letter from the Rev. G. Kalchbrenner in which he proposes to substitute for *Macowania* the generic name *Hypo-chanum*." Since, for nomenclatorial purposes the effective author is Berkeley who did not himself substitute the generic name or even write a word of approval regarding Kalchbrenner's proposal, we believe *Hypo-chanum* to be a *nomen nudum*. One may legitimately doubt that it was Kalchbrenner's intention to definitely publish this substitution in his letter; rather, he was merely making an informal suggestion to a colleague. This opinion is strengthened by the fact that roughly about the same time he wrote his own article for Hedwigia in which he proposed *Macowanites* as a new genus. On the other hand, Kalchbrenner may have been merely forgetful as is evidenced by the strange fact that six years later, 1882, he republished his *Macowanites agaricinus* as a new genus and species in Grevillea.

KEY TO SPECIES

1. Odor of garlic when fresh; known only from South Africa..... 66. *M. agaricinus*
1. Odor none or various but not as above..... 2
 2. Gastrocarp 3-14 cm broad, viscid, tan to dark brown; odor offensive..... 68. *M. magnus*
 2. Not as above..... 3
3. Spore ornamentation 0.8-1.3 μ or more high..... 4
3. Spore ornamentation regularly lower, rarely up to 0.8 μ high..... 6
 4. Stipe-columella conspicuous at maturity; peridium bright yellow on the disc (if variously colored blue, purple, violet olive or yellowish see *M. americanus* also)..... 69. *M. citrinus*
 4. Stipe-columella reduced at maturity; peridium white to pallid at first..... 5
5. Peridium lacking a differentiated epicutis (or this very reduced)..... 65. *M. krjukowensis*
5. Peridial cutis complex, consisting of a basal cellular layer and above it a turf of dermatopseudocystidia..... 67. *M. mollis*
 6. Peridium pallid, staining clay color or tawny; taste mild..... 70. *M. fulvescens*
 6. Peridium often with red, pink, purple, olive or white; if white then not stained markedly as above..... 7
7. Taste acrid to tardily acrid..... 8
7. Taste mild and remaining so..... 9
 8. Macrocystidia of hymenium $40-72 \times 12-19 \mu$; gleba white to cream color; hymenopodium poorly differentiated..... 71. *M. albidigleba*
 8. Macrocystidia $70-100 \times 6-13 \mu$; gleba pale tan; hymenopodium well differentiated..... 72. *M. acris*
9. Epicutis of peridium of a turf of long, sparsely branched hyphae (about 100 μ long); peridium dull fuscous-violaceous..... 73. *M. fuscoviolaceus*
9. Epicutis of shorter elements and color mixed and variable in different fruits of a single collection..... 10
 10. Spores $9-13 \times 9-12 \mu$ 74. *M. americanus*
 10. Spores $7-10 \times 6-8.5 \mu$ 75. *M. setchellianus*

65. *MACOWANITES krjukowensis* (Buchholtz) Singer & Smith comb. nov.
Secotium krjukowensis Buchholtz, *Hedwigia* 40:314. 1901.
Elasmomyces krjukowensis (Buch.) Sacc. & D. Sacc. *Syll. Fung.*
17:218. 1905.
Arcangeliiella krjukowensis (Buch.) Zeller & Dodge, *Ann. Mo.*
Bot. Gard. 22:368. 1935.
Figs. 83-85.

Gastrocarp globose or irregular, about 30 mm broad. Peridium smooth, pure white, drying warm buff to buckthorn brown (according to Zeller & Dodge), eventually somewhat furrowed at lower margin. Gleba at first either exposed or enclosed, later closed below because of the incurving margin of the gastrocarp, orange when fresh (drying clay color or tawny-olive according to Zeller & Dodge), loculate with gyrose tramal plates. Columella thin, at first percurrent, later obliterated; stipe white, short and thin, inserted in a depression on lower surface of gastrocarp and continuing the columella. Context white, with mild fungous odor.

Spores 9-11 μ in diameter, globose or subglobose, yellowish hyaline (in KOH), sterigmal appendage small and inconspicuous; ornamentation of isolated warts and rods 0.5-1.5 μ high (type VI), fairly closely spaced, amyloid (positive reaction with zinc-chloride-iodine according to Buchholtz).

Hymenium. Basidia clavate, 2-, 4-spored. Pseudoparaphyses present as clavate cells with walls about 0.5 μ thick. Cystidia aciculate, about 60-100 μ , projecting beyond the level of the basidia, contents often reticulate-amorphous, with thin walls and lacking any incrustation, aldehyde reactions unknown.

Hyphal layers. Subhymenium cellular; mediostrium of tramal plates heteromorous; oleiferous hyphae also present. Peridium with a context of heteromorous tissue, no differentiated epicutis demonstrable in sections of the type (they revived poorly, but even so some detail could be observed and we feel certain there is no epithelium, at the most a few appressed dermatocystidia). Clamp connections absent.

Hypogeous but finally erumpent, solitary or cespitose, under *Populus*, *Betula* and *Tilia*, fruiting in June. U.S.S.R. Krjukovo Station, Moscow region, F. Buchholtz, type (FH, NY).

The macroscopic data have been taken from the original accounts and the microscopical notes were by A. H. Smith and taken from a study of the type. They lack precise data on the chemical behavior of the cystidia (pseudocystidia ?) since these reactions are unreliable in material as old as this. It would be interesting to restudy material from the type locality (if it is still preserved) in order to obtain data on the type of contents seen in the cystidia and to verify the composition of the epicutis of the peridium.

Since a stipe-columella is present in at least the young stages, and since the gleba is exposed during its development at least to some extent, this species falls in the orbit of *Macowanites*, *Elasmomyces* and *Cystangium*. It cannot be identified as congeneric with *Cystangium*. In its anatomy it is similar to *Macowanites*, though it is to be admitted that in gross morphology it more closely resembles *Elasmomyces*. When we

add to this the fact that actually very little is known of the species, and we do know from Smith's observations in Idaho the gross morphology of all the secotiaceous fungi as found there varies greatly with the amount of moisture in the duff, it seems more logical at this point to place greatest emphasis on the one character which appears to be critical in separating the two genera, namely the presence or absence of sphaerocysts in the mediostratum of the tramal plates. If this character proves to be unreliable as a generic character, then it will be virtually impossible to maintain both as distinct genera. Fischer's attempt to separate *Macowanites* from *Elasmomyces* by the structure of the stipe-columella fails because heteromerous tissue is present in both.

66. *MACOWANITES AGARICINUS*¹ (Kalch.) Kalchbrenner, Hedwigia L5 (8): 116. 1876.

Macowania agaricina Kalchbrenner, Gardner's Chronicle 5 (n.s.): 785. 1876.

Gastrocarp 44-48 mm broad, about 30 mm high, "the size of a rather small potato," spherical-compressed (broader than high). Peridium very thin, even, smooth to somewhat rough, unpolished, dingy brown, not covering the hymenophoral structures below but projecting from the marginal zone of the peridium, (which is rounded at the edge) into the outer-lower ridges of the fertile glebal layers. Gleba sublamellar-anastomosing and cavernous in places, completely free from glebal covering below and decurrent on the stipe, open through orifices on lower side, white. Stipe cylindrical, 14-16 × 9-10 mm, smooth, solid, white; columella percurrent and somewhat ventricose, solid, white. Veil none. Context fleshy, apparently pallid-white when fresh; odor strong like that of garlic.

Spores (10.5)11.5-14(-15) × (8.5-)10.5-13 μ, short-ellipsoid to subglobose, hyaline, some with a slight citrine reflection, with an oblique sterigmatal appendage symmetrically attached or much more commonly attached at an eccentric point even in young spores, ornamentation amylaceous, consisting of a reticulum of fine lines and connecting warts, amylaceous suprahilar spot distinct.

Hymenium continuous, consisting of fertile and sterile elements. Basidia 45-56 × 9-15 μ, ventricose to subclavate, 2- to 4-spored, rarely 1-spored; sterigmata short and half-sickle-shaped to long and straight, also long and slightly curved or short and straight, (narrowly conic), reaching 14 μ in length, most frequently curved and thicker at the base, hence agaricoid. Pseudocystidia similar in shape and origin to the macrocystidia of *Russula* (corresponding to the pseudocystidia of *Russula rosea*), content either finely granular or loosely banded (hence of the kind not expected to turn blue in sulfovanillin and not likely to be macrocystidia in the definition of that type), 50-90 × 7-10 μ, broadest in the lower half at the level of the base of the basidia, with the upper portion of the cell narrower and cylindric or gradually attenuated to a rounded, rarely subacute tip, or more or less ventricose with a frequently curved pedicel,

¹ Although it is customary to consider the gender of generic taxa feminine if they end in *ites*, we have used the masculine gender since this is the way Kalchbrenner treated it both in *Hedwigia* and *Grevillea*.

connection to oleiferous hyphae often obvious. Ends of the primordial hyphae reaching the hymenial layer and having all the characteristics of the primordial hyphae of some species of *Russula* (such as *R. murrillii*, *R. dadmunii*, and *R. punctata*), with rounded or attenuated tip, with granular incrustation, sometimes septate, about $70 \times 7 \mu$, transitions between the two types of cystidium not infrequently observed on a single section.

Hyphal layers. Hyphae of the hymenophoral trama and the trama of the peridium of similar structure. Tramal plates with a mediostratum of heteromerous tissue, near and in the subhymenium showing a trend toward more regular arrangement with some degree of bilaterality, the sphaerocysts of the central strand surrounded by filamentous elements such as normally occur in *Russula*, oleiferous hyphae² and what appear to be promordial hyphae.

Tissue of the columella strictly heteromerous in structure. Outermost layers of the peridium similar to the epicutis of *Russula* spp., with a broadly gelatinized layer consisting of repent hyphae which are thin-filamentous, hyaline, smooth, and intermingled with a few elements with granular contents or granular incrustations (primordial hyphae); dermatocystidia none seen. Hyphae of all tissues inamyloid, without clamp connections.

Epigeous (at maturity) in fields among grasses at the base of old trunks of *Acacia horrida*. Somerset East, South Africa, MacOwan, February 1876, No. 1211, type (K, NY).

The fragments existing at New York are considerably better than anticipated. Some data on the fresh fungus not visible anymore in the dried specimen have been taken from the original diagnosis by Kalchbrenner since they seem to go back to MacOwan's indications.

Illustrations can be found in the first account in the Gardner's Chronicle, in Kalchbrenner's paper in Hedwigia, and in Fischer's treatment of the Gastromycetes in Engler & Prantl, second edition. Yet they are always based on the same figure.

67. *MACOWANITES mollis* Singer & Smith sp. nov.

Fig. 94.

Gastrocarpio 10-30 mm lato, molli albo demum subalutaceo, depresso-convexo; gleba pallide subochracea; columella percurrente; sporis $11-16 \times 9-13 \mu$, subglobosis; cystidiis $38-56 \times 5-8 \mu$. Specimen typicum legit D. E. Stuntz, Mt. Rainier Nat'l Park, Wash. 23 Sep 1948 (Smith—31683) (MICH).

Gastrocarp 10-30 mm broad, depressed globose to depressed-pileate, surface white and soft to the touch, lubricous, drying cinnamon buff to alutaceous; gleba white to buff and drying slightly paler than the peridium, moderately large, soft in consistency; stipe-columella present but

² These are not necessarily, or perhaps never in either Russulaceae or in the Secotiaceae, actually oil-carrying ducts since cresyl blue mounts do not show any easily demonstrable oil content in them. The term is used as an anatomical term, first introduced by Fayod, and is the only term which clearly differentiates between this kind of conducting hypha and the broader latex-conducting elements, the laticiferous vessels or laticifers, a term often misleading used for both types as found in *Russula* and *Macowanites* and also for the latex-carriers of *Lactarius*.

greatly reduced, columella part percurrent or nearly so, stipe portion 4.6×2.3 mm, white; peridium extending to stipe-columella or leaving a narrow to wide and irregular "ringhole" exposing the gleba.

Spores globose and $10\text{--}15\ \mu$ in diam. or $11\text{--}14(16) \times 9.5\text{--}13\ \mu$ and subglobose to ellipsoid; sterigmal appendage inconspicuous; ornamentation in the form of small spines unconnected or fused in groups of 2-3, $0.6\text{--}1\ \mu$ high and $\pm 0.25\ \mu$ broad at base, completely covered with amylaceous material; plage area ornamented as the remainder of the surface, spore wall thin to slightly thickened.

Hymenium. Basidia 1-, and 2-spored, clavate, $24\text{--}33 \times 10\text{--}13\ \mu$, hyaline, readily collapsing. Basidioles numerous. Cystidia rare to scattered, $38\text{--}56 \times 5\text{--}8\ \mu$, filamentose-acuminate to narrowly clavate-mucronate, with a small amount of refractive content variously distributed (as seen in KOH). Pseudoparaphyses none.

Hyphal layers. Subhymenium of vesiculose elements which at maturity are $10\text{--}18\ \mu$ in diam. and form a layer 2-3 cells deep. Mediostratum of tramal plates at first (near margin of peridium) filamentose but at maturity greatly enlarged cells seen scattered through it. Cuticle complex, in the form of a modified "virescens structure" as described by *Russula* specialists, i.e., a basal cellular layer, the cells $8\text{--}15\ \mu$ diam. over and from which there is a turf of dermatopseudocystidia mixed with branched filaments of fundamental hyphae and this layer somewhat gelatinous in KOH, the turf elements versiform—clavate, contorted, fusoid, capitate-pedicellate, etc., but generally under $30\ \mu$ long though dermatopseudocystidia may be longer. Oleiferous hyphae none. Clamp connections absent.

Collected under mixed conifers and hardwoods, Lower Tahoma Creek, Mt. Rainier National Park, Wash. Sept. 23, 1948, D. E. Stuntz collector, Sm-31683 Type.

This species is a *Macowanites* on the basis of its anatomical features but the fruiting body is that of *Elasmomyces* in that the "stipe" is greatly reduced in size and the "columella" is not always percurrent. As pointed out previously, if the two genera are distinct, the ultimate distinction must be based on the anatomical features of the mediostratum of the tramal plates of mature specimens. Thus we place Stuntz's collection in *Macowanites*.

In one fruiting body which we examined hyaline hyphae $6\text{--}8\ \mu$ in diam. were scattered through the tissues and were characterized by having clamps regularly at the cross-walls. We interpret these as the mycelium of another Basidiomycete since they were not present in all carpophores examined.

The distinctive features of this species are its soft flesh, white peridium and stipe which dry alutaceous, the very narrow elements of the spore ornamentation, and the structure of the cuticle of the peridium. No odor was noted at the time the fresh material was at hand and none is present in the dried specimens. The taste of fresh material was not recorded.

Smith—29876, collected on Lower Tahoma Creek also in Mt. Rainier National Park, by Betty and William Knowles appears to be the same

as Stuntz's collection. The data recorded from the fresh material are as follows: Gastrocarp up to 3.5 cm broad, surface glabrous, *moist*, pallid yellowish to whitish with "vinaceous buff" areas in age; columella extending to upper surface (percurrent) and flaring out there to form the thin context of the peridium; gleba whitish ("tulle buff"). Stipe short (3.5 mm) and margin of peridium not attached to it (hence stipe and columella not "differentiated").

Spore ornamentation up to 1.25 μ long; 1-spored basidia numerous; sphaerocysts conspicuous at times in the mediostratum of the tramal plates.

All other characters check well with Stuntz's collection and since the differences are slight and quantitative only, we are referring the Knowles' collection here. The dried specimens are very similar. This species is very close to *M. krjukowensis* but differs markedly in the structure of the cuticle of the peridium and also in spore size.

68. MACOWANITES MAGNUS Parks in Zeller & Dodge, Ann. Mo. Bot. Garden 22:369. 1935.

Arcangeliiella magna (Parks in Zeller & Dodge) Zeller, Mycologia 40:643. 1948.

Fig. 86.

Gastrocarp 30-140 mm broad, resembling a stout agaric or bolete, irregular, at first conic, then expanded and almost plane, with irregular to sinuate margins. Peridium smooth, viscid, pale tan to dark brown, drying fawn-brown to army brown or cinnamon-buff, duplex, about 250-380 μ thick. Gleba white at first, drying warm buff with vinaceous tints, spongy as in *Gautieria morchelliformis* expanded, more or less radiating from the center of the gastrocarp, free to adnexed to the stipe-columella, exposed below, cavities large, labyrinthiform. Stipe short, thick, central, 30-70 mm long, about 30 mm thick, brittle, stuffed becoming hollow, bulbous at base, abruptly attenuated below the blub, subglabrous to innately fibrillose, texture of interior homogeneous, white throughout. Context taste like a mild *Lactarius*, odor becoming pungent and offensive in age.

Spores (7.5)8.5-13.5 $\times$ 7.5-12.3 μ , globose to broadly ellipsoid, pale yellowish in dilute bases, wall 0.5 μ thick, ornamentation projecting 1-1.3 μ , in the form of a broken reticulum, the warts more or less connected by lines (type II, IIIb, or more rarely IV, IIIa).

Hymenium continuous. Basidia 35-60 $\times$ 6.5-12 μ , 4-spored or rarely 1-, 2-, 3-spored, clavate to ventricose; sterigmata either straight-conic or half-sickle-shaped as in agarics, mostly the latter. Macrocystidia (?) very scattered, narrowly clavate to fusoid, in ammonia merely granular within, 60-80 $\times$ 10-14 μ , aldehyde reactions unknown.

Hyphal layers. Subhymenium thin, intermixed but subcellular, hymenopodium strongly developed but often not clearly differentiated from either the subhymenium or the mediostratum, filamentous or with an occasional swollen element, continuous with the filamentous (connecting) hyphae of the mediostratum but the latter constantly containing some large sphaerocysts especially at the juncture of the tramal plates, i.e., with relatively more filamentous elements and relatively fewer sphaerocysts than for typical heteromerous tissue, with occasional oleiferous hyphae; laticiferous vessels none seen. Outer layer of peridium (epicutis)

entirely strongly gelatinized, very broad as revived in KOH, consisting exclusively of filamentous hyphae some of which have cystidioid end-cells which are capitate, subcapitate, ampullaceous, etc., and 3-4 μ in diam., many hyphae wavy or spiral in outline, smooth, lacking solid contents, narrow (about 1.5 μ broad); primordial hyphae, dematopseudocystidia, and ciliate dermatocystidia none. Hyphae inamyloid, without clamp connections.

Material studied. California. Santa Clara County, Parks No. 208 (part of type, courtesy of C. W. Dodge).

The description of macroscopic characters is drawn from the original description since it was found that there were misidentifications of this species in the Zeller Herbarium.

The generic position of this species puzzled us for a time. The structure of the tramal plates shows what might be regarded as a transition to *Elasmomyces*. Their appearance in good sections is often misleading since the sphaerocysts are sometimes not very numerous. To view them it helps to put moderate pressure on the cover glass to spread the sections while they are being viewed, and by this means we have been able to consistently demonstrate the sphaerocysts. The habit of the fruiting bodies must have been that of a *Russula* and not a *Lactarius* or bolete. The spore ornamentation likewise suggests a *Macowanites* rather than an *Elasmomyces*. We found only oleiferous hyphae, and consequently do not think that this species can possibly be correctly placed in *Arcangeliella*.

The collections reported from Oregon are not the same as the type. Zeller 8239 has spores with the ornamentation showing no reticulum at all, and the Agate Beach coll. (Zeller 8235) is the same as Zeller 8239, only the specimens were older and in poorer condition. It should be noted that the Zeller collections were from under *Picea* and that the type was associated with redwood. As yet we have been unable to identify the Oregon collections.

69. *MACOWANITES citrinus* Singer & Smith sp. nov.

Figs. 87-88.

Gastrocarpio 20-40 mm lato, albo, centro citrino vel viriduliluteo, peridio sulphati ferri ope haud mutante, mediostrato generatim tenuiculo, hymenopodio bene evoluto, subhymenio tenui subcellulari; sporis cristulatis vel reticulatis, plerumque $9-11 \times 8-10 \mu$, reticulatione (0.5) $1-1.3 \mu$ alto; macrocystidiis hymenialibus nullis vel subnullis, epicuticularibus praesentibus, elementis epicutis saepe ad septa separatis liberatisque. Specimen typicum legit prope Stanley, Idaho, 19 July 1958, Smith 58942 (MICH).

Gastrocarp 20-40 mm broad, convex, usually remaining so but rarely expanding to broadly convex, leaving gleba exposed below. Peridium thin, fragile, slightly viscid, smooth, in age surface cracking into irregular plates as in *M. americanus*, exposing the thin white context or even penetrating to the gleba, white with a lemon yellow to greenish yellow disc, in age watery gray along the margin; margin incurved and in places touching the stipe-columella, acute or subacute. Gleba chambered with irregular elongate cavities, gill outlines barely visible, color cartridge

buff when freshly cut but gradually becoming pale grayish when such surfaces remain exposed. Stipe-columella 10-15 mm long, 8-11 mm thick, white and unpolished, gleba attached at the apex. Veil lacking. Context of peridium, stipe and columella white, heteromerous; odor faintly pungent, taste mild.

Spores mostly $9-11(14) \times 8-10(-12) \mu$, stramineous in KOH, yellowish in ammonia, ellipsoid to subglobose, with oblique eccentrically attached sterigmatal appendage, rarely more symmetrical, ornamentation projecting (0.5) $1-1.3 \mu$, typically in the form of a broken reticulum and completely covered with an amylaceous material (type II, III).

Hymenium continuous. Basidia $31-36 \times 11-14 \mu$, 4-spored or more rarely 2-spored, sterigmata apical, half-sickle-shaped or more rarely either long-conic and straight, or irregular. Pseudocystidia rare, $48-64 \times 9-11 \mu$, mucronate at tip in most, with oily-refractive contents (apparently not typical macrocystidia); some oleiferous hyphae may enter the lower portion of the hymenium but do not form cystidiform terminal members.

Hyphal layers. Subhymenium consisting of some elongate branched hyphae but typically of subisodiametric elements, hence cellular, thin to medium width; hymenopodium generally indistinct at maturity, when present consisting of elongated filamentous elements. Mediostratum varying, according to thickness of tramal plates, from extremely thin (so thin that it may be overlooked and the hymenopodium be taken for the filamentous mediostratum known in *Martellia* and *Elasmomyces* to very thick particularly where tramal plates connect, and in these thicker places the tissue is heteromerous in fact the sphaerocysts are abundant so that in some sections the tissue appears cellular. Epicutis of peridium well developed but scarcely differentiated into an outer and an inner layer, consisting of a turf of filaments with some oleiferous hyphae intermingled, the filaments $3-6 \mu$ broad and many with numerous (2-4) cross walls, the cells usually irregular in shape, the filaments often breaking up at the septa and the cells becoming free; dermatopseudocystidia present, of the type known for *Russula sphagnophila*, aseptate to septate, the latter type often with homogeneous contents and thus constituting a transition to primordial hyphae, the aseptate ones rounded or narrowed to an obtuse tip, with granular or banded content which blackens in sulfobenzaldehyde, both types about $70 \times 6-6.6 \mu$. Epicuticular elements of the center of the gastrocarp with a bright yellow pigment permeating the preparation. Context heteromerous. All hyphae inamyloid and lacking clamp connections.

Chemical reaction. FeSO_4 on flesh of peridium no reaction; with gleba soon grayish; with context of stipe soon gray.

Gregarious under *Pinus contorta*, Stanley Lake, Sawtooth Mts., Idaho, July 19, 1958, Smith-58942, type (MICH).

This species is amply characterized by its reaction in FeSO_4 , spore characters and color of the peridium. Where the tramal plates are narrow (about 70μ thick) their structure bears some resemblance to the type characteristic for *Elasmomyces* and *Martellia*, but we are not prepared to assert that this is a transitional form.

70. *MACOWANITES fulvescens* Singer & Smith sp. nov.

Figs. 89, 90, 92.

Gastrocarpio 20-30 mm lato, globoso; peridio albido, dein diffracto atque fulvescente, haud viscido; gleba cinnamomeocalutacea, haud libera, subtus tramate marginis peridii ubi columellam attingit, connata, e loculis a columella peridium versus radiatim dispositis consistente; columella 4 mm crassa nec in stipitem liberum continuata, non dehiscens; carne columellae albida, rupta subbrunnescente. Sporis $9.5-15.2 \times 7-11.8 \mu$, ellipsoideis vel late ellipsoideis, ornamentatione vix prominente variabili fortiter amylacea subtiliter verruculoso-spinulosa et interdum plus minusve reticulatim connexa obtectis. Macrocystidiis praesentibus. Subhymenio cystangii modo lato ex elementis minoribus sphaerocystibusque voluminosis efformato. Strato externo peridii trichodermio haud gelatinoso efformato, e dermatopseudocystidiis partim fulvescentibus, sulfobenzaldehydica reactione subnigrescentibus hyphisque terminalibus irregularibus interixitis efformato; fibulis nullis. Sub Piceis Abietibusque specimen typicum, legit prope McCall, Idaho, 5 Aug. 1958, Smith 59584 (MICH).

Gastrocarp 20-30 mm broad, globose. Peridium at first continuous and whitish, later breaking up into aerolate patches and these patches staining clay color to tawny exposing the white context beneath. Gleba about 10 mm thick at the thickest point; slightly paler than "cinnamon-buff" (buff colored), attached all along the columella down to the base where the lower edge of the peridium is intergrown with the tissue of the columella, gleba not exposed at any time (in material thus far collected), consisting of cavities more or less radiating from the columella toward the peridium but chambers irregular in shape. Columella 4 mm thick, in the type collection not continued into a stipe, percurrent. Context of peridium white, thin; of columella whitish, consistency pithy, becoming cinnamon-buff when cut; odor and taste not distinctive.

Spores $9.5-15.2 \times 7-11.8 \mu$, pale yellow in dilute bases; broadly ellipsoid, sterigmal appendage eccentric and oblique; ornamentation projecting $0.2-0.8 \mu$, mostly $0.4-0.5 \mu$, of low almost wart-like cones which are more or less crowded into shorter or longer chains or short crests, and are usually connected by very fine amyloid lines or tail-like extensions to form a partial or broken reticulum (type VI, V, IV, IIb, II-IV, II, VIII), plage area ornamented and often showing a diffuse amyloid spot or area.

Hymenium continuous. Basidia $35-50 \times 11-16 \mu$, 2- and 4-spored, clavate or ventricose, sterigmata variable, straight or half-sickle-shaped. Pseudoparaphyses rather numerous, vesiculose, pseudocystidia rather numerous, content blackening in sulfobenzaldehyde, only a few practically without contents (as seen in KOH or NH_4OH), $63-110 \times 13-18 \mu$, mostly clavate-mucronate or apex merely obtuse to subacute; leptocystidia with protoplasmic content also present, $48-64 \times 18-24 \mu$, thin-walled, clavate-mucronate, readily collapsing (perhaps only an "empty" variant of the pseudocystidia).

Hyphal layers. Subhymenium broad, consisting of small and large sphaerocysts and a few elongated narrow elements; hymenopodium poorly developed, intermittent, filamentous; mediostratum heteromerous. Peridial trama heteromerous, epicutis consisting of a differentiated turf of dermatopseudocystidia and hyphal ends which are often irregular in out-

line or forked, not gelatinized, not originating from a hypodermal layer, tending to become fulvous, cystidioid elements with contents blackening or browning in sulfobenzaldehyde. Hyphae inamyloid, without clamp connections.

Under *Picea* and *Abies*, Brundage Mt., McCall, Idaho, August 5, 1958, Smith-59584, type (MICH).

This species is the most aberrant from the type of the genus and from the other species of *Macowanites* found in Idaho that we have encountered. It has a structure of the tramal plates which because of its extensive subhymenium, reminds one of *Cystangium* and *Elasmomyces* as well as of *Hydnangium* and *Martellia*. Although, on the other hand, there is no trace of a filamentous mediostratum. This as well as the other characters typical for *Russula* favor inserting this species in *Macowanites* unless one wishes to emphasize the absence of a free stipe to justify the erection of still another genus in this series, a solution which we wish to avoid at the present time. Depending on conditions of humidity at the time the fruit body develops, the stipe, in all these secotiaceous fungi from Idaho, including *Thaxterogaster pingue*, will vary from a more or less extended portion below the lower edge of the peridium to no extension there at all. Hence we are ready to expect that future collections will eventually show a stipe for *M. fulvescens* much like that found for *M. americanus*. The elements of the epicutis are very striking because of their ochraceous content as revived in KOH.

71. *MACOWANITES albidigleba* Singer & Smith sp. nov.

Figs. 91, 93.

Gastrocarpio 10-30 mm lato, convexo, haud expanso, opaco, pallido, gradatim tandem rosascente; peridio crasso, firmo, sicco; sapore miti demum tarde acri, inodoro, immutabili; gleba alba, demum pallide carneolo-alutacea, lacunosa, columellae adnata. Stipite columellaque albis. Sporis $8-11.7 \times 7.5-9.7 \mu$, ornamentatione variabili configuratione gaudente sed constanter fere humili ($0.3-0.7 \mu$). Macrocystidiis in epicute hymenioque praesentibus. Reactione roseola ferri sulphati in carne obvia. Sub Abietibus. Specimen typicum legit prope McCall, Idaho, 30 July 1958, Smith 59225 (MICH).

Gastrocarp 10-30 mm broad, convex, not expanding, with obtusely rounded margin, gleba exposed between margin and stipe. Peridium thick, firm, dry, moist but not viscid under moderately humid conditions, unpolished at maturity, uneven, pallid at first, slowly becoming pale dull rose-color (near "vinaceous tawny"). Gleba white until old age and then merely "pale pinkish-buff" in the interior, appearing obscurely lamellate over the exposed part, lacunose inside and with very small irregular chambers. Stipe about 10 mm long, 8-10 mm thick, white, firm, subequal, columella very broadly percurrent and gleba attached to it only near the apex. Context of peridium and stipe white, firm, taste mild at first, finally tardily acid, odor none.

Spores $7.5-11 \times 7.5-9.7 \mu$, pale yellowish in dilute bases, subglobose to broadly ellipsoid, sterigmal appendage oblique and eccentric, ornamentation rather variable, projecting $0.3-0.8 \mu$, the majority with ornamentation in the form of irregular short ridges and crests often fused or

connected by fine lines, some unconnected warts and smaller amyloid particles also present in an irregular pattern, at times almost forming a broken reticulum (type IIIb, IV, V, VI, II-IV).

Hymenium. Basidia $35-54 \times 13.5-15.8 \mu$, 2- or 4-spored. Macrocystidia $40-72 \times 12-18.5 \mu$, numerous, varying from fusoid to clavate and sometimes with a mucro, content banded and becoming black in sulfobenzaldehyde.

Hyphal layers. Subhymenium narrow, subcellular to cellular, with elements about as broad as the base of the basidium; hymenopodium poorly developed (1-2 hyphae broad); mediostratum heteromerous, with large and medium sized sphaerocysts abundant. Epicutis of peridium of dermatopseudocystidia having loose contents, sometimes septate, and rounded to obtuse at apex, $40-70 \times 5-12 \mu$, contents blackening in sulfobenzaldehyde (of the type known in *Russula sphagnophila*), these located among the elements of a turf of irregular often branched hyaline hyphal ends with homogeneous content and all loosely arranged in a subgelatinous layer. Context of peridium beneath this layer similar in structure to the mediostratum of the tramal plates; all hyphae inamyloid and lacking clamp connections.

Chemical characters. FeSO_4 on context of peridium and stipe pinkish.

Closely gregarious under *Abies grandis*, South Fork of Lake Fork Creek, Payette National Forest, July 30, 1958, Smith-59225, type (MICH), and Sm-59722, paratype (MICH).

This species was collected along with *M. americanus* and though the cap was in perfect condition, it was not viscid. However, in KOH-preparations the turf appears gelatinous, indicating that after rains it might become viscid to the touch. It differs from *M. americanus* in the much paler gleba and tardily slightly acrid taste, paler peridium when young and poorly differentiated hymenopodium.

72. *MACOWANITES acris* Singer & Smith sp. nov.

Figs. 95-96.

Gastrocarpio 50 mm lato, convexo-depresso, sordide griseolo-violaceo; gleba dura, carneolo-alutacea; stipite albo, paulum ochraceo ad basin; carne alba, acri; sporis $8-11.7 \times 7-9.7 \mu$, sat intense luteis vel flavo-ochraceis, ornamentatione variabili vel absente numquam complete reticulatis, $0.4-1 \mu$ projiciente. Macrocystidiis hymenialibus epicuticularibus praesentibus; epicute paullum gelatinosa. Sub Picea, Idaho. Specimen typicum legit prope Stanley Idaho, 20 July 1958, Smith 58967 (MICH).

Gastrocarp 50 mm broad, convex-depressed, with decurved margin, surface dry and unpolished, variously creased. Peridium dull grayish vinaceous ("Benzo brown"). Gleba as seen from the lower side obscurely lamellate, but loculate because of the development of cross walls and veins towards the peridium, 15 mm thick in deepest part, consistency hard and firm, "pinkish-buff". Stipe 30 mm long, 20 mm at apex, bulbous and 10 mm wide at base, solid, white, unpolished, stained faintly ochraceous at base, gleba attached at apex of stipe-columella. Context of peridium and stipe and columella firm and hard, taste acrid.

Spores $8-11.7 \times 7-9.7 \mu$, broadly ellipsoid, rather deep ochraceous in ammonia, ornamentation projecting $0.3-0.8(1) \mu$, mostly about $0.5-0.6 \mu$,

ornamentation of smaller spores (from 4-spored basidia) of cones and warts with occasional linear thin connections or tail-like extensions, or warts in series forming short chains (type VI-V-IV, VI-VIII, IV-VI-VIII); the larger spores mostly almost smooth to smooth (if smooth then amyloid, type X), with an eccentric oblique sterigmal appendage.

Hymenium continuous. Basidia 4-spored (more rarely 2-spored), hyaline revived in dilute bases, clavate, $45-66 \times 11-13 \mu$, sterigmata curved or straight, mostly the former, $6-8 \mu$ long. Macrocystidia $70-11 \times 6-13 \mu$, in dilute bases often only densely granular, in sulfobenzaldehyde with blackening banded contents, fusoid, abundant, subhyaline in KOH, projecting.

Hyphal layers. Subhymenium of mostly subisodiametric small elements intermixed with some short-cylindric or irregular elements extending towards the base of the basidia, characteristically of the subcellular type. Hymenopodium consisting of filamentose hyphae extending generally in the direction of the tramal plates, somewhat interwoven, diameter of hyphae $2-3 \mu$. Mediostratum heteromerous, sphaerocysts predominant. Trama of peridium and stipe also heteromerous but connecting hyphae also numerous and often aggregated into small strands; outer layers of peridium well differentiated, consisting of a clearly delimited epicuticular and an inner hypodermal layer, the former of loosely arranged hyphal ends $15-40 \times 2-3 \mu$, somewhat gelatinized and in a turflike arrangement, the elements irregular in outline or forked, interspersed with these are hypha-like dermatopseudocystidia $35-50 \times 4-5 \mu$, their content blackening in sulfobenzaldehyde, also present are septate promordial hyphae with broadly rounded apices but without banded contents as well as other elements intermediate between primordial hyphae and dermatopseudocystidia; the hypodermal layer similar in aspect to the homologous layer in typical acid *Russulae* (pink but bleaching quickly in ammonia and consisting of repent filamentous non-gelatinous hyphae); hyphae of all parts of carpophore inamyloid and lacking clamp connections.

Chemical reactions. FeSO_4 with context of peridium pallid to slightly dingy.

Solitary under *Picea*, Cape Horn Summit, near Stanley, Idaho July 20, 1958, Smith-58967, type (MICH).

This species approaches *Russula* more than all the other species known since it combines a strongly acid taste with structures in the hymenophore and peridial covering which are characteristic for typical *Russulae*. The sterigmata are those of an agaric and the spores are within the range most frequently encountered in *Russula*, rather deep yellow.

73. *MACOWANITES fuscoviolaceus* Singer & Smith sp. nov.

Figs. 97-98.

Gastrocarpio 30 mm lato, peridio fuscoviolaceo, marginem versus obtuse violaceo, fragili, intus albo, sapore miti; gleba labyrinthiformi vix lamellari, cavitiebus parvis angustisque, sublibera, stipite albo, ferruginascente ad basin. Sporis $7-9.7 \times 6-8.3 \mu$, cristatis vel reticulatis partim inter verrucas $0.3-0.7 \mu$ altas. Macrocystidiis in hymenio epicuteque praesentibus; hymenopodio maxime e parte manifesto. Sub Abietibus. Specimen typicum legit prope McCall, Idaho, 30 July 1958 Smith 59261 (MICH).

Gastrocarp 30 mm broad, convex, obtuse, with lobed or irregular more or less obtuse margin, leaving the lower surface of the gleba almost or entirely exposed. Peridium glabrous, viscid, with uneven surface, violaceous in buttons, soon becoming fuscous-violet on disc, marginal zone dull violaceous with pallid areas. Gleba scarcely lamellate on exposed surfaces, interior labyrinthiform with small and narrow cavities, milk-white except for tawny stains around the worm holes, free from the stipe-columella. Stipe 20 mm long, 12 mm thick at apex, solid, white, stained rusty around base and worm holes. Columella percurrent. Context of peridium and stipe white, brittle in the former; taste mild.

Spores $7.9.7 \times 6.8.3 \mu$, subglobose to very short ellipsoid, yellowish in dilute bases, ornamentation projecting $0.3-0.7 \mu$, rather variable, connecting lines not forming a complete network, warts often arranged in crowded rows or even fused together to form ridges (type II, IIIb, VIII, IV); sterigmal appendage oblique about 3μ long.

Hymenium continuous. Basidia $34.51 \times 11.5-15 \mu$, 4-spored, very rarely 2-spored, clavate; sterigmata most frequently half-sickle-shaped as in *Russula* but sometimes coarse and irregular or straight (fertile?). Macrocystidia $40.65 \times 9.16 \mu$, clavate, fusoid or ventricose, more rarely cylindric, obtuse to broadly rounded above, with rather loose to dense banded contents, rarely without any content, content when present turning blackish in sulfobenzaldehyde.

Hyphal layers. Subhymenium consisting of subisodiametric to short-cylindric very small hyphal cells. Hymenopodium not consistently present, filamentous, hyphae $2-3.5 \mu$ broad, longitudinally arranged; mediotrstrum strongly heteromerous except in the thinner connective tramal plates where sphaerocysts are rather scattered. Trama of the peridium and stipe heteromerous, the outermost layer of the peridium about 100μ thick, formed by a turf of long sparsely branched hyphae $2.5-4 \mu$ thick, imbedded in a gelatinous mass (in KOH mounts), terminal cells of some filaments cystidioid, numerous dermatopseudocystidia present which stain blackish in sulfobenzaldehyde. Hypodermium absent. Hyphae inamyloid, clamp connections none seen. Surface layer of stipe with a moderate number of dermatopseudocystidia similar to those on the pileus.

Chemical reaction. FeSO_4 slowly pinkish-buff on the context of the peridium.

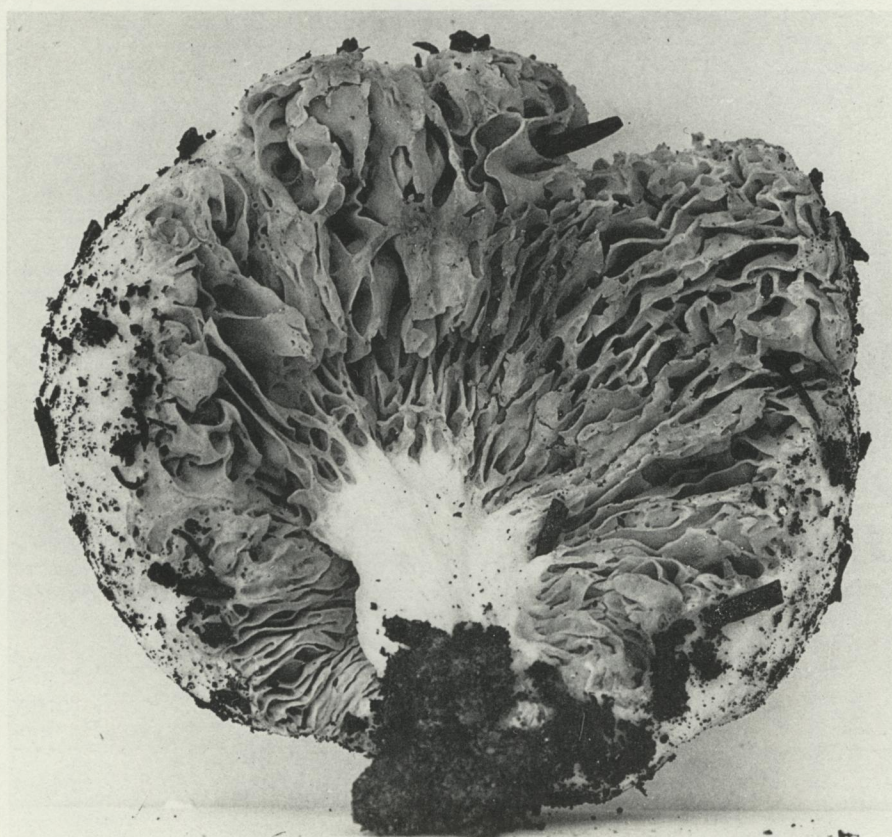
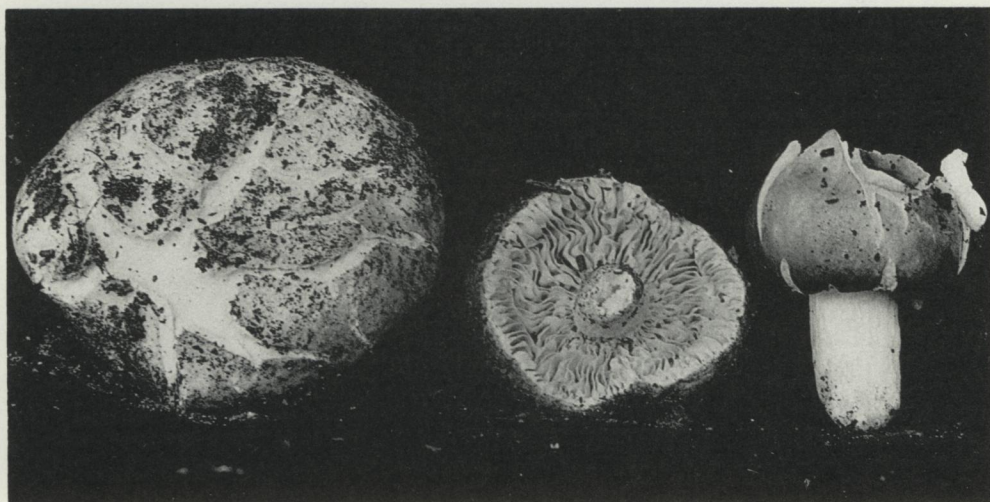
Solitary under *Abies lasiocarpa*, Payette National Forest, Idaho, July 30, 1958, coll. T. Westerdale, Sm-59261, type (MICH).

The relatively long elements of the peridial turf, the milk-white gleba and the fuscous tone in the center of the peridium are distinctive. *M. americanus* has deeper yellow gleba and spores.

74. *MACOWANITES americanus* Singer & Smith sp. nov. pl. 1, pl. 2, upper fig.

Species subvulgata sui loci Macowaniti fuscoviolaceo peraffinis a quo differt colore peridii magis variabili at vix centro soride fuscoviolaceo; basi stipitis ferruginascente numquam notata; dermatopseudocystidiis in peridii stipitisque superficie reactione sulfo-aldehydica maxima e parte colorabilibus (typi macrocystidialis) parcis vel nullis; epicute peridii primum e pseudocystidiis erectis, demum e strato intermixto gelatinoso

Macowanites americanus



Upper fig. *Macowanites americanus* S. & S. $\times 1$ Photo A.H.S.

Lower fig. *Macowanites americanus* S. & S. $\times 2$ Photo A.H.S.

depresso cutiformi consistente; hymenopodio vix vel paulum. Specimen typicum, legit prope McCall, Idaho, 16 Jul. 1954, Smith 45032 (MICH).

Gastrocarp 10-50 mm broad, semiglobate or convex-flattened to irregular, more rarely almost appanate from the beginning, eventually often expanding to plane with a decurved margin, frequently eccentric, margin acute or sometimes (especially in specimens with strongly secotiaceous gleba) obtuse. Peridium consisting of an outer cuticle-like layer which is very thin and an interior fleshy layer which is very thin at the margin but becomes thicker as it approaches the disc (where it is 1-4 mm thick), surface glabrous, viscid at first, smooth, soon cracking into large flakes (at times so deeply as to expose the gleba), color extremely variable, pale olive yellow, pale olive, pink, lilac, lilac-purple to purplish red, sometimes unicolorous and at other times showing various mixed colors in a single group of gastrocarps, often with mixed pigments in a single peridium, whitish at times when remaining covered by the duff. Gleba basically sublamellate and attached to the apex of the stipe-columella, but very convolute and intervenose, almost alveolate in many gastrocarps and frequently some hymenophoral bands extending from the margin to the stipe-columella and decurrent there, lamellar plates radiating but not regularly so, often bent or forking at various levels and not geotropically oriented, forming some completely closed winding chambers and a majority of broad chambers open toward the lower surface, thickness of the gleba variable, very broad at the margin of the peridium, or evenly narrow to the columella, or strongly ventricose and then deeply sinuate, or on the contrary concave below and then adnate to subdecurrent, at first white, soon (in correlation with the density of the accumulated spores) more or less deeply ochraceous ("ochraceous buff"), apparently always at least partly exposed, extremely fragile.

Stipe-columella 10-30 mm long, 4-12 mm at apex, usually shorter than the width of the gastrocarp, equal or nearly so, naked, uneven, white, solid, soon becoming stuffed and finally partly hollowed, percurrent to the thickest central part of the peridium, no basal mycelial tomentum present. Veil none.

Context of peridium moderately firm at first, becoming very fragile, odor none; taste mild.

Spores $8.7-13.2 \times 8.2-11.8 \mu$, short-ellipsoid to subglobose; the sterigmal appendage eccentrically to subcentrally attached and mostly oblique, very rarely almost straight; distinctly yellowish; ornamentation strongly amyloid, consisting of warts and short spines connected into (often straight) chains or lines by a sometimes interrupted network of fine lines and occasional short ridges (type III, II, VIII), ornamentation projecting $0.5-0.8 \mu$ or rarely up to 1.2μ ; plage area with a dark amyloid area of amorphous material which extends to the sterigmal appendage and forms a thin short jacket around its base or up to one fourth to one third the distance toward its apex.

Hymenium continuous. Basidia $23-46 \times 7-13.5 \mu$, mostly $23-38 \times 10-13 \mu$, broad and relatively short, clavate, hyaline, mostly 4-spored, rarely 1-, 2-, or 3-spored; sterigmata straight to curved usually conic. Pseudoparaphyses about $22 \times 18 \mu$, thin-walled. Pseudocystidia $40-90 \times 7-11.5 \mu$, apparently not bluing in sulfovanillin and contents not similar to that

generally expected to turn blue in the Russulaceae, ventricose, broadest in the lower, central or upper third, or rarely ampullaceous with obtusely rounded or more rarely acute attenuated tip, originating in the lower portion of the subhymenium or the outer portion of the mediostratum. Content yellow in KOH and ammonia and visible as granular to banded loosely distributed material, numerous in young specimens but appearing more scattered in mature gastrocarps.

Hyphal layers. Subhymenium well developed, of small cellular or somewhat irregular elements, hyaline, intermixed with hyphous cystidial pedicels; hymenopodium poorly differentiated, mostly inconspicuous (sometimes absent); mediostratum varying from regular to obscurely bilateral (toward the subhymenium the elements often diverging slightly), its elements mostly very strongly inflated, or typically heteromerous. Peridial trama and that of columella and stipe typically heteromerous. Epicutis of peridium at first consisting of strongly projecting pseudocystidia arranged in a palisade, the elements gradually becoming more decumbent and tangled, subgelatinous as revived in KOH, many primordial hyphae and ordinary filamentous hyphae also present in older peridia (these often dominant); dermatopseudocystidia apparently of a non-bluing type much as the pseudocystidia of the hymenium, cylindric to clavate, $25-85 \times 4-8 \mu$; some hyaline fusoid dermatocystidia without distinctive content or incrustation also present. Beneath the epicutis occurs a hypodermium (similar to that of *Russula*) consisting of repent filamentous hyphae but differing in containing scattered sphaerocysts. Clamp connections absent and all hyphae inamyloid.

Hypogeous to epigeous on and in deep conifer duff, often in large groups, near and under stands of *Abies*, *Picea* and *Pseudotsuga*, fruiting from July until the end of August, central Idaho, U. S. A.

Material studied: Idaho, Payette National Forest, July 16, 1954, Smith and Bigelow (Smith-45032, type MICH). Numerous additional collections from the same region made in 1954 by Bigelow, Smith and Stuntz, and again in 1958 by Smith and Westerdale. These were all accessioned under A. H. Smith's series of numbers as follows: 44032, 44033, 44980, 45032, 45034, 45035, 45051, 45052, 45053, 45055, 45116, 45118, 45119, 45120, 45121, 45123, 45124, 45126, 45175, 45177, 45616, 45617, 45618, 45619, 45621, 45749, 45821, 45822, 45823, 45824, 45825, 45826, 45827, 45828, 45829, 45831, 45833, 45834, 45835, 45836, 45839, 35840, 45842, 45843, 45844, 45845, 45846, 45847, 45848, 45852, 45862, 45863, 45868, 45870, 45871, 45878, 45894, 45915, 45949, 45975, 46028, 46071, 46072, 46074, 46095, 46097, 46117, 46426, 46481, 46674, 46762, 46778, 46911, 46912, 46986, 47150.

No. 45032 contained very young primordia as well as mature fruiting bodies. The smallest primordia were 0.8 mm and 3 mm respectively. The former did not contain any spores or recognizable hymenium and was covered by strongly elongated dermatopseudocystidia which gave it a fuzzy appearance under a lens on all surfaces including the lower surface of the gastrocarp which was not yet differentiated from the upper surface (peridium) or the surface of the ventricose stipe. The color of this primordium was pale yellow and its peridium did not yet have a gelatinous epicutis. There was a slight indication of the formation of

tramal plates indicated by the direction of the hyphal strands. In the smallest button, an intermediate stage, sporulation had just barely begun, and the gleba was already well formed and fully exposed on the underside of an almost flat pileus-like peridium. At this stage there were many pseudocystidia in the hymenium and the mediostratum was still mainly composed of filamentous hyphae which were in a more or less regularly arranged yet strongly interwoven pattern with many tramal plates close together. Among these elements there were a number of endocystidia of the pseudocystidial type and many of them were rather shortened to resemble sphaerocysts, but true sphaerocysts as seen in mature material were still exceedingly rare and scattered. Some of the filamentous elements were apparently continuations of the pseudocystidia (both hymenial and endocystidia) and the hyphous texture of the hymenophore was particularly noticeable at the forkings and anastomoses of the tramal plates which were not regularly lamellar. The hymenophoral trama, flanked by the well developed cellular layers of the subhymenium was remarkably similar to the corresponding structure of mature specimens of *Elasmomyces*.

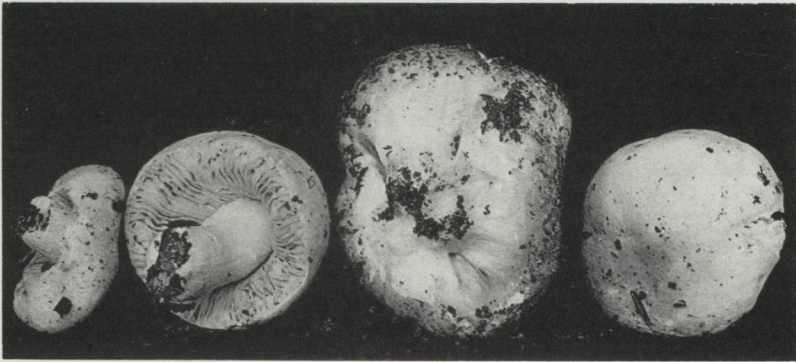
This is the one species of the genus which has been found to such an extent that worthwhile conclusions can be drawn as to its behavior in nature. In the mountains of central Idaho it exhibits the same pattern of behavior as many of the common agarics, such as species of *Clitocybe*. Its fruiting cycle begins with occasional clusters or individuals in early to mid July and reaches a peak in August as the conifer duff dries out. After that only occasional specimens or groups of specimens are found in areas where the duff is still moist. It is not at all uncommon to find whole clusters dug out by rodents and partly eaten. In fact one day Smith found it difficult to get undamaged specimens for our records. The pattern of behavior of this species excludes any possibility that these gastrocarps are abortions of particular species of *Russula*. These observations indicate that isolated collections of the same general type of specimen are better interpreted as representing distinct species than merely aborted stages of an agaric. None of the material reported on here corresponds directly to any given species of *Russula*, but the relationship to that genus as a whole is now more obvious than ever before. Eventually, when a more complete survey of *Macowanites* has been made, it will be possible to discuss in detail its relationships with *Russula*.

75. *MACOWANITES setchellianus* Singer & Smith sp. nov.

Fig. 82.

Gastrocarpio 10-30 mm lato, convexo-depresso, glaber in siccato pallide fulvo; gleba palide alutacea, lacunosa; columella percurrentia; sporis 7-10(11) $\times$ 6-7.5(8) μ ; cystidia 42-63 $\times$ 8-12 μ . Specimen typicum, legit prope Redwood Canyon, Contra Costa County, California U.S.A. H. E. Parks, 1440 (NY).

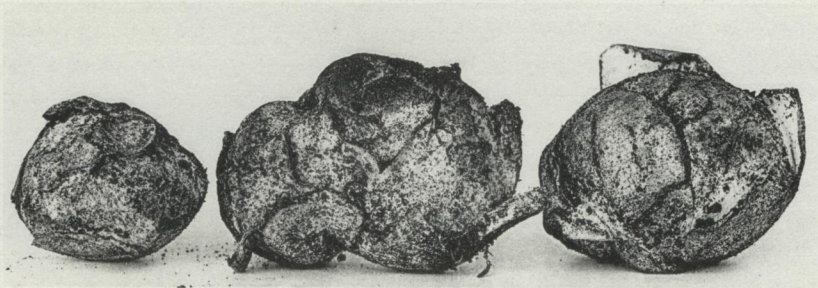
Gastrocarp about 10-30 mm broad (estimated) broadly convex-depressed, glabrous, near pale ochraceous tawny; gleba paler than peridial surface (cinnamon-buff to pale ochraceous tawny), lacunose; stipe-columella percurrent concolor with peridial surface (all data from dried specimens).



Macowanites americanus S. & S. × 1 Photo A.H.S.



Martellia idahoensis S. & S. × 1 Photo A.H.S.



Martellia monticola (Hark.) S. & S. × 1 Photo A.H.S.

Spores $7-10(11) \times 6-7.5(8) \mu$, ellipsoid, hyaline in KOH, yellowish hyaline in Melzer's sol. except for ornamentation; ornamentation about 0.25μ high as warts and ridges—mostly short and crooked with branches, very few fine lines, heavily amyloid; plage area not distinctive; sterigmal appendage inconspicuous.

Hymenium. Basidia $30-35 \times 10-15 \mu$ clavate, mostly 4-spored, thin-walled, hyaline in KOH, readily collapsing. Cystidia $42-63 \times 8-12 \mu$, subcylindric to narrowly clavate, thin-walled, hyaline to yellowish in KOH, content with scattered to bunched refractive particles more or less rod-like. Basidioles numerous, broadly clavate.

Hyphal layers. Subhymenium cellular, hyaline, cell walls thin and cells $6-11 \mu$ diam.; hymenopodium present only as 1-2 strands of narrow hyphal filaments; medio-stratum of filamentose hyphae with cells $6-9 \mu$ broad and some sphaerocysts intermingled. Cuticle of peridium complex; basal layer cellular but cells more or less catenulate and near surface a trichodermial structure more evident, the terminal members often giving rise to versiform dermatocystidia (some of which show refractive particles and may represent dermatocystidia) of various sizes—clavate to fusoid but never as large as hymenial cystidia. Context of heteromorous hyaline tissue. Clamp connections none.

Redwood Canyon, Contra Costa County, California, H. E. Parks 1440.

This species appears to be close to *M. fulvescens* from which it differs in narrower cylindric to narrowly clavate cystidia, smaller spores, in its association with redwood, and in the more complex structure of the cuticle of the peridium. It differs from *M. acris* in the structure of the cuticle. This species is named in honor of W. A. Setchell whose interest in these fungi materially advanced our knowledge of them.

DISCUSSION

It appears to us that *Hydnangium* as defined on the basis of the type species may be considered as the genus in which the Astrogastraceous Series originated. The possibility that the genus *Laccaria* of the Agaricales arose from the same genus seems clearly indicated from the data we have presented. The type of *Hydnangium* as recognized in this work is characterized by globose non-amyloid echinulate spores, clamp connections on the hyphae, no sphaerocysts in the peridial tissue or medio-stratum of the tramal plates, and in having a flesh-colored hymenophore. All of these are characters of *Laccaria*. *Hydnangium roseum* is so similar to the type of the genus that there may be those who dispute its position as an autonomous species. *H. soderstroemii* has a pale incarnate hymenophore, and sphaerocysts are definitely present in the peridial tissue but scattered instead of in bunches as in true heteromorous tissue. Thus this species connects the presence of sphaerocysts with the flesh-tinted gleba and the presence of clamp connections. In the fourth species, *H. nigricans*, we find the spores having a pseudoamyloid ornamentation, which intro-

duces this character to the series, but the elements are more like those found on spores of most species of *Octavianina*. Also, in this species there is apparently no incarnate tint to the gleba. Were it not for the clamp connections, this species could just as well be assigned to *Octavianina* on spore characters. Undoubtedly more species of *Hydnangium* will be discovered now that the genus can be identified readily, and it will be interesting to see how their characters fit into the pattern as established by the four we have included. At present it must be admitted that *H. soderstroemii* is the only one of the four which can legitimately be regarded as connected to the Astrogastreaous Series by a positive character. Some investigators might prefer to recognize three genera at this level, one with pseudoamyloid spores, one with sphaerocysts in the peridial tissue, and one with flesh-colored gleba but lacking sphaerocysts and having non-amyloid spore ornamentation. We believe such a division to be premature at present, and see no reason to be alarmed at the thought that two or three distinct lines of development might originate in a single genus.

At the next higher level, defined by the absence of clamp connections, we have found ten species which it appears logical to group together into a genus, *Octavianina*. Here the character of pseudoamyloid spore ornamentation is found in a number of species instead of just one, and along with it we find generally yellow to yellow-brown tints of the spore wall as viewed in KOH, and longitudinal striations on the elements of the spore ornamentation. In the genus as a whole, the elements themselves are typically coarse, sphaerocysts are more widespread in the sterile tissues, and finally, one species with a latex is known.

In *O. lutea*, *O. tuberculata*, *O. papyracea*, *O. macrospora* and *O. nigricans* sphaerocysts were not conclusively demonstrated. In all of these the spore ornamentation shows some degree of change to orange or dark red-brown in iodine (Melzer's reagent). This group clearly connects up to *Hydnangium nigricans*. In fact, because of the latter, one is inclined to question the weight given to the presence or absence of clamps in distinguishing *Octavianina* from *Hydnangium*. It is in this group that the rusty brown color of the mature gleba (as dried) is quite pronounced.

The second group in *Octavianina* consists of *O. laevis* and *O. lanigera*, two species obviously closely related to *O. lutea* and *O. tuberculata* by spore characters but further characterized by the presence of sphaerocysts in the peridial tissue. Here we have the pseudoamyloid character of the spores in combination with a truly astrogastreaous character, the presence of sphaerocysts.

The fourth group contains a single species, *O. papyracea* characterized by a latex, non-amyloid spores and no sphaerocysts. However, it remains to be seen whether some latex is not present in the *O. asterosperma* com-

plex. The color changes of the fresh peridium are such as to suggest that a hyaline latex might be present. Because there is the real possibility of a complicated situation here, we have not erected a new genus for *O. papyracea*.

It can be readily seen from the above that it is in *Octavianina* that the character patterns first appear which at the next level of complexity serve to distinguish genera. The new character which distinguishes the next level is the presence of amylaceous material over all or part of the basic spore ornamentation. At this level the presence of a latex is considered of generic importance, but the genus *Zelleromyces*, as typified by *Z. cinabarinus* has spores with heavily amyloid ornamentation in the form of a reticulum, and sphaerocysts in the peridial tissue. Actually only one species, *Z. glabrellus* appears to entirely lack sphaerocysts, and it has the elements of the spore ornamentation about as broad as in many species of *Octavianina* only in *Z. glabrellus* the elements are so heavily amyloid as to obscure the details on their surfaces.

Among the species without a latex two groups readily stand out. Those with sphaerocysts in the mediostratum of the tramal plates and those without. The genus *Martellia* is separated from *Gymnomyces* by not having them. The number of known species at this level is over three times that at the level of *Octavianina*, and there is a tendency for greater development of the columella. In *Martellia* the degree to which the amylaceous material is present on the spore ornamentation varies greatly both as to amount and position as is shown in the spores figured. In KOH many of the spores are still rather strongly ochraceous to rusty brown, and in *M. soehneri* we find the curious combination of ochraceous tawny spores with heavily amyloid spore ornamentation. It is curious that sphaerocysts are absent in this species. In *Martellia* the differentiation of the epicutis of the peridium is rather highly developed, and curiously enough, these types are nearly all repeated at higher levels of morphological complexity, even into the Russulaceae.

Gymnomyces has fewer known species than *Martellia*, but nevertheless it appears to be in the direct line to *Russula* because of the presence of sphaerocysts in the mediostratum of the tramal plates. Also, the discrepancy in the relative number of species in each genus might well be merely a sampling artifact as far as the total world flora is concerned. There are many more species to be studied than we have included here. At all events, in *Gymnomyces* we finally have all the main characters of the genus *Russula*, with the exception of the agaric-like fruit body, combined into a gastromycetous group in which the gleba never becomes exposed. It might also be noted here that if one wished to multiply genera, *Zelleromyces* could be divided into two genera on the same character which

distinguishes *Gymnomyces* from *Martellia*. We have used the character in the latter case to try to distinguish between two genera already described, and fully recognize that genera separated by a single character, especially one of this type, are likely to be of questionable value.

At the levels considered so far the fruiting body is a tubercle either with no interior sterile tissue other than the tramal plates or this material is limited to strands or plates which may or may not extend to the peridium. The next level of evolution involves the organization of this sterile tissue into a stipe-columella. In other words, it is at this level that the gastrocarp begins to resemble an agaric fruit-body.

It is clear from our study that one can select a line of species leading to *Elasmomyces* from *Martellia*, in which line sphaerocysts are absent from the mediostratum of the tramal plates. Also, one can establish a line, in which sphaerocysts are present in the mediostratum of the tramal plates, which extends from *Gymnomyces* through *Macowanites* into *Russula*. If one were to now go back to *Octavianina*, one can there find species which could serve as the ancestral types for both these lines. It is interesting to note, here, that the line leading to *Elasmomyces* appears to end in that genus, whereas the one through *Gymnomyces* and *Macowanites* ends in *Russula*. The genus *Cystangium* may be regarded as a side branch from *Gymnomyces* which has apparently not evolved into an agaric genus. At least the correlation of cellular cuticle, large leptocystidia (in the type species) and spores of the Russulaceae is not known to us in an agaric genus or other group of Gastromycete with the possible exception of a species of *Martellia*. *Cystangium sessile* simply cannot be interpreted as a direct line in the "reduction" of any known agaric.

Macowanites easily bridges the gap between *Gymnomyces* and *Russula*. As already stated, the only character which really separates them is the presence of spore discharge in *Russula* and its absence in *Macowanites*. In the characters of the cystidia and chemical reactions of both genera we find this similarity continued. The surprising feature of the species of *Macowanites* treated here is that they do not connect up exactly with known species of *Russula*, yet in the field we are certain that the majority have been passed by as aborted *Russulae* or have actually been collected for *Russulae* and then thrown out because spore deposits could not be obtained. We have included here fewer species of *Macowanites* than we have for the *Martellia-Gymnomyces* level, but we are almost certain this is an artifact that will be cleared up by more intelligent collecting in the future. To put it another way, we believe that eventually it will be found that there are more species at the *Macowanites-Arcangeliella* level than at the *Martellia-Gymnomyces* level. In the future, in view of the information presented in this paper, it will be important to study odd collec-

tions of *Russulae*, and not simply assume because no spores are deposited that they should be discarded. If spores have been discharged, some can practically always be seen on the apex of the stipe or on the soil around the specimen.

As mentioned previously, the elements of the series are so coherent as a unit that it is difficult to imagine any one attempting to refute the idea that they form an outstanding example of a clear cut line of evolution in the Basidiomycetes. The problem of which direction evolution has progressed, however, has been the subject of debate, and a review of this problem is now in order.

First let us examine the view of Heim and Malençon, that evolution progressed from *Russula* and *Lactarius* into the Gastromycete group. If we start with the Russulaceae, as these authors did, we admit that the steps as we have shown them can be interpreted either way, in their favor or in ours. For instance, it is an easy matter to visualize the basidium losing the function of spore discharge, and hence derive *Macowanites* from *Russula*. *Gymnomyces* is then very easily derived from *Macowanites* by the loss of the stipe-columella as a structure. According to this theory, *Elasmomyces* and *Cystangium* would have to be regarded as branches off the main line in which retrogressive evolution back toward agaric types has taken place. While this is possible in theory, we regard it as unlikely because the change in the structure of the mediostratum of the tramal plates need in no way be correlated with the changes in gross morphology of the fruit body, which are admittedly under more direct pressures from environmental influences. In fact one would expect that the tramal plates would retain their basic structure since this character is not subjected to stresses of the environment.

The changes which we have shown to take place from *Gymnomyces* to *Hydnangium*, with the exception of the appearance of clamp connections, can be read either way. The presence of clamp connections in *Hydnangium* simply cannot be logically explained by theories of degenerative evolution. To support Heim and Malençon's point of view one would have to assert that the Astrogastraceous Series actually ends in *Octavianina* and thus avoid considering a clamped species with sphaerocysts in the peridial tissue as pertinent to the discussion. We believe this to be begging the question.

The problem of the reduction of the stipe and the eventual loss of the columella is less of a problem from the Heim-Malençon school than for those advocating the idea of progressive evolution. McKnight, in unpublished data on *Psilocybe* (Agaricales), has shown that culture conditions can cause the reduction of the stipe to an indistinct columella, and that the spores of such a gastrocarp if grown under opposite conditions will

again produce stipitate agaric fruit bodies. On the other hand, practically every known group of fungi, Ascomycetes or Basidiomycetes, in which a fruiting body is produced, has found it possible to develop a stipe, so that we are forced to the conclusion that the appearance of a stipe is one of the very common modifications of fungous fruit bodies generally and that it is doubtless a response to some very widespread stimulus. In any to the same forces that have produced it in so many other diverse types of fungous fruit-body.

event, the appearance of a stipe in this Series, we believe, can be attributed

Perhaps the greatest argument in favor of degenerative evolution is that once the basidium loses its function of spore discharge, this is not easily regained, or, to state it in another way, it is very difficult for the basidium to acquire the ability to discharge spores. A consideration of this problem is certainly in order. First, a good case can be made for the loss of this function. As the timing of all processes in the fruit body is upset by adverse environmental conditions, it is easy to visualize how the processes of the alignment of the basidia by the hymenophore can be inhibited, and how this in turn could prevent the operation of the mechanism controlling discharge. Any one with much field experience in desert or subalpine habitats knows how the fruit body can become arrested in its development by adverse changes in temperature and humidity. In time these conditions could operate to select mutations which in their pattern upset the regular process of spore discharge. Also, again, one might cite the work of McKnight who found that under varied culture conditions, a single species of agaric could be made to produce mature spores in a gastroid fruit-body in such a way as to almost insure that the spores could not be normally discharged from the basidium. Yet these same spores isolated and mated, produced mycelia which in turn produced normal agaric fruit bodies from which spores were discharged. In fact, the arguments centered around spore discharge are the strongest ones which can be advanced in favor of degenerative evolution for the members of this Series.

What can be said on the other side in relation to this character. It can be argued, for instance, that the particular *Psilocybe* in question still contains a large number of "gastromycete" genes in its make up and is actually only an agaric when grown under certain environmental conditions. It cannot be denied that there are closely related gastromycetous species, see Singer and Smith on the genus *Weraroa* (1958c). This however, again assumes that the transition to active spore discharge by the basidium is a relatively easy one to make for agarics closely related to gastromycetous forms and again points out the need for critical studies on spore discharge in such agaric forms.

Let us next consider a few field observations. Smith has encountered many species of "*Russula*" in the Western United States which when the fruit bodies were fully expanded never discharged enough spores to give a recognizable spore print though the hymenium was loaded with spores. He has also found "*Russula*" buttons buried 4-6 inches in the conifer duff and measuring 3-5 cm broad which were still almost completely enclosed, and which showed faint indications of a spore print in places where the base of the stipe-columella flared out under the gleba. These were old specimens, as judged by the condition of the context. He has also fruitings of species of *Russula* in which nearly half of the fruit bodies matured hypogaeously, and deposited spores even though remaining completely buried in the duff. He has also demonstrated that species of *Macowanites* will expand like an agaric (*Russula*) if weather conditions permit, but that no spore deposits can be obtained from them. Also, we have shown that at the level where *Russula* and *Macowanites* are so easily confused, there is almost regularly a great deal of variation in the form of the sterigmata and their position on the basidium. In other words, gastroid and agaricoid types are hopelessly intermixed—possibly depending somewhat on the position of the basidium in relation to the pull of gravity.

It must be assumed, in fact it can be readily demonstrated, that in any expanded *Macowanites* gastrocarp a very large number of basidia are horizontally arranged. In view of the generally large spores of the group, it is obvious that as a basidium finally matures its spores, the weight of the latter places great strain on the wall of the sterigma at a spot near the spore, presumably the narrowest point, and that sooner or later the spore will simply break off of its own weight and fall free from the glebal tissue, and such spores could be collected as a thin spore deposit. One can thus expect to collect at least some fallen spores from a gastrocarp from which spores are not discharged in the manner of an agaric. We have evidence of this in one collection from Idaho. Also, one can reasonably expect that in the course of evolution, as such forces as that here postulated for gravity are felt, the sterigmata would become modified to more efficiently support the spore. We interpret the curved conic sterigmata as such a modification.

The important point as we see it, is that at least for the Russulaceae, a sudden mutation to functional spore discharge need not be assumed. It seems to us more logical to believe that spore discharge as found in the Russulaceae has arisen by a series of minor mutational steps, first by the spore breaking free of the basidium at the weakest point on the sterigma, then possibly being helped a little at the critical moment by a slight amount of pressure from the protoplasm. Further local changes in the

strength of the wall in the sterigma, which may be associated with greater thickening of the spore wall in the part referred to as the sterigmal appendage, may have taken place, and that this all finally led up to a regularly functioning mechanism of discharge which as a set of genetic characters was stable. If there is any survival value to be attributed to more effective means of spore dispersal, the spores which broke off and were carried away would be more effective than those remaining in the gleba. Hence any genetic tendency as a result of minor local mutations in the fungus fruit body which aided in this process by causing a weak spot in the sterigmal wall, or caused protoplasmic pressure to vary slightly at a late stage in the age of the basidium, would have a tendency to be preserved by the survival value accruing to the process in its entirety.

Although we have limited our discussion here to the Astrogastraceous Series, it can at once be recognized that if this pattern holds for this group, it could equally well apply to the other series on which we have already published. It is the case of a general response to one type or kind of stimulus at a comparable level in all secotiaceous fungi so far discussed. The principles and forces are the same throughout. At this point it seems to us that the critical need now as we have already stated, is for a painstaking and critical study of spore discharge on species where the secotiaceous genera "meet" the agaric genera. In the meantime we are not inclined to admit that the mere fact of spore discharge is a major consideration either way as far as the direction of evolution in the Astrogastraceae is concerned. We consider it highly probable that in this group we have admirable material in which to study this phenomenon in detail at a less specialized level than in such groups as *Coprinus* and other highly specialized Hymenomycetes.

If progressive evolution from gastroid to agaricoid types is assumed, how does the data fit the theory? First, if we start from *Hydnangium* we have a group of Hymenogastrales which has typically colored, ornamented spores and clamp connections on the hyphae. These characters connect *Hydnangium* to a known group of other Hymenogastraceous fungi, namely *Hymenogaster*, on the one hand, and at the same time on the other hand show diverging tendencies toward a group of Agaricales not included in the Astrogastraceae, the genus *Laccaria*, as well as one species showing the character of sphaerocysts in the peridial tissue, a positive astrogastraceous character. Here we are not lacking for possible sources of origin for the line in question, and we have one species which could well be regarded the type from which the Astrogastraceae originated. From here on the pattern of discontinuities which lead toward the Russulaceae is typical of what one finds in a truly natural line of organisms, and can be read "upward" with less difficulty than "downward". For instance,

Elasmomyces and *Cystangium*, from this point of view are simply side branches from the main line leading to *Russula*, and retrogressive evolution need not be assumed. From the progressive point of view, it is easy to see how the diagnostic characters of the Russulaceae developed. Those who argue degenerative evolution for the series simply avoid this important question or try to derive the Russulaceae from the Hygrophoraceae through the tenuous connection of *Bertrandia* and *Bertrandiella*. Actually Heim (1959) has recently emphasized this idea further in his description of *Bertrandiella*. However, after studying the data he has presented we are forced to admit that we cannot agree that there is a reasonable connection here. There are three outstanding characters of the Russulaceae: The heteromerous pileus trama, the amyloid spore ornamentation and the lack of clamp connections. As can be seen *Bertrandiella*, has none of these characters. Heim illustrates clamp connections at the base of the basidium, describes the spores as having pseudoamyloid granules beneath the endospore, and describes the context of the pileus as filamentose. The characters which our colleague emphasises in pointing out the supposed relationship to the Russulaceae are the presence of a latex, a character not essential to a definition of the Russulaceae and one found in numerous unrelated Basidiomycetes such as *Mycena*, one undescribed species of *Crepidotus* (known to Smith), and apparently *Lentodidium squamosum* in addition to *Lactarius* and *Bertrandia*. Thus this character could at best serve Heim's purpose only in a supporting role assuming other basic characters were present to make the relationship more likely. As for the pseudoamyloid particles in the spores, these apparently resemble pseudoamyloid particles found in the hyphae of certain species of *Hygrophorus* as pointed out by Smith and Hesler in their studies of this genus. It is almost a rule that when laticiferous hyphae are well developed they project into the hymenium as pseudocystidia. This is evident in *Mycena* and *Lentinellus*. Hence the presence of these structures, unsupported by the presence of the truly definitive characters of the Russulaceae, cannot be used as an argument in favor of a relationship in that direction. The russuloid aspect of the fruiting body can likewise be dismissed as merely a superficial resemblance. In short, we are forced to conclude that there are no basic similarities between the Russulaceae and the Hygrophoraceae (including *Bertrandiella*), and our statement still stands that there is no plausible phylogenetic connection between the Russulaceae and any other family of the Agaricales.

The evolutionary steps as we have presented them appear remarkably similar to those one usually finds in large groups of species, i.e., various combinations of characters—some building up to new characters, such as the heteromerous type of peridial tissue, and others disappearing

from the line, as for instance the pseudoamyloid reaction of the spore ornamentation. To our way of thinking it is very important to show how the characters of the Russulaceae could have evolved, and the interpretation of this series from the standpoint of progressive evolution is the only one which meets this criterion. It is also the only explanation which accounts for the isolated position of the Russulaceae among the gill fungi.

Since the hypothesis of progressive evolution from an Hymenogastraceous ancestor meets the most important considerations squarely and reasonably, it is the one to which we subscribe. We believe that this interpretation is strengthened by the evidence that *Laccaria*, a genus of the Tricholomataceae with spores remarkably similar to those of some Russulaceae but with entirely in-amyloid ornamentation, had its origin in the same primitive genus as the Russulaceae. It should be noted also that all these considerations are based on *Gastromycetes* in which the gastrocarp itself has not become modified for spore dispersal.

SPECIES EXCLUDED FROM THE ASTROGASTRACEOUS SERIES

1. *Arcangeliella africana* (Lloyd) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:365. 1935. This species has been transferred to *Neosecotium*, see Singer & Smith (1960).

2. *Arcangeliella ambigua* Zeller & Dodge, Ann. Mo. Bot. Gard. 22:365. 1935. This species has been transferred to *Chamonixia* see Smith & Singer (1959).

3. *Arcangeliella behrii* (Harkness) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:366. 1935. A Harkness collection from Sausalito, California has been studied, and the following data recorded: Spores $11-16(18) \times 9-14(16) \mu$, ellipsoid to truncate-elliptic, verrucose, *pale dingy straw color* in KOH, *dark red-brown* in Melzer's reagent, with a thick outer layer which is areolate-cracked in its outer part, with a thin darker brown inner layer. Basidia 2-, and 3-spored, $30-35 \times 9-11 \mu$, clavate or slightly ventricose in mid-portion when sporulating, thin-walled and readily collapsing; basidioles numerous, no pseudoparaphyses present; cystidia rare, about $47 \times 13 \mu$, fusoid-ventricose, thin-walled and readily collapsing, content homogeneous; hyphae of the tramal plates $3-6 \mu$ in diameter, subparallel; thin-walled, yellow-hyaline in KOH; peridium (none was present on material available for study); clamp connections absent.

Conclusions. This is a most peculiar species by virtue of its spore characters but certainly not belonging in the Astrogastraceous Series. It may belong in the Gastroboletus Series near *Chamonixia*.

4. *Arcangeliella becarri* (Petri) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:366. 1935. We cannot make a positive statement in regard to this species at the present time, but place it here because of the "yellow" spores and "amber brown" gleba, characters which indicate that the species may belong to some other series.

5. *Arcangeliella caudata* Zeller & Dodge, Ann. Mo. Bot. Gard. 6:49-52. 1919. Smith & Singer (1959) have transferred this to *Chamonixia*.

6. *Arcangeliella campbellae* Berk. & Br. in Zeller & Dodge, Ann. Mo. Bot. Gard. 22:366. 1935. The type and one specimen studied (J. B. Cleland, 13). The following data were taken from the type. Spores $7.9 \times 4.4.5 \mu$, oval in face view, varying to subelliptic, *some* in profile view obscurely inequilateral, pale rusty brown in KOH and minutely verrucose to subreticulate (very inconspicuously so under oil), wall about 0.5μ thick, no differentiation in wall at apex.

Details of the hymenium not evident from revived material; hyphae of tramal plates of gelatinous interwoven hyaline narrow (3.4μ) hyphae; peridium of interwoven, thin-walled, filamentous hyphae 2.6μ in diameter and not gelatinous, no incrusting pigment present and no differentiation into layers evident; clamp connections apparently absent (but condition of the material was such as to leave some doubts as to whether they might be present but rare).

Conclusion. The data obtained from the above collections check well with the description, hence the question of different species concepts is not involved here. The spores exclude the species from the *Astrogastraceae* Series and point to *Hymenogaster*.

7. *Arcangeliella ellipsoidea* Zeller & Dodge, Ann. Mo. Bot. Gard. 22:367. 1935. A portion of the type has been studied and the following data obtained. Spores $10.12.5 \times 6.7.5 \mu$, subelliptic to obscurely inequilateral in profile view, ovate to elliptic in face view, rich tawny in Melzer's reagent, rusty brown in KOH from a thickened colored endosporium, episporium hyaline to yellowish and perforated with tawny plugs of material (episporium a pale colored layer), apex with a broad thin callus or apex almost truncate (at times with a hyaline apical blister). Basidia $20.24 \times 6.7 \mu$, 2-, and 4-spored, hyaline, mostly collapsed; pseudoparaphyses present, inflated, 12.18μ in diameter; cystidia, some seen and these resembling collapsed mucronate "chrysocystidia" but without a refractive content; hyphae of tramal plates interwoven, hyaline, thin-walled and loosely interwoven (revived in KOH); peridium a thick (about 180μ) layer of interwoven filaments 3.8μ in diameter, much-branched, hyaline in KOH, thin-walled and smooth, some oliferous hyphae seen, surface region possibly a rudimentary trichodermium of branched hyphae (not well-revived); no sphaerocysts present; clamp connections none.

Conclusions. This species is not a member of the *Astrogastraceae*. We believe it to be an *Hymenogaster*, which is where it was originally placed by Rodway. Its proper position awaits a monograph of that genus.

8. *Arcangeliella violacea* (Masse & Rodway) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:369. 1935. The specimen from the Masse collection in the Zeller material is the one reported on here. Spores $7.9.5 \times 5.5.6.5 \mu$, ellipsoid, rusty brown in KOH and in Melzer's reagent, walls thickened somewhat, surface roughened in the manner of a *Cortinarius*—minutely warty-rugulose, no pore or plage at the apex.

Basidia 4-spored, $24.32 \times 7.9 \mu$, hyaline, thin-walled, readily collapsing; basidioles numerous but no pseudoparaphyses seen; cystidia none; hyphae of tramal plates poorly revived but apparently subparallel; peridium lacking a gelatinous surface layer (epicutis), (but this may have been torn off when specimens were sliced for drying), a hypodermium-

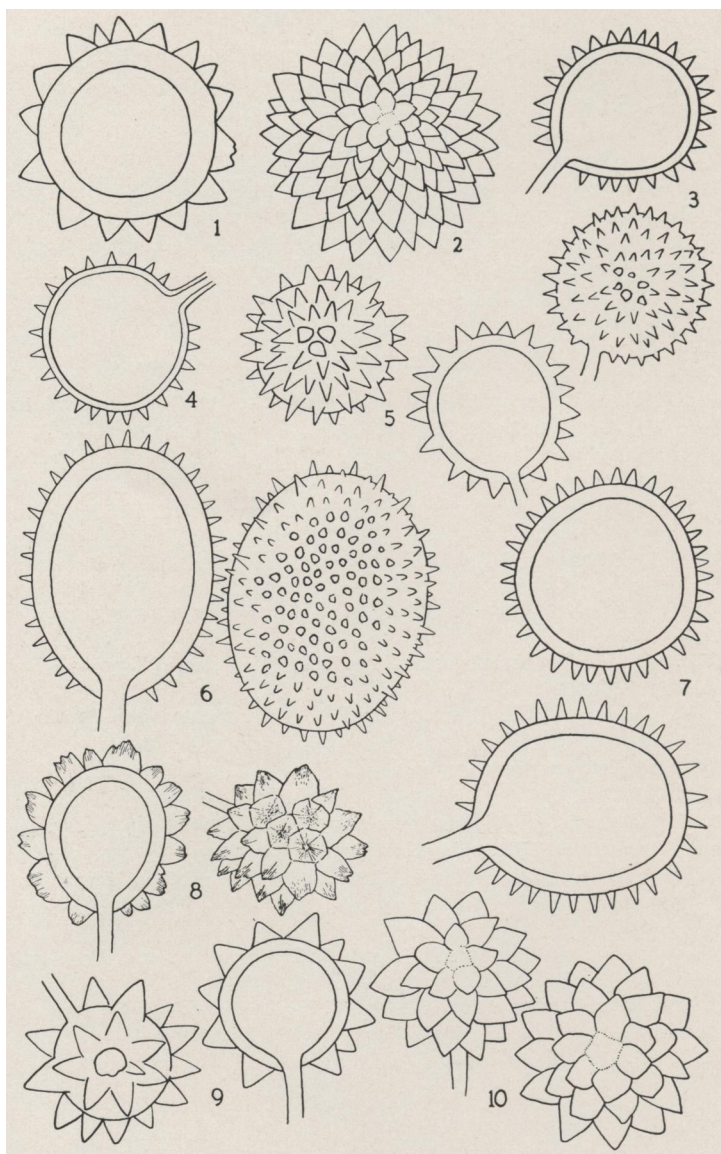
like layer was all that was left and consisted of brown-walled elongated but inflated cells 12-15 μ broad; clamp connections present.

Conclusion. This is a species of *Hymenogaster*, in which genus it was originally described.

9. *Arcangeliella vulvaria* (Petri) Zeller & Dodge, Ann. Mo. Bot. Gard. 22:369. 1935. No material studied. We exclude this species tentatively on the basis of the ochraceous tawny gleba and yellow spores, and by the apparent lack of sphaerocysts in the peridium and tramal plates. We interpret the statement in Zeller & Dodge (p. 629, 1936) "gelified with abundant large lactiferous ducts" as having a coma after gelified.

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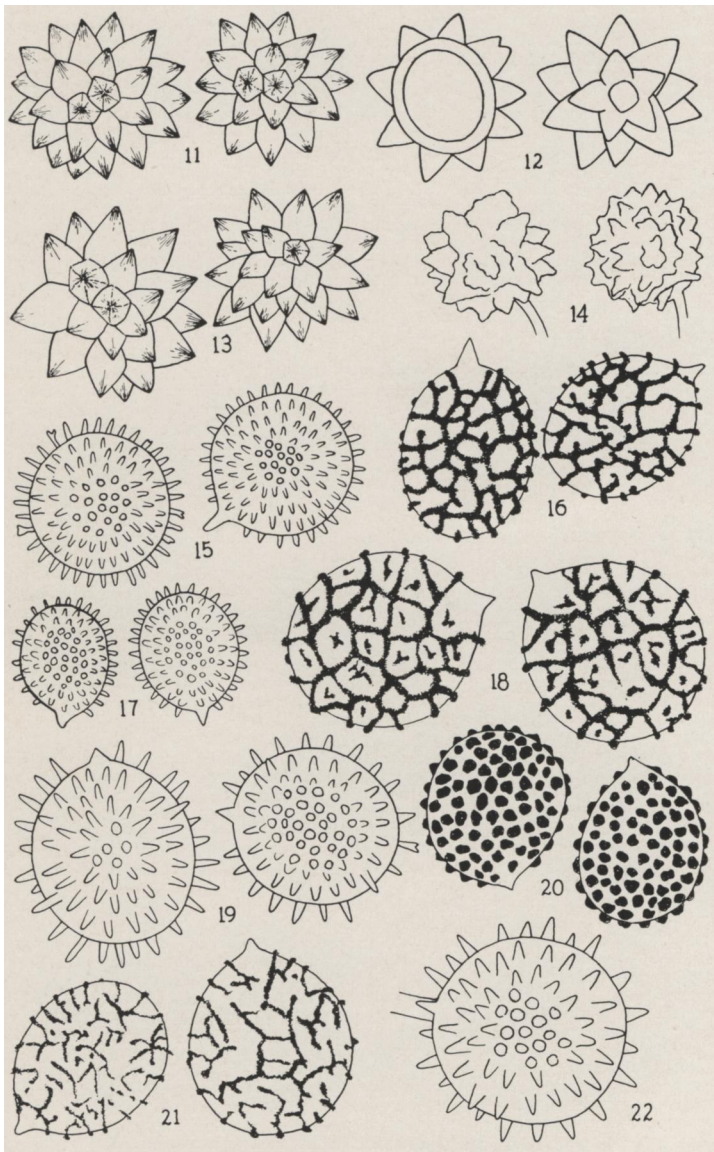


Figs. 1-10. Spores of *Hydnangium* and *Octavianina*, x 1200.

Figs. 1-2, *H. nigricans*; 3, *H. soderstroemii*; 4, *H. roseum*; 5, *H. carneum*; 6, *O. macrospora*; 7, *O. rogersii*; 8, *O. nigrescens*; 9, *O. asteroseperma* v. *potteri*; 10, *O. tuberculata*.

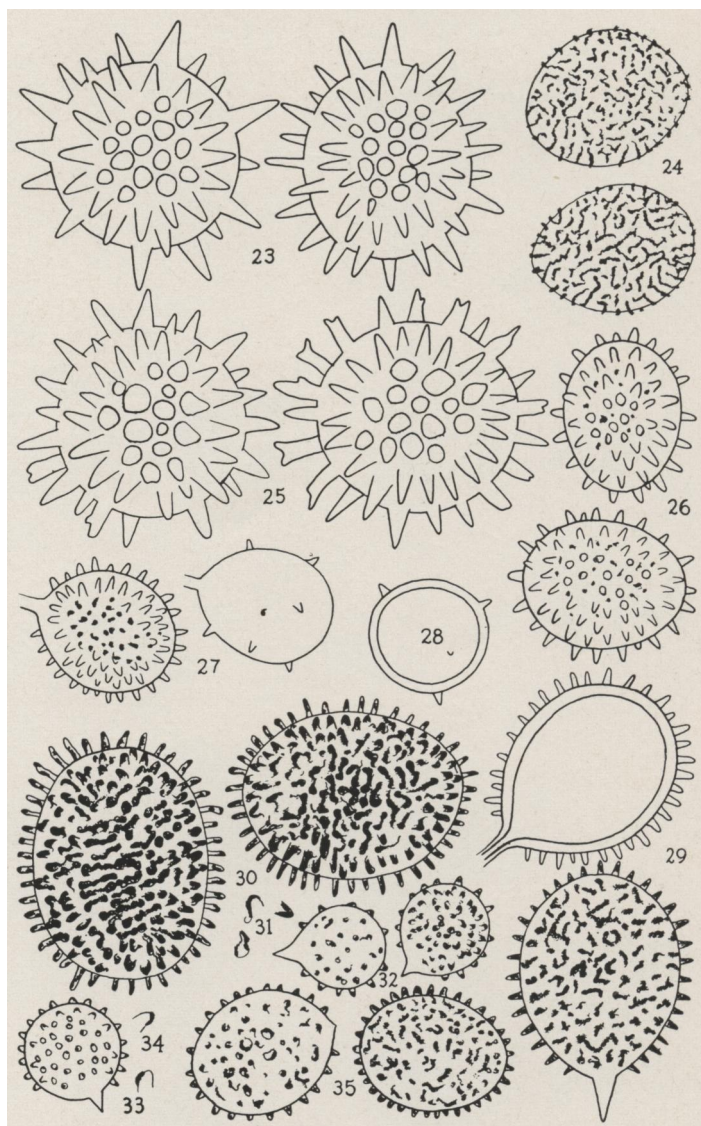
The details of the spore ornamentation are semi-schematic, especially for the smaller spores with complicated ornamentation. Hence the descriptions are to be considered more accurate as regards fine detail.

A. H. Smith.



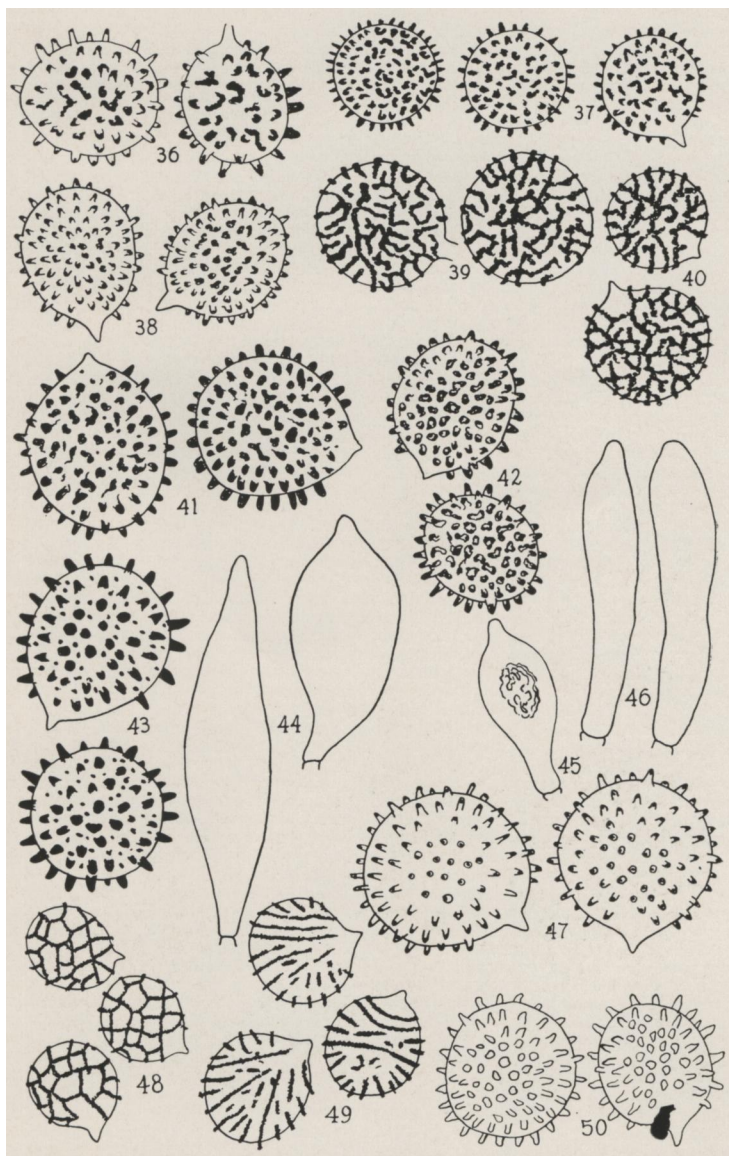
Figs. 11-22. Spores of *Octavianina* and *Zelleromyces*, x 1200.

Fig. 11, *O. lutea*; 12, *O. lanigera*; 13, *O. laevis*; 14, *O. flava*; 15, *O. papyracea*; 16, *Z. cinnabarinus*; 17, *Z. oregonensis*; 18, *Z. ravenelii*; 19, *Z. gilkyae*; 20, *Z. glabrellus*; 21, *Z. gardneri*; 22, *O. rogersii*.



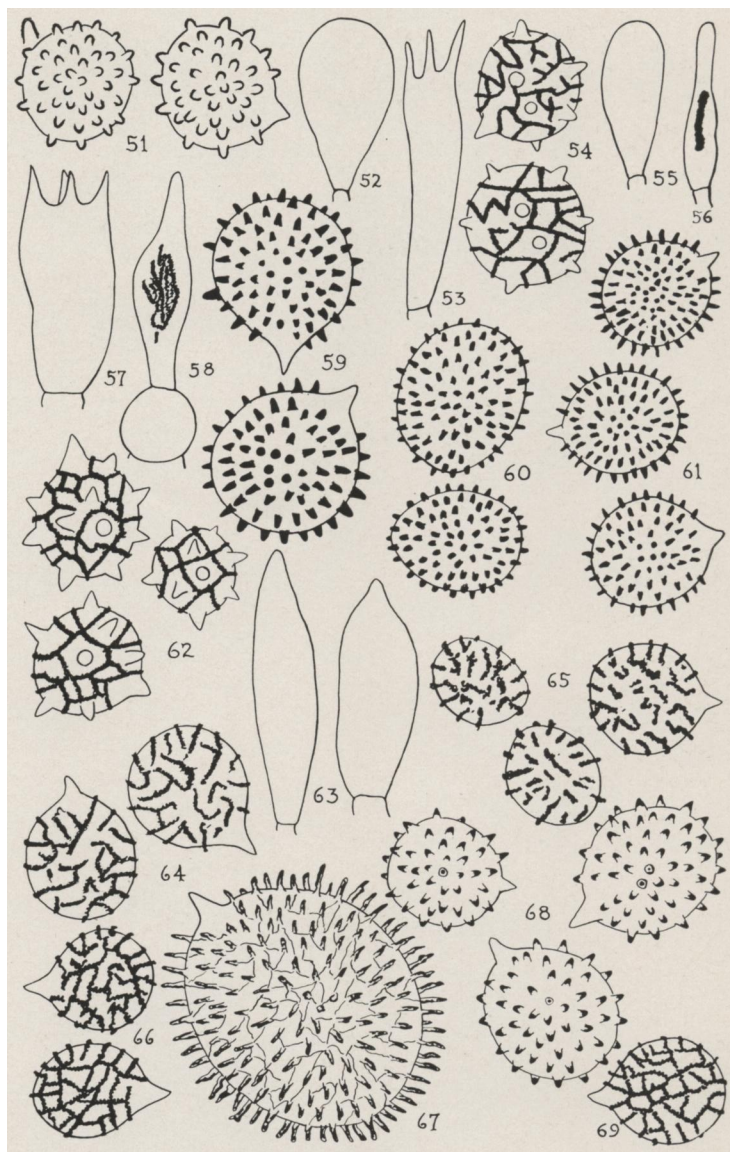
Figs. 23-35. Spores and spore ornamentation of species of *Martellia* x 1200 and about 1800.

Fig. 23, *M. oregonensis*; 24, *M. variabilispora*; 25, *M. gilkeye*; 26, *M. maculata*; 27-28, *M. vesiculosa*; 29, *M. soehneri*; 30-31, *M. ellipsospora*; 32, *M. californica*; 33-34, *M. fallax*; 35, *M. parksi*.



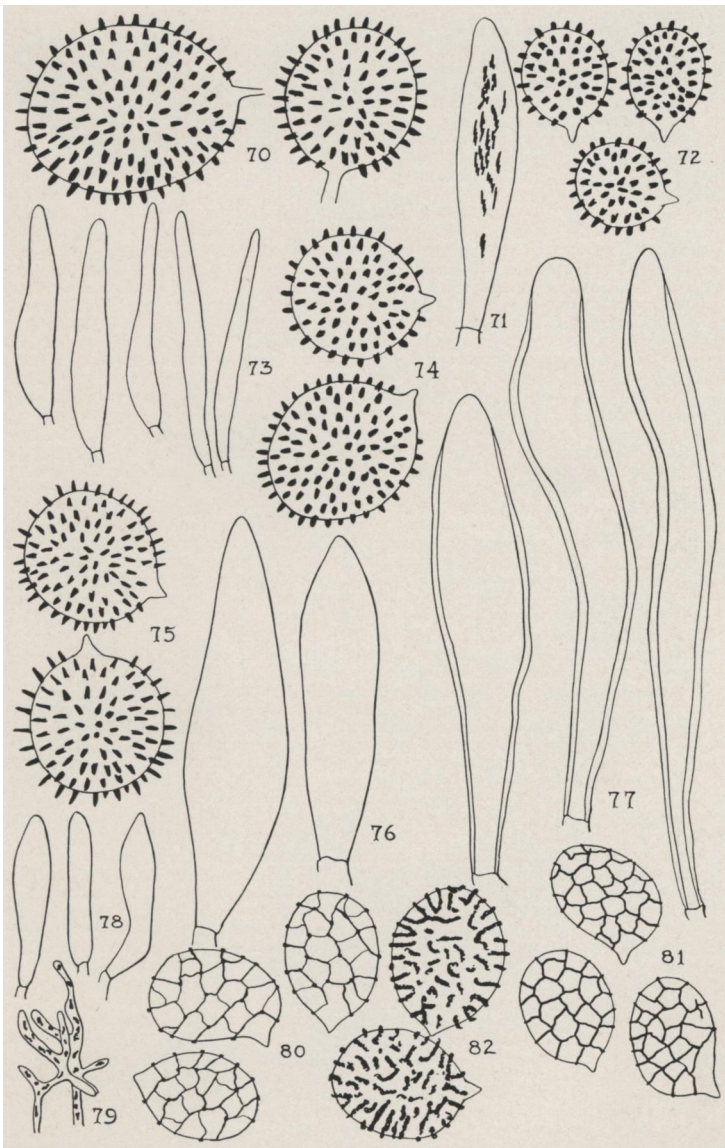
Figs. 36-50. Spores and cystidia in *Martellia* and *Gymnomyces*, spores x 1220, cystidia x 7000.

Fig. 36, *M. subfulva*; 37, *M. foetans*; 38, *M. brunnescens*; 39, *M. setigera*; 40, *M. monticola*; 41, *M. occidentalis*; 42, spores of *M. idahoensis*; 43, *M. cremea*; 44, cystidia of *M. cremea*; 45-46, cystidia of *M. idahoensis*; 47, *M. sicissilis*; 48, *G. pallidus*; 49, co-type of *Hydnangium glabrum*; 50, *G. roseomaculatus*.



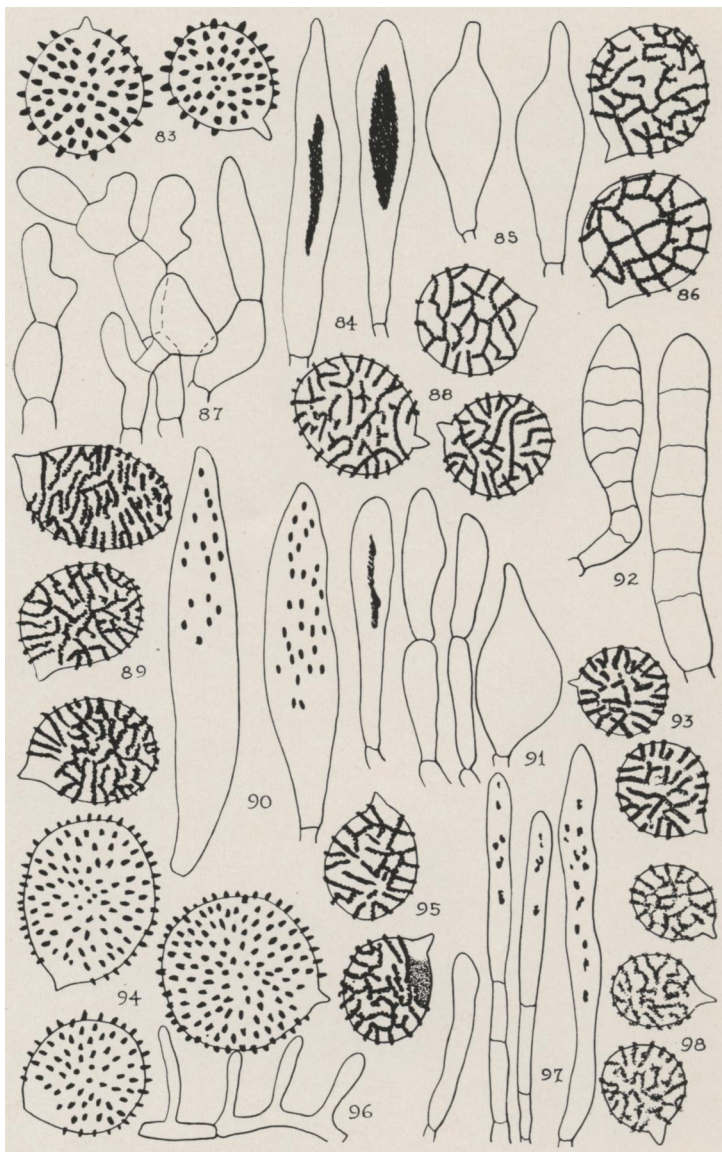
Figs. 51-69. Microscopic characters of *Gymnomyces* and *Elasmomyces*. Spores, x 1200, other structures x 700.

Figs. 51-53, *G. cinnamomeus*; 51, spores; 52, basidiole; 53, basidium; 54-66, *G. alveolatus*; 54, spores; 55, basidiole; 56, cystidium; 57-59, *G. socialis*; 57, basidium; 58, cystidium; 59, spores; 60, *G. compactus*; 61, *G. ferruginascens*; 62-63, spores and cystidia of *G. parksii*; 64, *E. camphoratus*; 65, *E. echinosporus*; 66 and 69, *E. rus-suloides*; 67, *E. odoratus*; 68, *E. rodwayi*.



Figs. 70-82. Microscopic characters of *Elasmomyces*, *Arcangeliella* and *Macowanites*. Spores $\times 1200$, cystidia and hyphae $\times 700$.

Fig. 70, *E. zellerianus*; 71-72, cystidia and spores of *E. roseipes*; 73-74, dermatocystidia and spores of *E. pilosa*; 75-79, *A. borizana*; 75, spores; 76-77, hymenial cystidia; 78, dermatocystidia; 79, hyphae of peridium; 80, *A. lactarioides*; 81, *A. crassa*; 82, *M. setchellianus*.



Figs. 83-98. Microscopic characters of *Macowanites*. Spores x 1200, other structures x 700.

Figs. 83-85, spores and cystidia of *M. krukowensis*; 86, *M. magnus*; 87-88, hyphae from turf of epicutis and spores of *M. citrinus*; 89, spores of *M. fulvescens*; 90 and 92, hymenial cystidia; *M. fulvescens*; 91 and 93, dermatocystidia and spores of *M. albidogleba*; 94, *M. mollis*; 95-96, spores and epicuticular hyphae of *M. acris*; 97-98, hymenial cystidia and spores of *M. fuscoviolaceus*.