NEW AND UNUSUAL BASIDIOMYCETES WITH COMMENTS ON HYPHAL AND SPORE WALL REACTIONS WITH MELZER'S SOLUTION

by

ALEXANDER H. SMITH [1])

(5.I.1965)

Generally speaking the false truffles (Hymenogastrales) are so rarely found in abundance that ecological observations on them are necessarily fragmentary, and studies of the variability of species within, as well as between, populations are fraught with difficulties caused on the one hand by inadequate information on basic features of the supposedly well known species, and on the other by a lack of agreement as to species concepts in the various groups in the family. In the course of attacking these problems the writer has had the opportunity of following the fruiting of many species in a single area over a period of years, and from extensive collections of a number of these, has had an excellent opportunity to study variation, seasonal occurrence, and substratal relationships. These investigations have been in progress since 1954 and have been concerned with the area in Idaho from Priest Lake southward to the mountains just north of Boise, particularly in the stream valleys draining westward into the Columbia River. McCall has served as a headquarters for the work in the Salmon River area.

The present contribution as it concerns the Hymenogastraceae deals mainly with two groups, those species collected in great quantity and those that apparently have not been previously described. In between these extremes and including them, one finds the members of this family to follow about the same pattern of fruiting as the Agaricales: Each species shows its own selectivity for substrata and pattern of fruiting under certain weather conditions during a particular season – spring, summer or fall.

The first problem to be dealt with was that of species concepts in relation to the Idaho flora, and the existing literature. In spite of the work done on this family in North America previous to 1950, the problems of speciation for any of the genera had not been

[1]) The University Herbarium and the Department of Botany, the University of Michigan, Ann Arbor, Michigan.

studied from what is currently considered a modern approach. SINGER & SMITH (1960) published a revision involving some fungi of this type, and SOEHNER'S (1962) work on *Hymenogaster* is a second substantial contribution to a special group. HAWKER (1954) and LANGE (1956) have given us two of the few existing detailed accounts of the flora of particular regions — covering hypogeous fungi generally. These works were all influential in the writer's attempts to arrive at more accurate species concepts based on morphological, anatomical and "chemical" characters in the material he collected. It had been clear for years that a new approach was needed in these fungi — one involving starting over from new observations on fresh material and involving the observed changes and variations in the basidiocarps as the fruiting season began, reached its peak, and tapered to a close. It was found useless to even think about problems of distribution until such time as more accurate species concepts had been worked out. The results of these studies will be published in monographs of the various genera. In North America *Rhizopogon* turned out to be the greatest problem-genus both from the standpoint of the number of species involved and the previous lack of recognizable concepts for many of those already described. It is fortunate that type specimens have been available for study of most of the American taxa with the result that it has been possible to use them as the basis for a revision of the North American species (SMITH & ZELLER, in press). Because the revision of *Rhizopogon* developed into a specialized major project itself, few species in this genus are treated here though many are among the commonest fungi of the Salmon River country. One of the features to develop out of this investigation was the discovery of certain curious patterns of the iodine reactions, as obtained with Melzer's reagent, on spore and hyphal walls, in many of these fungi. Since these reactions generally are now considered among the most valuable of characters in the Hymenomycetes (SINGER, 1963), some emphasis is given this subject here by way of a detailed discussion of the color reactions observed not only in Hymenogastraceous fungi but in other Basidiomycetes as well.

The writer is deeply indebted to the National Science Foundation (Grant 23139) for the financial support which made possible the field work. Field assistants employed were HAROLD BURDSALL Jr., VIRGINIA WELLS, PHYLLIS KEMPTON, PAUL MILLER, NANCY JANE SMITH and WM. SAVALE.

NOTES ON IODINE REACTIONS

In the so called modern approach to the classification of higher fungi, which actually dates back to FAYOD and PATOUILLARD as SINGER (1951) has emphasized by honoring them in his first edition, one of the characters most used in recent years is color shown by

spore and hyphal walls when treated with iodine. MELZER used a solution of iodine in chloral hydrate as a combination clearing and staining solution for studying spore ornamentation. This has now become so widely used that the term Melzer's solution (or reagent) appears in almost all taxonomic works on the higher fungi.

The color reactions obtained with this medium are quite varied and the nomenclature developed to designate them has become somewhat confusing. A brief review of the various designations is in order. Historically, the first one considered significant involved a change of the spore wall or the spore ornamentation to blue. This was termed *amyloid* and the range of color admitted under it extended from pale gray to blue to violet-black. At one time KÜHNER (1934) used the term for a blue reaction on spore walls and a purple-red reaction on hyphae of the basidiocarp, especially those of the stipe. SINGER later used the term *pseudoamyloid* for the dark reddish brown to purple-red reaction. The term applied to a yellowish-hyaline or to a yellow to pale orange-brown color-change became known as non-amyloid (inamyloid). ORTON has suggested the term *dextrinoid* for the dark red to red-brown color change and this term seems to be gaining in popularity as it is considered more expressive than pseudo-amyloid. SINGER (1963) gives a good discussion of the use of Melzer's reagent. It is against this background that I wish to elaborate on some problems of nomenclature as they exist at present and some which have come to light in the present research effort.

The one of most concern to me concerns the use in descriptions of the terms amyloid, dextrinoid and non-amyloid (inamyloid) with no follow-up on the actual colors observed. A violet-black reaction may be as significantly distinct from a weak gray reaction as the latter is from no reaction at all (negative reaction). The same point can be made in regard to the dextrinoid (pseudoamyloid) reaction. A strong purple-red reaction may indicate a distinctly different chemical present than a mere red-brown reaction; or a yellow constrasted to a reddish brown reaction may not be indicative of any real chemical difference in the constituents of the wall. It is, of course, important that the same terms be applied for the same color on both spore and hyphal walls.

There are also reactions other than those involved with cell walls. It can be argued for instance that the amyloid material coating the primary ornamentation of the spore wall in *Russula* and *Lactarius* is a secreted material actually not part of a wall system and hence constitutes a different category of material. The argument can be extended to intracellular granules, such as the particles in the paraphyses of some Discomycetes and intercellular granules observed in hyphae of *Chroogomphus* (MILLER, 1964), and SMITH & ZELLER in *Rhizopogon* (in press). HARRISON (1964) has noted somewhat similar particles along the hyphae of some of the stipitate Hydnaceae. The intercellular material in particular

possesses some interesting problems both from the standpoint of its distribution which is usually erratic and unpredictable, and qualitatively as to the nature of the particles.

In addition, some artifacts are not infrequently encountered. In some fungi, such as species of *Gomphidius* with a yellow stipe base, Melzer's sol. applied to the yellow portion appears to give a bluish black reaction, yet when individual hyphae from the colored spot are mounted under the microscope, it is found that the walls are not blue as for "truly" amyloid spore walls or "amylaceous" hyphal walls. It must be remembered that amyloid reactions to be valid as taxonomic characters must be checked under the microscope as well as seen in mass by the naked eye – especially as they are recorded from colored areas of the basidiocarp or ascocarp.

A second artifact is not infrequently encountered in *Rhizopogon*, and follows the following pattern. One makes a mount of a section through the peridium and mounts it in Melzer's solution. "Amyloid" particles violet-black in color occur along the hyphae in places, often distributed much as iron fillings along a magnet. This is straight forward and clean-cut. However, when other sections of the same peridium are mounted in KOH violet-black particles are also noted in similar arrangement along some hyphae. Are these identical with those becoming violet in Melzer's sol.? About the only safe conclusion to be drawn from this situation is that in mounts made in Melzer's solution not all violet or blue-black material (especially granules) is necessarily "truly amyloid". Obviously further research is needed to elucidate this situation further, but in the meantime it is imperative for taxonomists using Melzer's reagent to check their observations against material of the same source mounted in KOH or some other medium.

During the season of 1964 while collecting fungi in the Priest River district of Idaho, we were priviliged to use the facilities of the Priest River Experimental Forest [1]) as a base for operations. Here another facet of the problem came to light. A species somewhat resembling a *Leucogaster* was found in which the peridium, when tested with Melzer's reagent turned a copper green against a white background. Is copper green a blue or a green, and is the reaction to be considered an "amyloid" reaction? In what may be another species we have found basidiocarps on which a white peridium gave a grass-green reaction with Melzer's sol. In both, to some extent, this reaction can be verified under the microscope. Before we can ever use this gamut of color reactions in taxonomy with any finality we need to know more about the differences in chemical constituents of the walls, or particles involved. Although we use these characters at present, and find them very helpful, we should not let the matter rest there. But this emphasizes further

[1]) A unit of the Intermountain Forest and Range Experiment Station, U. S. Forest Service, U. S. Dept. of Agriculture, Mr. JOSEPH F. PECHANEC, Director.

the need for the taxonomist to record the actual color reactions he observes instead of simply naming them.

In *Rhizopogon* (SMITH l.c.) an additional feature has been known for some time. MORTON LANGE (1956) apparently was the first to emphasize "pigment balls" in mounts in Melzer's sol. of the peridium of *Rhizopogon* species. These are a common feature of the genus. It appears, on the basis of my own observations, that the amorphous pigment commonly noted in sections of the peridia revived in KOH, partly liquifies in chloral hydrate at least to the extent of forming globules of various sizes and shapes, and that these absorb the iodine to the extent of becoming orange to dark red-brown. At least the formation of these structures is correlated with a disappearance of amorphous pigment. In a number of species belonging to the section *Amylopogon* (SMITH, 1964) the droplets or balls of pigment that form are violet-black. In one species they vary from dull reddish brown to violet-brown. Is this a "dextrinoid" reaction? The existence of dark violet droplets as just mentioned should perhaps be considered in relation to an amyloid dark violet "drop" (solidified) on the spores of a few astrogastraceous fungi such as *Macowanites luteolus* SMITH & TRAPPE (1963). The droplet here covers about the same area as the liquid drop associated with spore discharge in the Hymenomycetes. From its position and shape it obviously is not part of the spore ornamentation. It must have been a viscous liquid which solidified in drying.

The most bizzare situation as regards amyloid spores is that reported for *Rhizopogon* (SMITH, 1964). In *R. subpurpurascens* three degrees of "amyloidity" were observed. First, some of the spores in every mount made remained nonamyloid. In each mount a percentile were entirely dark violet. This number was somewhat variable but is estimated at between 10—25%. An additional percentile was observed in which the outer half of the spore (distal half) was violet and the proximal half to one-third appeared to be weakly amyloid or non-amyloid. The dark violet color when present extended throughout the wall, which was thickened, and in many it appeared as if the deposition of the reactive material was first laid down at the interface of the endo- and exosporium. Since reporting this, other species of *Rhizopogon* have been found showing this same pattern and certain additional observations have been made. In *Rhizopogon milleri* [1]) it was found that in the locules near the peridium, where there are few loose spores and more groups of 8 are demonstrable on basidia than from other regions of the gleba, that in a fair number of instances (15 were counted on one slide) a group of 8 spores contained 7 that were non-amyloid and

[1]) *R. Milleri* sp. nov. Fructificationes 1—2.5 cm latea, globosae vel angulares, pallidae demum subargillaceae, in "KOH" vinaceae. Gleba cinnamonea. Sporae 6.5—9.2×3—4 μ, versiformes, inamyloideae, semi-amyloideae vel amyloideae. Typus: Sm-70789 (MICH); legit prope Nordman, Idaho, O. K. MILLER.

one that was dark violet (at least as seen from the apex). In about half as many cases 6 spores were non-amyloid and two were dark violet and one case was seen where the numbers were four and four. In mounts of loose spores where a good longitudinal optical section of the spore was seen, nearly all the dark violet spores in some mounts, or in some areas of a single mount, were seen to have only a dark violet cap over the distal half to one fourth of the spore with the remainder non-amyloid. In other mounts from the same basidiocarp, most of the spores were entirely dark violet. It was also noted that a number of angular to subglobose-angular spores were present and that a dark violet spot capped one or two of the bumps toward the apex and that in some of these amyloid lines appearing like small dark blue chromosomes radiated out from the bump. These lines are probably most accurately classified as ornamentation (obviously they are not chromosomes).

A feature encountered in the differential staining of spores by Melzer's reagent came to light in *Protogautieria* (see description). The spores of *P. lutea* are thick-walled and smooth, the wall being approximately the same thickness throughout. With Melzer's sol. the wall appears to be longitudinally striate because certain bands take the red-brown color more than intervening areas. The spore thus appears striate even though there is no morphologically visible ornamentation. A similar type of color change in a slightly different pattern has been observed in a local population of *Rhizopogon rubescens*. In that species the paraphyses are thin-walled at first, but soon develop very thick walls and in the center there remains a refractive mass which appears to be all that is left of the cell content. In Melzer's sol. in freshly maturing basidiocarps this mass is hyaline to yellowish, but in very old specimens we have found it to be dark reddish brown at times. But not all strains of *R. rubescens* have shown it – even when over-age basidiocarps are compared.

Another feature, involving a species of *Porphyrellus* (see desc.) was encountered during the fall of 1964. A bolete resembling *Xerocomus porosporus* IMLER as to general features and color was collected and gave a dark "wood brown" spore deposit, which is accepted as evidence the species belongs in *Porphyrellus*. A good deposit was obtained and no olive was noted in the color except where the tubes had stained the paper. When dried hymenophore tissue is crushed out directly in Melzer's sol. the solution and debris become violet black. Under the microscope the spores are seen to be dull violaceous singly and in some mounts were dark violet in mass – hence distinctly amyloid. The spores have the truncate apex of *X. porosporus* and the apical area involving this discontinuity is more distinctly dark violaceous than the remainder of the wall area. This test was repeated on numerous basidiocarps and observations checked by Dr. ROBERT L. SHAFFER. It was then decided to compare spores from the print with those from the hymenophore. This was done. In KOH the spores were golden yellow from both

sources. In Melzer's sol. the spores from the spore print had ochraceous walls in the portion toward the apiculus, and were dextrinoid in the distal part – especially in the pore-area. This observation was also checked by Dr. SHAFFER. Here, then, is a case in which spores from the same fruiting body of the same species give two different reactions to Melzer's sol. depending apparently on the type of preservation used – in this instance air drying for the deposit and heat-drying over an electric drier for the specimen. This observation has very important implications as far as the current rather arbitrary use of iodine reactions in the recognition of species and higher taxa is concerned. To my knowledge it also establishes the existence of "amyloid" spores in the boletes.

With more new situations as regards iodine reactions coming to light with the testing of groups heretofore untested with iodine, it is of the greatest importance for investigators not only to designate the reactions they note as to category, but to give the factual detail as to color of each observation made. The examples cited in this paper are admittedly a small number, and in my own opinion do not reflect adversely on the use of these features in delimiting species concepts, for even in the instances cited the particular variations appear to be constant. But it should be kept in mind that the supposed basic differences they are assumed to represent may not be very great as differences.

When one observes half the spores borne on a basidium to be dark violet in iodine (amyloid) and the other half inamyloid, one wonders as to the wisdom of using the difference as a generic character in such groups as the Tricholomataceae of the Agaricales. I have the distinct impression from my work on *Rhizopogon* that the pattern of amyloidity found there simply gives us additional taxonomic features, at the level of spore size and shape, to be used at the species level in the overall classification.

NEW GENERA, SPECIES AND VARIETIES

Mycolevis gen. nov. (Masculine)

Fructificationes circa 2.5 cm crassae, siccae, leves; gleba sicca, alveolata; columella filamentosa vel nulla; sporae amyloideae, punctatae, subglobosae. Typus: *Mycolevis siccigleba.*

Basidiocarps hypogeous, very light weight and gleba dry in consistency; spores subglobose, with a thickened inner wall perforated with minute numerous canals, over this a thin amyloid layer (deep blue); peridium green to blue in iodine fresh and as revived; epicutis of peridium a trichodermium; tramal plates of pseudoparenchymatous tissue; clamps none.

Mycolevis siccigleba sp. nov.

Fructificationes 1—4 cm crassae, globosae vel subglobosae, lobatae, albidae demum luteolae, in "Melzer's" viridis. Gleba albida,

alveolata, sicca. Sporae 9—12 × 8—11 μ, subglobosae, punctatae, amyloideae. Typus: SMITH-68654 (MICH).

Basidiocarp 1—4 cm in diam., globose or nearly so, at times angular from external pressure, or merely uneven to lobed, white at first in places, becoming yellowish and in age over all grayish olive, glabrous except for a few rhizomorphs appressed over basal area (as in many *Rhizopogon* species), dirt adhering to surface readily; KOH no reaction on peridium, $FeSO_4$ no reaction, Melzer's sol. copper-green to bluish on white surfaces. Gleba white when young and very dry in consistency, buff to olivaceous finally, fragile, chambers large and rigid; empty; columella a bluish gray streak from a rhizomorph into the gleba, unbranched, apparently not visible in all basidiocarps. Odor subspermatic as in *Inocybe* (nauseous), taste similar but slight, no well developed basal point of attachment evident.

Spores 9—12 × 8—11 μ (18 × 16 μ), globose to subglobose, hyaline in KOH, violet in Melzer's sol., outermost layer a thin amyloid crust breaking up in places and in some spores seen to separate in flakes, beneath this a thick layer (2 μ thick) traversed by canals opening to the outer surface as spots and so numerous that the openings (when one focuses on the spore surface) appear as an obscure closely knit reticulum, with a basal pore at place of attachment to sterigma and around this pore a dark violet (amyloid) mass of material spread out in the manner of a broad collar, this mass possibly connected to the thin amyloid crust seen over most spores. Basidia 4-spored, clavate, about 12 μ broad, hyaline and granular in KOH, in a loosely arranged hymenium. Cystidia none. Tramal plates of non-gelatinous pseudo-parenchema, hyaline in KOH, and orange in Melzer's sol. Peridium a tangled turf (often collapsed) of filaments 2.5—5 μ diam., hyaline and clean in KOH, arising from a subcutis of filamentous-interwoven hyphae, hyaline in KOH, both layers dark green in Melzer's (on fresh material as seen under the microscope), when revived in Melzer's sordid bluish to bluish green in some areas but color not clearly localized in cell walls in all cases, also much amyloid debris present in the mounts. Clamp connections none.

In duff under conifers, Priest River, Idaho, July 26, 1964. Sm-68654-type.

One of the outstanding features of the species is that when fresh the basidiocarps are as light as a piece of styrefoam and just about as rigid, though somewhat more fragile. At first glance one would think this species to be related to *Martellia* in the astrogastraceous line of gastromycetes, but the spore ornamentation is more like that of *Cribbea* (SMITH & REID, 1962) which SINGER, WRIGHT & HORAK (1963) placed in the family Cribbeaceae. *Mycolevis* appears to be a second genus in this family, if emphasis is placed on the type of spore ornamentation. At least this is a tentative assignment. The amyloid outer layer or crust is a most interesting feature, and

the peculiar iodine reaction of the peridium is no less unique.

Protogautieria gen. nov.

Fructificationes molles, alveolatae; peridium nullum; gleba convoluta; sporae leves, in "Melzer's" longe rufo-striatae; cystidia in "KOH" vinaceae.
Typus: *Protogautieria lutea*

Protogautieria lutea sp. nov.

Fructificationes circa 2×1 cm crassae, molles, alveolatae, laete luteae, demum brunneae; peridium nullum; gleba convoluta, laete lutea; sporae 14—19×9—$12\ \mu$, leves, in "Melzer's" longe rufo-striatae, crassotunicatae; cystidia $100 \times 20\ \mu$, in "KOH" vinacea. Typus: Sm-68073 (MICH).

Basidiocarps about 2×1 cm, flattened, consistency soft and fleshy, surface alveolate from chambers of the exposed gleba (no peridium present), color about "chalchedony yellow" (pale bright greenish yellow), dingy brownish from handling and with application of KOH; $FeSO_4$ no reaction; odor peculiar but soon vanishing, taste mild. Gleba of coarse folds much as in *Hydnotrya* to coarsely lacunose, chalchedony yellow; columella rudimentary, dendroid.

Spores 14—19×9—$12\ \mu$, ellipsoid, smooth as seen in KOH and pale cinnamon buff to (if immature) hyaline, in Melzer's sol. more reddish brown and most mature spores showing darker reddish-brown longitudinal bands (but no ornamentation visible in the wall), wall thick at maturity. Basidia about $35 \times 15\ \mu$, clavate, 4-spored, in a hymenium. Cystidia $100 \times 20\ \mu$ more or less, vinaceous red in KOH and with red incrustations; some vinaceous granules scattered in hymenium. Tramal plates of interwoven hyaline hyphae reddish in KOH in places, thin-walled, lacking incrustations. Peridium absent but exposed ridges of gleba with a palisade of cells reddish to purplish in KOH and with considerable incrusting material on them. Melzer's sol. causing entire mount to become dark red-brown. Clamp connections present.

Solitary under Douglas fir and larch, near Cusick, Wash. July 2, 1964, Sm-68073-type.

This species might possibly be related to *Hymenogaster luteus* as SOEHNER (1962) described it, but this seems very improbable. The lack of a peridium, the curious color pattern of the spores as observed in Melzer's reagent, and the cystidia are all very unusual. The fresh basidiocarps have much the aspect of *Gautieria morchelliformis* but the resemblance ends there. Although *Gautieria* species are abundant in Idaho none has been found with the fleshy consistency of *P. lutea*, let alone the combination of features given in the above diagnosis. In consistency it is softer than any *Gautieria* or *Hymenogaster* known to the writer.

Weraroa coprophila sp. nov.

Pileus 9—30 mm altus, cuspidatus vel conicus, luteolus, lubricus; "lamellae" crassae, intervenosae, angustae, subfuscae; stipes 6—12 cm longus, 1.5—5 mm crassus, deorsum fuscobrunneus; sporae 10—13×6—6.5(7) μ, in "KOH" sordide luteo brunneae. Typus Sm-58742 (MICH).

Pileus 9—30 mm high, sharply conic to cucullate, not expanding, 6—10 mm across the base, "ochraceous buff" (pale yellow) on disc and cream buff (paler) over margin, surface moist to lubricous but not hygrophanous, at first with ochraceous tawny flecs from the veil over marginal area and the edge fringed when young. Context yellowish, odor and taste mild.

Hymenophore lamellate but lamellae thick and intervenose, narrow, close, 2—3 tiers of lamellulae, adnate to stipe apex, "wood brown to hair brown", becoming fuscous or darker in age, edges even.

Stipe 6—12 cm long, 1.5—5 mm thick, equal, flexuous, silky fibrillose, whitish above, slowly pale bister from the base up, hollow, brittle, no readily visible remains of a veil at near maturity.

Spores 10—13×6—6.5(7) μ, truncate from an apical pore, dull violaceous drab in water mounts, bister (dull yellow brown) in KOH, smooth, thick-walled, Basidia 2- and 4-spored. Pleurocystidia ventricose with a narrow apical extension, content homogeneous, 35—50×9—13 μ, hyaline. Cheilocystidia not found on gill edges examined. Gill trama of irregularly arranged enlarged cells (10—15 μ diam.), subhymenium scarcely differentiated. Pileus epicutis with a thin gelatinous pellicle of narrow (1.5—3 μ) hyphae. Clamp connections present but rare.

On swampy soil around old manure, Lake Fork Creek, Payette National Forest, Idaho, July 9, 1958, Sm-58742.

This species closely resembles "*Bolbitius cucullatus*" SEAVER & SHOPE (1935), but differs in its darkening stipe, smoky gray to pale fuscous gills when fresh, and narrower spores. The interesting feature is the change in spore color when fresh spores are mounted in KOH. This is one of the important features of the Strophariaceae (Agaricales). The genus which resembles *Weraroa* most is *Galeropsis*. Presumably the latter is close to *Bolbitius* and *Conocybe* in the Agaricales, but belongs among the secotioid gastromycetes.

It has been observed and commented upon that the pileus (peridium) of *Galeropsis* does not have an hymeniform cutis (SINGER & SMITH, 1958). It is now desirable to re-collect all species of *Galeropsis* and carefully check the color of the fresh gills with mature spores on them. *W. coprophila* is a *Psilocybe* in every sense of the word with the possible exception of not having active spore discharge from the basidia. No spore print was obtained from the caps set up though they were all in good condition. Hence the species is described in *Weraroa*.

Weraroa nivalis sp. nov.

Pileus 3—10 mm latus, convexus, subviscidus, ochraceus; "lamellae" distantes latae, demum cinereofuscae; stipes 1—1.5 cm longus, 1.5 crassus, ochraceus; sporae 8—10×5—6.5×4.4—5 μ, in "KOH" sordide fulvae. Typus: Sm 68641 (MICH).

Pileus 3—10 mm broad, obtuse to convex, becoming broadly convex, surface shiny as if viscid when wet, margin faintly fringed in buttons 2 mm broad, but no signs of a veil elsewhere, color pale yellow-ocher to dingy ochraceous, rarely slightly spotted, in age pale ochraceous-tan; context pallid-buff, fleshy, $FeSO_4$ no reaction.

Lamellae thick, broad, distant, broadly adnate to subdecurrent, dingy yellowish (as in *Chroogomphus*) in youngest buttons, in age with a grayish cast, intervenose.

Stipe 1—1.5 cm long, 1.5 mm at apex, 0.5—0.9 mm thick near base (narrowed downward), concolorous with pileus over all, at first faintly fibrillose but soon naked and somewhat shining.

Spores 8—10×5—6.5×4.5—5 μ, smooth, thick-walled, with an apical pore, purplish brown in water mounts when fresh, in KOH mounts soon dull rusty brown. Basidia 4-spored, spores obliquely attached. Pleurocystidia 26—34×7—12 μ, ventricose with obtuse to knoblike apices (no chrysocystidia seen). Epicutis of pileus a thin layer of somewhat gelatinous appressed hyphae 3—7 μ in diam., walls smooth, ochraceous to hyaline in KOH, some cells of the hypodermium with ochraceous pigment; all tissues non-amyloid. Clamp connections present.

Gregarious on moss near a melting snow-bank, Gisborn Mt. Priest River Experimental Forest, July 26, 1964, (Sm-68641), NANCY JANE SMITH, collector.

If this species actually discharges basidiospores from its basidia, it would of course be placed in *Psilocybe*, but I am placing it in accordance with the evidence we have. There was no sign of deposited spores on the apex of the stipe of any of the basidiocarps, and many were old. The aspect was that of a *Galeropsis*. The oblique attachment of the spores to the sterigmata has been found in other secotioid gastromycetes so it can no longer be regarded as strictly an agaric character.

In view of *W. nivalis* and *W. coprophila* it now appears desirable to reconsider our ideas as to the relationships of *Galeropsis* to the Agaricales. The very strong possibility exists that there is no true relationship to *Bolbitius* or *Conocybe* on the part of those species lacking an hymeniform peridial epicutis. The possibility is equally good that the brown spored species in which an hymenial epicutis (or cellular epicutis) is absent from the peridium are merely brown spored species of *Weraroa*, just as a number of species of *Psilocybe* have brown instead of purple-brown spore deposits.

Calbovista subsculpta var. *fumosa* var. nov.

Fructifications circa 10 cm crassae; sordide cinerea vel violaceo-cinereae, demum valde squamosus; spore 4—6(7—12) μ, crassae, globosae, leves. Typus: Sm 71347 (MICH).

Basidiocarp up to 10 cm diam., subglobose to globose when mature, elliptic to subglobose when young, attached by a strong cord-like rhizomorph, when young glabrous and unpolished, drab-gray to violaceous gray ("drab-gray" to "Benzo brown"), epicutis soon breaking up to form tuftlike squamules, the squamules gray to violaceous-gray and longitudinally lined or striate, the epicutis a trichodermium, and the striae indicating the direction of orientation of the trichodermal elements; subcutis (endoperidium) about 1 mm thick fresh, watery gray to reddish chocolate color on drying, finally breaking up and falling away as the epicuticular warts fall off. Gleba white then yellow to Saccardo's umber (when wet oldest one with dark vinaceous brown colors), becoming powdery. Subgleba not differentiated morphologically but gleba maturing very slowly in basal part.

Spores 4—6(7—12) μ in diam., globose or nearly so, smooth, with a broken stump of a pedicel, dark olive when first revived in KOH but on standing slowly becoming pale bister, in Melzer's sol. bright rusty brown and with a prominent central body, surface seen to be very minutely depressed-punctate ornamented (not evident in KOH mounts). Capillitium of discrete elements consisting of a main thread and thornlike branches from it with blunt to pointed apices and rarely some further lateral ornamentation in the form of bumps or rudimentary spines, the whole element bright fulvous in Melzer's and wall of main thread 1.5—3 μ thick; threads 5—12 μ diam. Hyphae of the epicuticular trichodermium consisting of cylindric cells or the cells enlarged and at times quite short (but not sphaerocysts), or a mixture of both, the walls smooth, thin to thickened somewhat and hyaline in KOH, and in Melzer's sol. hyaline to yellowish, no clamp connections found.

Under *Pinus contorta*, gregarious, Dickensheet Camp Ground, Priest River, Kaniksu National Forest, Oct. 21, 1964 (Sm-71347, type).

Although *C. subsculpta* var. *subsculpta* is rather common in Idaho we have usually found it with solid areolate warts pallid in color and with many very thick-walled cells in the trichodermial elements comprising the epicutis. In both the capillitium is in some degree dextrinoid, and the spore ornamentation is also the same. In var. *fumosa* there are many more giant spores than in var. *subsculpta*, and the spores have thicker walls, but none of these features seems to be definitive taxonomically nor do they as a group. The variety is based primarily on the gray coloration and the very rudimentary type of squamule formation.

Porphyrellus amylosporus sp. nov.

Pileus 4—12 cm latus, convexus, demum late convexus, siccus, velutinus, olivaceo-fuscus, demum olivaceo-brunneus, demum areolatus vel rimosus. Caro tactu caerulescens. Tubuli olivaceo-lutei, tactu caerulescentes. Stipes 4—9 cm longus, 1—1.5(2) cm crassus, aequalis, intus ruber, extus olivaceogriseus vel sursum pallidus. Sporae 12—17 × 4.5—6 μ. Typus: Sm-70936 (MICH).

Pileus 4—12 cm broad, convex becoming broadly convex, surface dry and velvety, dark olive-fuscous becoming olive-brown to olive-buff and in aging the cutis areolate or merely rimose; context next to cutis red, pale yellow elsewhere, staining blue when cut and slowly becoming red around the worm holes; odor none, taste mild, $FeSO_4$ no reaction, KOH no reaction.

Tubes 1—1.5 cm deep, ventricose, dull yellow to greenish yellow, blue where cut; mouths large and irregular in outline when mature, greenish yellow, readily staining blue.

Stipe 4—9 cm long, 1—1.5(2) cm thick, equal, red within, reddish on surface in a few places but usually entirely olive gray to the pallid, faintly pruinose and longitudinally striate apex.

Spore deposit dark "wood brown" on white paper. Spores 12—17 × 4.4—6 μ, "boletoid" in shape, smooth, thick-walled, with a circular apical thickening depressed in the center and from here a discontinuity in the wall extends to the interior (much as in *Xerocomus truncatus* and *X. porosporus*); on spores crushed out from the dried hymenophore weakly but distinctly amyloid (dull violaceous) and more violaceous in the region of the pore than elsewhere; spores from a deposit on clean white paper dextrinoid in outer half or one third (apical region) and merely yellowish toward the apiculus.

Basidia 32—38 × 8—10 μ, clavate, 4-spored, non-amyloid. Pleurocystidia 40—60 × 8—12 μ, scattered, hyaline, thin-walled, narrowly fusoid to slightly ventricose to a subacute apex, not incrusted. Tube trama (in mature basidiocarps) somewhat divergent as seen in mounts revived in KOH, hyphae non-amyloid (yellowish hyaline in Melzer's). Pileus cutis a trichodermium of hyphae 8—15 μ diam., with plate like incrustations of pale bister (in KOH) pigment along the walls, end-cell somewhat cystidioid. Clamp connections rare, seen at the base of an occasional basidium on some basidiocarps.

Gregarious under *Alnus rubra*, Reeder Bay area, Priest Lake, Idaho, Sept. 29, 1964 (Sm 70936).

This species has a number of unusual characters in addition to the apical pore. The iodine reaction on the spores is very peculiar, and the flesh (context) of the cap was not reactive to either of the chemicals tried. The two other species, *X. truncatus* and *X. porosporus*, with spores having apical pores, have been placed in *Xerocomus*. *P. amylosporus* appears to be a connecting link between the two genera.

Xerocomus porospora IMLER

Pileus 4—11 cm broad, convex, expanding to plane or nearly so, surface dry, densely tomentose and distinctly plush-like in appearance, not becoming areolate as in *X. chrysenteron* but fibrils becoming aggregated into tufts in age in small areas, color evenly "buffy brown" to "olive-brown" (pale to dark olive-brown), context pallid and only showing slightly in the cracks. Context pale yellowish white, soon blue when injured and then fading to pallid, soft, taste acidulus, odor none.

Tubes yellowish quickly changing to bluish where injured, depressed around the stipe, 1—1.5 cm deep, readily separable; mouths angular to irregular, about 1 mm diam.

Stipe 4—10 cm long, 8—15(20) mm thick, solid, in age reddish within, yellowish at first, bister in the base (dark yellow brown) surface at maturity reddish in mid-portion and pruinose-scurfy, base with a grayish-buff cottony mycelium, extreme apex yellowish.

Spore deposit (not obtained) olive brown on apex of stipe. Spores 13—17 × 5—7 μ, thick-walled, smooth, with an apical pore when mature, yellow in Melzer's sol. when mature (crushed from hymenophore) or some pale yellow brown, when immature pale tawny (weakly dextrinoid).

Basidia clavate, 4-spored, 38—54 × 9—13 μ, yellow content at first, then hyaline (in KOH). Pleurocystidia (none demonstrable from dried material). Clamp connections none found. Cutis of pileus a trichodermum of non-gelatinous hyphae with yellow-brown plates of encrusting material, hyphae 9—15 μ diam.

Scattered under conifers, Mt. Rainier National Park, Wash., Lower Tahoma Creek, Aug. 29, 1948. STUNTZ & SIMMONS. (Sm 30719).

This species is assigned tentatively to *X. porospora* with the knowledge that the data on the spore deposit, the pleurocystidia and clamp connections are not entirely satisfactory. Pleurocystidia have been found (see Sm 16203) in other collections placed here on spore and other features, but unfortunately detailed notes were not recorded on this material fresh. An hours search revealed one "good" clamp at the base of a basidium. I accept these data as indicating that the correspondence between IMLER'S material and that from North America cited here is sufficiently close to justify the identification here indicated.

Xerocomus truncatus SINGER et al.

Pileus 3—8 cm broad, convex becoming broadly convex or the margin finally crenulate, surface velvety and evenly dark olive to olive-brown, very soon red to reddish along the margin and the epicutis becoming areolate with red showing in the cracks. Context whitish young but rose-red under the cutis, slowly becoming pale

yellowish, red around the larvae tunnels, staining blue when cut. Odor slight, taste mild, $FeSO_4$ on cut context greenish gray.

Tubes Isabella color, depressed around the stipe, pale yellow young; mouths pale yellow young, when mature 1—2 per mm or in age up to 2 mm, irregular in outline (but not boletinoid).

Stipe 4—8 cm long, 4—12 mm thick, equal or nearly so, solid, pallid yellowish within above, soon rose-red from base up (dark brown in KOH) surface inconspicuously pruinose to naked, with dingy ochraceous mycelium around the base.

Spore deposit olive-brown, spores 10—14 × 4.5—6.5 μ, with a broad shallow suprahiler depression in profile, oval to oblong or slightly ventricose in face view, wall slightly thickened, with a truncate apex at maturity from an apical pore (not as conspicuous as in *P. amylosporus* and *X. porospora*), in Melzer's sol. crushed mounts of hymenophore from young caps very dark but color fading, spores seen to be weakly amyloid when young (with a pale bluish fuscous-line in the wall near apex) in old caps merely pale-tawny in Melzer's, in KOH dingy ochraceous to pale yellowish brown.

Basidia clavate, 28—36 × 9—12 μ, often yellow in KOH; clavate, 4-spored. Pleurocystidia 50—70 × 10—16 μ, ventricose with a long neck and acute apex, smooth, thin-walled, readily collapsing, scattered to rare. Pileus cutis a trichodermium of hyphae 8—15 μ diam. with dull rusty brown (in KOH) plates of incrusting pigment, end cells tapered to an obtuse apex at times. Clamps none found.

Gregarious around old stumps on sandy soil. Emerson slashings, Emerson, Michigan. Aug. 9, 1963 (Sm 67089).

This species appears to check reasonably well with the original description. The amyloid reaction of the spore wall fades quickly and is best seen on young well preserved hymenophore tissue. Had it not been for the stronger reaction observed in *P. amylosporus*, I probably would have missed it here. In fact it is not present in many of the older basidiocarps studied.

It is evident now that all three species are closely related, and the question arises here as it did for *Suillus* and *Fuscoboletinus*, where does one place the most emphasis? It would be easy to solve the problem by describing a new genus of boletes with spores of this type, but it is probably more sensible to transfer all of them to *Porphyrellus* or *Boletellus*. It is not my purpose to try and settle this question here, as it will require a re-study of both genera to arrive at a worthwhile conclusion. Hence, the apparently previously undescribed species is placed in *Porphyrellus* where it logically belongs on the basis of the color of the spore deposit, but the others are left in *Xerocomus*. But it is interesting to know that we have three species with this type of spore here in North America. *Porphyrellus atrofuscus* DICK & SNELL is a possible fourth — I have seen no specimens.

NOTES ON THE OCCURRENCE AND DISTRIBUTION OF HYPOGEOUS FUNGI IN THE PACIFIC NORTHWEST

The Common Species. Four stand out in this respect since they occur in such quantity during July and August within a radius of one hundred miles of McCall, Idaho, that it is possible to find them almost every day during a normal season if one takes the trouble to look for them. These are: *Macowanites americana, Gautieria graveolens* (tentatively determined), *Hysterangium separabile* (determination tentative) and *Thaxterogaster pingue.*

Macowanites americana SINGER & SMITH. During the season of 1964 the writer had collectors working in Alaska, in Vancouver, B. C., Canada, and at Priest River Experimental Forest near the town of Priest River, Idaho, as well as at McCall. The group located at Priest River contained the most experienced collectors, three in number. Two experienced collectors were located at Anchorage, Alaska, one inexperienced graduate student in Vancouver, B.C., and one at McCall, Idaho. The period under consideration was the last two weeks in July, for at this time *M. americana* is usually at the height of its fruiting period. The results for the period were conclusive as far as the time period was concerned. The Alaskan, Vancouver, and Priest Lake parties failed to find any *Macowanites* whatever. The McCall party collected it pretty much at will. We were particularly interested in comparing the Priest Lake area with that around McCall. The results for Priest River for the whole season were one species of *Macowanites*, collected by KENNETH HARRISON in September. On the first of August the Priest Lake party joined PAUL MILLER at Mc Call, and we all collected *M. americana* in the quantity expected for this area, which includes the type locality. At least during the season of 1964 the fruiting of *Macowanites* appears to have been narrowly limited to the Salmon River drainage. In this area, however, it continues to appear each season according to a definite pattern just as does *Polyporus flettii* and other common fungi. The interesting problem now is to plot the abundance of this species northward. Was its absence at Priest Lake merely a seasonal quirk or is it really absent in the area? As it stands, on the basis of the season of 1964, the species appears to be of local distribution, but to fruit yearly in its region during both "good" and "bad" seasons.

Thaxterogaster pingue: We found this species to be widely distributed in the Pacific Northwest (Washington, Oregon and Idaho), but the only area in which we have been able to collect it at will is around McCall, Idaho. Here it is one of the common fungi under spruce and fir. As the conifer duff dries out the basidiocarps form in the duff and mature their spores without exposing the gleba. If the weather is wet, the stipe may elongate and the peridium separate from the stipe columella to expose the gleba as previously pointed out (SINGER & SMITH, 1958). At Priest Lake it was not

abundant. Our first record was July 6, which is about the time it begins to appear around McCall. In the Cascade mountains of Oregon and Washington during the rainy season we find it solitary to gregarious. In the drier climate of Idaho it is often cespitose. This species appears to be one of the locally common species with a fairly wide distribution.

Gautieria graveolens (determination tentative). This is one of the first hypogeous species to appear in late June and often continues to fruit all summer in sufficient quantity that one tires of collecting it. Our largest fruitings have occurred in the spruce-fir zone, especially under *Abies lasiocarpa*. If our identification is correct this is an example of an European species which apparently occurs in greater abundance here than anywhere else in the world, at least I have found no comparable reports in the literature. In the Salmon River country of Idaho it can, literally, be collected by the market-basket full during late July and August during a favorable season, and we have found it every season we have worked the area. It is also fairly common in the Priest Lake district (season of 1964), and I have collected it from most localities in the Pacific Northwest where I have looked for it. The odor develops with age. It is not unusual to find specimens dried in situ in the McCall area. My observations indicate that the life of a basidiocarp in the soil commonly exceeds two weeks. I have one report from a cabin owner in the Priest River district of northern Idaho that he removed two bushels of the basidiocarps from his woodshed one fall when cleaning up in preparation for the hunting season; these had been brought in by the pine squirrels.

Hysterangium separabile ZELLER. Like the *Gautieria*, during a normal season this species occurs in almost any amount you care to collect, though since the basidiocarps are small, it takes more time to collect as many as a peck. Its period of fruiting and its distribution throughout the Pacific Northwest are closely parallel to that of *Gautieria graveolens*. Also for this species the basidiocarps persist for a long time in the duff, and late in the season of 1964 it was not at all uncommon to find them dried in situ. In this condition they are hard as rocks. My impression is that there are waves of fruiting of this species in a single habitat with about a month in between. But since each stream valley varies slightly from each other valley, the point is reached where you can find old basidiocarps in one valley and fresh ones in another. From my experience the species is ubiquitous throughout the conifer forests of the region, but if one seeks it in quantity relatively young stands of *Abies lasiocarpa* are the best place to look.

Literature

HARRISON, KENNETH (1964). New or Little Known North American Stipitate Hydnums. Canad. J. Bot. **42**: 1205—1233.

HAWKER, LILIAN E. (1954). British Hypogeous Fungi. Phil. Trans. Roy. Soc. London. Series B. **237:** 429—546.
IMLER, LOUIS, (1964). *Xerocomus porosporus*. Bull. Soc. Myc. Fr. **80:** Atlas Pl. CXLI & CXLII.
KÜHNER, R. (1938). Le Genre *Mycena*. Encyc. Mycologique **10:** 1—710.
LANGE, MORTEN (1956). Danish Hypogeous Macromycetes. Dansk. bot. Arkiv. **16:** 1—82.
MILLER, O. K. (1964). Monograph of *Chroogomphus* (Gomphidiaceae). Mycologia **56:** 526—549.
SEAVER, FRED J. & P. F. SHOPE (1935). New or Noteworthy Basidiomycetes from the Central Rocky Mountain Region. Mycologia **27:** 624—651.
SINGER, ROLF (1951). The Agaricales in Modern Taxonomy. Lilloa **22:** 1—832.
SINGER, ROLF (1963). The Agaricales in Modern Taxonomy. Second Edition pp. 915, 73 pls. J. Cramer, Weinheim.
SINGER, ROLF (1963). Notes on Secotiaceous Fungi. *Galeropsis* and *Brauniella*. Proc. kon. Ned. Akad. Wet. Series C, **66:** 106—117.
SINGER, ROLF, JORGE E. WRIGHT & EGON HORAK (1963). Darwinia **12:** 598—611.
SINGER, ROLF & ALEXANDER H. SMITH (1958). Studies on Secotiaceous Fungi I. A Monograph of the genus *Thaxterogaster*. Brittonia **10:** 201—216.
SINGER, ROLF & ALEXANDER H. SMITH (1958). Studies on Secotiaceous Fungi III. The genus *Weraroa*. Bull. Torrey Bot. Club. **85:** 324—334.
SINGER, ROLF & ALEXANDER H. SMITH (1960). Studies on Secotiaceous Fungi IX. The Astrogastraceous Series. Mem. Torrey Club **21**, 3: 1—112.
SMITH, ALEXANDER H. (1964). *Rhizopogon*, A Curious Genus of False Truffle. The Michigan Bot. **3:** 13—19.
SMITH, ALEXANDER H. & DEREK REID (1962). A New Genus of the Secotiaceae. Mycologia **54:** 98—104.
SOEHNER, ERT (1962). Die Gattung *Hymenogaster* Vitt. Nova Hedwigia (Beihefte) **2:** 113. 8 pls.