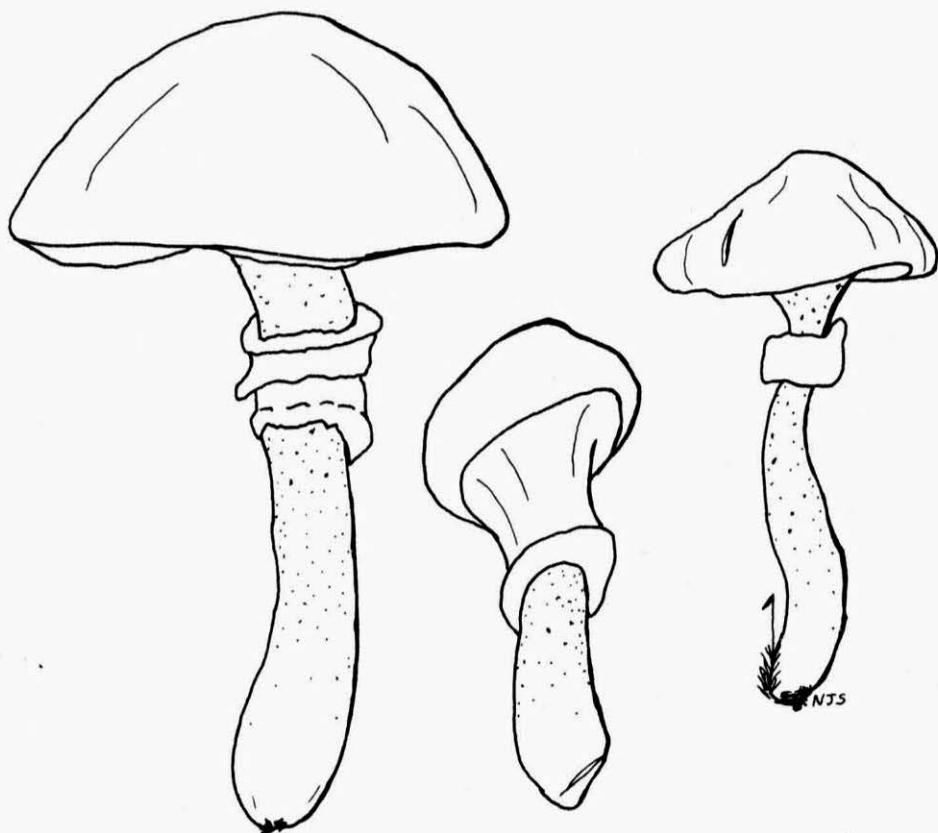


**A CONTRIBUTION TOWARD
A MONOGRAPH OF NORTH
AMERICAN SPECIES OF
SUILLUS**



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July 1964 Ann Arbor, Michigan

DEDICATION

To Albert W. Slipp
who persevered against great odds
in studies of the boletes of
northern Idaho.

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Alexander H. Smith and Harry D. Thiers

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**A CONTRIBUTION TOWARD A MONOGRAPH OF
THE NORTH AMERICAN SPECIES OF SUILLUS
(BOLETACEAE)**

Alexander H. Smith and Harry D. Thiers*

One of the most troublesome groups of the Boletaceae, as far as the recognition of taxa is concerned, has been the group generally known as the section *Viscipelles* of *Boletus* in the older literature. This group represented a "gray area" between *Boletinus* on the one hand and *Boletus* sensu lato on the other. However, attempts to distinguish species in *Suillus* were frustrating not so much because of the difficulty of recognizing them in nature by the ordinary characters used to distinguish species and varieties in the fleshy fungi generally, but because of the difficulty of interpreting the conflicting statements in the literature or one's inability to find specimens whose characters compared well with those given in the published descriptions. There is no denying that the species of *Suillus* are one of the most confused groups of fleshy fungi in North America. We offer here our observations and interpretations in the hope that future students will find them useful and to the point on taxonomic problems. Our treatment does not introduce much in the way of new characters, but we hope we have made a contribution toward a better evaluation of the features emphasized by previous authors, as well as having standardized others, such as the color of the spore deposit, so that their interpretation by future workers will be more accurately and readily made.

Our joint field work has been in progress since 1950 with special reference to the Rocky Mountain and Pacific Coast conifer forests, the upper Great Lakes region, where we both have collected extensively, and in the Gulf Coast area where Thiers has collected extensively. Smith, in addition, has collected in Ontario, Quebec, Nova Scotia, New York and Massachusetts, but not extensively in any of these areas.

Looking back at the problem from the summation of our field experience it is clear to us that most species of *Suillus* can be identified in the field if the collection at hand contains basidiocarps in various stages of development from the unexpanded buttons to those past maturity. Since a number of species may form mycorrhiza with a given

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conifer tree, and since they are likely to fruit at about the same time, it is easy to make collections representing a mixture of two or more species, and thus arrive at unworkable or uncritical taxonomic concepts. This was well illustrated one fall when Smith found a basidiocarp of *Suillus grevillei* and one of a *Gomphidius* growing with their bases in contact with each other and appearing to come from the same mycelium. If two species such as *Suillus granulatus* and *S. albidipes* were to fruit in the above manner, one would almost certainly consider them to be one species and would consider the remnants of the false veil on one basidiocarp to indicate the earliest stage of development. Thus two species would be confused. We suspect that a mistake of this order was involved in Singer's delimitation of *S. sphaerosporus* ssp. *snellei*.

As already indicated, *Suillus* species generally fruit abundantly in the late summer and fall, but the pattern varies with the region. In the conifer forests of the Rocky Mountains they are abundant in the summer time if the weather is wet. In California the height of the season coincides with the winter rains. Odd or unexpected fruitings, however, occur with such frequency that one should regard the above statements as a guide as to when to hunt for species of *Suillus* rather than establishing the seasonal limits of the fruiting pattern of any of the species.

It is now known on the basis of culture work and by repeated field observations by many students of the group that species of *Suillus* first of all are mycorrhiza formers and secondly that most species form mycorrhiza with conifers. Here, again, however, it is not desirable to be dogmatic. Smith has found collections in the *S. subaureus*-*S. hirtellus* complex in aspen woods with no conifers within a hundred yards of the basidiocarps. *S. sphaerosporus* occurs under oak. It is not at all surprising to find these exceptions, since other fungi, such as *Amanita muscaria* show the same range of adaptability. It is significant that there are so few exceptions in *Suillus*. However, we would not accept the idea of Singer that there has been significant evolution of species limited to forming mycorrhiza with a single conifer genus (such as *Larix*) and arising from parental stock also limited to forming mycorrhiza on the same host. Admittedly this is possible, as the over-all association with conifers indicates, but we consider it very premature at present to base infrageneric taxa on it. It seems to us that the probabilities are quite the opposite. Regardless of any taxonomic implications attributable or not to the mycorrhizal relationship, this relationship is one of importance to foresters because so much of our forest practice is concerned with species of conifers, and the pressures for growing timber rather than just cutting it are mounting on this continent.

One aspect concerned with the mycorrhizal relationship is correlated with the known use of *Suillus* basidiocarps for human food. This use is rapidly coming to the fore here in the United States. To be brief, many people collect *Suillus* basidiocarps for home consumption, and some of the local pine plantations in the recreation areas of southern Michigan furnish hundreds of pounds of edible mushrooms yearly. We know of no cases of poisoning in North America clearly attributable to

eating species of *Suillus* as we have delimited the genus. However, there is the possibility of a poisonous species in southern Spain. Smith has been interested for years in the use of *Suillus* species for food in connection with his teaching of adult education courses on the recognition of our native mushrooms in the field. The results have been interesting. From the taxonomic aspect in particular it was interesting to note that the amateur collector whether he was a lawyer, engineer, salesman, or worker on an assembly line could usually learn to recognize the species in this genus rather quickly. Why then so much confusion among the taxonomists? The question is very pertinent, and of course a number of qualifying factors are immediately apparent. The amateurs were collecting a limited area, had only one set of features for each species to keep in mind, and saw the combinations of features repeated over and over again in the short space of a few weeks. They did not face the problems of trying to resolve conflicting statements about a single species in the literature, or to compare specimens from widely scattered geographic areas. It remains as a demonstrated fact, however, that given the correct set of characters, species of *Suillus* can be readily recognized by those even with only a small amount of training.

One of the problems facing the serious taxonomist is that of interpreting the dried specimens as these are found in most herbaria. There are two aspects to this problem: First, the lack of notes on characters of the specimens when fresh, and the lack of spore prints. Second, the fact that if basidiocarps of *Suillus* species are not carefully dried, the features of the dried specimens can be misleading or at least of little help in making accurate identifications. However, it is true that carefully dried specimens with adequate notes, have inestimable value to the taxonomist. First, there is usually a distinct pattern of color changes taking place as the specimens dry and the dried material may show colors as characteristic as those of the fresh material--but of course not the same color necessarily. Specimens must be dried steadily over a source of heat until completely dry. If they are allowed to cool, as happens if the drier is turned off over night, the specimens are likely to blacken and the tissues collapse. It is true that some species blacken more easily than others, and that water-soaked specimens often dry poorly. If specimens are very wet when brought in, it is a good idea to place them on a table in a warm room and dry off the excess moisture before actually placing the material on the drier. There must be ample circulation of air among the specimens on the drier. They should never be placed on pieces of paper or on any object that materially interferes with air circulation. Specimens in cheese cloth bags do not dry well unless air is forced through the bag, and then the cheesecloth invariably becomes imbedded in the viscid layer of the pileus. Such specimens usually become badly broken on being removed from the bag. The use of such chemicals as activated silica gel (Hoseney, 1963) are highly recommended for drying small amounts of material, but in this process it is well to air-dry the specimens for a few hours before placing them in contact with the chemical. This process is the

best to use if one wishes to avoid blackening not inherent in the specimen itself. If drying over heat is used, electric heat is to be preferred. In the days when we did our drying over a kerosene or a gasoline stove, we obtained results that were consistently far inferior to those obtained by the use of electricity. If the equipment is available, deep freeze drying is a fine technique, but the material becomes very fragile.

Because of the situation as regards dried specimens, those cited are mostly our own collections. In recording data on fresh material, whenever possible we drew up our descriptions from large fruitings clearly of one taxon and observed the added precaution of recording the microscopic data from the actual specimens used for observing the macroscopic features. Other collections were then identified by means of these descriptions. For the most part it was found that this process served admirably for taxonomic purposes. The final descriptions as presented in this work contain additional data from other collections, such as maximum and minimum size ranges if such were indicated, but any distinct variations in color or some other feature of possible taxonomic importance are discussed separately following the description of the species.

In dealing with the literature we have recognized certain taxa even though we doubt their validity. In our estimation it is far less serious an error to do this than to obscure the identity of a distinct taxon by placing its name in synonymy with that of a closely related species simply because the one in question was incompletely described in the first place. Murrill (1910) and Coker & Beers (1943) in particular were guilty of this error, and their works did little to advance our knowledge of this group of boletes.

A summary of the species of *Suillus* brings out certain interesting points. First, the genus is a medium sized one; we recognize fifty odd species and varieties from North America. This is in contrast to about a dozen known from Europe. Here, as for most genera of the Agaricales, the flora of North America is obviously much richer in species than the flora of Europe. We hope that our contribution will aid in making a more accurate comparison of European and North American species possible. We have made no real effort in this direction because the necessity for learning the North American species first seemed most important. It appears to us that not only is the number of species in North America much larger than for Europe, but that many of our species show much more variations, as for instance *S. albidipes*. On the other hand it is also apparent that certain species such as *S. placidus*, are much more variable in Europe than in North America. Because the problem of comparing the two floras is complex, it is not likely to be solved by occasional visits of European and American mycologists to each other's collecting grounds but rather by detailed studies made on a comparable basis by each group of investigators in its own area and a free exchange of information. It is likely that no appreciable flora of *Suillus* species will be found in regions where native species of the Coniferales are absent or poorly represented.

It is a pleasure to acknowledge the aid we have received from a number of sources in the course of this investigation. Our field work has been supported in a large measure by grants to each of us from the National Science Foundation. These made possible the coverage of both the southern and the western United States. Without this aid the scope of our project would have been greatly limited. We both also wish to acknowledge the use of the facilities of the University of Michigan Biological Station, Dr. A. H. Stockard, Director, which served admirably as a base for field work in the northern Great Lakes region during late summer and fall on a number of occasions. In addition, the senior author wishes again to acknowledge the financial aid received from the Faculty Research Fund of the University of Michigan from 1935 to the present which made possible the development of his program on the fleshy fungi of North America, of which the present contribution is a part.

Dr. J. Walton Groves of the Canada Department of Agriculture very kindly read the manuscript and made valuable suggestions. Dr. Robert L. Shaffer has also critically read the manuscript and contributed much time to a discussion of many of the taxonomic problems encountered in the course of the study. We are also happy to acknowledge comments and an exchange of ideas on bolete problems with Dr. Walter H. Snell and Esther Dick, the well known specialists on the bolete flora of eastern North America. We are particularly indebted to Mrs. Ellen Thiers for writing most of the Latin descriptions.

The specimens cited are deposited in herbaria as indicated by the abbreviations recommended in Index Herbariorum. Color terms within quotation marks are from Ridgway, Color Standards and Color Nomenclature, Washington, D.C. 1912. Ridgway terms not in quotation marks indicate that the color was not matched in the chart but is the same or a close approximation to that indicated in the chart under the name used. Thus yellow ocher (or ocher yellow) is close to "yellow ocher" if not identical, and cinnamon would refer to a color close to "cinnamon." Unless otherwise stated, the photographs are about x1 as reproduced.

SUILLUS S. F. Gray, Emended

- Suillus* S. F. Gray, Nat. Arr. Brit. Pl. 1: 646. 1821.
Pinuzza Micheli ex S. F. Gray, Nat. Arr. Brit. Pl. 1: 646. 1821.
Rostkovites Karsten, Rev. Myc. 3: 16. 1881.
Cricunopus Karsten, Rev. Myc. 3: 16. 1881.
Boletus Fr. sensu Karsten, Rev. Myc. 3: 17. 1881 (Non S. F. Gray, 1821)
Viscipellis Quélet, Enchir. Fung. p. 155. 1886.
Versipellis Quélet, Enchir. Fung. p. 157 (in part).
Ixocomus Quélet, Fl. Mycol. p. 411. 1888.
Boletopsis Henn. in Engler & Prantl. Nat. Pfl. Fam. 1(1^{xx}): 194. 1898.
(non Fayod, 1889).
Boletinus Kalchbrenner, Bot. Zeitsch. 25: 182. 1867.
Euryporus Quélet, Enchir. Fung. p. 163. 1886.

Pileus fleshy and readily decaying; hymenophore tubulose and tube mouths of various sizes and shapes; stipe central to eccentric; spore deposit after evaporation of excess moisture "bister" "snuff brown" dingy cinnamon, "clay color" or "pinkish buff" (dark to pale yellow-brown), often with an olive tone when moist or in some species after fading; hymenophore usually having clustered pleurocystidia which as revived in KOH have dark rusty brown to cinnamon masses of amorphous pigment around the base of the bundles or over the cystidia themselves; caulocystidia often in clusters and similar to the pleurocystidia. As they become pigmented, visible dots or smears show on the surface of the stipe which are referred to as "glandular dots"; the pileus cutis is usually an ixotrichodermium but in a few it is dry and the elements aggregated into squamules. Clamp connections are typically present on the mycelium but usually absent from the hyphae of the basidiocarp; tube trama typically bilateral and at maturity usually gelatinous. Mostly occurring on the ground under conifers, with which they form mycorrhiza, but a few associated with hardwoods.

The development of the basidiocarp in those species with a veil (or a false veil) is said to be pseudoangiocarpic* and some of the so called gymnocarpic species may belong in this category also as the stage when the hymenophore is enclosed may be very transient.

TAXONOMIC FEATURES

SPORES. The color of the spore deposit, after moisture has escaped from it, is dark to pale yellow-brown or tan. It is very important at the generic level but of minor importance in the infrageneric taxonomy. This degree of standardization is desirable since the fresh moist spore deposits vary greatly in color depending on the density of the deposit, how much stain is carried to it from yellow pigment drops from the tubes, and possibly an actual change in the pigments as moisture escapes from the spores. The moist deposit usually is a darker yellow to olive-brown or less usual, a redder brown than after moisture has escaped. Species with purplish-brown to lilac-drab spore deposits (the color of that of *Naematoloma sublateralitium*) or a vinaceous-red, or dark reddish brown or permanently dark cinnamon-brown have been removed to *Fuscoboletinus* Pomerleau & Smith (1963).

The individual spores are not very distinctive. They are unornamented, usually thin-walled and rather small as compared to those of

other boletes generally. Under the microscope in KOH they are nearly hyaline to pale ochraceous or pale yellow-brown but in Melzer's solution there is a tendency toward the dextrinoid reaction but the color is not darker than clay-color to reddish tawny. Spore size, as in most fleshy fungi, is a feature of some importance at the species level, but small differences are apt to be unreliable, just as in other members of the Agaricales. The range in spore size for the genus is rather narrow, about 6-13 μ . Aside from *S. sphaerosporus* which has subglobose spores, spore shape varies slightly around the subfusoid type known as boletoid. No apical differentiation in the spores of *Suillus* has been noted under the magnifications we have used (15 \times eyepiece \times 1.3 oil immersion lens).

CYSTIDIA. Typically both pleurocystidia and cheilocystidia are present. There are usually two types of pleurocystidia: In the first type, which occurs singly, the shape is usually fusoid-ventricose and they have a hyaline to yellowish or brown content as revived in KOH. Pleurocystidia of this type are found on many groups of boletes and are not particularly diagnostic for *Suillus* as a genus. The second type, however, forms one of the central features of the genus. The cystidia of this type occur in clusters and vary in shape from subcylindric to narrowly clavate. When revived in KOH they are incrustated with an amorphous dark brown substance. Sometimes only the basal part of the cluster is incrustated but generally some material also adheres to the outer extremity of the group or individual cystidia. The content of the clustered cystidia may be yellowish brown as well, and when fresh material is mounted in weak KOH (2.5%), the content often becomes reddish to lilac-brown or dull lilac. As a rule the size and shape of these cystidia is of little help in the recognition of species, though differences in size have been of some help in a few. One occasionally finds places in the hymenium where the same type of incrustation as that found around a cluster of cystidia occurs, but apparently no cystidium is present, or only one can be found. The edges of the tubes usually show more incrustation along the hymenium and around the cheilocystidia than is found around the pleurocystidia. Also, the cheilocystidia may be so numerous that their pattern of occurring in clusters may be obscured, or they may be scattered along the tube edges.

Caulocystidia may also be present in clusters and rarely some are scattered as well; like the pleurocystidia they are usually heavily incrustated and brown as revived in KOH. These clusters become more or less pigmented by the time the basidiocarp is mature. They are most conspicuous in *S. placidus*, *S. punctipes* and *S. granulatus*. Here the clusters often merge to form colored smears on the upper area of the stipe, and the stipe is viscid to subviscid because of the nature of the exudate. These spots or smears form the ornamentation referred to as glandular dots. In many species these glandular dots are very inconspicuous when the basidiocarp is young because the exudate or the content of the caulocystidia has not darkened. *S. albidipes* is an example.

However, as the pigmentation develops the spots become more conspicuous and the ultimate degree of coloration results when the basidiocarps are dried, at which time the spots may be blackish. In a few species the glandular-dotted effect does not develop or is so poorly developed as to be scarcely discernible. However, a microscopic examination will usually reveal the presence of some caulocystidia. When one understands the nature of the glandular dots, the correlation of this feature with the clusters of pleurocystidia is obvious; it is merely an extension of it with slight modifications. If clustered pleurocystidia are present, and glandular dots are present on the stipe, the degree to which the tube mouths show spotting is not likely to be of any particular taxonomic significance. Spotting of the tube mouths may also be accentuated by accumulations of spores caught in the resinous exudate. These cystidia, as far as we can ascertain, are not part of a differentiated system of laticiferous or resin-containing hyphae.

THE CUTICLE OF THE PILEUS. It is a common feature of a large number of the larger genera in the Agaricales that the cuticle may be composed of dry floccose elements or those with gelatinous walls. Thus in *Suillus* we find species with dry, fibrillose pilei and those with a viscid or slimy surface. In *Suillus* the number of species with gelatinization of the cuticle or part of it is greater than the number which are dry and fibrillose. In a number e.g. *S. brevipes*, the layer of slime may be so thick that in wet weather it often drips from the pileus. This slime layer discourages many people from using these fungi for food. In a number of the species there is a floccose dry epicutis over a more or less gelatinous subcutis, and at times the epicuticular elements may be washed off by heavy rains leaving a glabrous viscid cap. A large number of species in *Suillus* have pilei with patches of fibrils resting on a gelatinous subcutis and may become more or less glabrous in age. In glabrous species the epicutis may be in the form of an ixotrichodermium.

COLOR CHANGES. These are important here as in the other groups of boletes and other families of the Agaricales. The change to blue or greenish blue or green occurs sporadically in the genus in a number of groups, but is not correlated with other features in such a way as to help define the genus. A more important color change, and one clearly associated with the fundamental features on which the genus is based, is the change to dingy vinaceous brown observed on the tube mouths and at times on other tissues of the basidiocarp when these are bruised. In older works this change was not always carefully recorded. Species were described as unchanging or no mention of a change was made, even though a change to brown apparently did occur. There is a tendency in the genus for yellow tones to develop throughout the hymenophore and stipe. In a number of species, e.g. *S. granulatus*, the young stipe is white but by maturity becomes lemon-yellow throughout. This change may take place rather rapidly and be somewhat localized. We have had some collections which when left overnight, developed

yellow areas on the stipe giving the impression of a color change caused by bruising. In the *S. granulatus* group we have not given such changes any emphasis taxonomically. The problem in this group appears to involve chemical changes normally leading to the production of the yellow pigment. However, in the *S. acidus* group we have emphasized a change to yellow on the stipe which takes place rapidly as the stipe is handled. This change appears to be distinctive in a group of otherwise very similar species. The same situation applies to other odd color changes noted in the descriptions of certain species such as *S. lithocarpi-sequoiae* where a change to blackish follows the change to blue. Color changes produced by the application of chemicals are treated under chemical characters.

PIGMENTATION OF THE BASIDIOCARP. The colors of the pileus in *Suillus* present a rather restricted range in comparison to most groups of fleshy Basidiomycetes. The basic pigment is yellow and is dissolved in the cell sap. The variations are to red, red-brown, cinnamon, or rarely olive. As with most fleshy fungi, color can be a very constant feature, as in *S. americanus*, or it can be variable as in *S. cavipes*. Each species has its own distinctive pattern which must be ascertained from an examination of specimens in all stages of development. Color can be a perplexing problem in species such as *S. sphaerosporus*, which have a pronounced tendency to stain brown. The young basidiocarps are a beautiful ochraceous at first, but few people ever find them in this condition because of the rapid change to dark dingy brown caused by contact with the substratum or from handling.

The disseminations of the hymenophore are typically some shade of yellow, or if white at first, soon develop yellow pigment. In age the tubes generally tend toward olive-yellow or dingy ochraceous. The olive tones may be very noticeable in old water-soaked specimens of some species. In general, the color of the hymenophore is of only secondary importance in the recognition of species. We exclude the section *Piperati* Singer from the genus on the basis of a number of features correlated with the reddish hymenophore of species of that group.

One feature of the tube mouths not sufficiently emphasized previously for the North American species is their color when young. In *Boletus* the red to red-brown tube mouths of a group of species has been used to set them apart as the section *Luridi*. The *B. edulis* group has stuffed tube mouths in the young basidiocarps, and this has been used as an important feature. The species of *Suillus* show neither of these conditions, but *S. punctipes* and *S. tomentosus* have very dark dingy yellow-brown tube mouths when young, whereas in others, even in very immature stages, the mouths are concolorous with the sides. Although we have observed some variation in this color pattern for *S. tomentosus* upon examination of hundreds of basidiocarps, it is a remarkably constant feature.

THE VEIL. The majority of the species in *Suillus* show some remains of a "veil" either as scattered tufts of fibrils over the caps, a roll of cottony tissue on the margin of the young cap, or an annular zone on the stipe or a membranous annulus. Developmental studies by Kühner (1927) and Elrod *et al* (1939 & 1940) have shown that the hymenophoral cavity is exposed in small buttons, becomes closed from tissue growing in from the margin of the cap and finally surrounding the stipe, and that as the cap expands the hymenophoral cavity is again exposed by the breaking or pulling away from the stipe of this tissue. In a large number of the gill fungi the gill cavity is covered by a veil until such time as the hymenophore is maturing, at which time the veil breaks to allow the hymenium to mature exposed to the environment directly. This is the pattern of development termed hemiangiocarpic since the gill cavity is enclosed during the early development of the hymenophore. In *Suillus* the term which should be applied to the developmental pattern, if a parallel term is preferred, it is pseudo-hemiangiocarpic (see footnote*), because the hymenophoral cavity is at first open, then closed, and later becomes exposed for the second time as the spores mature. In a sense then the veil in *Suillus* is a false veil, and one which at least for most species never becomes intimately intergrown with the stipe tissue even in cases where a membranous ring is left on the stipe as an annulus. In *S. subluteus* for instance, even though the veil is a baggy membranous structure around the stipe, glandular dots occur beneath it indicating that the cortex of the stipe is continuous from above to below the ring.

We have found from observing numerous collections of species that the veil characters show a constant pattern for each, and that they furnish valuable taxonomic characters. We list the important veil features as follows: 1) Whether or not the veil leaves a ring on the stipe. 2) Whether there is a characteristic color pattern, for instance, is there an outer layer differently colored from the inner layer. 3) Color changes which the veil undergoes. 4) Texture and tissue systems of the veil. 5) The degree to which it becomes differentiated as a tissue from the margin of the cap.

To our knowledge it has never been disputed that a veil which leaves an annulus on the stipe is an important taxonomic feature. Our observations in no way contradict this. It is true of course, that accidents happen and in a few specimens the veil may adhere mostly to the cap margin in species where an annulus is normally formed. In a number of species there is a characteristic color pattern. This is best known in *S. luteus*, where the outer layer is typically vinaceous gray to purplish drab. This is one of the important field characters of *S. luteus*. We have found a few specimens in which the veil broke in such a way as to leave no remnants on the stipe, the tissue adhering as flaps along the cap margin. But even here the color of the outer layer is an aid in the correct identification of the specimens. In *S. umbonatus* the gelatinous veil soon becomes dingy cinnamon in color. In *S. sphaerosporus* the veil material stains brown in the same degree as the pileus and hymenophore. In *S. subolivaceus* distinct olive tones develop, and in *S. subluteus* it

soon changes from salmon buff to dingy gray or with blackish streaks, or finally becomes blackish as it collapses on the stipe.

In texture there is also a range of characters, but there are also pitfalls. In such species as *S. umbonatus* the veil consists of a thin layer of gelatinous material. In *S. luteus* the veil is non-gelatinous, but the outer layer may gelatinize under conditions of high humidity. In *S. sphaerosporus* we find a tough thick membrane with a dry outer layer at first but with a gelatinizing inner layer. The tendency is for the veil material to collapse or gelatinize or both as the basidiocarp ages. For these reasons, the texture does not furnish very many reliable field characters, though its overall pattern of changes is important. We have not found a gelatinose veil which covers only a part of the hymenophoral cavity in *Suillus*.

There has been a difference of opinion as to the value of the false veil in the taxonomy of the genus when this tissue does not reach the stipe. Singer (1945) considered it of no value in his study of *S. granulatus*. We have studied this group in great detail and have arrived at the conclusion that as long as veil development has proceeded to the point of forming a tissue along the cap margin distinct from the cap tissue, that it is a constant feature and justifies the same taxonomic recognition as that given to the presence of an annulus. For instance, in *S. albidipes* a cottony roll of tissue develops along the cap margin but seldom touches the stipe. Because this tissue is delicate and collapses readily as the cap matures, it is seldom conspicuous on mature fruit bodies. We believe that the failure to grasp the real meaning of this tissue led Singer to confuse *S. albidipes*, *S. granulatus* and *S. brevipes*. We have found this incomplete veil to be valuable diagnostic feature not only in *S. albidipes* but in a number of other species described herein as well. Hence, the first or early stages of development of the basidiocarp are essential to gaining a proper understanding of species in the *S. granulatus* group. It is true that in some collections of *S. granulatus* the cap margin when young may be slightly appressed fibrillose, but this material cannot be separated as a tissue from the cap margin.

HOST RELATIONSHIPS. As previously pointed out most species of *Suillus* form mycorrhiza with members of the Coniferales, especially *Pinus* and *Larix* and a few form mycorrhiza with hardwoods. This relationship is of the utmost importance to the collector, as it enables the different species to be readily located, and by inference is equally important taxonomically. The degree of host specificity, however, has not been critically studied for most species. Existing data are based on field observations or studies made on pure cultures. The field observations are open to the criticism that the fungus may be secondarily dependent on the conifer associate rather than primarily dependent on it, and by field techniques there is no certain method of demonstrating which relationship prevails. Pure culture methods are open to the criticism that in the unrestricted environment of the laboratory, species may form mycorrhiza with species of conifers they cannot successfully

attack in nature. Because of the uncertainties in the situation we are not inclined to go as far as Singer does in assigning a high degree of taxonomic significance to the mycorrhizal relationship, especially as it applies to grouping all the species together in a "natural group" that occur under a given species or genus of the Coniferales.

THE TUBE MOUTHS. Configuration of the tube mouths furnishes important taxonomic features. Singer (1962) recognized subsections based on large tube mouths as contrasted to small ones. In the group with large tube mouths the latter are often compound; several smaller tubes being bounded by a common wall. In this group the tube mouths are often more or less radially arranged and elongated radially. This pattern is referred to as "boletinoid" since it was one of the distinguishing features of *Boletinus*.

SEPARABILITY OF TUBES: We have not given any particular emphasis to whether the tubes separate readily from the context of the pileus, a feature once thought to aid in distinguishing *Boletinus* from *Suillus*. In *Suillus* as we have defined it here, one finds all degrees of separability from adnate to readily separable. In general species in section *Suillus* have more readily separable tubes than those in section *Boletinus*. In the latter group the tubes are more adnate as one approaches the species with an epicutis of dry fibrils or tomentum.

HYPHAL ARRANGEMENT OF THE TUBE TRAMA. This is typically somewhat divergent. It is a difficult feature for most people to use as the mature tube walls have a trama of gelatinous hyphae which makes sectioning difficult. Even if good sections are obtained, the hyphae may at times be more or less parallel from straightening out. The feature of a basically divergent tube trama, however, is an important family feature.

ODOR AND TASTE. These are frequently used in the classification of fleshy fungi, but in *Suillus* they have relatively little value. In large collections of *S. punctipes* a peculiar odor is present. In *S. acidus* the taste of the pellicle is strongly acid in var. *acidus*, but a slight acid taste is found in most of the closely related forms. In a few western species a disagreeable taste is pronounced enough to discourage the use of these species as food. As for many groups of fungi, odor and taste may be regarded as secondary in *Suillus*, and are emphasized only in the more extreme cases.

CHEMICAL CHARACTERS. Many of the features emphasized in the taxonomy of *Suillus*, such as pigments, have a chemical basis. Those considered here, however, are color reactions obtained by applying an assortment of chemicals in solution, to the various parts of the basidiocarp. The reactions of iron salts and with weak solutions of strong bases such as KOH we are now using in a continuation of our

studies. We have included them in our descriptions where we have data available, but have not copied the data from the literature unless we were taking most of a description from a single author as in the case of some of Singer's descriptions. In general FeSO_4 and other iron salts give a blue to olive or green reaction, and KOH gives a pink to lilac-gray color change. We have not gone as far as Singer in trying to distinguish between a reaction by NH_3 vapors as contrasted to a reaction to NH_4OH . It is now evident that the color reactions to the above mentioned chemicals are strikingly parallel in the Gomphidiaceae and *Suillus*. It is also now evident that chemical characters of this nature are extremely important in any revisions of the gastromycetes of the family Hymenogastraceae, some of the members of which are thought to be related to the species of *Suillus*.

HISTORY OF SUILLUS

Detailed information on the history of the genus can be obtained from the references given by Singer (1962). From 1821 to the present there have been various opinions as to the desirability of maintaining *Boletus* in the concept of Fries (1821, 1838, 1872) or recognizing segregate genera. The first attempt at segregation was by S. F. Gray in 1821. The names that have been applied since then are given in the synonymy. There has been a general unanimity of opinion among bolete specialists that if any group in *Boletus sensu lato* should be recognized as a genus it was *Suillus*. But its limits vary with different authors. Singer's (1962) classification represents the point of view of the extreme splitter, whereas that of Kühner & Romagnesi (1953) is very conservative; they include nearly all boletes under *Boletus*. Our position is intermediate between these two.

THE LIMITS OF SUILLUS

Up to this point we have proceeded without giving a justification for our emended concept of the genus. It must be recognized on last analysis that any generic concept represents an author's opinion. This is true for those who place the species treated here in *Boletus* as a section, or divide them into several sections. It is true for Singer (1962) with his elaborate classification of families, subfamilies and genera, and it is also true for the system we present here.

In our estimation there is a combination of characters which form a core around which the species of *Suillus* are readily grouped. These characters in the order of their importance as we now view them are: 1) The spectrum of the spore-deposit color, which ranges from a dark yellow to olive-brown to paler yellow-brown to clay-color on down to pale tan ("cinnamon buff"). 2) The clustered pleurocystidia chemically reactive in KOH in both the fresh and dried condition. 3) The tendency

of the pileus to have a gelatinous subcutis or a truly glutinous epicutis. 4) The presence in many species of a false veil and of the pseudo-hemiangiocarpic pattern of basidiocarp development.

Let us now apply these characters to the species included in *Suillus* in this work. *S. sphaerosporus* has the yellow-brown spore deposit, the pseudo-hemiangiocarpic type of development as nearly as can be ascertained from the specimens available for study, and the gelatinous pileus cuticle and also the veil which gelatinizes. It lacks the clustered cystidia. In our estimation these features are sufficient to regard the species as a *Suillus* especially in view of the secondary features such as brown staining reaction of injured parts, and the brown color of the cystidia in KOH. Where else would one place this species?

Singer has erected a genus for it, *Paragyrodon*, and placed it in the subfamily *Gyrodontoideae* whereas *Suillus* is in the *Suilloideae*. This is done under the characterization of the *Gyrodontoideae* as: "Hyphae with clamp connections; spores ellipsoid or globose, brownish or yellow" (p. 709, 1962). If we compare these characters with those of the *Suilloideae* we find this situation: In the *Suilloideae* the cap is viscid to dry and fibrillose, Stipe with or without glandular dots; with or without a veil (veil not both pulverulent and bright yellow); stipe solid or hollow; hymenophore either completely orange red deep dusky red, or pink throughout or else some other color, but then mostly forming mycorrhiza with conifers; hyphae with or without clamp connections. The futility of this as a definition speaks for itself. As far as *S. sphaerosporus* is concerned it is kept out of the *Suilloideae* only because it has globose spores. It is worthwhile to recall at this point that in *Suillus* species (including some recognized as such by Singer) the spores are oblong to elliptic in a face view, and it is also worth recalling that the spores of *S. sphaerosporus* are subglobose to broadly elliptic in face view. They are not characteristically truly globose.

Singer (p. 712, 1962) states of *Paragyrodon*: "The only species known has been studied satisfactorily as far as the essential characters are concerned." He goes on in his description to say "stipe with a volva-like annulus which is viscid white and membranous." Actually, as we have shown here in our photographs, the annulus (veil) is not volvate (enclosing the base of the stipe); it tends rather to separate from the stipe as shown in our photographs and, less important, it is buff colored and readily stains brown. In reality the veil of this species is a lot like that of *S. subluteus*. Singer, lastly, places *Paragyrodon* next to *Gyroporus* (the *Boletus castaneus* group) with which it has no characters in common save perhaps those of the family. We have placed *S. sphaerosporus* in *Suillus* and given it the rank of a section because it lacks the fasciculate pleurocystidia and has subglobose spores, but it probably deserves to be ranked merely as a stirps near *S. grevillei*.

Let us now consider *Boletinus* and *Suillus*, both in the sense of Singer, in relation to our concept of *Suillus*. A third genus, *Psiloboletinus* is not within the scope of this discussion since it does not occur in North America. Its dubious claim to distinction is that the hymenophore

is lamellate near the cap margin but not near the stipe.

Boletinus according to Singer (p. 715, 1962) "has the pileus fibrillose to squamose, or even squarrose, the fibrils or scales not superimposed upon a viscid layer and therefore not detersible as fragments of a veil, the surface decidedly dry even in wet weather except for *B. spectabilis* where the cuticle of the pileus becomes viscid. . . ." Before going any farther let us now look at the list of species he includes in *Boletinus*. Among others he lists *B. amabilis* (Pk.) Snell. The correct name for the species Snell had when he made that transfer is *S. lakei*, and it has a gelatinous layer under the epicuticular fibrils). Singer also lists the combination *Boletinus lakei*. *B. decipiens* is also included and it has a subgelatinous to gelatinous subcutis as revived in KOH, much as in *S. lakei* which we know actually becomes viscid. *B. appendiculatus* is also listed as possibly belonging here, and the type shows a thick gelatinous pileus cuticle. Surely this is ample evidence to show that Singer's studies were either hasty or that he merely guessed at the proper position of some of the species. *Boletinus* as Singer has delimited it does not conform to the characters of the species he placed there. Such a situation requires a critical review of the genus, which is what we undertook in our study.

Let us now examine *Suillus* sensu Singer. Here his classification is much better and deals with the species generally placed in the group regardless of the name used for it. However, we exclude his section *Piperati*. This is a matter of opinion, but from our standpoint the group does not have the characters of the genus.

The chief difference between Singer's concept of *Suillus* and ours is that we include those species of *Boletinus* with a yellow-brown spore deposit. Unfortunately *Suillus* as a name dates back to 1821, and has priority over *Boletinus*, which would have been a more desirable name from every other aspect.

How does the inclusion of *Boletinus* in *Suillus* work out in relation to the characters we have already listed as being the foundation characters of *Suillus*? We limit *Suillus* to species having spore deposits in the yellow-brown series, from bistre on the dark side to cinnamon buff on the pale side. This immediately excludes a number of species Singer placed in *Boletinus*. In these the spectrum of the spore deposit color is from wood brown to vinaceous red to lilac drab. Thus *Boletinus paluster* and *B. spectabilis* with vinaceous brown spore deposits were transferred to *Fuscoboletinus* (see Pomerleau & Smith 1963, and Pomerleau 1964). *Suillus aeruginascens* sensu Singer and *Boletinus grisellus*, two very closely related species Singer had placed in different genera, were transferred to *Fuscoboletinus* because of the avellaneous to wood brown color of the spore deposits. There may be room for a difference of opinion as to whether the last two mentioned should be in *Fuscoboletinus*, because they are at the end of the spore-color spectrum nearest *Suillus*, but at least in *Fuscoboletinus* they can be grouped close to each other in a more natural grouping than is attained by having them in separate genera.

The type of *Boletinus* has a spore deposit color about "snuff brown" to "bister" after moisture has escaped. This places the species in the *Suillus* orbit. However, it does not have a gelatinous layer under the fibrillose epicutis, and it does not have the fasciculate incrustated pleurocystidia, two important features of *Suillus*. The hollow stipe and presence of clamp connections, even in combination, are not generic characters in our estimation. Clamp connections occur on the mycelium of many species of *Suillus*, and the hollow stipe is in the nature of a chance species character.

It is significant that Singer left out any mention of the color of the spore deposit in *Boletinus* though in his bolete classification generally he has made considerable use of this character, as have other authors before him. On p. 709 (Singer, 1962) he separates *Gyroporus* from *Phaeogyropus* by the yellow print of the former and the olive brown print of the latter. On p. 731 he keys out *Xanthoconium* with a rusty yellow spore print and *Tylopilus* with spores "deeper ferruginous brown or wood brown, fawn color, pinkish vinaceous. . . ." This last differentiation is especially interesting because the spore-deposit spectrum of *Tylopilus* is similar to that of *Fuscoboletinus* with apparently the exception that in *Tylopilus* the vinaceous reds of one extreme do not continue into lilac to lilac-drab tones as happens in the type of *Fuscoboletinus*. But the two genera are about as parallel as to color of spore deposit as two genera can be. In *Porphyrellus* the spore print is also emphasized in the description and before that in the selection of the generic name. Since Singer has used smaller differences in spore-deposit color for the recognition of genera than exist between *Fuscoboletinus* and *Suillus*, the comments by Singer, Snell, and Dick (1963) on this feature in *Fuscoboletinus* appear hasty in ill considered.

If we re-examine Singer's *Boletinus* we find the following: *B. cavipes* can be transferred to *Suillus* on the basis of the yellow-brown spore deposit. *Boletinus asiaticus*, we think, as does Pomerleau, that it belongs in *Fuscoboletinus* on the basis of Singer's description of the color of the spore deposit, but we have seen no material, and so make no transfer. Section *Palustres* Singer of *Boletinus* is based on *B. paluster* which Pomerleau has transferred to *Fuscoboletinus* because of the color the spore deposit. Section *Spectabiles* contains only *B. spectabilis*. This was transferred to *Fuscoboletinus* by Pomerleau and Smith (1963). The last section in Singer's infrageneric classification of *Boletinus*, section *Solidipes*, is defined by Singer as "veil double or simple, never showing a gelatinization in any of its layers, the whole carpophore remaining dry, never viscid or scarcely so; pores. . . ." *B. appendiculatus* was placed here provisionally. It has a gelatinous cutis. *B. grisellus* and *B. ochraceoroseus* go to *Fuscoboletinus* because of the color of the spore deposit. *Boletinus oxydabilis* Singer from Siberia probably is also a *Fuscoboletinus*. Singer described its spores as "fuscis in pulvere." *B. benoisii* (Lebedeva ex) Sing. is most likely a *Suillus*, and we suspect that at least in moist weather the cap will be found to be viscid. *B. solidipes* on the basis of the original description

and the detail of the cystidia is a *Suillus*, but we question whether the specimen now labeled type had a yellow-brown or ochraceous spore deposit. *B. subgrisellus*; if this has been properly described we have overlooked the description. *B. lakei* was placed here and it very definitely has a gelatinous cutis. *B. amabilis* Peck we have relegated to the excluded and doubtful species. *B. decipiens* we regard as a *Suillus*, and suspect that at least in moist weather the cap will be found to be viscid. From this it is evident that Singer's section is heterogeneous, not natural in the sense he intended it to be, and that some of the species simply do not have the characters of the section as he defined it.

In view of all this our problem was to re-examine the North American species in the *Boletinus-Suillus* gene pool and try to make a more accurate and intelligible arrangement of the species. Our results are expressed in our classification. We believe that *Boletinus cavipes* is at one extreme in a very clearly defined group and that such species as *S. placidus* are at the other. In between one finds such an intermeshing of combinations of characters that no meaningful generic distinctions can be made. Hence we recognize only one genus in the yellow-brown spored group. The number of species with a dry, fibrillose pileus is small: *S. castanellus*, *S. floridanus*, *S. cavipes*, *S. pictus*, and *S. lakei* var. *pseudo-pictus*, a total of five species. Of these *S. floridanus* has some brown fasciculate pleurocystidia and *S. lakei* var. *pseudo-pictus* has them characteristically. In *S. pictus* there is incrusting material around the cystidia though they are not typically in clusters. Thus the majority of the "dry" species show to some degree two of the major characters of *Suillus*. It is on this basis that we consider *Boletinus* and *Suillus* synonymous. Although for purposes of convenience we have divided the genus into sections *Paragyrodon*, *Boletinus* and *Suillus* it must be kept clearly in mind that these are recognized partly for historical reasons and for convenience in dealing with the species in contrasting groups even if these are based mainly on a single character. From the standpoint of phylogeny we can visualize only one group of very closely related species.

Since Singer, Snell and Dick have severely criticized *Fuscoboletinus* as a genus, and then erected a section in *Suillus* for basically the same group, it is pertinent here to comment briefly both on the characters of the genus and its relationships to *Suillus*. It removes from *Suillus* as defined by us species with spore deposit colors different from those of the main species pool. Is such a grouping any improvement over the one it is designed to replace and is *Fuscoboletinus* as a genus any more distinct from *Suillus* than *Boletinus* sensu Singer is distinct from *Suillus* sensu Singer? What are the facts in regard to basic characters? Two out of seven species have incrustated cystidia and these two have dry fibrillose pilei. The remainder can be divided as follows: *F. grisellus* is merely viscid beneath a fibrillose covering. This was demonstrated clearly on large collections in the fall of 1963 by Smith. *F. spectabilis* has a slime layer beneath broad appressed non-gelatinous scales; it also has yellow tubes. *F. aeruginascens* has a slimy cap

with some veil material over it and a grayish hymenium like that of *F. grisellus*, which has also been found to stain blue slightly in some collections. Here we have enough of the *Suillus* characters to place the genus very close to *Suillus*, but the most important character, the color of the spore deposit, diverges sharply if all the species are considered. If *Fuscoboletinus* is to be questioned because it is based on a single basic feature then the whole classification of the boletes as Singer has presented it must be redone. *Fuscoboletinus* as a genus is as distinct from *Suillus* as *Tylopilus* is from its close relatives, as *Gyroporus* is from *Phaeogyroporus*, or *Xanthoconium* is from its close relatives.

Fuscoboletinus can be justified on another basis, however, as Miller (1963) has shown. This genus is a logical connection from the boletes to the family Gomphidiaceae. But to discuss this properly we should consider the problem from the standpoint of the probable directions of evolution of all these fungi from a common ancestor or ancestors.

THE EVOLUTION OF *SUILLUS* AND THE RELATIONSHIPS OF THE SPECIES

If one accepts the homogeneity of *Suillus* as we have here characterized the genus, we can turn to the problem of its origin and any evolutionary lines which seem to stem from it. In view of what is known about secotiaceous fungi and connections from these to other gastromycetes and to the boletes and related fungi, this seems to be the area worthy of exploration. From present knowledge we are not inclined to derive the boletes from such gill fungi as *Clitopilus*, *Paxillus* or *Gomphidius*, which is in agreement with Singer's ideas as he has expressed them over the years. Singer (1962) has already discussed the gastroid stages of *Boletinus decipiens*. If these are regarded as distinct secotioid fungi, or at least barely one step removed, and adds to them the species of *Gastroboletus* and *Brauniellula*, one is impressed by the number of different gastromycetous species involved in the present consideration. The problem is: From among the possibilities can one recognize one or more primitive lines leading into the Hymenomycetes (or out of them) from these gastromycetes? What characters can be used as indicators of a primitive condition as compared to a derived one?

As a working hypothesis for a consideration of these problems let us assume that the primitive bolete (the one "nearest" the gastromycetes in the sum-total of its characters) has a pileus derived from the peridium pulling away from around the stipe-columella, that a stipe-columella is of course present, and that a gleba composed of irregularly shaped chambers is present as in other secotiaceous fungi. If the elongation of the stipe-columella carries the fertile parts of the basidiocarp up above the ground line, one has, in essence, a gastroid "Boletinus" of the *S. decipiens* type. Such an elongation of the stipe-columella in

Macowanites and *Thaxterogaster* has been observed many times by Smith in the Pacific Northwest, so it is not an assumption that the stipe-columella behaves in this way given proper conditions of soil and air moisture and temperature. Such a fungus as we have postulated would still be a gastromycete because the basidia would be nonfunctional in spore discharge. The gleba would be at least several chambers deep, and the spores would accumulate in the chambers being released for dispersal by air currents only if the chamber walls broke down releasing their spore load. If the gleba becomes limited to a single layer of lacunae so that all hymenial surfaces can shed spores which can then fall free of the hymenophore, the stage is set for the development of active spore discharge by the basidia. If this happens, as it must have happened in the astrogastraceous fungi, our hypothetical bolete is realized as an Hymenomycete with a "boletinoid" configuration of the tube mouths, representing the vestiges of the lacunar type present in the gastromycete stages. In such a fungus, the tubes would be shallow and with irregularly shaped mouths. It seems to us that very likely the boletinoid type of hymenophore could have developed in this manner and that the radial arrangement of the ribs or "lamellae" can just as logically be interpreted as the relics of branches from a stipe-columella as from the remains of "true" gills. Since we are inclined to accept Singer's general views as to the origin of the boletes from gastromycetes, we interpret the boletinoid configuration of the hymenophore as a feature derived from the lacunose type of gleba common to the secotiaceous fungi generally and in which radiating lines of sterile tissue from the stipe-columella are not uncommon. Hence, we regard this type of hymenophore as primitive for the *Boletaceae*.

It logically follows, if this assumption is correct, that both a truly lamellate and a truly tubulose hymenophore could easily be derived from this primitive condition, and both are found in the *Boletaceae*. The number of known species showing a lamellate hymenophore is smaller than that showing a tubulose one, but there is no reason to assume that there should be any equality in numbers as to these types in the present flora of the boletes. We find a tendency toward a lamellate type of hymenophore in *Fuscoboletinus paluster*, and it is only a step from this group to the *Gomphidiaceae*, whose species are truly lamellate. Also, as Miller (1963) has indicated, the spore-color spectrum for *Fuscoboletinus* is definitely toward that of the *Gomphidiaceae*. That a line of development from *Suillus* to the *Gomphidiaceae* existed was proposed by Singer (1951, p. 635). He also suggested a line leading to the *Strobilomycetaceae* through *Boletinus* to *Phylloporus*.

We believe these are the lines along which evolution occurred. The color of the spore deposit is of vital importance in the line leading to *Gomphidius* because the dark fuscous to olive-fuscous spores of that family are one of its foundation characters. In any line leading to the *Gomphidiaceae* there must be forms (species) which show a progressive color change in the color of the spore deposit leading from the parent type and finally approaching that of present day *Gomphidii*. Though

direct mutations from dark spores to white spores are known in the Agaricales, this is associated with albinism of the basidiocarp generally. The reverse, a mutation from a white spore to a black one in one step is not known to us, and in our estimation much less likely to occur than a more gradual change made possible by gene exchange between a number of species. Since *Fuscoboletinus* as a genus is a connecting series in this respect, it seems to us that this is the more probable course of evolution in these fungi. But how do the other characters of *Fuscoboletinus* compare with those of the *Gomphidiaceae*? The spores of course are "boletoid" in both groups, i.e., of the same general shape. The shape and the chemical reactions of the cystidia are also rather similar. We have already seen how the section *Suillus* is featured by fasciculate caulocystidia giving a vinaceous, a lilac or a brown reaction in KOH, and how the pleurocystidia may also be fasciculate, show the same chemical reactions, and have similar chemically reactive incrustations. In *Gomphidius* Miller (l.c.) has shown fasciculate chemically reactive caulocystidia. In some species of both *Suillus* and *Gomphidius* these reactions (in KOH) are carried over to other hymenial elements in a haphazard pattern. The individual cystidia in the clusters on the species of *Suillus* are quite similar morphologically to those of *Gomphidius* and *Fuscoboletinus*. Since cystidia of this morphological type and with such chemical reactivity are very unusual in the Agaricales as a whole, and are consistently present throughout the species of this series, this is strong evidence to support the relationships proposed on the basis of spore-deposit color. Other sets of characters bear out the indications based on color of spore deposit correlated with features of the cystidia. The glutinous veil in *Gomphidius*, one section of *Fuscoboletinus*, and in many species of *Suillus* is also very suggestive, as is the overall pigmentation of the pileus and stipe. Hence, it is futile to argue as Singer, Snell and Dick (1963) have, that the color of the spore deposit is merely a species character without implications at any higher level. They simply missed the point of *Fuscoboletinus* as a genus. In summary, it is a fair statement to say that *Fuscoboletinus* is as good a connection to *Gomphidius* from *Suillus* sensu Smith & Thiers, as *Thaxterogaster* is to connect *Cortinarius* with *Hymenogaster* sensu lato.

But let us return to the problems presented by such gastromycetes as *Gastroboletus* and *Brauniellula*. How does the idea that the primitive bolete has a shallow boletinoid type of hymenophore fit into the picture relative to the above mentioned genera? Is *Gastroboletus turbinatus*, for instance, primitive or derived? The logical interpretation based on our definition of the primitive state is that *G. turbinatus* is derived from *Boletus*. Why? Because the tubes are long and narrow as in highly developed groups of boletes. In other words the hymenophore has none of the primitive characters as we have defined them. It is hard to imagine how long narrow tubes could evolve directly from a lacunose gleba. Thus it is not necessary to take the position apparently assumed by Singer (1962) that all gastroid types are primitive. Indeed, it would be a most unusual situation biologically if such were the case. This has

further significance if one considers the relation of *Brauniellula* to *Gomphidius*. By the same token applied to the gastroid *Gomphidii*, if the former are derived from "agaric" ancestors, the configuration of the hymenophore should be more lamellate than lacunose, and this is exactly the condition found in *Brauniellula nancyae*. None of the other species of *Brauniellula* has been collected in sufficient quantity to establish a range of variation in this character. It is manifestly impossible to trace the actual course of evolution on the basis of the morphology of living types, but it is not unreasonable to assume that trends are accurately indicated at least in some groups. Singer (1962) would apparently now derive *Gomphidius* from *Brauniellula*. Since there are no connections known to us from *Brauniellula* to other gastromycetes, we prefer at least until further evidence is available, to think as does Miller, of the species of *Brauniellula* as derived from *Gomphidius*. Also, it should be evident now that the group of species (*Fuscoboletinus*), which did not fit well into Singer's 1962 classification as a group, do furnish a gene pool of characters from which in all probability *Gomphidius* originated. Since in striving for a natural arrangement of species in our classification of plants generally it is this type of a group which is commonly ranked as a genus, it is entirely logical to so recognize *Fuscoboletinus*. The attempt by Singer et al to set up a "section" in *Suillus* for a species they have apparently never seen, and to leave out of the diagnosis any mention of the color of the spore deposit, a character which Singer and others have always emphasized in the Boletaceae, is transparent in the extreme. If *Fuscoboletinus* were to be abandoned, then *Xanthoconium*, *Tylopilus* and other genera of the boletes would also have to be abandoned. This might be the best solution to the problem of classifying the boletes. It is the one adopted by Kühner & Romagnesi (1953).

In summary we believe it is a fair statement to say that the most likely line of development of the boletes as a group is from gastroid forms like those resembling the gastroid forms of *Suillus decipiens* to the genus *Suillus* as the central line of development, and that two side lines developed from *Suillus* diverging from the species near the area of intergradation of section *Boletinus* and sec. *Suillus*. One line leads through *Fuscoboletinus* to the Gomphidiaceae and the other leads from *S. castanellus* to *Phylloporus* and through *Xerocomus* to the Strobilomycetaceae of Singer. A consideration of the connection of the other genera of boletes to this system we prefer to postpone until we have completed our survey.

family. Hence, we prefer to classify *S. sphaerosporus* where those acquainted with the diagnostic features of *Suillus* will look for it.

Material studied. Michigan: Kauffman, 10-1907; 7-21-17. Smith 8-29-37; 9-7-40; 6067; 9612; 15138; 18375; 18571; 18663; 18708; 64136; 64513; 64482; 66448. Thiers 4508. Wisconsin: Kauffman, May 1902 (from type locality); August, 1907; Kelly Herb. 2010 (MICH).

Section Boletinus (Kalchbr.) Smith & Thiers, stat. nov.

Boletinus Kalchbrenner, Bot. Zeit. 25: 1852. 1867.

Stipe annulate by a fibrillose zone or a distinct membranous annulus or if an annulus or zone of fibrils is lacking then the pileus distinctly fibrillose-squamulose; stipe surface not glandular dotted though some encrusted caulocystidia may be present in some species; hymenophore sublamellate to poroid and often becoming decurrent on the stipe.

Type species *Suillus cavipes* (Opat.) Smith & Thiers.

It may seem reactionary to some to place *Boletinus* in synonymy with *Suillus*, but this is not important. What is important is whether or not any appreciable hiatus exists which would clearly separate the two groups. As we see it, there is none. *Boletinus* was described on the following features: the hymenophore being adnate to the pileus and not readily separable from it, and the obscurely lamellate configuration of the pore surface. This is a common configuration of the tube mouths in section *Suillus*. The more "boletoid" members of *Suillus* have readily separable hymenophore, but in the veiled species the tubes separate only with some difficulty (as in *S. ponderosus*) and finally one ends up with *S. cavipes* in which they are not at all separable.

Of the characters emphasized in recent years, the presence or absence of clamp connections on the hyphae of the basidiocarp follows this pattern in reverse. In the species with dry, fibrillose-squamulose pilei such as *S. cavipes*, clamps are readily demonstrated at the septa of the hyphae. As one progresses to the group of species with a viscid pileus epicutis or cutis they are typically difficult to find or absent. Pantidou (1961), however, has found clamps on the vegetative mycelium of many species in which they are lacking on the basidiocarp.

The fasciculate encrusted pleurocystidia in section *Boletinus* as we define it, show a more primitive condition the farther one advances into the group of species with dry fibrillose pilei and more readily demonstrable clamps.

KEY TO SPECIES OF SECTION BOLETINUS

1. Pileus surface covered by a dry tomentose to fibrillose epicutis, beneath this a subgelatinous to gelatinous subcutis may or may not be present 2
1. Pileus surface glabrous and viscid to glutinous, or with spotlike agglutinated scales from a poorly developed veil or epicutis 10
 2. Stipe hollow in the base; clamp connections present on hyphae of the basidiocarp 5. *S. cavipes*
 2. Stipe typically solid or if hollowed in some specimens then clamp connections absent to rare on hyphae of the basidiocarp 3
 3. Tubes grayish young; pileus with closely appressed purplish brown hairs . . . see *Boletinus solidipes* (excluded species)
 3. Tubes yellow to yellowish young and mostly so when mature 4
 4. Context white and unchanging *S. castanellus*
 4. Context yellow or if white at first becoming at least pale yellow 5
 5. Spores 11-13 (17) × 5-6.5 μ *Phylloporus boletinoides* (excluded species)
 5. Spores smaller 6
 6. Pileus covered with brick-red to rose-red fibrils or squamules when young 8
 6. Pileus with reddish cinnamon to reddish yellow or orange fibrils 7
 7. Pleurocystidia 43-72 × 10-13 μ (see *S. lakei* var. *lakei* also) *S. decipiens*
 7. Pleurocystidia 23-33 × 7-10 μ *S. floridanus*
 8. Stipe 3-5 mm thick, growing in cold bogs see *Fuscoboletinus paluster* (excluded species)
 8. Stipe 8-20 mm or more thick 9
 9. Species regularly associated with white pine; stipe having a sheath or zones of dull red fibrils 6. *S. pictus*
 9. Species regularly associated with Douglas fir; veil submembranous and palid 7. *S. lakei* var. *lakei* and *S. lakei* var. *pseudopictus*

10. Tube mouths typically 1 mm or more in greatest dimension at maturity 11
10. Tube mouths typically under 1 mm in greatest dimension 14
11. Pileus with agglutinated fibrils or fibrillose squamules 12
11. Pileus glabrous or practically so, if fibrillose-streaked the fibrils beneath the gluten 13
12. Stipe staining blue in lower part when cut; pileus nearly glabrous and slimy-viscid to glutinous; spores 8-11 μ long 9. *S. caerulescens*
12. Spores 9-14 \times 3.5 μ ; stipe reddish in base 18. *S. subvariegatus*
13. Annulus present; veil gelatinous (examine specimens with unbroken veil) 10. *S. ponderosus*
13. Annulus if present of felty-fibrillose soft material, sometimes a slight amount of slime along the edge from the cap margin 11. *S. imitatus*
14. Pileus glutinous; context staining blue and then fuscous 17. *S. lithocarpi-sequoiae*
14. Not as above 15
15. Stipe lacking an annulus 12. *S. appendiculatus*
15. Stipe annulate 16
16. Veil vinaceous gray to drab 17
16. Veil yellow to yellowish 18
17. Pileus avellaneous to pale drab, viscid when wet 16. *S. pseudogranulatus*
17. Pileus clay color to darker yellow-brown, glutinous when wet 15. *S. pseudobrevipes*
18. Stipe when cut staining green in lower part or over all; spores 4-4.5 μ wide 13. *S. proximus*
18. Stipe not staining green when cut; spores 2.8-3.5 μ wide 14. *S. grevillei*
2. *Suillus castanellus* (Peck) Smith & Thiers, comb. nov.

Boletinus castanellus Peck, Bull. Torrey Club 27: 613. 1900.
Boletinellus castanellus (Pk) Murrill, Mycologia 1: 8. 1909.

Pileus 3-7 cm broad, convex, becoming plane to depressed or wavy and irregular on margin, surface distinctly and densely tomentose,

"seal brown" at first, finally "chestnut brown" to "walnut brown", not striate. Context about 8 mm thick, white, unchanging, odor and taste not distinctive.

Tubes radiating, subdecurrent and continuing more or less as fine reticulations on upper part of stipe, about 6 mm deep, "pinkish buff" to "cinnamon buff" (pale yellowish tan) becoming ochraceous-tawny where bruised; mouths large, about 2 mm diam, radiate-angular, dissepiments thin, rigid.

Stipe 2-4 cm long, slender, 4-8 mm thick, equal, or nearly so, some tapered toward the base, central to slightly eccentric, solid, pallid within or tinged with the surface color, surface concolorous with pileus or paler, glabrous or at the base subtomentose.

Spores 8-11 \times 4.5-5.5 μ , ovate to narrowly elliptic in face view, ovate to obscurely inequilateral in profile view, yellowish hyaline in KOH and Melzer's sol., smooth, with a distinct hyaline sheath.

Basidia 24-30 \times 7-9 μ , clavate, hyaline to yellowish in KOH, non-amyloid. Pleurocystidia scattered, 55-72 \times 5-8 μ , narrowly fusoid to subcylindric, hyaline and thin-walled, non-amyloid, no incrusting material seen. Cheilocystidia similar to pleurocystidia but usually shorter. Tube trama non-gelatinous and interwoven (but not reviving well in our mounts). Cuticle of pileus apparently a very loosely tangled trichodermium of thin-walled hyphae which collapse readily and revive poorly. No clamp connections seen. All hyphae non-amyloid.

Habit, habitat and distribution. Late summer in deciduous woods, New Jersey and North Carolina. The description is from Kauffman's collection, Aug. 22, 1924 from North Carolina (MICH).

Observations. Fresh material is needed for better details of the microscopic characters. There is almost perfect agreement between Kauffman's notes and Peck's original description. Singer (1945, p. 257) excluded this species because the type could not be found. It should differ readily from *Boletinus squarrosoides* Snell & Dick in its white unchanging flesh as contrasted to watery yellow flesh changing to chocolate-brownish. Also the tubes of *B. squarrosoides* are described as watery yellow, unchanging. Those of *S. castanellus* according to Kauffman's notes are a pale cinnamon and bruise ochraceous tawny. Kauffman did not get a spore deposit. On the basis of Kauffman's collection and notes we would not place this species in either *Phylloporus* or *Xerocomus*, but it is obviously close to *B. squarrosoides*, which Singer has placed there. It is obvious to us, now, that there is a series of species connecting *Suillus* subgenus *Boletinus* to *Phylloporus*. These are *P. macrosporus*, *P. squarrosoides* and *S. castanellus*.

Since the spores of *S. castanellus* are typical of *Suillus* as to color in KOH under the microscope, we assume the color of the spore deposit will be in the yellow-brown series and hence we place this species near *S. decipiens* and *S. cavipes*.

3. *Suillus decipiens* (Berk. & Curt.) Kuntze, Rev. Gen. Pl. 3²: 535. 1898.

Boletus decipiens Berk. & Curt. Ann. Mag. Nat. Hist. II, 12: 430. 1853.

Boletinus berkeleyi Murrill, Mycologia 1: 6. 1909.

Boletinus decipiens (Berk. & Curt.) Peck, Bull. N.Y. State Mus. 8: 78. 1889.

Pileus 4-7 cm broad when mature, broadly convex to plano-convex when young, becoming plane to plano-convex to lobed in age; surface dry and not feeling viscid but leaves, sand, and other debris often adhere to the surface, appressed fibrillose to distinctly fibrillose to squamulose scaly during all stages of development; pale reddish cinnamon to clay color or dull yellow, ("pinkish cinnamon" to "cinnamon buff" to occasionally near "apricot orange" to "zince orange" when young, changing to "light pinkish cinnamon" to "pinkish buff" to occasionally "ochraceous buff" to "cinnamon buff" to light ochraceous buff" with age), typically evenly colored or disc at times becoming clay-color; margin strongly incurved, entire or somewhat appendiculate from a layer of whitish to grayish velar tissue. Context floccose, 0.5-1.5 cm thick, yellow ("Naples yellow" to "straw yellow" to "light ochraceous buff"), unchanging or becoming slowly "testaceous" upon exposure; taste slightly acid to non-distinctive, odor not distinctive.

Tubes strongly decurrent, conspicuously radiately arranged, colored yellow (near "chamois" to "honey yellow" to "mustard yellow" to "antiomony yellow") during all stages of development, short, not more than 5 mm in length; mouths highly irregular in outline, compound, concolorous becoming slightly avellaneous to "testaceous" when bruised.

Stipe 4-7 cm long, 0.7-1.5 cm thick at the apex, typically clavate and hooked at the base; solid, flesh yellow, unchanging when exposed; surface dry, cottony-tomentose and often appressed fibrillose, not punctate, colored yellow ("Naples yellow") often slightly darker at the apex; veil peronate and forming a slight annulus colored gray to whitish.

Spores 8.8-12 × 3.5-4 μ, pale ochraceous to hyaline in KOH, smooth, thin-walled, cylindric to subellipsoid.

Basidia clavate, hyaline, 4-spored, 30-33 × 7-9 μ. Pleurocystidia 43-72 × 10-13 μ, scattered, numerous toward the tube mouths, absent in hymenium near the pileus trama, dark brown in KOH, sometimes hyaline toward the apex, fascicled or occasionally solitary, cylindric to subfusoid to subclavate. Cheilocystidia similar to the pleurocystidia, scattered to crowded. Caulocystidia solitary to rarely in fascicles. Hymenium ochraceous in KOH. Tube trama hyaline, divergent from a distinct mediostratum, strongly gelatinous in KOH, occasional oleiferous hyphae present, hyphae up to 6 μ in diam. Pileus trama interwoven, homogeneous. Cutis interwoven, up to 300 μ thick, pale ochraceous and in KOH subgelatinous to gelatinous, outermost hyphae somewhat incrustated. Surface of the stipe with an interwoven layer of hyphae which partially gelatinize in KOH, apparently incrustated. Clamp connections not seen.

Densely gregarious in humus under pines in mixed pine-oak forests, southern in distribution.

This is one of the few *Suilli* belonging to the section *Boletinus* which occurs along the gulf coastal plain of the southeastern United States. It is, in addition, one of the relatively few species of the section which apparently enters into a mycorrhizal association with pine. *S. decipiens* is easily distinguished from *S. pictus* by the color of the pileus, the nature of the surface of the pileus and the species of pine with which it apparently forms a mycorrhizal association. From *S. floridanus* it is distinguished by the presence of oleiferous hyphae in the trama, larger spores and larger cystidia.

A gastroid form, or at least secotioid-type basidiocarps, have been found associated with this species and are discussed by Singer (1945). We have not checked such fruiting bodies ourselves to determine whether a spore deposit can be obtained from them or not. Our account of the species is based on Singer's 1945 account and from specimens collected by Thiers. The species is here classified in *Suillus* because of the small spores, color change of the context and the incrustated hymenial cystidia.

Material studied: Florida: Kelly 604. Maryland, Kelley 498. Massachusetts: Webster 2083 (all MICH). Mississippi: Thiers 6132; 6159; 6398; 6464; 6458. Texas: Thiers 5934; 5963.

4. *Suillus floridanus* Murrill, Lloydia 6: 224. 1943.

"Pileus convex to nearly plane, 6 cm broad; surface moist, uniformly pale yellowish-rosy-isabelline with small rosy-isabelline tufts of scales, margin acute, fertile, even, entire, appendiculate; context toughish, yellow, sweet, with pungent odor, about 5 mm thick; tubes plane, slightly decurrent, 2-3 mm long, 1-2 mm broad, thin-walled, regular, pale-yellowish to dirty-brownish-yellow; spores oblong-ellipsoid, smooth, hyaline under the microscope, about 7-8 × 3-4 μ; stipe solid, subequal, dry, tomentose, ochraceous, paler above, about 3 × 1 cm; veil whitish, forming a slight annulus at the middle of the stipe."

"Type collected by W. A. Murrill on a bank by a flatwoods pond under slash near Melrose, in Alachua Co. Fla., July 14, 1940 (F 19479). Two hymenophores, one normally developed and the other depauperate, were found together. The species must be very rare."

The description quoted above is a copy of Murrill's original. Although we have not seen fresh material of this species, Thiers has examined the type and data on the microscopic characters are given below.

Spores 8-10.5 × 3-4 μ, hyaline to pale yellow in KOH, smooth, thin-walled, cylindric to subcylindric to subellipsoid. Pleurocystidia very obscure, deeply embedded in the hymenium and appearing generally as ochraceous spots, fasciculate, staining ochraceous in KOH, apparently only 2-3 to a cluster, clavate, appearing heavily incrustated, 23-33 × 7-10 μ; cheilocystidia similar and not crowded. Basidia clavate,

four-spored, 24-29 × 6-8 μ. Tube trama appearing very loosely interwoven to obscurely divergent, hyaline, gelatinous to subgelatinous in KOH. Pileus trama interwoven, homogeneous except for the presence of hyaline, oleiferous hyphae. Cuticle differentiated as a narrow layer of more or less hyaline, interwoven hyphae, apparently partially gelatinous or non-gelatinous in KOH. Hypodermium distinct, compactly interwoven, dark ochraceous in KOH, hyphae apparently incrustated; caulocystidia none seen. Clamp connections absent.

Singer reduced this species to synonymy with *S. decipiens*, and there may be some justification for this action, however, there are obvious differences. The presence of oleiferous hyphae in the trama, smaller spores and smaller cystidia seem sufficient to us to consider the two species distinct at least until the presumably distinguishing characters can be further evaluated from a study of more abundant fresh material.

5. *Suillus cavipes* (Opat.) Smith & Thiers, comb. nov.

Boletinus (Boletus) cavipes (Opat.) Kalchbr. Ic. Hymen. Hung. 52. 1877.

Boletus cavipes Opat. Comm. Bolet. 11. 1836.

Boletus ampliporus Peck, Ann. Rep. N.Y. State Mus. 26: 67 (351), 1874. Pls. 3-4.

Pileus 3-10 (12) cm broad, obtuse to convex expanding to nearly plane or at times with an obtuse umbo, surface moist to dry but not viscid, densely tomentose to fibrillose-squamulose, "cinnamon rufous" to "tawny" or "orange cinnamon," rarely ochre yellow or paler, the tips of the fibrils often pallid, margin involute and usually with adhering veil remnants. Context white to yellowish in age, soft, not changing to blue when bruised, odor and taste not distinctive.

Tubes 3-5 mm deep, decurrent, pale yellow to greenish yellow ("empire yellow" to "prinuline yellow"), more olive-ochraceous in age; mouths 0.6-1 mm wide and 1-1.5 mm or more radially, angular, radiating, simple to compound, yellow when young.

Stipe (3) 4-9 cm long, (5) 8-15 (20) mm thick, usually narrowed below and enlarged at apex, subequal at times, solid in upper part, hollow in the base, usually concolorous with pileus or a paler shade, apex yellow ("amber yellow") at times, lower portion decorated with veil remnants at first but these soon vanishing, at times with a slight annulus.

Spore deposit dark olive-brown when moist, ("snuff brown" to "Saccardo's umber" after escape of moisture). Spores 7-10 × 3.5-4 μ, narrowly ovate to ventricose in face view, narrowly and obscurely inequilateral in profile view, nearly hyaline in Melzer's and greenish hyaline in KOH, smooth.

Basidia 18-35 × 4-5 μ, 4-spored, hyaline in KOH and nearly so in Melzer's sol. Pleurocystidia scattered to numerous, subcylindric to

fusoid-ventricose, hyaline, thin-walled, 42-56 × 6-10 μ. Cheilocystidia similar or obventricose. Tube trama subgelatinous and somewhat divergent from a central strand or central strand lacking and trama more or less interwoven (both seen in different areas); cuticle of pileus a deep loose trichodermium of hyphae 8-15 μ diam., the cells more or less equal or narrowed at cross walls, hyaline in KOH, yellow in Melzer's sol. Tramal body of hyaline interwoven, non-amyloid hyphae. Clamp connections present.

Habit, habitat and distribution. Gregarious to caespitose under larch (*L. laricina* and *L. occidentalis*). It is common in the fall during moderately wet seasons. Its range coincides with that of the two species of *Larix* mentioned.

S. cavipes can be readily identified by the hollow base of the stipe a feature not regularly possessed by any other species of this genus known to date in our region. We place it in *Suillus* because it appears to be near one end of a line leading from the *S. lakei* complex into the truly fibrillose-scaly species.

Material studied. Idaho: Gruber P-63. Kelley 1969; 1970. Kauffman 9-5-22; 9-11-22. Smith 23600; 23588; 23599; 66350. Massachusetts: Kelley 387. Michigan: Kauffman 9-23-07. Mains 31-791; 10-3-32. Smith 10-2-29; 33-426; 33-595; 33-639; 1079; 1938; 31900; 36009; 38917; 43782; 50998; 64676; 64745; 66437. Shaffer 1992. New York: Kauffman 9-5-14. Smith 632; 1030; 1040. Oregon: Smith 19117; 19521; 19807; 23743; 23743; 23746; 24311; 27864; 27980; 27917; 28099 (all MICH).

6. *Suillus pictus* (Peck) Smith & Thiers, comb. nov.

Boletus pictus Peck, Ann. Rep. N.Y. State Cab. 23: 128. 1872.

Boletinus pictus Peck, Bull. N.Y. State Mus. 8: 77. 1889.

Pls. 5-6.

Pileus 3-12 cm broad, broadly conic to convex or hemispheric, the margin incurved, expanding to broadly conic-umbonate with a spreading or decurved margin, or nearly plane, occasionally shallowly depressed, margin typically appendiculate with veil fragments, surface dry, never truly viscid but at times tacky when wet (especially when young), coarsely fibrillose, cuticle at first red ("ochre red" to "Pompeian red" to "brick red" or "dragon's blood red"), color fading (often becoming grayish to buff in extreme age), yellow flesh often prominent, and tips of squamules often fuscous in age. Context up to 1.5 cm thick, yellow ("maize yellow" to "warm buff"), changing to pinkish gray to reddish ("avellaneous" to "russet vinaceous") upon exposure, floccose.

Tubes not readily separable, adnate to decurrent, often extending down the stipe, mouths often radially elongated ("boletinoid" to "boletoid") yellow ("mustard yellow", "pinard yellow" to "baryta yellow" to "colonial buff"), changing to dull ochraceous to brown ("wax yellow" to "old gold" to "buckthorn brown"), about 5 mm deep; mouths concolor with the sides, large (0.5-2 × 5 mm), becoming smaller toward the cap margin, angular, often compound, changing to reddish or brownish

("avellaneous") when injured.

Stipe 4-10 (12) cm long, 0.8-2.5 cm thick, equal or enlarged downward, occasionally with a clavate to subclavate base, solid, rarely hollow, flesh white in interior or brownish at base, cortex yellowish or occasionally concolorous with exterior, lower portion sheathed with remains of a fibrillose coating similar to the cuticle of pileus and breaking up into zones or scales, terminating often in a fibrillose annulus, with a whitish, delicate, more or less cortinoid partial veil in addition, apex yellow and more or less reticulate from decurrent lines from the tubes.

Spore deposit clay color to tawny-olive, olive-brown before moisture has escaped. Spores 8-11 (12) \times 3.5-5 μ , narrowly ovate in face view, narrowly inequilateral in profile view, olive-yellowish in KOH under the microscope, yellow to pale tawny in Melzer's sol. smooth.

Basidia four-spored, 20-26 \times 6-8 μ , hyaline in KOH, yellow in Melzer's. Pleurocystidia abundant, clavate, 30-40 \times 9-12 μ , with cinnamon content in KOH, these rare; much more numerous are large prominently projecting cystidia 55--75 \times 7-10 μ , subcylindric, flexuous or straight and with subacute to obtuse apices, hyaline and thin-walled but usually with bister incrusting material where surrounded by the hymenium. Cheilocystidia similar to second type of pleurocystidia but frequently with yellowish content in KOH. Caulocystidia similar to large incrusting pleurocystidia, occasionally in fascicles.

Tube trama gelatinous and divergent, nonamyloid. Cuticle of pileus a deep trichodermium of tangled (loosely) hyphae with short more or less differentiated cells near apex 9-15 μ in diam., and with orange buff content revived in KOH. Tramal body of hyphae pale bister in KOH and with incrusting material (in contrast to the trichodermium), the hyphae thin-walled. Nonamyloid in all parts. Clamp connections lacking.

Habit, habitat and distribution. Scattered to gregarious under white pine (*P. strobus*). It is regularly associated with this species, and fruits during the summer and fall.

The cystidial characters connect this species with the viscid group. It is so distinctive macroscopically by color and veil that it must be regarded as one of our easiest species to recognize at sight. Old specimens are often found in which the fibrils of the pileus and stipe are dull gray, all traces of red having faded out. The fruiting bodies do not decay as readily as those of most other species in the genus. *S. pictus* is most closely related to *S. lakei* var. *pseudopictus* but the latter has a shorter stipe and the fibrils on the cap generally are more reddish brown than dingy rose-color and of course the two are associated with different conifers. Also, in *S. lakei* var. *pseudopictus* the base of the stipe stains green when injured.

Material studied. Maine: Rea 474; 618. Michigan: Kauffman 9-5-05; 7-12-06. Povah Fl-219. Smith 25982; 36811; 36858; 36963; 37090; 37880; 38192; 39192; 39499; 41818; 41902; 42903; 44113; 44116. Thiers 734; 880; 2578; 3226; 3390; 3401; 3465; 3562; 3572; 3583; 3620; 3752;

4323; 4339. New Hampshire: Rea 596. New York: Kauffman 8-24-14. Snell 3537, Shaffer 361; 389. North Carolina: Kauffman 8-8-24; 8-22-24. Smith 7500. Tennessee: Smith 9352; 9793; 10253; 10531; 10739. Vermont: Rea 458. Canada. Nova Scotia: Wehmeyer 694. Univ. Toronto Herb. No. Ontario 3725; 2685 (coll. H. S. Jackson). Kelley 1051; 1385. Smith 4079. (all MICH).

7. *Suillus lakei* var. *pseudopictus* Smith & Thiers var. nov. Pl. 7.

Pileus 3-9 cm latus, convexus demum planus, siccus, dense squamosus, primum "brick red" vel "vinaceous tawny" demum griseus; tubuli flavi, adnati demum subdecurrentes; pori flavi, taxtu badii; stipes 2-6 cm longus, 10-15 crassus, flavus, aequalis, basi viridis quando fractus; velum submembranaceum siccum; sporae in cumulo olivaceae, in sicco "cinnamon"; sporae 7-9 \times 3.5-4 μ , ellipsoideae vel subfusiformae; pleurocystidia numerosa, 36-96 \times 6-11 μ , in fasciculis, basi badia, cylindracea; cheilocystidia pleurocystidiis similia; cuticula pilei in fasciculis, non viscida. Typus: Smith 2771 (MICH).

Pileus 3-9 (10) cm broad, convex expanding to plane; surface dry, at first covered by tomentose to fibrillose squamules, the fibrils or squamules more appressed near the margin and more squarrose over the disc, in age the yellow context showing between the squamules; the tomentose-squamulose material brick red to reddish brown ("brick red to "vinaceous tawny"), in age grayish as the red pigment breaks down; margin typically appendiculate with fragments of broken veil. Context yellow, rather thick, tapered evenly to margin; odor and taste not distinctive.

Tubes bright yellow, typically less than 1 cm deep, adnate becoming slightly decurrent; mouths yellow, staining dingy pinkish brown, or darker when bruised, angular, 1 mm or more in widest dimension when mature, boletinoid in aspect when mature.

Stipe 2-6 (8) cm long, 10-15 (25) cm thick, solid, more or less equal or pinched off at base, yellow within, surface yellow above annulus, yellow with reddish streaks below, base staining greenish when injured; veil submembranous, dry, thin, usually leaving a thin evanescent ring or the fragments decorating the cap margin.

Spore deposit olivaceous drying to dingy cinnamon. Spores 7-9 \times 3.5-4 μ , pale ochraceous in Melzer's sol., greenish yellow to ochraceous in KOH, smooth, thin-walled, elliptic to subfusiform in face view, obscurely inequilateral and ventricose in profile, and sterigmatal appendage eccentric.

Basidia 4-spored, occasionally 2-spored, 24-30 \times 6-8 μ , hyaline to pale ochraceous in KOH. Pleurocystidia abundant, conspicuous, 36-96 \times 6-11 μ , typically occurring in bundles with rusty brown pigment surrounding the base, content of many staining pale brown in KOH, some remaining hyaline, more or less cylindric in shape with obtuse to ovate-pointed apices or clavate. Cheilocystidia similar to pleurocystidia. Caulohymenium present over stipe apex and containing some fascicles

of cystidia but these not prominent.

Hymenophoral trama hyaline, gelatinous, the hyphae at first divergent toward subhymenium but in age interwoven, often lacking a distinct mediostratum. Pileus cutis a trichodermium separated into fascicles of fibrils with the cells cylindrical to ellipsoid and up to 15 μ in diam., the cylindrical cells 6-10 μ in diam., hyaline to ochraceous tan in KOH and smooth to very finely roughened, lacking clamps at septa, thin-walled or walls slightly thickened; fascicles arising directly from floccose tissue of pileus, no gelatinous subcutis evident on fresh material. Large dark brown contorted laticiferous hyphae present in pileus context.

Gregarious under Douglas fir and other conifers possibly (*Abies* and *Picea*), Pacific Northwest, fall.

This variety differs from the type variety in having a redder and more scaly pileus. The gelatinous subcutis does not always show in sections revived in KOH, but we have not been able to make a clear distinction on the basis of this character. In the type of var. *pseudopictus* it did not show on fresh material, but does on most of the specimens sectioned after they had been dried. This variety has been confused with *S. pictus* by some collectors in the Pacific Northwest. We do not cite a large number of collections of this variety in the paragraph on material cited because of the danger of mixed collections.

Material studied. California: Largent 169. Thiers 8206; 8282; 8782. Washington: Smith 2771-type. (all MICH).

8. *Suillus lakei* (Murrill) comb. nov.

Boletus lakei Murrill, Mycologia 4: 97. 1912.

Ixocomus lakei (Murrill) Singer, Rev. Mycol. 5: 6. 1940.

Boletinus lakei (Murrill) Singer, Farlowia 2: 257. 1945.

Pls. 8-9. var. *lakei*

Pileus 6-15 (20) cm broad, plano-convex with an inrolled to incurved margin, in age broadly convex to plane or the margin uplifted, at first covered with superficial reddish to orange-buff or brownish squamules, finally more or less glabrescent, viscid beneath the fibrillose covering or when this is nearly all removed, ground color pale yellow when young, dingy ochraceous in age, surface ordinarily presenting a somewhat streaked appearance. Context thick, yellowish, odor and taste none.

Tubes typically shallow (5-10 mm deep), dingy ochraceous young and mouths staining brownish when bruised, broadly adnate to decurrent; mouths in age large and angular, 1-2.5 mm radially.

Stipe 6-12 cm long, 1-4 cm thick at apex, enlarged downward and then narrowed at base, solid, interior pallid yellowish young, unchanging or staining greenish in lower part when injured (fresh material), base often more or less cinnamon brown in age--old specimens often not showing greenish or blue when injured; with a superior thin

membranous annulus (or remains of the veil), veil yellowish pallid and floccose (not glutinous); surface of stipe bright yellow above the veil and yellow below but soon brownish from handling, or glandular dots present.

Spore deposit "Sayal brown" (dull cinnamon). Spores hyaline to pale greenish yellow in KOH, and in Melzer's sol., (7) 8-10 (11) \times 3-3.7 (4) μ , subellipsoid to subcylindrical to slightly ventricose, smooth, thin-walled, yellowish to pale tawny in Melzer's solution.

Basidia 2- and 4-spored, 28-36 \times 10-12 μ , clavate, hyaline, hymenium pale brown in KOH. Cystidia (both pleurocystidia and cheilocystidia) numerous to abundant, typically incrusting and staining dark brown in KOH, more often solitary along sides of the tubes but fascicled along the tube mouths, cylindrical, thin-walled, occasionally hyaline, 48-60 \times 7-9 μ . Layer where dissepiments join context of pileus staining brown to bright ochraceous in KOH.

Pileus trama interwoven, floccose, homogeneous. Tube trama hyaline, gelatinous, divergent from an indistinct mediostratum, oleiferous hyphae rare. Cutis of pileus differentiated as an inner layer of gelatinous interwoven hyphae and an outer layer of incrusting to smooth hyphae which stain brownish-ochraceous in KOH; scales differentiated as clusters of more or less erect free non-gelatinous hyphal tips. Clamp connections absent to very rare.

Scattered to gregarious, typically associated with *Pseudotsuga*, occurring throughout the Rocky Mountain area as well as in the Northwest, during the fall on the Pacific coast, and during the summer in the Rocky Mountains.

When the fall rains being along the northern coast of the Pacific Northwest this bolete is among the first to appear and fruits in relative abundance throughout the rainy period. It is typically found in mixed coniferous woods which include Douglas fir, hemlock, fir, pine and second growth redwoods. It occurs in association with *S. ponderosus* and often considerable difficulty is encountered in distinguishing between them if the annulus has become obliterated. Typically *S. lakei* var. *lakei* is fibrillose scaly, but has a gelatinous subcutis beneath the scales. The viscosity is not always strongly developed and may be overlooked because of the dense development of the squamulose coating. *S. ponderosus* is noticeably viscid, at least in wet weather, is massive, and is practically glabrous and has a gelatinous veil. The glutin in that species, when dry, however, often causes the pileus to be streaked and to appear as if fibrillose. Both species occupy the same type of habitat. The pileus colors of both species may intergrade and are not always of great value in distinguishing between the two.

Microscopic data from the type of *Boletus lakei* are as follows: Spores 8-9.6 \times 3.5 μ , inequilateral in profile, subelliptic to oblong in face view, smooth, pale tawny to ochraceous in Melzer's sol., nearly hyaline in KOH. Basidia mostly 4-spored, (16) 18-20 (25) \times 4.5-6 μ , clavate, yellowish to hyaline in KOH. Pleurocystidia in bunches with bister to snuff-brown amorphous pigment present around the base,

individual cystidia 32-35 × 6-10 μ, clavate, subcylindric or subfusoid, often with yellow to dingy brown content revived in KOH. Cheilocystidia similar to pleurocystidia but more abundant and with more incrusting pigment around them.

Tube trama of yellowish hyaline gelatinous hyphae more or less divergent toward the subhymenium, very rarely with dark brown crooked, oleiferous hyphae 9-15 μ diam. Pileus epicutis of non-gelatinous fascicles of hyphae with somewhat cystidioid end-cells up to 9-17 μ in diam., the walls thin to slightly thickened and smooth or minutely punctate-incrusted; subcutis a somewhat gelatinous layer of repent hyphae as revived in KOH. Hyphae of context proper, rusty brown in KOH, and some oleiferous or (laticiferous ?) hyphae present and 6-11 μ in diam. Clamp connections rare (one found in an hour's search).

As Singer (1945, p. 257) suspected, this is obviously the species described by Slipp and Snell as *S. amabilis* and the one Smith has carried under that name in his own studies. As Slipp and Snell pointed out and as has been repeatedly verified by Dr. Fred Johnston of the School of Forestry at the University of Idaho, Moscow, Idaho, this fungus is clearly associated with Douglas fir in the area where Douglas fir grows. Confusion with *S. amabilis*, collected in the high spruce forests of Colorado, no doubt resulted because the dried fruiting bodies (even when well dried) of all in the *S. lakei* group, rather closely resemble each other. But *S. amabilis* was described as glabrous and as having pallid flesh. Since the type has apparently been lost and there is confusion as to its identity, we have placed *S. amabilis* in the excluded list.

Our field studies indicate that *S. lakei* is common and found throughout the region of *Pseudotsuga* given favorable weather conditions. It is as variable as *S. tomentosus*. Young caps are typically squamulose, or even conspicuously squamulose as in the type, but there is great variation in the degree of development of the epicutis as well as in the persistence of its elements. In wet weather the gelatinous subcutis becomes quite gelatinized and the squamules perched on it tend to be washed away.

Material studied. Idaho: Cooke 24627; 26072. Smith 44273; 44256; 44261; 44297; 44415; 44506; 44588; 44822; 44897; 44940; 45507; 45384; 45725; 46197; 47313; 55137; 58397; 58469; 58512; 65004; 65945; 65974. Trueblood 1402; 1159. Oregon: Gruber 8-8; 10-8. Lawrence 1103. Sipe 382; 521. Smith 7745; 19664; 55431; 55498; 55685; 55686. Washington: Cooke 20781; 20954. Imshaug 2097; 2149. Smith 2989; 14242; 29198; 31176; 31184; 31186; 31262; 39936; 40074; 40394; 40554; 41017; 47765; 48107; 48981; 49506. Wyoming: Solheim 3892; 4695; 4778; 4949; 5010; 5021 (all MICH).

9. *Suillus caerulescens* Smith & Thiers sp. nov.

Pl. 10.

Pileus 6-14 cm latus, convexus demum planus, viscidus, "vinaceous" vel "ochraceous tawny", flavus ad marginem; tubuli adnati vel

subdecurrentes, "deep colonial buff" demum "honey yellow"; pori flavi, tacti badii; stipes 2-5.8 cm longus, 2-3 cm crassus, aequalis vel coartans deorsum, solidus, flavus, caeruleus basi quando fractus; sporae in cumulo "cinnamon" in sicco "sayal brown"; sporae 8-11 × 4-4.5 μ, ellipsoideae; pleurocystidia basi fusca, aut cylindracea vel clavata in fasciculis aut fusoides vel ventricosae quando solitariae; caulocystidia pleurocystidiis similia; cuticula pilei viscida, innexa. Typus: Smith n. 48733.

Pileus 6-14 cm broad, broadly and shallowly convex when young, finally plano-convex to plane or nearly so; surface viscid, but not truly glutinous and occasionally appearing only moist, usually with patches of agglutinated fibrillose tomentum which appears as scattered squamules or streaks, frequently appearing glabrous with age; color varying from uniformly dull "vinaceous" to "ochraceous tawny" on the disc and yellow toward the margin ("ochraceous buff"), or more dingy, squamules near the margin sometimes colored near "cinnamon", and margin at times appendiculate with veil remnants. Context 10-20 mm thick, pale yellow ("ivory yellow"), unchanging or assuming a dingy pinkish flush ("avellaneous"); taste mild to slightly acidulous, odor mild or slightly acidulous.

Tubes adnate to short decurrent, 6-10 mm deep, separable from the pileus context (but not readily); color when young "primrose yellow" to "sulfur yellow" to "deep colonial buff", in age extensively discolored dingy vinaceous brown ("avellaneous") from bruising; mouths yellow ("honey yellow"), very irregularly angular and uneven from the irregular configuration of the dissepiments, sometimes radially aligned but not always so, occasionally appearing compound, 1.5-2 mm broad radially, about 1 mm wide.

Stipe 2.5-8 cm long, 2-3 cm thick at the apex, tapered toward the base or apex or equal; solid, flesh yellow (like the pileus margin), slowly staining blue in the base when cut, elsewhere discoloring vinaceous brown ("avellaneous"); surface reticulate at the apex by fine lines from decurrent tubes, glabrous to furfuraceous-punctate above the annulus, glabrous to appressed fibrillose to dull and matted-fibrillose below, not glandular dotted, staining brown when handled, colored the same as the tubes above the annulus, becoming duller and often dingy brown below; annulus band-like, fibrillose, pallid to white but soon discoloring as the pileus, not gelatinous.

Spore deposit dingy cinnamon ("sayal brown" after moisture escapes). Spores 8-11 × 3-5 μ, smooth, hyaline to ochraceous in KOH, pale orange-buff to cinnamon-buff in Melzer's sol., elliptic in face view, merely obscurely inequilateral in profile.

Basidia 20-30 × 5-8 μ, 4-spored, clavate, yellowish in KOH and Melzer's sol. Pleurocystidia of two types, one cylindric to clavate with brown pigment around base of cluster, and the other fusoid-ventricose and isolated to scattered, the former 35-70 × 5-8 μ and content brown to hyaline in KOH, the latter type with refractive granules and 22-28 × 5-8 μ. Cheilocystidia in clusters and 60-100 × 5-9 μ, cylindric to

clavate or narrowly fusoid-ventricose, content hyaline to yellow-brown. Caulocystidia similar to cheilocystidia (in clusters and with pigment at base of cluster) occurring only to the level of the annulus.

Tube trama of non-amyloid, hyaline, gelatinous hyphae somewhat divergent near the subhymenium, with an obscure to distinct central strand, numerous large contorted laticifers present and these dark brown in KOH. Pileus trama more or less compactly interwoven, homogeneous, occasional laticifers present. Epicutis of pileus a collapsed trichodermium with elements 8-17 μ broad, and a basal layer with elements mostly unbranched and 3-7 μ in diam., and hyaline to pale ochraceous in KOH, the layer gelatinous and up to 400 μ thick, Hypoderm differentiated as a compactly interwoven layer staining ochraceous in KOH. No clamps seen.

Gregarious in humus in the fall months in the Pacific Northwest. Not common.

This species is not associated with larch, but may be found in mixed conifer stands where larch is present. It may be more common than our records indicate, since this whole *S. lakei* series has been one of the most confused groups in the boletes. We have found it mostly under mixtures of Douglas fir lowland fir, hemlock and redwood with larch present at times.

It differs from *S. lakei* in having a distinct change to blue in the stipe and in having numerous large laticiferous ducts in the context of the cap. The spores also seem to average broader, up to 5 μ as compared with 3-4 μ , but we hesitate to emphasize this slight difference. We have not found the stipe to be glandular dotted but the fascicles of caulocystidia with their colored incrusting pigment as revived in KOH actually place this species close to the type section of the genus. It is close to *S. ponderosus* but the dry annulus separates them.

Material studied. California: Peters 117; 167; 174; 214. Motta 94. Thiers 8279; 8762; 8765; 9967; 9974; 9246; 9251; 9284; 9338; 9406; 10040. Oregon: Smith 28220. Washington: Smith 48733-type (MICH).

10. *Suillus ponderosus* Smith & Thiers sp. nov.

Pl. 11.

Pileus 9-25 cm latus, convexus demum planus, glaber, viscidus, "cinnamon", ad marginem flavus et "cinnamon"; tubuli decurrentes, subflavi; pori subangulati, ampli, flavi, tactu badii; stipes 9-14 cm longus, 3-6 cm crassus, coartans deorsum, solidus, flavus, reticulatus, viridis basi quando fractus; velum membranaceum, viscidum; sporae in cumulo "snuff brown"; sporae 8-10 \times 3.8-5 μ , ellipsoideae vel sub-fusoideae; cystidia solitaria vel in fasciculis, basi (in KOH) fusca, cylindracea vel clavata, 29-72 \times 5-8 μ ; caulocystidia pleurocystidiis similia; cuticula pilei viscida, innexa. Typus: Smith 20204 (MICH).

Pileus 9-25 cm broad, convex to plane or wavy and irregular in age, surface glabrous or with veil remnants only near the margin,

viscid, somewhat streaked beneath the pellicle, margin appendiculate from veil remnants, color variable, at times deep vinaceous brown to testaceous, sometimes cinnamon or toward margin yellow streaked with cinnamon. Context thick, firm, yellow, unchanging; taste mild, odor sharply acidulous, very seldom with worm holes even in old specimens.

Tubes decurrent, readily separable from pileus, up to 1.5 cm deep in a 25 cm cap, dull yellow; mouths subangular and large, 1-3 mm in longest dimension, yellow staining brownish.

Stipe 9-14 cm long, 3-6 cm thick, narrowed downward, base pointed at times, solid, pale yellow throughout, greenish in base where cut, with a faint pink tinge above as well as in pileus finally; surface reticulate above the annulus from decurrent tubes, less reticulate below ring, bright yellow above ring and soon sordid rusty brown below from handling; annulus membranous, superior, often stained reddish cinnamon on under side from a gelatinous outer layer.

Spore deposit snuff brown. Spores 8-10 (12) \times 3.8-5 μ , hyaline to olive-yellowish in KOH, pale ochraceous in Melzer's sol. in face view elliptic to subfusoid or nearly oblong, in profile somewhat inequilateral, smooth.

Basidia 4-spored, 26-31 \times 7-10 μ , clavate, hyaline in KOH. Pleurocystidia solitary or in clusters and with dark yellow-brown pigment in and around base of cluster; individual cystidia 29-72 \times 5-8 μ , cylindrical to clavate, or crooked, at times subfusoid, hyaline or with dark brown pigment as revived in KOH. Cheilocystidia similar to pleurocystidia. Caulocystidia scattered and in clusters, hyaline to dark brown in KOH and some incrusting in addition, amorphous dark brown pigment around clusters and distributed in caulohymenium (as revived in KOH); individual cystidia 50-70 \times 6-12 μ in diam., cylindrical to clavate or fusoid.

Tube trama of hyaline gelatinous somewhat divergent hyphae 6-8 μ in diam.; no laticifers seen. Epicutis of pileus a gelatinous layer of interwoven hyaline to pale ochraceous hyphae 2-4 μ in diam. and branched not infrequently. Clamp connections none.

Scattered in forests of Douglas fir, hemlock and pine (*P. contorta*) mixed, fall and early winter along the Pacific Coast.

The fruits of this species are often gigantic. The best distinguishing features are the yellow ground color of the pileus, large tube mouths, lack of distinct squamules on the pileus and massive annulate stipe and the gelatinous veil. In all in this group weak greenish to bluish stains are present on the cut surfaces of the stipe somewhere. This species has been identified as *Boletus flavus* in North America, but it bears little resemblance to that species if the European literature can be relied upon. *Boletus flavus* apparently lacks a gelatinous veil and does not stain green in the stipe when injured. Bresadola's illustration (1931) is not at all like *S. ponderosus*.

Here again, the characters of the cystidia closely approach those of Section *Suillus*, indicating the very close relationship between the two groups.

Material studied. California: Motta 94. Peters 63; 117; 167. Thiers 8182; 8207; 8612; 8763; 8776; 8821; 8867; 9242; 9338; 9354; 9406. White 600. Oregon: Smith 19318; 20204-type; 24378; 24628; 25048; 27494; 27954. Washington: Smith 30834; 31524; 31560; 40546 (MICH).

11. *Suillus imitatus* Smith & Thiers sp. nov.

Pl. 12.

Pileus 4-12 cm latus, obtusus vel convexus, demum subplanus vel late depressus, glaber, glutinosus, aurantio-cinnamomeus ("orange cinnamon" vel "cinnamon"); pori luteolis ("deep colonial buff"), tacti subbadii, decurrentis; stipes 3.5-6 cm longus, 1.5-2.5 cm crassus, solidus, sursum flavidus, caeruleus basi quando fractus, annulatus; annulus siccus, floccosus; sporae 7-9 × 4-4.5 μ . Typus: Smith n. 48732 (MICH).

Pileus 4-12 cm broad, obtuse to convex, expanding to nearly plane or the disc depressed, surface glutinous and glabrous, unicolorous between "orange cinnamon" and "cinnamon", and dingy cinnamon. Context thick (up to 2 cm), soft, pale yellow, slowly becoming dingy with a faint tawny cast where exposed (no definite color change); odor acidulous, taste mild.

Tubes adnate or slightly depressed at the stipe, with decurrent lines up to 5 mm down the stipe apex, 7-15 mm deep, readily separable from pileus, "deep colonial buff" and becoming a little darker than honey yellow when older, staining dull reddish brown on the tube mouths which are angular or irregular and elongated radially to 2-3 mm (and are 1.5-2 mm wide), but the arrangement not obviously boletinoid.

Stipe 3.5-6 cm long, 1.5-2.5 cm thick, tapering abruptly at base, solid, context rather bright yellow, quickly becoming blue in basal half or third, elsewhere fading and becoming discolored like the pileus context; surface at apex with decurrent tube lines, or faintly reticulate and smooth from there to the annulus, matted fibrillose and more or less ridged below the annulus, not glandular dotted anywhere; color yellow ("Colonial buff") with tawny mottling above, pallid mottled cinnamon to pinkish cinnamon below, some finally discolored grayish brown to umbrinous; annulus band-like, well developed to faint, consisting of felty-tomentose soft material with some gluten adhering along the edges, color white to dingy pallid and discoloring to brownish.

Spores 7-9 × 4-4.5 μ , narrowly elliptic in face view, subelliptic in profile, pale ochraceous in KOH, smooth, wall slightly thickened.

Basidia 4-spored, 18-23 × 5-6 μ , hyaline to yellowish in KOH, clavate. Pleurocystidia solitary or in bundles, 36-54 × 7-10 μ , subcylindric, narrowly clavate or submucronate, thin-walled, hyaline or with ochraceous to yellow-brown content, typically with amorphous bitter (in KOH) pigment around the base of the bundle and at times over individual cystidia. Cheilocystidia similar to pleurocystidia or with more amorphous pigment in KOH. Caulocystidia clavate to subcylindric,

in fascicles, content ochraceous to tawny but lacking incrustations around the base or anywhere else.

Tube trama of divergent hyphae, no laticiferi seen. Pileus epicutis of repent gelatinous narrow hyphae in a thick layer (revived in KOH). Tramal body of floccose hyphae and poorly differentiated oleiferous hyphae (no colored content, but appearing more clearly outlined than those of tramal body), considerable amorphous pigment particles scattered through the trama as revived in KOH. Clamp connections none.

Gregarious in humus and mosses under mixed conifers, Mt. Rainier National Park, Washington, Oct. 9, 1954, Smith n. 48732-type.

This species occurred in the spruce-fir forest. It has been confused with *S. lakei* (see that species), but is distinct by virtue of its glabrous pileus and association with spruce rather than Douglas Fir. We at first were inclined to place it in *B. caerulescens* but that species has at least a slightly squamulose cap and larger spores. In addition no laticiferous ducts were observed in the tissues of *S. imitatus*. The two are closely related however. If any species recognized in this work should be recognized as *Boletus amabilis* of Peck it is this species, but we think the name *amabilis* is better dropped from consideration because of the fact that the type has apparently been lost and Snell's use of the name for *S. lakei* has become widely accepted and hence is certain to be a source of confusion for a long time to come.

Material studied. Washington: Smith 48732; 48878 (MICH).

12. *Suillus appendiculatus* (Peck) Smith & Thiers comb. nov.

Boletinus appendiculatus Peck, Bull. Torrey Bot. Club 23: 418. 1896.

Pileus 10-20 cm broad, fleshy, convex, glabrous, ochraceous-yellow, the margin appendiculate with an incurved membranous veil. Context pale yellow, unchangeable.

Tubes rather small, yellow, their mouths angular, unequal, becoming darker brownish where wounded.

Stipe 5-7.5 cm long, 8-15 mm thick, solid, slightly thickened at the base, yellow.

Spores 7.5-9.5 × 3-3.5 μ , nearly hyaline in KOH, near cinnamon-buff in Melzer's sol., smooth, thin-walled; narrowly elliptic to oblong in face view, in profile suboblong with scarcely any suprahilar depression.

Basidia 18-24 × 6-7.5 μ , 4-spored, hyaline to yellowish in KOH, and only slightly more ochraceous in Melzer's reagent. Pleurocystidia scattered or in fascicles, solitary cystidia clavate to subcylindric or subfusoid, 36-50 × 7-10 μ , thin-walled, hyaline in KOH, yellowish in Melzer's sol. smooth and thin-walled. Fasciculate cystidia 46-70 (80) × 9-15 μ , clavate to subcylindric, often curved at the apex and with a clay color gelatinous mass dried over apex as seen revived in KOH, sometimes 2-3 cystidia cemented together, many cystidia with capitate

apices as a result of the dried mucilage (?); many patches of pale tawny pigment in hymenium; but these caused by fascicles of colored cystidia (cylindric to clavate) about the size of the basidia.

Tube trama of gelatinous hyaline smooth hyphae (revived in KOH), and obscurely divergent in their arrangement, no laticifers seen and no clamp connections present. Pileus cutis a thick gelatinous layer of interwoven gelatinous hyphae with content hyaline to ochraceous in KOH, 2-3 (5) μ in diam. and rather twisted and crooked as revived in KOH. Context of interwoven floccose hyphae 4-12 μ diam., mostly with ochraceous content in KOH when first revived but fading to hyaline, the walls remaining faintly ochraceous. No clamp connections observed.

Under or near fir trees, Washington, September to December, Yeomans. Singer (1945, p. 257) gave the locality as Washington, D.C. but Yeomans collected in the state of Washington, mostly in the vicinity of Camas.

The dried stipe of the type was ochraceous brown and showed no sign of glandular dots, nor was it annulate. The type reminds one of the *Suillus lakei* group. When revived the membrane left by the veil on the cap margin is indeed a membrane with an extension of the gelatinous hyphae of the cutis along its outer surface, so it was possibly viscid, at least on the outside. As revived the tube mouths are less than 1 mm broad, but in the central area of the dried hymenophore they were broader and more boletinoid, and it is to be expected in the fresh specimens that they would measure more than 1 mm broad radially in this area. The stipe was not cut lengthwise so we have no way of knowing if a slight tinge of bluish green would have developed.

We are recognizing this species as a *Suillus* close to *S. grevillei* with a yellow cap, lacking an annulus at least at times (in the type), with less incrusting material around the fascicles of pleurocystidia, and somewhat more boletinoid tube mouths. The large pleurocystidia with the cemented mucilage to form a head may be distinctive also. This could easily be *Suillus neuschii* Singer based on Bresadola's plate 904, and identified by Bresadola as *Boletus flavidus*.

13. *Suillus proximus* Smith & Thiers sp. nov.

Pl. 13.

Pileus 6-9 cm latus, glaber, glutinosus, variegatus, subluteus; odor distinctissima; stipes 8-9 cm longus, 10-15 mm crassus, non-glandulosus, annulatus; sporae in cumulis rufo-brunneis demum pallide cinnamomeis. Specimen typicum: Smith 64508 (MICH).

Pileus 6-9 cm broad, obtuse, expanding to obtusely umbonate, convex or broadly convex; surface slimy-viscid, glabrous; with pale pinkish cinnamon streaks beneath the gluten and over a yellow ground color, margin soon watery brownish where bruised. Context thick, yellowish to watery-buff, in stipe apex with waterly lemon yellow streaks, typically slowly staining green when cut; odor acid-metallic, taste mild;

KOH on cuticle quickly olive, on context bluish gray; FeSO₄ slowly blue-gray on context and cutis.

Tubes 5-6 mm deep, decurrent, dingy yellowish, soon dingy to dull pale cinnamon where cut; mouths small, staining pale cinnamon brownish where bruised.

Stipe 8-9 cm long, 10-15 mm thick at apex, equal or nearly so, solid, yellow within at apex, dingy rusty brown below and turning green when cut in mid-portion or throughout; surface at apex canary yellow, downward vinaceous cinnamon, apex striate to subreticulate with decurrent lines from tubes, no glandular dots present; annulus superior, often with a gelatinous margin, remainder floccose and yellow.

Spore deposit "chestnut brown" to "cinnamon brown" moist but fading to pale cinnamon brown as it dries out and finally dingy pale cinnamon to clay-color. Spores 7-10 \times 4-4.5 μ , suboblong to obscurely inequilateral in profile, in face view narrowly elliptic to subcylindric tapered to an obtuse apex, smooth, dingy pale ochraceous brown in KOH, slightly paler in Melzer's solution.

Basidia 25-32 \times 7-9 μ , pale dingy ochraceous in KOH (in hymenium), about the same color in Melzer's sol., 4-spored; sterigmata very fine. Pleurocystidia in bundles or isolated, 35-60 \times 6-8 μ , hyaline to bister revived in KOH, with incrusting bister pigment surrounding the base of the cluster, thin-walled. Cheilocystidia similar to pleurocystidia but very numerous, and with more colored ones and more incrusting pigment in and around the bundles.

Tube trama of slightly divergent to parallel (?) gelatinous hyphae 4-8 μ in diam. (sections revived in KOH), no incrusting pigments present, hyphae thin-walled; subhymenium of interwoven hyphae appearing cellular in sections from the cut ends, only subgelatinous in KOH. Pileus cuticle a thick layer of interwoven gelatinous hyphae 3-7 μ in diam. (possibly a collapsed trichodermium), with thin walls yellowish in KOH, no incrusting pigment seen. Context of floccose non-gelatinous, interwoven, hyphae 5-15 μ in diam., with the cells often somewhat inflated, no incrusting pigment seen. Clamp connections none.

Gregarious in a swamp under *Thuja* and *Larix*, Oakland County, Michigan Oct. 16, 1961.

S. grevillei from the same locality had a "buffy brown" (olive-brown) spore deposit. The difference in the color of the fresh spore deposits was very striking at first but soon faded to about the same tone as for *S. grevillei*. The spores of *S. proximus* measured a micron or more wider (2.8-3.5 μ for *S. grevillei* as contrasted to 4-4.5 μ for *S. proximus*), and the acid-metallic odor was very pronounced. The color change in old specimens though slow was very pronounced, the whole cut surface of the stipe and part of the pileus context become bright green. These we believe to be major differences between *S. proximus* and *S. grevillei* and when one recalls that in addition, the color of the pileus in *S. proximus* often has pale pinkish cinnamon streaks beneath the gluten but over the yellow ground color, and that the tubes are typically a dingy yellow, one can hardly avoid the conclusion

that he is dealing with a species distinct from *S. grevillei*. Because of the color change and the tendency for the cap to be streaked, we believe that this species is an eastern representative of the *S. lakei* group, so characteristic of the conifer forests of the Pacific Northwest, and that it connects up nicely to *S. grevillei* to show the true relationships of the latter species. We do not believe that a taxonomic grouping of the *Suillus* species associated with larch has any phylogenetic significance, though for purposes of field identification such an artificial grouping has merit because of its convenience.

Material studied. Smith 64508-type; 66436; 67329 (MICH).

14. ***Suillus grevillei*** (Klotzsch) Singer, Farlowia 2: 259. 1945.

Boletus grevillei Klotzsch, Linnaea 7: 198. 1832.

Boletus elegans Fries, Epicr. Syst. Mycol. pp. 409-410. 1838.

Boletus clintonianus Peck, Ann. Rep. N.Y. Cab. 23: 128. 1872.

Suillus grevillei var. *clintonianus* (Peck) Singer, Agaricales in Modern Taxonomy, p. 721. 1962.

Pls. 14-15.

Pileus 5-15 cm broad, hemispheric becoming broadly convex to nearly plane, surface glabrous, glutinous, "chestnut" on the disc, "empire yellow" on margin, at times finally bright yellow over all, pellicle separable, margin sterile. Context "straw yellow" to "amber yellow", soon rufescent (becoming "salmon buff" or "flesh color"), rather thick (1-1.5 cm); taste mild to slightly astringent to bitterish; odor none to somewhat metallic.

Tubes adnate to depressed, becoming subdecurrent, 10-15 mm deep, "amber yellow" but finally "olive ochre", when bruised or cut becoming "testaceous" or "pecan brown"; mouths angular, 2 to 1 per mm, dissepiments rather thick and entire.

Stipe 4-10 cm long, 1-3 cm thick, equal to slightly clavate, solid, flavous to "primuline yellow" inside and out at first, sometimes slightly sulphur greenish in the base when cut, surface soon with chestnut variegations; annulate with a typically floccose annulus which may have a gelatinous outer layer, distinctly reticulate above annulus from extensions of the decurrent tubes, dingy in age, or after handling often with a vinaceous-brown cast.

Spore deposit olive brown moist, "saya brown" (dull cinnamon) when moisture has escaped. Spores 8-10 × 2.8-3.5 μ, more or less oblong in face view and obscurely inequilateral in profile view, smooth, with a faint hyaline outer sheath, pale olivaceous to ochraceous in KOH and Melzer's sol.

Caulobasidia present, surmounting a layer of gelatinous hyphae. Pleurocystidia numerous to scattered or rare, sometimes in fascicles, subcylindric to clavate, but some obscurely fusoid-ventricose, bister incrusting material at base only, 40-60 × 6-8 μ, cylindric, content brownish to yellowish in KOH and Melzer's, thin-walled, smooth.

Cheilocystidia in fascicles, incrusting with bister pigment at level of the hymenium, the bundles scattered to numerous, the individual cystidia similar to pleurocystidia. Caulocystidia solitary or in scattered small fascicles and with incrusting pigment as revived in KOH.

Tube trama gelatinous and divergent. Cuticle of pileus a trichodermium of long gelatinous hyphae 3-6 μ in diam., the cells very long and narrow, end cells not differentiated. Context of floccose hyaline to yellowish interwoven hyphae. Surface of stipe a layer of heavily incrusting hyphal tips. No clamps seen.

Cespitose to gregarious, often in arcs and always associated with a species of *Larix* as a mycorrhiza-former. Common in the fall where *Larix* occurs.

The problem of the characters of this "well known" species appears to be complex even if one leaves out of consideration the European variants. We have no first hand information on the latter. In North America the characters involved are the odor, taste, color change when the stipe is cut, the nature of the annulus and the color of the cap.

In Smith 54702 from Binarck Creek, Kaniksu National Forest in Idaho, the odor and taste were mild and no green stains were observed when the stipe was cut. This is very close to the concept of Slipp and Snell (1944). However, they described the context as mild in taste but the odor faintly resinous (resembling turpentine more or less) or faintly acid. We consider this variation as being within the limits of the taxon even for a narrow interpretation of the latter. We find this same bright colored taxon with a mild to slightly astringent taste and a slight odor in northern Michigan. Rarely in this material one can make out a faint flush of greenish in the cut surface of the base of the stipe. These data are in reasonable accord with most descriptions of the species from Europe, and hence we use the European name.

This is a striking and easily recognized species because of the very slimy pileus, annulus which may or may not have a gelatinous edge under moist conditions, and the lack of glandular dots on the stipe. The stipe is usually 1-2 cm thick. *S. luteus* has a pileus less brightly colored and a glandular-dotted stipe. *S. flavoluteus* has a glandular-dotted stipe and squamulose pileus, features readily distinguishing it from yellow specimens of *S. grevillei*.

Under conditions of low humidity the outer layer of the annulus may not gelatinize, and the ring is then entirely dry in texture. Under the opposite conditions considerable gelatinization may take place and then the outer layer is viscid to slimy. Hence this feature of the ring is not a reliable field character for this species.

We have not been able to get data on *Boletus vividarius* Frost for comparison. Frost's species has generally been considered a synonym of *S. grevillei*.

Material studied. We purposely refrain from citing collections here because of possible confusion with *S. proximus*. However, our data indicates that *S. grevillei* is typically northern whereas *S. proximus* to date has been found at the southern edge of the range of *Larix laricina*.

15. *Suillus pseudobrevipes* Smith & Thiers sp. nov.

Boletus granulatus var. *albidipes* Peck, Ann. Rep. N.Y. State Mus. 54: 168. 1901.

Pl. 16.

Pileus 6-14 cm latus, glutinosus, argillaceus, variegatus; stipes annulatus, non-glandulosus (immaculatus); sporae 7-9 × 2.5-3 μ. Typus: Smith 58958 (MICH).

Pileus 6-14 cm broad, convex to broadly convex, finally nearly plane, margin long remaining decurved and frequently appendiculate from veil remnants, surface glutinous at first (as in *S. brevipes*), finally merely viscid, glabrous or at times with thin white patches of veil material scattered near the margin, appearing fibrillose-streaked beneath the gluten at times, color evenly honey-yellow to "clay color" or a darker yellow-brown. Context thick, pale yellow or white at first then becoming yellow, unchanging when bruised but dingy pinkish around worm-holes, taste mild to slightly acidulous, odor not distinctive; FeSO₄ slowly olive.

Tubes 6-10 mm deep (in caps 14 cm broad), slightly depressed around stipe to short decurrent, pale dingy yellow becoming dull ochre yellow by maturity, separable from pileus context; mouths small (± 3 per mm), round, ochre yellowish, not staining when bruised.

Stipe 2-8 cm long, 1-3 cm thick, solid, equal or narrowed downward, white within but pinkish around the worm holes, often brownish in the base, surface white and naked at first, yellowish in age and then reticulate above from decurrent tubes, glandular dots present as whitish spots on young material, not darker in age or only slightly so; veil leaving a median annulus or more rarely a fibrillose zone, typically sheathing lower half of stipe with floccose to submembranous, avellaneous material which is soft and finally collapses to form a single ring.

Spore deposit near "cinnamon buff". Spores 7-9 × 2.5-3 μ, pale ochraceous in KOH, slightly darker (toward cinnamon-buff) in Melzer's reagent, oblong in face view, in profile suboblong to obscurely inequilateral, smooth, wall slightly thickened but less than 0.5 μ.

Basidia 14-18 × 5.5-7 μ, 4-spored, hyaline in KOH, short-clavate. Pleurocystidia short-clavate, 20-30 × 9-10 μ, projecting slightly from hymenium, in fascicles and these surrounded by copious rusty brown amorphous pigment; individual cystidia with ochraceous to rusty brown content as revived in KOH. Cheilocystidia subcylindric to subfusoid, 20-30 × 5-7 μ, content ochraceous to rusty brown; copious rusty brown amorphous pigment in the dissepiments. Caulocystidia rare, a few in a fascicle and fascicles rare to scattered, visible in the caulohymenium because of the brown amorphous pigment deposits; individual cystidia resembling cheilocystidia in size, shape and coloration.

Hymenophoral trama divergent and gelatinous, with a very narrow floccose central strand of scarcely colored hyphae 5-8 μ in diam. Epicutis of pileus a gelatinous trichodermium of hyphae (3) 4-12 μ in diam.,

mostly unbranched, becoming decumbent on cap surface, greenish-hyaline in KOH and with scattered hyaline granules in the interior, arising from a subcuticular zone of hyphae with dark bister content in KOH and less gelatinous than the trichodermial hyphae. Clamp connections none.

Gregarious to scattered under *Pinus contorta* in Idaho, July and August.

Peck's original account of *B. granulatus* var. *albidipes* mentioned a slight membranous veil which often forms a thin annulus on the young stipe, or forms fragments which adhere to the margin of the pileus. From the information available we have no choice other than to consider Peck's variety as the same as our western material, *S. pseudobrevipes*.

This species bears the same relationship to *S. luteus* that *S. brevipes* bears to *S. granulatus*. It differs from *S. luteus* in the broader hyphae of the gelatinous pileus trichodermium, and the almost complete absence of glandular dots on the stipe. From *S. brevipes* it is at once distinguished by the presence of a veil and, in the material seen so far, by the paler colored pilei. We are not inclined to emphasize this last feature, however, as in the group the cap color is a variable character. From *S. albidipes* it differs in having a veil which leaves an annulus on the stipe, but in other respects the two are rather close. However, we have not observed *S. pseudobrevipes* with a whitish pileus. See comments under *S. albidipes* also.

Material studied. Idaho: Smith 58797; 58958-type; 58970. Wyoming: Solheim 4710; 4735; 4741; 4877 (MICH).

16. *Suillus pseudogranulatus* (Murrill) Smith & Thiers comb. nov.

Suillus brevipes var. *pseudogranulatus* (Murrill) Singer, Farlowia 2: 268. 1945.

Boletus pseudogranulatus Murrill, Bull. Torrey Bot. Club 67: 63. 1940.

Pileus 6-11 cm broad, strongly convex becoming nearly plane or with a slight convex umbo, viscid when wet, sub-shining dry, smooth, glabrous or decorated with the thin membranous patches of "deep dirty gray" (Singer) veil along the margin, color "avellaneous" with a slight drab or cinnamon tinge "or rather tending toward clay color or umber" (Singer loc. cit. p. 268). Context white, yellowish near tubes, very thick and solid-and solid-fleshy, taste mild to acidulous, odor as in *S. luteus*, KOH on context and surface of pileus drab.

Tubes about 4-6 mm deep (rather short), "not quite readily separable" (Singer p. 268), adnate-decurrent, to decurrent and then mostly continuing on the apex of the stipe as an indistinct narrow reticulated belt, bright yellow (empire yellow to picric yellow); mouths somewhat irregular but not gyrose-merulioid, small (± 2 per mm).

Stipe 3-6 cm long, 2.5-4 cm thick (1.7-2.5 cm at apex), solid, context yellow, spongy in ventricose part of stipe, white but soon bright yellow ("lemon chrome") and finally entirely yellow, smooth or rarely

very indistinctly rugulose near the base, glabrous or with very small not very distinct pallid to blackish dots as in *S. brevipes* var. *brevipes*, "but often, at least on one side of the stipe, connected by very fine lines, and thus forming a network that may extend over a large portion of the stipe or be confined to the apex" (Singer p. 268), avelate or with a narrow indistinct soon evanescent annular belt which is deep dirt gray.

Spore deposit not given by Singer. Spores (6.7) 7.5-9.5 (11) \times 2.7-3.3 μ , in shape and color similar to those of *S. brevipes* var. *brevipes*. Basidia also as in *S. brevipes* var. *brevipes*. Cystidia 30-65 \times 7.5-10.5 μ , numerous, strongly fulvous-castaneus or melleous from resinous incrustation, oval or clavate above, more rarely fusoid or ampullaceous, with thin lower part.

In dense hammocks, under or near *Pinus palustris*, *P. taeda*, *P. australis*, solitary, fruiting from October to April.

As indicated, our description is taken mainly from Singer's. The dark sordid gray veil would appear to distinguish this species from *S. albidipes*. We of course, do not admit *S. pseudo-granulatus* to *S. brevipes* because of the presence of the veil.

Singer (1945) has redescribed *S. brevipes* var. *pseudogranulatus* based on Murrill's *Boletus pseudogranulatus*. In his discussion he states "The veil cannot serve as a distinguishing character since the same kind of a veil is observed also in a certain percentage of the fruiting bodies of the type variety". Since we have observed *S. brevipes* in great quantity both in the Great Lakes region and the Rocky Mountains, we feel justified in placing our observations on record. First, we question the propriety of assuming that the presence of a veil is not an important taxonomic feature in this group. Smith's observations over the last twenty years clearly show that *S. brevipes* var. *brevipes* has no veil. Like Singer, we have found collections which show cottony patches on the cap margin, but these do not surround the stipe. These collections in all probability should be placed in *S. albidipes*. In *S. pseudobrevipes* the veil at first sheaths the stipe as in *S. luteus* and is like the veil of that species in texture in dry weather. We are not in a position to judge between the descriptions of Murrill and Singer and say what the true situation is in regard to the taxonomic features of the Florida fungus. Neither Singer's nor Murrill's descriptions actually compare well with any species known to us, and so, for the sake of completeness, we recognize Murrill's species on the basis of Singer's redescription, but with certain reservations. The color of the veil and the tendency of the glandular dots to form on the stipe place the species very close to *S. luteus*.

17. *Suillus lithocarpi-sequoiae* Singer, Mycologia 51: 589. 1959.

Pulveroboletus lithocarpi-sequoiae Singer, The Agaricales in Modern Taxonomy, p. 734. 1962.

Illus. Singer, Ic. Fig. 4.

Pileus 7-14 cm broad, glabrous, obtuse expanding to broadly convex, glutinous over all but soon dry, more or less rugulose, variegated

cinnamon, reddish brown, and pale alutaceous (rarely uniformly colored). Context firm but soon soft, whitish to yellowish, staining blue than fuscous, in age lemon yellow throughout and then not bluing so readily; taste mild; odor agreeable, fruity.

Hymenophore tubular, tubes primuline to golden yellow, becoming dingy olive-ocher to dusky olive-brown, up to 8 mm deep (rather shallow), arcuate to short decurrent, ventral line (free edge in long section of carpophore) horizontal; pores (mouths) concolorous with sides of tubes, almost round to obscurely boletinoid, sublamellate near pileus margin for a short distance, becoming compound and finally about 1 mm in diam., tube walls decurrent a short distance down the stipe apex.

Stipe 8-11 cm long, 22-33 mm thick, solid, equal or attenuated near base (not rooting), surface pallid to dingy pale yellowish to brownish, apical part ferruginous-squamulose to furfuraceous, slightly ornamented in the same way below the annulus, ornamentation less pronounced downward. Veil with the outer layer glutinous (copiously so), inner layer whitish to yellowish and membranous; annulus becoming appressed to stipe and lacerate to denticulate on both margins, at times oblique, superior.

Spore deposit color unknown. Spores 7.5-9.8 \times 3.2-3.8 μ , apparently oblong in face view and subfusoid in profile, pale melleous, smooth, walls thin.

Basidia 29-30 \times 6-7 μ , elongate clavate, 4-spored. Pleurocystidia and cheilocystidia approximately similar, solitary or in fascicles, incrustated and pigment vinaceous in KOH. 48-84 \times 4-10.5 μ , cylindrical to somewhat ventricose. Subhymenium of irregular small elements, with incrusting pigment vinaceous in KOH. Tramal plates with bilateral trama, gelatinous, mediostratum of yellowish somewhat interwoven hyphae. Cutis of pileus a thick gelatinous layer of hyphae 1-2.2 μ in diam., some incrustations present which are yellowish. Clamp connections absent.

On the ground in mixed woods of *Sequoia* and *Lithocarpus*, during the winter rainy season, California.

On the basis of the original description upon which our account is based we consider the species closely related to *S. grevillei* but differing in staining blue and then fuscous when injured, and in the differently colored pilei. The mycorrhizal relationship is different also as no larch grew in the vicinity of the type locality.

Singer (1962) placed the species in *Pulveroboletus*, but the fasciculate cystidia which stain vinaceous when fresh, the small spores, gelatinous pileus and well formed annulus indicate to us a position in *Suillus*, where Singer originally placed it, and not too far removed from *S. grevillei*.

SECTION SUILLUS

Typically the stipe is glandular dotted, the spore print after moisture has escaped is nearly always dull cinnamon, and the cutis of the pileus is gelatinous. Clamp connections are absent to exceedingly rare on the septa of the hyphae of the basidiocarp.

Type species. *Suillus luteus* (Fr.) S. F. Gray

Rostkovites californicus has a dry pileus but a dotted stipe (see the excluded species).

KEY TO SPECIES

- 1. Changing to blue in some part when cut or broken 2
- 1. Not changing as above 4
 - 2. Spores 9-14 × 3.5-5 μ; stipe fibrillose to fibrillose-squamulose *S. subvariegatus*
 - 2. Spores 7-10 μ long; stipe glandular dotted 3
- 3. Pileus yellow to orange buff with patches of gray, brown or reddish tomentum or appressed squamules
(see *S. flavoluteus* also) *S. tomentosus*
- 3. Pileus "bright red, sprinkled with darker spots" *S. ruber*
 - 4. Veil or false veil well developed, in young specimens either leaving an annular zone or true annulus on the stipe, or adhering to pileus margin as a soft cottony mass of material in the form of patches or a continuous roll; at times never touching the stipe 5
 - 4. Veil absent to very rudimentary as found on young (immature) basidiocarps 21
- 5. Veil or false veil typically adhering to pileus margin 6
- 5. Typically with a distinct annulus on the stipe 11
 - 6. Pileus olive, gray, yellow or cinnamon 7
 - 6. Pileus white, glutinous, soon staining to chocolate color *S. brunnescens*
- 7. Pileus tubes and stipe ochre yellow; stipe 3-9 mm thick
. *S. americanus*
- 7. Not with above combination of features 8
 - 8. Pileus spotted or streaked with fibrils when young; stipe often vinaceous at base in age 9
 - 8. Pileus glabrous or merely with a few veil remnants along the margin 10

- 9. Tube mouths less than 1 mm broad; stipe white at first; tubes unchanging when bruised *S. glandulosipes*
- 9. Tube mouths 1-2 mm broad; stipe yellow when young; tubes staining vinaceous cinnamon when bruised
(see *S. hirtellus* var. *hirtellus* also) *S. sibiricus*
- 10. Tube mouths minute (2-3 per mm); odor not distinctive *S. albidipes*
- 10. Tube mouths 1-1.5 mm broad; odor or fresh specimens pungent *S. pungens*
- 11. Tube mouths broad (1 mm or more) 12
- 11. Tube mouths small (less than 1 mm) 13
 - 12. Pileus olive buff becoming avellaneous to dingy cinnamon; stipe staining pinkish cinnamon below from bruising *S. umbonatus*
 - 12. Pileus avellaneous to dingy cinnamon; stipe base with rusty-orange tomentum at times *S. megaporinus*
- 13. Stipe base conspicuously staining yellow when injured . *S. lutescens*
- 13. Not staining as above 14
 - 14. Stipe 1-2.5 cm thick; annulus with a thin gelatinous vinaceous gray to purplish layer or zone on outer (under) side in humid weather *S. luteus*
 - 14. Not as above 15
- 15. Annulus (in young specimens) baggy and thick, flaring away from stipe at lower as well as upper margin 16
- 15. Veil not thick and baggy as in above choice 17
 - 16. Dermatopseudoparaphyses present over upper part of stipe; southern in distribution *S. colthurnatus*
 - 16. Lacking dermatopseudoparaphyses on stipe *S. subluteus*
- 17. Taste of gluten of pileus strongly acid; tube mouths dull brown when young *S. acidus* var. *acidus*
- 17. Not with the above combination of features 18
 - 18. Hymenophore orange-yellow; tube mouths concolor; pileus context orange-buff *S. pinovirgidus*
 - 18. Not as above 19
- 19. Pileus bister to olive-brown or olive; tubes olive-grayish to grayish buff over mouths when young . . . *S. subolivaceus*
- 19. Pileus yellowish to alutaceous 20

20. Tube mouths pale yellow young; stipe cortex salmon-ochraceous in lower part *S. acidus* var. *intermedius*
20. Stipe cortex yellowish; tube mouths dull brownish when young. *S. acidus* var. *subalutaceus*
21. Pileus white when young and only slowly becoming yellowish to cinnamon buff 22
21. Pileus if whitish at first soon highly pigmented after exposure to light 23
22. Stipe with pinkish conspicuous smears or glandular dots; growing under white pine *S. placidus*
22. Stipe not (or very slightly) glandular dotted; growing under *Pinus contorta* *S. pallidiceps*
23. Context of pileus white and unchanging (except for pigmentation immediately under pellicle and along tubes) *S. punctatipes*
23. Context yellow or soon becoming so 24
24. Stipe not obviously glandular dotted 25
24. Stipe usually conspicuously glandular dotted 26
25. Pileus with appressed tomentum often in only minute spots or patches and these at times red, the ground color bright yellow *S. subaureus*
25. Pileus naked and glutinous, typically dark vinaceous brown (pale ochraceous to pale tan in var. *subgracilis*) *S. brevipes*
26. Taste unpleasant; pileus glabrous *S. acerbus*
26. Taste unpleasant, pileus squamulose at first *S. fuscotomentosus*
26. Taste pleasant; stipe 8-15 (20) mm thick 27
27. Pileus pallid becoming vinaceous cinnamon to dark orange-cinnamon, often obscurely mottled *S. granulatus*
27. Pileus yellow to ochraceous tawny or tawny 28
28. Pileus glabrous or with tufts of tomentum only in the button stages; odor fragrant *S. punctipes*
28. Not as above 29
29. Tubes exuding drops of a latex when young; glandular dots on stipe finally red *S. hirtellus* var. *thermophilus*
29. Not as above 30
30. Tubes 2-3 mm deep; stipe purplish red at base. . *S. flavoluteus*

30. Tubes deeper than in above 31
31. Spores $7-9 \times 3-3.5 \mu$ *S. hirtellus* var. *hirtellus*
31. Spores $8-13.5 \times 3-3.3 \mu$ *S. hirtellus* var. *cheimnophilus*

Series **HIRTELLINII** (Singer) stat. nov.

Subsection *Hirtellini* Singer, Farlowia 2: 273. 1945.

Type species. *Suillus hirtellus* (Peck) Kuntze.

The species we place in this series have a glandular dotted stipe and in the button stages the pileus is covered by a tomentum which later becomes aggregated into tufts as the cap expands and in some species the cap becomes glabrous before becoming fully expanded. Species with conspicuously cottony-floccose pileus margins when young are excluded. In *S. hirtellus* this feature is present to a slight degree. The species of this series are not connected directly to those of section *Boletinus*, but rather appear to be a divergence from the *S. acidus* complex by reduction of the veil.

18. ***Suillus subvariegatus*** Snell & Dick, Mycologia 48: 306. 1956.

Pileus plano-convex to plane, 5-12 cm broad; surface dry to moist or subviscid, somewhat slimy in wet weather, covered with dark superficial fasciculate, hairy squamules that may entirely disappear in the rain or in age; at first yellowish-gray or pale orange, gradually becoming yellowish-brown to orange-yellow, occasionally tinted with olive or reddish; scales darker than the ground color, yellowish, reddish-brown or even blackish. Context yellowish or pale orange, lemon-yellow above the tubes, becoming darker, changing to bluish-green or not at all changing; odor somewhat unpleasant, often disagreeable; taste not noteworthy.

Tubes adnate to subdecurrent, at first pale yellow, later brighter and more orange, soon more or less olivaceous and finally rich yellow-brown, perhaps becoming bluish-green when wounded; pores concolorous, angular, large 1.5-4 mm broad.

Stipe subequal, furfuraceous at the base, for the most part fibrillose to almost fibrillose-squamulose and often more or less pseudo-reticulate from the fibrils; pallid to pale yellow or more or less bright yellow, often more or less reddish, especially at the base; within yellowish above, brighter under the cortex, orange-yellow to brownish or even reddish toward the base; 4-7 cm long, 10-20 mm thick.

Spores olivaceous in deposit when fresh, brownish without olive tone when dry, subelliptical to elliptical-subfusiform, almost hyaline to very pale greenish, $9-14 \times 3.5-5 \mu$, mostly $11-12 \times 4-4.5 \mu$. Cystidia few, clavate, hyaline, $30-55 \times 8-10 \mu$. Hyphal structures in mounts of hymenium hyaline, with subclavate or variously pointed tips, $80-265 \times 7-11 \mu$.

Under white pine with admixture of oaks, Middleboro, Mass. Type collection WHS Bolete Herbarium No. 232.

"We reported previously (6, pp. 24-25) that we were certain that we had a collection of *Boletus variegatus* Swartz ex Fr. from Middleboro, Massachusetts, inasmuch as the only character different from the European descriptions was the large pores. We were wrong, for there is another difference--larger spores. Therefore, it now appears that this collection is not the European *variegatus*, but should be described as new".

"Since *B. variegatus* is now considered a *Suillus* (*S. variegatus* (Sw. ex Fr.) Kuntze) and since our specimens so much resemble this species, we are considering them to be a *Suillus* in spite of the lack of a pronounced viscosity of the surface (as far as we now know). In Singer's arrangement (1, pp. 259 and 278), *S. variegatus* is placed in the Section Bovini, Subsection Stenoporini, characterized by narrow pores (1 mm or less broad), squamulose pileus and indistinct reaction of the flesh with NH_3 , whereas the Subsection Euryporini is characterized by large pores, non-squamulose pileus and rosy or red reaction of the flesh with NH_3 . Our species accordingly will not fit properly in either subsection because, outside of lack of information on the reaction with NH_3 , the pileus is squamulose but the pores are very broad".

The above data and comments are all from the original account. The generic position of this species, however, remains to be verified. It is included here because of its supposed relation to *S. variegatus*. It could be a member of the *S. lakei* group, since the stipe is apparently not glandular dotted. For additional comment see Appendix.

19. *Suillus tomentosus* (Kauffman) Singer, Snell & Dick, Mycologia 51: 570. 1960.

Boletus tomentosus Kauffman, Pap. Mich. Acad. Sci. Arts & Letters 1: 117. 1921.

Boletus hirtellus var. *mutans* Peck, non. nud.

Suillus hirtellus var. *mutans* (Peck) Snell, Lloydia 7: 23. 1942.

Xerocomus lenticolor Snell & Dick, Mycologia 52: 448. 1960.

Pls. 17-18.

Pileus 5-10 (15) cm broad, obtuse to convex, becoming broadly convex, margin at first incurved somewhat and rather coarsely tomentose at first, gradually glabrescent; surface over all at first tomentose-floccose to squamulose but gradually glabrescent. The tomentum and squamules grayish, viscid beneath the tomentose-squamulose layer, ground color evenly pale clear yellow to pale orange-yellow (Naples yellow", "light orange-yellow" to "pale orange-yellow" or in age "orange-yellow). Context thick (8-15 mm), pallid to yellow but paler than the pileus surface, changing slowly to blue or greenish blue when cut or bruised, odor none, taste slightly acid to mild.

Tubes 1-2 cm deep, pale dingy yellow becoming dingy olive-yellow and staining dingy greenish blue when injured, adnate to decurrent, rarely depressed around the stipe; mouths bister to dark dingy cinnamon or vinaceous-brown young ("Verona brown"), slowly becoming dingy yellow, small (about 2 per mm), staining bluish when injured at least in age.

Stipe (3) 5-10 (12) cm long, 1-2 (3) cm thick at apex, equal or clavate, solid, yellow within but paler than pileus surface, staining greenish blue slightly when cut, surface concolorous with pileus or more orange, glandular-dotted to glandular-punctate over all; no veil remnants adhering and no evidence seen that tomentum of pileus actually represents the remains of a veil, (i.e., never enclosing tube cavity).

Spore deposit dark olive brown very slowly changing to dull cinnamon. Spores 7-10 (12) \times 3-4 (5) μ , smooth, pale yellowish in KOH, in Melzer's yellowish to pale tan, narrowly inequilateral in profile view, (sway-backed), obscurely fusoid to elongate-ovoid in face view.

Basidia 4-spored, 26-34 \times 5-8 μ , yellowish in KOH, and in Melzer's sol., clavate. Pleurocystidia typically in bunches and at level of hymenium the cluster surrounded by brown incrusting material, as revived in KOH, when fresh hyaline to pale vinaceous-brown in KOH; individual cystidia 30-46 \times 7-10 μ , subcylindric to narrowly clavate or narrowed to a blunt apex, often with incrusting debris, content hyaline to dingy yellow-brown. Cheilocystidia similar to pleurocystidia, very numerous and tube dissepiments often with copious brown amorphous pigment. Caulocystidia abundant, similar to cheilocystidia.

Tube trama of gelatinous hyaline hyphae somewhat divergent from a floccose central narrow strand, the hyphae 5-8 μ in diam. Pileus epicutis a layer of gelatinous interwoven hyphae in the form of an interrupted trichodermium the elements of which become fused to form the squamules, these hyphae 8-12 μ broad, and with the end-cells somewhat cystidioid and 10-16 μ in widest part. Clamp connections absent.

Scattered to gregarious under 2-needle pines along the Pacific Coast in the fall, in the Rocky Mountains in the summer, where it is very common, and in the north-central United States where it is less common but not rare in late August and early September.

During the season of 1962 at McCall, Idaho, Smith had a fine opportunity to study variation in this species. The following conclusions were drawn from observations on hundreds of carpophores. The color of the tomentum varies from pallid (young buttons) to pale buff, pinkish buff, grayish (when wet), orange-cinnamon to tawny, russet, or "Bordeau red" (dark red). When the tomentum has reached the red stage the base of the stipe and tissue bordering the worm holes is often red or reddish also. The mycelium around the base of the stipe is cream-color to cream-buff at first, but soon becomes vinaceous-buff or redder. The change to blue on fracturing varies with the specimen, some turn rapidly and the change covers the context of both pileus and stipe, in others there is scarcely any change, but about 90% of the specimens are intermediate in this respect.

The color of the pileus may be pale clear yellow at one extreme and dark dull orange at the other, with some populations rather constant, all pale, all intermediate, or all dark orange. These colors are present in buttons as well as mature specimens, i.e., there is not much change from youth to old age. The taste is typically mild or nearly so but by the time the squamules are red it is often rather acid. However, acid tasting yellow caps were found and a few with red scales practically lacked any flavor. The deposited spores were all dark olive when moist. A dozen deposits were taken on white paper and over a hundred observed in nature. Smith 15743 from the Olympic Mountains in 1941 gave an "Army brown" (dark vinaceous brown) deposit, but a second collection showing this feature has not been found to date. The tube mouths when young vary from dark vinaceous brown to bister to dingy yellow brown and rarely are they pale dull yellow.

We have concluded that only one species is involved and do not consider any of the variations dealt with here, in any of the combinations encountered, to be valuable for segregating infra-specific taxa. *Boletus variegatus* in Europe is close or may be identical with this species, at least we can find little in the descriptions to separate them. This problem, however, falls within the province of someone who has studied both in the fresh condition. Singer has not considered them identical. Apparently the European species does not have a glandular dotted stipe.

Thiers has examined material of *Xerocomus lenticolor* from Snell, and finds it identical with material of *S. tomentosus*. The original description strongly supports this conclusion. It might be worth pointing out that the discussion following the original description of *X. lenticolor* does not apply to it, but rather to the following species.

Material cited. California: Lanphere LP9; 12-27-56; 15. Pusateri 12. Smith 8342. Colorado: Kauffman 8-20-17; 8-24-17. Idaho: Gruber P-9; 9-25. Kelley Herb. 1947. Smith 15743; 44841; 44587; 45107; 46299; 46502; 43202; 535321; 53554; 53706; 59439; 59993; 65418; 65506; 65608; 65665; 65690; 56966; 66091; 66238. Trueblood 540b; 1133; 1699. Michigan: Smith 35834; 38322; 36806; 38368; 38609; 42227; 42297; 43952; 58013; 58178; 63980. Oregon: Kauffman 9-24-22; Sipe 326; 334; 364; 964; 968. Smith 19219; 23841; 24058; 24074; 26809; 26912; 26950; 26995; 55429. Washington: Smith 30835; 31022; 31264; 40118; 40268; 47648; 48129. Wyoming: Kauffman 8-22-23; Solheim: 3441; 4358; 4885; 5000; 5068; 5069; 5073; 5077; 5116; 5149; 5174; 5180; 5394; 5395; 5397; 5414. Smith 35018; 35405; 35463; 35478; 35487 (all MICH).

18. *Suillus ruber* Singer and Sipe, ex Singer, Papers Mich. Acad. Sci. Arts & Letters 32: 103. 1948.

Pileus bright red, sprinkled with darker spots, viscid, subfibrillose-verrucose when dry, spots sordid carmen with pale interspaces, similar to *Boletinus pictus* in shape and size. Hymenophore greenish-yellow when mature, pores and tubes like those of *Suillus tomentosus*

when dry; pores narrow, slightly round, adnate. Stipe yellow, glandulose, solid, subatenuate toward apex; without veil; glands composed of dermatocystidia for the most part fusoid-cylindrical or fusoid-ventricose, strongly chestnut-incrusted, very crowded, $35-85 \times 4.5-12.5 \mu$, dermatobasidia and dermatopseudoparaphyses none or few seen. Context in pileus white, in stipe yellow becoming blue in both when broken; odor not perceptible; taste mild.

Spores pale honey to honey colored, a few chestnut-brown, smooth, devoid of suprahilar depression, thin-walled, $7.8-9.8 \times 2-3.4 \mu$; basidia $20-21 \times 5.5-6.2 \mu$, 4-spored; cystidia either $24-32 \times 4.8-5.2 \mu$, hyaline, fusoid, or up to $50-75 \mu$, brown incrusted, clavate, both types present, the second type fasciculate.

September, Odell Creek, Oregon, U.S.A., F. P. Sipe 333 (FH).

The red pileus is unique and also the bluing flesh is distinct. It strongly resembles *S. hirtellus*. It grew under *Picea engelmannii* and *Pinus contorta murrayana* with which it probably forms mycorrhiza.

The above is taken from the original account. We include it here for the sake of completeness, but its relationship to *S. tomentosus* needs investigating. We suspect it of being an odd variation of that species. It was described from dried specimens.

19. *Suillus hirtellus* (Peck) Kuntze, Rev. Gen. Plant 3: 535. 1898.

Boletus hirtellus Peck, Bull. N.Y. State Mus. 8: 94. 1889.

Rostkovites hirtellus (Peck) Murrill, Mycologia 1: 14. 1909.

Ixocomus hirtellus (Peck) Singer, Ann. Mycol. 40: 30. 1942.

Boletus subaureus var. *siccipes* Coker & Beers, Bol. North Car. p. 83. 1943. var. *hirtellus*

Pl. 21.

Pileus 5-10 (15) cm broad, convex with an incurved margin, expanding to plane or slightly depressed, surface at first with appressed grayish fibrillose squamules and smaller reddish patches giving surface a spotted appearance, ground color bright yellow ("antimony yellow" to "yellow ochre") with a tendency to stain vinaceous-brown from handling, in age glabrous or nearly so, viscid when fresh; margin when young with cottony material along it like the tufts of fibrils on the cap. Context pale yellow, not staining blue when bruised, odor and taste mild.

Tubes shallow, 3-8 mm deep, decurrent and with lines extending down the stipe a short distance, pale yellow to ochraceous; mouths at maturity compound and elongated, about 1 mm wide, pale yellow young ("antimony yellow"), near "orange buff" in age, staining slightly vinaceous-brown where bruised.

Stipe 3-8 cm long, 1-2 cm thick at apex, equal or enlarged downward, solid, yellowish within above but soon olive-fuscous in the base; surface glandular dotted, pale yellow over all including the dots and these blackening from handling, base typically tapered to a point, veil absent (tomentum of pileus never connected to stipe).

Spore deposit "Sayal brown" (dull cinnamon). Spores $7-9 \times 3-3.5 \mu$, smooth, nearly oblong in face view, in profile somewhat inequilateral, apical end slightly turned up in many (as seen in profile), pale ochraceous in KOH, pale tawny in Melzer's reagent.

Basidia 4-spored, $17-23 \times 4-5.5 \mu$, narrowly clavate, pale ochraceous in KOH. Pleurocystidia in prominent clusters, incrustated with brown amorphous material, individual cystidia $(30) 40-70 (80) \times 6-9 \mu$, clavate to subcylindric, hyaline to brown in KOH, often with refractive reticulate content. Cheilocystidia similar to pleurocystidia, much amorphous pigment present. Caulocystidia similar to cheilocystidia, in clusters with surrounding incrusting material. Caulohymenium of basidia often sporulating, subhymenium gelatinous.

Tube trama of gelatinous divergent, hyphae hyaline in KOH. Epicutis of pileus a pellicle of loosely interwoven yellowish to hyaline gelatinous hyphae $3-6 \mu$ in diam. Clamp connections absent.

Gregarious under pine and aspen, Douglas Lake, Cheboygan County, Michigan, summer and fall, not uncommon.

The yellow glandular dots which quickly darken when handled, the olive-fuscous stipe-base, yellow tube mouths when young, along with the cottony material on the very young pileus margin are distinctive. *S. hirtellus* and *S. subaureus* are very close, however, and further study is desirable. *S. hirtellus* may be associated with pine. We place our material here provisionally. It had the tufts or squamules on the cap and the dark-cinnamon spores. Peck, however, did not mention the olive-fuscous stipe-base, and Coker and Beers stated of the stipe "rarely stained vinaceous on lower half". The Michigan collection is certainly neither of the two variants described by Singer (1945). *Boletus subaureus* var. *siccipes* Coker & Beers we place here because a cottony roll of false veil material on the cap margin is present to some extent. We find this species under hardwoods also. The description and photograph are of Smith 58079, Douglas Lake, Mich.

20. *Suillus hirtellus* var. *thermophilus* (Singer) Stat. nov.

Suillus hirtellus ssp. *thermophilus* Singer Farlowia 2: 275. 1945.

Pileus initially cinnamon, soon becoming "baryta yellow", somewhat "maize yellow" on the disc, then "Martius yellow" or "sulphur yellow" or "light chalcedony yellow", subviscid, innately fibrillose and minutely hirtose, the margin initially covered with cobweb-like to wooly remnants of the veil which in the primordia continues into an indistinct, glutinous, hyaline veil that disappears before full maturity, convex, soon flat around the umbo, but sometimes without an umbo (subumbonate or obtuse), 38-58 mm broad.

Hymenophore between "deep colonial buff" and "olive ochre", depressed around the stipe; tubes 5-8 mm long; pores initially "capucine buff", then "ochraceous buff" then "barium yellow", then "light ochraceous buff," and eventually between "deep colonial buff" and "dark olive

buff" or "sulphine yellow", small (2 to 3 per mm) to medium (7 to 5 mm tangentially or 4 to 5 mm radially), up to 1 mm in diameter; spore print deep olivaceous.

Stipe concolorous, the brightest portions about "primuline yellow", beset with glandular dots which are sparse to very numerous and initially white or cinnamon, later concolorous with the remaining surface of the stipe whitish, then becoming carmine red, brownish red or indefinitely remaining concolorous; the upper part of the stipe and also sometimes the pores guttulate (droplets consisting of a whitish rarely avellaneous latex), entirely solid, cylindric (after having been thinner at the apex in very young stages) to subequal, or with a root-like tapering base, $50-60 \times 6-9$ mm; mycelium mostly salmon-color; veil none.

Context yellow, unchanging; odor none, or very slight, like that of *S. luteus*; taste mild.

Spores $(6.8) 7.5-10.2 \times 3-3.2 \mu$, brownish melleous, some pale melleous, smooth, fusoid to ellipsoid, in profile cylindric to fusoid. Basidia $26 \times 7 \mu$, 4-spored; cystidia $37-71 \times 5.3-16 \mu$, with about 0.5μ thick walls (the often strongly developed resinous incrustation not included), most of them colored because of the incrustation, few hyaline, elongate-clavate, in fascicles; dermatocystidia of the glandulae of the stipe of one type only, viz. the incrustated, clavate (*Suillus*-) type, $17-77 \times 6-9.5 \mu$; hyphae without clamp connections.

Chemical reactions: KOH on surface of pileus, deep brownish yellow or lilaceous brown; on pores dirty brown; on context various shades of brown. NH_3 little reaction immediately but if exposed long enough, the disc of the pileus becomes "Persian lilac", and the margin "acajou red"; on pores slowly drab; on context negative or similar to the reaction on the surface of the pileus. NH_4OH on surface of pileus, lilac, then carmine, then amethyst color, then fading; on the context of the stipe, almost negative, or slowly sordid; in the base of the stipe rapidly drab. FeSO_4 on the context slowly olivaceous yellow.

In mixed stands in low hammock and in flatwoods under *Pinus palustris* in small groups, fruiting from June to September, or perhaps October. It is known from Georgia to south Florida (not in the tropical zone).

Material studied. Florida. Highlands Co. Highlands Hammock State Park, Aug. Sept. 1942, R. Singer, F543-type; F543a; F543b (FH). Alachua Co. Gainesville, W. A. Murrill, (as *B. granulatus*) F16526 (FLAS). Georgia. Vicinity of Talullah Falls, Sept. 1901, A. B. Seymour & W. L. Moss (det. W. H. Snell as *B. hirtellus*) (FH); Fern Valley, Sept. 1901 (FH); Fern Brook and Bad Branch, Sept. 1901 (FH).

We have not seen specimens of this variety, but the differences pointed out by Singer in his description as given above are sufficient for its recognition. The red tones which develop on the stipe appear to be a striking field character, and the glutinous veil of young specimens is most unusual in this group and would lead us to recognize the taxon as an autonomous species, but we have not seen fresh material and believe that in this instance it is very important to restudy this point,

especially since in one part of the description (the cap) Singer speaks of a veil and at the end of his account of the stipe says "veil none".

21. *Suillus hirtellus* var. *cheimonophilus* (Singer) stat. nov.

Suillus hirtellus ssp. *cheimonophilus* Singer, Farlowia 2: 274. 1945.

Pileus "barium yellow" to "pinnard yellow" with subconcolorous or somewhat darker innate fibrils which form subappressed but hirtose squamulae on the disk, dry in dry weather, decidedly viscid in wet weather, occasionally showing a grayish band around the extreme margin (veil), convex, becoming subplane, 50-90 mm broad.

Hymenophore "wax yellow" to "olive lake", adnate to slightly depressed, not decurrent; tubes moderately long; pores concolorous but often with some brownish glandulae, medium wide (around 1 mm in diameter), not exuding drops unless diseased; spore print rather deep olive. Context pale yellow, unchanging; odor none; taste mild.

Stipe yellow, pallid toward the base, beset with numerous pale brown, then testaceous-chocolate, eventually blackish glandulae over its entire length, solid, equal or at least equal in its upper two thirds, and then the base slightly thickened and again acuminate below, 40-70 × 5-20 mm, mostly 45-60 × 5-20 mm; veil none on the stipe; mycelium mostly whitish.

Spores 8-13.5 × (2.5) 3-3.3 (3.7) μ, melleous, smooth, cylindric or subfusoid-cylindric, rarely subellipsoid with suprahilar depression, or without depression; basidia and cystidia as in ssp. *thermophilus*; trama and glandulae not studied.

Chemical reactions. KOH on surface of pileus and stipe and on the pores and context, "bay" but somewhat deeper. NH₃ and NH₄OH on surface of pileus, negative for a long time, then assuming a vinaceous hue, then "cinnamon buff"; on pores, more sordid grayish olive, then becoming deep olive gray with a cinnamon ring; on context, an undefinable grayish tinge, then becoming pallid sordid brown.

Habitat. On sandy soil under pines, in Florida under *Pinus palustris*, *P. australis* and *P. taeda*, usually solitary, or in small groups, fruiting in Florida in December and January.

Distribution. Florida (if the northern form is included, it is distributed from New York to Florida with the western limits unknown).

Material studied. FLA. Alachua Co., Newnans' Lake, Jan. 30, 1943, R. Singer, F1772 (FH); Magnesia Springs, Jan. 5, 1941; G. F. Weber, (indet.) F19826 (FLAS).

The data and comments presented here are from Singer's account. We have seen no material. In our estimation the spore size and yellow fibrils on the cap separate it from the type variety. If the spore print remains "rather deep olive" after moisture has escaped this would also be an important feature.

22. *Suillus flavoluteus* (Snell) Singer, Farlowia 2: 260. 1945.

Boletinus flavoluteus Snell, Mycologia 33: 34. 1941.

Pileus 5-7 cm broad, plano-convex to nearly plane, surface more or less viscid, squamulose on disc to fibrillose-squamulose toward margin, golden to dull yellow with scales brownish to reddish brown, vermilion in places. Context firm, pale yellow becoming dull yellow, tinged reddish or greenish in places, odor sweetish to not distinctive, taste mild to slightly farinaceous.

Tubes convex, adnate or perhaps slightly decurrent, golden yellow becoming ochraceous in age or upon drying, 2-3 mm deep; mouths medium to large, angular, more or less compound and radiately arranged, a few with separating veins, glandular-dotted, concolorous.

Stipe stout, 4-5 cm long, 15-20 mm thick, tapering downward, golden yellow becoming dark yellow to more or less brownish, with occasional touches of vermilion, covered full length with ochraceous to brown glandular dots, solid, fibrous, deep yellow, tinged greenish at apex and purplish red at base.

Spores pale ochraceous brown in mass, elliptical, hyaline, 7-9 × 2.5-3 μ, mostly 8-8.5 × 2.5 μ. Cystidia not abundant, single or clustered, cylindric, clavate, or irregular, hyaline to colored, 35-50 × 4-7 μ.

Solitary and scattered, in a stand of hardwoods and hemlock. New York, Snell Herbarium #95-type.

The above data are taken from the original account. To us the species is very close to *S. sibiricus*, but does have slightly smaller spores. Snell's comments however, seem to miss the point, as both *S. americanus* and *S. flavoluteus* have squamules on the pileus. White pine must have been in the hemlock-hardwood stand as Snell found *S. americanus* there later. Hence no ecological difference can rightfully be assumed.

The problem of this species in relation to *S. tomentosus*, *S. hirtellus* and *S. subaureus* is difficult to resolve. Snell's species should be readily distinct from both *S. hirtellus* and *S. subaureus* by the purplish red base of the stipe. Also, the tubes are exceptionally shallow. Snell indicates that the context may be greenish in places, which reminds one of collections of *S. tomentosus* which stain only slightly. The stipe characters also fit *S. tomentosus* better; but the shallow tubes with boletinoid configuration of the pore surface would seem to prevent assignment to that species.

23. *Suillus subaureus* (Pk.) Snell in Slipp & Snell, Lloydia 7: 30. 1944.

Boletus subaureus Peck, Ann. Rept. N.Y. State Mus. 39: 42. 1886.

Rostkovites subaureus (Peck) Murrill, Mycologia 1: 13. 1909.

Ixocomus subaureus (Pk.) Singer, Rev. de Mycol. 3: 45. 1938.

Pls. 19, 20.

Pileus 3-.2 (17) cm broad, convex with an incurved margin, expanding to broadly convex to nearly plane, often with a fluted or flared

margin, margin may remain inrolled for a long time and be slightly downy, but no veil or false veil present on buttons, surface viscid beneath a covering of appressed tomentum which may be brownish at first but on many caps becomes aggregated into patches or fibrillose scales which become scarlet to cinnabar color and spot-like in appearance, surface rarely appearing glabrous with age, ground color yellow ("mustard yellow", "ochre yellow", "light cadmium yellow" or "apricot yellow"). Context up to 3 cm thick, floccose, when young colored yellow ("primuline yellow" or "apricot yellow") changing to tawny when exposed, when older dull ochraceous ("cream color" to "straw yellow"), unchanging or staining brownish to vinaceous brown; taste mild to slightly acid, odor not distinctive.

Tubes subdecurrent when young becoming decurrent in age, (3) 4-10 mm deep, somewhat radially arranged, ochraceous to luteous becoming flavous ("ochraceous buff" to "antimony yellow" becoming "yellow ochre"), unchanging when bruised, somewhat separable from cap, mouths about 2 per mm., angular and arranged so as to be inconspicuously lamellate, dingy yellow becoming dull ochraceous.

Stipe 4-8 cm long, 1-2 cm thick, equal to tapering downward to occasionally subclavate, solid, flavous within, then reddish ("tawny") where cut, with a ferruginous to fulvous zone in the base when cut in half; colored yellow (pinnard yellow") at base, granular-pruinose (not truly glandular dotted) at first but becoming distinctly glandular, (clusters of dots) as the caulocystidia become colored, brownish to very sordid brownish when bruised, viscid at least when young, white mycelium at the base.

Spore deposit olive-brown ("light brownish olive") fresh. Spores 7-10 × 2.7-3.5 μ, narrowly ellipsoid to subfusoid in face view, in profile obscurely inequilateral, smooth, pale greenish yellow in KOH to nearly hyaline, scarcely darker in Melzer's sol.

Basidia 4-spored, 23-88 × 5-7 μ, clavate, 4-spored, hyaline to yellowish in KOH, yellowish in Melzer's reagent. Pleurocystidia (25) 40-50 × 4-6 μ, clavate to cylindrical, mostly in bunches and more or less covered with dark yellow-brown amorphous pigment as revived in KOH, in mounts of fresh material (in KOH) purple to lilac or rarely some of them hyaline, or with bister content, thin-walled. Cheilocystidia similar to pleurocystidia, very abundant, often crooked near the apex, surrounding amorphous pigment very abundant. Caulocystidia abundant and scattered over surface; 50-70 (100) × 3-5 μ, filamentous to cylindrical (often flexuous), varying to narrowly clavate, subgelatinous, no incrusting pigment around most of them but some patches of an amorphous pigment present and purplish in KOH fresh, some cystidia also with purplish content in KOH fresh, often in distinct clusters.

Tube trama of gelatinous somewhat divergent hyphae hyaline in KOH, the central strand of floccose yellowish hyphae. Pileus epicutis a pellicle of hyphae 3-6 μ broad, interwoven and gelatinous, no incrusting material present. Clamp connections absent.

Scattered to gregarious under aspen and scrub oak, central and

eastern United States and southern Canada, summer; common some years.

This species is unusual in *Suillus* because it is not an obligate mycorrhizal associate with conifers, having been found under aspen with no conifers present anywhere in the area. Junipers have been present in some habitats. The greatly elongated, gelatinous cheilocystidia which are often narrowed at the upper (outer) end and lacking amorphous incrustations we consider an important character. A similar layer on the stipe causes it to be slightly viscid at times. This species is very close to *S. hirtellus* but may be distinguished by the smaller pores, a less conspicuous tomentum on the pileus, a practically naked pileus margin when young, and according to Singer, a lighter colored spore deposit. It is also likely to be confused with *S. americanus*, but that species has a narrower, darker yellow, conspicuously glandular dotted stipe, and is always associated with white pine.

S. subaureus typically produces a heavy-set fruit body and these develop rather slowly so that the tubes remain shallow (3-5 mm deep) a long time and one might be led to regard this as a taxonomic feature (see *S. flavoluteus*). In Smith 66962 the cap margin was intergrown with the stipe as in *Gastroboletus*.

Material studied. Dried specimens of *S. hirtellus* and *S. aureus* are almost impossible to distinguish because the cottony material on the cap margin of *S. hirtellus* collapses readily and disappears in drying (at least as most dried specimens are found in herbaria). Our description is from Smith 7290 (MICH).

24. *Suillus punctipes* (Pk.) Singer, Farlowia 2: 277. 1945.

Boletus punctipes Peck, Ann. Rept. N.Y. State Mus. 32: 32. 1880.

Ixocomus punctipes (Peck) Singer, Ann. Mycol. 40: 30. 1942.

Pl. 22.

Pileus 3-10 cm broad, convex becoming broadly convex or finally the margin spreading and wavy, when young covered by tufts of dull grayish brown tomentum, soon becoming glabrous and dull ochraceous-orange in color, then becoming pale dingy ochraceous and at times with obscure grayish tufts or patches of tomentum over marginal area, finally becoming pale yellow ("warm buff" to "Naples yellow") and entirely glabrous. Context thick and soft, pallid yellow and unchanging when cut, in KOH turning purplish to vinaceous; odor like that of *Hygrophorus agathosmus*; taste mild.

Tubes 4-6 mm deep (shorter than the thickness of the context at deepest point), adnate to short-decurrent, dull brownish young, becoming olivaceous to honey-yellow when mature; mouths dark dingy brown ("bister") first, slowly paler through "snuff brown" and finally merely dingy yellow, small (about 2 per mm), round to angular.

Stipe 4-9 cm long, 9-14 mm at apex, equal to clavate, solid, dull ochraceous to dull ochraceous-orange within (color about as in

Gomphidius rutilus), base often cinnabar color, cut surface slowly staining dull brown; surface at first bister from dense coating of viscid glandular dots, the flavous ground color showing through by maturity, when handled the fingers quickly becoming stained sordid ochraceous and the fragrant odor can be noted on them; no veil remnants showing anywhere on the surface except in the smallest buttons observed.

Spore deposit dark olive brown fresh. Spores $7.5-10 (12) \times 3-3.5 \mu$ in face view elongate-elliptic to subfusoid, in profile narrowly inequilateral to sway-backed and with a broad suprahilal depression, smooth, pale dingy yellowish in Melzer's sol., with a few becoming dull tawny brown (faintly dextrinoid), dingy pale buff in KOH varying to pale olive yellowish.

Basidia 2- and 4-spored, $16-20 \times 5.5-7 \mu$, sections of hymenium dingy yellowish in KOH, individual basidia nearly hyaline, yellowish hyaline in Melzer's reagent. Pleurocystidia of two types, as cystidioles $18-26 \times 6-8 \mu$, with hyaline content, thin smooth walls and obtuse to subacute apex and the second type in clusters with dark bister to dull rusty brown incrusting material around the base of the cluster, individual cystidia $36-55 \times 7-11 \mu$ and clavate to subfusoid, with hyaline to brown content in KOH and Melzer's sol. Cheilocystidia in masses and with brown content, incrusting around base, clavate to subfusoid and $50-70 \times 7-14 \mu$ in broadest part. Caulocystidia similar in size and coloring to cheilocystidia and frequently forming an hymeniform layer over large areas of upper part of stipe.

Tube trama of subparallel elements in central area and somewhat divergent toward the subhymenium, cells pale yellowish to hyaline in KOH and Melzer's sol.; the hyphae $5-8 \mu$ in diam. and subgelatinous. Epicutis of pileus a tangled trichodermium of gelatinous hyphae, the end cells of which are narrowly clavate to equal, $6-7 (8) \mu$ in diam., the main filament $4.5-6 \mu$ in diam., some with dark brown content but most merely yellowish throughout, considerable debris held in the layer but incrustations were seen only near the base of the trichodermium and on the floccose hyphae beneath. No clamp connections present and no amyloid reactions present on any of the tissues as observed in Melzer's sol.

Scattered under spruce and balsam in a sphagnum bog, Burt Lake, Cheboygan County, Michigan, late summer and early fall. Not uncommon. The description and photo are of Smith 62939, Aug. 18, 1960. Coker and Beers reported it for North Carolina. Its distribution appears to be eastern and boreal.

This species has been observed for years in the one locality but the 1960 fruiting was the most abundant and fruit bodies in all stages of development were repeatedly collected. The surface of the stipe is actually viscid from the profuse development of the caulocystidia. Peck's original description emphasized that the pileus has tufts of tomentum along the margin and that the tubes have mouths yellowish brown at first. The odor is hard to describe. We missed it in collections of only a few fruit bodies, but when one gets a basket full of specimens

it is quite pronounced. The colors of the cap are duller than in *S. hirtellus* and the cap lacks the red spots of *S. subaureus* which also has brighter yellow colors.

There is rather good agreement on the features of this fungus in the literature, but most collectors have found it, as we have, after the tomentose covering over the buttons has all but disappeared. The fact that such a coating is present at first strongly suggests an affinity between this species and *S. tomentosus*. The latter, however, is very distinct, if button stages are compared, because those of *S. tomentosus* stain blue when broken.

Material studied. Michigan: Smith 36942; 37856; 38056; 44115; 57498; 57892; 62939; 62947; 62979; 63340; 64042. Thiers 3243; 3867. New York: Snell 9-12-37. Smith 1010. North Carolina: Smith 7502; 7517. Canada. Ontario: Kelley 1324; 1416; 1914 (all MICH).

25. *Suillus fuscotomentosus* Thiers & Smith sp. nov.

Pileus 3.5-15 cm latus, obtusus vel convexus demum late convexus, subviscidus, tomentosus-squamulosus, fusco-brunneus demum vinaceo-brunneus; sapor subacidus; stipes 4-10 cm longus; 1-3 cm crassus, subclavatus, glanduloso-maculatus, pallide luteus; vellum nullum; sporae $9-12 \times 3-4 \mu$; pleurocystidia fasciculata. Typus: Thiers 10759 (SFC).

Pileus 3.5 - 15 cm broad when mature; when young subconic to convex to obtusely convex, becoming broadly convex to plano-convex, occasionally highly irregular in shape with undulating margin; surface moist to obscurely viscid with age, conspicuously fibrillose to fibrillose-scaly to almost squamulose when young, fibrils often becoming agglutinated at the tips, sometimes becoming less dense with age and appearing appressed, sometimes appearing glabrous when very old; when young colored olive brown near to fuscous "clove brown" to "bone brown" to "fuscous") on the disc, unchanging or fading slightly toward the margin, with age slowly fading to dark vinaceous brown ("Roods brown" to Vandyke brown" to "verona brown" to "warm sepia"), eventually becoming near cinnamon ("clay color" to "tawny olive" to "cinnamon" to "saya brown"), occasionally disc remaining as dark as "verona brown" and fading to "cinnamon" to "avellaneous" on the margin, fibrils more or less concolorous or darker than the surface; margin entire, glabrous, no evidence of partial veil during any stage of development. Context 1-2 cm thick on the disc, colored "ivory yellow" to "cartridge buff" in young carpophores, changing to "primrose yellow" to "cream color" to "naphthalene yellow" in older carpophores; unchanging when exposed; taste not distinctive to weakly acid and unpleasant, odor not distinctive.

Tubes adnate to shallowly and narrowly depressed around the stipe, unchanging or becoming subdecurrent to broadly shallowly depressed with age; up to 1.5 cm long; when young pale yellow ("deep colonial buff" to "colonial buff" to "deep olive buff") changing to near

"antimony yellow" to "warm buff" finally becoming olive yellow "isabella color" to "chamois" to "old gold" to "olive lake"), unchanging when exposed or bruised; pores up to 1 mm broad, frequently less, rarely more, angular, concolorous, unchanging when bruised.

Stipe 4-10 cm long, 1-3 cm broad at the apex; equal to typically obscurely clavate to clavate; surface strongly and often noticeably punctate, glands relatively large and often becoming elongated with age, more or less concolorous with surface, darkening when handled; moist but not viscid, when young colored near "Naples yellow" to "mustard yellow", with age sometimes becoming near "amber yellow" to "strontian yellow" at the apex, typically becoming "pale olive buff" to "warm buff", occasionally becoming "pale pinkish vinaceous", particularly at the base; unchanging upon bruising; white to "avellaneous" mycelium at the base; solid, flesh concolorous with surface, unchanging when exposed; no evidence of an annulus.

Spores in fresh deposit colored near "light brownish olive" to "deep olive" to "olive brown"; pale yellow in KOH, pale ochraceous in Melzer's Reagent, 9-12 × 3-4 μ, smooth, thin-walled, fusoid to subellipsoid to subellipsoid to subcylindric.

Basidia apparently 2 and 4-spored, hyaline, clavate, 21-24 × 6-8 μ; cystidia in clusters or fascicles, rare to absent on sides of tubes, abundant on the pores, typically staining dark brown to black in KOH, and appearing incrustated near the pores, often only basal portion of cluster staining when located on side of tubes, cylindrical to subclavate to obtusely fusoid to highly irregular in outline, 30-45 × 8-10 μ; tube trama hyaline, subgelatinous in KOH, divergent, hyphae ± 5 μ in diam.; pileus trama interwoven, homogeneous; cuticle differentiated as a highly uneven turf of more or less erect, septate hyphal tips, not at all or only slightly gelatinous in KOH, hyphae typically appearing incrustated, and staining pale brown, cells ± 7 μ in diam.; surface of stipe not gelatinous in KOH, with numerous large clusters of caulocystidia which stain dark vinaceous to black in KOH, cylindrical to highly irregular in outline, 60-90 × 6-10 μ; clamp connections not seen.

Solitary to gregarious in sandy soil under mixed woods including Ponderosa pine, Douglas fir, and various oaks near Felton, Santa Cruz County, California.

The tomentose to fibrillose surface of the pileus of this species is remindful of *Suillus tomentosus*, a very common species on the west coast, and of *Suillus hirtellus*, a species not yet found in this area. There are, however, significant differences between each species. In contrast to *S. tomentosus* the flesh of *S. fuscotomentosus* does not change to blue when exposed, the color of the pileus is conspicuously darker and the spores are significantly larger. *S. hirtellus* var. *cheimophilus* to which this species appears most similar, has a much paler colored pileus which develops reddish stains or discolorations on the pileus and stipe and has a rudimentary veil - all characters not present in *S. fuscotomentosus*.

Type species as for the genus.

In this series the stipe is annulate or the veil adheres to the pileus margin when it breaks, or in the young specimens a distinct false veil (one not attached to the stipe but at first nearly covering the tube cavity) is present.

25. *Suillus luteus* (Fr.) S. F. Gray, Nat. Arr. Brit. Pl. 1: 646. 1821.

Boletus luteus Fries, Syst. Mycol. 1: 385. 1821.

Cricunopus luteus (Fr.) Karst. Rev. Myc. 3: 16. 1881.

Viscipellis luteus (Fr.) Quél., Enchir. Fung. p. 155. 1886.

Ixocomus luteus (Fr.) Quél., Fl. Mycol. Fr. p. 414. 1888.

Pl. 23.

Pileus 5-12 cm broad, hemispheric to obtuse at first, broadly convex to plane in age, surface glabrous and viscid but at times somewhat streaked beneath the gluten, color "raw sienna" to "Sudan brown" or tawny to bister (color rather variable in the yellow-brown to red-brown series), pellicle separable. Context white or tinted more or less with pale yellow especially near tubes and stipe; taste pleasant, odor not distinctive.

Tubes 3-7 mm deep, gradually shorter toward the cap margin, adnate to subdecurrent, at first whitish to pale yellow, at length "honey yellow" to "old gold", unchanging when cut; mouths 3 per mm, in age 1-2 per mm, surface with a sheen and mouths yellow at first but becoming dark-dotted.

Stipe (3) 4-8 cm long, 1-2.5 cm thick, equal or attenuate at base, typically peronate by the whitish veil up to the membranous often reflexed, rather persistent annulus, glandular dotted above the annulus and pale yellow, concolorous with surface within or whitish, glandular dotted beneath the sheath, solid; veil membranous and with a gelatinous purplish zone on the under side or outer surface in humid weather, or exterior layer of sheath purplish gray in age.

Spore deposit ("sayal brown" to "clay color") dull cinnamon when moisture has escaped. Spores 7-9 × 2.5-3 μ, smooth, with a pronounced hyaline sheath, more or less oblong in face view, narrowly inequilateral in profile view, nearly hyaline in KOH, yellowish in Melzer's.

Basidia 4-spored, 14-18 × 4-5 μ, yellowish in Melzer's and in KOH. Pleurocystidia in scattered to rare bundles surrounded by bister debris (details of bundle obscured by overall covering of debris), when isolated 20-35 × 5-7 μ and narrowly clavate, content usually bister as revived in KOH. Cheilocystidia similar, but tube edges often a mass of bister incrustation obscuring the cystidia.

Tube trama gelatinous and divergent. Pileus cuticle of narrow (2-4 μ) gelatinous filaments forming a tangled trichodermium, hyaline in KOH and pale yellowish in Melzer's sol.; tramal body of floccose,

interwoven, hyaline, non-amyloid hyphae; stipe with numerous fascicles of caulocystidia over surface, the clusters bister in KOH. No clamp connections seen.

Scattered to gregarious under conifers (both *Pinus* and *Picea*) in the fall. One of the common species in conifer plantations in the Great Lakes region. It ranges through the conifer areas of at least southern Canada and in the United States, but is not equally abundant in all areas. Its distribution in our native conifer forests remains to be ascertained, as almost any *Suillus* with an annulus has passed under this name in North America.

S. pseudobrevipes is probably closest to *S. luteus* but differs in lacking glandular dots on the stipe as observed in the fresh state, and in the broader hyphae of the pileus trichodermium. The colors of the pilei in both species will intergrade, as both are quite variable.

In collections of *S. luteus* made under conditions of low humidity the veil is dry, but there is usually a thin avellaneous to purplish outer layer present. Under conditions of high humidity the hyphae of this layer will gelatinize producing finally a narrow purplish gelatinous zone. Thus, here as in *S. grevillei* the gelatinous outer layer or zone is not a good key character. The stipe of *S. proximus* turns greenish when cut, lacks glandular dots on the surface and the crushed context has an acid metallic odor. *S. grevillei* grows under larch and has brighter colors as well as having the under or outer side of the annulus ochraceous rather than purplish or grayish purple. *S. acidus*, *S. subluteus*, and *S. cothurnatus* have narrower stipes and each has one or more additional distinguishing features such as color of the pileus, etc.

The most confusing situation we have encountered concerns specimens of *S. luteus* in which the veil separates from the stipe leaving soft cottony patches of tissue appendiculate on the pileus margin. Such basidiocarps could be mistaken for dark colored specimens of *S. albidipes*. In North America they may possibly account for some of the confusion around *S. granulatus*, especially where descriptions give *S. granulatus* as both dark colored and having cottony patches on the cap margin. *S. pseudogranulatus* is undoubtedly more closely related to *S. luteus* than to other species. The color of the veil material is suggestive of such a relationship.

Material studied. Michigan: Mains 32-85. Smith 51169; 56142; 62363; 66400; 66420 (MICH). These are typical of the European concept.

26. *Suillus subolivaceus* sp. nov.

Pls. 24-25; also Mycologia 54: 284. Fig. 38 (as *Boletus subluteus*)

Pileus 5-10 cm latus, glutinosus, variegatus, sordide luteo-brunneus demum olivaceo brunneus vel subolivaceus; sapor acidus; stipes 6-10 cm longus, 8-14 mm crassus, sursum subluteus, deorsum pallidus glanduloso-maculatus; annulus olivaceo-brunneus, glutinosus. Typus: Smith 48328 (MICH).

Pileus 5-10 cm broad, broadly convex to nearly plane, or obtuse and expanding to broadly umbonate, surface covered with a copious gluten and appearing streaked beneath by agglutinated fibrils, color variable, "snuff brown", "Saccardo's umber", "olive brown" or dull olive (dark dingy yellow-brown to olive-brown or dingy olive). Context thick (up to 1 cm), spongy, palid to yellowish or olivaceous gray, odor slight, taste acid, no color changes when bruised.

Tubes grayish buff to olive-buff young and beaded with drops of a hyaline to cloudy exudate, adnate becoming somewhat decurrent, about 1 cm deep at maturity, dingy yellow when mature; mouths 1.5-2 per mm in age, about 1 per mm when young, concolorous with sides more or less or slightly browner, unchanging when bruised.

Stipe 6-10 cm long, 8-14 mm thick, equal, solid, yellowish in the interior in upper part, pallid to brownish below; exterior yellowish above and pallid below but conspicuously covered with glandular dots which are pinkish brown but soon blacken from handling and nearly always dry blackish; annulus membranous with an outer gelatinous layer colored like the pileus, often sheathing but not flaring at lower edge, inner layer white and floccose, annulus median to superior and shrinking rapidly after breaking.

Spore deposit dingy cinnamon (typical for genus). Spores (8) 9-11 \times 3-4 (4.5) μ , in profile with a broad suprahilar depression, in face view typically subfusoid, smooth, pale ochraceous to greenish hyaline in KOH, walls slightly thickened.

Basidia clavate, 4-spored, hyaline in KOH, 18-23 \times 5-6 (7) μ . Pleurocystidia in fascicles with rusty brown incrusting pigment around the base as revived in KOH; individual cystidia 40-55 \times 6-11 μ , sub-cylindric to narrowly clavate or subfusoid with obtuse apices, and as revived in KOH either hyaline or with yellowish-brown content. Cheilocystidia scattered and in groups, like the pleurocystidia but often longer and frequently (as revived in KOH) with so much surrounding encrusting pigment that the cystidia themselves are obscured. Caulocystidia in dense fascicles and with a copious amount of incrusting pigment; individual cystidia up to 70 \times 12 μ but mostly 40-60 \times 6-10 μ , content of most of them dark yellow brown as revived in KOH.

Hyphae of the hymenophoral trama gelatinous and somewhat divergent from a central strand 2-3 hyphae wide, hyaline or nearly so revived in KOH. Epicutis of pileus a thick layer of gelatinous hyphae 3-7 μ in diam. and with some bister incrusting pigment seen as revived in KOH, the hyphae as revived appearing to be appressed and rather crooked; the entire layer appearing olive-brownish in KOH under the microscope. Clamp connections none.

Gregarious under mixed conifers, Lower Nisqually River, Mt. Rainier National Park, Wash. Oct. 5, 1954, Sm-48328. The species is rather common during the fall in Oregon and Washington.

This species has been identified by most mycologists including ourselves in times past as *S. subluteus*. However, it is a robust bolete with an annulus or veil which at first sheaths the stipe. Peck in his

original description states that this is not true of *S. subluteus*, and it is not true of the specimens we have described under Peck's name in this report. The pileus color also differs in being dark muddy yellow-brown to distinctly olive or grayish olive-brown instead of yellowish, and the tubes are grayish buff to olive-buff when young.

Material studied. Idaho: Smith 53705. Wier (Kelley 1964). Oregon: Smith 19140; 19181; 24475; 24765; 24769. Washington: Smith 3101; 40625; 40393; 40955; 48134; 48328-type (MICH).

27. *Suillus pinorigidus* Snell & Dick, Mycologia 48: 304. 1956.

Carpophore in its entirety tending to dry blackish instead of being destroyed by moulds, eelworms, etc.

Pileus plano to plano-convex, the margin in a thin roll which is glandular-dotted, up to 8 cm broad. Surface viscid, variously yellowish to cinnamon buff, clay color, cinnamon or tawny to between dark olive buff and buffy brown, to almost buffy olive, deep olive, or deep grayish olive with darker (almost black) streaks or fibrils, tending to have the olive tones when older, and drying blackish. Context pale orange yellow, light orange yellow, or orange buff, mostly the last; odor pleasantly fungoid, taste pleasant, perhaps very slightly farinaceous.

Hymenophore slightly depressed around the stipe, dull capucine yellow to orange buff and later more Mars yellow, or perhaps raw sienna, finally mummy brown: tubes 5-8 cm (sic) long, pores concolorous, glandular-dotted, less than 1 mm broad.

Stipe 3-7 cm long, 8-13 mm thick, subequal, straight or curved, almost always bent at a sharp angle at the very base, thickly glandular-dotted almost to base, annulate (sometimes as low as half-way down), mostly capucine buff becoming grayish above the annulus, the basal portion almost salmon orange becoming a dull salmon orange, the glandular dots at first ferruginous becoming almost black on the upper portion of the stipe and brownish below; within like the context in the upper portion, but the lower half between xanthine orange and orange, with these colors continuing up the rind. Veil covering the hymenophore membranous and fairly tough, whitish, brown to blackish at stipe, rupturing to form an annulus up to 4 mm wide when fresh, whitish with a dark band in the middle, later collapsing to a gray band dark brown inside, finally entirely black.

Spores in deposit between honey yellow and clay color when fresh, later between honey yellow and Isabella color, or buckthorn brown, elliptic-subfusiform to cylindrical, hyaline to very pale greenish, 7.5-10 × 2.5-3.5 μ . Cystidia mostly clustered, obtuse, subcylindric, more or less undulating, hyaline more rarely clavate or cylindrical-clavate or fusoid, 21-35 × 3-9 μ ; dermatocystidia of glandular dots, undulating, cylindrical to clavate, brown, more or less encrusted, 35-65 × 5-9 μ .

Under *Pinus rigida*, Scituate, R. I. Type collection in WHS Boletus Herbarium No. 2112.

In order to present accurate data on all the variants of the

S. subluteus complex we include the original account of this species. One can get little data on macroscopic features from dried specimens which have blackened in drying, and most of the variants in this group will so blacken if slightly overheated, or if they are too wet when placed on the drier. Snell & Dick in their account of the annulus give the impression that it is gelatinous at least on the outer (under) side, but in comparing this species they center their discussion around *S. luteus* in which this character is variable depending on the weather. We regard the presence of glandular dots on the tube walls as an unimportant feature--they often do not show on young or freshly matured specimens. They are caused by the development of pigment around the bundles of cystidia, or in these organs themselves, and the pigment may not develop until late maturity. Of the features emphasized by Snell & Dick, *S. pinorigidus* has a stature more slender than *S. luteus*, the pileus is not as thick or as convex, the stipe is thinner, the pileus runs more to olive colors, especially in age, the carpophores are more apt to dry blackish, the colors of the context of cap and stipe run more to orange, and it should be kept in mind that glandular dots are apt to show wherever there are fascicles of cystidia. The small tube mouths are like those of *S. luteus*. The color of the pileus is most like that of *S. subolivaceus*, at least apparently in age, but these two should differ markedly in the color of the context of the pileus. This is pallid to yellowish to olive-gray as compared to orange-yellow. Also, the tube mouths are colored olive-gray at first in *S. subolivaceus* but are apparently rather bright yellow in *S. pinorigidus*. We are not sure that *S. pinorigidus* is distinct from *S. subluteus*, since most of the characters Snell and Dick emphasize also apply to that species. Snell's concept of *S. subluteus* has changed over the years. At one time he determined specimens of *S. subolivaceus* as *S. subluteus*. Since there is a good type collection of *S. subluteus* and since a concept can be clearly established on it, as we have done in this work, there is no more need to discard the name as a source of confusion that there is for discarding the names for many of the common European species which have been variously misinterpreted over the years by different authors.

28. *Suillus lutescens* Smith & Thiers sp. nov.

Pileus 3-6 cm latus, olivaceobrunneus, glutinosus; sapor mitis; tubulis adnatis, luteus; stipes 5-12 cm longus, 10-15 mm crassus, annulatus, deorsum tactu lutescens. Typus: Smith 57893 (MICH).

Pileus 3-6 cm broad, convex to obtuse, expanding to nearly plane or remaining broadly umbonate, glabrous, glutinous, "buffy brown" to "deep olive buff" (pale olivaceous to olive-brown), in age a grayish "pinkish buff". Context yellowish pallid and slightly yellower when bruised, odor slightly fragrant, taste mild.

Tubes adnate, near "massicot yellow" (pale yellow) young, adnate to decurrent, shallow (about 5-7 mm deep, but old specimens not numerous); mouths minute, about 2-3 per mm when mature, pale massicot

yellow. No color change when bruised.

Stipe 5-12 cm long, 10-15 mm at apex, equal or nearly so, solid, yellowish within and near lemon-yellow in the cortex in upper part, interior watery mottled, surface pallid and overlaid with brownish glandular dots above and below the band-like annulus, base conspicuously staining yellow where handled; annulus thick, soft and readily collapsing, outer layer gelatinous, inner layer of soft floccose tissue.

Spore deposit dark cinnamon moist, or olive-brown where smeared and dried. Spores 7-10(11) \times 3-4 μ , smooth, subfusoid to narrowly ellipsoid in face view, obscurely inequilateral in profile, pale greenish yellow in KOH, pale tawny in Melzer's.

Basidia 4-spored, 20-26 \times 5.5-7 μ , narrowly clavate, hyaline in KOH. Pleurocystidia scattered and at times with a slight amount of brown pigment around base, 33-52 \times 6-8 μ , content hyaline or coagulated and yellowish (as revived in KOH). Cheilocystidia in large clusters with copious brown amorphous pigment surrounding the base of the cluster; individual cystidia 50-90 \times 6-10 μ , narrowly clavate, smooth, and mostly with dark yellow-brown content; yellow brown pigment often pervading throughout the cheilohymenium. Caulocystidia in large clusters, amorphous brown pigment around the clusters; single cystidia 50-100 \times 5-10 μ , narrowly clavate to narrowly fusoid-ventricose, some cylindrical and flexuous, nearly all with dark brown content; caulohymenium mostly with basidia paler than cystidia but still colored and with amorphous pigment throughout the hymenium, subhymenium gelatinous.

Tube trama of somewhat divergent gelatinous hyaline hyphae. Epicutis of pileus a layer of widely spaced, interwoven, branched gelatinous hyphae 2-5 μ in diam., yellowish in KOH, apparently trichodermial in origin as in young caps the general orientation is vertical or at an angle to the surface; hypodermial area dark bister in KOH. Clamp connections absent.

Under conifers (*Picea*, *Abies* and *Pinus strobus*) Reese's Bog, Burt Lake, Cheboygan County, Michigan. Sept. 4, 1957, Sm-57893-type (MICH).

This is a peculiar species because of the strong yellow staining reaction of the base of the stipe, the pale yellow tube mouths when young, the scattered pleurocystidia and gigantic cheilocystidia. In the tube trama near the tube edges the tramal hyphae of the central strand are often yellow-brown, the same as the cheilocystidia. This has been noted on a number of species of *Suillus* but is most conspicuous in the *S. subluteus* group. *S. lutescens* is most closely related to *S. acidus*, but the taste is mild, the stipe is yellow when bruised, and the tube mouths pale yellow when young.

29. *Suillus acidus* (Peck) Singer, Farlowia 2: 271. 1945.

Boletus acidus Peck, Bull. N.Y. State Mus. 105: 15. 1906.
var. *acidus*

Pls. 26 & 27.

Pileus 4-10 cm broad, slightly umbonate to broadly convex, surface copiously glutinous; glabrous beneath the gluten at first, but in age more or less streaked with brownish fibrils; color at first pale yellow (a dull "warm buff"), in age nearer cinnamon-buff and more virgate; margin floccose-appendiculate at least when young. Context thin, firm, dull yellow, becoming dark yellow-brown in Melzer's sol., not changing when bruised, odor not distinctive, taste of gluten very acid.

Tubes 4-6 mm deep in large caps (rather shallow), adnate to short-decurrent, dull yellow; mouths small (2-3 per mm), dull brown when young and instantly darker brown in KOH.

Stipe 4-12 cm long, 8-12 mm at apex, equal, solid, pallid to yellowish within, glandular dotted above and below the superior annulus, ground color pallid, often stained grayish around the base; glandular dots dingy brownish; annulus of soft floccose material coated on outer side with a layer of gluten.

Spore deposit dull cinnamon. Spores 7-9 (10) \times 3-3.5 μ , smooth, olive-yellowish in KOH, pale tan (near cinnamon-buff) in Melzer's sol., obscurely fusoid to suboblong (tapered slightly to apex), in profile narrowly inequilateral.

Basidia 4-spored, clavate, 16-20 \times 5-6.5 μ , hyaline in KOH, yellowish in Melzer's sol. Pleurocystidia 26-40 \times 6.6-10 μ , cylindrical to clavate, hyaline or with yellow-brown content as revived in KOH, when fresh hyaline to dark lilac-brown, in fascicles and these with amorphous brown pigment surrounding them at the level of the hymenium. Cheilocystidia abundant, 40-65 \times 5-9 μ , cylindrical or clavate, mostly with yellow to yellow-brown content; tube dissepiments dark yellow-brown from amorphous pigment. Caulohymenium with a subgelatinous subhymenium, a palisade of basidia and fascicles of caulocystidia resembling the cheilocystidia and imbedded in amorphous dark yellow-brown pigment, some clavate and enlarged to 14 μ at apex, some fusoid to obventricose.

Tube trama of divergent gelatinous hyphae from a narrow floccose central strand of hyaline to slightly brownish hyphae. Epicutis of pileus a collapsed tangled mass of gelatinous yellowish (in KOH) hyphae 3-7 μ in diameter, probably originating as a trichodermium. Clamps absent.

Scattered to gregarious under pine, Quebec, New York and Michigan. The type has been studied. Our description is from Smith 57938. Smith 61798 was from Baie-St. Paul, Charlevoix County, Quebec.

The significant features of this species are the copiously glutinous, pale yellow pileus, the floccose patches of tissue along the cap margin when young, the dull brown tube mouths when young, the very shallow tubes, extremely acid taste of the slime on the cap, and the

grayish stains over the base of the stipe. It differs from *S. subluteus* in not having a baggy veil and the consistently paler pileus in age. There is a group of variants rather close to *S. acidus* var. *acidus*: *S. lutescens*, *S. pinorigidus* and Singer's redescription of *S. subluteus* (Farlowia 2: 269-270. 1945), in addition to the varieties of *S. acidus* described in this work.

Material studied. Maine: Parlin 15442. Michigan: Bartelli 274; 357. Mains 32-126; 5029. Shaffer 1893; 1925. Singer 8-22-53. Smith 36942; 42298; 43548; 43940; 57938; 62944; 62953; 62972. New York: Peck's type; Smith 1012. Pennsylvania: Kauffman 9-5-24. Canada. Ontario: Smith 9-11-36. Quebec: Smith 61798 (MICH).

30. *Suillus acidus* var. *intermedius* var. nov.

Pileus 5-10 cm latus, convexus, glaber, glutinosus, pallide luteus demum argillaceus; ad marginem appendiculatus; sapor acidulus vel mitis. Tubulis adnatis, luteis; stipes 4-10 cm longus, 5-12 mm crassus, annulatus, deorsum corticibus salmoneo-ochraceo. Sporae 8-11 × 3.5-4 μ. Typus: Smith 58078 (MICH).

Pileus 5-10 cm broad, convex to obtuse becoming plane or obscurely umbonate; glabrous, glutinous, pallid yellow when young, smooth to uneven, color "cartridge buff" to "cream buff" and slowly darkening to near "clay color" or a dingy cinnamon and then often streaked or spotted with the drying gluten; taste of glutinous material acid to mild; margin often appendiculate with soft yellow patches of veil tissue. Context thick, yellowish white to pale ochraceous, unchanging when cut; odor none or slight.

Tubes 4-6 mm deep in large caps, adnate to short decurrent, pale yellow; mouths small (about 2 per mm), pale yellow ("cartridge buff") and beaded with hyaline drops when young, darker yellow in age, often spotted in age, unchanging when bruised or becoming slowly brownish.

Stipe 4-10 cm long, 5-12 mm thick, equal or nearly so, solid, cortex salmon-ochraceous in lower part; surface pallid yellowish with darker dingy glandular spots which are dingy brown and slowly change to fuscous by old age, surface darkening where handled and one's fingers soon stained black from handling it; annulate near the apex with a gelatinous soft, pale buff band of veil tissue (a floccose layer interior to a gelatinous layer).

Spore deposit "Sayal brown" (no olive tone when fresh). Spores 8-11 × 3.5-4 μ, pale dingy ochraceous in KOH, and only slightly more tan-colored in Melzer's sol., wall very slightly thickened, in face view obscurely fusoid, in profile inequilateral and with apex often slightly upturned.

Basidia clavate, 4-spored, 16-20 × 4-6 μ, hyaline to pale ochraceous in KOH. Pleurocystidia in bundles with incrusting material around the base of the bundle dark bister in KOH, 38-35 × 8-12 μ, clavate to subfusoid, content hyaline or dark yellow brown, walls thin, smooth or at times with pigment incrustations. Cheilocystidia similar to

pleurocystidia but more numerous and more of them colored. Caulocystidia numerous and the entire caulohymenium becoming dark bister from amorphous material in age.

Hymenophoral trama somewhat divergent from a narrow parallel strand of floccose hyphae, subhymenial zone gelatinous, floccose hyphae colored to hyaline. Epicutis of pileus a collapsed trichodermium of pale dingy ochraceous hyphae (in KOH) with scarcely any granular content and little incrusting debris which are gelatinous and measuring 3-6.6 μ in diam., their outlines very distinct as revived in KOH. Clamp connections none.

Scattered to gregarious under pine, mostly under *Pinus resinosa* in the Great Lakes Area, though Singer reported it as associated with *Pinus strobus* in northern Michigan.

In northern Michigan where Singer made his observations it is impossible to be sure with which pine, *P. strobus* or *P. resinosa*, this variety is associated. Singer identified this variant as *S. subluteus*. Our observations over a period of years clearly indicate *P. resinosa* in many collections, but we cannot state that it is never clearly associated with *P. strobus* alone. We have not found it in the white pine plantations of southern Michigan. *S. pinorigidus* is close but according to descriptions differs in the orange-buff context of the pileus, the more orange hymenophore and the darker more olive colored mature caps (see *S. subluteus* also).

31. *Suillus acidus* var. *subalutaceus* var. nov.

Pileus 3-6 cm latus, glutinosus, variegatus, subalutaceus demum "vinaceous buff"; sapor mitis; stipes 8-10 cm longus, 10-15 mm crassus, glandulosus, annulatus; annulus viscidus. Sporae 8-11 × 3-3.5 μ. Typus: Smith 50221 (MICH).

Pileus 3-6 cm broad, obtuse to convex or in age with an obtuse umbo, surface thinly slimy viscid, somewhat variegated, color when young "pinkish buff" to more yellowish but soon changing toward vinaceous-buff ("vinaceous buff") especially on the variegations, often merely "light pinkish cinnamon", margin often appendiculate with remains of the veil. Context thick, pallid near the cutis, nearly lemon yellow above the tubes, odor and taste mild; where bruised slowly becoming vinaceous brownish.

Tubes 4-6 mm deep, (shorter than the depth of the cap), decurrent, pale yellow and staining vinaceous cinnamon where bruised or in contact with KOH; mouths round small, pale brownish, about 2 per mm.

Stipe 8-10 cm long, 10-15 mm thick, equal, pallid to yellowish, near apex the interior yellowish, solid, surface with numerous vinaceous-cinnamon glandular dots both above and below the annulus; annulus a broad band of floccose material, the outer layer gelatinous.

Spores tawny to "snuff brown" in deposit, 8-11 × 3-3.5 μ, smooth, subfusoid in face view, inequilateral in profile, dingy pale yellowish in KOH and pale brownish in Melzer's.

Basidia 4-spored, clavate, yellowish in KOH and slightly more so in Melzer's sol. Pleurocystidia in clusters and more or less embedded in amorphous brown material; individual cystidia $30-48 \times 5-7 \mu$, cylindrical or nearly so, mostly hyaline but yellowish to brown in some. Cheilocystidia mostly in a palisade on tube edge, hyaline to yellowish in KOH but amorphous pigment present around the basal portion, $30-45 \times 5-6 \mu$, subcylindric. Caulocystidia in large clusters almost obscured by amorphous material as revived in KOH; individual cystidia with dark brown content, $40-65 \times 5-8 \mu$, narrowly clavate to cylindrical; amorphous pigment also present along the caulohymenium.

Tube trama of gelatinous hyaline somewhat divergent hyphae, central strand of parallel slightly colored floccose to subgelatinous hyphae. Epicutis of pileus a gelatinous layer of semidecumbent to interwoven hyphae (originating as a trichodermium), $2.5-4 \mu$ in diam. and content pale dingy ochraceous in KOH. Clamp connections absent.

Gregarious in mixed stand of Norway and white pine, Tahquamenon Falls State Park, Aug. 22, 1945. Smith no. 50221-type. One additional collection from near St. Ignace, the same date.

This appears to be a color variety of *S. acidus*. It is not yellow, the taste of the slime on the cap is mild and the spores are slightly larger than in the type variety. It is close to *S. pinovigidus* but lacks the color of the flesh and interior of the stipe of that species and has brown tube mouths when young. Since the acid taste of the gluten is a feature of many species of *Suillus* at least to some degree, and since the taste in *S. acidus* is not one of the major features on which the justification for this species rests, (it was given prominence in the selection of a species epithet), we prefer to describe Sm-50221 as a variant of *S. acidus*.

32. *Suillus cothurnatus* Singer, Farlowia 2: 261. 1945.

Suillus cothurnatus ssp. *aestivales*, Singer loc. cit.

Boletus luteus var. *cothurnatus* (Singer) Murrill, Lloydia 11: 24. 1948.

var. *cothurnatus*

Pileus 1.6-4 cm broad, obtusely conic to convex-subumbonate, finally with a somewhat flattened disc, viscid, glabrous, smooth, naked, pale ochraceous to clay color (or ochraceous on margin and disc pale ochraceous tawny to clay color), sometimes marbled with these colors. Context marbled "orange buff" and "light buff", unchanging, soft and somewhat watery; odor fragrant as in *S. punctipes* or none, taste not distinctive.

Tubes pale yellow ("ochraceous buff" to "colonial buff") near cap margin or overall, or appearing spotted with orange ("capucine orange"), at times more of a greenish yellow, when mature (near "honey yellow"), adnate to decurrent by a tooth, about 4 mm deep; pores pale yellow to orange yellow, irregular, some radially elongate and 0.5-1.0 mm in

radial direction, but never more than 0.5 mm transversely.

Stipe 2.3-4 cm long, 4-7 mm thick, equal or tapering downward, solid, pallid to brownish or grayish pallid, or somewhat lutescent, finally darkening to "hair brown", glandular dotted with dark brown dots above and usually below the annulus. Veil complete (enclosing the tube cavity in young specimens, whitish, outer layer glutinous, grayish by maturity, annulus inversely infundibuliform (lower edge flaring more than upper edge) about as high as broad.

Spores $7.8-9.8 \times 2.7-3.2 \mu$, most frequently $8.3-8.5 \times 2.8-3 \mu$, pale melleous, smooth, ellipsoid-oblong to subcylindric; basidia $19-22 \times 5.8-6.8 \mu$, 4-spored; cystidia $40-68 \times 6.5-10.3 \mu$, strongly to moderately strongly incrustated, mostly elongate-clavate to broadly clavate, more rarely more fusoid or cylindrical; dots of the surface of the stipe consisting not only of the ordinary *Suillus*-type cystidia, but also of hyaline structures recalling the scales of *Leccinum* (*Krombholzia*) showing parallel, multi-septate hyphae terminating in a palisade of sterile, large basidium-like bodies (dermatopseudoparaphyses), and cystidia-like bodies (dermatocystidia of the *Leccinum*-type, i.e., rather small, hyaline, ampullaceous with narrowed bases); trama truly bilateral; all hyphae without clamp connections.

Chemical reactions. KOH on surface of pileus "bone brown", on pores dark dull lilaceous; on context of pileus "dark purple drab"; on context of stipe "dull Indian purple" or "deep purplish vinaceous"; on glandulae dark lilac. NH_3 on surface and context of pileus and on pores little or slow reaction, especially in young specimens; on cortex of stipe "vinaceous rufous" when quite mature. NH_4OH on surface of pileus "cinnamon drab"; on context of pileus "cinnamon drab" or indeterminably darkening; on pores and tubes lilaceous pink, becoming drab, old specimens "vinaceous rufous" becoming testaceous; on context of stipe lilaceous pink, in age slowly to "dark vinaceous brown", middle portion more dark brown. FeSO_4 very deep olive to black.

On the naked or mossy ground and on mossy trunks in hammocks (low and high as well), more rarely in flatwoods and scrub, always in the neighborhood of either *Pinus palustris* or *P. taeda* though occasionally as far as 11 miles from the nearest pine tree, scattered or in small groups, fruiting from May to September in north Florida, in central Florida until October.

Distribution. North and central Florida.

Material studied. FLA. Highlands Co., Highlands Hammock State Park, R. Singer, F478, F478a, etc. (the Type is F478) (FH); Lake Co., Eustis, R. Thaxter (det. Singer (FH); Levy Co., Gulf Hammock, W. A. Murrill, F18751 (FLAS); Alachua Co., Gainesville, R. Singer, F2164 (FH); near Dayville, R. Singer, F3035 (FH); Tung Oil-mill on Newberry Road, W. A. Murrill, F17882 (FLAS); there were notes by W. A. Murrill at FLAS indicating the occurrence of what must be this form in Columbia Co.

Observations. Our account is taken from Singer. According to the present rules of nomenclature, one of the two subspecies described by

Singer must bear the epithet *cothurnatus*. We have selected the first one described because it was indicated as the "type variety" by Singer.

The distinctive features appear to be the baggy annulus, pale yellow to pale yellow-brown cap, and pallid to brownish stipe with brown glandular dots, the fragrant odor, and the "dermatopseudoparaphyses" on the stipe. In keeping with our policy of recognizing all variants which seem to have a claim to distinction, we are recognizing Singer's species here. We have not seen fresh material, and hence hesitate to reduce it to varietal status under *S. subluteus*. The inflated cells on the stipe seem to be a distinctive character.

33. *Suillus cothurnatus* var. *hiemalis* (Singer) stat. nov.

Suillus cothurnatus ssp. *hiemalis* Singer, Farlowia 2: 263. 1945.

Pileus 5-6.3 cm broad, pulvinate becoming convex with a depressed center, glabrous, smooth, pileus dingy brown when young (near "wood brown" to "tawny olive"), becoming orange or finally dark dingy yellow brown (near "bister"). Context marbled "zinc orange" and "pinkish buff" or "buff yellow" near pileus surface and sometimes near tubes, unchanging; odor agreeable as in *S. punctipes*, or none; taste mild to slightly acid.

Tubes 7-8 mm deep, pale yellow to ochre yellow, slightly more olivaceous in age, adnate, becoming slightly decurrent at times, or with only a decurrent tooth; tube mouths concolorous with sides of tubes, with some glandular spots the same color as those of the stipe, small, about 2 per mm, rarely 1 mm broad, not quite round.

Stipe 3-6 cm long, 9-13 mm thick, solid, equal, pallid or whitish, becoming "light cinnamon drab", at the base "light cinnamon drab", to "light salmon orange", dingy yellowish with age, glandular dotted above and below the ring with dull brown glandular dots which tend to blacken in age. Veil pallid, later olivaceous to olive gray, or concolorous with pileus, breaking to leave an annular sheath which separates from stipe at lower edge, collapsing rapidly after breaking, the outer surface gelatinous, the inner fibrillose membranous.

Spores 7.5-9.8(12.3) × 2.7-3.5(5) μ , ellipsoid-oblong to cylindrical, smooth, pale melleous; basidia 20-26 × 6-7 μ , 4-spored; cystidia 34-90 × 4.7-11 μ , with castaneous or melleous incrustations, elongately clavate, not very numerous except at certain spots; trama and pellicle as in var. *cothurnatus*.

Chemical reactions. KOH on surface of pileus plumbeous-gray; same reaction on tubes and context. NH₃ on surface of pileus almost negative; on pores quickly "carrot red", then "vinaceous rufous", sometimes even "Hay's russet"; on context "carrot red" to "vinaceous rufous", sometimes even "Hay's russet", sometimes bright and lasting pinkish red in the base. NH₄OH on surface of pileus slowly as with KOH; on pores as with NH₃, then slowly as with KOH on context as on pores. H₂SO₄ on context very deep olive to black (a very sensitive reaction).

On soil under *Pinus palustris*, *P. taeda* and *P. australis*, fruiting in Florida from October (north Florida) or November to January, farther north apparently during the fall months.

Distribution. From North Carolina to Florida. In Florida rather frequent in the north and probably also occurring in central Florida.

Material studied. FLA. Alachua Co., Gainesville, December and January 1942-43, R. Singer, F1666 (Type), F1666a (FH); Sugarfoot Hammock, January 1943, R. Singer, F1666b (FH); Orange Heights, November 1938, W. A. Murrill, F194000 (FLAS); Gainesville, W. A. Murrill, 8778; from schedulae (with the specimens removed) at FLAS by W. A. Murrill, it would seem that ssp. *hiemalis* also occurs in Marion Co.

Our description is from that of Singer. This variety is apparently distinguished by the browner pileus, the salmon-orange stipe base and slightly longer spores. The spores are almost exactly like those of the type of *S. subluteus*.

34. *Suillus subluteus* (Pk.) Snell, ex Slipp & Snell, Lloydia 7: 34. 1944.

Boletus subluteus Peck, Bull. N.Y. State Mus. 1: 62. 1887.

Pl. 28.

Pileus 3-8 cm broad, obtuse to convex, becoming obtusely umbonate or expanding to nearly plane; surface glabrous, glutinous; color "light ochraceous salmon" to "light ochraceous buff" (salmon-buff to pale buff) when young and fresh, gradually becoming darker dingy yellow-brown (often finally near "bister"), typically developing a fuliginous or finally fuscous cast from the darkening gluten or streaked with these shades over an obscurely ochraceous ground color. Context thick at first, pale salmon-ochraceous to light ochraceous-buff, darkening somewhat on standing, taste (especially the gluten) acid at first but soon fading, odor not distinctive.

Tubes 6-10 mm deep (often deeper than depth of context), adnate to short-decurrent, pale olive-yellowish young, becoming light ochraceous buff (pale yellow) to orange-buff; mouths round at first and 1-2 per mm, becoming somewhat angular in age, yellowish with brownish spots (from clusters of cheilocystidia).

Stipe 4-7 cm long, 6-12 (16) mm thick at apex, equal or enlarged downward, solid, cortex ochraceous (color of stipe as in *Gomphidius rutilus*), central area paler, soon blackening around the worm holes; surface pinkish-ochraceous at first and dotted above and below the baggy annulus with vinaceous dots which slowly blacken; annulus with a thick inner layer of soft floccose tissue and with a gelatinous layer over the exterior (under-side), in young specimens the lower margin flared outward in a rather characteristic manner, upper edge flared even more, in age collapsing and rather inconspicuous.

Spore deposit dull cinnamon after moisture escapes. Spores 7-10 (11) × 2.3-3.2 μ , smooth, pale greenish-hyaline to yellowish in KOH,

pale cinnamon to yellowish in Melzer's sol., narrowly oblong to narrowly elliptic in face view, inequilateral in profile, with the apical end slightly upturned.

Basidia 4-spored, 16-20 × 5.5-6.6 μ, clavate, nearly hyaline in KOH, yellowish in Melzer's sol. Pleurocystidia in fascicles with brown incrusting material surrounding the bundle at the level of the hymenium as revived in KOH, when fresh and mounted in 2% KOH dark lilac to lilac brown; individual cystidia 30-45 × 7-11 μ, clavate, hyaline or with colored content as revived in KOH. Cheilocystidia similar to pleurocystidia or obfusoid, many with dark brown content as revived in KOH, colored like pleurocystidia in KOH when fresh. Caulohymenium with a broad gelatinous subhymenium, with numerous fascicles of caulocystidia surrounded by copious bister (revived in KOH) amorphous incrusting pigment; also some areas of the hymenium incrusting with similar pigment but no cystidia seen in them; caulobasidia in an interrupted hymenium with subgelatinous filamentose hyphal projections between them but no apical differentiation into dermatopseudoparaphyses (enlarged hyphal end cells) seen.

Tube trama with a colored to hyaline narrow central strand of parallel floccose hyphae, from this gelatinous hyphae diverge to the subhymenium. Epicutis of pileus a tangled trichodermium of narrow (2-4.4 μ in diam.) branched hyaline to yellowish hyphae, considerable debris present in the layer. Clamp connections none.

Gregarious under jack pine, Michigan; late August into September, not common. The type (from New York) was examined, and the microscopic data on revived material are from it.

The amorphous pigment around the clusters of pleuro- and cheilocystidia is vinaceous to lilaceous in KOH in fresh material, but dark bister in KOH mounts of dried material. The clusters of pleurocystidia are rare to scattered and in some mounts cannot be demonstrated. The species is at the same time one of the most distinctive in the genus and the one most frequently misidentified by all mycologists in North America starting from Peck himself and including the present authors prior to their examination of the type. Smith included it in his Mushroom Hunter's Field Guide, pl. 48, as *Boletus cothurnatus*. This identification was based on Singer's recognition and identification of the species in northern Michigan during the season of 1953.

A study of the type of *Boletus subluteus* Peck shows clearly that it is the same as *Suillus cothurnatus* Singer, his northern variant, which he stated was not quite identical with the type from the southern United States. There is a painting with the type of *B. subluteus* at Albany which shows the heavy baggy veil on the young specimen, and such young specimens are among those preserved in the type collection. Peck's painting shows the cap with basic ochraceous colors flushed with dull salmon, exactly as we have seen the species in northern Michigan. The spores are almost identical with the exception that in the type there is more variation in length or width, but not necessarily both combined. Smith, who made the actual comparison with the type, is convinced that

S. subluteus and Singer's northern variant of *S. cothurnatus* are the same.

For a long time we wondered why Peck had not encountered *S. cothurnatus*. Obviously he had and had described it. It also explained why Peck did not give a detailed comparison of *S. acidus* and *S. subluteus*; they are so different he did not see any need to do so.

S. cothurnatus must now be regarded as a southern species differing from *S. subluteus* in the dermatopseudoparaphyses over the upper part of the stipe. The description of *Suillus cothurnatus* in Snell, Singer & Dick (1959), is the one Singer drew from the material he found in northern Michigan and he did not describe dermatopseudoparaphyses on the stipe. We have not studied any of Singer's Florida collections.

Material studied. Michigan: Shaffer 1947. Smith 36961; 42030; 42050; 42290; 42475; 43784; 43936; 50235; 50371; 50403; 58019; 58196 (MICH).

35. *Suillus megaporinus* Snell & Dick. Mycologia 48: 302. 1956.

Carpophore squat, short-stipitate, broadly turbinate.

Pileus 2-7 cm broad, plane to somewhat depressed, occasionally subumbonate; surface apparently subviscid, if not viscid, glabrous or perhaps in places appressed-tomentose, with or without scattered fibrillose or fibrillose-squamulose ornamentations; yellowish to pale yellowish-tan or avellaneous, the fibrils or scales reddish-brownish, when dry between cream buff and chamois, darker and dingy reddish-brown when old. Context pale reddish-tan, unchanging.

Tubes deeply decurrent, boletinoid to coarsely lamellate-tubulose with thick lamellae or veins and large compound "tubes" up to 5 mm long, with the walls and edges glandular-dotted, and the openings or "pores" up to 7 or rarely 10 mm radially and 1 mm or more broad; bright yellow becoming rusty with age.

Stipe 8-20 mm long, about 10 mm at apex and 5-7 mm near base, central to more or less eccentric, very short, tapering downward; tomentose to pubescent, perhaps minutely hispid, perhaps more or less scabrous, thickly glandular-dotted to base, concolorous, the tomentum at base buff to rusty-orange. Veil covering the tubes when young, contracting where the tubes terminate on the stipe to a flaring, membranous annulus, which may disappear entirely or may leave remains variously membranous or fibrous on the stipe or on the lower tubes.

Spores perhaps somewhat olivaceous in deposit, hyaline to very faintly yellowish-greenish, elliptical, (5-) 7-10 × 3.3-3.8 μ. Cystidia of two kinds, in the hymenium hyaline, clavate to lanceolate, 25-50 × 4-5 μ, and in the glandular dots, yellowish to brownish, irregularly clavate to irregularly wrinkled or undulating, 50-105 × 5 μ.

In grass or moss at the edge of mountain meadows near *Pinus contorta* and *Abies concolor* at 7000 feet, at Huntington Lake, California. Late August and early September.

The type collection is No. 2111 in WHS Bolete Herbarium, and there are specimens in the Herbarium of the Department of Botany of the University of California.

The chemical reactions of dried material are as follows: NH_3 pileus more or less violet to violet-gray or brownish, flesh faintly rosy to dark lilac, tubes definitely red, stipe more or less so; acids--pileus and tubes orange and flesh orange to reddish; KOH--flesh deep lilac and tubes red; FeSO_4 , pileus somewhat bluish-gray and flesh possibly somewhat so.

This species apparently belongs in Singer's Subsection Hirtellini of the Section Granulati (1c, pp. 269 and 273).

In 1949, Mrs. Phyllis Gardner McMillan, then Herbarium Botanist at the University of California, sent some specimens from frequent collections by Mrs. Morton R. Gibbons at Huntington Lake, Fresno County, California, with notes on fresh and dried material. Mrs. Gibbons sent abundant material later.

The carpophores are noteworthy for their squat appearance, their short stipes, and especially the coarse hymenophore with very large "tubes" and very thick, irregular veins or lamellae. The hymenophore and stipe are glandular-dotted, the stipe thickly so to the base. A veil covers the hymenophore when young and breaks to form a thin but ample annulus which later may entirely disappear.

All the above data and comments are from the original account. This by all odds is one of the most unusual species in the genus. We have not seen fresh material.

36. *Suillus umbonatus* Dick & Snell, Mycologia 52: 446. 1960.

Pls. 29, 30 and 31.

Pileus 3-5 (9) cm broad, obtuse when young, expanding to plano-umbonate or remaining convex-umbonate, in some the margin uplifted, surface viscid, typically uneven and often appearing streaked from dried gluten, color typically "deep olive buff" or toward the margin somewhat paler, young caps often evenly colored, at maturity the margin often avellaneous to dingy cinnamon from dried gluten. Context pale yellow, soon dingy cinnamon when cut, very soft, odor none, taste slightly sour.

Tubes not readily separable but separating cleanly, 4-6 mm deep, adnate to subdecurrent, mouths compound to irregular, about 1-1.5 mm broad, obscurely radiate to typically boletoid, pale yellow to greenish yellow ("chamois", at maturity "deep colonial buff"), staining sordid pinkish cinnamon when bruised.

Stipe (2.5) 3-5 (9) cm long, 4-8 (12) mm thick, equal, solid, pale yellow inside and on the outside above the annulus, paler to pallid below or whitish but base sometimes discoloring, surface glandular dotted with pallid to yellowish dots both above and below the gelatinous median to superior annulus, becoming dingy cinnamon where handled; gelatinous veil soon dingy pinkish cinnamon.

Spore deposit dull cinnamon ("Sayal brown"). Spores 7-9 (10) \times 4-4.5 μ , smooth, yellowish in KOH, darker yellowish to pale tawny in Melzer's sol., narrowly elliptic to nearly oblong in face view, in profile obscurely inequilateral.

Basidia 20-26 \times 5-7 μ , clavate, 4-spored, hyaline or nearly so. Pleurocystidia scattered, or present in bundles with brown amorphous pigment around base of bundle; individual cystidia 28-46 \times 5-8 μ , cylindrical, clavate, or narrowed at the apex, content hyaline to yellowish brown, and some amorphous debris adhering to the outer surface. Cheilocystidia similar to pleurocystidia. Caulocystidia in bundles surrounded by brown pigment and similar to cheilocystidia, and unincrusted septate (near base) crooked filaments 30-50 \times 4-6 μ also present in a dense to lax turf; the subhymenium gelatinous.

Tube trama of gelatinous hyaline hyphae divergent to the subhymenium. Epicutis of pileus a thin layer of gelatinous to subgelatinous hyphae 3-6 μ in diam. and yellowish in KOH, the ends often ascending to form an obscure turf. Clamp connections absent.

Gregarious to subcespitate under *Pinus contorta* Oregon, Washington and Idaho in the United States, late summer and fall, often common.

Discussion. The identity of the western species of *Suillus* in this group seems to be in a confused state for a number of reasons. To begin with Smith (1949) published an account of *Suillus (Boletus) sibiricus* based on his collections from Oregon and Idaho. These were found under *Pinus contorta*. His identification was based on Singer's determination of some of this material. His description, however, was drawn entirely from American specimens and included nothing from Singer's original account. Secondly, Dick and Snell (1960) published *Suillus umbonatus* on specimens McKnight sent them from Utah. When McKnight was in the field with Smith in 1962 at McCall, Idaho, he quickly identified the fungus Smith was calling *S. sibiricus* as *S. umbonatus*. A check against the characters of *S. umbonatus* as described shows that some of the macroscopic features are described from fresh and some from dried material. In most instances those from dried material are so designated. However, certain features presumably from the fresh specimens, are misleading if so interpreted. The tubes are a greenish yellow, not wax yellow and the stipe is not "rather thickly reddish-brown glandular dotted to the base". If this condition ever applies to the stipes of this species it is when they are dried. When fresh the glandular dots are whitish to pale yellow and very inconspicuous. Also, it is not stated whether the annulus is floccose or gelatinous, and the dimensions of the stipe are not given. Collection F 1470, Aug. 15, 1956, at Hayden Creek Camp Grounds in Utah, by Kent McKnight, is unquestionably this species.

We believe it proper and correct to assume under these circumstances that McKnight knows the fungus he sent Snell and hence do not hesitate to identify *Suillus sibiricus* (Smith 1949) as *S. umbonatus* (which in 1949 was still undescribed). We have given here a revised description based entirely on collections studied by Smith in the fresh condition. In

summary, the outstanding features of *S. umbonatus* are: The narrow stipe, pallid to pale yellowish glandular dots on the stipe in freshly matured specimens, the gelatinous veil which soon stains cinnamon, the relatively wide tube mouths at maturity and the association with *Pinus contorta* (2-needle rather than 5-needle pine species).

Once this species was disposed of the question of the occurrence of *Suillus sibiricus* in North America was considered. At this point we tried Singer's description in our key and came out directly to a "new" species which we had from under white pine in northern Idaho (see *S. sibiricus* of this work for a description). From Singer's description it appears that the diagnostic features of the species are: The dingy yellow to olive-yellow pileus with the brown spots, the floccose veil forming a roll of soft tissue on the pileus margin, the annulate stipe, the spores up to 11.5 μ long, the stipe up to 15 mm thick and staining reddish at the base, and the occurrence under 5-needle pines. Since Smith 54266 has all these features we believe it is the element in our *Suillus* flora which should be known under the name *S. sibiricus*, and we have so placed it. There are a number of minor differences, which need further study, which might eventually lead to the recognition of an American variety, but we are not prepared to propose one at present.

Material studied. California: Smith 8670; 8940; 56064; 56198. White 287. Idaho: Smith 23559; 23565; 46166; 46263; 46775; 46901; 53211; 53327; 53559; 60063; 60082; 60390; 60436; 65752; 66235; 66292. Oregon: Gruber P-58. Sipe 319; 338; 925; 1164. Smith 19648 (as *S. sibiricus* by Singer); 19649; 23729; 24151; 24121. Washington: Imshaug 2154; 2158 (MICH).

37. *Suillus albidipes* (Peck) Singer, Farlowia 2 (March): 45. 1945.

Boletus albidipes Peck, N.Y. State Mus. Bull. 57: 22. 1912.

(Not *Boletus granulatus* var. *albidipes*, Ann. Rep. N.Y. State Mus. 54: 168. 1901.

Suillus albidipes (Pk) Snell, Mycologia 37(June): 378. 1945.

Suillus granulatus subsp. *albidipes*, (Pk) Snell & Dick Mycologia 53: 232. 1961.

Pl. 32-33.

Pileus 4-10 cm broad, convex becoming broadly convex, surface glutinous to viscid, color white or pallid varying to near "vinaceous buff" on young stages, by maturity pale ochraceous or varying toward vinaceous cinnamon, or darker (much as in old specimens of *S. granulatus*), when old often spotted by the drying gluten as in *S. granulatus*; margin at first decorated by a dry cottony roll of whitish to vinaceous buff material representing a false veil (never attached to stipe), in age this tissue collapsing and evanescent but at times forming pallid patches along the margin in mature specimens. Context white, slowly becoming yellow (by maturity), odor and taste not distinctive, KOH pink, then lilac-gray on context and gluten; FeSO₄-olive blue on context, slowly

olive gray on pileus surface.

Tubes about 5 mm deep where context is about 1 cm deep, pale dingy yellow, adnate becoming adnexed; mouths round, minute (± 3 per mm), yellow (like the sides), typically not staining when bruised.

Stipe 3-6 cm long, 10-15 mm thick, equal, bulbous, or tapered at base, solid, yellowish within but cortex of midportion reddish in age, lemon chrome above, in age dingy brown in the base; surface white at first and not glandular dotted, but in age dark very fine glandular dots present lower down, slowly yellow above and reddish brown below.

Spore deposit dull cinnamon as soon as moisture has escaped (about "Sayal brown"). Spores 6.6-8.8 \times 2.5-3 μ , thin-walled, greenish hyaline in KOH, yellowish in Melzer's reagent, oblong in face view, oblong to obscurely inequilateral in profile, with 1-2 oil droplets.

Basidia 15-20 \times 4.4-6.6 μ , clavate, sterigmata about 2.5 μ long; 4-spored, content hyaline in KOH. Pleurocystidia 26-35 \times 8-11 μ , clavate, hyaline in KOH, or content dingy yellow brown, rare, in fascicles mostly near edge and with dingy yellow brown encrusting pigment surrounding the bundle at the level of the hymenium. Cheilocystidia similar to pleurocystidia but as dried more with yellow brown content and more amorphous pigment present at the level of the basidia (or gill edge entirely of short clavate colored to hyaline cells). Caulocystidia 30-50 \times 7-10 μ , in fascicles, clavate to narrowly fusoid, some with bister content, some hyaline to pale ochraceous, with heavy deposits of dark rusty brown pigment around the bases of the bundles. Caulobasidia in an hymeniform layer with a gelatinous subhymenium. Clamp connections absent.

Hymenophoral trama of a central strand of brownish to hyaline hyphae parallel in arrangement and 4-7 μ in diam., with hyaline somewhat divergent and gelatinous hyphae leading to the hymenium, hyaline to brownish in Melzer's sol.

Epicutis of pileus a gelatinous trichodermium becoming indistinct because of the way the hyphae become decumbent and tangled, dingy ochraceous in KOH and Melzer's; hyphae 2.2-6 μ in diam., smooth, content with scattered, fine hyaline granules (in KOH).

Scattered in 2-needle but especially in 5-needle pine forests (*P. contorta*, *P. strobus*, and *P. monticola*), New England to the Pacific Coast, often common in pine plantations in the Great Lakes Region.

The taxonomy of this species has been one of the most confused situations in the family, but we hope our solution is reasonably close to the truth of the matter. In our estimation the confusion started with Peck, who first described *Boletus granulatus* var. *albidipes* in 1901. This fungus was characterized by an annulus or at least a slight annular zone (see our *S. pseudobrevipes*). Then in 1912 he described *Boletus albidipes* sp. nov. (!) and cited the above variety as a synonym. However, on p. 168 (loc. cit), he gave a good description, for the times, and it is clear that an annulus was not present (see both the description and illustration). We have two distinct species, *S. pseudobrevipes* which is like Peck's 1901 description of *B. granulatus* var. *albidipes*, and

S. albidipes which is like his 1912 description and illustration. The former is not limited to white pine whereas the latter is characteristically found under white pine. After Peck, however, many authors, including Singer (1945), and Snell & Dick (1961) have paid little attention to the veil (or false veil) of *S. albidipes* and have admitted collections with this feature to both *S. brevipes* and *S. granulatus*. Snell & Dick (1961) have tried to recognize *S. albidipes* on the basis of spore size, but the ranges they give are not convincing. There is actually no need to bring *S. placidus* into the picture as it is easily distinct from *S. albidipes* at a glance in the field and by the conspicuous glandular smears on the stipe if one cares to disregard aspect.

We limit *S. albidipes* to collections with a false or incomplete veil, the generally paler color than in *S. brevipes*, and the lack of brown stains on injured young tubes. As such this is not an uncommon species in the white pine areas of North America where we have collected, but it is not limited to white pine. This is clearly the Peck concept of 1912. It is readily distinct from *S. granulatus*, in which the margins of the young sporophores are naked or merely thinly coated with a white appressed tomentum. In both species the pileus color is an extremely variable feature within the ranges indicated and hardly serves to separate the two.

We have encountered a form of *S. luteus*, growing under Scots Pine, in which the veil remnants adhere to the pileus margin leaving no traces on the stipe. In this form, however, the presence of glandular dots on the stipe at once excludes *S. albidipes*. Also, the outer layer of the veil has the purplish umber fibrils as in *S. luteus*. These however, are easily overlooked after the veil has broken. We cannot comment, from first hand knowledge, on the southern material described by Singer (1945), but the deep cinnamon-rufous color of the young pileus and the somewhat glandular stipe indicate that the collections might possibly belong to the exannulate form of *S. luteus*. Actually, what is needed to further resolve the taxonomy of this group is a study of the complete biology of the variants and the time for that appears to be some distance in the future. In order for studies of morphological and chemical features to contribute further to the taxonomy of this group, complete data should be recorded for each collection for all features. Only by doing this can we build up both a detailed and reliable picture of the variation occurring between established mycelia in nature.

Material studied, Michigan: Kauffman 10-7-24; Smith 58179; 66419; 66455; 64747. Thiers 4542 (MICH).

38. *Suillus glandulosipes* Thiers & Smith sp. nov.

Pileus 7-12 cm latus, viscidus, fibrillosus demum glaber, "ochraceous buff" vel "pinkish buff" vel "verona brown" vel "Mikado brown" demum "cinnamon buff" vel "pinkish cinnamon" vel "cinnamon rufous"; caro flava demum "avellaneous", immutabilis; sapor mitis; tubuli decurrentes vel subdecurrentes, "cream buff" dein "chamois", immutabili;

stipes 5-11 cm longus, 1-2 cm crassus, siccus, punctatus, flavus, solidus, siccus; caro flava demum apice "avellaneous" et basi badia; sporae 6-9 × 3-4 μ; pleurocystidia in fasciculis, rara, 43-65 × 8-12 μ; cheilocystidia numerosa, in fasciculis, atra vel badia in KOH, pleurocystidia similia; cuticula pilei innexa, viscida; caulocystidia in fasciculis. Typus: Thiers 9335 (SFSC).

Pileus 6-12 cm broad at maturity; convex when young becoming broadly convex to plano-convex to plane or shallowly depressed with age, often highly uneven to undulating or irregular toward the margin with age; surface viscid, when young glabrous or with irregularly distributed fibrils near the margin and more rarely on the disc, typically becoming glabrous with age, with the gluten drying in streaks, rarely appearing somewhat fibrillose and pitted or rugose with age; when young colored yellow to pale tan or reddish cinnamon ("pale ochraceous buff" to "pinkish buff" to "vinaceous cinnamon" to "orange cinnamon" to "cinnamon" to "apricot buff" to "ochraceous orange", unchanging with age or becoming near "ochraceous tawny" to "Mikado brown" to "verona brown" to "warm sepia" to "cinnamon rufous"); margin strongly incurved to inrolled, with a conspicuous white cottony roll when young, disappearing with age, entire. Context 1-2 cm thick on the disc, white when very young, changing to pale yellow (near "marguerite yellow" to "cartridge yellow" to "ivory yellow"), unchanging when bruised or rarely becoming pale "avellaneous" with age, firm; taste and odor not distinctive.

Tubes decurrent to subdecurrent to occasionally shallowly depressed, 0.4-1 cm long, when young colored "warm buff" to "light ochraceous buff" to "pale ochraceous buff" to "cream buff" changing to "antimony yellow" to "chamois" with age, unchanging when bruised, often with reddish brown glandulae on the mouths; pores angular, 1-2 per mm, concolorous, unchanging when bruised.

Stipe 4-11 cm long, 1-2 cm broad at the apex, equal, solid; flesh white when young becoming colored near "warm buff" to "ivory yellow" with age, usually unchanging when exposed, but sometimes darkening slightly at the base, or becoming vinaceous in older carpophores; surface dry, white to "marguerite yellow" to "primrose yellow" to occasionally "pale pinkish buff", unchanging with age; densely colored with irregularly shaped glandulae which are colored dark brown to black, and often stain dark brown when handled; no annulus; white mycelium at the base.

Spores 6-9 (12) × 3-4 μ, hyaline to pale ochraceous in KOH, smooth, thin-walled, cylindric to subellipsoid; basidia 23-28 × 5-8 μ, clavate, 4-spored, hyaline, content often granulose in KOH.

Pleurocystidia very rare, found only near the tube mouths, fasciculate, basal portion staining dark brown revived in KOH, apical portion typically remaining hyaline, contents sometimes staining brownish, 30-50 × 7-12 μ, no solitary cystidia seen. Cheilocystidia very abundant, completely occupying the margin of the tube mouths; dark brown in KOH, similar in size and shape to the pleurocystidia. Surface of stipe

differentiated as a gelatinous layer with numerous fascicles of darkly staining caulocystidia similar to the pleurocystidia.

Tube trama hyaline, divergent from a distinct mediostratum, subgelatinous, hyphae up to 7 μ broad; tissue at junction of pileus and tube trama often staining pale vinaceous in KOH. Pileus trama interwoven, homogeneous. Cuticle differentiated as a broad (330 μ) layer of interwoven hyphae, gelatinous, contents of hyphae appear brownish-granulose in KOH, outermost hyphae often somewhat enlarged and incrustated, hypodermium well differentiated as a compactly interwoven layer staining dark brown in KOH. Clamp connections absent.

Gregarious to cespitose in humus under scrubby lodgepole pines (*Pinus contorta*) in pygmy forest, Jackson State Forest near Mendocino, Mendocino County, California. Thiers 9335 - type (SFSC). Other collections: California: Thiers 8394; 9307; 9332; 9472. Breckon 40. Michigan: Smith 67583 (MICH).

This species is often very abundant under pines in the scrubby pygmy forest of northern California. It has been found occurring in troops of as many as 50-100 carpophores and is often found associated with *S. tomentosus*, *S. brevipes* and *S. granulatus*. It is obviously in the *S. granulatus* - *S. albidipes* series but appears distinct from either of these species by the combination of the conspicuous cottony tissue on the cap margin when young and the numerous conspicuous glandulae of the stipe. The length of the stipe as well as the presence of the conspicuous glandulae also distinguish it from *S. brevipes*.

Smith 67583 from Rose City Michigan had the characteristic false veil of this group, the pileus was covered with appressed patches of matted tomentum, and the upper half of the stipe even in young specimens was distinctly glandular dotted. The tubes did not stain brownish when injured. We assign this collection to this species. The cap is not spotted in age as for the American *S. granulatus* and for *S. albidipes*.

39. *Suillus sibiricus* (Singer) Singer, Farlowia 2: 260. 1945.

Ixocomus sibiricus Singer, Rev. de Mycol. 3: 46. 1938.

Boletus sibiricus (Singer) Smith, Mushrooms in Their Natural Habitats p. 220. 1949. Sawyer's Inc., Portland, Oregon.

Illus. Singer 1938, pl. 4, figs. 1-2.
Pls. 34-35.

Pileus 3-10 cm broad, convex to obtuse, expanding to plane or slightly umbonate, surface viscid to glutinous, spotted overall but especially toward the margin with snuff-brown to cinnamon-brown appressed squamules, ground color "chamois" to dingy olive-yellowish; margin at first with a soft cottony roll of pale dingy yellow veil remnants, or the roll often breaking up into denticulations and finally evanescent. Context pale olive yellow ("deep colonial buff"), slowly dull cinnamon when cut, taste acidulous, odor none or slight.

Tubes 1-1.5 cm deep, adnate becoming decurrent, dingy ochraceous

to near "honey yellow"; mouths angular and often compound, 1-2 mm broad, dingy ochre yellow, staining dull cinnamon when bruised.

Stipe 5-10 cm long, 7-15 mm thick at apex, solid, dingy olive-yellowish within, surface dingy ochre yellow above, soon stained vinaceous at base, glandular dotted overall; occasional specimens annulate but veil typically hanging on the edge of the pileus.

Spore deposit "Sayal brown". Spores 8-11 \times 3.8-4.2 μ , narrowly elliptic in face view, inequilateral in profile, pale dingy ochraceous in KOH, pale tawny to yellowish in Melzer's sol. smooth, a few reddish tawny.

Basidia 4-spored, 22-28 \times 5-7 μ , clavate, nearly hyaline in KOH, yellowish in iodine. Pleurocystidia in bunches surrounded by brown amorphous pigment, individual cystidia 40-70 \times 6-9 μ , cylindrical to narrowly clavate and often crooked, content of yellow to dark brown pigment. Cheilocystidia similar to pleurocystidia, many somewhat ventricose, masses of amorphous pigment encrusted on the gill edge. Caulocystidia similar to cheilocystidia. Caulohymenium with a gelatinous subhymenium.

Tube trama of gelatinous divergent hyaline hyphae coming from a narrow parallel central strand. Epicutis of pileus a pellicle of appressed-interwoven hyphae 3-6 mm in diam., gelatinous and dingy ochraceous in KOH. Clamp connections absent.

Gregarious under *Pinus monticola*, in the fall, in the Pacific Northwest.

S. sibiricus is closest to *S. umbonatus* (see the discussion under the latter). It is a dingier yellow than *S. americanus* and has brown spots on the pileus as well as a thicker stipe. The veil in these two, however, is quite similar in texture and color though in *S. americanus* an annulus does not form, in the American material of *S. sibiricus* one forms part of the time, and we can infer that in typical material of the latter an annulus is characteristic. Broad tube mouths are characteristic of both species, as is the occurrence under 5-needle pines. There is excellent agreement of our material with Singer's illustration. The fungus reported on by Snell and Dick (1961) under this name should be checked against *S. umbonatus*, as the latter consistently occurs under lodgepole pine in the west and if found in the east would be expected under jackpine.

Material studied. Idaho: Smith 54076; 54147; 54266. Oregon: Sipe 970. Smith 24050; 26951; 27417; 31101. Washington: 31823; 40420; 40480; 48331 (MICH).

40. *Suillus americanus* (Peck) Snell ex Slipp & Snell, Lloydia 7: 39. 1944.

Boletus americanus Peck, Bull. N.Y. State Mus. 1: 62. 1887.

Pis. 36-37.

Pileus 3-10 cm broad, obtuse with an incurved margin, expanding to broadly convex or with a low obtuse umbo; margin with soft cottony

veil material appendiculate or continuous all along it, the veil yellowish but in age the collapsed patches typically brownish; surface bright yellow ("Naples yellow" to "mustard yellow"), viscid, with scattered appressed patches of fibrils pale buff to dingy cinnamon in color, at times streaked with reddish fibrils in places (but veil never red). Context mustard yellow, staining vinaceous brown when cut, odor and taste not distinctive.

Tubes 4-6 mm deep, adnate to decurrent, dull yellow and staining vinaceous brown where injured; mouths large and often angular, up to 1.5 (2) mm diam. at maturity, mustard yellow young, duller ochraceous in age, drying dark yellow brown.

Stipe 3-9 cm long, 3-10 mm thick, equal, often crooked, becoming hollow, cortex yellow ("buff yellow" or deeper), lacking salmon tints; surface lemon-yellow and covered with glandular dots which darken to cinnamon-buff or browner in age or from handling, surface generally vinaceous brown where handled; annulus lacking, "veil" material seldom if ever truly attached to stipe.

Spore deposit "Sayal brown" (dull cinnamon). Spores 8-11 (12) \times 3-4 μ narrowly and obscurely fusoid in face view, in profile narrowly inequilateral, dingy yellow to brownish in KOH, smooth, weakly dextrinoid (pale tawny to pale cinnamon in Melzer's reagent).

Basidia 17-22 \times 5-7 μ , clavate, 4-spored, yellowish to hyaline in KOH, yellowish in Melzer's sol. Pleurocystidia in fascicles surrounded by amorphous bister-brown pigment as revived in KOH; subcylindric to clavate or obventricose, 38-60 \times 7-11 μ , content hyaline or dark brown. Cheilocystidia abundant along the dissepiments, hyaline to brown, 40-65 \times 7-12 μ , cylindric, clavate or fusoid-ventricose, with a great deal of dark brown amorphous pigment at the level of the hymenium. Caulocystidia like the cheilocystidia, in massive clusters and dark brown amorphous material often obscuring the entire caulohymenium.

Tube trama of gelatinous hyaline hyphae diverging to the hymenium. Epicutis of pileus a pellicle of appressed gelatinous yellowish hyphae 2.5-5 μ in diam., clamp connections absent.

Gregarious under *Pinus strobus* during late summer and early fall in the northern and eastern United States. (Description from *Smith n. 58080*).

The slender stipe, bright yellow color; yellow tube mouths when young, wide tube mouths in age, cottony tissue along pileus margin at first, and the epicutis of the pileus in the form of a pellicle rather than a trichodermium all aid to make this one of the most distinctive species in the genus.

Material studied. Michigan: Smith 7167; 58080. These were large collections. The species is so well known it appears pointless to take up space citing large numbers of specimens.

41. *Suillus brunnescens* Smith & Thiers sp. nov.

Pl. 38-39, 41b.

Pileus 4-15 cm latus, convexus, glaber, glutinosus, sordide albidus tactu brunnescens. Stipes 3-6 (8) cm longus 1-2.5 (3) cm crassus, solidus, albidus denum pallide luteus, subglandulosus; deorsum brunnescens; sporae 6.6-8.8 \times 2.8-3.2 μ . Typus: Smith 55483 (MICH).

Pileus 4-15 cm broad, convex to nearly plane, surface glutinous to viscid; color at first dead white, the gluten soon changing to chocolate color, but often showing a lilac brown tone in the darkening process; often appearing streaked from the gluten; herbarium specimens nearly "Natal brown" over all. Context thick, white when young, in age yellowish in apex of stipe and along the tubes or finally yellowish throughout, not staining when cut or bruised, in KOH at first vinaceous-lilac on the cuticle and this slowly changing to greenish in places.

Tubes up to 15 mm deep in large caps, mostly less than 10 mm deep, pale ochraceous, adnate to decurrent, mouths small (about 2 per mm), pale ochraceous and not staining when bruised.

Stipe 3-6 (8) cm long, 1-2.5 (3) cm thick, solid, white within at first but slowly yellowish, especially in apex, exterior white at first and unpolished, apical region becoming yellowish and small glandular dots then showing, base where handled staining vinaceous and then brownish like the pileus; veil thin, membranous, white, staining vinaceous-gray, breaking away from the stipe and collapsing on cap margin, in age all traces have disappeared.

Spore deposit (not obtained). Spores 6.6-8.8 \times 2.8-3.2 μ , oblong in face view, in profile oblong to obscurely inequilateral, smooth, thin-walled, hyaline to dingy yellow-brown in KOH, pale yellow brown in Melzer's reagent.

Basidia 4-spored, 18-25 \times 4.4-6.6 μ , clavate, hyaline to yellowish in KOH and often with amorphous granules, in Melzer's sol. pale yellowish to brownish. Pleurocystidia, 40-70 \times 8-12 μ , in fascicles with the bundles surrounded by incrusting pigment more or less bister in KOH, content hyaline to dingy yellow-brown, subcylindric to fusoid-ventricose, thin-walled, smooth or with some incrusting debris. Cheilocystidia similar in size and shape to pleurocystidia but more with brown content and adhering debris, also so numerous at times as not to appear clustered. Caulocystidia similar to cheilocystidia, in bundles and heavily incrustated around the base of the bundle with bister material. Caulobasidia forming an hymenium over upper part of stipe, either continuous or in patches.

Hymenophoral trama with a central strand of parallel hyaline to dingy yellow-brown hyphae (in KOH and in Melzer's), from this hyaline gelatinous hyphae diverge to the hymenium, the hyphae of the central strand (4) 6-10 (12) μ in diam., walls thin, hyaline to yellowish in Melzer's sol. Epicutis of pileus a gelatinous trichodermium of hyphae 4-9 μ in diam. and containing numerous dark brown granules in KOH; the walls soon almost completely gelatinized. Clamp connections none.

All hyphae non-amyloid to merely dingy yellow brown in Melzer's sol.

Scattered to gregarious under sugar pine, near Grant's Pass, Josephine County, Oregon. November.

This species, apparently, is not uncommon in the above designated area during wet seasons. It is close to *S. albidipes* (Pk) Singer, but is at once distinguished in the field by the white pileus readily staining brown where handled. When the veil breaks its remnants may be left on either the stipe or the cap margin but most frequently on the latter. There also appear to be microscopic differences in the hyphae of the epicutis of the pileus. The color change, white pileus at first, non-gelatinous veil, and scattered to rare glandular dots distinguish it readily from all other North American species.

Material examined. Oregon: Smith 55483 (type); 55495; 55632; 55719; 55720; 55902 (MICH).

42. *Suillus pungens* Thiers & Smith sp. nov.

Pileus 9-14 cm latus, viscidus, glaber, "deep grayish olive" vel "grayish olive" vel "citrine drab", striatus; caro alba demum flava; sapor ingratus; odor acer; tubuli adnati vel subdecurrentes, flavi, immutabiles; stipes 5-7 cm longus, 1-2.5 cm crassus, punctatus, glaber, albus demum flavus; caro alba, immutabilis; annulus nullus; sporae 9-5. $10 \times 2.8-3.5 \mu$, ellipsoideae vel subcylindraceae; pleurocystidia in fasciculis, fusca in KOH, cylindracea vel subclavata, incrustata, $43-79 \times 7-10 \mu$; cheilocystidia pleurocystidiis similia; cuticula pilei innexa, viscida. Typus: Thiers 9330 (SFSC).

Pileus 4-14 cm broad when expanded; obtusely convex to convex when young becoming broadly convex to plano-convex with age; surface viscid to glutinous during all stages of development; glabrous during all stages of development but sometimes appearing obscurely streaked from gluten when older; when young colored "deep grayish olive" to "grayish olive" to "citrine drab" with splotches or irregularly shaped areas colored "pale olive buff" to "olive buff", frequently strongly variegated with a mixture of light and dark colors, when older unchanging or becoming colored near "ochraceous tawny", sometimes a mixture of all of the pigments mentioned above; margin incurved and with a cottony roll of white tissue when young, becoming naked and merely decurved with age. Context 1-2 cm deep, white and unchanging in young carpophores, frequently changing to near "pinard yellow" in older carpophores; taste harsh, subnauseous and weakly acid; odor strong, pungent.

Tubes adnate when young, becoming decurrent to subdecurrent with age up to 1 cm in length, when young whitish to near "cartridge buff", changing to near "colonial buff" and finally to "honey yellow"; when young with conspicuous droplets of latex which are whitish but become brown to ochraceous when dried; mouths up to 1.5 mm broad, usually about 1 mm broad, not radiately arranged, unchanging when bruised.

Stipe 3-7 cm long, frequently shorter, 1-2 cm broad at the apex;

equal to tapering at the base to sometimes subventricose; solid, flesh white, unchanging when exposed; surface dry, glabrous, strongly punctate, glandulae large, irregular in outline, reddish at first then becoming brownish; remainder of surface whitish to more or less concolorous with the tubes when young, becoming near "Pinard yellow" to "massicot yellow" with age, unchanging when bruised; no annulus.

Spores $9.5-10 \times 2.8-3.5 \mu$, hyaline in KOH, smooth, thin-walled, ellipsoid to subcylindric.

Basidia hyaline, clavate, granulose in KOH, 4-spored, $33-36 \times 8-10 \mu$. Pleurocystidia rare to scattered, found only near the mouths of the tubes, typically occurring in massive clusters, dark brown in KOH, cylindric to subclavate, incrustated, occasionally hyaline, thin-walled, $43-79 \times 7-10 \mu$. Cheilocystidia abundant, fascicled, similar in size and shape to the pleurocystidia. Surface of stipe with clusters of cystidia similar to those found in the hymenium. Clamp connections absent.

Tube trama hyaline, divergent to subparallel, hyphae $3-5 \mu$ in diam. Pileus trama interwoven, homogeneous; cuticle differentiated as a layer of interwoven hyphae which gelatinize in KOH and stain brown, hyphae $4-5 \mu$ in diam.

Solitary to gregarious in humus under Monterey pines (*Pinus radiata*). Campus, San Francisco State College, San Francisco, San Francisco County.

Suillus pungens is a member of the *Suillus acerbus*-*S. granulatus*-*S. albidipes* complex and is frequently confused with the other members of this group. As a matter of fact this fungus is commonly referred to as *S. granulatus* on the west coast. There are, however, at least three macroscopic characters which make this species easily distinguishable. The most obvious is the pileus color which most commonly is some shade of gray or a mixture of gray and yellow. The yellow pigment is often more pronounced near the margin. It is not uncommon, on the other hand, to find carpophores which are almost white or entirely some shade of yellow. In addition to the characteristic pigmentation of the pileus, the taste and especially the odor are quite distinctive. *S. granulatus* does not have either a strong taste or odor and *S. acerbus* does not possess a noticeable odor. The odor and taste, however, of *S. pungens* are both unpleasant and are not easily overlooked. Finally, at least in our concept of *S. granulatus*, it does not possess a distinct marginal roll of white tissue on the pileus, but such is found in *S. pungens* and in *S. albidipes*.

Material studied. California: Thiers 9330-type. Other collections: Thiers 7490; 8570. Largent 143; 55. Johnson 1. Peters 271; 239; 204; 500; 588 (MICH. et SFSC).

Series ANGUSTIPORINI (Singer) stat. nov.

Subsection *Angustiporini* Singer, Rev. de Mycol. 3: 45. 1938.

Type species: *S. granulatus* (L. ex Fr.) S. F. Gray.

The species of this series have the margin of the young pileus naked or only at first very slightly coated with appressed white tomentum. There is no roll of cottony tissue as in some of the species of Subsection *Suillus*.

43. *Suillus punctatipes* (Snell & Dick) Smith & Thiers comb. nov. Pl. 45

Boletinus punctatipes Snell & Dick, Mycologia 33: 36. 1941.

Pileus at first hemispherical, becoming expanded and broadly convex, up to 10 cm broad. Surface even, very viscid when wet, glabrous except margin which is appressed-tomentose, pellicle entirely separable; pinkish-brown when moist, drying avellaneous at least in spots. Context thick, 2-5 cm in center, firm, compact, tinged grayish-vinaceous under the pellicle and greenish-yellow next to the tubes, otherwise pure white, unchanging, odorless and tasteless.

Tubes arcuate, short decurrent, radiately arranged and more or less separated by veins, somewhat glandular-dotted, warm buff, becoming yellow ochre, unchanging, short, 5-6 mm long; mouths glandular-dotted, irregular, generally oval, elongated radially, medium to large.

Stipe equal or tapering upward, very obscurely reticulated at the apex, with a subviscid pellicle which becomes minutely areolate on drying, glandular-dotted on the upper half or so, glabrous below, white when young, remaining white above or becoming straw-yellow, pinkish-brown below, with the dots brownish-vinaceous; within solid, hard and compact, pure white with base dull vinaceous, unchanging; 5-7 cm long, 1-3 cm thick.

Spores bright ochraceous-brown in mass, elliptical, hyaline, a few deep olivaceous, $7-10 \times 3-3.5 \mu$, mostly $8 \times 3 \mu$. Cystidia densely clustered, hyaline to dark-colored, cylindrical to somewhat clavate, $40-80 \times 6-9 \mu$.

Under Douglas fir, hemlock and fir. Frying Pan Creek, Washington, August. No. 886 in Bolete Herb. WHS. Coll. and comm. D. E. Stuntz.

Our description is taken from the original as we have not encountered such a fungus in our western collecting. The discussion by Snell & Dick, however, is misleading on a number of points. *Fusco-boletinus glandulosus* (Pomerleau & Smith 1962) has nothing in common with this species except for the features which place it in the Boletaceae. *F. glandulosus* has a gelatinous veil and lilac-drab spore deposit. On the features as described *S. punctatipes* is distinct because of its white stipe when young which is glandular-dotted above, very reduced veil not leaving fibrils on the stipe, and "unchanging" tubes (but here we cannot be sure that the author did not simply mean *Not changing to blue* - we do not know for certain that they did not stain brown). The species

appears to us, on the information available from the original account, to be somewhat similar to *S. punctipes* and *S. hirtellus* but has more elongated tube mouths than either.

Th. H. Hoffman (1963) gives an excellent supplementary account and illustration. This is to be regarded as authentic as it was Stuntz who sent the specimens to Snell in the first place. The excellent photograph shows clearly a bolete with the stature of *S. brevipes* but with boletinoid configuration of the hymenophore.

44. *Suillus placidus* (Bonorden) Singer, Farlowia 2: 42. 1945.

Boletus placidus Bonorden, Mohl's Bot. Zeitschr. 19: 204. 1861.

Ixocomus placidus (Bonorden) Gilbert, Les Boletes P. 132. 1931.

Pl. 40.

Pileus 3-10 cm broad, broadly convex when young, remaining so, or becoming plane or finally with a wavy margin, margin naked, surface glabrous and viscid to glutinous, soft to the touch, white to ivory white at first, gradually becoming yellowish, finally pale lemon yellow, dingy olive in age when water-soaked, gluten often becoming grayish to blackish with age, surface often showing depressions as the soft context collapses. Context white but slowly lutescent, when cut often slowly becoming pale vinaceous, taste mild, odor mild to acidulous; chemical reactions: on pileus cutis and context, instantly dingy vinaceous in KOH. Red in ammonia (all taken on fresh material).

Tubes 3-8 mm deep (rather shallow), at first adnate to depressed around the stipe but soon decurrent, "cartridge buff" young (pale buff), pale yellow at maturity (near "Naples yellow"), unchanging when injured; mouths "pale cartridge buff" young (yellowish) near ochre yellow at maturity, small at first (0.5 mm), finally up to 1-2 mm broad in age, often beaded with pinkish droplets of an exudate and with pinkish glandulate like those on the stipe.

Stipe 4-12 cm long, (3) 5-12 (22) mm thick, equal, solid, becoming hollow, white within but soon lemon yellow, surface white with "vinaceous buff" to "vinaceous fawn" smears and dots, ground color, yellow in age. The glandular areas discoloring to gray or blackish on drying; no veil present at any stage of development.

Spore deposit "Sayal brown" (dull cinnamon). Spores $7-9 \times 2.5-3.2 \mu$, nearly oblong in face view, somewhat inequilateral in profile, smooth, a hyaline sheath evident, nearly hyaline in KOH, pale yellow in Melzer's sol.

Basidia $24-28 \times 6-7 \mu$ hyaline in KOH, and yellowish in Melzer's reagent, clavate, 4-spored. Pleurocystidia $49-60 \times 6-9 \mu$ subcylindric to narrowly clavate, scattered, numerous or rare, but typically in fascicles, often with a bister content and dark brown amorphous pigment incrusting the bundle at the level of the hymenium. Cheilocystidia in larger aggregations, more capitate and darker colored as revived in KOH, but otherwise similar to pleurocystidia. Caulocystidia numerous

to abundant, often in fascicles similar to pleurocystidia or with more apical enlargement, abundant over large areas, content hyaline to bister, mostly heavily incrustated with amorphous debris as revived in KOH.

Tube trama of gelatinous divergent hyphae from a central floccose strand. Epicutis of pileus a layer (collapsed trichodermium) of narrow (3-6 μ) hyphae gelatinous, and with bister content in KOH and in Melzer's reagent; context hyphae floccose and hyaline. Clamp connections absent.

Scattered to gregarious under *Pinus strobus* during periods of wet weather in July, August or early September. Not rare within the range of *P. strobus* but we have not found it under the western pines, but Isaacs and Stuntz (pers. com.) report it from white pine north of Seattle.

This species is one of the easily recognized *Suilli*. The slender stipe, literally smeared with glandular covering, the white pileus at first, the tendency of the gluten to darken in age and in drying, and the lack of a veil is a very constant set of characters. This species is close to *S. albidipes*, *S. granulatus*, and *S. brevipes*, but can be readily distinguished by the combination of characters mentioned above. *S. brunnescens* is also close, but has a thicker stipe that is shorter, stains readily when bruised and has a distinct veil. The white or pallid forms of *S. granulatus* are often misidentified as *S. placidus*. Kallenbach attempted to recognize a series of forms in Europe based upon the mycorrhizal hosts, however, as far as we are aware here in North America *S. placidus* has been found only with *Pinus strobus* and no indication of the existence of different races or forms has been observed by us.

Material studied. Maine: Rea 619; 635. Michigan: Bartelli 267; 372. Ckmielewski 15; 38. Shaffer 2180. Smith 3706; 3860; 7230; 36918; 36930; 37150; 38049; 41893; 42228; 42629; 44114; 44118; 57500; 57950; 58177; 62974. Thiers 4334. New Hampshire: Miller 320; 511. New York: Smith 877; 1050. Snell 391. Tennessee: Smith 7480. Vermont: Burlingham (Kelly 621) or *Boletus albus* Pk. Canada, Ontario: Kelly 1435; 1800. Quebec. Smith 62096 (MICH).

45. *Suillus pallidiceps* Smith & Thiers sp. nov.

Pl. 41a.

Pileus 3-8 cm latus, glutinosus, albidus demum subluteus, stipes non-glandulosus; sporae 8-11 \times 3.5-4.2 μ . Typus: Smith 58968 (MICH).

Pileus 3-8 cm broad, convex to broadly convex, glabrous, copiously glutinous and in age minutely areolate beneath the gluten, whitish at first, slowly becoming pale yellow and finally discoloring to a dull cinnamon buff, not staining when handled, but in contact with waxed paper staining purplish umber; margin naked but extending slightly beyond the tubes. Context white then yellowish, no color change when cut, odor and taste not distinctive.

Tubes about 10 mm deep, yellow, slowly dingy ochraceous in age,

adnate to short decurrent; mouths small (2-3 per mm), pale yellow and unchanging when bruised.

Stipe 1-2 cm long, 12-16 mm thick, bulbous at the base and up to 25 mm, solid, lemon yellow in apex in age, white at first, margins of worm holes merely ochraceous brownish, surface pure white and naked; no veil present.

Spore deposit pale cinnamon ("Sayal brown", in a thick deposit), spores 8-11 \times 3.5-4.2 μ , oblong in face view, in profile oblong to very obscurely inequilateral, nearly hyaline in KOH, in Melzer's yellow to pale tan, smooth, relatively thin-walled.

Basidia 4-spored, 18-24 \times 5-6 μ , hyaline in KOH, yellowish in Melzer's. Pleurocystidia 20-30 \times 5-8 μ , fusoid-ventricose, often the neck 1.5-2.5 μ thick and 8-9 μ long, only a slight amount of nearly hyaline incrusting pigment around the bases or none at all, cystidial content hyaline. Cheilocystidia in fascicles, 40-55 \times 5-8 μ , cylindrical to narrowly clavate, typically with coagulated yellowish content or hyaline as revived in KOH bases of clusters surrounded by dingy pale yellowish brown amorphous material as revived in KOH. Caulocystidia in fascicles as revived in KOH surrounded by dark brown incrustated amorphous pigment at base of cluster, individual cystidia, 40-65 \times 7-10 μ , hyaline or with colored coagulated content evenly distributed or in particles, narrowly clavate to cylindrical and often crooked, rarely varying to fusoid-ventricose. Caulohymenium with a gelatinous subhymenium, basidia hyaline to dingy ochraceous.

Tube trama of a hyaline central strand of a few parallel hyphae flanked on either side by more gelatinous hyphae diverging slightly toward hymenium but in old specimens trama appearing gelatinous and interwoven, pileus epicutis of appressed-interwoven (rather tangled) gelatinous hyphae 2-3.5 (5) μ in diam. and with some hyaline granular content, the inner layer dingy ochraceous in KOH and subcutis dark yellow brown. No clamp connections present.

Gregarious under *Pinus contorta*, central Idaho, July, rare, Sm-58958; 65703; 65721 (MICH).

This species is to *S. brevipes* what *S. placidus* is to *S. granulatus*. The features which distinguish it from *S. brevipes* are the larger spores, whitish cap at first which never becomes as dark as typical *S. brevipes*, and possibly the staining reaction with waxed paper. We do not put much emphasis on the apparent absence of encrusted bundles of pleurocystidia, since these do occur as cheilo- and caulocystidia. Their rarity, however, may be a quantitative feature of some importance. Both *S. brevipes* and *S. pallidiceps* were growing in the same pine forest the same day and easily distinguished at sight. *S. albidipes* has a roll of white cottony material along the margin of the pileus when young. Its pileus, as in a number of species in this genus, may be whitish at first.

46. *Suillus brevipes* (Peck) Kuntze, Revisio Generum Plantarum 3: 535. 1898.

Boletus viscosus Frost, Bull. Buffalo Soc. Nat. Sci. 2: 101. 1874. (not *B. viscosus* Vent.)

Boletus brevipes Peck, Ann. Rept. N.Y. State Mus. 38: 110. 1885.

Suillus brevipes var. *aestivalis* Singer, Farlowia 2: 217. 1945.

Pl. 42.

Var. *brevipes*

Pileus 5-10 cm broad, hemispheric to broadly convex, in age broadly convex to nearly plane, the margin at times lobed slightly, surface glabrous and glutinous, in wet weather the gluten often 2 mm deep, color evenly dark vinaceous brown ("Natal brown" to "army brown") when young, gradually becoming paler to dull cinnamon ("Sayal brown" to "cinnamon") at times dingy yellow ocher in age; margin in buttons faintly white-tomentose but veil lacking and no distinct roll of white cottony tissue present. Context white when young, becoming yellow in age at least in the apex of the stipe, soft, unchanging when bruised, odor and taste not distinctive.

Tubes 4-10 mm deep, adnate to decurrent, near "honey yellow" (dingy yellow), darker and more olivaceous in age; mouths small (1-2 per mm at maturity) round, not elongating radially appreciably, when young pale dingy yellow, in age spotted from the spores and cheilocystidia.

Stipe 2-5 cm long, 1-2 (3) cm thick, short, solid, white within, but finally becoming yellow in cortex or apex generally, surface white becoming pale yellow, unpolished to pruinose under a lens and when young lacking glandular dots, glandular dots at times visible in age but never well developed.

Spore deposit near "cinnamon". Spores 7-9 (10) \times 2.8-3.2 μ , in face view narrowly elliptic to oblong, in profile obscurely inequilateral, smooth, pale yellowish in Melzer's sol. and in KOH.

Basidia 4-spored, 18-24 \times 5-6 μ , clavate, hyaline in KOH, yellowish in Melzer's sol. Pleurocystidia in bunches with amorphous brown pigment surrounding the base of the cluster, individual cystidia 35-50 \times 6-9 μ , cylindrical to clavate, content hyaline or either partly or entirely brown from coagulated pigment. Cheilocystidia similar to pleurocystidia or larger and more broadly clavate, with considerable dried amorphous pigment along the edge of the dissepiments. Caulocystidia like the cheilocystidia but the bundles not numerous.

Tube trama of divergent hyaline gelatinous hyphae from a narrow subgelatinous central strand. Epicutis of pileus a thick gelatinous pellicle of narrow (4-6 μ) hyphae appressed-interwoven but possibly originating as a trichodermium. Clamp connections absent.

Scattered to cespitose under 2-needle and 3-needle pines apparently throughout the range of these species in North America. In the Great Lakes area it is abundant under *P. banksiana*, in the Rocky Mountains it

is under *P. contorta*, and in our southeastern states it occurs under *P. taeda*; on the Pacific Coast it is under *P. contorta*. It fruits both during the summer or fall, or during warm wet weather in the winter.

The color of the pileus is exceedingly variable, as Singer (1945) has indicated and as both of us have observed on many occasions. Singer mentions a veil in this species but Peck did not, and our numerous collections showed none. For a discussion of the veiled form see *S. albidipes*. The length of the stipe is variable, and is short when the fungus is on hard-packed soil and longer in loose-duff, as true of other boletes such as *Boletus edulis*. We do not attach much significance to differences within the range of pileus size of 3-10 cm in fungi of this type. *S. granulatus* is very similar to *S. brevipes*, but its stipe is distinctly more glandular dotted when young, and it typically has a more mottled pileus. Both have a naked to faintly tomentose margin when young. For additional comments see *S. albidipes*. *S. brevipes* sensu Singer (1945) we regard as a mixture of *S. albidipes* and the type variety of *S. brevipes*.

Material cited. California: White 339. Colorado: Kauffman 8-30-20. Whetstone 8-1917. Florida: Murrill 1-1-43. Singer F1646 (no veil remnants on cap margin). Idaho: Kelley Herb. 1963; 1672. Smith 23524; 44361; 44819; 45199; 46069; 46265; 46509; 53720; 53522; 53556; 58857; 59435; 65504; 65508; 66299. Trueblood 5-24-59. 975. Michigan: Smith 38789; 43929; 58015; 66442. Shaffer 1948. Oregon: Sipe 341. Smith 20089; 26763; 26832; 26996; 28216; 44544; 44714; 45902; 55355; 58969; 59124. Tennessee: Hesler 19485. Texas: Thiers 1715. Washington: Smith 48830. West Virginia: Nuttall 97. Wyoming: Smith 34563; 34678; 34829; 35020; 35355; 35412; 35456; 35557. Solheim 37; 3625; 4908; 5181 (MICH).

46a. *Suillus brevipes* var. *subgracilis* var. nov.

Pileus 3-8 cm latus, convexus, glutinosus, glaber, sordide ochraceus vel subalutaceus; tubulis luteis demum vitellinis; stipes 3-5 cm longus, 7-12 mm crassus, albus demum luteus vel vitellinus, nudus; sporae 6.5-8 \times 2.5-3 μ . Typus: Smith 66452 (MICH).

Pileus 3-8 cm broad, obtuse to convex, in age broadly convex, glabrous, glutinous when wet, varnished when dry, pale pinkish tan young, dingy ochraceous in age, or on the disc about cinnamon buff; margin curved in at first and naked at all times; in age the cap surface appearing slightly virgate beneath the gluten. Context white at first, slowly becoming pale lemon-yellow, olive gray in FeSO₄, pinkish then vinaceous drab in KOH, taste and odor not distinctive.

Tubes up to 1 cm deep, adnate to depressed around the stipe, lemon yellow, mouths up to 1 mm broad when mature, bright yellow ("mustard yellow"), not staining either brownish or bluish when bruised.

Stipe 3-5 cm long, 7-12 mm at apex, solid, equal or nearly so, cortex lemon-yellow with the pith paler, surface white and lacking glandular dots, gradually becoming bright lemon-yellow or apex

lemon-chrome, some grayish brown discoloration on the surface fibrils lower down.

Spore deposit pale cinnamon. Spores $6.5-8 \times 2.4-3 \mu$, smooth, thin-walled, obscurely inequilateral in profile, in face view nearly oblong, greenish hyaline in KOH, yellowish in Melzer's reagent.

Basidia $16-20 \times 4-5 \mu$, 4-spored, hyaline in KOH, clavate. Pleurocystidia in bundles with rusty brown to vinaceous brown encrusting pigment around base of bundle, individual cystidia with brown to vinaceous brown content and smooth to encrusted. Cheilocystidia abundant, tube edge often heteromorphous, also encrusted with reddish brown amorphous pigment; details of individual cystidia the same as for the pleurocystidia. Caulocystidia in patches or bundles, individual cystidia $40-70 \times 5-9 \mu$, and cylindric to clavate, with vinaceous brown content in KOH, bases surrounded by some amorphous incrustation.

Tube trama bilateral and gelatinous but with conspicuous broad (up to 15μ) laticifers with dark brown content as revived in KOH present. Epicutis of pileus a thick layer of appressed-interwoven hyphae $2.5-5 \mu$ in diameter and hyaline in KOH, but many of the hyphae or segments of them with a hyaline highly refractive content. Subcutis of floccose hyphae with pigment pockets which become vinaceous in KOH, or the entire region flushed vinaceous. Clamp connections none.

Gregarious under 2-needle pines, Proud Lake Recreation Area, Oakland County, Mich. Oct. 11, 1962, Smith 66452.

Variety *subgracilis* consistently has a thinner stipe, paler colors and conspicuous laticiferous hyphae in the trama of the hymenophore. Also, the tubes are a more brilliant yellow. Singer pointed out that *S. brevipes* var. *aestivalis* Singer is hardly distinct from the type variety. For a time we considered describing a bright yellow variety but it seems to warrant more study. The following is a description of this "form" which occurs in Michigan along with the type form.

Pileus 3-9 (12) cm broad, convex with a naked margin, expanding to nearly plane or with the disc depressed and the margin wavy, surface glabrous and glutinous; margin in small buttons obscurely matted-fibrillose with pallid fibrils but no false-veil tissue present, very soon perfectly naked; color very pale dingy vinaceous-cinnamon when very young, very soon becoming evenly lemon-yellow to near ochre-yellow, never spotted as in *S. granulatus*, gluten often discolored reddish-cinnamon where in contact with oak leaves, only in age faintly to distinctly virgate beneath the gluten. Context thick, soft, white, becoming flushed lemon yellow to sulphur yellow; odor and taste mild or odor becoming faintly fragrant like that of *S. punctipes*.

Tubes up to 1 cm deep, depressed around the stipe in age; adnate at first, pale lemon-yellow becoming more or less ochre yellow, *unchanging* when bruised (no change to brownish); mouths 1-2 per mm in mature caps, \pm round, pale yellow and unchanging, near ochre yellow in age.

Stipe 1-4 cm long, 5-15 mm thick, short, solid, pure white inside and out when young and fresh, becoming lemon-yellow over all or in

part, only in age becoming very finely and obscurely glandular dotted (as in the type form), surface typically appearing unpolished, in age dingy reddish cinnamon in and over the base.

Spore deposit pale cinnamon.

The microscopic characters are as in the type form. No large laticiferous hyphae were observed, and the epicutis of the pileus is a trichodermium of narrow gelatinous hyphae.

Under jackpine, Ogemaw Game Refuge, Ogemaw County, Mich. Sept. 15, 1963. (Smith 67586).

The material from this area differed consistently from the type form in that the entire cap is soon lemon yellow, a slight fragrant odor is present, and the tubes become depressed around the stipe. Also the stipe is usually very small in relation to the size of the cap. We have seen it during only one season.

47. *Suillus granulatus* (Fries) Kuntze, Rev. Gen. Plant 32: 535. 1898.

Boletus granulatus Fries, Syst. Mycol. 1: 385. 1821.

Rostkovites granulatus (Fr.) Karsten, Rev. Mycol. 3: 16. 1881.

Viscipellis granulatus (Fr.) Quélet, Ench. Fung. p. 156. 1886.

Isocomus granulatus (Fr.) Quélet, Fl. Myc. Fr. p. 412. 1888.

Pls. 43-44.

Pileus 5-11 (15) cm broad, becoming broadly convex, viscid to glutinous when wet, glabrous or streaked or spotted with "cinnamon" on a pale buff ("pinkish buff" to "cinnamon buff") ground color, in age more or less cinnamon over all ("orange cinnamon"), immature specimens often pallid for a long time; margin naked to minutely tomentose; cutis in age often separated to form minute areolae. Context whitish young but soon pale yellow, soft, unchanging, with a watery green line above the tubes, odor mild to slightly fragrant, taste of pellicle mild to acid, olive gray with FeSO_4 , KOH on cutis olive gray, on context Natal brown.

Tubes adnate-subdecurrent, about 1 cm deep, pallid at first, but soon pale yellow becoming dingy yellow, not staining when bruised; mouths small, about 2 per mm, or in old caps 1 per mm and somewhat boletinoid to merely elongated, pale honey yellowish, in age brownish spotted, staining dingy cinnamon when bruised, in very young stages beaded with droplets of a cloudy liquid.

Stipe 4-8 cm long, 1-2 (2.5) cm thick at apex, equal or narrowed to a point at base, solid, white inside at first but soon bright yellow within at apex, tinged cinnamon toward base, surface whitish but soon bright yellow above, pallid downward but base becoming dingy cinnamon, covered over all by pinkish tan to vinaceous brown glandular dots; veil none.

Spore deposit dingy cinnamon to cinnamon ("cinnamon" to "pinkish cinnamon"). Spores 7-9 (10) \times $2.5-3.5 \mu$ smooth, yellowish in KOH and Melzer's sol. oblong or tapered slightly to the apex, in profile somewhat inequilateral.

Basidia 4-spored, 18-24 × 5-6 μ, clavate, hyaline in KOH, merely yellowish in Melzer's. Pleurocystidia in bundles with brown incrustated material around base, individual cystidia 36-50 × 7-9 μ, clavate to sub-cylindric, hyaline or with yellowish to brown content. Cheilocystidia similar to pleurocystidia. Caulocystidia 40-70 × 7-10 μ, clavate, sub-fusoid or cylindric, mostly with colored content, bases of clusters surrounded by brown pigment, content of cystidia hyaline to colored and mostly coagulated; incrusting pigment present over much of caulohymenium.

Tube trama of gelatinous divergent hyphae from a colored floccose central strand. Epicutis of pileus a gelatinous trichodermium of hyphae 4-7 μ broad, in KOH the content dingy ochraceous to bister, some encrusting material present in the layer. Clamp connections absent.

Scattered to gregarious under pine, common during the summer and fall but peak fruiting mostly in September; wide spread throughout the United States. *Pinus strobus* is the most common conifer associate in the Great Lakes Region (Smith n. 66476).

Singer's original account of *S. granulatus* subsp. *snellii* (Farlowia 2: 40. 1945) is curious. He states that they (subsp. *granulatus* and subsp. *snellii*) differ both macroscopically and microscopically, but he makes no comparison and one is left to conclude that the "Isabella color" spore print is a difference. Burt (Icones Farlowianae pl. 7) stated that he collected *Boletus granulatus* in Sweden with Robert Fries and that the European and American collections resembled each other very closely. Our own collections, upon which our description is based to avoid confusion, are very well illustrated by the plate 48 in Kallenbach's Pilze Mitteleuropa. The descriptions by European authors we have consulted cover the American species equally well. In the numerous spore prints we have taken the deposit is dingy cinnamon, not "Isabella color"--which is quite a different color. In his habitat data Singer apparently accepts the description of Slipp and Snell as he lists *Pinus monticola* and other conifers (*Tsuga* and *Abies*) as mentioned by these authors. The concept of Slipp & Snell is obviously broader than ours--it at least included some of the variants with a false veil, since they describe the pileus margin as fibrillose-appendiculate, and a "false" annulus (?) near the stipe apex. The color range and brown stains on the cap also suggest that other variants are included here--possibly *S. brunnescens*. Hence, we do not accept the description of Slipp and Snell as a valid description of *S. granulatus* subsp. *snellii*. The chemical reactions given by Singer presumably go with the fungus with olive yellow ("Isabella color") spores. Since there is not enough data to characterize this variant we are not recognizing it, and simply refer our collections to the species without regard to infra-specific categories.

We have little trouble in recognizing *S. granulatus* and consider it at the same level of distinctness as *S. brevipes*, *S. albidipes*, and *S. placidus*; these are the most closely related species. For further comment see the discussions following them. The variable features of

S. granulatus are the length of time the pileus remains pallid. (Some fully developed caps are almost dingy white.) The range of variation is from pallid to rather rich orange-cinnamon, the yellow tones becoming more evident in age. The stipe is white at first with vinaceous spots and smears over the apex. It gradually becomes yellow, nearly lemon yellow at times, and some specimens change to this color slowly after handling. The tube mouths may or may not present a somewhat boletinoid outline, indicating a connection to *S. punctatipes*. In wet weather the pileus may be very glutinous, but, depending on the relative humidity, varies to merely viscid. We have encountered all degrees of gelatinization of the pileus cutis in specimens from a single pine plantation, and regard this feature as correlated with the relative humidity in the habitat. If a distinct American variety exists the tendency of the cap to become spotted from aggregations of the gluten of the epicutis is probably the best field character on which to base it.

Material studied. Michigan: Smith 62507; 66399; 66417; 66421; 66442; 66453; 66476. (MICH).

We deliberately refrain from citing large numbers of specimens here though we have studied many in all stages of development. Collections made prior to 1960 (our own included) often lacked young specimens, and so confusion with *S. albidipes* was probably not avoided in all cases. The collections cited here are large and served well for observing variation.

48. *Suillus acerbus* Smith & Thiers sp. nov.

Pileus 7-14 cm latus, viscidus, glaber, "tawny" vel "ochraceous tawny" vel "buckthorn brown" vel "cinnamon" vel "cinnamon buff"; caro alba demum flava; sapor acer; tubuli decurrentes vel arcuato-decurrentes, "colonial buff" to "deep colonial buff" demum "reed yellow" vel "primrose yellow", immutabiles; stipes 6-9 cm. longus, 1-2.5 cm crassus, albus vel "ivory yellow" demum "Naples yellow" vel "amber yellow", punctis badiis; caro alba demum flava; annulus nullus; sporae 9.3-12 × 3.3-4 μ, cylindratae vel subellipsoideae vel sub-ventricosae; pleurocystidia in fasciculis, rara; cheilocystidia pleurocystidiis similia; cuticula pilei innexa, viscida. Typus: Thiers 9685 (SFSC).

Pileus 8-13.6 cm broad when mature; when young convex becoming plane to plano-convex with a shallow to moderately deep depression on the disc, often undulating to highly irregular toward the margin; surface distinctly viscid, glabrous, but often streaked with gluten when older, no evidence of fibrils or scales; color highly variable "tawny" to "ochraceous tawny" to "hazel" to "buckthorn brown" to "cinnamon" to "cinnamon buff", in some pilei these colors appear overlain with grayish pigments giving the appearance of being colored "chestnut brown", occasionally the entire pileus appearing grayish, unchanging or fading to "pale cinnamon buff" to "buffy brown", more often a slightly paler mixture of several of the colors mentioned above, frequently with a

greater concentration of yellow pigments toward the margin; margin entire, incurved, glabrous. Context 1.5-2.5 cm thick on the disc, white, staining yellow in irregular areas and near "avellaneous" to "testaceous" around larval tunnels, no change occurring in badly riddled caps; taste difficult to describe, unpleasant, somewhat harsh and acid but not acrid; odor not distinctive.

Tubes adnate to arcuate-decurrent, typically becoming decurrent with age, short, not more than 1 cm in length and often not more than 0.5 cm; when young white to pale yellow ("colonial buff" to "deep colonial buff" to less frequently "pale pinkish buff" becoming colored near "reed yellow" to "primrose yellow" to "chamois" with age), not changing when bruised or exposed; mouths angular, concolorous, not exceeding 1 mm broad, unchanging when bruised.

Stipe 4-10 cm long, 1.5-2.5 cm broad at the apex, equal to slightly enlarged at the base, straight or frequently bent or crooked; solid, flesh white, typically staining yellowish when exposed; surface dry, but ones fingers often feel sticky or waxy after handling the specimens; white to colored very pale "ivory yellow", changing with age or when handled to near "Naples yellow" to "amber yellow", not changing in same intensity in all parts of the stipe; glabrous but covered with large, inconspicuous to conspicuous glandulae which become brown ("cinnamon" to "ferruginous") with age or when handled; some obscure reticulation apparent at the apex and often with irregular longitudinal lines forming a crude network toward the base, no true raised reticulation present; annulus none.

Spores $9.3-12 \times 3.3-4 \mu$, hyaline to pale ochraceous in KOH, smooth, thin-walled, cylindrical to subellipsoid in face view to subventricose in profile.

Basidia hyaline, clavate, contents granulose in KOH, 4-spored, $24-29 \times 5-8 \mu$. Pleurocystidia fasciculate, scattered to very rare, found only near the mouths of the tubes, basal portion often staining dark brown in KOH, apical portion remaining hyaline, occasionally staining vinaceous, $30-46 \times 7-10 \mu$, no solitary cystidia seen. Cheilocystidia occupying entire margin of tube mouths, dark brown to occasionally vinaceous in KOH, similar in size and shape to the pleurocystidia. Surface of stipe gelatinous with massive clusters of darkly staining (brown to dark vinaceous) caulocystidia similar to the pleurocystidia.

Tube trama hyaline, divergent from a distinct mediostratum, subgelatinous, hyphae up to 7μ broad. Pileus trama interwoven, homogeneous. Cuticle interwoven, broad (300μ), gelatinous, contents of hyphae appear brownish in KOH, outermost hyphae appearing somewhat differentiated and incrustated, hyphae up to 3.5μ broad. Hypodermium well differentiated and the hyphae incrustated, interwoven and dark brown in KOH.

Scattered to cespitose in humus under pines, usually Monterey pine (*Pinus radiata*). The Presidio, San Francisco County, California. Thiers 9685-type. Other collections examine: California: Thiers 9686; 9687. (MICH. et SFSC).

This species is apparently very closely related to *Suillus*

granulatus, but is distinguished from it most readily by the combination of colors of the pileus and the noticeably unpleasant taste. In addition the cespitose habit of fruiting and the large size of carpophores are not characteristic of *S. granulatus*. It is also closely related to *S. pungens* but can be distinguished by several characters. Among these are the large size of the carpophores, the cespitose fruiting habit, the larger spores, considerably smaller cystidia, strong odor and the presence of a cottony roll of tissue on the margin in *S. pungens*. *S. acerbus* is one of a complex of *Suillus* species apparently associated with Monterey pine, and is often locally referred to as *S. granulatus*. On the basis of our observations it seems likely that true *S. granulatus* does not grow in this area.

EXCLUDED SPECIES

Phylloporus boletinoides sp. nov.

Pileus 2-4 cm latus, late convexus demum plano-convexus, siccus, velutinus demum subsquamulosus, cinnamomeus vel subtetaceus; caro albida vel pallida, immutabilis; tubuli sublutei vel pallide olivacei; pori 2-3 mm lati, sublamellati; stipes 3-5 cm longus, 0.5-1 cm crassus, aequalis vel deorsum attenuatus, solidus vel deorsum cavus, immutabilis, sursum pallide luteus, deorsum fulvus; sporae $11-13 \times 5-6 \mu$; pleurocystidia $40-60 \times 10-17 \mu$, fusoid ventricosa, hyalina. Specimen typicum in Her. Univ. Mich. conservatum est; legit prope Gainesville, Fla. July 31, 1958, Thiers 4960.

Pileus 2-4 cm broad, broadly convex when young, becoming plano-convex when mature, surface dry and unpolished to velvety tomentose or tomentum aggregated into small squamules, glabrous in age as tomentum becomes matted down; color cinnamon to dark vinaceous brown ("cinnamon" "caco brown" to "Hays brown" or "burnt umber"); margin strongly incurved, entire and fertile. Context white to whitish, 3-10 mm thick, unchanging when bruised, taste mild to slightly acid, odor not distinctive.

Tubes strongly decurrent, pallid yellow to olive buff ("marguerite yellow" to "pale olive-buff" becoming "deep olive buff"), at maturity deep olive buff (not yellow); mouths 2-3 mm or longer in radial direction, configuration of hymenophore strongly boletinoid to sublamellate, unchanging when bruised, concolorous with the sides.

Stipe 3-5 cm long, 0.5-1 cm thick at apex, equal or tapering slightly toward the base, solid or hollowed in the base, yellow within and unchanging when bruised; surface yellowish at apex and tan to russet ("cinnamon", "tawny" or "russet") over the lower portion but yellow within mycelium around the base pallid; surface dry and smooth, glabrous.

Spores $11-13 \times 5-6 \mu$ ($13-17 \times 5-6.5 \mu$ from fresh material), pale snuff brown in KOH, pale tawny in Melzer's sol., smooth, walls about 0.5μ thick, in face view subcylindric to narrowly oval, in profile somewhat inequilateral.

Basidia 4-spored, 23-29 × 9-12 μ, hyaline in KOH, clavate, non-amyloid. Pleurocystidia 40-60 × 10-17 μ, hyaline in KOH, yellowish in Melzer's sol., thin-walled, smooth, fusoid ventricose varying to sub-cylindric or narrowly clavate, apices obtuse. Cheilocystidia scattered to numerous, similar to the pleurocystidia.

Hymenophoral trama slightly divergent from a distinct central strand, hyaline, not gelatinous or only slightly so as revived in KOH, hyphae 5-7 μ broad, non-amyloid. Epicutis of pileus a trichodermium of upright but tangled hyphae 7-11 μ in diam., and ochraceous as revived in KOH, the end-cells varying from somewhat cystidioid to undifferentiated, no incrustations seen on walls, all hyphae non-amyloid. Context of interwoven floccose, non-amyloid hyphae. No clamp connections seen.

Growing under pines, solitary, in a low hammock, Newnan's Lake, east of Gainesville, Fla. July 31, 1958. Thiers 4960 (type), 5530, 6275.

This is in the *Phylloporus rhodoxanthus* complex but differs in not staining blue anywhere, in the hymenophore being olive buff to olive citrine (in age), in not changing color on bruising and in the hymenophore being more boletinoid than lamellate in the fresh condition. *Phylloporus rhodoxanthus* subsp. *foliiporus* has a bright yellow hymenophore that stains blue or bluish green, according to Singer, but its cap is the same color as that of *P. boletinoides*. The latter is certainly different from *P. rhodoxanthus* subsp. *americanus* which both of us know well in a large number of its variations. Subsp. *americanus* dries with strong yellow tones preserved in the gills and stipe and the yellow mycelium around the base of the stipe. Subsp. *europaeus* Singer, has a conspicuously yellow hymenophore that is truly lamellate, and a solid stipe according to descriptions.

We key out this species in this work because it is possible that it is a connection from the section *Boletinus* of *Suillus* to the *Xerocomus* group. It does not have a veil unless the tomentum on the cap is so regarded, the cystidia are not those of *Suillus*, and the spores are more like those of *Xerocomus* species.

Boletus paluster Peck, Ann. Rep. N.Y. State Cab. 23: 132. 1872.

Boletinus paluster (Peck) Peck, Bull. N.Y. State Mus. 8: 78. 1889.

Boletinellus paluster (Peck) Murrill, Mycologia 1: 8. 1909.

Pl. 45.

Pileus 2-7 cm broad, obtuse when young, expanding to convex-umbonate or margin pale to arched and disc often retaining a low umbo, surface deep red ("rose doree" to "jasper red") from the colored floccose-tomentose covering which breaks up into fibrillose squamules; flesh yellowish white to golden or deeper yellow, unchanging when bruised, odor and taste (according to Snell) farinaceous or the taste slowly becoming persistently acid.

Tubes with large angular mouths more or less in radial arrangement or sublamellate with cross veins producing a merulioid effect, decurrent, yellow, not changing to blue or bluish green when injured, in age merely dingy ochraceous.

Stipe 3-6 cm long, 5-10 mm thick, equal or nearly so, solid, yellow to golden within, surface yellow above, somewhat roughened to furfuraceous and often with an evanescent annulus concolorus with squamules on cap, or the veil material variously distributed and finally evenescent, central part often reddish to bright red, yellow and tomentose at base.

Spore deposit dark purplish brown to pinkish brown. Spores 7-9 × 3-3.5 μ, somewhat boat-shaped in face view, inequilateral in profile, smooth, with a hyaline sheath, greenish-hyaline in KOH and barely yellow in Melzer's sol., smooth.

Basidia 20-24 × 5-6 μ, 4-spored, hyaline in KOH, yellowish in Melzer's sol. Pleurocystidia scattered, free of incrustations, 50-72 × 9-12 μ, subcylindric with obtuse apices, short-pedicellate below, hyaline in KOH, thin-walled and readily collapsing, nonamyloid. Cheilocystidia similar but content often smoky yellow in KOH and often shorter and more clavate.

Tube trama apparently interwoven and not particularly gelatinous, hyaline in KOH, nonamyloid. Cuticle of pileus a tangled trichodermium of large (9-15 μ in diam.) non-gelatinous hyphae orange to red or red-brown in Melzer's sol., the cells somewhat narrowed to the cross walls and greatly elongated. Tramal body of floccose interwoven hyphae pale yellow in Melzer's sol. and hyaline in KOH, no incrustations; clamp connections present but often difficult to find.

Gregarious to cespitose in cold northern bogs, cedar swamps and the like, often on very decayed conifer logs, apparently throughout the northern Great Lakes area and northeastern United States and eastern Canada. Our data are taken from notes by Kauffman on a collection which did not stain blue, and some data, as indicated, from Snell (1936).

This species is distinct in the herbarium by the iodine reaction of the cuticle and in the field by small stature and red cap. There is an unresolved puzzle as far as this species is concerned. Peck never stated that the hymenophore turned bluish green either in his original description or in the 1889 account. He first described the spores as pinkish brown but in 1889 indicated them as dull purplish to pinkish brown. Pomerleau and Smith did not transfer this species to *Fusco-boletinus* where it belongs because at least Smith was under the strong impression that the hymenophore did turn bluish when injured and that the spores were merely dark yellowish brown after moisture escaped from the print. This concept dated back to identifying the species with Murrill's account in the North American Flora. However, it must be recognized that Snell's account (1936) certainly checks with Peck's original and subsequent descriptions in all essential features save for the color of the pileus, which Snell considered to be "nothing if not a purple". This comment of Snell's, however, caused Pomerleau and

Smith to omit the species from the treatment of *Fuscoboletinus*. Color terms, when not matched in a chart, can be misleading and we now believe that is what happened in the above instance. The basic features which cannot be ignored are the lack of color change and the purplish red to pinkish brown spore deposit. It would appear to be most closely related to *F. ochraceo-roseus*.

The unresolved problem is: What is the small bright rose-red "*Boletinus*" found in our northern cedar swamps which does stain blue on the tubes and which presumably has an olive-brown spore deposit? Or is there such a species? Smith's data are incomplete though he was under the distinct impression that the hymenophore did stain bluish green. No record of this feature or of the color of the spore deposit was made at the time.

Pomerleau (in press) is transferring this species to *Fuscoboletinus*.

Boletinus solidipes Peck, N.Y. State Mus. Bull. 167. p. 38. 1913.

Pileus 5-10 cm broad, fleshy, convex becoming broadly convex or nearly plane, squamose with radiately arranged closely appressed brown or purplish brown hairs, sometimes purplish brown or yellowish brown in the center, context whitish.

Tubes small, angular, radiately arranged, grayish becoming brown, adnate or decurrent.

Stipe 5-8 cm long, 8-10 mm thick, equal, solid, slightly annulate, yellowish below the annulus, grayish above, often stained with darker spots or marks, white or yellowish within; veil grayish, adhering partly to the margin of the pileus, partly to the stipe.

Spore print ochraceous; spores 8-10 (12) \times 3.3-4 (4.5) μ smooth, fairly thin-walled, subfusoid to narrowly oval in face view, somewhat inequilateral in profile; ochraceous hyaline singly, bister in large groups, pale ochraceous tawny in Melzer's solution.

Basidia 4-spored, 16-20 \times 4.5 μ , clavate to narrowly clavate, pale dingy ochraceous in KOH and about same color in Melzer's solution. Pleurocystidia in bunches, clavate, 36-57 \times 7-11 μ , hyaline or colored, with incrusting pale bister pigment surrounding the fascicle in the hymenium. Cheilocystidia similar to pleurocystidia or more incrusting and less fasciculate.

Tube trama subgelatinous and of somewhat divergent hyphae, broad (8-12 μ) hyaline laticiferous hyphae also present. Pileus cutis of parallel masses of pale ochraceous hyphae but not truly gelatinous in KOH, some hyphae with serrate walls. Context of loosely interwoven hyphae ochraceous to hyaline in KOH, no appreciable change in Melzer's reagent. Clamp connections not found.

Friendship, Maine, August. G. E. Morris. (type studied).

This is very likely a *Fuscoboletinus* as judged by the dull yellow-brown spores in mass in KOH, but we hesitate to make the transfer because the spore print was originally described as ochraceous. It appears

to us to be closely related to *Fuscoboletinus grisellus* because of the white flesh and grayish tubes, but that species is smaller and has much larger tube mouths. The description of the cap is also against this. It appears to us to be a species distinct in its own right, but more data are needed to place it in the proper genus. Hence, it is placed here in the "doubtful" group. We have found basidiocarps of *S. pictus* which had become faded out and the colors changed markedly so that the details seemed to fit *Boletinus solidipes* fairly well--but the tubes were always yellow.

Boletus amabilis Peck, Bull. Torrey Club 27: 612. 1900.

This species was collected in dense spruce woods in Colorado by Bartholomew, but Snell transferred it to *Boletinus* basing his concept on a species (*Suillus lakei*) which is usually associated with Douglas fir. We have been unable to locate the type of *B. amabilis* either at Albany or the Farlow Herbarium, (where Singer said part of the type was deposited). Hence we exclude the species, since it can hardly be the same as *S. lakei* and we are unable to get accurate data on it. Singer's type study is very sketchy. The species cannot be accurately compared in the *S. lakei* series because we know nothing of its staining reactions. Its flesh is said to be pallid whereas all of the *S. lakei* series is characterized by yellow flesh.

Rostkovites californicus Murrill, Mycologia 7: 44. 1915.

We have been unable to locate the type and from Murrill's account cannot place the species in our system. The following is Murrill's account:

"Pileus thick, convex to plane, solitary, 6-9 cm broad; surface smooth, conspicuously subtomentose, brown, margin concolorous, entire, rather thick; context thick, fleshy, flavous, unchanging; taste mild; tubes adnate, plane or slightly convex in mass, 4-6 mm long, yellow, exuding drops which blacken with age, mouths large, angular; spores oblong-ellipsoid, smooth, yellowish brown, 7-8 \times 3.5-4 μ ; stipe subequal or bulbous, smooth, yellow, with black dots, unchanging, solid, yellow within, unchanging, 3-6 cm long, 1.5-2 cm thick.

Type collected on the ground in pine woods in Grass Valley, California, Nov. 12, 1914, H. S. Yates and F. H. Bolster 251 (herb. N.Y. Bot. Gard.). Excellent field notes accompany the specimens. The species is strikingly different from other members of the genus in having a conspicuously subtomentose surface resembling that of *Ceratomyces communis*.

The black dotted stipe and tube mouths becoming black dotted do indicate *Suillus* as a genus, but the cap surface is out of line with anything in sections *Boletinus* and *Suillus*. If pleurocystidia are present and fasciculate a special section should be erected for it in the genus *Suillus*.

Suillus americanus var. *reticulatipes* Coker & Beers. Bol. of North Car. p. 82. 1943.

We exclude this variety on the basis that it seems so unusual, as described, that we do not know how to interpret it. It may very likely be an undescribed species, but if so it should be carefully redescribed from fresh material. A good photograph of the stipe detail would be most helpful. The one in Coker & Beers shows nothing distinctive.

Suillus granulatus (Fr.) Kuntze subsp. *snellii* Singer, Farlowia 2: 40. 1945.

This is excluded because it is a confused concept and the spore deposit color indicated by Singer for the type is not that of *S. granulatus* as it is known to us. Apparently the description of macroscopic features was taken from the literature where a confusion of the characters of several species is evident. The spore size and color of the spore deposit (moist) used as a difference between *S. granulatus* ssp. *snellii* and ssp. "*typicus*" are those of *S. albidipes*, again indicating that Singer confused these two taxa.

Suillus neuschii Singer, Sydowia 15: 82. 1961. (1962).

This species is based on Bresadola's plate 904. Singer has identified certain collections here described as *S. ponderosus* as this species but we do not accept his identification. *S. ponderosus* has a gelatinous annulus and the base of the stipe stains green. *S. neuschii* var. *caerulescens* Singer, Sydowia 15: 82. 1961 (1962), stains blue and grows under larch. It was found in Siberia. *S. caerulescens* of our classification does not have a glabrous pileus and does not grow under larch.

APPENDIX

Suillus subvariegatus Snell & Dick

Through the courtesy of Dr. Walter H. Snell I have been privileged to study the type of *S. subvariegatus*. The following data were recorded:

Spores pale lemon yellow in KOH, tawny in Melzer's sol., $10.5-15.5 \times 4.5-6.5 \mu$, narrowly inequilateral in profile and with a broad suprahilar depression, in face view subfusoid, apex obtuse, wall smooth and only slightly thickened, apex lacking and distinct differentiation. Basidia 4-spored, $22-34 \times 7-8.5 \mu$, hyaline to pale yellow in KOH and in Melzer's sol., but in Melzer's some amyloid granules were noticed between basidia in the hymenium. Pleurocystidia very rare and merely fusoid-ventricose $30-40 \times 7-10 \mu$, apex subacute, walls thin; some hyphal ends $60-100 \times 8-11 \mu$ projecting (cystidia?) and these often with a lemon-yellow amorphous content revived in KOH, also many pockets of lemon yellow amorphous pigment scattered in the hymenium and in some of the hyphae of the tube trama. Pileus cutis poorly revived (all hyphae \pm appressed as seen in my mounts and possibly gelatinous. In Melzer's amyloid particles rarely found in the cap trama near the cutis. Clamp connections none.

Observations: This is an interesting species but does not belong in *Suillus* as the genus is defined in the present work. The amyloid debris in the tramal and hymenial zones reminds one of the condition found in many species of *Rhizopogon*, and the projecting hyphal ends remind one of the cystidia of some Gomphidii. Though no close relationship to the latter group is suspected, the details recorded are interesting and may eventually be shown to be important as we progress in our study of the origin and evolution of the major characters used in Hymenomycete taxonomy.

Alexander H. Smith

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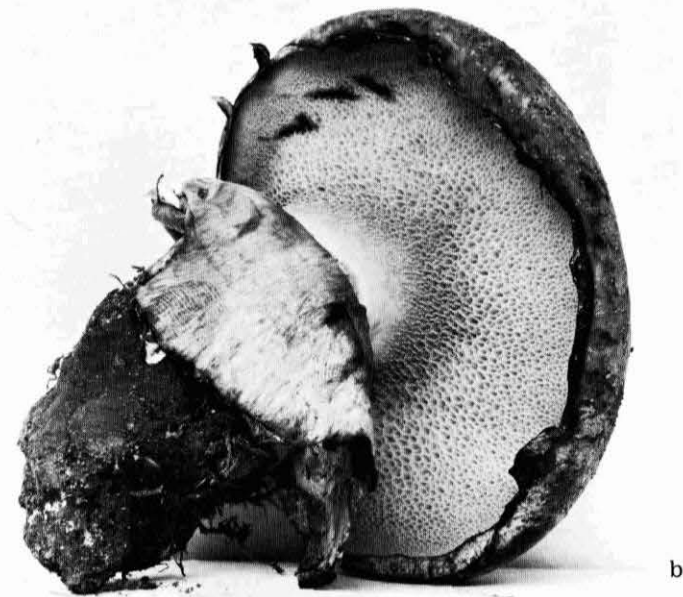
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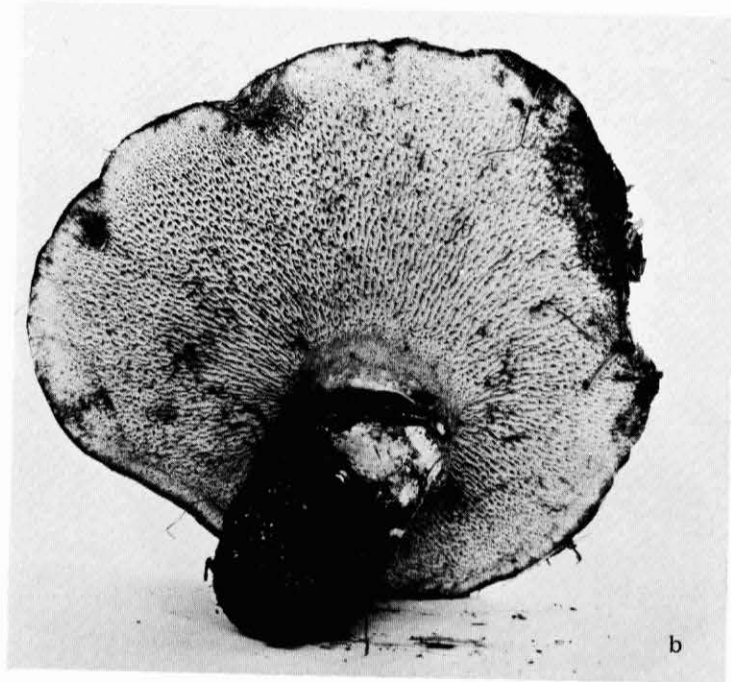
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Pl. 1. *Suillus sphaerosporus*



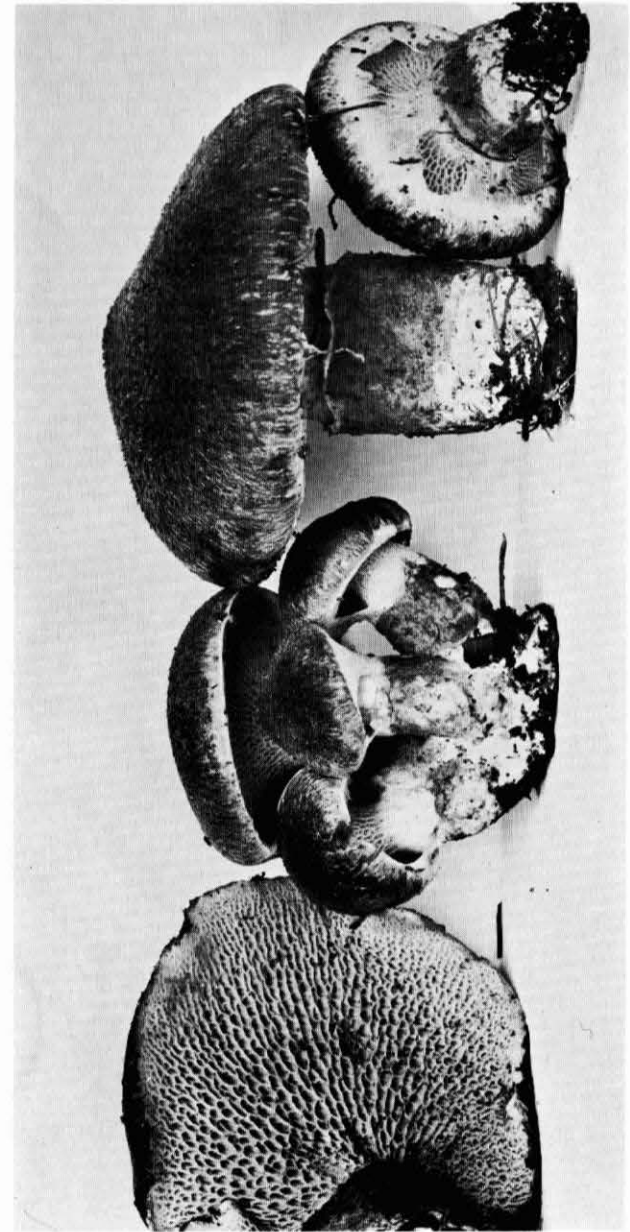
a,b; *Suillus sphaerosporus*, young specimens.
a, Smith 66488; b, Smith 62557.

Pl. 2. *Suillus sphaerosporus*



a, *Suillus sphaerosporus*, button stages, Smith 6-21-60.
b, *Suillus sphaerosporus*, mature specimen, Smith 6067.

Pl. 3. *Suillus cavipes*



Suillus cavipes, Smith 28099

Pl. 4. *Suillus cavipes*



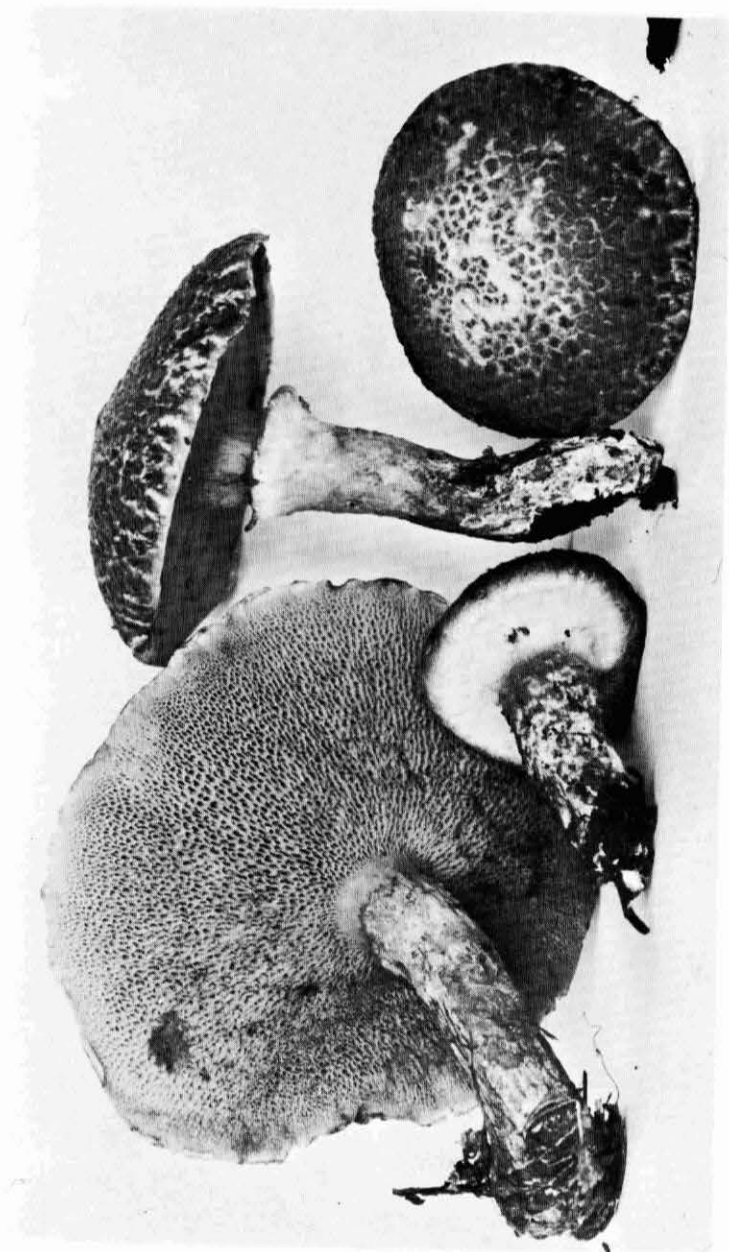
Suillus cavipes, Smith 66437.

Pl. 5. *Suillus pictus*



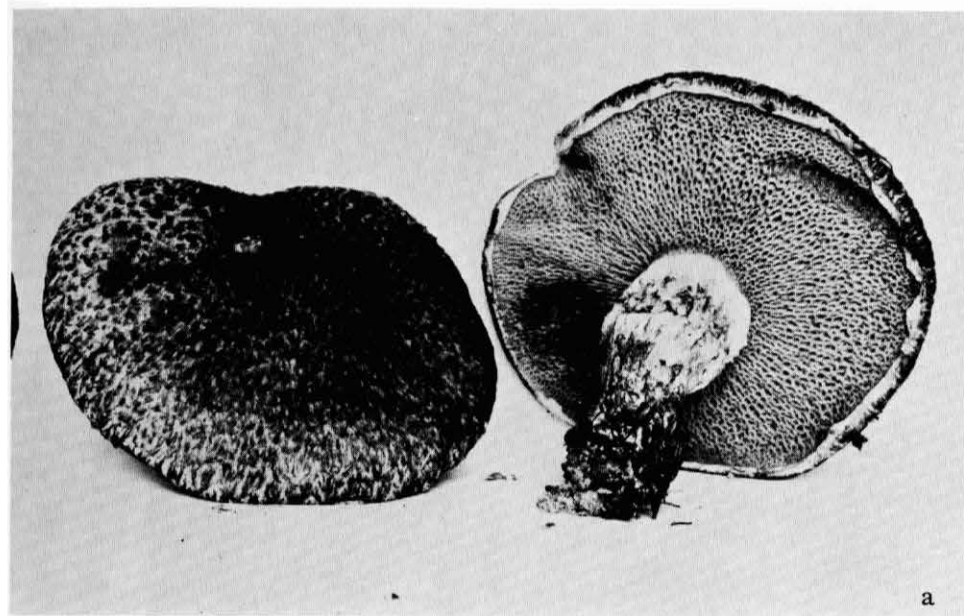
Suillus pictus, Smith 67797

Pl. 6. *Suillus pictus*



Suillus pictus, Smith 62937.

Pl. 7. *Suillus lakei* var. *pseudopictus*



a



b

a. *Suillus lakei* var. *pseudopictus*, Smith 31184.
b. *Suillus lakei* var. *pseudopictus*, Smith 17038.

Pl. 8. *Suillus lakei* var. *lakei*



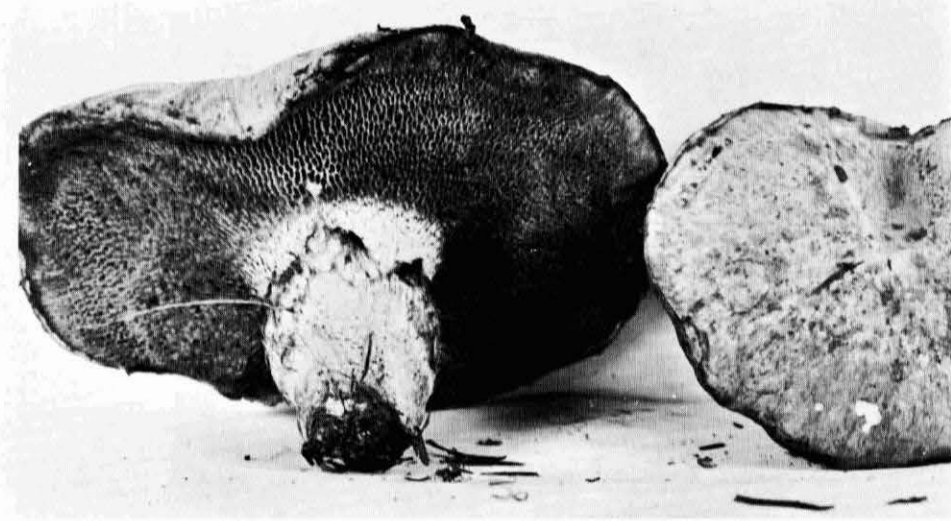
Suillus lakei var. *lakei*, Smith 44588.

Pl. 9. *Suillus lakei* var. *lakei*



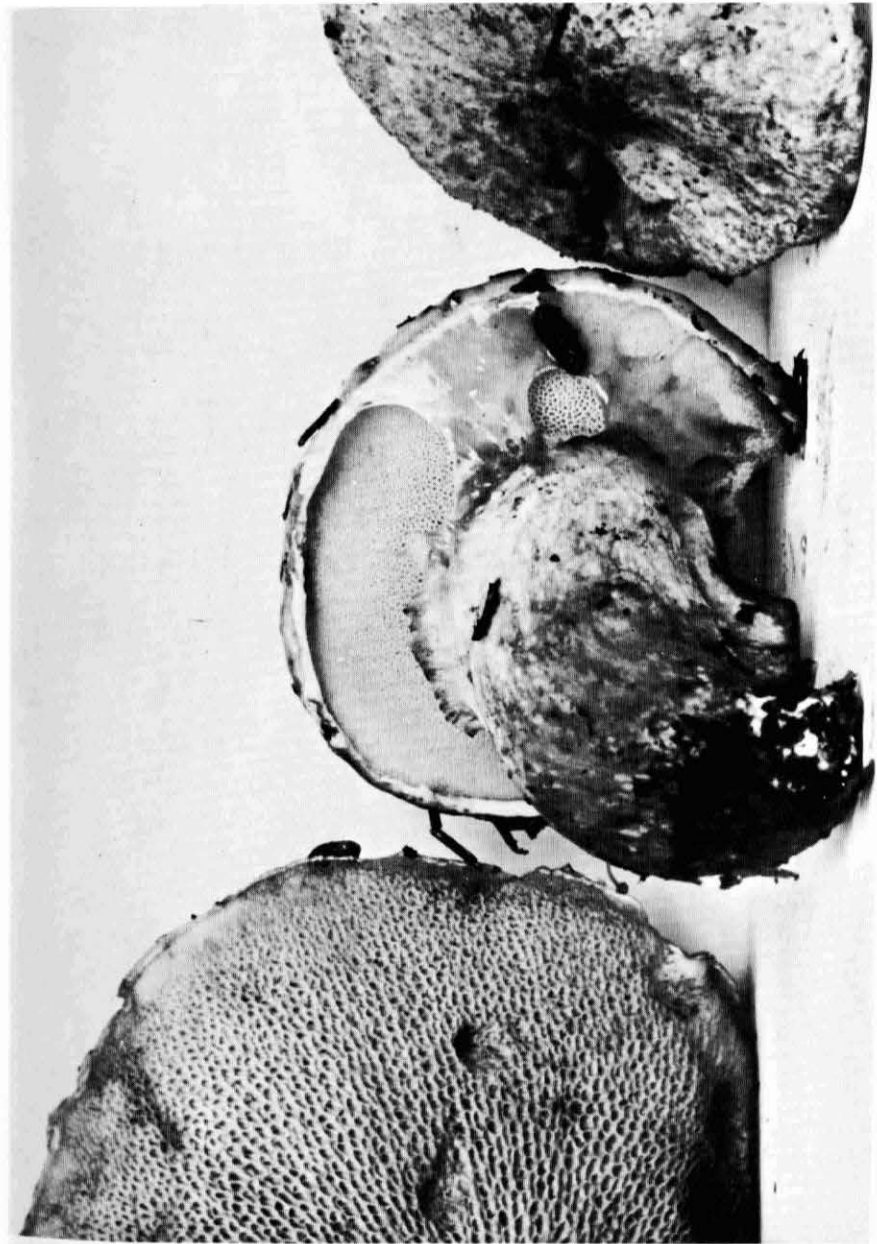
Suillus lakei var. *lakei*, Smith 58397.

Pl. 10. *Suillus caeruleus*



Suillus caeruleus, Smith 48733b and Smith 48733a.

Pl. 11. *Suillus ponderosus*



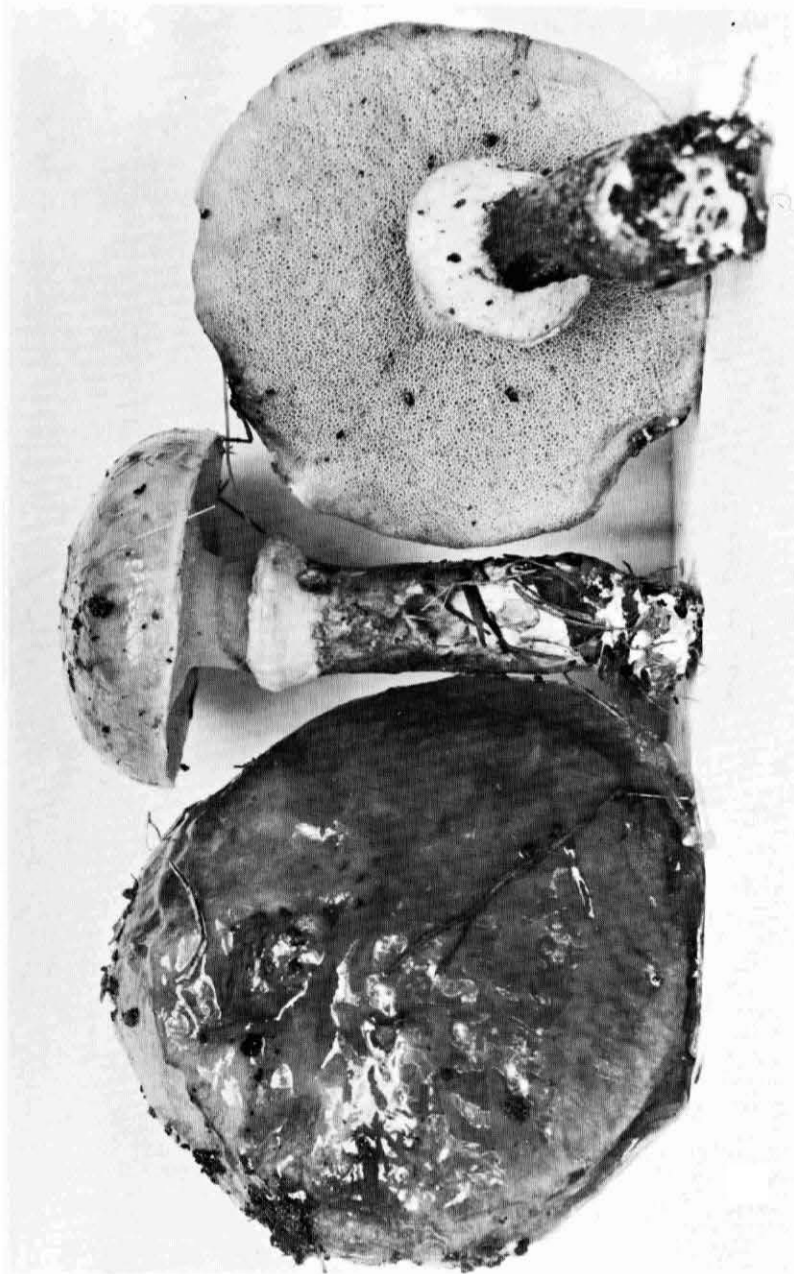
Suillus ponderosus, Smith 27494.
About x 1/2.

Pl. 12. *Suillus imitatus*



Suillus imitatus, Smith 48732.

Pl. 13a. *Suillus proximus*



Suillus proximus, Smith 64545.

Pl. 13b. *Suillus proximus*



Suillus proximus, Smith 67759.

Pl. 14. *Suillus grevillei*



Suillus grevillei, Smith 54702.

Pl. 15. *Suillus grevellei*



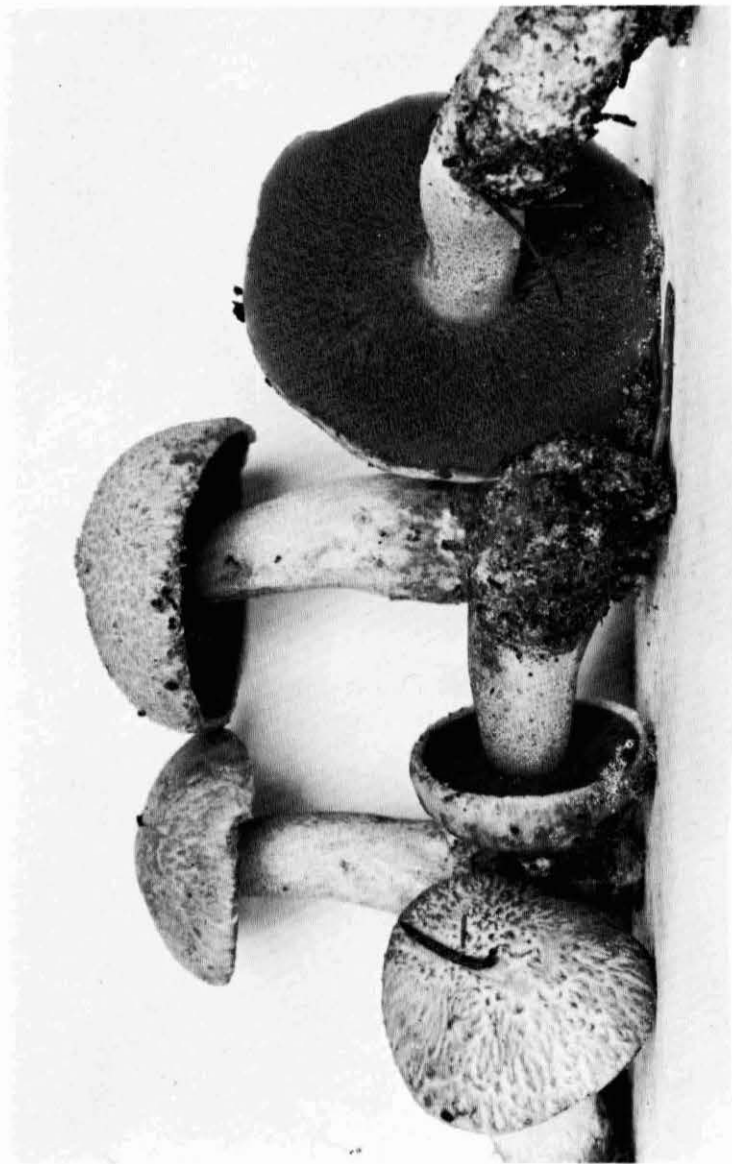
Suillus grevellei, Smith 27862

Pl. 16. *Suillus pseudobrevipes*



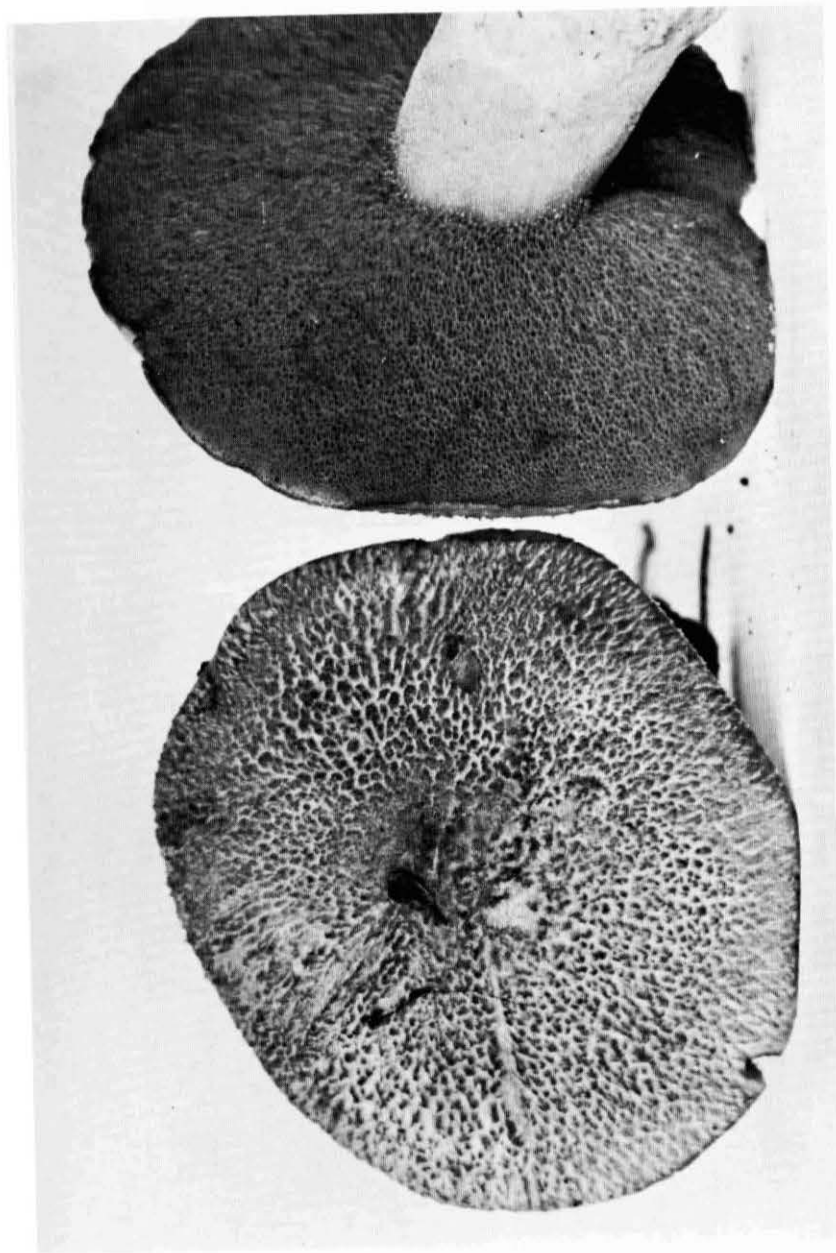
Suillus pseudobrevipes, Smith 58958.

Pl. 17. *Suillus tomentosus*



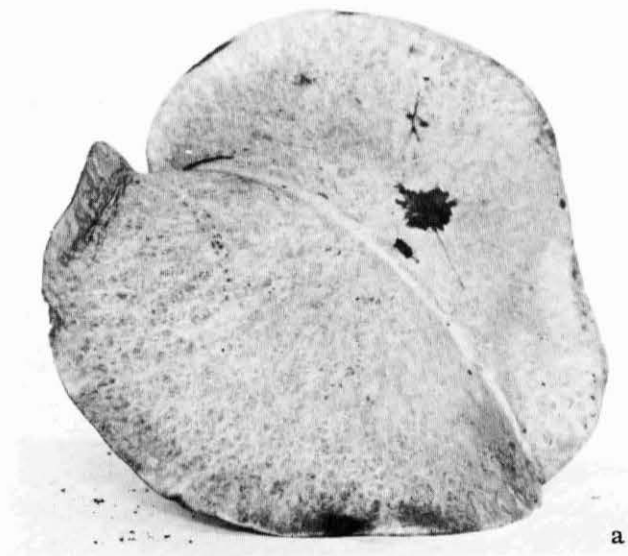
Suillus tomentosus, Smith 64019.

Pl. 18. *Suillus tomentosus*



Suillus tomentosus, Smith 53554.

Pl. 19. *Suillus subaureus*



a. *Suillus subaureus* (freshly matured), Smith 32432.
b. *Suillus subaureus* (old specimen), Smith 7920.

Pl. 20. *Suillus hirtellus*



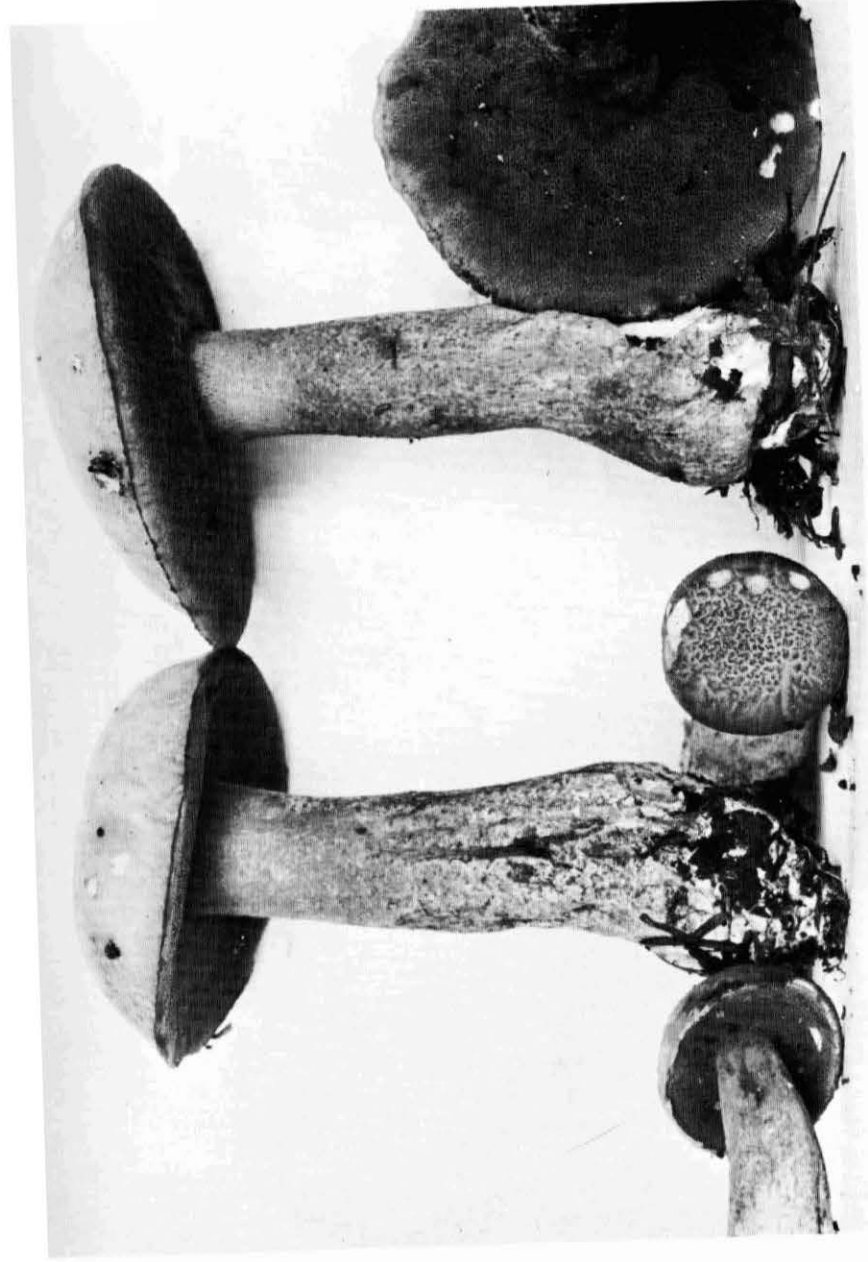
Suillus hirtellus, Smith 32408

Pl. 21. *Suillus hirtellus*



Suillus hirtellus, Smith 67679.

Pl. 22. *Suillus punctipes*



Suillus punctipes, Smith 62939.

Pl. 23. *Suillus luteus*



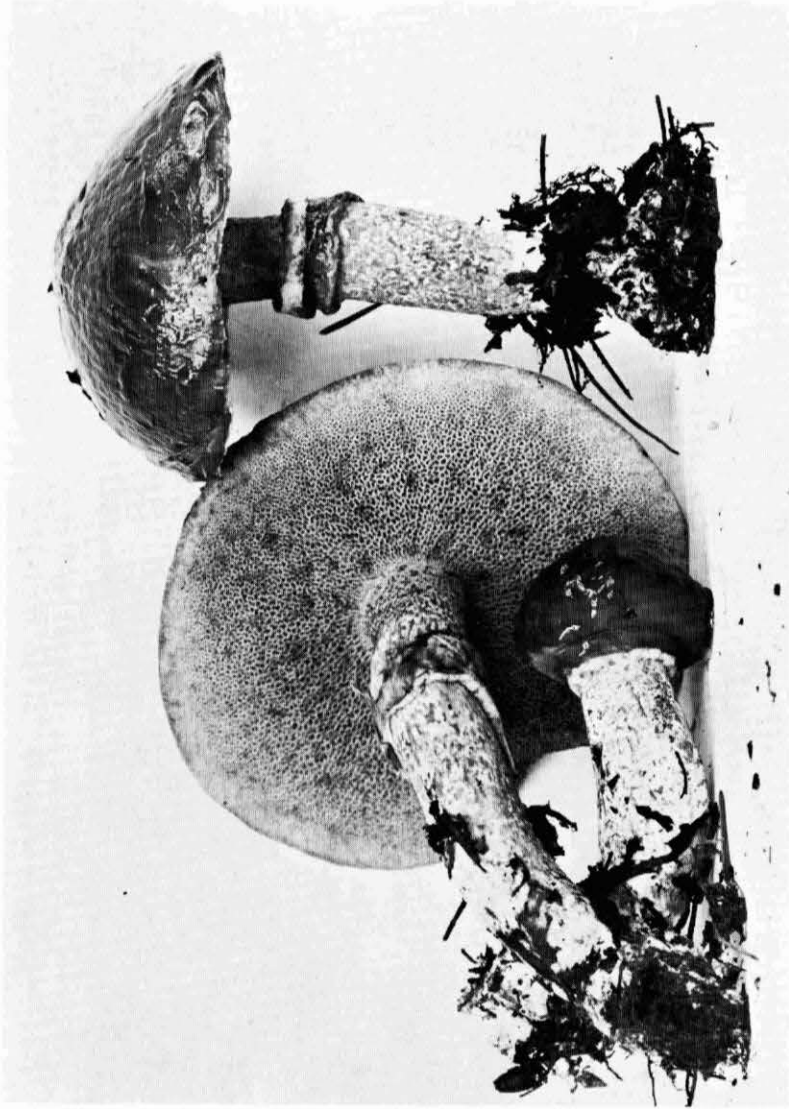
Suillus luteus, Smith 64548.

Pl. 24. *Suillus subolivaceus*



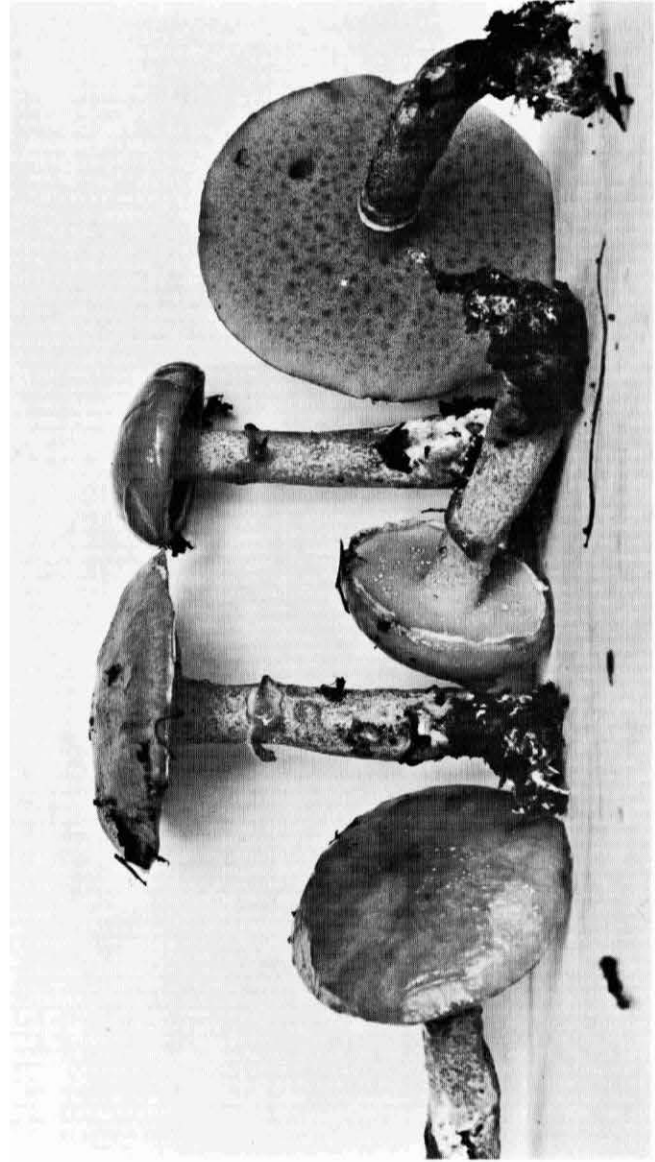
Suillus subolivaceus, Smith 53842.

Pl. 25. *Suillus subolivaceus*



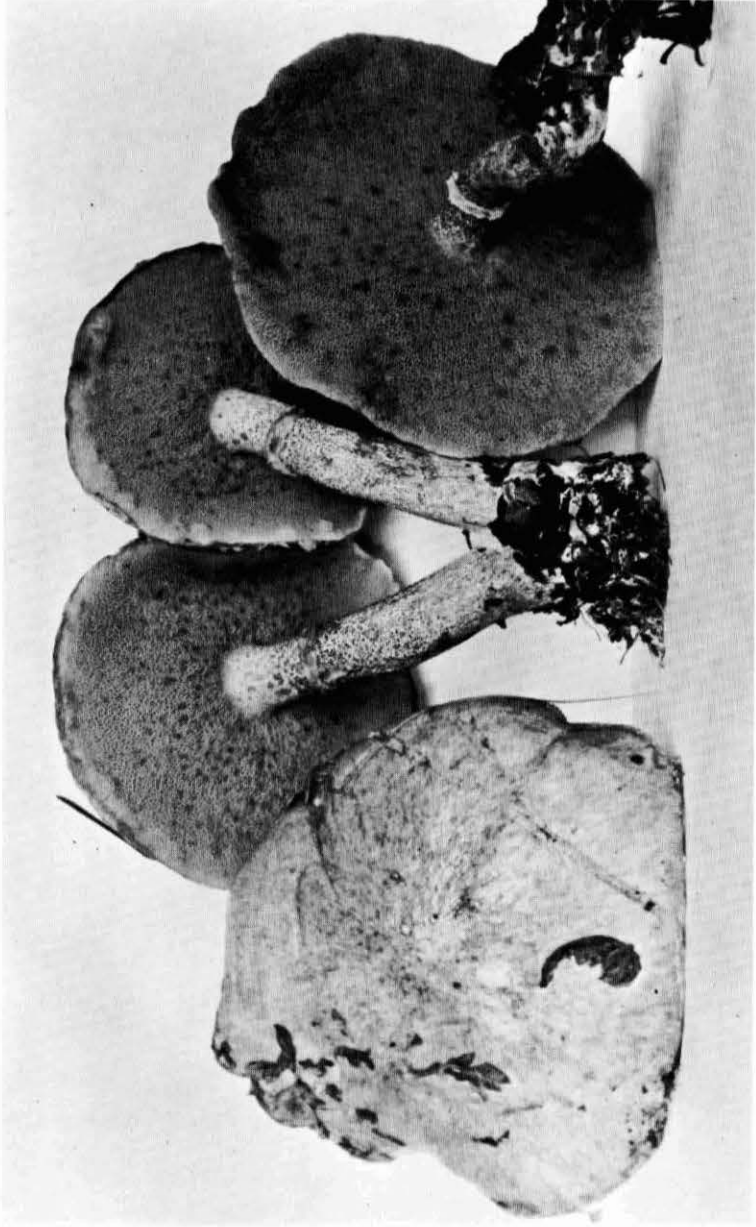
Suillus subolivaceus, Smith 24769

Pl. 26. *Suillus acidus*



Suillus acidus (young specimens), Smith 58078.

Pl. 27. *Suillus acidus*



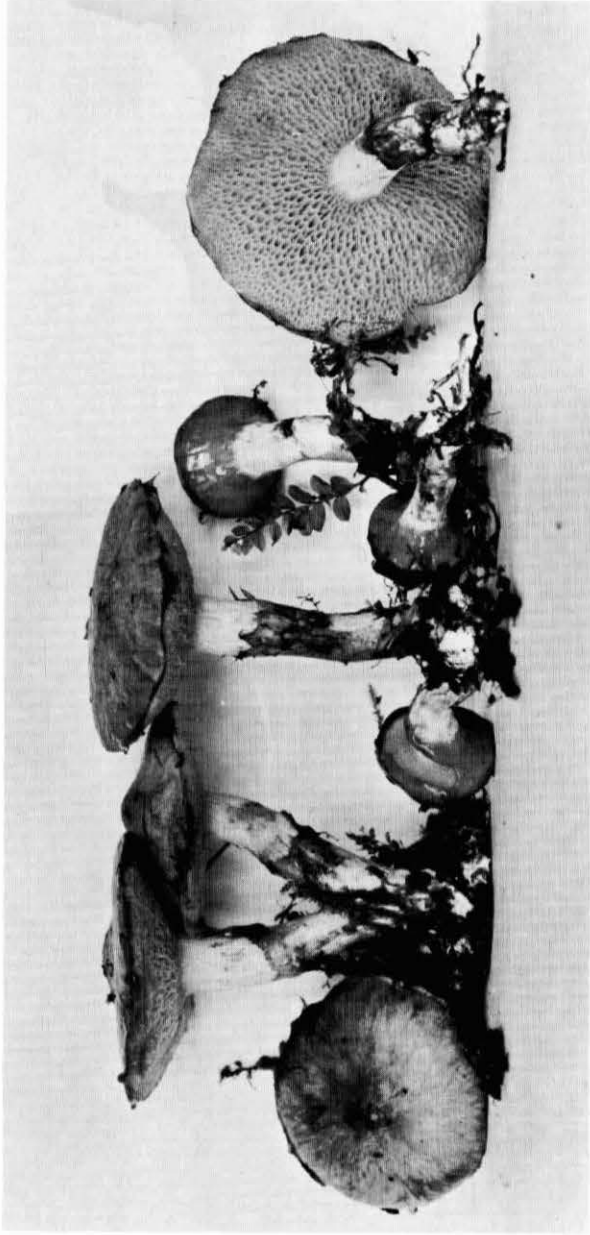
Suillus acidus (mature specimens), Smith 58078.

Pl. 28. *Suillus subluteus*



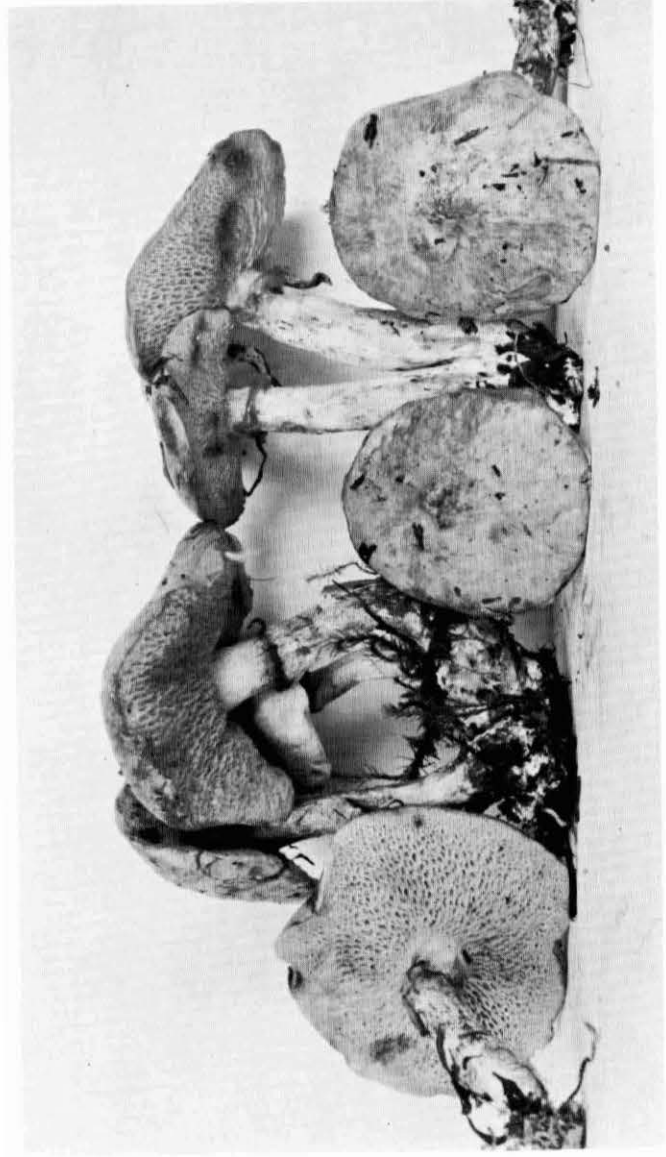
Suillus subluteus, Smith 36961.

Pl. 29. *Suillus umbonatus*



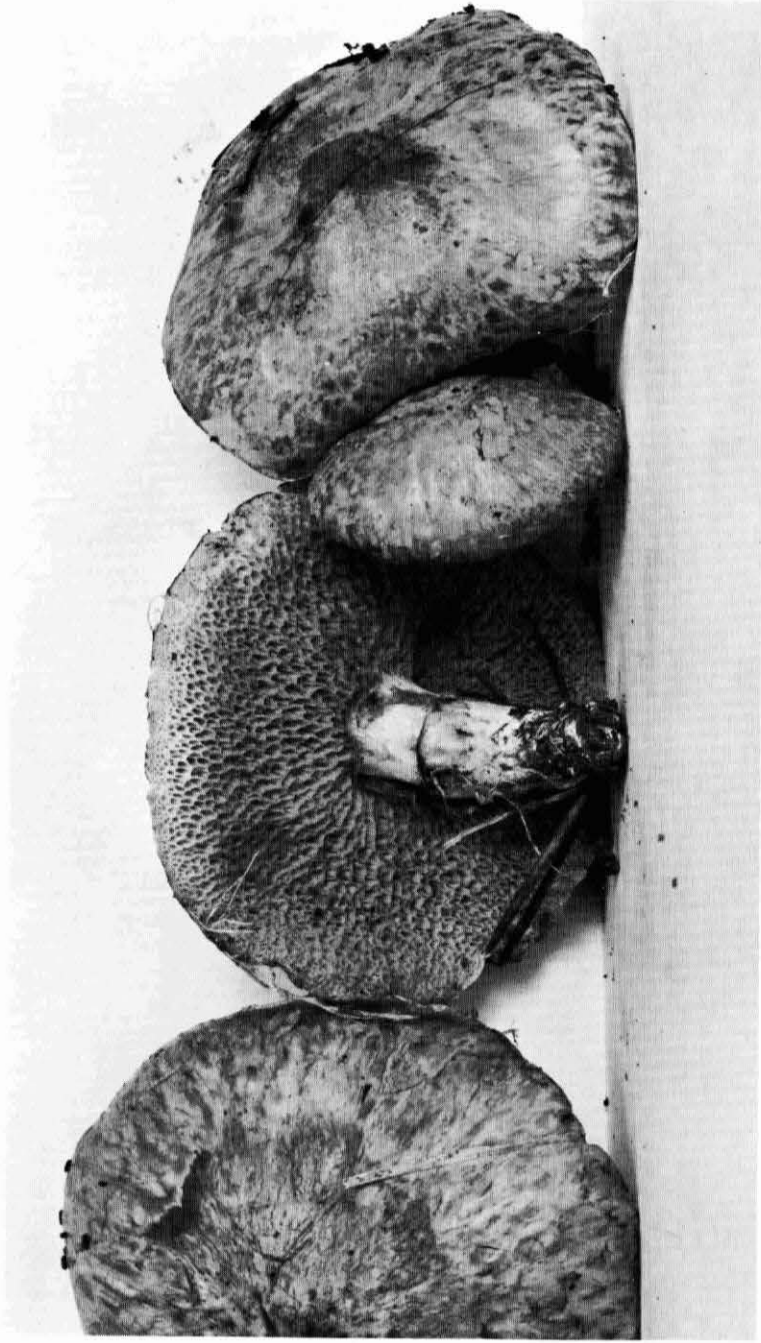
Suillus umbonatus, Smith 53559.

Pl. 30. *Suillus umbonatus*



Suillus umbonatus, Smith 65752.

Pl. 31. *Suillus umbonatus*



Suillus umbonatus, Smith 66292. Large form.

Pl. 32. *Suillus albidipes*



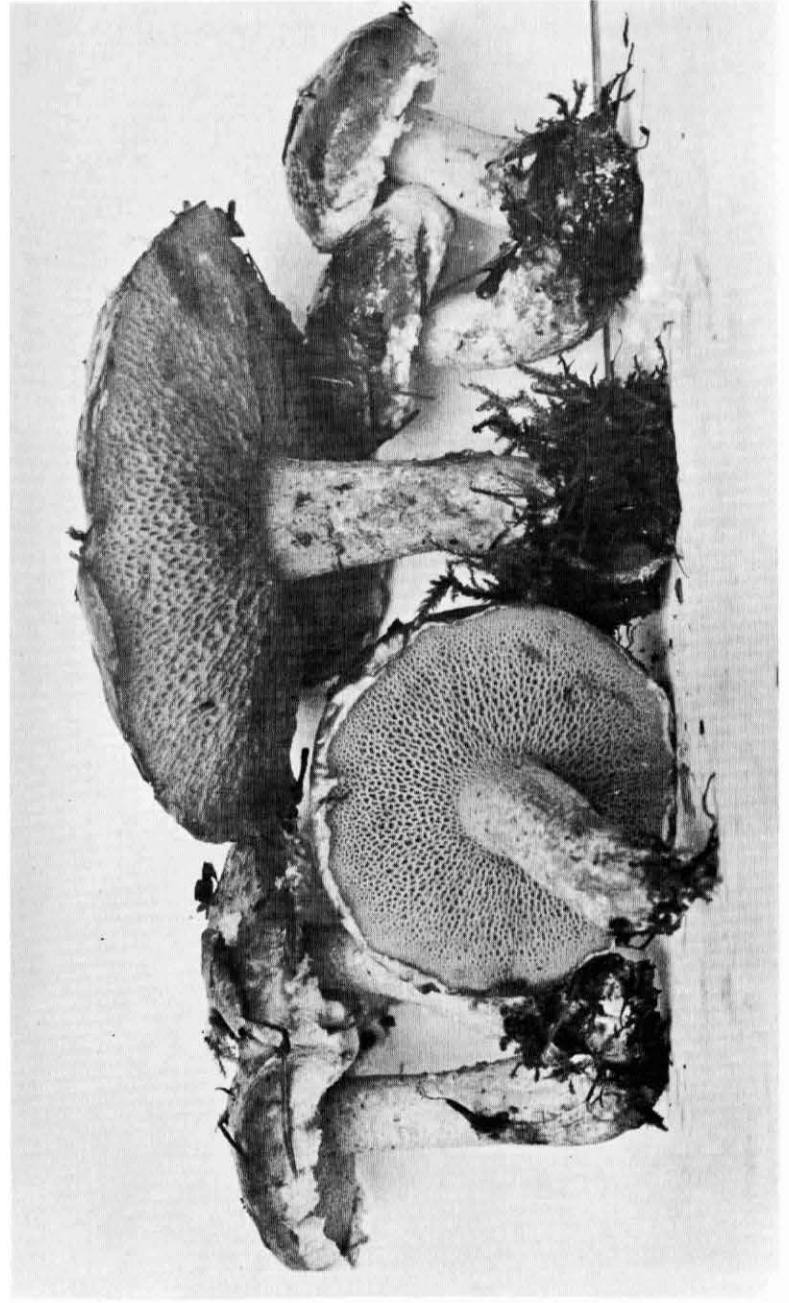
Suillus albidipes, Smith 64747.

Pl. 33. *Suillus albidipes*



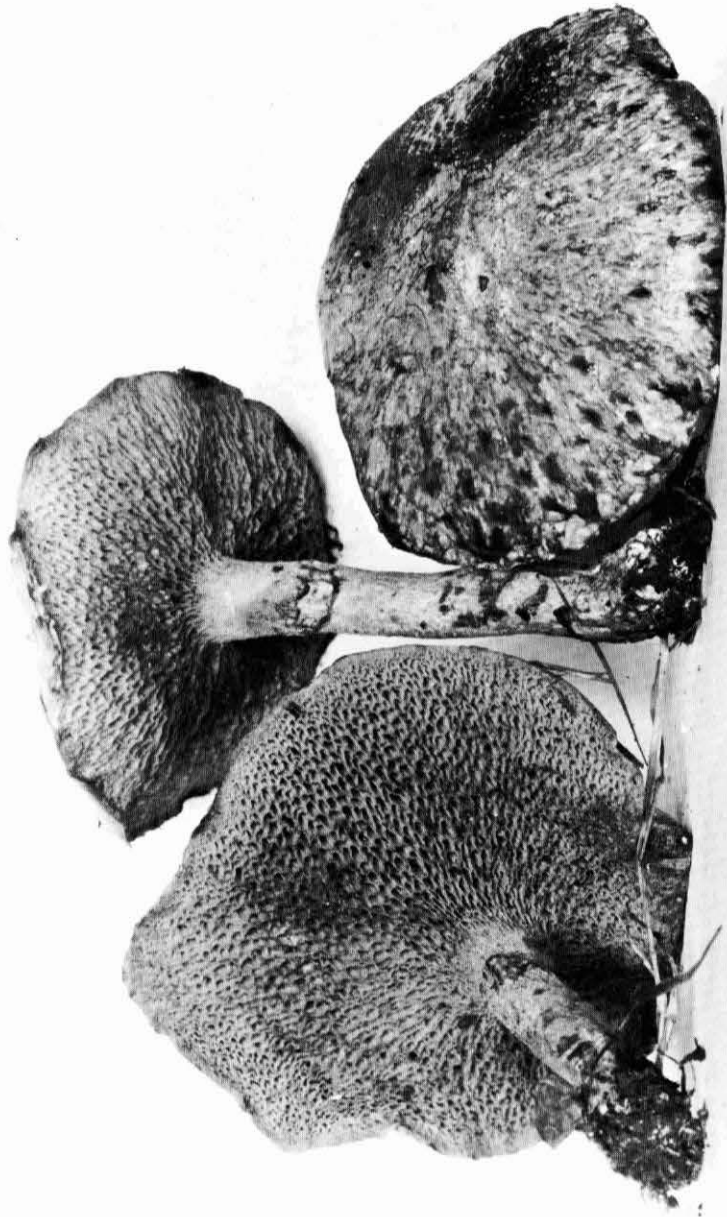
Suillus albidipes, Smith 58179.

Pl. 34. *Suillus sibiricus*



Suillus sibiricus, Smith 27416

Pl. 35. *Suillus sibiricus*



Suillus sibiricus, Smith 54266.

Pl. 36. *Suillus americanus*



a



b

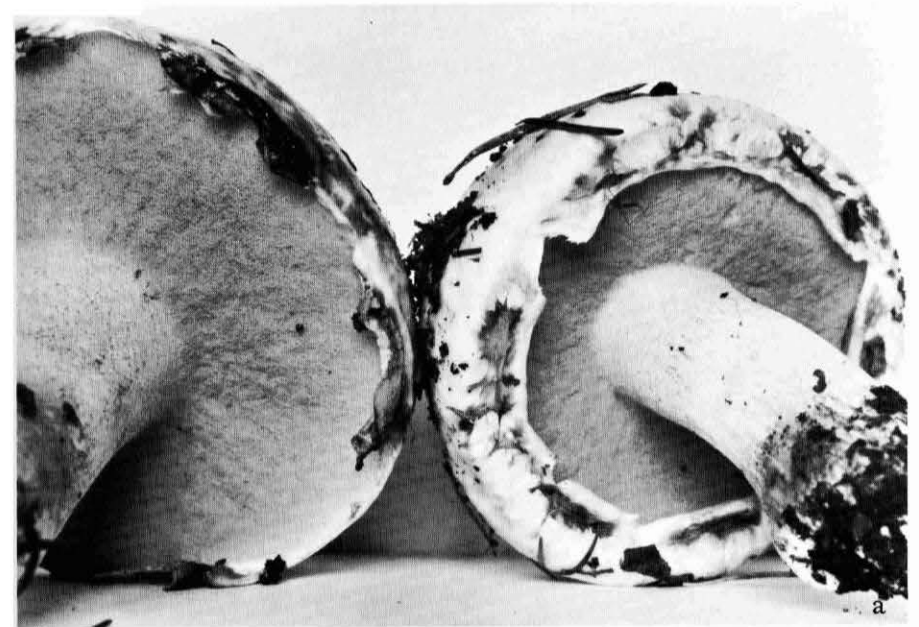
a. *Suillus americanus* (young), Smith 63876.
b. *Suillus americanus* (old), Smith 53936.

Pl. 37. *Suillus americanus*



Suillus americanus (young), Smith 54076.
About x 2-1/2.

Pl. 38. *Suillus brunnescens*



a. *Suillus brunnescens*, Smith 55719.
b. *Suillus brunnescens*, Smith 55495.

Pl. 39. *Suillus brunnescens*



Suillus brunnescens, Smith 55719.

Pl. 40. *Suillus placidus*



Suillus placidus, Smith 58117.

Pl. 41. *Suillus pallidiceps*



a. *Suillus pallidiceps*, Smith 65721.
b. *Suillus brunnescens*, Smith 55718.

Pl. 42. *Suillus brevipes*



Suillus brevipes, Smith 66299.

Pl. 43. *Suillus granulatus*



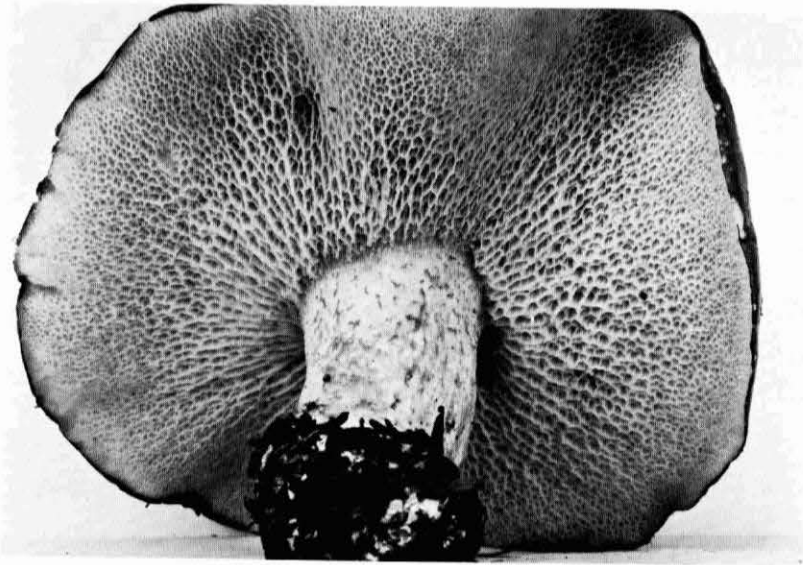
Suillus granulatus, Smith 10-9-59.

Pl. 44. *Suillus granulatus*



Suillus granulatus, Smith 54075.

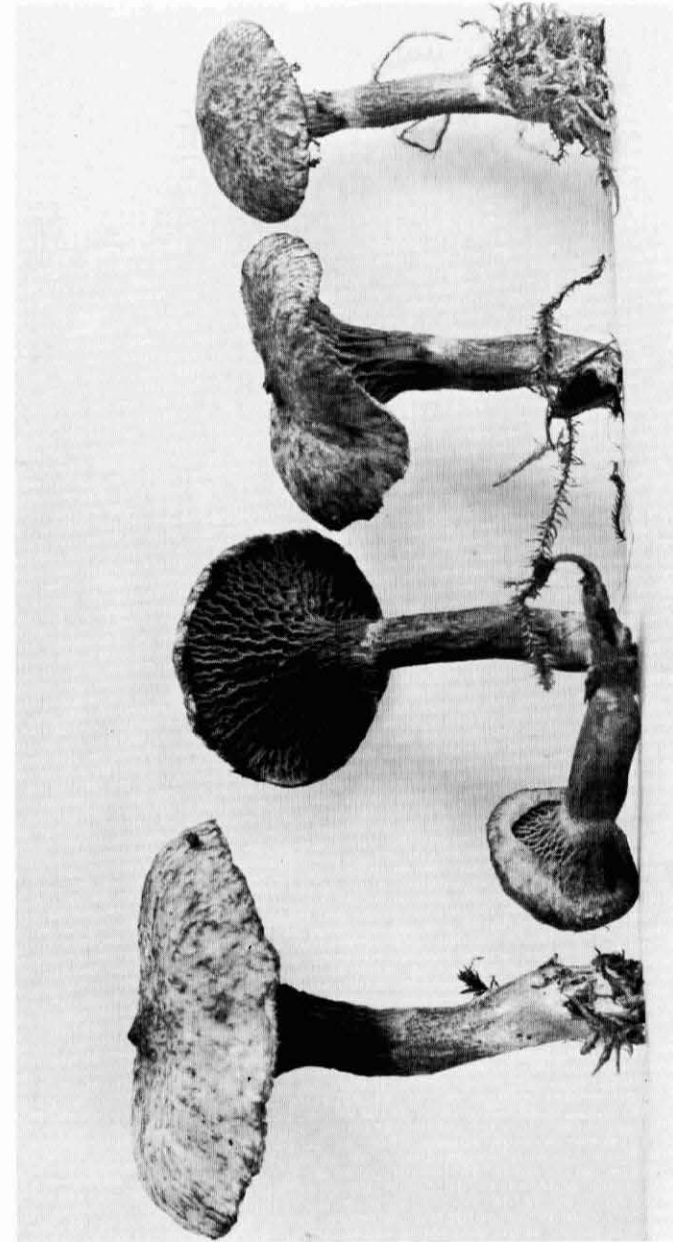
Pl. 45. *Suillus punctatipes*,



Suillus punctatipes, slightly reduced.

Photo Courtesy D. E. Stuntz

Pl. 46. *Fuscoboletinus paluster*



Fuscoboletinus paluster, E. B. Mains 33-596.