MEMOIRS

OF

The New York Botanical Garden

VOLUME 14, NUMBER 2

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March, 1966 MEMOIRS OF THE NEW YORK BOTANICAL GARDEN 14(2):1-178

A PRELIMINARY ACCOUNT OF THE NORTH AMERICAN SPECIES OF RHIZOPOGON[1]

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PREFACE
BY
ALEXANDER H. SMITH

The genus *Rhizopogon,* a member of the Hymenogastraceae, is one of the largest and most diverse groups of the so-called hypogeous fungi. My own interest in it developed as its members were encountered in the conifer forests of our western states over the years since 1935, when I made my first trip to that area. However, it was not until many years after Dr. Zeller's death that I actually made an effort to collect and study the species critically, partly as a result of becoming interested at the research level in the problem of the origin of the Hymenomycetes with particular reference to secotiaceous fungi.

The history of the study of *Rhizopogon* is as spotty as the collection of its species. As for all groups of higher fungi it dates roughly from the time of Fries (1817). The treatment of *Rhizopogon* by the Tulasnes (1851) may be said to have clearly established the genus, but even to this day in Europe there has been no major revision of the genus along the lines of the modern approach to the taxonomy of the Hymenomycetes. In North America the monograph by Zeller and Dodge (1918) has been the outstanding contribution, although the treatment by Coker and Couch (1928) added much to clarity of species concepts regardless of the names used. A study of their approach furnished many of the ideas elaborated upon in the present work.

In the European literature the works of Hawker (1954, 1955) and Morten Lange (1956, 1957) represent significant contributions. No systematic attempt has been made at this stage of my investigation to verify reports in the literature on *Rhizopogon* species as these have been used in mycorrhizal studies or reported in lists in North America. In one case, (Baxter, 1929), the species involved turned out to be new though identified by Zeller as *R. rubescens.*

The present approach to *Rhizopogon* is that currently in use for the Hymenomycetes. In other words I have tried to correlate the macroscopic features with the microscopic characters and have in addition included two of the more realiable chemical tests (contact with iron sulphate and with 2.5% potassium hydroxide, herein referred to as $FeSO_4$ and KOH respectively) along with the iodine reactions of the spores and tissues. After three years of studying fresh material in the Salmon River drainage of Idaho, such a large number of taxa had been encountered and studied that I felt rather hopelessly lost. It was seldom possible to make a satisfactory identification of any of this material in the existing literature. It was in this period that I was approached by The New York Botan-

[1]Publication of this monograph was financed under National Science Foundation Grant 6N-348.
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ical Garden to finish the work started by Zeller on the Gastromycetes of North America. This seemed like a good opportunity to settle the questions in regard to *Rhizopogon*. However, things are not always what they seem, and after working through Zeller's collections I found relatively few of my Idaho species. In addition to this, other disconcerting problems raised their ugly heads. The first point to be clarified was that Zeller and Dodge (1918) and later Zeller (1939, 1941) had described many truly unusual species from the Pacific Northwest. These for the most part were easily recognizable once a careful study of the types had been made. However, when one approached the problem of the recognition of European species in the North American *Rhizopogon* flora chaos reigned supreme. American collections were frequently identified as European species even though such simple characters as spore size were completely out of line. In searching for an approach to more accurate and meaningful species concepts in this genus it at once became evident that if scientific accuracy was to have any priority at all it could be obtained only by describing the American species on the basis of their own features, and by not trying to "force" collections into old or indefinite concepts originating in Europe and quite obviously not applying well to American material. A good house cannot be built with poor materials. Since European authors had not used the same characters I am using, meaningful comparisons for the most part are unobtainable at the present time.

Rhizopogon species are generally so rare and difficult to find that one cannot as a rule go into an area and get a fair representation of the flora in a single season or even several. In a life-time one investigator cannot hope to more than collect the *Rhizopogon* flora of a single continent. The best procedure, in my estimation, is for investigators on different continents to work independently but use the same set of characters, so that their findings are directly comparable to those of other workers. It is only in this way that meaningful distribution patterns can be worked out. As of the present writing I do not consider reports of the distribution of such common species as *R. rubescens* and *R. roseolus* to be at all reliable—true, some of them are correct—but this must be proven on the basis of more accurate species concepts than have existed to date. I am not being at all facetious in entitling this a preliminary contribution toward a monograph. It is an attempt to establish concepts upon which significant distribution data may be accumulated. This is a very important point because it now appears that many species of *Rhizopogon* are highly restricted in their distribution. In a sense this work is also preliminary because of the introduction of a different set of characters than that used previously in the genus. The resulting concepts, like all new concepts, need testing by other workers than the one proposing them to see if they stand the test of objectivity. It is always easy to point out the short-comings of the classical characters used in a previous classification, but it is not always easy to introduce a better and different set. The shortest road to the evaluation of a new set of characters is to set up a classification based on them and then let your colleagues try to find fault with it. In short, this is what I am doing here. My outline (1964) of the infrageneric classification was published separately because Zeller had never used such features as the amyloid character for spores and tissues or the KOH and $FeSO_4$ reactions. I assume sole responsibility for the classification, and any shortcomings which may come to light are to be laid at my door. As previously mentioned, the interesting feature to come out of this study so far is that the flora Zeller was working on in the coastal area is apparently quite distinct from that of the Salmon River drainage in Idaho. The two areas taken together, however, certainly represent the *Rhizopogon* center of the world. The number of previously undescribed species became particularly embarrassing, but

it was a choice between using the combinations of characters that were constant or simply ignoring them. The latter course has never contributed to a better understanding of species in any group.

My greatest disappointment in this investigation was an inability to satisfactorily identify dried specimens in herbaria where notes on the fresh characters were lacking. I know of many new species which are not included here simply because essential data are lacking. Actually dried specimens as found in herbaria present a most discouraging problem to an investigator. In the case of old collections (made more than 30 years ago) one does not know whether the specimens were first preserved in liquid and then dried (which makes color reactions obtained from them by the application of chemicals subject to possible error), or dried first and then soaked in some poison to keep out the insects. In either case the consistency of the specimen and reaction of chemicals on them could have been substantially altered. One does not know the drying techniques used—and this can make a tremendous difference in the consistency and appearance of the specimens. With these uncertainties in mind and a lack of notes on the features of the specimens when fresh, in most cases one simply cannot be sure as to the identity of a given collection.

On the other hand if the color of young, mature, and old basidiocarps is recorded even in general terms, if color changes which take place when a specimen is injured are noted, along with distinctive odors, the color of the young, mature and old gleba, and the KOH as well as the $FeSO_4$ reactions of the peridium, then the specimens properly dried, such material is extremely valuable. The microscopic features can be obtained from dried material as can certain color reactions. The best drying technique is that of Hoseney (1963) because it is easy, safe and can be carried on in the home without the bother of a lot of debris. Specimens prepared by her technique are a valuable addition to any herbarium.

In the following presentation I am responsible for all statements and all details unless otherwise qualified. Zeller did not leave a manuscript on *Rhizopogon*. I have made free use of his collections, however, and it must be recognized that in the species he described and in the materials he accumulated, he made a major contribution to our knowledge of the genus.

The problem of selecting names for species became rather acute in the present work—not because there was a shortage of words but because descriptive names as previously used in the genus had unquestionably led directly to many misidentifications. The best example is *R. rubescens*. In the course of this study at least fifteen species were found under this name—all of which apparently stain red when injured. Although many descriptive names have been used, it seemed to me that there was considerable worth in the alternate idea of naming species after collectors, as this has both historical value and usually involves geographic implications. A list of them covers a large number of collectors who have concerned themselves with the higher fungi of the western and southeastern states, the regions in which most of the *Rhizopogon* species apparently occur.

SUMMARY

One hundred and thirty-seven species are recognized in this work. Svrcek (in Pilat 1958) recognized *R. luteolus, R. vulgaris* var. *vulgaris, R. vulgaris* var. *intermedius, R. roseolus* var. *roseolus, R. roseolus* var. *foetens,* var. *sulphureus* and var. *intermedius*. He also keyed out *R. angustisepta* and *R. briardi*. He gives *R. rubescens* as a synonym of *R. roseolus*. As is readily seen, this is a very meagre aggregation of species and emphasizes, again, that either the flora of Europe is actually poor in representatives of this genus or that they have been inadequately

studied. This comment applies equally well to date for the Great Lakes region and northeastern North America generally. Zeller and Dodge (1918) recognized 12 species in North America and listed 15 as extralimital but recognizable, most of which were European. Zeller in his unpublished key recognized 23 species, *R. provincialis,* and *R. vittadinii* which are presumably one species, are found under *R. vulgaris* of this work. Cunningham (1942) included 3 species from Australia and New Zealand. The only correlation apparent to me of possible botanical significance is that, as in *Suillus,* the regions with the most diverse *Rhizopogon* floras are also those with the greatest diversity in species of conifers.

In the following account color names in quotation marks are taken from Ridgway, Color standards and Color Nomenclature, Wash. D. C. 1912. The place of deposit of the specimens cited is indicated by the system of abbreviations as published in Index Herbariorum. Over 2000 collections were studied, not counting the material in the Zeller Herbarium or the Herbarium of the University of North Carolina. The total number examined is close to 2500. Eleven hundred of these were collected and studied during the field season of 1964. To my knowledge this is the largest number of collections of *Rhizopogon* ever to form the basis for a classification of its species.

ACKNOWLEDGMENTS

I am deeply indebted to The New York Botanical Garden, Dr. W. C. Steere, director, for the opportunity to finish up the project Zeller had undertaken in the Gastromycetes. Zeller's collection, obviously, was the foundation for the present work and was essential for the building up of a classification that was broad enough to include my own material. That this has resulted in a veritable "*Rhizopogon* explosion" is not too surprising in view of the endemism in other groups of fungi for the region involved.

My indebtedness to the National Science Foundation, grant G-23139, as well as previous grants to work on the Agaricales of our Western States, is gratefully acknowledged. It made possible a planned approach to field problems and their execution, and also supported both field and laboratory assistants. Students employed on the project with NSF funds were Thomas Westerdale, Robert Jeanne, David Largent, Nancy Jane Smith, Donald Kowalski, Rodney Cyrus, Harold Burdsall Jr., Paul Miller and Wm. Savalle.

Of special significance to the project was the opportunity afforded to work in the Priest River district of Idaho with the Priest River experimental Forest as a base for operation. The Priest River Experimental Forest is a unit of the Intermountain Forest and Range Experiment Station of the U. S. Forest Service, U. S. Dept. of Agriculture. Through the cooperation of Mr. Joseph F. Pechanec, director, the facilities were made available to my party from June through most of October, enabling a concentrated study of the fruiting habits of this genus to be carried out in areas that have been relatively undisturbed. The results of this study form a major part of the present contribution.

The University of Michigan Biological Station, A. H. Stockard, director, was made available to me both during the regular sessions of the Station and afterward during the fall months. Numerous individuals have contributed specimens, but Mrs. Ellen Trueblood of Nampa, Idaho, the members of the Oregon Mycological Society, Mr. Kenneth Harrison of the Research Station, Kentville, Nova Scotia, Mr. Jim Trappe of the Pacific Northwest Forest and Range Equipment Station, Portland, Oregon, and Dr. Kent McKnight, of Provo, Utah, were noteworthy in this respect. I am especially indebted to Dr. Harry E. Ahles, Curator of the Herbarium, Department of Botany, The University of North Carolina, for

the loan of the *Rhizopogon* collections from that institution, and to Dr. Lilian Hawker of the University, Bristol, England, for specimens and consultations on some of the problems involved. Dr. J. Walton Groves of the Canada Department of Agriculture, Ottawa, kindly allowed me to examine their material. I also wish to acknowledge the help of the Huron Mountains Club, Big Bay, Michigan, which, through its Wildlife Foundation, furnished facilities during the spring of 1963 for a study of the fleshy fungi in the virgin forests which the Club is preserving as a Natural Area. The paintings were made by Helen V. Smith.

TAXONOMIC FEATURES

Macroscopic characters

Since the basidiocarp of *Rhizopogon* is a relatively simple structure, consisting as it does of a tubercle with a lacunose interior, there are not many strictly morphological features to be considered. In fact most macroscopic features are concerned with the nature of the wall (the peridium), its color and any color changes wrought by injury of by the application of chemicals. These are the features that were more or less neglected in many of the early descriptions; so much so that in their monograph Zeller and Dodge (1918) based their key, and for the most part their descriptions, on dried specimens. That their work turned out to have many concepts that were too generalized was due largely to this feature. It now seems clear that color patterns, color changes and the texture of the surface are as valuable for the recognition of species in *Rhizopogon* as they are in the Agaricales. For this reason these features are treated in some detail in the following discussion.

Size and shape: The basic shape of the basidiocarp is globose and any appreciable deviation from this norm is more likely to express the pressures of the location on the developing basidiocarp than any inherent genetic differences in the species. External pressures which may effect shape are contact with obstructions or the mutual pressure from a number of basidiocarps growing in a cluster. It not infrequently happens that as the duff dries out this seems to stimulate the fruiting of *Rhizopogon* species and they develop in or near the line separating the duff from the mineral soil. Under such circumstances, if the basidiocarps grow to any size, they tend to grow out horizontally and are described as "flattened." This term is actually improper in a sense since the basidiocarp is not flattened after having been globose. Growth simply follows the lines of least resistance. The same principle applies in a general way to lobed or irregularly shaped fruiting bodies. It is a fairly safe rule to assume that the smaller basidiocarps in a collection will approach the spherical shape more closely than very large ones.

However, as any biologist would expect, there are species which depart from this rule, especially in the young stages where one merely finds fluffy nodules along the rhizomorphs in the soil. These have neither a definite shape nor is the peridium truly formed, but a poorly formed gleba with cavities lined with hymenium producing spores can be found in them. In other words the *Rhizopogon* basidiocarp does not necessarily start from a primorium the size of a pin head and grow larger. It is undoubtedly true that in some species this happens, but it is also equally true that I have found young fruiting bodies rather shapeless and of indefinite limits that were roughly 5–10 mm. broad in which the peridium had not yet become organized into a tissue but in which a gleba was present with spores in the locules. From observations on species in Idaho, it is obvious that some detailed developmental studies should be made to learn the pattern of development in all of the sections of the genus. Shape of the basidiocarp in its

first stages of development, or, more accurately, the degree to which the fruiting body is delimited in the younger stages, may turn out to be of some taxonomic importance.

Size as a character in *Rhizopogon* is of general value just as it is for species of the Agaricales. There are species which produce small, well defined fruiting bodies and those in which even the primordia appear to be 5 mm. or more broad. We have found specimens the size of tennis balls, but in that stage they ordinarily vary considerably from the globose norm. Size is one of the most easily misinterpreted features of the basidiocarp for the simple reason that one ordinarily does not find 50 to 100 specimens of a single species in one location and thus one rarely has sufficient material for an adequate statistical sample. If one approaches the problem of size from the extremes in the genus as represented in the technical descriptions, it is at once apparent that a span of 5–90 mm. is involved, with most of the measurements falling between 10–35 mm. This does not facilitate distinguishing between taxa to any appreciable extent.

Consistency of the basidiocarp: There are certain undeniable taxonomic features in this category which apply to the fresh state and some which apply to the dried state. It has already been mentioned that at least for some species the young fruiting body is soft and cottony. At this stage it sections easily and there is no indication of any gelatinization of the hyphae of the tramal plates. This soft fragile state gradually changes as the peridium becomes well formed and the gleba becomes colored. The basidiocarp becomes firm and then slowly more rubbery, and if sections are made of the gleba one notices that there is considerably more drag on the razor, and that the tramal plates have become more pliant. These changes have been followed in a number of fruitings for species in sect. *Rhizopogon*. The change is an extremely important one for a collector to realize because it would be very easy for one to separate his material of a collection into two "species" on this basis, one soft and fragile, and one distinctly of cartilaginous consistency.

However, in some species there are distinct differences in consistency at maturity. There is for instance a large number which are relatively firm-cartilaginous, and a number which become distinctly gelatinous. The final interpretation of this difference, however, is better made from properly dried than from fresh specimens.

As Zeller and Dodge noted, the gleba of dried material may be hard and bone-like in consistency. Such specimens are very difficult to section in the dried state. In fact it is because some species have basidiocarps which dry to this consistency that it is a good idea to cut all of them in half when they are fresh. They dry better if this is done and it is easier to make sections of the dried specimens later. On some fruiting bodies dried whole I have had to use a hammer and chisel to open them for study. The above observations apply to material which was mature but had not started to break down from decomposition. Most basidiocarps of *Rhizopogon* eventually break down into a gelatinous mass, but this stage is readily recognized in the fresh state by the color and softness of a specimen, and if such an old specimen is dried it collapses into an amorphous state.

In a large number of species of *Rhizopogon,* however, the gleba dries to a somewhat friable consistency which allows sections to be easily cut; in fact the basidiocarp itself is easily cut in half in the dried state. In a few species it is so crumbly that it is difficult to obtain sections when working on dried specimens. Between these two extremes, one encounters many degrees of hardness in the gleba of dried specimens of the various species, and it is not too difficult to be sure that one is comparing basidiocarps of approximately the same stage of de-

velopment. Hence the differences in the consistency of the gleba in dried specimens have distinct value in the recognition of species and in particular are of value in the study of herbarium specimens.

Two possible sources of error however, may cause trouble. First, in herbaria generally one finds dried material which was originally preserved in some liquid. The consistency of such specimens is not to be trusted. To draw valid conclusions from the study of herbarium materials one must be sure that the specimens were properly dried and have remained untreated, i.e., not dippd in some poison following drying by way of protection against insect damage. A second source of error is associated with the change from the soft fleshy stage to the development of the firm-cartilaginous stage. However, in a large collection one can nearly always recognize the more immature basidiocarps by their greater shrinkage, and of course if the collection is large, one will find all degrees of consistency present. The difficulties arise in interpreting collections of one or two fruiting bodies.

Color: The species of *Rhizopogon* frequently exhibit distinctive color patterns on the fresh as well as the dried basidiocarps, especially if they are properly dried. The color of the gleba falls into two main patterns: The olive to olive-brown series as represented by sect. *Rhizopogon,* and the rusty brown series as represented by sect. *Fulviglebae.* In the sections *Rhizopogon* and *Amylopogon* the young gleba is at first white or whitish but as it becomes more cartilaginous and as more spores develop, olive-buff to olive or olive-brown colors develop, and in old specimens the gleba is often a dark olive gelatinous mass reminding one of the gleba of a phalloid. These colors are not necessarily retained in dried specimens however. The mature gleba of many species in these groups dried pale tan ("pinkish buff" to "cinnamon buff"). In sect. *Fulviglebae* and sect. *Fibulatae* the gleba is ochraceous to fulvous or darker and more vinaceous brown when fresh and mature. These colors serve to distinguish species in the fresh and often in the dried condition and are valuable in interpreting dried herbarium specimens, as they are fairly constant for a given stage of development.

The color of the peridium when fresh is a most important character, and if specimens are properly dried their color in that condition also may be very helpful, but here one must first establish the pattern of changes by studying the same specimens both in the fresh and the dried condition. A number of color patterns are evident in the genus. The most common one is that exhibited by the *R. rubescens* group in which the basidiocarps are first white and cottony, become dingy ochraceous to honey-yellow or dingy-olive-ocher as the peridium becomes well formed, and finally changes to dull brown ("cinnamon brown" to "bister") over the parts exposed to daylight, or injured places may finally become a dark reddish brown. In a second series, mostly in sect. *Amylopohon,* the peridium is white at first but soon develops wood-brown or darker exterior fibrils and in age may be dark vinaceous brown to fuscous over all. Also, in this series, some species retain the white condition until late maturity. The species of sect. *Villosuli* are mostly some shade of cinnamon brown or darker because of the colored epicuticular hyphae of the peridium. In some however, a ground color of pallid to vinaceous buff will show through as the peridial epicutis becomes separated into patches. Some species are ochraceous to clay-color at first and gradually become dark rusty brown or retain their original color, depending on degree of exposure in the habitat. The commonly encountered color states are white and ochraceous, and the changes must be observed for each species in order to establish the pattern. This at times makes it difficult to identify single specimens.

Color changes are as important as the original colors, and those changes resulting from injury to the basidiocarp are particularly important. Those ob-

served upon the application of chemicals will be discussed under chemical characters. The color changes associated with injury to the peridium fall into a red to vinaceous series, a brown one, and in a few species a change to blue-olive or yellow occurs. In *R. lutescens* the gleba changes to cadmium yellow when cut. When working with fresh specimens it is of the utmost importance to record such color changes as result from cutting or rubbing the peridium or gleba. One of the outstanding features of *R. rubescens* is that it changes to red on bruising. This, unfortunately, has led to confusion of a large number of species in North America all showing this feature. In some species the change is to vinaceous red or purplish, in some it is to dingy olivaceous, in others, the largest group, it is to some tint of rose to scarlet. The areas where these changes occur often dry to a different color than do undamaged areas of the peridium. In some species the reaction is almost instantaneous and in others it is slow to develop. In other species the reaction may be to dingy vinaceous and progress to fuscous. In these species the peridium usually dries to a dark fuscous or blackish hue and is thus totally different in color from fresh undamaged specimens. In a number the original color may be ochraceous to clay color, but change to dark cinnamon-brown or russet on handling, a change well known in a number of groups of the Agaricales such as *Paxillus* and *Suillus*. The character, in my estimation, is just as significant in *Rhizopogon* as in the above mentioned genera. In a few species a change to blue occurs, reminding one, of course, of the color change in many boletes or in *Chamonixia*. The color change may be located in the epicutis of the peridium if the latter is more than one layer thick, or it may be located mostly in the region of the peridial context. Further careful studies on the localization of color change are desirable. In a number of species in sect. *Rhizopogon* the change is rapid in the white stage of basidiocarp development, but rather slow to even absent in the ochraceous to brown stages. By using the developmental color pattern in conjunction with the color changes that take place on injured parts, one can arrive at combinations of characters that are as reliable for distinguishing species in *Rhizopogon* as they have been found for distinguishing species in the Agaricales. The same applies to the colors exhibited by properly dried basidiocarps, only here, in both groups, the distinctions are more on an individual species basis. For instance, in some species which stain red on bruising, the stained areas dry vinaceous, in others they dry a dull brown, and in a few the stained area dries the same color as the unstained surface.

The nature of the surface of the basidiocarp gives us some features of taxonomic significance but not to the degree observed for color combined with color changes. The type of surface which is the norm for the genus is that referred to generally as appressed fibrillose. This does not apply to the rhizomorphs which are here regarded as part of the mycelium. It is very rare in *Rhizopogon* that one encounters a basidiocarp with an outer gelatinous or subgelatinous cuticular layer or zone. Species in which the fibrils are so matted down as to give a practically glabrous surface are known but are not numerous. At maturity the typical *Rhizopogon* may be described as having a dry unpolished to distinctly appressed-fibrillose surface. In the sect. *Villosuli* where an outer loose epicuticular zone or layer is present the basidiocarp may develop a spotted appearance from the sloughing off of this layer in patches, or from the aggregation of its elements into areolae leaving exposed paler areas. It must also be remembered that the epicutis develops late in the life of the basidiocarp, and hence a measurement of how thick it is or how many hyphae deep it may be may only indicate the age of the specimen and be of no real taxonomic value.

However, another situation prevails to give an areolate to irregularly spotted

appearance to dried specimens. In some species with a one-layered peridium there appears to be a weak line along the area where the new locules are developing, and pieces of the peridium flake off rather readily especially after the stresses which take place in drying. In these species the color characteristic of the dried peridium must be observed on the patches of peridium remaining in place. The texture of the surface of the denuded and undisturbed areas may be about the same, they may be appressed-fibrillose. In some species there may be a weak area separating the epicutis from the context of the peridium, and in these the surface of dried specimens may also appear spotted because the epicutis tends to disappear in patches. This situation occurs mostly in species where there is a zone of nests of enlarged cells in the context.

Color changes following the application of chemicals: These are best recorded from fresh material but some show on well-dried specimens. Chemical color reactions have in recent years come into prominence in the taxonomy of the Agaricales (Singer 1962). They have not been used extensively previously in the classification of species of *Rhizopogon* to my knowledge. In an attempt to evaluate their use in this genus tests were made during three seasons in Idaho. The two chemicals selected were two which have proved their worth in the Agaricales. Iron salts ($FeSO_4$ and others) have proved to be constant in their results in the Clavariaceae where a green to olive or bluish green reaction is well known particularly in *Ramaria*. In the Agaricales most species of *Inocybe* also show this reaction to some degree, and in *Suillus* it is present in most species also. In *Rhizopogon* some dramatic differences are obtained with this chemical. When $FeSO_4$ is applied to the peridium, certain species give an inky-black reaction, some give a dark olive color, and many merely give a pale to moderately dark olive hue. In a small number no color reaction is obtained. Although these reactions should be taken on fresh material, properly dried specimens will also show them to some extent.

The most distinctive color changes, however, are obtained with KOH in about a 2.5% solution. Three distinctive color patterns develop. The most common is one to rose-red, pink, vinaceous or purplish. This reaction is usually limited to the peridium but in some spreads to the gleba. It is typical for those species which change to red on bruising, but the correlation is not infallible. A second change, also typical of the Agaricales, is a change to olive or blackish green. This change may occur on hyphae of the epicutis and a red reaction may show in the subcutis of the same basidiocarp. In a few species no color change takes place. We have used ethanol as a third chemical, but the results with it have not been very distinctive. Ethanol is frequently used as a wetting agent in the process of making sections from herbarium specimens, and it appeared desirable to test it on fresh material to see if it produced color changes. Preservation in FAA apparently dissolves the substances producing the color reactions with $FeSO_4$ and KOH but it has no effect on the amyloid granules as these occur along the hyphae of the peridium and hymenium.

The color changes shown by the gleba to the above chemicals are not as numerous as those shown by the peridium, but some reactions are obtained. $FeSO_4$ may stain the gleba olive in some species and this reaction may even show on the spores in the locules near the peridium.

The classification proposed by Smith (1964) is based largely on color, color changes resulting from injury, and color changes produced by the applications of chemicals. This represents an attempt to introduce new characters into the problem of more accurately delimiting species of *Rhizopogon* and the results appear very promising. It is interesting to see that the same color reactions obtained on

many species of Agaricales are equally distinctive in the Hymenogastraceae. Further studies along this line are needed for other genera of the Hymenogastraceae.

The rhizomorphs: One of the generic features of *Rhizopogon* is that the surface of the basidiocarp is more of less covered by coarse rhizomorphs, these constituting the only attachment of the basidiocarp to the mycelium which permeates the surrounding duff. In my estimation these structures are more properly regarded as remnants of the mycelium than as special features of the fruiting stage. Species vary in the degree to which these strands are present however. In some, the majority of the strands are attached at or near a basal point. In others hardly any rhizomorphs are present. The color changes which result from bruising often show on the rhizomorphs. In a fair number of species the surface of the basidiocarp may have strands of various distinctness closely appressed to or actually partly included in the peridium. This, along with the observations on young basidiocarps as previously discussed, indicate the rather unspecialized (primitive?) nature of the *Rhizopogon* basidiocarp.

The glebal chambers: These do not offer many features of taxonomic significance. They are typically small and irregular in size, but in large specimens may be ± 0.5 mm. in longest dimension. I have not been able to use the size of the chambers effectively in any species. In those with truly gelatinizing gleba it is not uncommon to observe that the cavities are filled with spores, but in most the chambers remain at least partly empty. It is those species with strongly gelatinized gleba which usually have a bone-hard consistency when dried.

MICROSCOPIC CHARACTERS

The spores: The basic shape of the *Rhizopogon* spore is narrowly oblong. The wall is typically thin to slightly thickened and smooth, and the color is typically pale ochraceous to pale yellow-brown in mass. In a few species the spores are fulvous to dingy yellow-brown, and many have a basal scar marking the spot where the sterigma was attached or where the spore was attached to the basidium in sessile spores. In most species, especially if the spores are 2–3 μ wide, this scar is very inconspicuous. In a number, however, it is large enough so that the base of the spore appears truncate to concave. It must be kept clearly in mind that the term truncate as applied to a *Rhizopogon* spore is different than as applied to spores of species of the Agaricales, where it means a flattened apex usually because of the presence of a germ spore.

The most important spore feature to come to light in the present investigation is that in a number of species the spores are amyloid. This characterizes the sect. *Amylopogon*. In most of these the spores are thin-walled, smooth and pale greenish blue in Melzer's sol. However, in *R. subpurpurascens* and related species a most unusual situation was encountered. Here the spore is minutely ornamented, and a fair number are dark violet in iodine. The most unusual feature however is that in a number of spores it can be seen that a dark violet line first forms between the two spore-wall layers and then the outer wall gradually seems to become impregnated with amylaceous material. In many spores, however, only the distal portion becomes dark violet. I have not seen this situation on the spore of any other Basidiomycete. In addition, many spores in some of these species appear to remain non-amyloid. Also, in a small number of other species it is clear that there is an immature stage in the development of the spore when its wall is amyloid and that in the more mature stages when the spores have become colored, they are clearly nonamyloid. The variations pointed out here are considered sufficient reason for not recognizing *Amylopogon* as a genus.

Spore size and shape are very important characters. As pointed out the basic

shape is narrowly oblong, but variations to ellipsoid are not uncommon and are constant for a number of species. In others the spores are subfusoid. The most interesting variations, which might be regarded as abnormalities, are variations in which a protuberance develops in such a manner that the spores have a pistol-grip. Other spores vary to boomerang-shaped, some are triangular in optical section. One cannot help but wonder if some cytological abnormality is not involved.

I have found that spore size, when correlated with the other features of the basidiocarp, is very constant for each species, and that spore sizes given in the older literature indicating a range of 5–10 × 3–5 μ are unrealistic and indicate a collective concept. This is not an unexpected situation, rather it is the usual history of the development of species concepts. Spore width in particular appears to be a realiable species index. There are two groups, spores 2–3 μ wide and those in which the spores are wider. The break is rather sharp.

The basidium: The basidium in *Rhizopogon* in many species does not closely resemble the basidium of the hymenomycetes. In fact when one compares his observations with the descriptions and illustrations encountered in the literature, there appear to be serious discrepancies. My own observations check with those of Coker and Couch and earlier those by Tulasne who found the spores to be sessile on the basidia or on very short sterigmata. Actually the basidia are difficult to demonstrate on specimens old enough to have the glebal cavities partly filled with spores, as the spores adhere along the hymenium obscuring most details. I usually observe the basidia in the younger locules near the peridium but here one often finds the hymenial elements varying from the normal type particularly as to size. As I have found it, in most species the basidiole is clavate to subcylindric and as the spores form it may remain clavate, it may elongate to cylindric, or the apex may elongate and the spores form on the narrow apex of the neck. The basidia of *Rhizopogon exiguus* are an exception to the general rule and may indicate that this species is misplaced in this genus. Its basidia are agaric-like with slightly thickened walls, the sterigmata are conspicuous and some also have both slightly colored and thickened walls.

According to my experience the basidia (those seen bearing spores) are typically thin-walled and collapse as soon as the spores mature. The thick-walled elements I have seen are better interpreted as paraphyses; I have never seen anything closely resembling the illustrations of the hymenium for *R. roseolus* in Zeller and Dodge (1918). Smith and Reid (1962) in their study of *Cribbea* found bodies which appeared to be indurated basidia and it would not be surprising to find that some basidia in *Rhizopogon* underwent similar wall thickenings, but from my observations it is at most a rare occurrence. I have not observed colored (red to purplish) granules in *Rhizopogon* basidia such as one finds in a number of species of *Cortinarius*.

Paraphyses: The hymenial elements other than the basidia in *Rhizopogon* are mostly of a specialized type not found in many other Basidiomycetes to my knowledge. Cystidia are rarely present and then mostly in the cavities next to the peridium. I do not regard them as of much taxonomic significance. The paraphyses, however, deserve more comment. The basic element is a hyphal branch extending the length (or depth) of the hymenial layer. Very soon in its development it becomes divided up into a number of isodiametric cells. The apical cell elongates somewhat to form the hymenial element and the basal (or lower) cells remain as a cellular supporting column which is somewhat comparable in the aggregate to a subhymenium and is so described in the technical descriptions. The apical cell, in old basidiocarps of many species, develops an internal wall thickening of apparently a mucilaginous nature since it is more

highly refractive in KOH than most hyphal wall thickenings. This is a pronounced feature in many species and very rarely observed in others. It is not to be regarded as a stage in decomposition, as these cells do not liquify like the rest of the hymenium and tramal plates in age. In fact in a few species the wall thickenings occur in all the cells of the paraphysis filament and even in some sections of hyphae in the tramal plates. There is a tendency for these thick-walled elements to disarticulate if pressure is applied to the cover glass and the individual units are then found floating free in the mounts. The central cavity becomes very small and in one population studied contains a strongly dextrinoid body in the oldest specimens. This situation reminds one of the type of hymenial element found in *Cribbea.*

Hymenium: A detailed study of the hymenium and subhymenium worked out in accordance with the classification proposed here will be rewarding in elucidating in a more concise manner the relationships of species in a number of groups and possibly relationships between genera. This phase of the work is still in progress. Fresh material, however, is desirable, though in order to study all aspects cytological studies should also be made to ascertain if conidial variants also occur in the genus. The problem centers around the development of what might be called a "trichodermial hymenium" much like that figured by Malençon (1938) for *Dodgea occidentalis* on the one hand, and a simple palisade of basidia arising from a subhymenium of branched filaments on the other. When the comparative anatomy of the hymenium, subhymenium and such development of a hymenopodium as occurs (rarely) is elucidated, it may be possible to arrive at more accurate conclusions as to the general trends of evolution in the genus—whether it is toward or away from the hymenial type of the Hymenomycetes.

The tramal plates: In the older literature these are referred to as septa but this term is so well established for the cross-wall in a hypha that its use in any other way should be abandoned. There is not much of taxonomic significance in the tramal plates. The hyphae are thin-walled for the most part, smooth, appear highly refractive (glassy) or gelatinous in KOH and give few if any significant color reactions. In *R. anomalus* they have a colored content. The width of the tramal plates as a taxonomic character I discarded early in this study. The hyphal details are not much more helpful. The hyphae may be narrow and uninflated, inflated at the septa, or variously unequally inflated in the midportion, apparently, depending on their age. Sphaerocysts or greatly inflated cells were seen in *R. ellenae* and *R. fragmentatus.* The feature of some significance in regard to the hyphae of the tramal plates is that in young specimens they are typically floccose and not gelatinous but in most species as the basidiocarp ages they become more or less gelatinous. In the descriptions we have pointed out a few instances in which this change does not occur. This makes for a significant difference in the texture of the mature gleba. In stirps Olivaceoniger the hymenium gelatinizes before the hyphae of the tramal plates change.

The peridium: The structure of the peridium has been given emphasis as a major feature in dividing *Rhizopogon* into two groups: those with a peridium of one layer and those in which it is two layered. Svrcek (1958) erected two sections, *Simplices* and *Duplices.* In the present work they are included in sect. *Rhizopogon.* I have not found this separation practical for the reasons which follow: If one approaches the problem of layering in the peridium, it soon becomes evident that one must be clear as to whether he is thinking in terms of hyphal differentiation or layering of pigments. The sect. *Villosuli* is based on the differentiation of a distinct epicutis of hyphae with differentiated walls and basically of a loosely interwoven or trichodermial arrangement. It is thus truly

distinct from the subcutis or context of the peridium. One of the main features of this layer is the development from it of a structure termed a flagellate cell (Fig. 88), which in reality is no more than a rather primitive seta with a long tapered flexuous neck ending in a subacute or acute apex. The base is scarcely inflated and the walls are slightly thickened and brown about to the same extent as the parent cell. In other species, in this layer, one finds cells of irregular shape and with protuberances. In some the projections may be nearly thorn-like. This layer represents the most highly developed cuticular type in the genus. The peridial context in species having it does not necessarily contain pockets of sphaerocysts as is true for some species in other sections, but inflated thick-walled cells occur, as in *R. colossus.*

In most species the peridium is made up of appressed hyphae showing relatively little differentiation other than having pigment deposits on, in, and between the hyphae. These are important in relation to color changes with KOH and $FeSO_4$, as is noted in many of the descriptions. In some species the peridium is remarkably clean, i.e., pigment deposits are rare, and in others there is so much debris as to obscure hyphal detail. Although the hyphae are usually appressed-interwoven, it is not uncommon in sections to find that one has sectioned parallel to the main hyphal arrangement but at the same time has cut across bundles of hyphae extending at right angles—and hence these are seen in cross section. These pockets of or single "globose" cells are not to be confused with those described as sphaerocyst-like, which also occur in pockets and form one of the distinctive anatomical features of the genus. In sections parallel to sphaerocyst-like cells the hyphae are seen to be made up of short broad cells, i.e., the inflated cells are not always borne on special branches. In no species that I have examined, however, have I seen a truly heteromerous condition similar to that found in the astrogastraceous fungi. Rather it is more primitive.

The peridium, with the exception of species of sect. *Villosuli,* is composed of hyphae with little differentiation. The cells may be of equal diameter throughout; this may be true of narrow (2–4 μ) or broad (8–15 μ) hyphae. The walls are typically thin but in a few species they may be somewhat thickened (see *R. luteolus* sensu Hawker). The walls may be colored as revived in KOH or remain hyaline, and may be smooth to incrusted. Some degree of cell inflation is common, such as a slight to a prominent enlargement. The details of the peridium should be described from mature specimens. We have not tried to place emphasis on the thickness of the peridium per se as this is found to vary greatly. It is believed that qualitative features should be given most emphasis.

One of the features of the tissues of the *Rhizopogon* basidiocarp of greatest interest to this investigation was whether or not any gave a violet reaction in Melzer's reagent. It was found (see sect. *Villosuli*) that in a number of species especially those giving a green reaction to KOH that dark amyloid particles were found along some hyphae of the peridium and occasionally among the basidia. These particles often adhere to the hyphal wall in a manner reminiscent of the way iron filings cling to a magnet, but many can also be found free in intercellular spaces. In one species a few segments of hyphae with violet walls were observed. Otherwise all species gave non-amyloid to dextrinoid iodine reactions for the tissues. Amyloid debris is found between the hyphae in *Chroogomphus* (Miller, 1964) in much more copious amounts than observed for *Rhizopogon.* The origin and composition of this material would make an interesting study. There is one artifact, however, which is curious. In a few instances, in species showing amyloid granules and some not showing them, dark violet black granules were observed in KOH mounts in both the hymenium and along the peridial

hyphae. As yet I have no explanation for these but obviously they are not truly amyloid.

An interesting case of either a natural chimera or a *Rhizopogon* parasitized by a *Chroogomphus* or *Brauniellula* species is noted for *R. milleri* where the darkly amyloid hyphae of the *Chroogomphus* were easily traced into and throughout the peridium of the *Rhizopogon* basidiocarp. This relationship deserves further study.

One of the features which deserves some comment is that in a number of species large vascular hyphae (laticifers or oleiferous hyphae) occur. These are hyaline in some species in KOH and yellow in others. In Melzer's sol. they are usually pale to rich ochraceous. Their presence is considered important at the species level but they are at times not readily demonstrated. To date I have found no species otherwise clearly a *Rhizopogon* in which a distinct copious latex is present but a few exhibit a viscous hyaline to colored liquid when the gleba is cut, see *R. olivaceoniger*.

Clamp connections: To date I have found clamp connections in only *R. diplophloeus* and *R. pachyphloeus* in sufficient numbers to use them as a taxonomic feature. *R. diplophloeus* is one of the species in which the spores are weakly amyloid when immature but not so when mature. In regard to the presence or absence of clamp connections, I have made certain interesting observations which point up the necessity of identifying foreign hyphae in the peridium of a given species. It must be remembered that the fruiting bodies form in the duff where mycelia of numerous Basidiomycetes are competing for existence and that it is to be expected that on occasion some of these hyphae may invade or become incorporated into the peridium of a *Rhizopogon* with no particular effect on the *Rhizopogon*. On a number of occasions I have found brown-walled hyphae bearing clamps extending some distance in the peridium, but was never able to trace the connection of such a hyphal system to a hypha clearly representing an integral part of the peridium. When these supposed contaminants have hyphae sharply different from any obviously belonging to the *Rhizopogon,* it is relatively easy to identify them as contaminants. But this might not always be an easy decision to make. Hence it is always important to check the base of the basidium for clamps if any clamps are found on hyphae in the peridium and there is any question as to the origin of the hyphae bearing them. It was a distinct surprise to me to find so many species to lack clamp connections. Zeller had noted clamp connections on one white species but the material was so badly insect-eaten it could not be used as the basis for a description. I feel certain, however, that additional species with clamps will be found.

HABIT, HABITAT AND SEASONAL OCCURRENCE

It is clear to me now, after over twenty years of collecting fungi in our western states that species of *Rhizopogon* are as selective in their habitats, and possible mycorrhizal associates as are species of *Suillus*. From circumstantial evidence I am convinced the majority of the species are mycorrhiza formers. This is in line with the observations of other investigators for the most part. It is also clear to me that the *Rhizopogon* flora of our western states is more than likely the largest for any region in the world; and that most species, like those of *Suillus* in the Agaricales, are associated with conifers, very likely often with only a single species or a single genus. They also have the habit of fruiting at a time when certain moisture relationships of the habitat are realized. In the Pacific Northwest if you know when and where to look for them you will find them in abundance—at times in quantities of a hundred or more basidiocarps—as my daughter, Nancy

Jane and Norman Goetz of Portland, Oregon, demonstrated one day at a meeting of the Oregon Mycological Society at Bear Springs in the Mt. Hood National Forest, where they collected a market basket full of *R. colossus*. This western flora still remains relatively unexplored. Zeller did not have the time or the facilities to do justice to the problem for the Pacific Slope, and I have had only three seasons of intensive work in Idaho. The rest of the time, for me, and also for Zeller during his active collecting career, the genus was considered incidental to other problems. There is still a large field open for investigation here at the survey level to say nothing of the possibilities of bringing these species into culture and comparing their behavior with, for instance, species of *Suillus*. It seems obvious that these fungi will be found to play a significant role in the ecology of our western conifer forests.

It is curious that although this genus is abundant in California, and Harkness did his work on hypogeous fungi in this area at the turn of the century, the *Rhizopogon* flora of California must be regarded as relatively unknown at present. This lack of a critical scientific approach to a fascinating feature of our west coast flora in general is all the more anomalous when one reviews the excellent taxonomic work which has been done on other groups of plants in that state.

The fact that the fruit bodies form underground has made an effective survey of their pattern of occurrence so difficult that we are just now beginning to realize that *Rhizopogon* species are many and varied rather than being organisms on the verge of extinction. They fruit in a solitary manner, gregarious, or caespitose as do most species of the Agaricales. They have distinct fruiting patterns—certain species appear late in the fall and some fruit soon after the snow melts, though I have not found them as yet forming a distinct element of the "snow bank" mushroom flora of the Rocky Mountains. They seem to prefer well drained soil, at least I have not found them in truly wet boggy situations. Because their pattern so closely follows that of such genera as *Cortinarius* in the agarics, it is worth considerable time and energy to explore our hardwood forests to see if they have a *Rhizopogon* flora of any magnitude. If they do, we have not yet encountered it, but that in itself is not conclusive. H. Gilkey made a number of collections from under oak in central Oregon, but these could not be identified for lack of data now regarded as essential.

DISTRIBUTION

At this stage I am inclined to believe that generally individual species of *Rhizopogon* are not widely distributed, even though some such as *R. rubescens* appear to be exceptions. It is evident as I studied Zeller's collections and my own from the Pacific Coast slope (west of the Cascades) that the species in that area are quite different from those in the central Salmon River drainage. It was only when Zeller, Rogers and Gilkey collected in the Wallawa Mts., near Hell's Canyon that our collections coincide as to species in any real sense. This does not mean that sharp dividing lines exist, as there is more than likely a merging of *Rhizopogon* species where the conifer forests of the regions merge. At this stage of my investigation, I believe it is essential to try and work out distribution patterns based on the species concepts as presented here, and that when and if this is done it will be found that the hymenogastraceous floras of Europe and North America have fewer species in common than is indicated by a perusal of existing literature. In order to establish a real basis for comparing both floras I have deliberately described many species as new in this work because of combinations of features unobtainable for most European species at present. It has been shown all too frequently in the Agaricales that had such a policy been followed for the

hymenomycetes we would have had more accurate species concepts for the North American populations at a much earlier date. I do not recognize the occurrence of South Pacific species in North America. The likelihood of their being here is too remote. Species from Japan and eastern Asia, however, are a different problem. Here there is a need for comparative studies based on comparable characters.

This presumed restricted distribution of species of *Rhizopogon* may be caused by their very ineffective means of spore dispersal. It is a fact that rodent and insect dispersal are the major possibilities, with the emphasis on the insects. The small, almost Phallales-like spores may be regarded as an evolutionary step in that direction. But it would appear that the majority of the species have not moved from one place to another with the same ease as have species with wind borne spores. Future investigations will shed more light on these matters. My point in bringing them in here is to question certain assumptions which may have been accepted in the past on too little or actually faulty evidence. If my assumptions as to the mycorrhizal forming capacities of rhizopogons are correct we can expect a correlation of these fungi with the distribution of our species and genera of conifer trees.

SUGGESTED PROCEDURE FOR STUDYING SPECIES OF *Rhizopogon*

As previously indicated, the approach used in the present work is not original in the sense that it has never been used on the higher fungi before. It is merely the application of the methods instituted by Fayod, refined by Patouillard and later by Kühner, and finally summarized in Singer's (1962) monumental work on the Agaricales, by Corner's on the coral fungi, and by Donk and others on the "Thelephorales." It is a combination of the anatomical, and cytological approach, which includes hyphal anatomy.

Hyphal differentiation is important in *Rhizopogon,* particularly the chemical differences between the hyphae of the tramal plates and the hyphae of the peridium. This amounts to a generic character: the hyphae of the tramal plates with rare exceptions become gelatinous, those of the peridium rarely do so and then only slightly. The following is a list of hyphal and other features which at present is considered minimal in descriptive work on this genus.

1. Gelatinization of hyphae (discussed above).
2. Inflation (or lack of it) in hyphal cells. This may occur in gelatinous but mostly in nongelatinous hyphae.
   - A. Whether the cells become keg-shaped, or
   - B. Inflated at the ends more than in the middle, or
   - C. Whether the end-cells or hyphae become greatly enlarged (sphaerocyst-like) or whether intercalery, cells enlarge to a vesiculose shape.
   - D. The pattern of location of enlarged elements; scattered or in a layer; if in a layer are they near the gleba or near the surface or in the medial region.
3. Cell inclusions and incrustations on the walls; wall pigments and wall thickenings.
   - A. The paraphyses: Do the walls "thicken" internally from an accumulation of a viscous material which in some species apparently solidifies?
   - B. Do the paraphyses and basidia have any small "highly refractive" inclusions differing from the normal globules and other protoplasmic content?
   - C. Do the hymenial elements and hyphae of the tramal plates have any

dissolved pigment which when the specimens are dried remains as colored amorphous masses or strands?

D. Color of dissolved pigment in peridial hyphae when fresh in water mounts, in KOH mounts and in $FeSO_4$.

E. Color of precipitated pigment in revived material in KOH and in mounts in Melzer's sol. (including any amyloid material).

F. Incrustations on the hyphal walls. These should be described from mounts in Melzer's sol. as well as KOH. Color will usually vary with the species—also degree of solubility in the mounting medium. In particular one must look for amyloid granules or particules.

G. Intercellular pigment. This is the "amorphous debris" referred to in many of the descriptions. It is found between the hyphae and often is apparently merely more of the material incrusting the hyphal walls.

H. Pigment in the cell wall. This should be checked in water, KOH and Melzer's sol. in both fresh and revived material.

I. Thickenings of the wall and reaction in Melzer's sol. These are rather routine for higher fungi at present but should be measured or described in *Rhizopogon*.

4. Arrangement of hyphae in tissue systems.

A. Note whether an epicutis is distinguished in any way from the body of the context. This differentiation may occur as a loose wheft of hyphae with walls colored differently from those of the context hyphae, or the layer may be more or less of a trichodermium or it may be in the nature of a lax hymeniform layer.

B. Do groups of enlarged cells occur in peridial context and how are they arranged? Be sure to distinguish between cut ends of large elongate cells and truly vesiculose elements.

C. Hymenium: Is it a "hymenial trichodermium" (of hyphae divided into a number of cells, the terminal cell of which is properly the hymenial element) or is it a hymenium in the usual sense of the word, a palisade of single cells.

D. Subhymenium: Is it "cellular" (of isodiametric elements) or branched filaments.

E. Tramal plates: Are the hyphae subparallel to interwoven or intricately interwoven. Are the cells of equal diameter throughout?

5. Spore morphology. Spores are best measured from rather old basidiocarps. Hence these are worth saving even if they dry poorly. Shape and size are major features in *Rhizopogon* species, as is the basal truncation marking the point of attachment to the basidium (see stirps *Truncatus*).

In general one can judge the maturity of the gleba by its color: if white it is either young or sterile, and the color deepens as the spores mature. Spore color has value in recognition of *Rhizopogon* species, but we can't realize its full value at present. It is reflected in the color of the mature gleba.

6. Stains on the basidiocarp from the application of chemicals. I have used KOH and $FeSO_4$. Others will surely be introduced. When testing a basidiocarp cut it in half and dry one half. Cut the other half into as many sections as you have chemicals and test each segment with only one chemical. Be sure to note any layering in the peridium of any of the color

reactions. KOH, as pointed out, may stain one zone red and another green or olive.

7. Stains resulting from injury. The final test for a color change in the peridium is to cut it with a knife and allow it to stand for 5–15 minutes, and also to rub the surface slightly and observe as above. By using both of these one can be sure of whether or not a change will occur.

8. Color pattern of basidiocarp. It is of the utmost importance to observe the colors at the time the basidiocarp are discovered, because this is the starting point for determining the color pattern. It is equally important to check the same basidiocarps after they have dried. These colors do not need to be matched in a color chart, the differences used are not that fine, but one needs to distinguish between yellow and yellow-brown, olive-yellow and olive, so the simplest way is to use a chart if you have it.

9. Texture of surface and ornamentation: is the surface covered with rhizomorphs, is it somewhat viscid to the touch, is it matted-fibrillose, etc.?

10. Be sure to note all species of conifers in an area where the specimens are found as well as any hardwoods and even such shrubs as hazel nut, scrub alder, dwarf willow, etc.

It should not be inferred that all the descriptions in the following text were written with this outline as a basis. Rather the descriptions are the basis of the outline. The outline represents what should be done in the future to aid in establishing accurate species concepts in the genus. Much important data is lacking for many of the species I have described as new, but in all cases such species do have important features which separate the collection from any other included here.

COMMENTS ON THE INFRAGENERIC CLASSIFICATION OF *Rhizopogon*

The division of *Rhizopogon* into only two subgenera may seem illogical to some since *Rhizopogonella* is a natural group and may eventually deserve generic rank, and the grouping within *Rhizopogon* may be artificial in spots. In subg. *Rhizopogon* the sections are recognized on the basis of a single major feature, and this apparent "one character taxonomy" has the same faults here as in other groups of plants. The excuse for using it is that it divides the genus into rather easily recognized groups and hence is a great aid to the practical problem of correct identification of species, a feature I consider of paramount importance in the present stage of our knowledge.

I am sure that species with clamp-connections will be found in subg. *Rhizopogon,* but the data are insufficient to include here. Zeller had found such a species but insects destroyed the collection to the point where an accurate characterization could not be made. The subsect. *Megaspori* is artificial in that the species could be placed in other sections, but I think they are worth grouping together if for no other reason than making them easily found and in pointing up a situation which may not be an abnormality in the true sense of the word but certainly focuses on a biological problem which almost cries to be elucidated. I refer to the question of whether a true basidium produces all the types of spores seen. The pattern of spore-shape variation in this group is foreshadowed in other sections (see *Amylopogon*).

Section *Amylopogon* is the group most likely to be raised to the rank of genus, but I caution against this. First, I should like to see a detailed study of the

character of amyloidity *per se*. As has been pointed out for *R. milleri* it is known that single 8-spored basidia produce 1, 2, or 4 strongly amyloid spores with the remaining spores inamyloid. It is tempting to ask what kind of gene exchange is going on here. But it is equally important to inquire as to the rate at which the amylase (?) is being laid down, and does the rate vary even among the 8 spores of a basidium? In other words is it merely a problem of maturation? The answer seems to be in the negative, but as yet we have only a few observations. It appears clear to me that as far as the amyloid reaction on spores of *Rhizopogon* is concerned, we have a generalized condition in which a few changes not noted yet for other fungi have occurred.

Section *Villosuli* in my estimation contains the most highly evolved species likely to always remain in *Rhizopogon*. In fact a critical study of more material is almost certain to show all degrees in the development of the peridial epicutis, which is used here as the principle character of the section. I say this because the evidence is in some of Zeller's unidentified material which lacks notes. In these the epicutis was found to consist of a few appressed dark-walled hyphae clearly connected to the other hyphae of the peridium. The problem with this material is: How much of such an epicutis if it existed, was lost by abrasion? Also, is this epicutis derived from the rhizomorph system? Species of this section must be handled as carefully as any delicate agaric since this outer layer is easily rubbed off.

Section *Fulviglebae,* even as amended, is still based on the color of the mature gleba since there is such a strong correlation between truncate spores and gleba color. It undoubtedly brings many truly related species together, as well as serving as a practical grouping. There are, of course, as in other sections, odd species still of doubtful affinities.

Section *Rhizopogon*. Any group defined by the "residuum method" is bound to be more heterogeneous than one defined on positive features; such is the case here. The division of the section is equally arbitrary. The only justification for this is to attempt an arrangement which will enable investigators to correctly identify species. As I see it now the species as a group are so closely related that it is almost hopeless to try to arrange them in a "natural" sequence. Hence the division into subsections, series and stirpes on the basis of characters as indicated in the text. "One-character" taxonomy can thus be made to serve a useful purpose at a level where at best a supposed natural classification would be less precise and of doubtful theoretical value.

THE TAXONOMIC CHARACTERS IN RELATION TO EVOLUTION IN *Rhizopogon*

It is always important to trace the evolution of characters in any large genus as this is the essence of overall trends. Let us briefly consider some of these in *Rhizopogon*.

Spore characters: If we see the Agaricales as a background for contrast and consider the features of *Rhizopogon* spores against it, the following points stand out immediately in bold relief.

First, in the thickness of the spore wall at maturity for the genus as a whole it may be said that spores of *Rhizopogon* are intermediate between the extremes of truly thin-walled spores as found in *Mycena* and thick-walled spores as found in *Coprinus*. Actually in most species I would estimate a thickness of 0.25–0.75 μ with some up to one micron, and in *R. melanogastroides* M. Lange we apparently have a spore with walls over 1.5 μ thick, i.e., truly thick-walled. The other extreme is represented by *R. subbadius,* in which, at least in the stages observed, the spore wall is too thin to measure by routine microscopic procedures. To me the im-

portant feature in regard to thickness of spore wall is that it has stabilized at an intermediate level in this genus and is of little help in recognition of species.

Spore color, however, offers more possibilities in this respect, but the differences are difficult to bring into focus because of the problem of degree of maturity of the spores at the time of observation. In old basidiocarps, however, the color of the spores in mass can usually be estimated from the color of the gleba, and this checked in mounts under the microscope, both in water mounts of fresh material and in KOH mounts of revived material. The latter are particularly valuable and emphasize three types of colorization: 1) the pale dull ochraceous type usually found in species with an olivaceous gleba. 2) The dark yellow-brown type (near "snuff brown" as seen in KOH) in which the gleba finally is bister, sepia or olive-brown. 3) The cinnamon to rusty brown (fulvous) type represented by *R. exiguus.* In view of the importance of spore color in Basidiomycetes generally I have used it in this work, but, it must be admitted, in a minor role. The sect. *Fulviglebae* is based upon it. I fully expect that future investigators will have trouble even recognizing this section as the intergradations to the other color types are numerous and, unless you see the specimens fresh, confusing; for many species with pale to dark olive gleba have the gleba pale tan to rusty yellowish as dried. The point which in my estimation is truly of major importance is that *Rhizopogon* is to be regarded as a genus with essentially yellow-brown to olive-brown spores and with the pigment in the wall. The question of whether any species have truly reddish angular spores is also pertinent (see comments on *Nigropogon*).

Spore shape: Spore shape in *Rhizopogon* varies from a basic pattern of oblong or narrowly ellipsoid to rod-shaped at one extreme, and broadly ovate at the other but rarely to isodiametric, and if the latter then not truly globose as in most astrogastraceous fungi. Among the species showing odd patterns of spore shape, however, one can find angular-rectangular, angular-cylindric, boomerang-shaped spores, triangular-shaped spores, etc., and some with a protrusion on one side. As yet we do not know the meaning of this variation in this genus, but I doubt if it is of much significance in establishing connections to other genera save *Richoniella.* The impression one gets from mounts of species in subsect. *Megaspori* is that he is dealing with abnormalities of some sort.

The main body of species is so situated that from it hyaline spores could easily originate on the one hand, or very dark colored spores (as in the Coprinaceae) on the other. This central position in relation to this character, may be found to have some real significance when we know more about related genera. It would be very plausible, for instance, to postulate the origin of *Hysterangium* from *Rhizopogon* with spore color as one of the main features of the connection between them.

Spore ornamentation and the number of spore walls: The spores of *Rhizopogon* are usually described as smooth, and this is true with the exception of a few species in sect. *Amylopogon* which have a faint punctate ornamentation as seen under oil immersion, and a few which to some degree are ornamented with amyloid particles. With Melzer's sol. (iodine) the spores of *Rhizopogon* run the gamut of known reactions with that reagent. We have very dark violet, violet-blue, greenish-blue, and bluish-gray over *all* or *part* of the spore depending on the species, as well as having species in which the spores are weakly amyloid young and nonamyloid when mature. Also, several degrees of dextrinoid reactions are known. I know of no correlated characters by which any of these species can be separated meaningfully into other genera. To me the most important consideration in regard to the iodine reactions of *Rhizopogon* spores is that it should

cause us to re-evaluate our use of these reactions in seggregating genera in other groups of Basidiomycetes. The characters do appear constant and valuable at the level of species recognition, however. So far the amyloid-spore "line" in *Rhizopogon* does not appear to connect up to known genera related to *Rhizopogon*. As a matter of fact the features in regard to the development of the violet color and its location in or on the spore wall of a number of species appear to be unique in the Basidiomycetes. There appears to be no relation of the amyloid character and the tendency toward heteromerous peridial trama as in the astrogastraceous fungi. The most interesting feature is that we have varying degrees of the amyloid reaction, the dextrinoid reaction and intermediate stages connecting both to the nonamyloid condition in what to me at least is a single natural genus.

From preliminary observations I suspect that some species of *Rhizopogon* have both an endo- and an exo-sporium, but this point should be settled by electron microscopy as the spores are mostly small and the walls relatively thin. That the amyloid material is first layed down as a thin medial line between an outer and an inner layer in *R. subpurpurascens* is suggestive.

Under the heading of spore ornamentation we should also consider the inverted-cup at the base of the spore in sect. *Fulviglebae* and the transverse basal septum as shown by other species. Both of these are features of species with sessile spores or very broad sterigmata. From the standpoint of evolution in the higher fungi these two features are truly gastromycete characters and are to be expected under the conditions mentioned above. As far as the *Gastroboletus* series is concerned these two characters are among those which indicate *Rhizopogon* either does not belong there or is at the gastromycete end of the series.

A critical study, including nuclear history, should be made of the *Rhizopogon* hymenium. In many of the species it is actually a hymenial trichodermium with the apical cells forming, strictly speaking, the hymenial elements—and these may not be in an even palisade. Also certain modifications occur in the paraphyses, i.e., the development of internal thickenings. The shape of the basidium at time of sporulation varies greatly among the different species, and deserves more study than I have been able to give it here. But I am satisfied that for the majority of the species it is different enough from that of other members of the *Gastroboletus* series to strongly suggest there is no real phylogenetic connection from them to *Rhizopogon*. When one adds to this that the basidia are typically 8-spored, a condition one might well regard as primitive in the Basidiomycetes, we find that actually there is little in the way of fundamental morphological features to connect these species to *Gastroboletus* and much that separates them. I caution any one taking statements of 2-, 4- and 6-spored basidia too seriously in *Rhizopogon*—even my own. One does record what he observes, but in *Rhizopogon* there is always the chance that on a 4-spored basidium four additional spores were present at first. I feel certain that this is true in most 6-spored basidia, but proof is difficult because the scars left by the missing spores are almost impossible to see even with a good oil-immersion lens. In my studies I have never seen anything like the Fig. 2, *pl. 3* of *R. roseolus* in Zeller and Dodge (1918). My observations confirm the comments made by Coker and Couch (1928).

Cystidia do not appear to be very important at the level of species circumscription or in phylogenetic considerations. For the most part they are very rare and occur mostly in the locules near the peridium. When present they are usually some variation of the clavate to fusoid-ventricose type, but since the basidia often assume this shape as they start to sporulate, one cannot be sure that such a cell is actually sterile.

The structure of the peridium is one of the most important remaining features pertinent to a consideration of the evolution of the genus. *Rhizopogon* is not the only genus to lack a basal attachment of the basidiocarp to the vegetative mycelium. This occurs in some of the astrogastraceous fungi also. In the latter however, it was found that, from species to species, there was in the main a progressive development of the heteromerous type of peridial tissue and considerable differentiation of the epicutis into cellular layers or in developing coverings of dermatocystidia. The latter are practically lacking in *Rhizopogon* and the development of a heteromerous type of tissue is rudimentary to say the least. In *R. diplophloeus,* a peripheral species in *Rhizopogon,* in some collections one finds a lax hymeniform epicutis. In most all others it is appressed-fibrillose—the exceptions being mostly in sect. *Villosuli* where at times suggestions of a trichodermium may be found. In the context it is often difficult to distinguish between the cut ends of wide hyphae and sphaerocysts. To do this tease the tissues apart after sectioning. From the standpoint of evolution, the features of the peridium, like those of the hymenium, indicate a primitive condition not likely to have been derived from any hymenomycete.

The chemical characters, pigment patterns, and color changes on injury I consider to be characters of such wide-spread distribution in hymenomycetes and gastromycetes generally, as to be important within the genus only to relate the species in the various infrageneric categories.

The features of the gleba are much like those of many other Hymenogastraceae, that is, the tramal plates are of gelatinous-interwoven to subparallel hyphae. In this respect the genus approaches *Hysterangium* most closely but must be regarded as more primitive because of the lack of a basal attachment and a columella. In the consistency, which is directly associated with the degree of gelatinization of the hyphae of the tramal plates, the gleba of *Rhizopogon* also shows a strong progression toward *Hysterangium* to the point of obvious relationship. There are a few species in *Rhizopogon* however in which no gelatinization of the tramal plates has occurred by late maturity.

RELATIONSHIPS OF *Rhizopogon* TO OTHER GENERA IN THE HYMENOGASTRACEAE

The problem which actually started me on an intensive study of this genus was one of exploring the *Gastroboletus*-line, consisting of *Gastroboletus, Chamonixia, Gautieria, Truncocolumella,* and at the "bottom" presumably *Rhizopogon.* The question to be answered was whether or not *Rhizopogon* showed a progressive series of features that could be traced to *Truncocolumella* and thence to the other genera mentioned.

As can now be seen *Rhizopogon* as a genus shows trends in a number of directions, some which seem to connect to *Truncocolumella.* Malençon's (1938) illustration of the hymenium of *Dodgea* (a synonym of *Truncocolumella*) could have been made from some of the species of *Rhizopogon* which are included in this work. In my own collections identified as *Truncocolumella citrina* by Zeller I find the hymenium to be more like that of a true hymenomycete (a palisade of single cells rather than a hymenial trichodermium). Also, the hyphae of the tramal plates were not gelatinous in KOH (Smith 31118) and clamp connections are regularly present.

At present I am not satisfied that *Truncocolumella citrina* is a bonafide connection to *Rhizopogon.* The possibility is there, but it is very difficult for me to imagine a genus like *Truncocolumella* giving rise to a group such as *Rhizopogon* in the sense of the present work. If there is a connection here it almost certainly must indicate that *Rhizopogon* gave rise to *Truncocolumella.* After what has

recently been discovered in *Rhizopogon,* it seems wise not to proceed with too much haste in connecting *Truncocolumella* to any line until more variations of it are known. *Dodgea occidentalis,* for instance, may be at least a distinct species after all. Also the hymenial structure in all related genera, *Gautieria, Chamonixia, Hymenogaster,* etc., should be compared.

Regardless of what comparisons eventually show in relation to these other genera, in my estimation *Rhizopogon* must be regarded as a primitive gastromycetous genus of considerable size and diversity—considering the paucity of characters with which one has to work. As evidence I cite the following: The basidia characteristically bear more than four spores each, a columella is lacking (rarely present in a few species), there is no constant basal attachment of the basidiocarp to the mycelium, the structure of the hymenium appears to be of a primitive type in most species, and the gleba is gelatinous at maturity with few exceptions, any statements to the contrary notwithstanding.

In addition, one gets the impression that it is an "old" genus because of the evolution of the features of the spores as already discussed. These are quite diverse. In this matter *Rhizopogon* has a pattern of spore evolution reminiscent of that in *Galerina*—only the characters involved are different. Lacking clear connections to other genera in basic morphological characters, it seems pointless to suggest, for instance, that the brown, angular spores of *Inocybe* in the Agaricales were derived from *Rhizopogon.* It seems obvious, in fact, that the similarity noted is an accidental parallelism—especially since the situation in *Inocybe* can be adequately explained by comparing spores of species related to (and including) *I. lacera.*

The idea that the *Gastroboletus* series originated from *Rhizopogon* seems more untenable to me now than it did earlier. For one consideration, a revision of certain concepts within the *Gastroboletus* series was pointed out by Smith and Thiers (1964). It is now plausible to explain *Gastroboletus* as a genus as a regression from the Hymenomycetes. The boletes would then be derived from ancestors resembling *Suillus decipiens,* i.e., boletoid species with shallow, boletinoid hymenophore, rather than having the hymenophore of long narrow tubes as in *Gastroboletus.* It is rare among the secotioid fungi to find basidia with 6 or more (8) spores, but this is the rule in *Rhizopogon* and in addition the basidiospores are mostly sessile or subsessile. As this situation applies to *Rhizopogon* and *Truncocolumella* we have the following to explain: If Smith and Thiers are right, and the *Gastroboletus*-like fungi can be divided into two groups, one primitive and one "reduced" Hymenomycetes, then at the level of *Truncocolumella* we should have species with rather large locules in the gleba rather than the minute cavities actually found to be narrow tubes in *Truncocolumella citrina* var. *separabilis.* Hence, at least at present, *Truncocolumella citrina* var. *separabilis* fits into the picture better as a species derived from *Gastroboletus* and the boletes. The same position appears to be tenable for *T. rubra.* But more observations are needed on *Truncocolumella.* The resemblance of *T. citrina* to species of stirps Rubescens in *Rhizopogon* is very suggestive at first glance. At present I merely wish to establish my position as it has been modified by the present study and hope that further field work will serve to turn up some of the "missing links." *Hymenogaster* because of the spore characters appears as yet to be unconnected to *Rhizopogon* but, this area deserves further study here in North America, where, apparently, *Hymenogaster* is much more difficult to find than *Rhizopogon.*

If we were to graphically represent the evolution in the two best known lines connecting Agaricales to Gastromycetes (namely the astrogastraceous line and *Gastroboletus* line), we would have this situation if we let a vertical line repre-

sent the axis along which evolution occurred: In the astrogastraceous line we have at the "bottom" *Hydnangium* with 7 species. Proceeding upward we have *Octavianina* with 11 species, 8 for *Zelleromyces,* 25 for *Martellia* and 10 for *Gymnomyces* (making 35 at this level), 12 for *Elasmomyces* and *Cystangium,* 27 for *Macowanites* and *Arcangeliella* combined, making 39 for this level, and finally in the Agaricales (*Lactarius* and *Russula*) with species counted in the hundreds. When one contrasts the *Gastroboletus* line to this one it is evident that there is quite a different pattern of distribution. *Rhizopogon* at the "bottom" of the series has about 137 species, *Truncocolumella* the next stage up morphologically has possibly 3 species; *Gastroboletus* possibly 4, and in the Boletaceae at the hymenomycete level at least 200. Add to this that *Truncocolumella* as a genus leaves much to be desired as an intermediate link connecting *Gastroboletus* to *Rhizopogon,* and the line clearly is very weak at this point. In fact one is tempted to postulate that *Dodgea* and *Truncocolumella* are distinct genera! This question I hope eventually to be able to resolve from a study of fresh material of both. *Dodgea,* as illustrated by Malençon (1938), appears to connect up to some degree with stirps *Luteolus,* though in such other features as clamp connections, stipe-columella, etc. it is "far" removed. The observations of Smith and Singer (1959) indicate basidia of the narrowly clavate type for *Truncocolumella* species, and they were 4-spored. As the situation stands at present the morphological features of the hymenium must be critically restudied before we can map the connections of the hymenogastraceous genera to each other on a horizontal plane and connect them to other genera in lines leading toward hymenomycetous genera.

Dodge and Zeller (1934) placed *Nigropogon* Coker & Couch (p. 37, 1928) in synonymy under *Richoniella. Richoniella* has been considered as a gastromycete connecting to *Rhodophyllus* in the Agaricales because of its angular spores and a reddish color usually attributed to them at maturity. In my opinion the relationship between *Nigropogon, Richoniella* and *Rhizopogon* must be re-examined in the light of the angularity of the spores of many Rhizopogons and the great range in spore color in the genus. The description of *Richoniella* by Dodge and Zeller (1934) is not particularly helpful in this respect as they describe the spores as "angular as in *Leptonia,* russet or rosy." Russet in their sense is close to fulvous, so at once, as to color, we have confusion between rusty brown spored species and those with vinaceous spores (Rhodophyllaceae). The statement that the spores are angular as in *Leptonia* is not helpful beyond indicating that the spores are angular. *Inocybe* also has angular spores and it is in the rusty brown spored series (Cortinariaceae). Pecan brown of Ridgway is a reddish cinnamon. This clearly influenced Dodge and Zeller in their decision. For the type of *Richoniella* they give the spores as hyaline, then pink or rosy—data obtained by microscopic study. They say of the gleba "white at first, then rufescent." The following are my data on *Richoniella macroscopora* Cribb. taken from the type: Spores 15–20 × 7–9 μ, angular with a prominent sterigmal appendage, basically rectangular in shape, wall slightly thickened, appearing hyaline in KOH. Basidia 2-spored. Tramal plates of interwoven hyphae (no peridium was available for study).

Here then we have three species of hymenogastraceous fungus with angular spores. Are they all congeneric? I am convinced that *R. macrospora* could be a connection to *Rhodophyllus* because the spores are truly *Rhodophyllus*-like in shape and in *color* under the microscope! Most *Rhodophyllus* spores are practically hyaline as seen by transmitted light. The structure of the hymenium and subhymenium of *Nigropogon* is closely in line with that of *Rhizopogon* species reported in the present study, and the color of the gleba indicates sect. *Ful-*

viglebae. To me the natural relationships of *Nigropogon* are with this group. I have not seen the type of *Richoniella (R. leptoniispora)*. It appears rather clear to me that the problem of the relationships of these species needs further study on the basis of fresh collections and more critical comparisons of spore color. I am certain that *Nigropogon* is a genus very close to *Rhizopogon* and possibly should be regarded as a subgenus. This conclusion is based primarily on the structure of the hymenium and subhymenium. I feel equally certain that *Richoniella macrospora* in spore features particularly might connect to *Rhodophyllus*. The type of *Richoniella,* on the basis of spore color, might be interpreted either way—at least I am suspicious of "rosy" spores as seen by transmitted light, the possibility that they were reddish cinnamon is too great.

These considerations are important from the standpoint of connections from gastromycetes to agarics. In view of the great diversity of spore characters discovered for *Rhizopogon* during the present study, the first question to be asked is: What, exactly, does spore morphology in the Hymenogastraceae mean in relation to phylogenetic connections to groups of Hymenomycetes? At present we must admit that in a large genus such as *Rhizopogon* we now have established that: 1) The character of angular spores is clearly associated with the genus; in fact we find species in which the character *appears to be emerging*; 2) We find three interesting lines of development in *amyloid* spores: One, in which the spore wall is thin and amyloid when young, and becomes nonamyloid by maturity. Two, in which the spores are violet black (evenly) at maturity. Three, in which the amyloid character first shows as a line between the inner and outer spore wall, and in which finally, *only part* of the spore wall becomes amyloid. We of course have dextrinoid and nonamyloid spores in the genus. The point of all this is that it appears almost certain that this evolution in spore features has occurred *within Rhizopogon,* and does not represent a contribution of genetic material from outside sources.

To me the time is now ripe to start with a large genus such as *Rhizopogon* which admittedly is "strongly gastroid" in all essential or basic features, and try to trace lines of evolution from it to other groups of the Hymenogastraceae. This has not been possible previously because of lack of information about *Rhizopogon* as a genus. The greatest source of error is likely to be that investigators will jump to conclusions prematurely. An example is concerned with the angularity of the spores. It could turn out that *Richoniella* is merely a subgenus of *Rhizopogon* and not actually connected to *Rhodophyllus* phylogenetically. With the data at hand this is a legitimate conclusion because of the range in spore color established here for *Rhizopogon*—from pale ochraceous to dark yellow-brown (bister), and a line with a diverging tendency to reddish-cinnamon spores as in sect. *Fulviglebae*. It must be remembered that spores reddish in deposits, in the Agaricales, occur in *Coprinus, Hebeloma* and *Psathyrella* as well as in *Rhodophyllus,* so that the independent origin of a few species with reddish spores in a large genus like *Rhizopogon* is to be expected in view of our present knowledge.

The feature of angularity probably has no significance as far as *Inocybe* is concerned. It is easy to see how angular to nodulose spores originated in that agaric genus from smooth spored species and this seems to be the most probable manner of origin of the character there. Hence the temptation to link up rusty brown and angular spores to indicate the origin of *Inocybe* from *Rhizopogon* should be resisted. On the other hand, the genus *Rhizopogon* as treated here, is large enough and shows such a diversity of features indicating the origin of characters and their evolution along a number of lines, that Singer's thesis that the Hymenomycetes have originated from the Gastromycetes can now be examined on

a more realistic basis. Instead of working "back" or "down" 'to the most gastromycete-like groups, we can now start with such a group and try to follow the evolution of characters from it as these occur in other genera of the family.

As already pointed out, one obvious relationship now more apparent than ever is that *Rhizopogon* leads directly into *Hysterangium*. All the features which characterize the latter genus are present to some degree in some species of *Rhizopogon*. In stirps Subsalmonius in some species the gleba is much the same color and very gelatinous.

RHIZOPOGON Fries & Nordholm, Symb. Gast. 1: 5. 1817, emend. Tulasne, Giorn. Bot. Ital. 2: 56–63. 1844.

Fructifications globose to variously irregular in shape, lacking a distinct basal attachment to the substratum and lacking a columella (with a few exceptions); surface usually covered sparsely, or almost not at all, by appressed rhizomorphs or coarse fibrils representing the only attachment to the mycelium, rarely with a basal attachment; developing in the duff and often becoming partly or wholly exposed at maturity. Gleba chambered; the chambers empty or mostly partly filled with spores, lined with hymenium. Basidia two- or four- but mostly six- to eight-spored, thin-walled and readily collapsing. Spores sessile or nearly so on the basidium (rarely are long sterigmata present), nearly hyaline to sordid yellow-brown or cinnamon from pigment in the wall, nonamyloid, amyloid, or amyloid when young but not so when mature.

Typically found under conifer trees in the summer and fall.

Type species: *Rhizopogon luteolus* Fries & Nordholm.

Key to Subgenera of *Rhizopogon*

1. Gleba virgate with whitish streaks; peridium pseudoparenchymatic or nearly so. Subg. *Rhizopogonella*
1. Gleba not with pallid streaks or mottlings and wall of peridium prosenchymatic or with some vesiculose or inflated cells present. Subg. *Rhizopogon*

Key to Sections of Subg. *Rhizopogonella*

1. Clamp connections present on hyphae of the peridium. Sect. *Fibulatae*
1. Clamp connections absent; latex present in the gleba when fresh. Sect. *Rhizopogonella*

Key to Sections of Subg. *Rhizopogon*

1. With one of the following characters: a) Amyloid spores; b) Sections of fresh peridium showing olive in KOH at least in some places (under microscope), but if this condition prevails then an epicutis of brown-walled hyphae is lacking. Sect. *Amylopogon*
1. Not as above. 2
   2. With one or more of the following characters: a) Spores truncate at base (often showing a "cup"); b) dark yellow-brown to rusty brown or cinnamon to fuscous gleba when fresh and often when dried; c) if spores are truncate the peridium may show scattered rusty brown thick-walled hyphae or these may be numerous enough to form an epicutis. Sect. *Fulviglebae*
   2. Not as above. 3
3. Basidiocarp with an epicutis of brown-walled (and often thick-walled) hyphae as revived in KOH. Sect. *Villosuli*
3. Basidiocarp lacking an epicutis of brown-walled hyphae. Sect. *Rhizopogon*

Rhizopogon subg. **Rhizopogonella** A. H. Smith, subg. nov.

Gleba pallide virgata, saepe lactiflua; peridium cellulis vesiculosis praeditum. Species typicum: *Rhizopogon olivaceoniger*.

Rhizopogon subg. **Rhizopogonella** sect. **Rhizopogonella.**

Gleba pallid, virgate; hyphae lacking clamps.

Key to Species of Sect. *Rhizopogonella*

1. Spores 2.5–3 μ wide; gleba as dried vinaceous brown.	1. *R. olivaceoniger*
1. Spores 3–4 (–5) μ wide; gleba pallid mature.	2. *R. olivaceotinctus*

1. **Rhizopogon olivaceoniger** A. H. Smith, sp. nov.

Fructificationes 1.5–2.5 cm. crassae, saepe 4 cm. longae, globosae, brunneo-olivaceae tactu umbrinae, fibrillosae. Gleba pallide virgata, dura. Lac subochraceum. Odor aromaticus. Sporae 6.5–9 × 2.4–3 μ, oblongae vel anguste ellipsoideae, leves, nonamyloideae. Typus: Harrison 4666, (DAOM, MICH).

Illustrations: Fig. 1, spores.

Basidiocarps 1.5–2.5 cm. thick, when elongated, up to 4 cm. long, very irregular in shape, when young brownish olive, darker from being handled, when dry dirt gray, surface finely fibrillose as dried. Gleba with cavities becoming filled with spores, pallid tramal plates causing a whitish marbling to the otherwise vinaceous brown color (as dried), hard, when fresh exuding a sticky pinkish buff latex. Odor fruity. Taste mild.

Spores 6.5–9 × 2.4–3 μ, oblong to narrowly ellipsoid, smooth, basal scar distinct, thin-walled or wall slightly thickened, hyaline in KOH singly, weakly ochraceous in groups, in Melzer's sol. yellowish and with a false septum. Basidia too gelatinized to study, but basically short-clavate with walls of indistinct thickness, 5–7 μ broad, spores in groups of 4 and 6 seen. Paraphyses, if present very soon gelatinizing like the basidia. Tramal plates of hyaline nongelatinous hyphae (at least in early maturity) with inflated cells, the layer often pseudoparenchymatic or nearly so, walls thin, smooth, hyaline. Peridium a thick layer with a thin epicutis of fulvous hyphae (in KOH) with the pigment mostly in the cell, these appressed over surface or forming a weak tangled trichodermium from the projecting undifferentiated hyphal tips, many of these hyphae thick-walled; beneath this a cutis of bright fulvous cells more or less pseudoparenchymatic in structure, containing enormous cells with walls 2–6 μ thick and bright fulvous in KOH; beneath this a hyaline subcutis of pseudo-parenchymatous tissue. Clamp connections none. All tissues nonamyloid but amyloid granules present in the layer.

In sandy soil under spruce and *Pinus resinosa* mixed, North Williamston, Annapolis County, Nova Scotia, Canada. 3 Oct 1963. Ken Harrison 4666.

In some sections the thick-walled elements appear to be in a basic trichodermial arrangement with some of the units 2-celled like uredinia spores of a *Puccinia*. The cells in this layer are exceedingly variable in shape and many are up to 40 μ in diameter. The manner in which the hymenium gelatinized before the elements of the tramal plates is also peculiar. The cavities become filled with spores and the tramal plates cause white streaks in the gleba. Some pigment incrustations are found on the hyphal walls but the peridium is basically a "clean" one. In Melzer's sol. the gelatinization of the hymenium is not so pronounced and a layer of clavate hyaline basidia 5–7 μ broad can be clearly seen. Also in Melzer's sol. the medial thickening in the spore wall which produces the false-septate appearance is seen to be in the form of a double band. The enlarged hyphal cells in the tramal plates remind one of the condition described for *Nigropogon* by Coker and Couch. In a collection from Aylecford Lake, Nova Scotia, by Harrison, June 10, 1952 (6–10–52) there were numerous amyloid particles in the

peridium as found for most species in sect. *Villosuli,* and large clavate bodies were observed in the hymenium as revived in KOH.

Material examined: CANADA: Nova Scotia, Harrison 4666 (TYPE); Harrison, 15–10–52a, 27–9–38a, 27–9–38b, 15–10–52b, 6–10–52, 26–7–53, 21–10–55a, 21–10–55b, 17–9–58, 10–58. (KM).

2. Rhizopogon olivaceotinctus A. H. Smith, sp. nov.

Fructificationes 2–4.5 cm. thick, globosae vel irregulares, fibrillosae sordide brunneae vel olivaceotinctae. Lac viscosum. Gleba pallide virgata, subdura. Sporae 8–10 × 3–4 μ, subfusoideae vel ellipsoideae, leves, nonamyloideae. Peridium bistratosum. Typus: Hoxie 13 (MICH).

Illustrations: Fig. 2, spores.

Basidiocarps 2–4.5 cm. wide, 1.5–2.5 cm. deep, globose to lobed and irregular, or elongated, faintly fibrillose over all and with scattered rhizomorphs at first, when fresh yellow-brown, when dried tinged olive over a dull brown ground color. Gleba exuding a latex when cut (causing mounting medium to become opaque), mottled with whitish streaks, the cavities near the peridium drying filled solid with spores, those in the mid-portion with a sulphur tinge as dried and showing powdery spores in unfilled cavities. Odor and taste not recorded.

Spores 8–10 (–12) × 3–4 (–5) μ, somewhat ellipsoid, some obscurely angular, many oblong, a few subfusoid, smooth, wall thickened slightly, basal scar present but not conspicuous, in KOH greenish hyaline singly and slightly more yellowish in groups, in Melzer's sol. pale yellowish singly or in groups pale brownish. Basidia soon gelatinous and details indistinct but basidia do form a hymenium beyond a doubt. Paraphyses soon gelatinous as in the basidia. Tramal plates of hyaline interwoven at first nongelatinous hyphae (as in *R. olivaceoniger*) subhymenium indistinct. Peridium with a distinct epicutis of lemon-yellow cells with pigment in the walls (revived in KOH), the hyphae appressed and many enlarged cells present (almost pseudoparenchymatic), no incrusting pigment seen; subcutis a hyaline almost pseudoparenchymatic layer, no incrusting pigment seen. Clamp connections absent. All tissues non-amyloid, no amyloid granules present.

Collected by Mrs. Hoxie, no. 13, Feb. 9, 1956 (?) in Northern California.

This species lacks the thick-walled elements in the epicutis as seen in *R. olivaceoniger* and the layer is lemon yellow instead of bright fulvous in KOH. The two are similar in having the gleba mottled with white streaks, in having a latex, in having at least some of the cavities filled with spores and in having the hymenial elements gelatinize before the hyphae of the tramal plates. Although more data on both these species is desirable they are worth putting on record now.

Material examined: CALIFORNIA: Hoxia 13 (TYPE).

Rhizopogon subg. **Rhizopogonella** sect. **Fibulatae** A. H. Smith, Mich. Botanist 3: 13–19. 1964.

Clamp connections are present on the hyphae of the peridial epicutis or if an epicutis is not clearly defined, on the hyphae of the peridium. Care must be taken to avoid interpreting contaminating hyphae often on the surface of a basidiocarp, and which may have clamps, as belonging to the *Rhizopogon*. Such contaminating hyphae do not show any connection to the hyphae of the basidiocarp.

Type: *R. diplophaeus.*

Key to Species of Sect. *Fibulatae*

1. Dermatocystidia present, often conspicuous.	3. *R. diplophloeus*
1. Dermatocystidia absent.	4. *R. pachyphloeus*

3. Rhizopogon diplophloeus Zeller & Dodge, Ann. Missouri Bot. Gard. 5: 8. 1918.

R. parvisporus Bowerman, Canad. Jour. Bot. **40**: 239. 1962.

Illustrations: Fig. 3, spores; fig. 4, clamp connection.

Basidiocarp 1–2.5 cm. in diam, globose to rather irregular in outline; colors when fresh "clay color" but becoming darker brown on bruising and when dried blackish with some ochraceous tones showing in the depressions; surface scantily fibrillose from appressed fibrils, few rhizomorphs present, with scattered appressed fibrils leading to the scattered rhizomorphs; $FeSO_4$ on sections of dried material dark green on both the gleba and the peridium; KOH giving a reddish pigment diffusing from the peridium into the mounting medium but the peridium itself soon rusty brown in sections. Gleba mottled to virgate and with irregular cavities, at maturity filled with spores, color when dry near russet and consistency bone hard. Columella absent.

Spores 4.5–5.5 × 2.3–2.8 μ, ellipsoid, oblong or in some cases allantoid in one view, or with a slight lateral protrusion (causing the spore to be slightly angular), hyaline in KOH singly, in masses pinkish buff; in Melzer's sol. distinctly amyloid when young, at maturity nonamyloid, wall slightly thickened at maturity and dingy yellow brown in Melzer's sol., basal scar inconspicuous. Basidia 6- to 8-spored, hyaline, thin-walled, readily collapsing; 10–16 × 4–5 μ. Tramal plates of interwoven hyaline nongelatinous hyphae 2–6 μ in diam; subhymenium revived poorly but apparently filamentous. Peridium basically a trichodermium of hyphae with rusty-fulvous walls mostly thickened somewhat, the cells in the layer up to 25 μ broad and about isodiametric to elongated (the layer appearing cellular as a result) at the outer surface the hyphal ends more or less projecting or the tips crooked and coiled around each other, septate, the cells versiform (many odd shapes) and smooth walled. Clamp connections present at the septa regularly on the colored hyphae of the peridium. All tissues nonamyloid.

Found clinging to the sides of an overhanging rocky cliff among rhizomes of *Adiantum pedatum,* Washington, Friday Harbor, Washington, Zeller 1360 (TYPE) (NY). Known from California, Colorado, Oregon, Utah, Washington, Wyoming and Northwest Territory and Newfoundland in Canada.

The distinctive features of this species are almost too numerous to list. The clamp connections on the thick-walled colored hyphae of the peridium are unique in the genus, the organization of the peridium is unusual and reminds one of the type found in the *Plinthogali* of *Lactarius,* only in the *Rhizopogon* it is developed to the point of being a compact, cellular layer except for the outer hyphal extremities. The spores are distinctly amyloid when young and distinctly nonamyloid when mature. In fact they are distinctly yellow-brown in Melzer's sol. at maturity. In addition to these features the $FeSO_4$ reaction and that of KOH on the peridium are distinctly positive. The color change on fresh specimens is a good field character, but others in the genus show the same change. *R. abietis* in sect. *Rhizopogon* rarely has clamped hyphae in the basidiocarp, but is not in any way closely related to *R. diplophloeus.* The relationships of the latter in *Rhizopogon* are obscure and yet the differences hardly justify erecting a new genus for it. The dermatocystidia are often so numerous as to suggest a lax hymeniform palisade. For further comment see *R. pachyphloeus.*

Material examined: CALIFORNIA: White, 121. COLORADO: Kauffman 8–8–17 (as *R. rubescens*). OREGON: Kauffman & Wehmeyer 10–10–22 (fide as *R. rubescens* by Zeller). UTAH: McKnight F–138 (BYU). WASHINGTON: Smith 30059. WYOMING: Kauffman Aug.-Sept. 10, 1923 (5 colls.). CANADA: N.W.T., Fort Smith, DAOM 45793; Nfld., St. Anthony, DAOM 45792 (TYPE of *R. parvisporus*).

4. Rhizopogon pachyphloeus Zeller & Dodge, Ann. Missouri Bot. Gard. 5: 9. 1918.

Illustrations. Fig. 5, spores; fig. 7, cells from peridial cuticle.

Basidiocarps 2–3 cm. diam, ovoid to globose, shrinking appreciably in drying, when fresh ochraceous-isabelline (Murrill), (dingy ochraceous in my terminology—A.H.S.), drying to "Brussels brown" or darker yellow brown (bay at times), dark cinnamon-brown in the part of type in Zeller Herbarium; odor "foul but not very spreading" (Murrill); surface with prominent fibrils much branched and reticulated to enclose the basidiocarp in a net darker than the peridium when dry; surface blackish green with $FeSO_4$ on dried specimens; KOH dull vinaceous red. Gleba umbrinous but olive black in $FeSO_4$, mottled or streaked with white when fresh, drying almost black, cut surface shiny hard and almost black, when fresh the consistency soft-gelatinous, cavities small and becoming filled with spores.

Spores 4.5–5.5 × 2–2.5 μ, ellipsoid, nearly hyaline singly in KOH, in groups pale dingy tan, in Melzer's sol. pale snuff brown in groups, pale tan individually, smooth, basal scar distinct under oil. Basidia in part of type studied too gelatinized to study, groups of 6 and 8 spores indicate a possible condition of 6- to 8-spores basidia. Hymenium, subhymenium and tramal plates all of gelatinous refractive hyphae. Peridium of appressed-interwoven hyphae, the layer with groups of enlarged cells up to 40 μ diam, dispersed irregularly through it (layer appearing almost pseudoparenchymatous at times), walls of the interior hyphae hyaline in KOH, toward the exterior the walls vinaceous brown in KOH and a red pigment diffusing out when sections are mounted, the epicuticular zone finally becoming fulvous. Clamp connections present. All tissues nonamyloid.

On a bank among lichens, in a rather dry place, Cinchona. Jamaica, Dec. 25, Jan. 8, 1908–09. Elev. 4000 ft. Wet mountainous region. Murrill 605 (Zeller Coll. 1417) (NY).

The problem of *R. pachyphloeus* and *R. diplophoeus* as distinct from each other turned out to be much more difficult than was anticipated from using the key of Zeller and Dodge. First as far as I could ascertain both have essentially a one layered peridium, but in both the epicuticular zone is a darker rusty brown than the inner region. In some collections the enlarged cells in the peridium are more numerous near the surface and this might be regarded as a layer. Because of the variation in the distribution of the cells in the layer, however, when one examines a number of collections, this feature is found to be inconstant and not a reliable character. Zeller and Dodge (1918) described the spores of *R. pachyphloeus* as 3–5 × 5–10 μ and *R. diplophloeus* as 5.3–7 × 2–3.5 μ. In my study of both type collections the spores measured 4.5–5.5 × (2–)2.3–2.5 μ. Hence no difference between the two exists in their spore sizes. The presence of clamp connections is readily established on both types, as is the presence of enlarged cells in the peridium and the very dark $FeSO_4$ reaction which extends to the spore mass (as seen in dried material). Both have the mottled gleba reminding one in the dried state of a *Melanogaster*. Both become very dark brown (blackish brown) in drying and are clay-color to isabelline fresh.

The points of difference are that *R. pachphloeus* was described as having copious rhizomorphs giving to fresh basidiocarp a reticulate appearance, and by the thinner-walled, less coiled hyphae of the epicutis, and it lacks any conspicuously clavate to cystidioid end cells of the epicuticular hyphae.

Material examined: NEW YORK: Miller 4345 (as *R. rubescens* NY). NORTH CAROLINA: Wehmeyer 8–22–24. VIRGINIA: Kauffman 8–19–19. JAMAICA: Murrill 605 (TYPE) (NY).

Rhizopogon subg. **Rhizopogon** sect. **Amylopogon** A. H. Smith, Mich. Botanist 3: 17. 1964.

Species included here give a dark violet to blue, greenish blue or gray reaction with iodine, but in addition those giving a gray to fuscous reaction on the fresh gleba with Melzer's sol. are included even though their mature spores are yellow-brown in Melzer's sol. and appear to lack any amyloid reaction as seen under the microscope. Also, those species which give an olivaceous to inky fuscous KOH reaction on the fresh peridium, but lacking the specialized epicutis of sect. *Villosuli* are included here. In many species of this section a fresh peridium in cross section mounted in KOH and viewed under the microscope may give both an olive and a red color change, the colors being limited to pockets. The section thus contains species at one extreme with the immature spores weakly to inamyloid to those with violet-black spores at the other.

Type species: *R. subpurpurascens* Smith.

Comments on Stirpes of Sect. *Amylopogon*

Although this section appears in the main to be as "natural" as one can expect in a genus of such closely related species, it can be subdivided into smaller groups.

Stirps Anomalus. *R. anomalus* and *R. semireticulatus.*

This grouping is based on the pigment masses in the hyphae of the tramal plates (at least in plates near the peridium). Correlated with this is a tendency in the peridium for ochraceous to cinnamon-brown colors.

Stirps Arctostaphyli: *R. arctostaphyli, R. salebrosus, R. rudus,* and *R. milleri.* All of these tend toward ochraceous to cinnamon colors in the mature peridium, but lack the intracellular pigment noted for stirps Anomalus. A connection to sect. *Villosuli* appears to be through these species.

Stirps Subpurpurascens: *R. subpurpurascens, R. atroviolaceus, R. kauffmanii* and *R. fallax.* These have some dark violet spores present in mounts in Melzer's sol. They feature the erratic behavior of the spores as colored by iodine. In most the basidiocarp is white but dries dark vinaceous brown to fuscous.

Stirps Ellenae: *R. ellenae, R. pedicellus, R. subbadius, R. subgelatinosus, R. idahoensis* and *R. subcaerulescens.* These species like those of the previous stirps are white at first but dry dark vinaceous brown to fuscous. The spores give an even reaction to iodine in contrast to most of those in stirps Subpurpurascens.

Stirps Alkalivirens: Because of the amyloid spores this species keys out in this section instead of in subsect. *Megaspori* of sect. *Fulviglebae.* It is worth a note that the pattern of irregularity in spore size and shape is exactly that found in *R. variabilispora* and *R. griseogleba* as well as in *R. clavitisporus* to some extent. To me it suggests that we have here a mixture of conidia and basidiospores or possibly only conidia. A cytological study should be made to settle this point.

Key to Species of Sect. *Amylopogon*

1. Hyphae of tramal plates as revived in KOH containing strands or masses of amorphous-brown to cinnamon pigment; spores 6–8.5 × 3.5–4.5 μ, some dark violet in Melzer's sol. 5. *R. anomalus*
1. Not as above. 2
2. Basidiocarps with violaceous umber stains on a dull white background when fresh; as revived in KOH the entire peridium (in section) bright vinaceous red in KOH; spores 7–9 × 2.6–3.2 μ. 6. *R. semireticulatus*
2. Not as above. 3
3. Basidiocarps dull cinnamon to gray shaded yellowish; when dried ochraceous to cinnamon tones evident. 4
3. Basidiocarp white becoming wood brown or darker and as dried dark vinaceous brown to fuscous. 7
4. Spores 6–7.5 × 2.2–2.5 μ, essentially nonamyloid. 7. *R. rudus*
4. Spores 7–9 × 2.8–3.5 (–4) μ. 5
5. Gleba dull green fresh; no olive-fuscous pigment in sections of peridium revived in KOH (see *R. fragmentatus* also). 8. *R. arctostaphyli*
5. Not as above. 6
6. Gleba pallid becoming cinnamon-brown. 9. *R. milleri*
6. Gleba olive-gray; olive-fuscous pigment copious in sections of peridium revived in KOH. 10. *R. salebrosus*
7. Spores or at least some of them dark violet in iodine. 8
7. Spores nonamyloid or weakly but evenly amyloid. 11
8. Over 60% of the spores completely dark violet in Melzer's sol. 11. *R. atroviolaceus*
8. Under 40% of the spores dark violet. 9
9. As revived in Melzer's some hyphae of peridium with dark violet globules in or between them, some with amyloid granules or incrustations on the walls, and a few with thick amyloid walls in short segments. 12. *R. kauffmanii*
9. Not as above. 10
10. Inner region of peridium with enlarged cells up to 20 μ diam; fresh peridium vinaceous in KOH. 13. *R. fallax*
10. Peridium lacking cells up to 20 μ diam; fresh peridium olive on surface when fresh and treated with KOH. 14. *R. subpurpurascens.*
11. Spores 5.5–7.2–2.5 μ (see *R. parksii* and *R. nitens* also). 15. *R. pedicellus*
11. Spores 2.8–3.2 μ wide if under 8 μ long, typically 6 μ or more long. 12
12. Spores 9–12 μ (10–20 μ at times) long. 13
12. Spores 7–9 (–10) μ long. 14
13. KOH staining fresh peridium dingy vinaceous. 16. *R. subbadius*
13. KOH staining fresh peridium olive; or both olive and vinaceous in localized areas. 13a
13a. Spores 9–12 × 3–4.5 μ. 17. *R. subgelatinosus*
13b. Spores 10–18 × 4–8 μ (see *R. clavitisporus* also). 21. *R. alkalivirens*
14. $FeSO_4$ slowly grass-green on fresh peridial surface. 20. *R. subcaerulescens* var. *viridescens*
14. $FeSO_4$ causing a change to olive or bluish olive. 15
15. Spores weakly amyloid at maturity. 16
15. Spores practically nonamyloid (weakly amyloid immature). 17
16. Spores 3–3.8 μ wide. 18. *R. ellenae*
16. Spores 2.3–3 μ wide. 19. *R. idahoensis*
17. Fresh peridium often flushed bluish to purplish after handling; gleba avellaneous to wood brown fresh. 20. *R. subcaerulescens* var. *subcaerulescens*
17. Fresh peridium in white stage merely slightly vinaceous bruised; gleba dark cinnamon-brown to bister mature. *R. subcaerulescens* var. *subpannosus*

5. **Rhizopogon anomalus** A. H. Smith, sp. nov.

Fructificationes 1–2 cm. latae, globosae vel irregulares, ochraceae denum cinnamomeo-brunneae; gleba avellanea indurata; sporae 6–7.5(–8.5) × 3.5–4.5 μ, amylodeae; peridium unistratosum. Typus: C. H. Kauffman, Copeland, Idaho (MICH).

Illustrations: Fig. 10, 10a, spores.

Basidiocarps 1–2 cm. broad globose to ellipsoid or irregular from pressure, surface dull and unpolished, color at first dingy ochraceous drying to cinnamon-

brown or darker, no color changes noted. Odor not noted. Gleba as dried grayish brown (near "avellaneous"), hard and bone-like in consistency as dried; cavities very small and indistinct in dried state.

Spores 6–7.5(–8.5) × 3.5–4.5 μ, ellipsoid to narrowly ellipsoid, in KOH hyaline individually but dingy brownish ochraceous to cinnamon in masses along the hymenium; in Melzer's sol. most of them pale bluish but a small number dark violet and some only partly dark violet, smooth, wall thin to very slightly thickened. Basidia gelatinous, 20–30 × 5–7 μ, 6- or 8-spored as judged by clumps of spores, in KOH often showing an amorphous dull orange-ochraceous content in the form of amorphous masses. Paraphyses and cystidia not studied because of the failure to see much detail in the hymenium. Tramal plates of intricately interwoven hyphae with thin walls gelatinous-refractive, hyaline and homogeneous in $FeSO_4$, but as revived in KOH and in Melzer's sol. (at least near the peridium) with dull orange-brown masses and ropes of amorphous material conspicuous within them, subhymenium of filaments like those of the central strand and with same content, the plates very tough-cartilaginous and not breaking up under pressure. Peridium a single layer of hyphae, as revived in KOH so much rusty brown amorphous material present in and between the hyphae as to make details indistinct, many of the hyphal segments completely filled with "raw sienna" to cinnamon or darker material, in Melzer's sol. also dark orange-brown and with some large globules of orange-brown pigment. No clamp connections seen but their possible presence is not excluded. All tissues nonamyloid.

Material examined: IDAHO: Copeland, C. H. Kauffman, Sept. 2, 1922, in a forest of cedar, larch, pine and hemlock, along a road, TYPE (MICH). Part of this collection is No. 8282 in the Zeller collections (NY). It was identified as *R. graveolens* by Zeller.

Although this species is imperfectly known I have no hesitation in describing it because of the distinctive microscope features as seen in sections revived in KOH and in Melzer's sol. The amyloid spores narrow the possibilities down to relatively few species, none of which have tramal plates of the structure of *R. anomalus*. There is no "cellular" structure to the subhymenium. The scanty information on *R. graveolens* from Europe indicates that this is a poorly known species there. It may very well be that when complete data are obtained on *R. anomalus* it will be advisable to erect a genus for it. The spores remind one of those of *R. subpurpurascens* in that they may have an amyloid cap which is thicker than the remainder of the spore wall, and the edge of this cap is very uneven at times and on some spores isolated amyloid granules may occasionally be observed in this area indicating that the spore may be properly classed as ornamented.

6. **Rhizopogon semireticulatus** A. H. Smith, sp. nov.

Fructificationes 4–6.5 cm. crassae, 2.8–3.5 cm. latae, fibrillosae, albidae, brunneo-fibrillosae, semireticulatae, tactu tarde violaceo-umbrinae, in "KOH" vinaceae demum fusco-brunneae. Gleba pallide ligno-brunnea. Sporae 7–9(–10) × 2.6–3.2 μ. Typus: Smith 71330 (MICH).

Basidiocarps 4–6.5 cm. wide, 2.8–3.5 cm. deep, circular in outline, surface dry, appressed fibrillose and this layer with an overlay of rhizomorphs to give a somewhat reticulate appearance, dull white when young and fresh, the rhizomorps brownish, slowly spotting dull violaceous umber ("benzo brown") from handling and when dried whitish with dark umber areas and an overlay of brown rhizomorphs fairly conspicuous; KOH on peridium vinaceous then fuscous brown,

$FeSO_4$ dark olive-brown. Gleba pallid to "wood brown," blackish with Melzer's sol. fresh, and when fresh dry in consistency, the chambers labrynthiform and medium sized (visible to naked eye).

Spores 7–9(–10) × 2.6–3.2 μ, smooth, mostly subfusoid, lacking a distinct basal truncation, yellowish to hyaline singly in KOH, groups dingy yellowish, in Melzer's sol., dingy yellow-brown in groups with some suggestions of an amyloid reaction. Basidia 8-spored, narrowly clavate. Paraphyses resembling basidia (if distinct). Tramal plates of interwoven gelatinous hyphae, near peridium often with vinaceous red content; subhymenium of diverging filaments with short cells often red in KOH in areas near the peridium. Peridium of appressed interwoven hyphae 4–12 μ diam, the layer bright vinaceous red in KOH from amorphous intracellular and intercellular pigment, some groups of inflated cells present and about 15 μ in diam but no true sphaerocysts present. Clamp connections none. All tissues nonamyloid.

Under Douglas fir and larch, near Pend Oreille State Park, Wash., Oct. 19, 1964, Smith 71330 (TYPE), and 71324, 71325, 71362.

The amyloid reaction is scarcely evident on mature spores. The outstanding feature is the bright vinaceous red peridium as revived in KOH. There was no olive anywhere upon application of KOH on either the fresh specimens or as revived in KOH. In spore features the species is close to *R. ellenae*.

7. **Rhizopogon rudus** A. H. Smith, sp. nov.

Fructificationes circa 5 cm. latae, circa 3 cm. crassae, in "KOH" olivaceae, fibrillosae, pallidae demum luteo-brunneae, tactu sordide cinnamomeae, demum minute areolatae. Gleba griseo-olivacea. Sporae 6–7.5 × 2.2–2.5 μ, oblongae, leves. Typus: Smith 71352 (MICH).

Basidiocarps up to 5 cm. wide or long and 3 cm. deep, variously shaped, surface loosely matted-fibrillose causing much dirt to adhere, pallid at first but epicutis soon dingy snuff-brown, becoming dull cinnamon ("Sayal brown") from handling (no red stains at all), when epicutis is removed the subcutis staining bluish-fuscous, epicutis minutely areolate were protected from the dirt, surface olive in KOH and also with $FeSO_4$; peridium grayish when cut and in section green in KOH. Gleba dry and spongy, deep olive buff with russet stains and near peridium in some places dingy rusty yellow, with Melzer's sol. orange-brown. Columella absent.

Spores 6–7.5 × 2.2–2.5 μ, oblong, smooth, no distinct basal scar, nearly hyaline singly in KOH and in groups merely more dingy greenish-hyaline to brownish, in Melzer's sol. yellowish singly and in groups weakly tawny, Basidia clavate (none seen sporulating). Paraphyses becoming thick-walled and with an amorphous central body not staining in Melzer's sol. Subhymenium cellular and with cells beneath the basidia also tending to become thick-walled; hyphae of tramal plates gelatinous, narrow (2–5 μ), hyaline, smooth, more or less interwoven. Peridium with a thin (1–3 hyphae deep and lacking over some areas) epicutis, the hyphae thin-walled or some thick-walled, dull fulvous in KOH and also with particles of incrusting pigment, many of the cells inflated to 15–20 μ and irregular in shape (end-cells clavate but with irregularities, knee-joint-like, etc.), when cylindric 4–12 μ diam; subcutis of hyphae closely interwoven, dull cinnamon in KOH and with darker cinnamon pigment deposits both intracellular and intercellular, some giant inflated cells 25–75 μ scattered throughout peridium next to the gleba, with olive pockets as revived in KOH. Clamp connections none; all

tissues nonamyloid, with amyloid particles present in peridial layer, no pigment balls present in mounts in Melzer's sol.

Near Douglas fir but growing hypogeously in an old logging road, Priest River Experimental Forest, Priest River, Idaho, Oct. 21, 1964, Helen Smith collector. Smith 71352 (TYPE).

This species is close to *R. subareolatus,* but the latter lacks the giant cells in the peridium, lacks flagellate cells characteristic of so many of sect. *Villosuli,* and it lacks the copious incrustations in the lower layer of the peridium as the latter is revived in KOH. Also, the epicutis is much more poorly developed in *R. rudus.* Because of this *R. rudus* is placed here but also keyed in sect. *Villosuli.* It would not be surprising to find in *R. subareolatus,* in an examination of many collections, enlarged cells approaching in size the giant cells of *R. rudus* as these occur more widely in sect. *Villosuli* than was at first suspected.

8. Rhizopogon arctostaphyli A. H. Smith, sp. nov.

Fructificationes 2–5 cm. latae, globosae vel irregulares, griseo-ochraceae; gleba sordide viridis, sporae 7–9 × 2.8–3.5 μ, amyloideae. Typus: J. P. Tracy 5705 (NY).

Illustrations: Fig. 11, spores.

Basidiocarps 2–5 cm. broad, globose to oval or somewhat irregular in outline, finely fibrillose and with few rhizomorphs, color cinereous to smoke gray with "yellowish shadings"—(Tracy), grayish-ochraceous in places as dried, slowly turning reddish bruised when fresh. Odor none. Gleba dull green, with fine small cavities.

Spores 7–9 × 2.8–3.5 μ, ellipsoid to narrowly ellipsoid, but truncate at base from the sterigmal scar, hyaline in KOH singly or ochraceous in groups, in Melzer's sol. pale bluish over all and collapsing readily, smooth, thin-walled. Basidia 6- and 8-spored, mostly collapsed, small, 11–15 × 4–6 μ, subcylindric to clavate. Paraphyses not distinct—apparently collapsed like the basidia from partial gelatinization. Tramal plates of hyaline gelatinous interwoven hyphae, outlines not clear in KOH or Melzer's sol. Peridium of appressed hyphae 3–9 μ broad, branched, thin-walled and in sections near ochraceous tawny, some rusty brown pigment pockets present but layer actually rather clean, no sphaerocyst-like cells present. Clamp connections none. All tissues nonamyloid.

Willow Creek, Humboldt Co., Calif., 1935, coll. J. P. Tracy 5705 (TYPE) (NY).

This species is amply distinct by the basic yellow tones of the basidiocarp overlaid by the gray, along with the amyloid spores. It is the only species known to date with amyloid spores at maturity and a basically yellow basidiocarp. However, there appears to be a very weak amyloid reaction on immature spores of *R. pseudaffinis.* There is a strong possibility that the pattern of color change in *R. arctostaphyli* is from white to yellow to gray, with the gray developing in age or on drying.

9. Rhizopogon milleri A. H. Smith, Mycopath et Mycol. App. 26: 389. 1965.

Basidiocarps 1–2.5 cm. broad, globose to oval or somewhat angular, surface dry and appressed fibrillose (but some with an over-lay of vinaceous fibrils believed to have come from a mycelium of *Brauniellula* since fruiting bodies of the latter were found close to the *Rhizopogon*), the *Rhizopogon* peridium whitish at first but discoloring to cinnamon buff and drying this color where not overlaid by the vinaceous *Brauniellula* mycelium, KOH dark vinaceous red on fresh peridium, $FeSO_4$ dark olive. Gleba pale cinnamon young, becoming cinnamon, but when dried near pale sepia (a yellow-brown), cartilaginous fresh, hard as a rock when carefully dried, chambers very minute.

Spores 6.5–8.5(–9.2) × 3–4 μ, ellipsoid, oblong, oval, subglobose or obscurely angular, wall distinctly thickened, in KOH dingy yellow-brown in groups, nearly hyaline singly, in Melzer's sol. some dark violet in upper half, upper three-fourths or on some spores only in spots in the wall. Hymenium gelatinous (both basidia and paraphyses) as revived in KOH. Tramal plates of hyaline gelatinous smooth interwoven hyphae; subhymenium of gelatinous filaments, very rarely with some colored content as revived in KOH. Peridium with an outer region of pigment filled and incrusted hyphae with some areas olive as revived in KOH; subcutis vinaceous red in KOH; in Melzer's reagent large orange to brown pigment balls forming in mount, some hyphae in peridium of some basidiocarps strongly amyloid (dark violet) but these possibly of foreign origin, clamp connections none found.

In larch-pine stand near Nordman, Idaho, Sept. 25, 1964. Collected by O. K. Miller (Smith 70789, TYPE).

This species is related to *R. semireticulatus* but is distinct by the subcutis only becoming red in KOH as revived, the dark yellow-brown gleba, and in some of the spores being dark violet in Melzer's sol.

Rhizopogon milleri is a most important species from several points of view. First, in the material known to date there is the association of this species with *Brauniellula*. The latter genus has amyloid (dark violet in iodine) mycelium with much amyloid debris in and coating the cells—to the point that mounts become full of it. In those basidiocarps having amyloid mycelium (vinaceous in color as dried) over the surface, sections of the peridium mounted in Melzer's sol. show hyphae, similar to those coating the surface, penetrating clear through the peridium and extending parallel with the *Rhizopogon* hyphae for considerable distances. No haustoria were seen to indicate parasitism, but of course their lack does not rule out the possibility that the *Brauniellula* could be parasitic on the *Rhizopogon*. One might regard such basidiocarps merely as natural chimeras, but nothing short of detailed biological studies can ever give us the true picture of the association.

The most interesting feature, however, is the pattern of amyloidity of the spores. The erratic pattern (Smith, 1964) noted for *R. subpurpurascens* is very evident in this species. The following are some of the detailed observations made: In instances where good sections were obtained it appeared that in some areas the percentage of dark violet spores was 75% or more, in others less than 3%. It was also noted, that, where individual basidia with their 8 spores could be seen, then very often one spore would be dark violet. Cases were seen where it appeared that only two spores were dark violet and one was found with 4-spores dark violet and 4 merely yellow-brown (nonamyloid). In these cases "dark violet" refers to the color when looking down on the spore so it is essentially an apical view. Most spores, when lying flat in a mount, are seen to have a dark violet cap over the upper half and a lower portion nonamyloid or with only a faint amyloid line in the region one might call the middle layer. In other words most of the "amyloid" spores are only partly amyloid. In this connection it was noted that a number of angular to subglobose-angular spores were also present in the mounts and on some of the angular-subglobose individuals it was noted that a dark violet spot capped one or two of the bumps and that on some of these amyloid lines appearing like small dark blue chromosomes radiated out from the bump. These are probably most accurately described as ornamentation, since obviously they are not chromosomes, but the whole effect of the iodine reaction on spores of this species is most bizzare.

10. **Rhizopogon salebrosus** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae vel subglobosae, subcinnamomeae, in siccatis vinaceo-brunneae, in "KOH" viridi-olivaceae; Gleba cartilaginea, dura; sporae 7–9(–10) × 2.8–3.5 μ, versiformes (oblongae, fusiformes, etc.), leviter amyloideae. Typus: Smith 69273 (MICH).

Basidiocarps 1–3 cm. broad, globose to oval or elliptic or angular from external pressure, ground color about "snuff-brown" to "cinnamon-brown" and appressed fibrillose (dull cinnamon-brown), rough with an over-layer of coarse darker rhizomorphs as dried dark cinnamon-brown to slightly more vinaceous (near "Natal brown"), cut peridium white and unchanging, KOH on cutis olive-green darkening to olive-black but on cut surface vinaceous; $FeSO_4$ dark olive on cutis and cut peridium. Gleba olive-gray becoming cinnamon-brown, very hard-cartilaginous fresh, hard when dry, chambers so small as to be barely visable under a 6 × handlens, dark fuscous in Melzer's sol. when fresh.

Spores 7–9(–10) × 2.8–3.5(–4) μ, oblong to subfusoid or some boomerang-shaped, smooth, thin-walled, hyaline singly in KOH, in masses pale bister, in Melzer's sol. weakly amyloid (pale bluish young and when older and browner appearing pale bister in masses), no obvious basal truncation. Basidia 8-spored, cylindric when sporulating. Paraphyses hyaline, clavate, gelatinous, in age collapsing. Tramal plates of gelatinous hyaline hyphae interwoven and with no pigment incrustations; subhymenium a cellular layer about 2 cells deep from filaments diverging from tramal strand. Peridium of subgelatinous hyphae 5–12 μ diam and with subgelatinous walls in KOH, much olive-fuscous pigment in pockets and along the hyphae, inflated cells present in interior region, in Melzer's sol. with orange-brown pigment balls to bister or nearly violet-brown. Clamp connections none. All tissues nonamyloid and no differentiated epicuticular hyphae as in sect. *Villosuli*.

In humus under fir and pine, near Florence, Idaho, Aug. 13, 1964, Nancy Jane Smith collector (Smith 69273, TYPE) and 69292, 69299.

This species has larger spores than *R. rudus* and the paraphyses collapse instead of becoming thick-walled. Most species with a cinnamon brown peridium do not give an olive KOH test.

11. **Rhizopogon atroviolaceus** A. H. Smith, sp. nov.

Fructificationes circa 3.5 cm. crassae, 2.5 cm. altae, fibrillosae, albidae, tactu vinaceae. Gleba subviridis. Sporae 6–8 × 3–3.6 μ, angulari-ellipsoideae, amyloideae. Typus: Smith 58888 (MICH).

Illustrations: Fig. 12, spores; pl. I, 1, and pl. V, 3, basidiocarps.

Basidiocarps up to 3.5 cm. thick and 1–2.5 cm. high, globose to pear-shaped, surface typically uneven, dry and fibrillose-silky, at times with appressed rhizomorphs brownish avellaneous in color, staining vinaceous when bruised, ground color white, becoming shell pink from staining or flushed pink over all and when dried fuscous, $FeSO_4$ dull blue on peridial surface, KOH lilac and slowly lilac brown; peridium in section white when fresh. Gleba white becoming green ("Vetiver green") fresh, pale buff as dried, drying very hard in mature specimens (almost like bone), cavities small and irregular, when fresh quickly dark violet with Melzer's sol.

Spores 6–8 × 3–3.6 μ and ellipsoid or 7–9 × 3–4 μ and angular-elongate to angular-elliptic, hyaline in KOH individually and in groups dingy buff (in KOH fresh some with reddish content but not so as dried and revived); in Melzer's sol. dark violet individually and blackish-violet in mass, wall slightly thickened,

smooth to minutely punctate-ornamented, sterigmal scar inconspicuous. Basidia 17–20 × 5–7 μ, subcylindric or narrowed near apex, 4-, 6- or 8-spored, hyaline in KOH, thin-walled, Paraphyses resembling basidioles, thin-walled, hyaline in KOH, 5–8 μ broad. Tramal plates of interwoven narrow hyaline gelatinous-refractive hyphae branching to a filamentous subhymenium of refractive hyphae, no oleiferous hyphae seen. Peridium a single layer of appressed-interwoven hyphae with hyaline nongelatinous walls but dark brown amorphous masses of pigment present in and along the hyphae to give the layer a dark brown color (revived in KOH), in Melzer's sol. many of these masses becoming orange-brown globules. Some hyphae with inflated cells but pigment deposits obscure nearly all cell detail. Clamp connections none. All tissues nonamyloid.

Under mixtures of pine, spruce and fir, summer, Idaho. It is known from the Priest River District as well as near McCall.

The distinctive features of this species are the dark violet amyloid spores many of which are angular, the white basidiocarp becoming pink and drying fuscous, and the filamentose subhymenium. *R. subpurpurascens* is close but does not become pink. It gives an olive-fuscous reaction with KOH but *R. atroviolaceous* does not, and in the latter the subhymenium is filamentose rather than cellular.

Material examined: IDAHO. Smith 58888 (TYPE), 68261, 68263, 69178, 69179, 69225, 69257, 69416, 69797, 69798, 69800, 69810.

×12. **Rhizopogon kauffmanii** A. H. Smith & Zeller, sp. nov.

Fructificationes 1.5–6 cm. crassae, globosae vel subangulares, siccae, fibrillosae, albidae, tactu caeruleo-griseae, tarde demum vinaceo-fuscae, in "KOH" vinaceo-fuscae, in "$FeSO_4$" caeruleae. Gleba albida demum subolivacea. Sporae versiformes, amyloideae 7–10 × 3.5–5 μ. Typus Smith 69813 (MICH).

Illustrations: Fig. 13, spores.

Basidiocarps 1.5–6 cm. diam, globose, subglobose, oval or angular from external pressure, surface dry and appressed fibrillose, white, with a few coarse rhizomorphs mostly basal, when handled often developing bluish gray areas but mostly slowly becoming fuscous to vinaceous-fuscous, KOH on peridial surface vinaceous and finally vinaceous fuscous (no olive tone present), $FeSO_4$ quickly deep blue, dried basidiocarps vinaceous fuscous. Gleba white to olive buff (not darker when liquifying), cavities very minute, when fresh the consistency hard and cartilaginous, bone-like when dried and then dingy pale ochraceous-clay color. Columella absent or a false one present.

Spores variable in size and shape, 7–10 × 3.5–5 μ, ellipsoid, subglobose, angular-globose (± 8 × 6 μ) or ovoid (6.5–8 × 3–4 μ), many somewhat angular and many more or less collapsed, many dark violet in Melzer's sol. over all or only in part (upper one-fourth to three fourths), smooth or very faintly marbled near edge of amyloid cap (when one is present), some nonamyloid and some weakly amyloid spores also present, wall finally becoming somewhat thickened. Basidia 8-spored, subgelatinous. Paraphyses present but gelatinous, outlines not distinct as revived in KOH, as seen revived in Melzer's sol., 6—10 μ diam and clavate. Tramal plates of gelatinous intricately interwoven hyphae 2–5 μ diam, hyaline, smooth, and loosely interwoven; subhymenium filamentous and elements highly refractive in KOH. Peridium a thick single layer of hyphae 4–12 μ diam, laticifers scattered in this layer, hyphae with heavy dark brown pigment deposits in and over them, and pigment also in large amorphous masses (pockets), some hyphae (in Melzer's sol.) with strongly amyloid masses or globules of the content present

and many orange-brown pigment balls present in crushed mounts, amyloid granules often present also and some hyphae with thickened amyloid (dark violet) walls in short segments also present. Clamp connection absent.

Under conifers in the duff. Kauffman made one collection at Copeland, Idaho, Sept. 11, 1922. H. Burdsall collected the type on Heaven's Gate Ridge, Seven Devils Mts., Nez-Perce Nat'l. Forest Aug. 27, 1964 (Smith 69813).

This species differs from *R. subpurpurascens* in that KOH stains the peridium vinaceous to vinaceous-fuscous instead of olivaceous, and in Melzer's sol. some hyphae have dark violet pigment balls in addition to those that are orange-brown. The best way to study the peridium of this species is to scrape off the material with a scalpel and crush it out in the mounting medium.

13. **Rhizopogon fallax** A. H. Smith, sp. nov.

Fructificationes 10–65 mm. crassae, globosae, subglobosae vel irregulares, albidae vel pallidae demum avellaneae vel fuscovinaceae. Gleba pallida demum sordide olivacea. Sporae 6–7.5 × 2.6–3 μ (vel 8–10 × 3.3–5 μ), leves, anguste ellipsoideae, amyloideae. Typus: Smith 65650 (MICH).

Illustrations: Fig. 16, spores; pl. V, 4, basidiocarp.

Basidiocarps 10–65 mm. thick, globose, subglobose, or irregular in outline, white and more or less covered with fine fibrils and over these occur rhizomorphs both of which eventually stain wood-brown, gradually becoming wood-brown to darker vinaceous brown over all and drying fuscous-brown, fresh peridium staining olive to dark olive with $FeSO_4$; KOH staining it vinaceous-fuscous to inky-black; ethanol not producing a color change. Gleba pallid becoming dull olivaceous, very firm, chambers small and of irregular shape.

Spores 6–7.5 × 2.6–3 (8–10 × 3–3.5 μ) in same gastrocarp, in some 7–10 × 2–2.5 μ, ellipsoid to narrowly oblong, varying to ovoid, smooth, yellowish in KOH individually, in masses along the gills cinnamon-buff, in Melzer's sol. greenish blue (weakly but distinctly amyloid), at times a few in a mount dark violet, wall finally becoming slightly thickened, basal scar small and inconspicuous. Basidia 4-, 6-, 8-spored, hyaline, thin-walled, readily collapsing. Paraphyses septate, terminal cells 15–20 × 7–9 μ, ovate to subclavate, hyaline in KOH, thin-walled. Cystidia none. Tramal plates of hyaline highly refractive hyphae interwoven and 2–8 μ diam, subhymenium cellular and not gelatinous. Peridium about 1 mm. thick fresh, pallid in section but in KOH the outer region soon olivaceous and the inner one pinkish, the inner region containing enlarged cells up to 20 μ in diam or these also present to a lesser degree in the outer layer, as revived in KOH the outer layer brown in KOH and pigment deposits numerous, the inner layer vinaceous brown as revived in KOH, and in Melzer's sol. with numerous orange-brown globules (from dissolved amorphous pigment in the layer). Clamp connections none. All tissues nonamyloid.

Under *Pinus contorta,* Idaho and Wyoming, August and September.

This species has conspicuous enlarged hyphal cells in the peridium. The spore size is somewhat variable even in a single gastrocarp. It is close to *R. ellenae* but the spores of that species are more consistently subfusoid, and the hyphae of its tramal plates frequently have greatly enlarged hyphal cells, a feature very rare in *Rhizopogon.*

Material examined: IDAHO: Smith 65650, 65762 (TYPE), 66030, 66116. WYOMING: Kauffman 9–5–23 (identified by Kauffman as *R. rubescens*).

14. Rhizopogon subpurpurascens. A. H. Smith, Mich. Botanist 3: 17. 1964.

Illustrations: Fig. 14, spores; fig. 15, detail of spore wall; pl. II, 4, basidiocarps.

Basidiocarps 1–4 cm. broad, globose to irregularly compressed, surface dry, white over laid by vinaceous buff to avelaneous fibrils, felty-fibrillose and with appressed rhizomorphs over all, when handled slowly staining brownish and finally dull purplish red (no yellow stage present at any time in the natural sequence of color changes), when dried dark purplish-fuscous overall; $FeSO_4$ staining peridium bluish to olive; KOH staining peridium slowly olive-fuscous. Gleba olivaceous, cavities minute.

Spores 7–8.5(–9) × 3–3.5 μ, narrowly oval to oblong, broadest part toward apex in some, many irregular in shape, some 10–11 × 2–2.5 μ and curved, some with a lateral protuberance (pistol-grip type), wall thickened slightly, surface faintly mottled as seen under an oil immersion (1.3 N.A.) lens, appearing smooth under ordinary magnifications, many spores dark violet in Melzer's sol. and some of these dark violet only over the upper part or half with the remainder hyaline; in many the deposition of the amyloid material is seen to be on the line separating the endo- from the exo-sporium; many spores apparently remaining nonamyloid; hyaline individually in KOH but yellowish in masses along the hymenium.

Basidia 6- and 8-spored, 5–7 μ in diam, cystidia none. Paraphyses all thin-walled, oval to subglobose, 12–20 × 8–12 μ, the walls very indistinct in KOH, with 1–3 isodiametric cells below to give a cellular subhymenium. Tramal plates of gelatinous interwoven hyphae diverging to subhymenium and enlarged at the septa to 8–10 μ, walls thin, hyaline smooth. Peridium of appressed more or less cylindric hyphae 4–10 μ diam which are hyaline, thin-walled and smooth or many hyphae with yellowish incrustations on the walls to the point of discoloring the hyphae, with a purplish-vinaceous color between the hyphae; consisting of only a single layer. Clamp connections absent. All tissues nonamyloid.

In a group near *Pinus contorta* and *Abies lasiocarpa,* Iron Creek, 16 July, 1962, Stanley, Idaho, coll. Nancy Jane Smith (A. H. Smith 65398); Smith 65669, July 31, 1962, and Heavens Gate, Seven Devils Mts., Idaho, Aug. 27, 1964 (Smith 69801, 69802, 69812).

This is a most peculiar species. In consistency the basidiocarps are rubbery when fresh much as in *Hysterangium.* The spores are very peculiar for the amyloid reactions as described, and for the finely mottled surface. The dark purple-fuscous of the dried basidiocarp and the olive-buff gleba are also distinctive. It is possible that there are three conditions present as to the degree of the amyloid reaction of the spores. The most prominent is the dark violet spore, as dark as the ornamentation on a coarsely ornamented *Lactarius* spore. That this degree of coloration may occur over only a part of the surface, usually the distal half of the spore, is most unusual, but the pattern of its development, as far as this has been observed at present is even more unusual. One can select a series of spores starting with those which show a dark line between the endo- and expo-sporia, to those in which in addition the exosporium is partly violaceous to those in which the whole spore is dark violaceous. In addition, however, many spores seem to be weakly amyloid as in the other species of this section, and it is possible that some are nonamyloid, but this is a difficult point to prove on a spore with such a thin wall.

In Melzer's sol. the peridium of *R. subpurpurascens* shows many large dark orange-brown pigment balls and versiform bodies often with granular but not amyloid content. In *R. kauffmanii* some hyphae have darkly amyloid contents.

15. **Rhizopogon pedicellus** A. H. Smith, sp. nov.

Fructificationes circa 15 mm. crassae, globosae, fibrillosae, albidae, tactu tarde vinaceae. Sporae 5.5–6.5(–7) × 2–2.5 μ, leves, oblongae, amyloideae. Peridium unistratosum. Typus: Smith 66214 (MICH).

Illustrations: Fig. 17, spores.

Basidiocarps about 15 mm. thick, globose but outline irregular, surface white and unpolished to fibrillose, slowly staining pinkish where handled and when dried dark vinaceous-fuscous; KOH staining peridium vinaceous fuscous, $FeSO_4$ staining it olivaceous. Gleba white, with minute chambers, cutting easily when dried (in young condition) when fresh the cut surface slowly vinaceous.

Spores 5.5–6.5(–7) × 2–2.5 μ, smooth, oblong, distinctly amyloid but not dark-violet in Melzer's sol., hyaline in KOH, basal scar inconspicuous. Basidia mostly 8-spored, hyaline, 12–16 × 4–6 μ, collapsing. Paraphyses thin-walled (all young) resembling basidioles. Tramal plates of interwoven thin-walled hyaline refractive hyphae as revived in KOH, subhymenium cellular. Peridium a single layer of appressed interwoven hyphae so filled with deposits of fuscous pigment in and between the cells as to obscure all details. Clamp connections none. All tissues nonamyloid.

In duff under pine, Warm Lake, Idaho, Aug. 24, 1962. Robert Jeanne (Smith 66176) and Smith 66214 (TYPE), Warm Lake, Aug. 26.

This species is readily distinguished from *R. ellenae, R. idahoensis* and the others in the group on spore characters.

16. **Rhizopogon subbadius** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. crassae, globosae vel pyriformes, fibrillosae, albidae tactu tarde vinaceo-brunneae. Gleba alba demum griseo-olivacea. Sporae 9–12 (–14) × 3.5–4.5(–5) μ, subfusoideae vel ellipticae, tenui-tunicatae, leves, nonamyloideae. Typus: Smith 58998 (MICH).

Illustrations: Fig. 22, spores, pl. VIII, 3.

Basidiocarps 1–2.5 cm. thick, globose to ovoid or pyriform, surface white overlaid with drab matted-down fibrils, more or less covered with rhizomorphs that are white around the base and fawn color (vinaceous brown) over the upper part, $FeSO_4$ not producing a color change on dried material, KOH causing a dingy vinaceous stain; fresh peridium pallid in section but staining slowly to brownish-vinaceous. Gleba white, becoming olive gray, spongy when fresh, not darkening in Melzer's sol.

Spores 9–12(–14) × 3.5–4.5(–5) μ, subfusoid to elliptic or oblong, some concave on dorsal line in medial section, very thin-walled and readily collapsing, hyaline in KOH singly but dingy buff in groups, in Melzer's sol. yellowish to buff in groups ("cinnamon buff") but some staining a faint greenish tone as if weakly amyloid when immature. Basidia and paraphyses nongelatinous (could not be sure that spores were born on basidia; they may be borne on conidiophores). Tramal plates of gelatinous highly refractive hyphae interwoven in central strand and extending out (branching) to form subhymenium. Peridium one layered, hyphae hyaline, thin-walled and many containing dark brown pigment masses, the layer mostly dull vinaceous brown in KOH, many of the cells up to 15–25 μ diam but no sphaerocysts present. Clamps none. All tissues nonamyloid.

In duff under lodgepole pine, Stanley Lake, Idaho. July 20, 1957, Smith 58998 (TYPE), Priest River, July 19, 1964 (Smith 68485), and Medicine Bow Mts., Wyoming, Albany County, Smith 35775.

This species is very close to *R. subcaerulescens* but has distinctly larger spores which are so thin-walled they do not revive readily in Melzer's sol. They seem to be weakly amyloid young but not when mature. Some of the basidiocarps of the collections give the impression of being partly sterile. For a comparison with *R. subgelatinosus* see that species.

17. **Rhizopogon subgelatinosus** A. H. Smith, sp. nov.

Fructificationes 8–30 mm. latae, globosae vel irregulares, udae, fibrillosae, albidae, tactu tarde ligno-brunneae. Gleba albida, demum olivaceo-brunnea. Sporae (8–)9–12 × (2.5–)3–4 μ, subfusoideae, leves, nonamyloideae. Peridium unistratosum, heteromerum. Typus: Smith 65990 (MICH).

Illustrations: Fig. 21, spores.

Basidiocarps 8–30 mm. diam, globose to subglobose or somewhat irregular, surface moist but fibrillose, white, the fibrils becoming wood-brown in places where there was pressure from the substratum, very few rhizomorphs present; $FeSO_4$ staining fresh peridium olive, KOH staining it dark olive on the surface, ethanol no reaction. Gleba white slowly dark olive to olive-brown, drying a grayish olive buff, chambers very fine, rather hard in consistency when fresh and bone-like when dried. Odor none.

Spores (8–)9–12 × (2.5–)3–4 μ, subcylindric, ellipsoid to subfusoid, lacking a basal scar, walls thin to very slightly thickened, yellowish olive in KOH fresh, dingy cinnamon-buff in masses along the hymenium as revived, with a greenish tint in Melzer's sol. fresh but as revived near "snuff-brown" (yellow-brown) in masses along the hymenium, smooth. Basidia 6-, 8-spored, gelatinous in KOH and outlines not clear. Basidioles also gelatinous. Cystidia not seen. Tramal plates of interwoven gelatinous glassy hyphae 3–8 μ broad, hyaline and lacking incrustations, typically flexuous, and diverging to subhymenium; subhymenium cellular but the cell walls "glassy" as are the hyphae of the central strand. Peridium white in section, about 1 mm. thick, unchanging when cut, but in KOH with magenta areas in the interior (sections under the microscope), with pockets of enlarged cells scattered through the layer and also along the surface, nearly all cell walls thickened and "glassy" as revived in KOH, vinaceous buff in color with brown pigment deposits numerous and these in Melzer's sol. becoming orange-brown globules. Clamp connections absent. All tissues nonamyloid.

Gregarious in mixed conifers (pine, spruce, and fir). Upper Payette Lakes, Idaho, Aug. 18, 1962, Smith 65990 (TYPE), and Smith 66072; Priest River, July, 1964, Smith 68282, 68283, 68558, 68623.

In some basidiocarps of these collections many misshapen spores are present, even to resembling boomerangs. The distinguishing features are the broad subgelatinous hyphae of the peridium, the long spores which are dingy yellow-brown in Melzer's sol., the dark olive KOH reaction of the fresh peridium, and the completely subgelatinous to gelatinous structure of the gleba. The spores appeared weakly amyloid when fresh but this was not borne out by later studies on dried specimens. *R. subbadius* appears distinct not only because of the different KOH reaction on the fresh peridium, but because the hyphae of the peridium have thinner walls and sphaerocysts were not present in pockets. In Smith 68623 the $FeSO_4$ and KOH reactions were blue to olive-black. The peridial surface was white but stained vinaceous brownish from handling, especially on the surface fibrils. Refractive globules were present in the cells of the hymenium as the latter was seen revived in KOH.

18. **Rhizopogon ellenae** A. H. Smith, sp. nov.

Fructificationes 1–6 cm. latae, globosae vel compresso-irregulares, siccae, fibrillosse, candidae, tactu avellaneae. Gleba pallida demum sordide luteo-brunnea ("bister"). Sporae 7–9 × 3–3.8 μ, subfusoideae, pallide argillaceae, amyloideae, leves. Peridium unistratosum. Typus: Smith 66137, (MICH).

Illustrations: Fig. 18, spores; pl. I, 3, basidiocarps; pl. VII, 9.

Basidiocarps 1–6 cm. broad, globose to flattened or somewhat irregular in outline; surface dry, appressed-fibrillose and this overlaid by conspicuous white rhizomorphs arising from basal area and extending up the sides, snow-white when young and to late maturity, when handled slowly staining avellaneous to vinaceous fuscous, when dried the surface near fuscous, $FeSO_4$ staining surface of peridium olive; KOH staining peridium a muddy vinaceous brown. Gleba pallid becoming dark bister and when dried buffy-brown (dark olive-brown), the chambers large in large specimens in age, small at first. Columella none. Odor none.

Spores 7–9 × 3–3.8 μ, subfusoid, near cinnamon-buff in groups as seen in KOH, in Melzer's sol. weakly but distinctly greenish blue, wall smooth, slightly thickened, no obvious basal scar. Basidia 6-, 8-spored, 15–20 × 5–7 μ, subcylindric and readily collapsing. Paraphyses present only as basidioles, thin-walled, hyaline, readily collapsing. Cystidia none. Tramal plates of nongelatinous hyaline hyphae 3–5 μ in diam, with enlargements up to 8–12 μ at times but not forming sphaerocysts, hyaline in Melzer's sol., distinctly interwoven; subhymenium of inflated cells broader than the basidioles (2 often arising from a single basal cell). Peridium of appressed-interwoven hyphae, 4–8 μ in diam, and with more or less vinaceous brown walls as revived in KOH, some debris adhering to walls and dark brown pigment masses numerous, in Melzer's sol. these masses becoming dull orange-brown and subglobular; local areas of short hyphal cells up to 14 μ diam present, but these not true sphaerocysts; large crooked laticiferous hyphae also present, yellow in Melzer's sol., peridium consisting of a single layer. Clamp connections absent. All tissues nonamyloid.

Scattered in duff under conifers, during late summer and fall, Idaho, Oregon and Utah.

This species is named in honor of Mrs. Ellen Trueblood of Nampa, Idaho, who found the type collection. *R. ellenae* is a large white species with a dark olive-brown gleba, subfusoid weakly but evenly amyloid spores, a muddy brown KOH reaction on the fresh peridium, conspicuous rhizomorphs over the surface and spores +3 μ broad. *R. idahoensis* is close and since they occur in similar habitats, mixed collections are to be expected. It has narrower spores. In *R. ellenae* the basidiocarps tend to remain white to old age and the KOH reaction of the peridium did not progress to an inky black. Both *R. subcaerulescens,* and *R. idahoensis,* however, are very closely related species. In the former the spores are not amyloid at maturity.

Material examined: IDAHO: Smith 59528, 60676, 65443, 65962, 66137 (TYPE), 66138, 66141, 66174, 68816. OREGON: Smith 49482, 71147, 71148, 71150. UTAH: McKnight F-3068. WASHINGTON: Two collections by the Oswalds Oct. 3, 1964 near Trout Lake and one on Oct. 18.

19. **Rhizopogon idahoensis** A. H. Smith, sp. nov.

Fructificationes 1–6 cm. latae, globosae vel irregulares, siccae, fibrillosae, reticulatae, albidae demum brunneae ("wood-brown"), tactu lilaceo-vinaceae. Gleba albida demum olivaceo-grisea. Sporae (6.5–) 7–9 × 2.3–3 μ, oblongae, amyloideae, leves. Peridium unistratosum. Typus: Smith 66300 (MICH).

Illustrations: Fig. 19, spores; pl. I, 2, basidiocarps; pl. VIII, 2.

Basidiocarps 1–6 cm. in diam, globose, compressed or irregularly shaped; surface dry, white, unpolished to woolly or fibrillose and with an inconspicuous net of rhizomorphs, slowly becoming wood-brown and in drying becoming "hair brown" to "fuscous" (blackish), when injured slowly staining dingy lilac-vinaceous, collections partly dried in situ not always staining. $FeSO_4$ staining peridial surface greenish to inky black; KOH staining peridium purplish to vinaceous-fuscous or bluish black; ethanol no reaction. Gleba white, slowly olivaceous to olive-gray, chambers small to medium-large. Columella none. Odor none.

Spores (6.5–) 7–9 × 2.3–3 μ, oblong, or in profile view slightly curved, hyaline in KOH, pale greenish blue in Melzer's sol., when revived in KOH the aggregations along the hymenium pale cinnamon buff. Basidia 4-, 6-, 8-spored, 10–17 × 4–6 (–7) μ, hyaline, thin-walled, readily collapsing. Paraphyses 6–10 × 5–9 μ, (the terminal cells), thin-walled, hyaline. Cystidia none. Tramal plates of interwoven hyaline smooth hyphae nongelatinous in KOH on young material and refractive-gelatinous in older specimens, subhymenium cellular (including lower part of hymenium). Peridium 0.5–1 mm. thick fresh, whitish in section but with KOH vinaceous in places, the hyphae 3–9 μ in diam, mostly cylindric and with much incrusting debris as particles or amorphous material, revived in KOH the hyphal walls near avellaneous to darker brown, smooth, 0.2–0.3 μ thick, in Melzer's sol. many orange-brown globules present in the layer, no groups of enlarged cells present. Clamp connections none. All tissues nonamyloid.

In duff under conifers, July and August, Idaho.

The description is drawn from the cited collections. The distinguishing features are the conspicuous rhizomorphs over the surface, the color pattern of white to wood-brown and finally drying near fuscous, the narrowly oblong amyloid spores lacking a truncate basal scar, and the pale cinnamon rather than ochraceous tone to spore masses along the hymenium. Though thick, the peridium is single layered. The $FeSO_4$ reaction (bluish) of *R. subcaerulescens* appears to separate immature specimens of *R. subcaerulescens* from those of *R. idahoensis* ($FeSO_4$ olive to inky-black), and the KOH reaction, vinaceous as compared to olive, also appears to separate them. The reason I have finally decided to include *R. idahoensis* as a species is that the spores are still amyloid when the pigmentation has progressed to the cinnamon-buff stage. But that there remains a taxonomic problem in relation to *R. subcaerulescens* cannot be denied.

Material examined: IDAHO: Smith 16034, 46291, 65400, 65452, 65560, 65583, 66022, 66160, 66161, 66163, 66164, 66171, 66172, 66178, 66207, 66300 (TYPE), 69051, 69128, 69133, 69140, 69794, 70712, 70714, 70715, 71422, 71422a.

†20. **Rhizopogon subcaerulescens** A. H. Smith, sp. nov. var. **subcaerulescens.**

Fructificationes 10–40 mm. latae, globosae, siccae, fibrillosae, pallide olivaceae, fibrillis cinnamomeis tecta, tactu tarde subcaerulescens. Gleba avellanea vel "wood-brown." Sporae 7–9 × 2.8–3.2 μ, oblongae vel subfusoideae, leves, nonamyloideae. Peridium unistratosum. Typus: Smith 66162 (MICH).

Illustrations: Fig. 20, spores; pl. VII, 7.

Basidiocarps 10–40 diam, globose, subglobose or outline irregular; surface dry and fibrillose, ground color olivaceous white and this overlaid with numerous fine cinnamon-brown fibrils, no basal attachment present; surface bluish in $FeSO_4$, in KOH dark olive, ethanol no reaction, unchanging when injured or slowly flushed bluish fuscous as dried. Gleba chambered and chambers 2–3 per mm.,

avellaneous to wood brown fresh and slightly darker as dried; bluish green in $FeSO_4$. Columella absent.

Spores 7–9 × 2.8–3.2 μ, oblong to subfusoid, wall slightly thickened, hyaline individually in KOH, in masses along hymenium hyaline to tinged cinnamon slightly, in Melzer's sol. yellowish hyaline individually but in masses along hymenium pale "buckthorn-brown" and in places the groups of young ones having a bluish green tint indicating a possible weak amyloid reaction on immature spores. Basidia 12–16 × 5–6 μ, hyaline, thin-walled, 6-, 8-spored, spores sessile or nearly so. Basidioles thin-walled (no thick-walled elements seen). Cystidia none. Tramal plates of gelatinous highly refractive hyphae subparallel but diverging to subhymenium, the walls hyaline and lacking any incrustations; subhymenium of short broad cells only subgelatinous as revived in KOH. Peridium of appressed hyphae 4–9 μ in diam, the inner zone with pigment granules in hyaline (otherwise) hyphae and a diffuse rose color pervading mounts of fresh material in KOH; outer zone or layer with yellowish walls in KOH fresh; when revived in KOH no differential visable and cells somewhat "glassy", pigment pockets extending through entire peridium and the entire layer dingy cinnamon, in Melzer's sol. the layer flushed vinaceous and orange-brown pigment globules (intercellular) abundant. Clamp connections none. All tissues nonamyloid.

In duff under conifers, summer, Idaho, common during some seasons.

The unusual features of this species are the slow change to blue which sometimes develops on handling (but not when cut), the bluish $FeSO_4$ reaction, dark olive KOH reaction, the avellaneous to wood-brown gleba, and the vinaceous tones seen in the peridium under the microscope. The mature spores are not as dark brown as in *R. subgelatinosus* and they are distinctly smaller, but the two species are somewhat similar in the KOH reaction of the fresh peridium, the amyloid reaction on young spores, and the subgelatinous nature of the hyphal walls of the peridium. The olive reaction to KOH on fresh peridia is peculiar in that it does not show to any extent on dried material. In many collections KOH stained the peridium vinaceous to purplish and finally inky-fuscous. For a time these collections were separated as a possible additional species. This may still be desirable to do but first more data on the differential staining in different zones of the peridium must be obtained. I suspect one layer of staining olive and a second of staining vinaceous.

Material examined: IDAHO: Smith 45546, 45587, 45622, 59276, 59522, 59523, 59524, 59525, 59527, 59529, 59531, 59533, 59534, 59535, 59536, 59537, 59539, 59540, 59541, 59542, 59543, 59544, 59545, 59546, 59548, 59549, 59550, 59551, 59560, 59719, 59742, 59753, 59826, 59875, 60002, 60253, 60254, 60255, 60256, 60257, 60258, 60402, 60405, 60406, 60407, 60408, 60409, 65486, 65487, 65872, 66162 (TYPE), 69683, 69684, 69685. Trueblood 1587 (all MICH). OREGON: McP. Brown 476. WASHINGTON: Zeller 9646 (NY as *R. rubescens*).

Rhizopogon subcaerulescens var. **viridescens** A. H. Smith, var. nov.

Fructificationes 2–2.5 cm. crassae, subglobosae, siccae, fibrillosae, albidae tarde ligno-brunneae, in "$FeSO_4$" viridescens, in "KOH" atro-fuscae. Gleba olivaceigrisea. Sporae 7–9(–10) × 2.8–3.3 μ. Typus: Smith 67895 (MICH).

Basidiocarps 2–2.5 cm. in diam globose to subglobose, surface dry and appressed fibrillose, with scattered distinct rhizomorphs over at least the lower surface, ground color dull white (pallid) but the rhizomorphs and the more loosely appressed fibrils soon near wood-brown giving an over-all brownish overtone; $FeSO_4$ slowly grass-green on peridial surface, KOH quickly inky-black; peridium

in section under microscope not showing a red zone or red pockets (only olive colors). Gleba olive-gray, dry to the touch, chambers very small, very tough-cartilaginous fresh.

Spores 7–9(–10) × 2.8–3.3 μ, smooth, weakly amyloid near maturity, ellipsoid and with an obscurely truncate to cup-like base, smooth, dingy yellowish in KOH singly when mature, hyaline immature, in masses dingy yellow-brown; in Melzer's sol. masses of dingy brown spores with a greenish blue tint. Basidia 8-spored. Paraphyses basidium-like and thin-walled (hymenium almost entirely of basidia). Hyphae of tramal plates highly refractive, hyaline and smooth in KOH, narrow (3–5 μ); subhymenium inconspicuous and of cells basal to basidia 1–2 deep and about the diameter of the base of the basidium (not much enlarged). Peridium of appressed more or less parallel hyphae, in epicuticular region 4–10 μ diam and with much olivaceous amorphous pigment both intercellular and intracellular as revived in KOH, walls somewhat refractive; subcutis of more interwoven hyphae the cells often inflated to 18 μ but no true sphaerocysts observed. Clamp connections none. All tissues nonamyloid; large red-brown pigment balls present in mounts in Melzer's sol.

Under mixed conifers including hemlock, Priest Lake State Park, Idaho, June 26, 1964, Nancy Jane Smith collector (Smith 67895).

The basidiocarps did not stain from handling, and there was no sign of red on the fresh peridium either on the surface, on sections made from fresh material and mounted in KOH, or when sections from dried peridia were revived in KOH. This variant is described under *R. subcaerulescens* because it is felt that such differences as a bright green $FeSO_4$ reaction as compared to bluish one might not mean much. At the time the specimens were available I neglected to check the reaction by adding a drop of alcohol to the spot. The change to blue in the type variety of *R. subcaerulescens* does not always show, and there is a tendency in the group for the development of wood-brown to vinaceous brown fibrils over the surface of the basidiocarp. This change is most pronounced in var. *subpannosus*. The difference in the size of the subhymenial cells between the type variety and var. *viridescens* may be of some significance, but here again many observations are need.

Rhizopogon subcaerulescens var. **subpannosus** A. H. Smith, var. nov.

Fructificationes 1–4 cm. crassae, subglobosae vel angulares, siccae, fibrillosae, albidae tarde "natal-brown" (vinaceo-brunneae), in "$FeSO_4$" subcaeruleae, in "KOH" olivaceae. Gleba cinnamomeo-brunnea vel sordide luteo-brunnea. Sporae 7–9(–10) × 2.8–3.5(–3.8) μ. Typus: Smith 68604 (MICH).

Illustrations: pl. VII, 5.

Basidiocarp 1–4 cm. diam, globose, subglobose, varying to oval or angular from external pressure, when young white and surface matted-fibrillose, slowly developing an overlay of dark vinaceous-brown fibrils until in age the color becomes entirely dark vinaceous-brown ("natal-brown"), with concolorous coarser rhizomorphs over the surface in addition; KOH dark green on fresh peridium, $FeSO_4$ slowly bluish olive (or no reaction on old specimens); peridium in section (fresh) colored like the gleba and unchanging. Gleba firm-cartilaginous, dark cinnamon-brown to bister, cavities very minute, blackish with Melzer's sol. when fresh, bone-hard when dried.

Spores 7–9 × 2.8–3.5 (–3.8) μ, oblong to subfusoid, pale yellow brown singly in KOH, dark yellow-brown in masses, in Melzer's sol. dark yellow-brown in masses with some indication that immature spores are amyloid, single spores yel-

lowish or if young many with a suggestion of blue. Basidia 8-spored, subclavate to contorted, gelatinizing. Paraphyses thin-walled, hyaline, gelatinizing in KOH, in Melzer's sol. many seen to have a hyaline droplet 2–4.5 μ diam. Tramal plates of hyaline very refractive smooth hyphae 3–6 μ diam, subparallel to interwoven; subhymenium filamentous, the elements gelatinous. Peridium lacking an epicutis of thin or thick-walled dark yellow-brown hyphae (hence the species not in sect. *Villosuli,* instead the layer of appressed-interwoven hyphae 4–10 μ diam having subgelatinous walls and granular incrustations on the hyphae), greenish in KOH in the epicutis, with green pigment in intercellular masses and apparently also in the wall; subcutis with reddish areas from intercellular pigment (above data all from KOH mounts of fresh material); as revived in KOH the layer dingy olive and hyphae not gelatinous, pigment both intercellular and intracellular; in Melzer's sol. with numerous orange-brown globules of various sizes present; no sphaerocysts or greatly enlarged cells seen, all tissues nonamyloid. Clamp connections none.

Solitary to scattered in conifer duff but abundant at times; summer and early fall, Idaho.

This variety has the colors as described in *R. pannosus* as the latter was originally described, but the resemblance ends there. This variety is a widely distributed one fruiting over a long period of time. It begins to appear during late June, at which time the basidiocarps are pure white with no suggestion of a brown overlay of fibrils. As the season progresses, one finds what is apparently the same fungus but with scattered brown fibrils, and finally along about the last of July and early August one finds dark vinaceous-brown basidiocarps with no suggestion of white. Were it not for the Hoodoo Mt. collection (designated as type), one might have been tempted to recognize several "species" here. In the type, however, all stages in the progression cited above were present and a detailed study of them was made. The odd feature is that in spite of the color of mature basidiocarps, they do not have the features of species in sect. *Villosuli.* This was a distinct surprise. By the time the basidiocarps have become dark brown they are very difficult to see, so that one's chances of finding them are greatly reduced. The white ones stand out clearly against the soil and are easily spotted in a digging operation.

In Smith 69182 immature spores are amyloid and mature spores are not. The basidiocarps were white but slowly became flushed vinaceous but did not stain when bruised. KOH is olive on the surface of the peridium but in a section red and olive pockets show and the surface reaction is olive but this may be clouded with vinaceous tints and shortly the result is an inky blackspot. $FeSO_4$ alone gives an olive reaction but with addition of a drop of ethanol quickly turns blue. Spores of basidiocarps with a white gleba were evenly and weakly amyloid; those with dark colored gleba had colored spores which were nonamyloid.

This species is thus confusing on a number of accounts: First by the characters used for the recognition of varieties, and at least within var. *subpannosus* by the change in the reactions of the spores to iodine on immature as contrasted to mature basidiocarps; thirdly in the development of the overlay of brown fibrils which completely changes their appearance; and fourthly, in the chemical reactions with KOH and $FeSO_4$. Further study may reveal how to distinguish additional taxa here, but for the present I simply regard it as the most difficult of all species of *Rhizopogon* to identify.

Material examined: IDAHO: Smith 67927, 67988, 68009, 68013, 68158, 68277, 68281, 68285, 68289, 68290, 68305, 68330, 68358, 68367, 68370, 68385, 68491, 68396, 68502, 68539, 68604 (TYPE), 68605, 68606, 68609, 68610, 68612, 68613, 68614, 68615,

68616, 68617, 68619, 68621, 68624, 68630, 68661, 68675, 68702, 68950, 68952, 68961, 68968, 68991, 69129, 69134, 69139, 69147, 69152, 69153, 69161, 69162, 69163, 69182, 69183, 69184, 69186, 69187, 69320, 69350, 69786, 69789, 70365. WASHINGTON: Smith 68077, 68119, 68232, 68233.

21. **Rhizopogon alkalivirens.** A. H. Smith, sp. nov.

Fructificationes 1–2.5 (–3) cm. latae, globosae vel subglobosae, siccae, pallidae, fibrillosae, demum brunneae vel vinaceo-brunneae, in "KOH" virides vel virido-atratae, in "$FeSO_4$" caeruleo-olivaceae. Gleba alba demum griseo-olivacea. Spores versiformes, 12–18 × 3.5–5 μ, angulari-cylindricae, 9–12 × 6–8 μ et ovatae vel angulari-ovatae vel subtriangulares, amyloideae. Typus: Smith 69037 (MICH).

Basidiocarp 1–2.5 (–3) cm. diam, globose to subglobose, surface dry and pallid, fibrillose and with an overlay of loosely appressed brownish rhizomorphs, gradually darkening and in age or when dried "army-brown" to "natal-brown"; KOH green becoming blackish on fresh peridium, $FeSO_4$ bluish-olive. Gleba white to olive-buff and remaining pallid even when collapsing, firm but easily sectioned.

Spores versiform, 12–18 × 3.5–5 μ and angular-cylindric or wall merely slightly flexuous to even, base obscurely truncate; 9–12 × 6–8 μ and ovate to angular ovate, some mitten-shaped with the thumb either to right or left, some variously triangular or bifid; walls often flexuous but thin (0.25–0.5 μ), when mounted in Melzer's sol. bluish but fading out to brownish in a half hour, hyaline when young (in KOH) but pale yellow-brown in oldest ones, bases typically truncate. Basidia (or conidiophores?) 1–4 spored, soon gelatinizing and collapsing but oval to clavate or subcylindric when young. Paraphyses thin-walled, clavate, 8–12 μ wide. Tramal plates of gelatinous thin-walled hyaline interwoven hyphae, no incrustations or enlarged cells noted. Peridium of interwoven hyphae 4–12 μ diam, some giant cells scattered in the layer (±30 μ diam), and having thickened hyaline walls, also numerous cells up to 20 μ broad (inflated but not sphaerocyst-like), in KOH with floccules of bister pigment between the hyphae and along them, in Melzer's sol. with numerous orange-brown pigment balls; no clamps, amyloid hyphae or amyloid particles seen.

Boulder Creek, New Meadows, Idaho, Aug. 8, 1964, Harold Burdsall collector (Smith 69037, TYPE).

This species could easily become confused with *R. subcaerulescens* and its variants because when fresh and when dried they all have a very similar appearance. The spores readily separate them, of course. *R. alkalivirens* is close to *R. griseogleba* but the latter stains vinaceous when handled and pinkish-lilac in KOH. In addition in *R. alkalivirens* the spores are weakly but distinctly amyloid. *R. subgelatinosus,* is perhaps the most closely related species but has smaller spores, and KOH stains some areas of the peridium reddish. Also, the gleba does not become as gelatinous or as darkly colored.

Rhizopogon subg. **Rhizopogon** sect. **Fulviglebae** A. H. Smith, Mich. Bot. **3**: 19. 1964.

Rhizopogon sect. *Megaspori* A. H. Smith, Mich. Bot. **3**: 13. 1964.

The diagnostic features of this section are either of two characters or both in combination: 1) Truncate spores, with or without remnants of the sterigmal wall around the truncation to form an inverted "cup." 2) The fulvous to cinnamon to dark yellow-brown gleba at maturity. However, there are species in sect.

Rhizopogon with spores having an obscure truncation and a pale to moderately dark yellow-brown gleba when old. In general, if the spores are consistently under 3 μ wide and the gleba is dark to medium yellow-brown, try sect. *Rhizopogon*. It cannot be emphasized too strongly that it is practically impossible to circumscribe groups at the level of sections in this genus without numerous intermediates remaining to cloud the distinction.

The present emendation of sect. *Fulviglebae* has necessitated reducing sect. *Megaspori* to synonymy under it as a subsection. As a subsection it retains its previous delimitation as a group of species featuring very large spores often very irregular in shape. Of the five species placed in it one, *R. hysterangioides,* is clearly not closely related to the others, but I hesitate to erect a section for it alone. *R. clavitisporus* and *R. subclavitisporus* show indications of a peridial epicutis of the kind which features sect. *Villosuli,* and this is in keeping with the situation found in subsect. *Fulviglebae* stirps Vinicolor where a similar trend is evident both as to thick-walled brown hyphae and in the production of giant cells (see *R. vesiculosus*). However, it seems to me that the species grouped in subsect. *Megaspori* justify the taxonomic emphasis given them if for no other reason than to call attention to the fact that most of them show the same "abnormal" feaures; features noted to a lesser degree on species in other sections. Studies on the cytology of the basidium (if it is indeed a basidium), are needed here to determine whether the nuclear cycle is typical. Many of the structures here described as basidiospores could easily be conidia.

Concerning subsect. *Fulviglebae,* if it eventually happens that *R. luteolus* is conceived as a species with truncate spores, the sectional nomenclature will have to be adjusted, since that species is the type of the genus. My disposition of the problem has been made in accord with the evidence as presented in this work. The species in stirps Vinicolor present some problems in the color of the gleba. In fact it was this group which was largely responsible for the present emendation of the section. Some species will have a rusty brown gleba fresh but it dries olive colored. In *R. olivaceofuscus* the changes are quite confusing: the young gleba is pallid then distinctly yellow, then olive, at maturity blackish brown, and when dried "olive-brown" to "Prout's brown." By placing emphasis on the spore characters in this group one can deal with it effectively. Immature specimens nearly all show a croceus colored gleba before the olive stage, and this is some help, along with color changes of the peridium, in placing them.

Type species: *R. exiguus* Zeller.

Comments on Stirpes of Sect. *Fulviglebae*

Stirps Hysterangioides. This contains only the type species and its correct position in the Hymenogastraceae still needs to be ascertained.

Stirps Clavitisporus: *R. clavitisporus* and *R. subclavitisporus*. These two form a clear connection to sect. *Villosuli* as judged by the variable number of epicuticular hyphae with brown walls that are present.

Stirps Variabilisporus: *R. variabilisporus* and *R. griseogleba* both tend to develop vinaceous-brown tints or stain this color. Both have groups of enlarged cells in the subcutis.

Stirps Lowii: The type species appears to be a misfit in the genus.

Stirps Pannosus: Not much can be said of this species until certain problems concerning its circumscription have been settled.

Stirps Fragmentatus: Only the type species is placed here. The hyphae of the tramal plates are like nothing else in the genus.

Stirps Exiguus: Again, only the type species is placed here. It is unusual by virtue of large 4-spored basidia which resemble hymenomycete basidia as to shape.

Stirps Cokeri: *R. cokeri* and *R. truncatus*. Both of these dry to a very bright yellow.

Stirps Thaxteri: *R. tsugae, R. thaxteri, R. atlanticus, R. ochraceisporus*. All of these become rather dark brown on drying.

Stirps Lutescens: Only the type species is placed here. The color changes are unusual for the genus.

Stirps Vinicolor: *R. subcinnamomeus, R. parvulus, R. diabolicus, R. vesiculosus, R. inquinatus, R. olivaceofuscus, R. vinicolor*. In drying they all tend to become vinaceous red at least to some extent.

Key to Subsections of Sect. *Fulviglebae*

1. Spores 9–18 μ long and often of irregular shape.	subsect. *Megaspori*
1. Spores 6–10 μ long and mostly oblong, ellipsoid or oval.	subsect. *Fulviglebae*

Rhizopogon subg. **Rhizopogon** sect. **Fulviglebae** subsect. **Megaspori** (A. H. Smith) A. H. Smith, stat. nov.

Rhizopogon sect. *Megaspori* A. H. Smith, Mich. Botanist **3**: 13. 1964.

The large spores (10 μ or more long) often of irregular shape characterize it. For additional comment see under sect. *Fulviglebae*. *R. alkalivirens* and *R. ventricosporus* may also be considered as belonging here; see sections *Amylopogon* and *Rhizopogon* stirps Rubescens.

Type species: *R. variabilisporus* Smith.

Key to Species of Subsect. *Megaspori*

1. Spores hyaline in groups in KOH under microscope.	22. *R. hysterangioides*
1. Spores in groups colored.	2
2. Young gleba pallid but changing to dark yellow-brown when cut; peridium not red when injured.	23. *R. variabilisporus*
2. Not as above.	3
3. KOH on revived sections showing olive to blue-green areas and/or KOH on fresh peridium olivaceous.	4
3. KOH on fresh peridium red to vinaceous (no olive present at any time).	7
4. Spores 12–18 × 5–9 μ or wider.	25. *R. clavitisporus*
4. Spores 9–12 × 3.5–4.5 μ.	5
5. Peridium staining red when injured.	see *R. rogersii*
5. Peridium not staining red.	6
6. Basidiocarps 3–8 cm. diam; hyphae of epicutis lacking thornlike projections.	see *R. ponderosus*
6. Basidiocarps 8–15 mm. diam; hyphae of epicutis with scattered thorn-like projections.	see *R. zelleri*
7. Gleba rusty brown at maturity; spores 9–13 × 4.5–7 μ.	26. *R. subclavitisporus*
7. Gleba wood brown (gray-brown) mature; spores 12–18 × 6–12 μ.	24. *R. griseogleba*
7. Gleba near honey-yellow to olive.	see *R. ventricosporus*

22. **Rhizopogon hysterangioides** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, noduloso-globosae vel irregulares, siccae, sordide albidae, demum subluteae. Gleba alba, cartilaginea. Sporae 11–14 × 4.5–6.5 μ, subfusoideae vel ellipsoideae, hyalinae. Typus: Smith 69015 (MICH).

Basidiocarp 1–3 cm. diam, globose-nodular to very irregular, surface dry and dull white or in some of the depressions pale yellowish, no rhizomorphs present; consistency dry and firm like a *Martellia*, KOH slowly dingy yellowish to pinkish;

$FeSO_4$ slowly pale bluish to pale bluish olive, C_2H_5OH, no reaction, Melzer's reagent no reaction, blue where $FeSO_4$ and C_2H_5OH meet. Gleba white, drying a pale pinkish-buff, consistency firm-cartilaginous; no latex present.

Spores subfusoid to ellipsoid, 11–14 × 4.5–6.5 μ, with a droplet, smooth, hyaline in KOH and yellowish in Melzer's sol. Basidia 4-spored, clavate above a wavy pedicel or tip subglobose. Cystidia none. Peridium of compactly interwoven hyaline hyphae 3–8 μ in diam or some cells variously enlarged but not sphaerocysts, as revived in KOH flushed reddish near surface (where debris is present) but hyaline in the interior, yellowish in Melzer's sol. Clamp connections none. Many oil drops present in KOH and Melzer's mounts.

In the duff under conifers, Brundage Mt., McCall, Idaho. Aug. 8, 1964, Smith 69015 (TYPE) and 69020.

This is a most unusual species for several reasons. The basidiocarp is very nodulose and the color change with KOH is to yellowish to pinkish, the gleba is that of a *Rhizopogon* but the spores are those of a *Hysterangium*.

23. **Rhizopogon variabilisporus** A. H. Smith, Mich. Botanist 3: 18. 1964.

Illustration: Fig. 6, spores.

Basidiocarps 2–4 cm. broad, globose to ovoid or angular from external pressure, usually attached by a group or cluster of basal rhizomorphs, surface rough and fibrillose, ground color whitish, but the fibrils soon dingy vinaceous brown and much dirt adhering to the surface, when dried blackish brown. Odor none. Gleba pallid becoming nearly "bister" (dark yellow brown) when cut, slowly darkening to olive-brown, in old specimens about concolorous with the peridium in the dried state, chambers minute and nearly empty. Columella none or rudimentary (not evident on dried material).

Spores versiform: 20 × 5 μ and subcylindric, 14 × 7.5 μ and ovoid, 12 × 8 μ and obcordate, 14–16 × 7–8 μ and clavate, 18 × 6 μ and allantoid, or 12 × 6 μ and angular-ovate (sizes given here are averages for each type); also in above patterns some may show constrictions or protuberances or be merely somewhat angular in outline; pale bister in masses in KOH, dull brownish singly, yellow-brown in Melzer's sol., but with a thin hyaline apparently mucilaginous sheath, basal scar obscure. Basidia (?) 15–30 × (6–)8–12 μ and 1–6-spored, spores sessile, basidial walls often somewhat thickened but not colored, shape varying from clavate to cylindric or irregular in outline. Paraphyses not distinguishable from basidioles. Cystidia none. Tramal plates of interwoven highly refractive elements, the subhymenium cellular. Peridium when fresh up to 1 mm. thick, pallid when cut and not discoloring readily but becoming dark brown in drying; context of peridium of enlarged cells scattered and in pockets and their walls mostly slightly thickened, the ground tissue of filamentose hyphae which are vinaceous as revived in KOH and are heavily encrusted with debris; epicutis not differentiated from context but numerous hyphal tips project and these heavily incrusted but the walls not appreciably colored (fresh material in H_2O mounts), as revived in KOH the walls of these hyphae and those near the surface hyaline to pale bister. Clamp connections none. All tissues nonamyloid.

Gregarious to solitary in duff under spruce and fir, July and August. Idaho.

The spore-producing elements in the hymenium are assumed to be basidia, but a cytological study is needed to verify this. Six spores were seen attached to some of the broad clavate bodies. Cylindric elements bearing a single spore were also seen and could be conidiophores. The spores vary in shape around an essentially oblong spore—which is typical for *Rhizopogon* species generally. In

other species throughout the genus, to a lesser degree, the same "abnormalities" in spore shape can be found, so on spore features alone, the species can hardly be excluded from the genus. The broad hyphae of the peridium correlate with the large spores causing one to think of a tetraploid condition, but even allowing for this there is no clear parental species evident at present.

Smith 45575, from Heaven's Gate Ridge, Seven Devils Mts., Idaho, had a pinkish exterior, thick peridium and pale olive gleba which dried pallid. A rudimentary columella was noted on the fresh basidiocarps when sectioned and in these rhizomorphs were scattered over the surface of the peridium. The spores are paler than in the type, but it is obvious that the collection contained younger basidiocarps.

This species is in some respects an intermediate between *Nigropogon* and *Rhizopogon* because of the pockets of sphaerocysts in the peridial context.

Material examined: IDAHO: Smith 45549, 45575, 66083 (TYPE).

24. **Rhizopogon griseogleba** A. H. Smith, sp. nov.

Fructificationes 10–15 mm. crassae, siccae, fibrillosae, ligno-brunneae tactu vinaceae. Gleba griseo-brunnea. Sporae 10–18 × (3–)5–12 μ, versiformes. Typus: Smith 66309 (MICH).

Illustrations: Fig. 8, spores.

Basidiocarps 10–15 mm. thick, globose to subglobose, outline uneven, surface dry, nearly glabrous but under a lens matted-fibrillose and this overlaid with scattered rhizomorphs, color pale to dark wood-brown and staining vinaceous when handled; KOH staining peridium pinkish lilac and $FeSO_4$ dark olive. Gleba grayish wood-brown fresh, pale drab as dried, consistency when dried hard and bone-like, cavities very small. Odor none.

Spores versiform: narrowly fusoid and 18 × 5 μ; clavate to obcordate and 12–15 × 6–9 μ; angular-subglobose and 10–14 × 9–12 μ, triangular and 9–12 μ; flexuous-cylindric and 14–18 × 3–5 μ; *Rhodophyllus*-like (angular-rectangular, etc.). All nonamyloid (yellowish in Melzer's sol.), walls slightly thickened and brittle (many broken spores in mount), *ochraceous-tawny* in KOH and Melzer's sol., basal scar distinct but not conspicuous. Basidia not clear as revived, many "spores" seen to be the apical cell of a filamentous projection into the hymenium. Paraphyses none clearly defined. Tramal plates of hyaline gelatinous hyphae refractive as seen in KOH, some oleiferous hyphae present in the layer. Peridium a thick layer of hyaline hyphae 4–12 μ diam and with copious fuscous-brown pigment masses in the hyphae and between them, groups of enlarged cells present near the gleba. Clamp connections none. All tissues nonamyloid.

Dug from the ashes of an old camp fire, under spruce, Squaw Meadows, Valley Co., Idaho. Aug. 30, 1962, Coll. Nancy Jane Smith (Smith 66309, TYPE).

This species has spores with the same pattern of variation in shape as *R. variabilisporus,* but the color of the fresh gleba should allow them to be easily distinguished. The pinkish-lilac color change on the peridium with KOH, and the vinaceous stains on injury should also aid in the recognition of fresh specimens.

25. **Rhizopogon clavitisporus** A. H. Smith, sp. nov.

Fructificationes 10–25 mm. crassae, globosae vel subglobosae fibrillosae, cinnamoneo-brunneae; sporae 11–18 × 5–9 μ, subclavatae vel angularis. Typus: Smith 65395 (MICH).

Illustrations: Fig. 9, spores.

Basidiocarps 10–25 mm. thick, globose to subglobose, surface dry and covered

by a thin cinnamon-brown fibrillose epicutis which easily pulls apart or wears away to expose the pallid to vinaceous-buff ground color, when dried the ground color distinctly vinaceous where not covered by the cinnamon-brown epicutis, on the dried peridium $FeSO_4$ stains olive-black, KOH stains it both olivaceous and vinaceous. Gleba white to olive gray to dull olivaceous, grayish buff as dried, chambers small; consistency when dried firm but sectioning easily.

Spores basically clavate to cylindric but many obscurely to distinctly angular, 18 × 5 μ; 12–16 × 6–9 μ or angular-ovate and 11–15 × 6–8 μ, smooth, wall thin to slightly thickened, basal scar distinct, hyaline to ochraceous singly in KOH, darker ochraceous in groups, pale ochraceous in Melzer's sol., some medial wall thickenings present but few showing any false septum. Basidia (2 seen), 36–40 × 7–9 μ, 3 μ at base, clavate, hyaline. Paraphyses 7–11 μ broad, thick-walled, the central amorphous body not colored in Melzer's sol., often 2–3 cells in a chain all thick-walled. Tramal plates of narrow hyaline refractive-gelatinous hyphae; subhymenium cellular. Peridium with an epicutis of loosely woven dark-brown hyphae with flagellate cells in the layer; the context of dull rusty brown hyphae and pigment deposits and next to the gleba often strongly blue-green (all in KOH). Clamp connections absent. All tissues nonamyloid.

In duff under conifers, Cascade Lake, (west side), Valley County, Idaho, July, and Oregon, Josephine County, November.

The similarities of this species are clearly with those of sect. *Villosuli*. The paraphyses distinguish this species readily from either *R. variabilisporus* or *R. griseogleba*. The KOH stain is olive in the interior of the peridium next to the gleba and vinaceous in the epicuticular region.

Material examined: IDAHO: Smith 65395 (TYPE). OREGON: Brown 11–29–25.

26. **Rhizopogon subclavitisporus** A. H. Smith, sp. nov.

Fructificationes 1–2 cm. diam globosae, siccae, fibrillosae, albidae demum roseae et tarde argillaceae. Gleba crocea demum olivacea. Sporae 9–13 × 4.5–7 μ. Typus: Smith 68577 (MICH).

Basidiocarps 1–2 cm. diam, globose to ellipsoid, surface dry and fibrillose, whitish when young, soon rose purplish and finally darkening to brownish, dingy clay-color in age but as dried dull vinaceous; KOH red on young specimens, garnet-brown on old ones. Gleba pale croceus when young, soon olivaceous and at maturity dull rusty brown.

Spores 9–13 × 4.5–7 μ, ovate, ventricose-ovate, to clavate, with a truncate base having a distinct cup, wall smooth, becoming thick-walled, in KOH pale yellow-cinnamon to cinnamon, in Melzer's reddish cinnamon. Basidia 6–8-spored, becoming cylindric; paraphyses clavate to fusoid (cystidium-like), soon thick-walled and walls ochraceous in KOH, central body not coloring in Melzer's sol., basal cells also with thick colored wall. Tramal plates of gelatinous hyaline interwoven thin-walled hyphae 3–7 μ diam; subhymenium also gelatinous, filaments extending to the basal cells of paraphyses and basidia. Peridium of interwoven hyphae with ochraceous walls and some adhering debris in epicuticular region, in subcutis with heavy masses of reddish to cinnamon pigment, giant cells scattered in epicuticular region and some fulvous hyphae (in KOH) with walls 2–3 μ thick (but not forming a layer), some hyaline to pale ochraceous flagellate hyphae also present. No olive reaction with KOH, hyphae of epicutis mostly 4–9 μ diam with inflated cells to 18 μ (giant cells to 40 μ). Clamp connections none. Amyloid debris present but all hyphae with nonamyloid walls.

In duff under mixed conifers, Hoodoo Mt. Priest River, Idaho. July 24, 1964. Smith 68577 (TYPE).

This lacks the blue-green reaction in KOH of *R. clavitisporus,* the epicutis is less well developed, and the series of colors presented by the gleba is different.

Rhizopogon subg. **Rhizopogon** sect. **Fulviglebae** subsect. **Fulviglebae.**

Most of the species in this subsection have spores 3 μ or more broad. To be placed in this section a species with narrow (less than 3 μ) spores must have a truly rusty brown to cinnamon gleba at maturity. In other words there is a distinct correlation between broad spores and their basal truncation. This results from the manner in which the mature spore is attached to the basidium.

Type species: As for the section.

Key to Species of Subsect. *Fuliglebae*

1. Spores 3.8–5 μ broad. 2
1. Spores 2–3.5 (–4) μ broad. 10
2. Basidia clavate, 20 × 4 μ long; odor farinaceous fresh. 30. *R. exiguus*
2. Not with either of the above features. 3
3. Peridium lemon yellow fresh, and clean as revived in KOH (see *R. cokeri* also). 31. *R. truncatus*
3. Not as above. 4
4. Spores 9–12 × 3.5–5 μ. see *R. abietis*
4. Spores 7–10 × 2.8–4.5 (–5) μ. 5
5. Gleba pallid fresh but soon cadmium when cut. 37. *R. lutescens*
5. Not as above. 6
6. KOH on fresh peridium instantly dark rusty brown on young and old specimens. 36. *R. ochraceisporus*
6. KOH on fresh peridium red to garnet-brown. 7
7. Gleba olive-brown mature. see *R. vinicolor*
7. Gleba distinctly fulvous to russet mature. 8
8. Spores 6.3–8.4 × 3.5–4.5 μ; KOH lilac on young basidiocarps, rusty brown on old ones. 40. *R. diabolicus*
8. Not as above. 9
9. Staining pinkish to lilac when handled (on young fresh basidiocarps). 39. *R. parvulus*
9. Staining dingy brown when handled. 38. *R. subcinnamomeus*
10. Peridium bright yellow. 11
10. Peridium not as above, or if yellow then darkening to yellow-brown by maturity. 12
11. Peridium stains red when bruised; dark bay red over all as dried. 27. *R. lowei*
11. Peridium not staining, drying bright yellow. 32. *R. cokeri*
12. Giant cells scattered in the epicutis and subcutis of the peridium. 41. *R. vesiculosus*
12. Not as above. 13
13. Tramal plates with some hyphal cells 12–25 (–40) μ in diam. 29. *R. fragmentatus*
13. Tramal hyphae 2–10 μ in diam. 14
14. Cystidia present at least in cavities near the peridium. 28. *R. pannosus*
14. Cystidia absent (but large clavate cells present at times in cavities near peridium). 15
15. Spores 8–10 × 2.8–3.4 μ and mostly subfusoid (see *R. villescens* also). 33. *R. tsugae*
15. Not as above. 16
16. Spores 7–10 × 2.2–2.5 μ, oblong to cylindric (see *R. fragrans* also). 34. *R. thaxteri*
16. Spores 6.5–9 × 3–4 μ. 17
17. Gleba changing to fuscous or blackish brown when cut. 43. *R. olivaceofuscus*
17. Gleba not changing as above. 18
18. Peridium when injured staining inky-fuscous; sections of peridium revived in Melzer's sol. showing dark violet pigment balls. 42. *R. inquinatus*
18. Not as above. 19
19. Dried basidiocarps near cinnamon-brown; gleba lacking a croceus-yellow stage. 35. *R. atlanticus*
19. Dried basidiocarps vinaceous red at least in part; young gleba with a croceus-yellow stage. 44. *R. vinicolor*

27. **Rhizopogon lowii** A. H. Smith, sp. nov.

Fructificationes 1.5–2 cm. crassae, ovoideae, vitellineae demum rubro-maculatae. Gleba olivacea, subavellanea, dura. Sporae 7–9 × 3–4 μ. Typus: Univ. N. C. Herb. 13626 (NC).

Illustrations: Fig. 45, 8 spores.

Basidiocarps 1.5–2 cm., egg-shaped, fibrils few and inconspicuous, colors egg yellow mottled with red ("deep chrome" to "orange" mottled with "Mahogany-red"), drying dark bay-red over all. Gleba with minute cavities, olivaceous fresh, grayish cinnamon-buff dried, consistency bone-hard when dry much as in *R. luteolus*.

Spores 7–9 × 3–4 μ oblong to truncate-ovoid, smooth, walls slightly thickened, base truncate from the sterigmal scar and in optical section with a tooth on either side (hence with a "cup" as in *R. atlanticus*), yellowish in KOH singly, more ochraceous in groups, yellowish in Melzer's sol. Basidia thin-walled readily collapsing, none found with spores. Paraphyses 6–10 μ broad, becoming thick-walled and typically with one or more round highly refractive inclusions (as seen in KOH). Tramal plates of refractive-gelatinous thick-walled to thin-walled interwoven hyphae; subhymenium not demonstrated clearly but apparently of interwoven narrow gelatinous hyphae. Peridium of interwoven hyaline hyphae 3–8(14) μ broad, but with much amorphous pigment in and between the hyphae magenta-red in KOH, and in Melzer's sol. pigment rounding up into large "pigment balls" red or orange in color. Clamp connections none. All tissues nonamyloid.

The TYPE, Univ. of N.C. Herb. 13626, was collected by Josiah L. Lowe on the surface of the soil in a mixed woods, Laurel Hill, Chapel Hill, N.C., Oct. 14, 1945.

This is a most unusual species apparently closely related to *R. ochraceorubens* and *R. luteolus*. The highly refractive granules described for the paraphyses are very abundant throughout mounts revived in KOH and are a distinctive feature. They remind one of those of *R. subcroceus* but are much more abundant. The spores place *R. lowii* in this section even though the gleba is olive. The hard consistency of the gleba as dried is like that of *R. luteolus*. The peridium probably stained red on bruising but Lowe's notes did not specifically state this.

28. **Rhizopogon pannosus** Zeller & Dodge, Ann. Missouri Bot. Gard. 5: 6. 1918.

Basidiocarps 1.5–3 cm. diam, globose, depressed-globose, subpyriform or variously angled from mutual pressure, color russet-vinaceous to sorghum-brown and light seal-brown where bruised, the sorghum-brown patches of the outer peridial layer being isolated as this layer cracks; fibrils inconspicuous, almost entirely wanting above to innate-appressed below, where they are short but large, appearing as large smooth almost shiny ridges, light seal-brown. Gleba light buff when dry, coriaceous, cavities averaging 5–6 per mm. subglobose to irregular, empty (above data from type description).

The following microscopic data are from the portion of the type in the Zeller Herbarium (NY). Spores 7–9 × 3–3.5 μ, narrowly ellipsoid in face view, in profile varying toward inequilateral (subfusoid), hyaline as revived in KOH individually or in groups but groups in cavities near the peridium pale cinnamon, in Melzer's sol. yellowish individually and in groups, smooth, wall thin to slightly thickened, basal scar distinct. Basidia 4-, 6-spored, 17–30 × 6–7 μ, hyaline, subcylindric to narrowly clavate. Basidioles similar to basidia. Cystidia abundant in cavities near the peridium, 40–80 × 7–12 μ, narrowly fusoid-ventricose to subcylindric, apices subacute to obtuse, hyaline in KOH, thin-walled, readily col-

lapsing, and difficult to revive. Hymenium in Melzer's sol. orange-brown to orange-red. Tramal plates of subparallel hyaline smooth highly refractive (in KOH) hyphae but no more than subgelatinous. Peridium of a single layer of appressed-interwoven hyphae 4–16 μ in diam, tawny to pale cinnamon in KOH, in Melzer's sol., yellow to orange-red, the hyphae near the surface paler and more refractive as seen in KOH but layer not gelatinous or sharply defined as a layer, no laticiferous hyphae evident in either Melzer's sol. or KOH mounts. Clamp connections none. All tissues nonamyloid.

Mariposa County, Calif., W. A. Setchell 1380, in Zeller Herb. (NY).

I have cited only the specimen in the Zeller Herbarium. The following are details of the macroscopic features of this basidiocarp: As dried, (and it is well dried) the gleba is between "light buff" and "cinnamon-buff" in other words a very pale yellowish tan. The surface of the peridium varies from a dingy cinnamon-buff to reddish tan in places, but nowhere does one find colors as given in the type description. The difference is so great and so obvious, that one can only conclude that somewhere in previous handling of the specimens, collections became mixed. The microscopic features given in the type description do not check too well with those I recorded from the portion of the type studied. The spore width is given as up to 5 μ and the color as cream color in mass. It is clear to me that two species are involved. The species represented by the basidiocarp in the Zeller collection is the one keyed out in my key, but unless the question in regard to the material described in the original account can be cleared up the name may have to be dropped.

29. **Rhizopogon fragmentatus** A. H. Smith, sp. nov.

Fructificationes circa 3 cm. crassae, ovatae, siccae, subfibrillosae, olidae. Gleba fulva, gelatinosa. Sporae 6–8 × 3–3.7 μ, ellipsoideae vel ovoideae, leves, amyloideae. Typus: Oswald 5 (MICH).

Basidiocarps about 3 cm. broad, ovate, surface with only inconspicuous rhizomorphs; peridium duplex when fresh the inner layer white, the outer layer lateritious to dark brown; odor when fresh strongly of carmel. Gleba of small chambers, soft when fresh, rusty brown as dried.

Spores 6–8 × 3–3.7 μ, ellipsoid to oval, truncate at base, smooth, *pale cinnamon* in KOH, dingy violaceous in Melzer's sol., walls thin, basal scar distinct, no false septa seen. Basidia 8-spored, 14–20 × 5–8 μ, hyaline in KOH; thin-walled. Paraphyses all thin-walled and resembling basidioles. Subhymenium and tramal plates of very thin-walled nongelatinous hyphae with cells often 20–40 μ thick and readily disarticulating, some filaments with irregularly enlarged cells 6–15 μ diam also present, tramal plates crumbly when sectioned, hyphal arrangement basically interwoven, the cells weakly outlined as revived in KOH. Some hyphae as revived in Melzer's sol. containing hyaline granular particles. Peridium of appressed-interwoven cylindric hyphae 4–15 μ diam, heavily incrusted with rusty-brown pigment in KOH, in Melzer's sol. forming large orange-brown pigment balls but all hyphae still remaining granular incrusted; no layering visible in revived mounts. Clamp connections none. All tissues nonamyloid, but some amyloid debris present but possibly extraneous.

Under conifers, Trout Lake Swimming pool, Mt. Adams, Wash. Nov. 2, 1962, R. Oswald 5 (TYPE).

This is an unusual species because of the enlarged cells of the tramal plate hyphae, the pale cinnamon spores in KOH as well as their dingy violaceous color

in iodine, and the rusty brown gleba. It is a perfect intermediate between sections *Amylopogon* and *Fulviglebae*.

30. **Rhizopogon exiguus** Zeller, Mycologia 31: 2. 1939.

Illustrations: Fig. 40, spores.

Basidiocarps 2–10 mm. broad, globose or nearly so, lobed in large specimens, consistency soft and spongy, surface smooth, white with ochraceous mottling, becoming snuff-brown, fibrils scanty above, rhizomorphic below. Gleba white then brown (concolor with peridium as dried in mature specimens) cavities small, rounded, partly filled with spores. Odor farinaceous.

Spores 7–8 × 5–5.5 μ, oval to elliptic and base truncate from a broad basal scar, yellowish individually as revived in KOH and rusty cinnamon in mass, in Melzer's sol. yellowish to rusty yellowish, wall smooth and slightly thickened. Basidia 20–40 × 6–7.5 μ, narrowly clavate, walls often slightly thickened and refractive, 4-spored; sterigmata distinct and walls may be thickened slightly as well as colored pale cinnamon (revived in KOH). Paraphyses 14–20 × 7–10 μ, hyaline, thin-walled, nongelatinous. Cystidia none seen. Tramal plates of hyaline refractive hyphae, not obviously gelatinous, subparallel to interwoven, subhymenium of branched filaments. Peridium a single layer of compactly interwoven hyphae in mass bright rusty cinnamon in KOH, at the exterior with loosely interwoven hyphae yellowish in KOH but not forming a distinct epicutis, hyphae thin-walled or walls very slightly thickened. Clamp connections absent. All tissues non-amyloid.

In heavy duff under hemlock, Pierce County, Wash., S. M. Zeller 8278 (TYPE) (NY).

In KOH the spores and peridium are rich rusty cinnamon and the colors are about the same in $FeSO_4$. The species is readily distinct by its broad oval spores, color changes of the peridium from youth to age, and the farinaceous odor. The long basidia are unusual in this genus, and may eventually lead to the species being placed elsewhere. Morphologically the basidia are more "agaricoid" than "gastroid".

31. **Rhizopogon truncatus** Linder, Rhodora 29: 196. 1924.

Illustrations: Fig. 47, spores.

Basidiocarps about 3 cm. diam, subglobose to subellipsoid, outline irregular, surface at first fibrillose and bright lemon-yellow, when dried duller yellow (chamois, honey-yellow or ocher-yellow), outer fibrils at times conspicuous in dried specimens, or mummy-brown filaments ascending from the base to near the summit; when drying emitting a faint odor like that of the phalloids. Gleba distinctly buff colored (dingy yellow) as dried, sectioning readily in dried state, cavities globose to irregular empty.

Spores 7–9 × 4–5 (10 × 3.5 μ) μ smooth, elliptic-truncate to oblong-truncate, strongly ochraceous as revived in KOH, in Melzer's sol. ochraceous singly and in groups somewhat dextrinoid, wall up to 0.75 μ thick, base with a prominent sterigmal scar consisting of a cross wall with extensions of the spore wall down beyond it to form a cup. Basidia 18–23 × 9–11 μ, clavate, hyaline in KOH, thin-walled, spores nearly sessile at maturity (sterigmata 3–4.5 μ long—Linder), number of spores on basidium not determinable. Paraphyses resembling basidioles, thin-walled, hyaline revived in KOH. Tramal plates of refractive-subgelatinous hyphae hyaline in KOH; subhymenium cellular but only 1–2 cells deep and cells

5–8 μ broad. Peridium orange-yellow throughout in Melzer's sol., nearly sulphur-yellow in KOH, filamentose throughout and the cells more or less equal in diameter throughout their length, walls thin to slightly thickened but not gelatinous, no orange-brown pigment globules present in mounts in Melzer's sol. and no encrusting material or deposits of pigment on or between the hyphae, no sphaerocysts present. Clamp connections none.

In duff in a mixed forest of white birch and hemlock, New Hampshire, D. L. Linder (TYPE) (FH), and Canada; Nova Scotia, Harrison 26–7–53.

The basidiocarp as dried is more or less sulphur-yellow and firm. The gleba is buff colored as dried, firm but sections well, and the cavities are small. The species is closely related to *R. atlanticus* Coker & Dodge, but the latter has a fragrant odor, and the peridium becomes yellow-brown on drying. In Harrison's material some of the original color was still evident on the dried basidiocarp. In it the paraphyses were thick-walled, the spores nearly sulphur-yellow individually in KOH, and merely richer yellow in mass, and in Melzer's sol. they were weakly dextrinoid in mass. The measurements were 7–9 × 3.5–4.5 μ.

32. **Rhizopogon cokeri** A. H. Smith, sp. nov.

Fructificationes 0.5–1 cm. crassae, globosae, impolitae, laete sulphurae, immutabiles. Gleba pallide cinerea. Sporae 7–9 × 3.5–4 μ, ellipsoideae ad basin truncatae, leves, dextrinoideae. Typus: Coker 10511 (NC).

Illustrations: pl. VIII, 5.

Basidiocarps 0.5–1 cm. thick, globose or nearly so, surface unpolished to granulose-appearing, bright sulphur-yellow overall including the mycelium and on exposure to air or injury merely bright olive-yellow. Gleba light ashy color, chambers very minute, when dry firm but sectioning easily. Odor and taste not distinctive.

Spores 6–8 × 3–4 μ, (Coker) 7–9 × 3.5–4 μ (Smith), oblong-truncate to ellipsoid-truncate, with a conspicuous basal cup, smooth, thin to slightly thick-walled; in KOH hyaline-yellowish singly, in groups slightly ochraceous; in Melzer's sol. strongly dextrinoid as seen in groups along the hymenium, paler dextrinoid singly. Basidia and paraphyses not reviving well enough to study but no thick-walled elements present in the hymenium. Tramal plates hyaline, of gelatinous to subgelatinous hyphae, subhymenium not distinct in material studied. Peridium thin and delicate, one-layered, sections revived in KOH giving off a greenish yellow pigment in the mount; consisting of loosely interwoven hyphae 3–6 μ in diam, thin-walled, smooth, no pigment pockets present, the layer pale greenish yellow in KOH, some hyphal cells inflated to 15 μ but no sphaerocysts present. Clamp connections absent.

Type collected by W. C. Coker 10511 (TYPE) on a bare bank by a road around Mirror Lake, Highlands, N. C., Aug. 12, 1937 (NC). Harrison, Nova Scotia, DAOM 39436.

If any *Rhizopogon* can be described as beautiful this is it. The color when dried reminds one of that of *Boletus ravenelii*. The species is distinct from *R. truncatus*, with which Coker had identified it, by the strong dextrinoid reaction of the spores and by their not measuring more than 4 μ broad. It differs from *R. atlanticus* by its more brilliant colors both fresh and dried, and the dextrinoid reaction of the spores in iodine. There was not enough material in the type collection to justify taking $FeSO_4$ and KOH reactions. The species appears amply distinct without them. The Nova Scotia collection contains 2 basidiocarps which measured over 1 cm. thick fresh and which have retained the bright color in dry-

ing. During the summer of 1964 the species was found abundantly in Idaho, but because of the color of the gleba when mature these collections are described separately as follows:

Rhizopogon cokeri (Idaho collections)

Basidiocarps 10–20 mm. diam, globose to subglobose, nodulose at times, surface covered by a thin coating of appressed fibrils and closely appressed rhizomorps, "lemon-chrome" over all from this layer and retaining this color in drying, not changing color when handled or bruised but the surface duller on rubbed portions (the epicutis breaks up readily from abrasion), $FeSO_4$ no reaction, KOH no reaction. Gleba white when young, becoming olive gray to olive-brown and finally at maturity nearly fuscous-black, when dried in oldest specimens near "Dresden brown" to cinnamon-brown, chambers small and labryinthine, consistency dry and somewhat cartilaginous; columella none.

Spores 6.5–8 × 3–3.5 (–4) μ oblong, oval to oblong, rarely obscurely angular, nearly hyaline immature, at maturity rusty cinnamon, immature spores dextrinoid but mature spores rusty cinnamon in Melzer's sol., as in KOH; smooth, wall up to 1 μ thick, base cup-like (truncate with extensions of the wall surrounding the truncation). Basidia 6-spored, cylindric to clavate, hyaline in KOH. Paraphyses thin-walled until maturity, then developing thickened walls (somewhat) and as revived in KOH with a large amorphous hyaline refractive body (as in cystidia of *Naematoloma*), tramal plates of hyaline thin-walled hyphae ± ? parallel in arrangement; subhymenium filamentous. Peridium a thin layer of yellow (in KOH, fresh) hyphae giving off at surface a weak trichodermium of long narrow (± 2 μ diam) filaments, smooth in KOH (or as revived having granular intercellular debris), granular in Melzer's sol., and with scattered dark particles (amyloid?) on fresh specimens, as revived in Melzer's sol. with yellow and orange globules as well as granules, but no amyloid particles. Clamp connections none. All tissues nonamyloid.

In duff along and in decayed white pine logs, July, Priest River area. (Smith 68155, 68288, 68292, 68332, 68345, 68359, 68511).

Certain features of the mature specimens are strikingly different from the specimens collected in Nova Scotia and North Carolina. The dark color of the gleba develops rather late and one finding such a specimen by itself would think it quite a distinct species from the immature specimens. However this point was checked in the field and all intergradations were found. It is peculiar that the spores are dextrinoid when immature, but when mature they are about the same color in KOH and Melzer's sol., hence the dextrinoid feature is not obvious. The most curious feature to develop in mature specimens however is the inclusion found in the paraphyses as revived in KOH. It was not evident in fresh material. If further collections in the east show that material from this region never matures in the manner described above, the western collections should be regarded as belonging to a different species.

33. **Rhizopogon tsugae** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. crassae, globosae vel subglobosae, cinnamomeo-brunneae, obscure reticulatae, impolitae. Gleba sordide cinnamomea. Sporae 8–9.5(–10) × 2.8–3.4 μ, subfusoideae, in cumulis sordide luteobrunneae, leves, nonamyloideae. Typus: Zeller Herb. 8264 (NY).

Illustrations: Fig. 43, spores.

Basidiocarps 1–2 cm. broad, globose or nearly so, surface as dried rough and

unpolished and under a lens faintly reticulate "cinnamon-brown" to "Mars-brown" as dried. Gleba cinnamon-brown dried, hard (almost bone-like) cavities very small.

Spores 8–9.5(–10) × 2.8–3.4 μ, mostly subfusoid varying to narrowly ovoid, smooth, a fair number obscurely angular, walls thickened slightly, ochraceous singly in KOH but near snuff-brown in groups, yellowish to yellowish brown in Melzer's sol., basal scar mostly indistinct. Basidia at least some 6-spored, more of them 4-spored, thin-walled, gelatinous in age, more or less cylindric when sporulating and spores sessile. Paraphyses not distinct from basidioles and all thin walled, finally gelatinizing. Tramal plates of intricately interwoven hyaline gelatinous hyphae 3–7 μ diam but width irregular in some; subhymenium gelatinous-filamentose, the outlines of the hyphae in the tramal plates indistinct because of the gelatinization. Peridium of appressed hyphae with slightly thickened walls and 3–8 μ diam almost cemented together from incrusting amorphous material, sections olive-brownish first revived in KOH but fading out to dingy yellow-brown, in Melzer's sol. orange-brown but lacking pigment balls, many hyphae with an orange brown content of amorphous material but walls hyaline. Clamp connections none. All tissues nonamyloid and no amyloid granules in the peridium.

The TYPE was collected by Rogers and Zeller at Twin Bridges Forest Camp, Clackamas County, Oregon; under hemlock, Aug. 9, 1937 (Zeller Herb. 8264).

When dried this species is indistinguishable from *R. argillaceus* but the peridium lacks the sphaerocysts of that species. Unfortunately I do not have data on the color pattern of the fresh basidiocarps. The spores are more like those of *R. subaustralis* than of any other species but *R. tsugae* is at once distinguished when dry by the darker more russet basidiocarps and by not giving off a red pigment when sections are revived in KOH.

34. **Rhizopogon thaxteri** Zeller, Mycologia 31: 4. 1939.

Basidiocarps about 1.1 cm. thick, subglobose, dingy white staining reddish fresh, becoming carob brown to chestnut brown as preserved in liquid, fibrils scanty, free but flattened against the lower side, giving a general felty appearance to the surface (glabrous as preserved). Gleba dirty olive when fresh, dark brown ("Mars-brown" or darker) as preserved. Cavities subglobose to irregular, empty.

Spores (6–)7–9(–10) × 2–2.5 μ, oblong to cylindric, in KOH hyaline to yellowish individually, brownish in groups along the hymenium, in Melzer's sol. yellowish singly and weakly dextrinoid in groups, smooth, thin-walled, often with a false septum, basal scar very indistinct. Basidia 13–18 × 6–8 μ, clavate, mostly hyaline in KOH (some with yellowish-hyaline granular content) 4-spored and possibly 6-, or 8-spored. Paraphyses clavate, many with a faint refractive granular-hyaline content in KOH which becomes more amorphous and distinctly yellowish in Melzer's sol. and the same content found in the subhymenial cells as well, walls, thin to slightly thickened. Tramal plates of interwoven nongelatinous nonrefractive hyphae 3–5 μ diam; the subhymenium filamentous-branched, contents of hyphae "empty" like that of paraphyses in KOH. Peridium a single layer of filamentose-interwoven hyphae, the epicutis poorly differentiated as a loosely tangled layer of pale cinnamon (in KOH) hyphae 1.5–2.5 (–3) μ in diam: Context of trama cinnamon in KOH and with some rusty brown pigment debris below the epicutis, the hyphae all 4–8 μ diam and no sphaerocysts in the layer; the cinnamon pigment in and on the hyphal walls; in Melzer's sol. the layer yellowish and hyphae individually greenish yellow and with incrusting yellow pigment

particles or layers of it, content of hyphae homogeneous. Clamp connections none.

Under *Pinus strobus,* Riley Place, Kittery, Maine, R. Thaxter (1902 y), TYPE (FH).

The microscopic data given in the description are taken from the type which is preserved in fluid. Zeller noted a distinct red pigment in the oxidized outer layer of the peridium. The species is very close to *R. brunnescens* Zeller. The latter, however, has a duplex peridium with the inner layer more or less pseudoparenchymatic. Very likely there are a number of other differences, but they should be evaluated on a comparable basis, an evaluation that cannot be made from the material available at present.

35. **Rhizopogon atlanticus** Coker & Dodge in Coker & Couch, Gastr. of Eastern U. S. A. & Canada, p. 35. 1928.

Illustrations: Fig. 46, spores.

Basidiocarps 1–4 cm. diam subglobose, oblong or irregularly ovoid, when young and fresh pure white, then dull yellow toward maturity, not turning rose when rubbed, becoming pinkish-cinnamon or sordid yellow-brown upon drying. Superficial veins few, not conspicuous, innate-appressed, darker colored than the peridium; usually attached at base by a single small strand which is not conspicuous, separating very easily from substratum. Peridium when fresh 300-450 μ thick, when dried and resoaked 250 μ, simple, of loosely much entangled encrusted hyphae, pale under the microscope, separable from the gleba. Gleba white becoming Isabella-color to buffy-brown, cavities very small (5–8 per mm.), becoming partly filled with spores, odor becoming fragrant.

Spores 7.4–8.5 × 3–3.7 μ, blunt-elliptic, brown in mass (low power) base, with a concave sterigmal scar, smooth. Basidium 5.5–7.8 μ wide, 4- or 8-spored, spores sessile.

Under pine, South Carolina and Florida.

The following microscopic data were obtained from the type: Peridium as revived in KOH of interwoven hyaline smooth hyphae 3–6 μ diam and thin-walled, no incrustations on the walls and no pigment deposits between hyphae, one-layered, but in the epicuticular region the hyphae compactly interwoven and many with a dull ochraceous content, mostly with slightly thickened walls and somewhat refractive, the layer very "clean"; spores frequently abundant along the surface, but none found attached. In Melzer's sol. peridium yellow but with deeper yellow pigment balls as well as numerous hyaline droplets, no amyloid reactions anywhere and no pigment deposits observed in either medium, no inflated cells observed. Spores 7–9 × 3.5–4 μ, oblong-truncate to ellipsoid-truncate, with a most conspicuous basal "cup" and truncation as a scar left from breaking away from the basidium, smooth wall thin to slightly thickened. Basidia 6-, to 8-spored, readily collapsing and reviving poorly. Paraphyses clavate to ellipsoid, 8–12 μ broad, thin-walled, and readily collapsing. Tramal plates of hyaline narrow, gelatinous interwoven hyphae; subhymenium a layer 1–2 cells deep of isodiametric cells at base of hymenial element. Clamp connections none.

Coker observed incrustations on the hyphae of the peridium but he was probably studying fresh material in water mounts.

The dried specimens in the type are tan to near cinnamon-brown whereas those of *R. truncatus* are yellow. This, along with the wider spores, distinguishes Linder's species, but the two are closely related.

36. **Rhizopogon ochraceisporus** A. H. Smith, sp. nov.

Fructificationes 2–3.5 cm. latae, globosae, subglobosae, vel irregulares, impolitae, pallide ochraceae tactu cinnamomeo-brunneae, in "$FeSO_4$" olivaceae, in "KOH" fulvae. Gleba fulva, tenax, in siccato fragile. Sporae 7–9 × 3.8–4.5 μ, ovoideae, ochraceae, leves, nonamyloideae. Peridium unistratosum. Typus: Smith 65267 (MICH).

Illustrations: Fig. 42, spores.

Basidiocarps 2–3.5 cm. broad, globose, flattened, or irregular in outline, largest one lobed, surface more or less covered by inconspicuous rhizomorphs, unpolished and when fresh pale ochraceous, soon ochraceous-tawny to rusty brown from handling; odor none or slight; $FeSO_4$ on peridial surface slowly dark olive, and dark olive on the gleba fresh; KOH instantly dark rusty brown on the peridium, dark olive on dried specimens at times. Gleba rusty cinnamon-brown ("russet"), chambers small, consistency tough but moderately brittle when dry and not difficult to section.

Spores 7–9 × 3.8–4.5 μ, oval, ochraceous in KOH fresh, and brownish-ochraceous in masses along the hymenium as revived in KOH; in Melzer's sol. yellowish singly and pale rusty brown in masses, smooth, wall slightly thickened, with a distinct basal truncation as seen under oil immersion. Basidia 4-, 6-spored, subcylindric and 4–6 μ in diam, 14–20 μ long, thin-walled and readily collapsing. Paraphyses clavate to ellipsoid, 12–19 × 9–12 μ, thin-walled and hyaline in KOH. Cystidia none. Tramal plates of subparallel to interwoven hyaline smooth hyphae 2–4 μ in diam and gelatinous both in H_2O mounts of fresh material and as revived in KOH; subhymenium scarcely more than 2 cells deep and not as refractive in KOH as the hyphae of the central strand. Peridium of appressed interwoven hyphae yellow in KOH, fresh and with much adhering debris, 4–12 μ in diam, much branched; fascicles of short branched crooked hyphae present forming a poorly differentiated epicutis of irregular extent, the peridium essentially a single layer. Clamp connections absent. All tissues nonamyloid.

Under fir, in duff, Idaho and Washington, summer and fall.

As revived in KOH there is so much dark brown debris in the cuticle that sections must be crushed out to get the details of the hyphae. This is a well marked species by virtue of the relatively deep spore pigmentation, the ochraceous colors of the fresh basidiocarp, the change in KOH to rusty brown, the strong reaction of the gleba to $FeSO_4$, and its dark cinnamon color when mature.

Material examined: IDAHO: Smith 1958, 58928, 65267 (TYPE), 65963, 68395, 68406. WASHINGTON: Kauffman 9–20–15. OREGON: Zeller's colls. (Rogers 6–14–39; Zeller 4080, 8265, 8477).

37. **Rhizopogon lutescens** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. latae, globosae vel irregulares, siccae, albidae demum aurantioluteae. Gleba pallida tactu aurantia, demum atriolivacea. Sporae 8–10 × 4.5–6 (–6.5) μ, ellipsoideae vel ovoideae, ad basim truncatae, leves, nonamyloideae. Peridium unistratosum. Typus: Smith 66212 (MICH).

Illustrations: Fig. 38, spores.

Basidiocarps 1–2.5 cm. broad, globose to variously irregular, surface dry and with few rhizomorphs, some basidiocarps apparently with a basal attachment (but this is not evident in dried material); when fresh dingy pallid but soon flushed cadmium-buff and finally becoming dingy vinaceous over some areas and dingy ochraceous elsewhere; $FeSO_4$ on the fresh peridium slowly black all over, KOH

dingy purplish or, where the color has changed to ochraceous, more of a rusty brown. Gleba pallid fresh but soon changing to cadmium when cut, chambers large for the genus. Columella lacking. Odor none.

Spores 8–10 × 4.5–6 (6.5) μ, ellipsoid to ovoid and truncate at the sterigmal attachment from a broad scar, smooth, pale ochraceous in KOH singly and in mass near orange-ochraceous, pale ochraceous in Melzer's sol., but in $FeSO_4$ (revived material) dingy olive brownish in large groups; the wall slightly thickened (0.33 μ); with an "oil drop" as revived in KOH but this disappearing in Melzer's sol., Basidia 30–40 × 8–10 μ, cylindric, thin-walled, very soon collapsing. Cystidia none. Paraphyses of the ellipsoid to oval type and arising from an inflated cell 16–25 × 8–13 μ. Subhymenial layer not truly distinct but hymenial layer 2–3 cells deep from chains of inflated cells. Tramal plates of subgelatinous narrow (3–8 μ broad) thin-walled smooth hyphae (in KOH and Melzer's sol.), budding off hymenial elements laterally, often enlarged at point of branching. Peridium a layer of interwoven hyaline hyphae 2–6 μ in diam (fresh) and with some incrusting debris, no enlarged (swollen) cells present; as revived in $FeSO_4$ with many narrow (2 μ) dark olive-brown hyphae present and interwoven; the hyphae of the context dingy rusty to vinaceous in KOH and with considerable debris present; the layer very tough and difficult to separate the component hyphae. Clamp connections none. All tissues nonamyloid.

Gregarious in a rotten conifer log, Warm Lake, Idaho, 26 Aug. 1962, legit H. V. Smith (A. H. Smith 66212, TYPE), Graham, Idaho, July 8, 1961, Ellen Trueblood 1495.

The specimens dry near "Fawn-color" (distinctly vinaceous) over the exterior and the gleba near "'Saccardo's umber" (a dingy olive-brown). One of the outstanding features of this species is the oval spores with a truncation at the base representing the sterigmal scar. The spores were seen attached to sterigmata on basidia. The other features are the colors and color changes of fresh material and the dark reaction in $FeSO_4$. The hymenium is typical for that of a large number of *Rhizopogon* species.

R. melanogastroides M. Lange is close to this species but its spores have thicker walls and the peridium is said to be cinnamon-buff changing to cinnamon-brown instead of pallid becoming cadmium-buff.

38. **Rhizopogon subcinnamomeus** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm diam, globosae vel ellipsoideae, pallide griseoluteae, tactu brunneae, udae. Gleba pallida demum crocea, tarde cinamomeobrunnea. Sporae 7–10 × 4–5 (–6.5) μ, truncatae, cinnamomeae. Typus: Smith 68556 (MICH).

Basidiocarps 1–2.5 cm. diam, globose to ellipsoid, surface a grayish "pale pinkish-buff" fresh and young, appearing unpolished but at maturity wet to the touch (not viscid), soon becoming dingy brown from handling as the epicutis becomes matted down, finally near "cinnamon-brown" (dark dull brown), $FeSO_4$ olive-black on peridium and gleba, KOH dark garnet-red on fresh undamaged surface, very few rhizomorphs present. Gleba when young pallid becoming pale croceus, finally dark rusty brown (near "Mars-brown"), chambers small, consistency hard like bone when dried. Columella absent.

Spores 7–10 × 4–5 (–6.5) μ, smooth, walls somewhat thickened, oval to elliptic, some obscurely to distinctly angular, some angular-subglobose or bifid at apex, base obviously truncate, pale ochraceous to pale cinnamon singly as revived in KOH, strongly cinnamon in groups, in Melzer's sol. strongly cinnamon in

groups (fresh spores darker in Melzer's sol. than in KOH). Hymenium yellowish to pale cinnamon in KOH, yellowish in Melzer's sol.; basidia 6–8 spored. Paraphyses thin to thick-walled. Subhymenium cellular with some cells thick-walled, 2–3 (–4) cells deep. Tramal plates of interwoven hyaline gelatinous hyphae 2–4 μ diam. Peridium consisting of a loosely tangled outer layer of narrow (3–5 μ) hyphae with pigment incrustations (dark cinnamon as revived in KOH); subcutis of broader hyphae forming a clean layer red in KOH fresh, no nests of sphaerocysts seen, as revived in Melzer's sol. with small oil drops and pigment granules in the layer. Clamp connections absent. All tissues nonamyloid.

Gregarious under conifers, Priest River, Idaho, July 22, 1964, Smith 68556 (TYPE) and 68630.

This species is very close to *R. ochraceisporus* and *R. parvulus*. It differs from *R. parvulus* in that the gleba is hard as bone when dried, in the wet tacky surface of the mature basidiocarp, and in the colors and color changes of the fresh basidiocarp. In both the dried specimens are tinged vinaceous red. From *R. ochraceisporus* it differs in having fewer rhizomorphs, less yellow in its coloration, and in KOH the change is to garnet-red rather than quickly dark rusty brown, and it has darker very distinctly cinnamon spores as revived in KOH and Melzer's sol.

39. **Rhizopogon parvulus** A. H. Smith, sp. nov.

Fructificationes 7–14 mm. latae, subglobosae, siccae, albidae tactu sublilaceae, in "KOH" rubrae. Gleba alba dein lutea demum fulva. Sporae 8–10 × 4–5 μ. Typus Smith 68673 (MICH).

Basidiocarps 7–14 mm., globose or nearly so, surface dry and unpolished, lacking conspicuous rhizomorphs, whitish when young but staining lilacous to purplish and soon entirely so colored, drying dull vinacous, KOH reddish on cutis; $FeSO_4$ olivaceous; (oldest gastrocarp dull clay-color and drying reddish). Gleba white soon yellowish and in oldest one dull fulvous, (the tramal plates blackened in drying in oldest one). Consistency when dried firm but not hard, sectioning easily. Columella none.

Spores typically 8–10 × 4–5 μ, ellipsoid to ovoid, smooth, ochraceous singly in KOH, but in masses dull rusty brown, in Melzer's sol. reddish fulvous in masses but singly ochraceous, base distinctly to obscurely truncate, many (in some mounts) angular-globose to variously angular or bifurcate at apex, 7–9 × 5–8 μ. Hymenium pale ochraceous as revived in KOH. Paraphyses thin-walled, inflated. Subhymenium filamentous, with an enlarged cell at base of basidium; tramal plates of narrow gelatinous hyaline hyphae. Peridium as revived in KOH with a central strand or upper half (in section) with heavy dull magenta to fulvous pigment deposits, some granular pigment deposits in epicuticular region, lower part consisting of appressed radially arranged hyphae with thin walls rather intricately interwoven. Clamp connections none, all parts nonamyloid.

Under Douglas fir, *Abies* species and *Larix*, Hoodo Mt., Priest River, Idaho, July 27, 1964. Smith 68673 (TYPE), also 68364; 69060.

Young specimens of this species change color in the manner of those of *R. vinicolor* and the gleba also becomes pale croceus at an early stage. The spores, however, at once distinguish it from that species as well as *R. olivaceofuscus*. In the dried state all three closely resemble each other to some extent in the color of the peridium.

40. **Rhizopogon diabolicus** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. latae, globosae vel angulari-subglobosae, siccae, fibril-

losae, albidae demum subochraceae, tarde sordide fulvae. Gleba lutea, tarde fulva. Sporae 6.3–8.4 × 3.5–4.5 μ. Typus: Smith 70305 (MICH).

Basidiocarps 1–3 cm. broad, globose to angular or elongate, surface dry and appressed fibrillose beneath scattered appressed rhizomorphs of very fine diameter and scattered thicker coarser ones, the latter loosely appressed, color when young whitish, soon with a vinaceous flush in the outermost fibrils but this soon obscured by development of ochraceous tones overall, in age as gleba matures becoming dull rusty brown, KOH dull lilaceous on young basidiocarps, rusty brown on old ones, $FeSO_4$ no reaction on young ones, olive-black on dark brown stages, when dried the colors vinaceous-buff on young stages to dull vinaceous-cinnamon on oldest, no color change on bruising other than an ochraceous to dull brown change (which was also evident on undamaged basidiocarps). Gleba yellowish in young stages, "russet" mature and when dried rather bright rusty cinnamon, rather cartilaginous, chambers small. Columella absent.

Spores 6.3–8.4 × 3.5–4.5 μ, ovate, truncate at base, smooth, yellowish singly in KOH, pale to rusty cinnamon in groups, in Melzer's sol., yellowish singly and rusty cinnamon in groups. Basidia 6–8-spored, clavate, thin-walled, hyaline in KOH, yellowish in Melzer's sol. Paraphyses 7–11 μ diam, soon thick-walled and with a central inclusion not colored in Melzer's sol. Subhymenium cellular, the cells with thick walls as in the paraphyses; tramal plates of hyaline gelatinous smooth narrow (3–8 μ) to moderately broad hyphae. Peridium consisting of an epicutis of loosely interwoven hyphae incrusted and pigment dull cinnamon in KOH, hyphae 4–9 μ diam, a medial layer of closely interwoven-subparallel hyphae also with pigment on the walls and an inner zone in which the glebal cavities form, the hyphae very entangled here and heavily pigmented in Melzer's sol., orange-brown pigment balls developing. Clamp connections none. All hyphae nonamyloid.

Roadside, Shingle Creek, Seven Devil's Mts. Idaho (Nez Perce National Forest). Sept. 8, 1964, collector Kenneth Harrison (Smith 70305, TYPE) and 68211, 68404, 68405, 68424, 68436, 68489, 68543 (all from Idaho).

In the dried condition the bright rusty cinnamon gleba distinguishes this species from both *R. vinicolor* and *R. olivaceofuscus*. Also, as dried, the peridium is not as red as in the last two mentioned. *R. diabolicus* is actually very close to *R. brunneicolor,* but the pattern of color changes in drying and with KOH on fresh specimens is different, as is the color of the gleba. No inflated cells (sphaerocyst-like) were observed in the epicutis of *R. diabolicus.*

41. **Rhizopogon vesiculosus** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. latae, globosae vel subangulares, siccae, albae demum croceae, tarde subbadiae. Gleba alba demum crocea, tarde olivaceo-brunnea. Sporae 6–6.5 × 3.2–3.6 μ. Paraphyses crassitunicatae. Typus: Smith 68040 (MICH).

Basidiocarps 1–2.5 cm. diam, globose to oblong, some irregular in outline, surface dry and soft to the touch, matted fibrillose, rhizomorphs few and scattered, white when young, becoming pale dingy saffron, staining red from handling and finally dull reddish to reddish brown and about this color as dried, KOH-red on epicutis, $FeSO_4$ "fuscous." Gleba white when young, soon pale yellow and at maturity blackish-brown, mature gleba as dried near "Dresden brown," consistency firm but not hard, dried specimens easy to section, columella none.

Spores 6–6.5 × 3.2–3.6 μ, ovate-truncate, smooth, hyaline to yellowish in KOH, slightly more yellowish in Melzer's sol. Basidia 6-spored, cylindric. Paraph-

yses becoming thick-walled, content hyaline to dull ochraceous in Melzer's sol. Tramal plates of gelatinous narrow hyaline interwoven hyphae; subhymenium of filaments diverging to hymenial cells. Peridium reddish in KOH fresh, rusty brown as revived, of interwoven hyphae 5–10 μ diam; the hyphal walls thin, scattered through the epicutis are yellow-brown (fresh) inflated cells similar in size and shape to those found in many species of sect. *Villosuli* (up to 50 μ diam), these collapsing on drying and then not so readily demonstrable; rusty brown to ochraceous pigment and debris present in peridium as revived in KOH, (both intercellular and intracellular). Clamp connections none. All tissues nonamyloid but some amyloid (?) particles between hyphae of peridium.

Under lodgepole pine, near Blanchard, Wash., but in Idaho July 1, 1964, Smith 68040 (TYPE), also 68041, 68216, 68564.

The dried specimens are scarcely distinguishable from those of *R. vinicolor* or *R. olivaceofuscus* but the former has longer slightly narrower spores, lacks inflated cells in the epicutis of the basidiocarp, and the gleba is never as blackish-brown fresh.

42. **Rhizopogon inquinatus** A. H. Smith, sp. nov.

Fructificationes circa 2 cm. diam globosae, siccae, fibrillosae, albidae demum luteolae, tactu violaceo-fuscae. Gleba olivacea, tactu atro-olivacea. Sporae 6.5–7.5(–8) × 3–3.8 μ, truncatae, cinnamomeae, leves. Typus: Smith 68016 (MICH).

Basidiocarps about 2 cm. diam, globose to subglobose, surface dry and appressed fibrillose when perfectly fresh, whitish at first, on exposure to air pallid buff and where handled slowly staining inky-fuscous but with an intervening reddish stage, KOH on white surface reddish then fuscous-black, $FeSO_4$ olivaceous but finally blackish, odor none. Gleba olive at maturity, when cut soon becoming olive-brown to blackish but when dried brownish olivaceous, rubbery in consistency, chambers labrynthiform. Columella absent.

Spores 6.5–7.5(–8) × 3–3.5 μ, elliptic to oval and with a distinct cuplike truncation at base, smooth, walls only slightly thickened, dingy yellowish in KOH singly, dull cinnamon in masses, in Melzer's sol. dull yellowish singly and dull rusty brown in groups. Basidia 4- and 6-spored (possibly all 8-spored). Paraphyses hyaline, thin-walled, subgelatinous, 6–9 μ broad. Tramal plates of gelatinous narrow branched interwoven hyphae 3–5 μ diam; subhymenium of gelatinous-filamentous branches extending to a weak cellular region below hymenium. Peridium of loosely interwoven hyaline thin-walled filaments 3–5 μ diam, smooth and the layer clean (as seen in KOH fresh), as revived in KOH with dark cinnamon granules of amorphous pigment, in Melzer's sol. (both fresh and dried) with dark violet globules up to 30 μ or more diam free in the layer, no sphaerocysts or large inflated cells present. Clamp connections none. All tissues nonamyloid.

In duff in cedar-hemlock association, Priest River Exp. Forest, June 30, 1964, Coll. Nancy Jane Smith (A. H. Smith 68016, TYPE).

This species is distinct from all others in this group by the fuscous stains on fresh specimens and the large amyloid globules as seen in Melzer's sol. both in the fresh and dried state.

43. **Rhizopogon olivaceofuscus** A. H. Smith, sp. nov.

Fructificationes 1–3.5 cm. latae, globosae vel subglobosae, albae demum subargillaceae, in "KOH" subpurpurascens, in "$FeSO_4$" olivaceofuscae. Gleba subolivacea demum atro-brunnea. Sporae 6.5–7.5 × 3.3–4 μ. Typus: Smith 68156.

Basidiocarps 1–3.5 cm. broad, globose to ellipsoid or ovoid, outline often

showing indentations; surface moist, appressed fibrillose, youngest specimens white, becoming dingy pale buff (near pinkish-buff), then nearly clay color and often developing reddish to pinkish areas but not staining readily when bruised, usually finally staining reddish to brown or not staining at all, dull brown in age and when dried mostly dull vinaceous red; KOH on cutis causing a dark garnet brown to purplish stain (on old peridia merely dark-brown); $FeSO_4$ olive-black; odor pungent in age. Gleba pallid young, soon dull olive finally at maturity blackish brown, usually staining fuscus when mature basidiocarps are sectioned, but when dried nearer "Prouts brown" (dark yellow brown), chambers labrynthiform and moderately large (1 mm. +) sectioning easily when in dried state. Columella none.

Spores 6.5–7.5 × 3.3–4 μ, elliptic to oval in outline, base slightly truncate-cupped on some, smooth, pale cinnamon revived in KOH, in Melzer's sol. slightly darker. Basidia 6–8-spored. Paraphyses thin-walled. Tramal plates of gelatinous narrow interwoven to somewhat divergent hyphae; subhymenium mostly filamentose but some ± iso-diametric cells at base of basidia; some oleiferous hyphae present. Peridium a single layer of appressed-interwoven hyphae 3–9 μ diam, ochraceous tawny or paler in KOH (revived), some incrusting debris present (and blackish granules present in places in both KOH and Melzer's sol.); no inflated cells seen; no clamp connections present.

Under mixed conifers (spruce, fir and white pine), Priest River Experimental Forest, Priest River, Idaho. July 3, 1964. Coll. Harold Burdsall. Smith 68156 (TYPE). Not uncommon in the area in July and August of 1964.

Although in KOH and Melzer's sol. the spores are various shades of rusty brown (cinnamon), this color is not accurately reflected in the gleba which is the color of a green olive at maturity. When cut, however, it becomes fuscous to blackish brown and dries a dark yellow-brown. There are few rhizomorphs over the basidiocarp. One of the distinctive features is that the peridium becomes dull vinaceous red in drying. The $FeSO_4$ reaction is quick and reliable. The KOH reaction is more variable depending apparently on the age of the basidiocarp. In young specimens it is red to reddish brown, in older discolored ones it is dark brown to blackish. From *R. vinicolor* this species is at once separated by the stronge $FeSO_4$ reaction and the change in color of the gleba when cut.

Material examined: IDAHO: Smith 67982, 68085, 68018, 68100, 68101, 68109, 68156 (TYPE), 68157, 68178, 68224, 68226, 68231, 68236, 68361, 68394, 68399, 68488, 68473, 68544, 68545, 68557, 68568, 68586, 68591, 68593, 68644, 68692, 68704, 69043, 69263, 69291, 69294, 69307.

44. **Rhizopogon vinicolor** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae vel irregulares, siccae, fibrillosae, albidae demum luteae, tarde vinaceae. Gleba griseo-olivacea. Sporae (5.5–)6–7(–8) × 3–4(–4.5) u, ellipsoideae, leves, ad basin truncatae, nonamyloideae. Peridium unistratosum. Typus: Trueblood 2195 (MICH).

Illustrations: Fig. 76, spores; pl. V, 2, basidiocarps; pl. VII, 8.

Basidiocarps 1–3 cm. globose to subglobose, ovoid, or angular from external pressures, surface dry and appressed fibrillose, rhizomorphs lacking or only a few present, color white at first and soon staining pink, finally becoming vinaceous-red over all, if basidiocarps develop without injury the color pattern is white, then yellow for a short time and then entirely vinaceous-red, when dried dull vinaceous over all or a little yellow showing on some basidiocarps in depressed areas; $FeSO_4$ on peridial surface producing a slight olive-brown color change to

none at all; KOH produces a purplish stain fading to vinaceous. Odor none. Gleba white to dingy ochraceous becoming olive to dark olive-brown, tramal plates dry in consistency when fresh; chambers small and nearly filled with spores.

Spores (5.5–)6.5–8.5(–9) × 3–4(–4.5) μ, ellipsoid to ovoid with a truncate base from the attachment to the basidium, in optical section (under oil immersion) a slight tooth projects on each side of the scar to produce an incipient cuplike base, wall smooth, thickened somewhat, yellowish in KOH and Melzer's sol. Basidia 4- and 6-spored, clavate, 5–8 μ broad, thin-walled, clavate, readily collapsing. Paraphyses clavate to elliptic or subcylindric, 15–30 × 6–12 μ, becoming thick-walled in age, lacking any distinctive content. Tramal plates at maturity of hyaline interwoven refractive-gelatinous narrow (3–6 μ) hyphae; subhymenium cellular. Peridium of appressed-interwoven hyphae 3–8 (–12) μ diam, the cells mostly equal in diameter but some enlarged, no pockets of sphaerocysts present however, as revived in KOH the entire layer is dull vinaceous, pigment in masses between the hyphae (obscuring almost all detail in the layer). Clamp connections absent. All tissues nonamyloid.

In groups or single in duff under Douglas fir, Valley County, Idaho, July and August.

This is a most interesting species because it shows either a primitive state in the evolution of the yellow pigment characteristic of the *R. rubescens* group, or a reduction from that group. At any event, the yellow stage may or may not be present depending on local conditions of the habitat, the weather pattern at the time of fruiting, and the stage of development when the specimens are discovered. The spores with the slight basal "cup" remind one of *R. atlanticus,* but the pattern of color change is different. *R. truncatus* is yellow and stays yellow in drying. The peridium in *R. vinicolor* in dried material shows a slight tendency to slough off leaving small pallid spots but this was not noted on fresh material and has been found to be a not uncommon feature of many species of *Rhizopogon*. The dried specimens, as already mentioned are distinctly vinaceous rather than the range of brown tones found for the discolored areas in *R. rubescens*. *R. vinicolor* is certainly close to *R. roseolus* Corda, in fact his illustration depicts mature specimens of *R. vinicolor* remarkably well. However Corda illustrates a spore like that of *R. rubescens* var. *ochraceus* and thick-walled hymenial elements. Also, the spores of *R. vinicolor* are broader than those of *R. roseolus*. In Smith 58595 and 59147 the spores were hyaline, the vinaceous reaction of the peridium in KOH as revived was not dark vinaceous, and the gleba was white. These collections are placed here on the assumption that the differences noted are due to the immaturity of the specimens.

Smith 68177 is also very close. It is placed here tentatively, but a complete description is given.

Basidiocarps 1–3 cm. diam, globose to ellipsoid, ovate or slightly irregular in outline, often lobed, surface dry and appressed fibrillose, rhizomorphs few and mostly over the basal part, white when young and fresh and at this stage staining dull rose-red, very soon developing ochraceous areas where handled or from contact with soil, finally discolored sordid clay-color to "Prout's brown" from handling or in contact with soil, but where peridium is deeply injured still showing red stains, when dried dull vinaceous-red, with KOH vinaceous red; with $FeSO_4$ slowly olive-fuscous. Gleba white at very first but soon "'pale ochraceous buff" to pale croceus (long before spores mature), slowly becoming olivaceous to olive-brown and near "sepia" mature, dull yellow-brown as dried, consistency when dried firm but not hard (sectioning readily if properly dried). Chambers labrynthiform and moderately large; columella none.

Spores 6.5–7.5 × 3–3.5 (8 × 4 μ) μ, subellipsoid to nearly oblong, base obscurely truncate, smooth, yellowish brown to hyaline in KOH, yellowish to pale tawny in Melzer's sol. Basidia cylindric, 4–6-spored, hyaline in KOH. Paraphyses thin-walled and hyaline. Tramal plates of narrow (3–6 μ) gelatinous hyaline (revived in KOH) hyphae appearing interwoven in most sections (slightly divergent in young stages); subhymenium appearing filamentous, cells at base of basidia enlarged slightly. Peridium a thin layer of interwoven fibrils, in sections of fresh material the central part reddish in KOH, and in sections of dried material reddish to reddish-fulvous, the region of the epicutis in fresh material having yellow hyphae with brownish walls in KOH, as revived in KOH with heavy pigmentation and deposits in central region, and in KOH hyphal walls near cinnamon-buff in revived material in epicuticular region. Clamp connections none; all tissues nonamyloid but rusty brown pigment balls forming in Melzer's sol. in the interior areas.

Solitary to gregarious under Douglas fir, hemlock and Abies. Not uncommon in the Priest River area, Idaho, during July 1964.

The collections of this species presented a problem in color changes. Young basidiocarps soon become dull rose to lilac-rose color and are likely to be confused with *R. roseolus*. Older ones, with the gleba mature, are to be placed in sect. *Fulviglebae* as the gleba is more brown than olive. The spores, with their obscurely truncate base are not typical of the section. Yet when once known in its variation pattern from youth to maturity it is a readily recognized *Rhizopogon*. It is close to *R. olivaceofuscus,* but the gleba is not as distinctly olive nor does it change when cut. I was at first inclined to recognize the cited collections as a species distinct from *R. vinicolor* but abandoned the idea because of the lack of a distinctive combination of features. Material collected near Vancouver, B. C. by Wm. Savalle probably belongs here also.

Material examined: IDAHO: Smith 68050, 68071, 68092, 68115, 68120, 68177-typical, 68179, 68189, 68214, 68220, 68221, 68227, 68387, 68499, 68559, 68567, 68576, 68579, 68590, 68595, 68602, 68690, 68705, 68882.

Rhizopogon subg. **Rhizopogon** sect. **Villosuli** A. H. Smith, Mich. Botanist 3: 17. 1964.

This section is based on the distinctly colored walls and loose arrangement of the hyphae of the peridial epicutis. The correllated character is the presence of amyloid particles and rods on at least some of the hyphae of the peridial context and often in some areas of the hymenium, but some species in other sections also show this feature. As these particles are arranged along the hyphae they give the impression of iron filings adhering to a magnetic bar. They are extra-cellular for the most part. In a few species one finds an occasional thick-walled cell in which the wall appears slightly amyloid locally and rarely other hyphae which have an amyloid apparently viscous content. In some species one finds blackish particles in mounts in KOH. These of course are not amyloid even though they also are blackish in Melzer's sol. The term "duplex" has been used for the peridium of some species in this section but it has also been used in the sense of an outer layer of different structure which peels off readily. Hence the term is not emphasized here. Some species in this section have such a thin eipcutis that it can scarcely be called a layer. A third character correlated with the two already discussed is that in KOH the peridium almost always gives a green to olive reaction in some degree. *R. gilkyae* is one exception. *R. clavitospora* of subsect. *Megaspori* has a somewhat similar epicutis and could be placed in this section. Finally, many species give

both a red and green reaction with KOH, the pigment being located in pockets or obscurely layered. The species of this section, on the basis of their chemical reactions, are related to species of sect. *Amylopogon*. There is also a strong resemblance between the two sections in the color the basidiocarps assume when dried.

Type species: *Rhizopogon villosulus* Zeller.

Stirpes of Sect. *Villosuli*

Stirps Viridis: *R. viridis, R. gilkyae, R. brunneifibrillosus.* In this stirps at least one of the central characters of the section are lacking. *R. viridis* lacks amyloid granules in the peridium, whereas the others lack a green to olive KOH reaction.

Stirps Parksii: *R. villescens, R. parksii, R. pseudo-villosulus,* and *R. umbrinoviolascens.* In these species the peridium (at least the subcutis) stains blue to violaceous or fuscus on injury. There is considerable intergradation between the species and further study is desired.

Stirps Villosulus: *R. villosulus, R. sepelibilis, R. subareolatus, R. mutabilis, R. colossus, R. fragrans, R. hawkeri, R. ponderosus, R. zelleri.* As a group these species are scarcely separable from the above, but the majority stain red when bruised.

Stirps Florencianus. The type species is distinct from all others in staining bister from handling, and in appearing wet in spite of the loosely fibrillose epicutis.

Key to Species of Sect. *Villosuli*

1. Spores 3 μ or more wide. 2
1. Spores typically less than 3 μ wide. 6
   2. Spores 6–8 μ long. 47. *R. gilkyae*
   2. Spores (7–) 8–12 μ long. 3
3. Peridium staining red when injured (at least in the subcutis). 48. *R. rogersii*
3. Not as above. 4
   4. When fresh the peridial subcutis staining bluish-fuscous on injury but when dried dull vinaceous. 49. *R. villescens*
   4. Not as above. 5
5. Subhymenium of branched filaments; basidiocarps 8–15 mm. thick. 50. *R. zelleri*
5. Subhymenium cellular; basidiocarp 3–8 cm. thick. 51. *R. ponderosus*
   6. Peridial layer of fresh specimens staining blue to violaceous drab on injury. 7
   6. Peridial layer not staining as above. 11
7. Spores 5.5–6.5 × 2.3–3 μ. 52. *R. parksii*
7. Spores typically 6.5–8 μ long. 8
   8. Fresh basidiocarp blackening quickly when injured. see 63a. *R. colossus* var. *nigromaculatus*
   8. Fresh basidiocarp staining distinctly violaceous. 9
9. Peridium pallid becoming dark yellow-brown to dull cinnamon; gleba with russet to rusty yellow stains around larval tunnels. see *R. rudus*
9. Not as above. 10
   10. Paraphyses and subhymenial cells all thick-walled and readily disarticulating under pressure. 53. *R. pseudovillosulus*
   10. Paraphyses thin-walled at maturity. 54. *R. umbrinoviolascens*
11. Lacking any olive stains when sections of the peridium are mounted in KOH (fresh or dried material). 12
11. KOH causing olive stains (often very localized). 15
   12. Paraphyses with yellow-brown walls at least in locules near peridium, 8–12 μ diam. 55. *R. brunneifibrillosus*
   12. Not as above. 13
13. Peridium dull cinnamon-brown; paraphyses thin-walled and soon collapsing; growing under oak. 58. *R. quercicola*
13. Not as above (paraphyses soon thick-walled). 14

14. Peridium olivaceous fresh, becoming olivaceous-black. 56. *R. viridis*
14. Peridium pallid becoming ivory, as dried grayish brown; with KOH deep reddish brown. 57. *R. molallaensis*
15. Fresh peridium staining bister when bruised, in KOH rusty brown, wet in appearance when mature. 46. *R. florencianus*
15. Not as above. 16
16. Subcutis of peridium vinaceous as dried, staining pinkish when fresh peridium is cut. 17
16. Not as above. 19
17. End cells of epicuticular hyphae 8–15 μ diam and clavate to cystidioid; flagellate cells none. 59. *R. subareolatus*
17. Not as above. 18
18. Spores 5.5–6.5 × 2–2.3 μ. 60. *R. mutabilis*
18. Spores 6.5–8 × 2.2–2.8 μ. 61. *R. hawkeri*
19. Odor pungent-fragrant on fresh basidiocarps; gleba cinnamon-brown mature. 45. *R. fragrans*
19. Not as above. 20
20. Paraphyses soon thick-walled; basidiocarps 8–25 mm. 62. *R. villosulus*
20. Paraphyses thin-walled. 21
21. Epicuticular hyphae mostly thick-walled; basidiocarps wood-brown as dried. 63. *R. colossus* var. *colossus*
21. Epicuticular hyphae mostly thin-walled; dried basidiocarps fuscous. 64. *R. sepelibilis*

45. **Rhizopogon fragrans** A. H. Smith, sp. nov.

Fructificationes circa 18 mm. diam, globosae vel subglobosae, siccae subtomentosae, cinnamomeo-brunneae, siccatis obsurior, demum areolatae. Gleba cinnamomeo-brunnea. Sporae 6.5–8 × 2.2–2.8 μ, anguste oblongae, nonamyloideae. Peridium bistratosum. Typus: Smith 65796 (MICH).

Illustrations: Fig. 34, spores.

Basidiocarps about 18 mm. diam, globose or nearly so, surface dry and unpolished to subtomentose, dull cinnamon-brown fresh, drying russet or darker, the epicutis separating into patches to expose the pallid subcutis, no rhizomorphs present. Odor pungently fragrant. Gleba dark cinnamon-brown at maturity, chambers small to medium in size. Columella lacking.

Spores 6.5–8 × 2.2–2.8 μ, narrowly oblong, faintly yellowish in KOH singly, in mass along hymenium pale dingy brown, in Melzer's sol. merely yellowish and mostly with a false septum, smooth, no obvious basal scar. Basidia soon collapsed and not reviving. Hymenium made up of thick-walled paraphyses with the cells in chains 1–4 cells long, the central body remaining yellowish in Melzer's sol., the cells versiform (some lengths of hyphae even develop thick-walls), 6–12 μ diam, the terminal cells 10–25 × 7–12 μ. Tramal plates with hyaline highly refractive hyphae 4–10 μ diam, cells enlarged in places at times, the hyphae loosely interwoven; subhymenium cellular and cells often thick-walled (as part of the chains of cells forming the paraphyses). Peridium 2-layered: Epicutis of coiled to crooked dark brown (in KOH) hyphae 4–15 μ broad, and walls up to 1.5 μ thick, many with "knee-joint-like" shapes, these elements forming an obscure tangled turf which collapses or becomes rubbed off, flagellum-like hyphae tapering to an acute subhyaline apex also present; inner layer of appressed thin-walled hyphae green in KOH and $FeSO_4$, mostly 4–8 μ in diam and many of these hyphae developing wall thickenings comparable to those of the hymenial elements, amyloid granules present but often rare in the peridial context or along hymenium. Clamp connections absent.

In duff under conifers, Brundage Mt., McCall, Idaho, 9 Aug. 1962, Nancy Jane Smith (A. H. Smith 65796, TYPE and 60155).

The very dark brown gleba, pungent-fragrant odor, russet-brown peridium and olive-black reaction in both KOH and $FeSO_4$ are distinctive. The extreme

development of the mucilaginous wall thickening, extending to the subhymenium and tramal hyphae is also unusual. The $FeSO_4$ reaction is distinct on both fresh and dried material. The dark cinnamon-brown gleba distinguishes *R. fragrans* from *R. villosulus* if one disregards the fragrant odor. The coiled epicuticular hyphae of *R. fragrans* are another possible difference, but here more collections are needed to verify the character. This species indicates a progression to sect. *Fulviglebae* where *R. fragrans* would be placed if one disregarded the epicutis as a major feature. Smith 60145 appears to belong here but lacks the fragrant odor. Nos. 8324, 8360, 8365, and Shirley Smith 7–14–44, Trail Creek Forest Camp Linn County, Oregon (NY), all probably belong here but data on the odor are lacking.

46. **Rhizopogon florencianus** A. H. Smith, sp. nov.

Fructificationes 1–4 cm. diam, globosae vel subglobosae, pallidae, tarde sordide luteo-brunneae, tactu "bister," udae, in "KOH" fulvae. Gleba sordide ochracei-brunnea. Sporae 7–9 × 2.3–2.6 μ, oblongae, nonamyloideae. Typus: Smith 69284 (MICH).

Basidiocarps 1–4 cm. diam, globose to subglobose or oval, pallid when fresh but soon with an overlay of "snuff-brown" (dingy yellow brown) fibrils, staining bister from handling and this color over all in age but on drying becoming nearer cinnamon-brown, wet in appearance when mature (but dug from duff scarcely moist), with some rhizomorphs over the basal area; KOH on fresh peridium rusty brown, $FeSO_4$ olive-black. Gleba with large chambers (very distinct under a 3 × lens), dull ochraceous brown becoming dark yellow-brown but drying a pale dingy cinnamon, when dried hard but not bone-like.

Spores 7–9 × 2.3–2.6 μ, oblong, basal scar inconspicuous, nearly hyaline singly but dingy ochraceous in groups in KOH, in Melzer's sol. not much change in color, smooth. Basidia 8-spored. Paraphyses very soon becoming thick-walled and the change finally including the subhymenium and some of the tramal hyphae, the elements readily disarticulating, cells of hymenial layer 6–12 μ diam. Peridium of a loosely woven epicutis of thick-walled yellow-brown hyphae (fresh), rusty brown in KOH and 4–9 (12) μ diam, no inflated giant cells found but flagellate hyphae often numerous; subcutis of hyaline hyphae with inflated cells mostly hyaline in KOH or greenish and with deposits of bluish-green pigment. Clamp connections none. In Melzer's sol. the hymenium and subcutis with much amyloid debris but no amyloid hyphae.

In duff in *Abies-Picea* zone, near Florence, Idaho, Aug. 13, 1964 Smith 69284 (TYPE).

Both the staining when bruised and the KOH reaction are unusual for species of this section.

47. **Rhizopogon gilkyae** A. H. Smith, sp. nov.

Fructificationes 10–75 mm. crassae, subglobosae, siccae, griseo-brunneae, in siccatis cinnamomeo-brunneae, demum pallide areolatae. Peridium subseparabilis. Gleba olivacea. Sporae 6–8 × 3.3–4.2 μ, ovatae vel ellipsoideae, leves, nonamyloideae. Typus: Zeller Herb. no. 6815, legit H. Gilkey (NY).

Illustrations: Fig. 35, spores.

Basidiocarps 10–15 mm. thick, globose to subglobose, surface unpolished and nearly smooth, "light cinnamon-drab" fresh, varying to drab but when dry darkening and becoming more or less cinnamon-brown, no rhizomorphs visible on dried material; peridium tending to scale off in patches exposing pallid areas;

dried peridium scarcely staining olivaceous in $FeSO_4$. Gleba olivaceous when mature, chambers small, consistency when dried grayish cinnamon-buff, and firm though not bone-hard.

Spores 6–8 × 3.3–4.2 μ ovoid to ellipsoid, smooth, base obscurely truncate from sterigmal scar, yellowish in KOH singly, pale cinnamon in groups, in Melzer's sol. pale yellowish singly and more ochraceous-brown in groups, walls scarcely thickened. Basidia 6-spored, clavate, 8–10 μ broad at apex, hyaline collapsing. Paraphyses resembling basidioles or up to 12 μ broad, hyaline, thin-walled but often appearing to be filled with a viscous content. Tramal plates of hyaline refractive-gelatinous hyphae interwoven, thin to very slightly thick-walled; subhymenium of branched filamentous hyphae. Peridium of interwoven hyphae, the entire layer tawny in KOH, the hyphal walls smooth, thick-walled hyphae interwoven over surface but not dense enough to form a layer, appressed setae and flagellate hyphal ends present; body of peridium of hyaline hyphae but with tawny amorphous material between them, the walls smooth or with adhering granules; some hyphae with amyloid granules scattered along the outer surface, no stain to green anywhere as revived in KOH.

Collected by Helen Gilkey at Corvallis, Oregon, April, 1925. Zeller Herb. 6815 (TYPE) (NY).

In mounts of the type large (10–20 μ) globose cells floating free in the mount were often found but no clear attachment to *Rhizopogon* hyphae was demonstrated. They had a yellow content in Melzer's sol. and a practically hyaline but slightly thickened wall. This is one of the few species found to date which has the amyloid granules along cuticular hyphae and in which a green reaction in KOH does not develop. This is interesting because the epicutis is also very poorly developed.

The type was a mixed collection and identified as *R. rubescens* by Zeller. The other component was *R. hawkeri*. The spores readily separate the two. We cannot be sure that *R. gilkyae* stains red on handling. Coll. 485 in the Zeller collections, and one made at Cascadia, Ore. by Lee Powell, July 17, 1938 (NY) in all probability also belong here.

48. **Rhizopogon rogersii** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. crassae, subglobosae, siccae fibrillosae, sordide cinamoneae. Gleba subolivacea. Sporae 8–10 × 3–4 μ, ellipsoideae, vel ovatae vel subfusoideae, leves, nonamyloideae, ad basin subtruncatae. Peridium bistratosum, separabilis. Typus: legit. D. P. Rogers, Hat Point, Oregon. 7–25–39, (NY).

Illustrations: Fig. 25, spores.

Basidiocarps 1–2.5 cm. thick, globose or nearly so and as dried irregular in outline, surface dry and matted-fibrillose from the loosely interwoven epicutis, this easily worn away to expose portions of a pallid layer (on the dried basidiocarp), apparently staining red when injured (Zeller identified the specimens as *R. rubescens*) but scarcely any vinaceous tinge present on dried specimens; $FeSO_4$ staining epicutis olive-black on dried specimens, KOH staining surface area dark olive. Gleba white when young, becoming olivaceous, firm but not hard when dried.

Spores 8–10 × 2.8–3.6 (–4) μ, ellipsoid to oblong or ovate, some obscurely fusoid, obscurely truncate from sterigmal scar, walls thin to slightly thickened, hyaline to yellowish singly in KOH, more ochraceous in groups; yellowish in Melzer's sol. Basidia 4 to 6-spored, clavate, 6–8 μ broad, subcylindric when sporulating, readily collapsing. Paraphyses thin-walled, readily collapsing, 7–12 μ

broad, clavate to ellipsoid. Tramal plates of hyaline subparallel to interwoven hyphae 3–8 μ diam and both hyaline and refractive in KOH; subhymenium cellular to filamentose-branched, often poorly delimited. Peridium consisting of an epicutis of loosely interwoven hyphae with rusty brown walls and an inner layer of paler compactly arranged hyaline to yellowish hyphae: Epicutis of hyphae (2–) 3–10 (–12) μ broad, and some swollen cells in the layer up to 20 μ in diam but their shape variable from subvesiculose to nearly cylindric, walls of some hyphae 3 μ or more thick, all hyphae in layer smooth, flagellate hyphae down to 1.5–2 μ near apex present in the layer. Subcutis (or context) of cylindric to inflated hyphae (but no groups of sphaerocysts seen), the walls thin, the layer near ochraceous tawny as revived in KOH but much dark green pigment in area where it borders on the gleba, some amorphous material in the layer between hyphae or more or less encrusted on them. In Melzer's sol. some hyphae with adhering granules and irregular particles of amyloid material (resembling iron filings adhering to a magnet). Clamp connections none.

Collected at Hat Point, near Imnaha, Wallowa County, Ore. July 25, 1939, D. P. Rogers (TYPE). Idaho, July 22, 1964, Smith 68439; 68554.

This species has enlarged cells in the epicutis of the peridium much as *R. colossus* but the resemblance in other characters is merely that of the sect. *Villosulii*. The amyloid granules occur in the peridium, the KOH reaction on dried material is distinctly green, and the epicutis is well developed. In spore size it is close to *R. zelleri*. However, Zeller, said of *R. zelleri:* "never any red tints." He identified *R. rogersii* as *R. rubescens* which should mean that the specimens stained red, especially since he undoubtedly saw specimens fresh. This would place *R. rogersii* close to *R. hawkerii* but distinct because of the much larger spores. No greatly enlarged cells were observed in the peridium of *R. zelleri*.

49. **Rhizopogon villescens** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. crassae, globosae vel subglobosae, brunnei-fibrillosae, tactu griseo-caeruleae, in "KOH" violaceo-fuscae. Gleba olivacea, in "KOH" viridis demum pallida. Sporae 7–10(–11) × 3–3.8(–4) μ, nonamyloideae. Typus: Smith 68438 (MICH).

Basidiocarps 1–2.5 cm. diam, globose to ellipsoid or angular, surface with a thin epicutis of dark yellow-brown ("sepia") interwoven fibrils (appearing a grayish snuff-brown as dried), beneath this a layer of pallid fibrils which stain dull blue on bruising and when dried is dingy vinaceous, KOH bluish black on this layer, $FeSO_4$ dull olivaceous. Gleba olivaceous, around the worm holes dull violet, chambers medium sized, green in KOH but quickly fading.

Spores 7–10(–11) × 3–3.8(–4) μ, subellipsoid to oblong, with a distinct basal truncation, smooth, thin-walled, hyaline in KOH singly, yellowish in groups, in Melzer's sol. yellowish, in groups yellowish brown. Basidia clavate, 6- to 8-spored. Paraphyses thin-walled. Tramal plates of subinterwoven hyaline hyphae 3–6 μ diam, subgelatinous; subhymenium cellular. Peridium with an epicutis of loosely interwoven dull cinnamon-walled hyphae 2–7 μ diam, some with incrustations cinnamon in color, many greatly elongated flagellate hyphae present, some inflated cells found, with violet black granules and amorphous masses present in KOH; in Melzer's sol. the hyphal walls dull fulvous, numerous "amyloid" granules and masses present and at broken hyphal ends a short part of the wall dark violet. Clamp connections none.

Gregarious under fir and pine near Priest River Exp. Forest, Idaho, July 16, 1964, Nancy Jane Smith collector, Smith 68438 (TYPE), also 68434, and 68550.

As dried the basidiocarps are reddish beneath the over-lay of dull yellow-brown fibrils. The blackish violet debris is often conspicuous both in Melzer's sol. and KOH. The spores are relatively large and the dull violaceous staining of the subcutis along with the dull violet discolorations around the worm holes in the gleba are unusual and make this a readily identified species.

50. **Rhizopogon zelleri** A. H. Smith, sp. nov.

Fructificationes 8–15 mm. crassae, globosae, siccae, ligno-brunneae, impolitae. Gleba firma, subargillaceae. Sporae 9–12 × 3.5–4 μ, leves, oblongae vel subangularis, nonamyloideae. Typus: Zeller, 28 April, 1944, Gresham, Ore. (NY).

Illustrations: Fig. 26, spores.

Basidiocarps 8–15 mm. diam, globose to subglobose and more or less creased and uneven; surface dry and dull, appearing scurfy and about "wood-brown" when fresh ("never any red tints"—Zeller), as dried near cinnamon-brown except for paler areas where epicutis has been removed. Gleba chambered, color when dried near "cinnamon-buff" to "avellaneous" (a grayish tan), firm when dried but sectioning readily (neither bone-like nor crumbly).

Spores 9–12 × 3.5–4 μ, suboblong to oblong-angular or many with a slight medial constriction, some subclavate, a fair number obscurely angular in outline, truncate from the sterigmal scar, in KOH pale ochraceous singly, or in groups near cinnamon-buff, in Melzer's sol. more ochraceous but not dextrinoid, smooth. Basidia 6-spored, (as far as observed), 5–7 μ broad, hyaline, thin-walled, spores sessile or nearly so. Paraphyses of septate filaments with apical cell basidiole-like, thin-walled. Cystidia none. Tramal plates of smooth hyaline, gelatinous-refractive hyphae subparallel to interwoven; subhymenium of filamentose elements refractive-gelatinous in KOH. Peridium composed of a loosely interwoven thin epicutis of dull brown-walled hyphae 3–8 μ diam, the walls 1–1.5 μ thick, some hyphae lumpy but none seen with thorn-like projections, flagellate hyphae present; inner layer of compactly interwoven hyaline hyphae 4–10 μ diam, no sphaerocysts seen, much bright green to olive-green pigment diffused in region next to glebal cavities, no truly reddish areas observed. Clamp connections absent, all tissues non-amyloid, but scattered amyloid granules present on some hyphae.

In duff under conifers, Oregon and Idaho, April in Oregon, July and August in Idaho.

This species is dedicated to Dr. S. M. Zeller, whose work in the Pacific Northwest did much to advance our knowledge of this group of fungi. There are only two other species in this section with large spores. One is *R. ponderosus*. *R. zelleri* is distinct from the latter by its smaller size, more cinnamon colored when dried, and by having little or no pigment deposits in the peridial context. In *R. ponderosus* the peridium is clearly somewhat separable which is not true of the material of *R. zelleri* examined. The other species is *R. rogersii*. Its peridium presumably stains red on injury and its spores are slightly smaller than those of either of the other two.

Material examined: IDAHO: Smith 59145, 60521, 65166 (MICH). OREGON: Zeller, Gresham (TYPE) (NY).

51. **Rhizopogon ponderosus** A. H. Smith, sp. nov.

Fructificationes 3–8 cm. crassae, subglobosae vel irregulares, impolitae., siccae, fibrillosae, pallidae demum ligno-brunneae. Gleba olivacea. Sporae 9–12 × 3.5–4.5 μ, suboblongae vel ellipsoideae vel subclavatae, hyalinae, leves. Typus: Goetz 15-a (MICH).

Illustrations: Fig. 27, spores.

Basidiocarps 3–8 cm. broad, globose to irregular in outline, pallid becoming wood-brown, surface dry and matted fibrillose, the fibrillose layer tending to rub off in age, dark wood-brown as dried; KOH staining the dried peridium olive to dark green, $FeSO_4$ staining dried peridium olive-black. Gleba pallid becoming olive-buff to olive, when dried pale dull cinnamon; cavities large in dried material.

Spores 9–12 × 3.5–4.5 μ, hyaline in KOH singly and dingy cinnamon-buff in groups, in Melzer's sol. yellowish, nonamyloid, basically oblong but varying to ellipsoid, subclavate or with a slight medial constriction, most having a false septum. Basidia 2-, 4-, and 6-spored observed, 15–23 × 7–10 μ, narrowly clavate, ellipsoid or subfusoid. Tramal plates of hyaline refractive gelatinous hyphae interwoven and cells often enlarged somewhat; subhymenium cellular but indistinct because of refractive-gelatinous cell walls. Peridium with a thin epicutis of dark-brown walled hyphae 3–16 μ diam, the walls thin to up to 2 μ thick, smooth, or incrusted, the cells versiform to cylindric (but no thorns projecting from them and very few with bumps), flagellate hyphal cells present; the inner layer (the peridial context) green to olive in places in KOH, the hyphae mostly hyaline but so much dull rusty brown amorphous pigment in the layer as to obscure the color of the hyphal walls, also some brown-walled hyphae occurring in the layer, this layer rather easily separating from the young glebal chambers, no oleiferous hyphae observed. Clamp connections absent. All tissues nonamyloid but amyloid granules scattered along some hyphae.

In duff under pine (lodgepole and ponderosa pines), Oregon and California, October and November.

This species grows along with *R. colossus* and is easily confused with the latter, until one measures the spores. For additional comparisons see *R. zelleri*.

Material examined: OREGON: Goetz 15a (TYPE); Smith 49480a. CALIFORNIA: Lamphere Br-82.

52. **Rhizopogon parksii** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. latae, globosae vel oblongae, subfibrillosae sordide brunneae tactu caerulescens, siccatis subfuscae. Gleba submollis, pallide vinaceo-brunnea. Sporae 5.5–7 × 2.3–3 μ, luteobrunneae, leves. Peridium bistratosum. Typus: H. E. Parks 4626 (NY).

Illustrations: Fig. 31, spores.

Basidiocarps 1–3 cm. in diam, globose to oblong or the outline irregular, surface pallid with dark fibrils over it, becoming dull brown, unpolished to loosely appressed-fibrillose, the outer layer separating to expose a pinkish ground color, but this soon turning to blue and finally umber (blackish) on exposure to air, when handled staining bluish (dull indigo) and then blackish, when dried bluish fuscous with dingy vinaceous brown areas often showing between the fuscous patches, KOH on fresh peridium inky fuscous, $FeSO_4$ slowly dark olive. Gleba dull tan (pale wood-brown as dried), chambers small, empty, firm but not bone-like in consistency.

Spores 5.5–7 × 2.3–3 μ, smooth, ellipsoid to ovoid, hyaline individually in KOH but pale snuff-brown in masses along the hymenium. In Melzer's sol. yellowish and more so in aggregations, with a false septum as seen in KOH and Melzer's sol., basal scar very inconspicuous. Basidia 14–16 × 4–6 μ, hyaline, thin-walled, readily collapsing. Paraphyses with end cell 14–20 × 6–12 μ, ovate, elliptic or elongate, thin-walled at first, becoming thick-walled, amorphous central inclusion not coloring in KOH, in the thick-walled stage easily breaking at the septa.

Tramal plates of hyaline refractive gelatinous hyphae interwoven; subhymenium cellular and the cells with refractive-gelatinous walls but most not developing thickenings. Peridium duplex, outer layer a loosely interwoven weft of hyphae with dull cinnamon-brown walls, sparingly to frequently branched, walls thin to thickened and smooth, flagellate hyphal ends fairly numerous, some amorphous pigment greenish in KOH along the base of this layer; subcutis a thick (about 100 μ) layer of interwoven hyphae strongly reddish as revived in KOH and with numerous large laticiferous hyphae hyaline in KOH and yellow in Melzer's sol. (up to 20 μ broad), also in Melzer's sol. much blackish green to blackish violet debris present on the hyphae of this layer, in KOH the zone beneath this layer including the young locules dark green, the red pigment as seen in KOH is in intercellular pockets and masses of pigment aggregated along the hyphae. Clamp connections none. All tissues nonamyloid, but some hyphal fragments amyloid.

Under Sitka spruce, Trinidad, Calif. H. E. Parks, 4626 (TYPE). No date was given. It is known from California, Oregon and Washington.

This species is related to *R. villosulus* but is readily distinct by its changing to blue on handling, the reddish tones of the subcutis and smaller spores. The violet blackish debris incrusting the subcuticular hyphae as seen in Melzer's sol. is copious. This color change appears to be an "amyloid" reaction. In some mounts of the type short segments of some hyphae are violet in Melzer's sol. and the amyloid debris is often encrusted on the hyphae as violet granules and short rods in bundles ($\pm 2 \times 0.5$ μ). Rarely are the thin-walled hyphae faintly bluish. In some collections amyloid particles occur in the hymenium. The specimens in which the gleba is still white lack the thick-walled paraphyses. There are probably inflated cells in the subcutis but that layer was full of pigment deposits to the point that the cellular details were obscured. The large laticiferous elements, however, were readily made out in either Melzer's sol. or KOH. With the exception of Trappe 112, the Washington collections are questionably identified. The Oswalds of Portland, Oregon, made a collection at Twin Bridges Forest Camp, Mt. Hood Nat'l. Forest, which contained young fruiting bodies. These were white and stained pink when bruised. The gleba became spotted wine red.

Material examined. CALIFORNIA: Parks 4626 (TYPE); Whited 56–133; Smith 8828. OREGON: Zeller, at Kellog, Nov. 15, 1938 (NY); Oswalds #5; Smith 71145, 71146, 71155, 71155a, 71157, 71158, 71159, 71161. WASHINGTON: Kauffman Oct. 1915 (3 colls.); Trappe 112; Oswalds Oct. 10, 1964 and Oct. 18.

53. **Rhizopogon pseudovillosulus** A. H. Smith, sp. nov.

Fructificationes 9–16 mm. diam, globosae vel subglobosae, fibrillosae, cinnamomeo-brunneae, tactu caerulei-fuscae. Gleba olivaceo-brunnea, cartilaginea. Sporae 6.5–8 × 2–2.5 μ, oblongae, nonamyloideae. Typus: Smith 71328 (MICH).

Basidiocarps 9–16 mm. diam, globose to subglobose, surface dry and appressed fibrillose when fresh, near cinnamon-brown when collected because of the epicutis, epicutis readily separable when rubbed and subcutis then showing as pallid areas which soon stain to a bluish-fuscous (no red anywhere), very few rhizomorphs present and these loosely attached, KOH instantly olive to dark olive on peridium, $FeSO_4$ instantly olive. Gleba "olive-brown," chambers distinct only under a lens, when fresh the consistency moist and cartilaginous. Columella absent.

Spores 6.5–8.5 × 2–2.5 μ, oblong, thin-walled, smooth, lacking a distinct basal truncation, singly in KOH dingy yellowish, in masses dull yellowish brown, in Melzer's sol. dingy yellowish singly and dingy yellowish brown in groups. Basidia

8-spored. Paraphyses and subhymenial cells all thick-walled and readily disarticulating with pressure on the cover glass. Tramal plates of refractive hyphae hyaline and smooth in KOH, content homogeneous, subgelatinous. Peridium with an epicutis of loosely interwoven hyphae with bister (in KOH) slightly thickened walls, the hyphae 4–10 μ diam, and with many cells knee-joint like or taking other odd shapes and up to 15 μ diam, flagellate cells also present; subcutis of mostly hyaline interwoven hyphae often green in KOH (no red anywhere) and hymenium next to peridium also often green and with deposits of green to blue-green amorphous pigment. Clamp connections none. Many of the hyphae with intracellular dark violet granules as seen in Melzer's sol.

In duff under conifers, Lake Fork Creek, McCall, Idaho, Aug. 2, 1964 Smith 68838 and 68841 (collected by Harold Burdsall), and in Washington, near Pend Oreille State Park, Oct. 19, 1964 Smith 71328, TYPE and 71329.

This species is obviously very close to *R. villosulus* but stains bluish fuscous on the fresh subcutis and lacks any red tints in KOH either fresh or dried (as revived in KOH). Zeller did not mention bluish-fuscous stains on the subcutis for *R. villosulus*. For the present at least, in order not to confuse any previously unrecognized taxa, I am recognizing *R. pseudovillosulus* as staining when bruised as already mentioned, and lacking any red pigment when treated with KOH in either the fresh or dried condition. *R. villosulus* is recognized as not staining when fresh. Speciments have been found which fit both concepts. The problem is whether or not the two groups are biologically distinct. Culture-studies might prove very helpful here.

54. **Rhizopogon umbrinoviolascens** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. longae, 1–2 cm. crassae, versiformes, fibrillosae, pallide fusco-violaceae, tactu atro-violaceae. Gleba pallida demum griseo-olivaceae. Sporae 6–7.5 × 2–2.5 μ, oblongae, nonamyloideae. Typus: Smith 71321 (MICH).

Basidiocarps 1–3 cm. long, 1–2 cm. thick, variously shaped (even subfusiform), surface dry and unpolished, when fresh "Benzo-brown" to "cinnamon-drab," (brownish violaceous to violaceous-drab), where injured staining dark violaceous, with an over-lay of wood-brown fibrils and when dried "wood-brown" (gray-brown) or darker (no violet or red showing), olive gleba showing where cracked (when fresh), rhizomorphs practically lacking; peridium when cut dull violaceous to bluish drab; KOH on cut surface olive (no red anywhere), $FeSO_4$ dark olive. Gleba pallid to olive-buff, chambers large and labrynthiform, columella lacking.

Spores 6–7.5 × 2–2.5 μ, oblong to narrowly ellipsoid, smooth, thin-walled, dingy hyaline in KOH singly, dingy brownish in groups, in Melzer's sol. yellowish singly and in groups slightly more yellowish brown, lacking an obvious basal truncation. Basidia 6–8-spored. Paraphyses clavate to oval, thin-walled, 6–9 μ broad. Tramal plates of hyaline, thin-walled, gelatinous refractive interwoven to subparallel hyphae, content homogeneous; subhymenium cellular, the cells thin-walled. Peridium with an epicutis of loosely interwoven hyphae with bister walls (in KOH) and many cells inflated-versiform and 9–15 μ diam, the walls thickened and little or no incrusting pigment on surface, flagellate end-cells present; subcutis of narrow interwoven non-gelatinous hyphae with some pigment incrustation (near epicutis) and near glebal chambers olive in KOH (including adjacent spores and hymenium in many cases). Clamp connections none. Some amyloid debris present in mounts revived in Melzer's sol.

In duff hypogeous to subhypogeous under conifers near Florence, Idaho,

Aug. 13, 1964, Smith 69285, 69288, and under Douglas Fir and larch, near Pend Oreille State Park, Wash. Oct. 19, 1964, Smith 71321 (TYPE) and 71327.

There is no sign of violaceous colors in the dried basidiocarps, as for instance there is in *R. parksii*. Also, in *R. parksii* the spores are 5.5–7 × 2.3–3 μ. In *R. umbrinoviolascens* when the epicutis is removed and before the blue to blackish stain develops there are no pinkish or red tones. The colors when fresh, of course, are very striking for a *Rhizopogon*. It differs from *R. pseudovillosulus* in having thin-walled paraphyses and in the violaceus-drab colors the basidiocarp.

55. **Rhizopogon brunneifibrillosus** A. H. Smith, sp. nov.

Fructificationes circa 3 cm. crassae, globosae vel subglobosae, fibrillosae, cinnamoneo-brunneae, tactu brunneo-fuscae. Gleba firma (non dura); sporae 7–8.5 ×2.2–2.5 μ, laeti-brunneae, leves, nonamyloideae. Typus: Oswald no. 13, (MICH).

Basidiocarps about 3 cm. diam, subglobose, surface dry and unpolished from a loosely-fibrillose layer, with a basal cluster of rhizomorphs, dark cinnamon-brown (±"cinnamon-brown" as dried), darker when rubbed (dark russet in these areas finally, and as dried), darker brown with KOH, $FeSO_4$ slowly blackish, $FeSO_4$ following a drop of ethanol quickly blackish. Gleba firm as dried but not hard, in sectioning rather crumbly, chambers distinct, dull sepia as dried.

Spores 7–8.5 × 2.2–2.5 μ, oblong, smooth, mostly ochraceous-hyaline in KOH singly, dark yellow-brown in groups; in Melzer's sol. yellowish singly, in masses reddish brown, typically with a false septum, basal truncation present but obscure. Basidia clavate, 8-spored, 8–10 μ broad, with yellow-brown walls as revived in KOH and Melzer's sol., not at all gelatinous. Paraphyses clavate to vesiculose, 8–12 μ diam, thin-walled, walls yellow-brown in KOH and not at all gelatinous, content homogeneous or with a poorly defined amorphous central body (but not thick walled as in *R. villosulus*). Tramal plates of nongelatinous hyaline to slightly yellow-brown interwoven hyphae 4–9 μ diam, no pigment incrustations seen; subhymenium cellular, the cells with hyaline to yellow-brown walls, not at all gelatinous, content similar to that of paraphyses. Peridium with a very well developed epicutis of loosely interwoven smooth walled rusty-brown (in KOH) hyphae mostly with walls at least somewhat thickened and cells equal to inflated, cells mostly 6–12 μ broad, but some inflated cells up to 50 μ and some narrowed hyphal tips 2–3 μ diam (rudimentary flagellate hyphae); subcutis of interwoven yellow-brown hyphae in KOH, reddish cinnamon in Melzer's sol., and the cells 6–20 μ diam, some inflated cells in the layer, orange-brown pigment balls present in mounts in Melzer's sol. No olive seen anywhere in KOH, very little amyloid debris present. Clamps none.

Single in duff under mixed conifers, Bear Springs, Mt. Hood National Forest, Oregon, Oct. 25, 1964. Ruth Oswald 13 (TYPE), Idaho, Smith 68592.

This species is distinct by having nongelatinous hyphae in the tramal plates and yellow-brown hymenial and subhymenial elements for the most part. It is close to *R. gilkyae* in some respects but differs sharply in the well-developed peridial epicutis, in the narrower spores, and in that the peridium does not flake off.

56. **Rhizopogon viridis** Zeller & Dodge, Ann. Missouri Bot. Gard. 5: 5. 1918.

Illustrations: Fig. 36, spores.

Basidiocarps 1–2 cm. in diam, subglobose to globose, not shrinking appreciably in drying, 'citrine-drab" to "olivaceous-black" when fresh, drying very dark brown ("surface somewhat mottled due to the partial sloughing off of the darker

outer layer, the darker places squarrose"—Zeller & Dodge). Specimens in Zeller collection are merely very dark brown and unpolished as dried (AHS). Gleba olive to deep olive drying dark olive (near "olive-brown" in type at present—AHS), cavities minute, empty. Columella none.

Spores 6.5–8 × 2–2.5 μ, oblong, in KOH nearly hyaline individually, in masses yellowish brown, in Melzer's sol. yellowish, smooth, basal scar inconspicuous. Basidia 12–18 × 6–7 μ, subcylindric, 6- to 8-spored (spores seen in groups), hyaline, thin-walled and readily collapsing. Paraphyses 9–20 × 7–11 μ, apical cell ovate to elliptic or clavate, becoming thick-walled but the amorphous central body not coloring in Melzer's sol. Tramal plates of gelatinous-refractive interwoven hyphae; subhymenium cellular and the cells tending to develop mucilaginous thickenings but the hyphae not breaking up under pressure into the individual cells. Peridium a double layer structurally, the upper one with numerous dark brown hyphae (cinnamon-brown in KOH) arranged in a tangled turf but not reviving readily in KOH, the cells mostly remaining collapsed (thin-walled) and no flagellate hyphae seen, lower layer of intricately interwoven hyphae 5–15 μ in diam, no larger cells grouped into pockets noted. Clamp connections absent. All tissues nonamyloid.

In duff under pine. Priest River, Idaho, J. R. Wier. Type examined. (NY).

This species belongs in sect. *Villosuli* but appears to be chemically inactive, no flagellate hyphae were found in the epicutus and the elements of the latter layer, though dark brown tend to remain indistinct as revived in KOH. The color of the peridium fresh is also distinctive. No amyloid granules were found along the hyphae of the peridium. When fresh material is available and a more critical study can be made it may be desirable to place this species in sect. *Rhizopogon*. It cannot be overemphasized that no matter what combinations of characters are used to delimit subdivisions of this genus intergrading species will be found.

57. **Rhizopogon molallaensis** A. H. Smith, sp. nov.

Fructificationes circa 2.5 × 4 ×4.5 cm., compressae, versiformes, siccae fibrillosae, pallidae demum eburneae, tarde subsquamulosae, in "KOH" rufo-brunneae, in "$FeSO_4$" subgriseae. Gleba olivaceo-brunnea, subdura. Sporae 5.5–7 × 2.4–3 μ, oblongae. Typus: Trappe 186 (MICH).

Basidiocarps about 2.5 × 4 × 4.5 cm. compressed, in outline more or less irregular, surface dry and appressed-fibrillose, pallid becoming ivory (M&P, 11B2), becoming decorated with olivaceous to umber squamules and patches, KOH on peridial surface deep reddish brown becoming blackish, $FeSO_4$ faintly grayish; rhizomorphs sparse, appressed, concolorous with peridium or darker. Gleba firm, when dried not hard as bone, soon olive-brown (M&P, 15L8) and drying olivaceous; odor pleasant (of Swiss cheese).

Spores 5.5–7 × 2.4–3 μ, oblong to narrowly ellipsoid, smooth, yellowish in KOH, in groups yellowish tan; in Melzer's sol. yellowish and with a false septum, no obvious basal truncation. Basidia not revived well. Paraphyses clavate, oval or versiform (some mitten-shaped), up to 12 μ broad, very soon becoming thick-walled as do the cells of the subhymenium and even some in the tramal plates, inclusion colorless in Melzer's sol. to merely yellowish. Subhymenium cellular, the cells soon thick-walled; hyphae of the central strand in the tramal plates gelatinous-interwoven, hyaline, narrow to moderately broad (2–7 μ diam), the width often indistinct because of gelatinization. Peridium with an epicutis forming slowly, often visible as segments of hyphae in which the walls have become thickened and are fulvous as revived in KOH, in well developed epicutis the layer of

tawny interwoven thick- to thin-walled hyphae with some inflation of the cells or the latter equal, but no sphaerocysts or flagellate hyphae seen, subcutis of interwoven hyphae yellowish to hyaline with copious cinnamon incrusting pigment and coagulated cell-content (revived in KOH), in Melzer's sol. with orange pigment balls and some "amyloid" debris; no olive reaction to KOH seen on hyphae of peridium or on tramal and hymenial elements next to peridium. Clamp connections absent.

Gregarious under grass near Douglas-fir roots, Molalla, Clackamas County, Oregon, Elev. ca. 200 ft. Nov. 7, 1964, Trappe 186 (TYPE).

This species may be considered close to *R. rudus* but differs in the KOH reaction of the peridium. It is closest to *R. brunneifibrillosus,* but differs sharply in the reaction to iron salts as well as in not staining russet when injured, in not drying dark cinnamon brown, and in the paraphyses not having yellow-brown walls.

58. **Rhizopogon quercicola** A. H. Smith, sp. nov.

Fructificationes 2–3 cm. crassae, globosae, vel subglobosae, fibrillosae, cinnamomeo-brunneae. Gleba sicca, molle, fragilis, subargillacea. Sporae 5.5–7 × 2–2.2 μ, oblongae, leves. Typus: Harding, Oct. 1964 (MICH).

Basidiocarps 2–3 cm. diam, globose, subglobose or globose-nodulose, surface dull cinnamon-brown over all from a loosely interwoven fibrillose epicutis, as dried with a cinnamon-brown epicutis covering a vinaceous subcutis, the epicutis tending to slough off in patches exposing the subcutis, no rhizomorphs visible except for a basal single one (in one basidiocarp). Gleba very dry and soft (as dried), near cinnamon-buff, cavities distinct to the naked eye.

Spores 5.5–7 × 2–2.2 μ, oblong or nearly so, smooth, thin-walled, nearly hyaline singly in KOH, in groups yellow-brown, in Melzer's sol. yellowish singly and pale tawny in masses, no visible basal truncation. Basidia 8-spored. Paraphyses 10–15 × 7–9 μ, vesiculose to clavate, thin-walled, soon collapsing. Hyphae of tramal plates subparallel, 3–6 μ diam, not gelatinous; subhymenium cellular but often one cell deep. Peridium with a loosely interwoven epicutis of cinnamon-brown hyphae (in KOH) thin to thick-walled, cells equal and 4–12 μ diam or variously inflated (up to 40 μ), the inflated cells intercalary, hyphae with smooth or nearly smooth walls; subcutis reddish cinnamon in KOH, of closely interwoven hyphae, intercellular pigment incrustations present, in Melzer's sol. with cinnamon pigment balls, no sphaerocysts seen in subcutis. Clamp connections none. All hyphae nonamyloid.

In duff under chinquapin oak, Bear Springs, Mt. Hood, Nat'l. Forest, Oregon, coll. Wm. Harding, Oct. 1964 (TYPE).

The distinguishing features are the small narrow spores, vinaceous red subcutis as dried overlaid by a cinnamon brown epicutis, the dry soft, fragile gleba, and lack of any conspicuous development of rhizomorphs. It is close to *R. brunneifibrillosus* but the features of the hymenium readily separate them.

59. **Rhizopogon subareolatus** A. H. Smith, sp. nov.

Fructificationes 1–6 cm. crassae, globosae vel ellipsoideae vel irregulares, pallidae demum sordide cinnamoneo-brunnea vel subfuscae, areolatae. Gleba in siccatis subochracea. Sporae 6–7 × 2–2.3 μ, anguste oblongae, leves, nonamyloideae. Typus: Smith 19675 (MICH).

Illustrations: Fig. 28, spores.

Basidiocarps 1–6 cm. thick, globose to subglobose, surface dry and un-

polished, the epicutis becoming separated into minute areolae or small warts, color pallid at first and becoming dingy vinaceous, when dried with dark dingy yellow-brown or rarely with bluish fuscous areas, often with an obscure ochraceous under tone, dark olive in $FeSO_4$ (on dried peridium), in KOH inky black on old specimen, vinaceous on young ones, with olive areas in the subcutis as revived in KOH. Odor none. Gleba pallid to olivaceous, drying dull ochraceous, when dried firm and easy to section; chambers small.

Spores 6–7 × 2–2.3 μ, narrowly oblong, smooth, hyaline in KOH singly, dingy yellow brown in groups, in Melzer's sol. yellowish-hyaline, in masses deeper yellowish, basal scar indistinct. Basidia hyaline, clavate, 6- and 8-spored, readily collapsing. Paraphyses hyaline in KOH, thin-walled to having wall slightly thickened in age, 5–10 (–12) μ broad. Tramal plates of refractive interwoven hyphae lacking colored contents and wall incrustations; subhymenium inconspicuous, of narrow basal cells at bottom of hymenium. Peridium with an epicutis in the form of a collapsed trichodermium of hyphae with rusty yellow-brown walls in KOH, the cells 8–15 μ in diam and short, the end-cells clavate to cystidioid, walls smooth to encrusted, no flagellate hyphal cells observed, areas of dark green in the layer as revived in KOH; lower layer of smooth to incrusted hyaline to brown hyphae with much of the area green in KOH, amorphous dark brown to fuscous pigment pockets and incrustations copious throughout the layer, no sphaerocysts seen but some cells up to 20 μ in diam, oleiferous hyphae not uncommon. Clamp connections none. All hyphae nonamyloid but amyloid particles scattered along some hyphae.

In duff under pine, Oregon, during the fall rainy season.

The distinguishing features of this species are the strong reactions with $FeSO_4$ and KOH, the ochraceous tone of the dried gleba, and the flush of ochraceous in the ground color of the dried peridium.

Trappe's collections were white, slowly becoming umber brown, and the KOH reaction was vinaceous on pale specimens, and there is a tendency for the subcutis to stain vinaceous. This is also evident on sections revived in KOH. The odor is apparently also distinctive but variable, according to Trappe resembling fresh frankfurters, fermenting molasses, or merely pungent-fruity. The gleba is distinctly olivaceous-ochraceous as dried. His collections are placed here on the features of the peridial epicutis, spores and chemical reactions. However, in his 183 the gleba near the peridium became violaceous on application of KOH. This collection probably represents an undescribed taxon, but further studies are needed to describe it accurately.

60. **Rhizopogon mutabilis** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. diam, globosae vel ovatae demum irregulares, siccae, fibrillosae, pallidae, tactu vinaceae vel vinaceo-lilacinae, in "KOH" olivaceae. Gleba pallida, tactu pallide vinacea. Sporae 5.5–6.5(–7) × 2–2.3 μ. Typus: Smith 69278.

Basidiocarps 1–3 cm. diam, globose to oval, compressed or irregular, surface dry and fibrillose, whitish, with a few rhizomorphs over the basal area and attached to soil by a small cluster of these, surface soon dull vinaceous to vinaceous-lilac over all from handling, vinaceous-fuscous as dried; KOH olivaceous on epicutis and cut peridium, $FeSO_4$ olive-brown. Odor none. Gleba pallid young, becoming vinaceous-buff near peridium when cut, in oldest ones vinaceous-fuscous around worm holes, with Melzer's sol. remaining orange-brownish, rather pithy as dried and sectioning readily (all young).

Spores 5.5–6.5(–7) × 2–2.3 μ, oblong to narrowly elliptic, hyaline in KOH (all young) both singly and in groups, yellowish in Melzer's sol. wall slightly thickened, no basal truncation evident. Basidia clavate, 8-spored, 5–8 μ broad. Paraphyses thin-walled, clavate to elliptic, yellowish hyaline and homogeneous as revived in Melzer's sol. Tramal plates of nongelatinous (all young) hyaline parallel to intermixed narrow (3–6 μ) smooth hyphae; subhymenium cellular but cells small (4–8 μ diam), nongelatinous. Peridium consisting of a distinct epicutis of fuscous-brown walled hyphae 3–8 (–12) μ diam, and with some cells 10–15 μ and of various shapes, no giant vesiculose cells seen, flagellate hyphae abundant and varying from hyaline to fuscous-brown walled; subcutis of hyaline interwoven hyphae 4–9 μ diam and flushed blue-green in KOH at least in some areas, no nests of sphaerocysts seen. Clamp connections none. All hyphae nonamyloid and no amyloid particles seen.

Gregarious under lodgepole pine, near Florence, Idaho, Aug. 13, 1964, Smith 69278 (TYPE), 69298.

One's first reaction to this species is that it is a mistake. The whitish over-all color of young basidiocarps suggest the sect. *Amylopogon,* as do the KOH reactions. The species is probably closest to *R. hawkeri* but lacks both cystidia and amyloid granules, as well as having the gleba stain vinaceous buff when cut and become dark vinaceous-fuscous around the worm holes.

61. **Rhizopogon hawkeri** A. H. Smith, sp. nov.

Fructificationes 1–4 cm. latae, globosae, ovatae vel irregulares, pallidae, siccae, demum ligno-brunneae vel vinaceo-brunneae, tactu roseolae. Gleba pallida, demum fusca. Sporae 6.5–8 × 2.2–2.8 μ, anguste ellipsoideae, nonamyloideae, leves. Peridium bistratosum: Epicutis brunneae, hyphis crassitunicatis (1–2 μ diam), levis, intertextis. Typus: Smith 65672 (MICH).

Illustrations: Fig. 24, spores.

Basidiocarps 1–4 cm. in greatest dimension, globose, oval or variously irregular from mutual pressure, surface dry, wood-brown to vinaceous-fuscous, when fresh the fibrils overlying a whitish ground color, soon bright pink where peridium is injured; $FeSO_4$ on peridium dark olive; KOH quickly pale olive, ethanol no reaction. Gleba pallid becoming olive-buff and finally nearly fuscous in age; chambers empty, small and irregular. Columella none.

Spores 6.5–8 × 2.2–2.8 μ, narrowly ellipsoid to suboblong, hyaline in KOH individually as well as in masses along the hymenium, weakly yellow in Melzer's sol., smooth, thin-walled, no appreciable basal truncation evident. Basidia 20–23 × 4–5 μ, clavate, thin-walled, readily collapsing, 4–6-spored forming a typical "hymenomycete type" of hymenium. Paraphyses resembling basidioles, none seen with thickened walls, in KOH many with minute highly refractive globules. Cystidia rare to scattered, fusoid-ventricose, 26–30 × 8–10 μ, projecting 10–15 μ beyond hymenium, hyaline, thin-walled. Tramal plates of somewhat interwoven narrow refractive hyaline hyphae (revived in KOH), nongelatinous in water mounts of fresh material. Peridium two-layered. Epicutis of hyphae with dark brown walls in KOH and H_2O, and the walls thickened (1–2 μ), smooth to rarely incrusted, the cells versiform, 2–11 μ diam; many seta-like elements present in or projecting from the layer and tapered to a whiplike flexuous nearly hyaline apex about 1 μ in diam; the bases 3–6 μ in diam (the so-called flagellate hyphal ends). Subcutis of hyaline appressed-interwoven hyphae bluish in places in KOH (fresh) and with amyloid granules as revived in Melzer's sol., 2–11 μ in diam no

pockets of enlarged cells present, as revived in KOH dingy vinaceous and with darker brown pigment pockets abundant. Clamp connections absent.

In a very rotten log, South Fork, Lake Fork Creek, Payette National Forest, McCall, Idaho, 2 Aug. 1962, legit Lilian Hawker (Smith 65672, TYPE).

The dried basidiocarps are dingy vinaceous except for the pallid buff gleba and the overlay of brown fibrils. When fresh it is a pallid species with an overlay of wood brown fibrils, it stains pink when injured, and is olive colored both in $FeSO_4$ and KOH. *R. villosulus* often has knobby to thorn-like cells in the epicutis in addition to flagellate cells. Some collections of *R. subareolatus* stain pinkish and have a pinkish subcutis as dried but the epicutis lacks flagellate cells. This species is named in honor of the collector, Dr. Lilian Hawker of Bristol, England, who joined the expedition to Idaho in 1962.

Here as in a number of sect. *Villosuli* more than one species may be included under a single binomial. For instance Trappe 193, Wasco County, Oregon may represent a distinct species. It had an odor of iodine fresh and the young gleba was pale yellow, ("Marguerite yellow" M&P, 10C1) and no cystidia were seen. One basidiocarp was found.

The KOH reactions are negative for specimens preserved in FAA, but the amyloid particles are present in abundance. The granular bodies in basidia and paraphyses show up better in material preserved in FAA than in dried specimens. Some specimens in which no cystidia have been found are also placed here on the basis of the change to red in the subcutis.

Material examined: IDAHO: Smith 65672 (TYPE), 68090, 68410, 68411, 68416, 68417, 68561, 68563, 68583, 68626, 69296, 69298. OREGON: Trappe #4, 193 (?).

62. **Rhizopogon villosulus** Zeller, Mycologia 33: 196. 1941.

Illustrations: Fig. 32, spores; 33, hymenium; 87–93, epicutis; pl. VII, 2.

Basidiocarps small, 8–25 mm. in diam, subglobose, arising from a large rhizomorph; surface soft, slightly villose, brown (bister) when fresh, changing but little in drying often, becoming areolate due to the rupture of the peridial epicutis, also the latter easily removed by abrasion, in KOH olive on fresh peridium, $FeSO_4$ olive, not staining when bruised. Gleba light brown drying buffy brown (dingy avellaneous in the type); cavities small and labryinthiform. Columella absent.

Spores 6–8 × 2–2.5 μ oblong or nearly so, in KOH hyaline or nearly so, in masses dingy ochraceous to dingy pinkish buff, in Melzer's sol. hyaline individually and in aggregations pale reddish brown, smooth, basal scar inconspicuous. Basidia 6-, 8-spored, more rarely 4-spored, 15–20 × 4.5–6 μ, subcylindric, readily collapsing. Paraphyses septate, terminal cell ovate, obovate to clavate, 15–25 × 7–12 μ, mostly with mucilaginous thickenings both in the terminal cell and those (2–3) beneath it, the paraphyses readily disarticulating at the septa and then found floating separately in the mount, the amorphous central body not coloring in Melzer's sol. Tramal plates of highly refractive gelatinous hyphae more or less interwoven; the subhymenium cellular and the cells thickened as indicated above as well as separating at the septa readily under pressure. Peridium "duplex": Epicutis of loosely interwoven smooth brown-walled (near cinnamon-brown) hyphae often with thickened walls, the hyphae branched and often enlarged near the septa, some with short branches but these not thorn-like, very few flagellate hyphae seen, greatly inflated dark brown cells present and often abundant; the inner thick layer of interwoven hyphae hyaline in KOH but with

dull brown pigment pockets present and in places in KOH becoming dark green, red pigmentation observed in the layer on some collections, no pockets of distinctly inflated cells present, amyloid particles present on sections of peridium revived in Melzer's sol. Clamp connections absent. All tissues nonamyloid.

In duff under conifers, Oregon and Idaho, June to September. Not rare in Idaho but it is one of the most difficult to collect since the basidiocarps are often about the size of rabbit pellets and the same color as the soil. The epicutis tends to be worn away in places exposing the pallid subcutis but the peridium as such cannot be said to be readily separable.

Material preserved in FAA solution for 18 months lost both the green and red reactions in KOH, but in Melzer's sol. the amyloid particles were as abundant as on material dried and then revived in Melzer's sol. Smith 68084 appears to be a young specimen with a "clean" peridium (no pigment deposits) and hence unreactive in KOH though when fresh $FeSO_4$ gave an olive reaction and KOH a darker brown one on the epicutis. It is very likely that in this group the age of the basidiocarp will have a direct bearing on reactions with chemicals. On this basidiocarp there was no stain to bluish fuscous—a stain to be expected if the reaction is a feature of this species. Smith 69071 is considered typical.

Material examined: CALIFORNIA: Parks 6350 (NY). OREGON: Goetz & Oswald, 9–17–64; Zeller (TYPE) (NY), Zeller colls. 8337; A. M. Rogers, July 26, 1939, Hat Point, Ore. (NY). IDAHO: Smith 45632, 45978, 59143, 59243, 593308, 60106, 60110, 60119, 60130, 60134, 60145, 60148, 60155, 60569, 65159, 65179, 65347, 65445, 65628, 66084, 66085, 66102, 66104, 66169, 66177, 66210, 66215, 68051, 68084, 68093, 68104, 68382, 68435, 68534, 68553, 68560, 68588, 68627, 68629, 68693, 68695, 68885, 69064.

63. **Rhizopogon colossus** A. H. Smith, sp. nov., var. **colossus.**

Fructificationes 1.5–6 (–9) cm. crassae, globosae vel irregulares, pallidae demum ligno-brunneae, siccae, fibrillosae, tactu imutabiles. Sporae 6–7.5 × 2.2–2.7 (–3) μ, levae, oblongae vel ellipsoideae, nonamyloideae. Typus: Smith 49480 (MICH).

Illustrations: Fig. 29, spores; 94, 95, epicutis; pl. IV, 1, basidiocarps.

Basidiocarps 1.5–6(–9) cm. thick, globose to compressed or variously irregular from external pressures, surface dry and fibrillose, some rhizomorphs present, pallid when young (not truly white) gradually darkening to dark wood-brown to dull cinnamon-brown when properly dried (otherwise tending to blacken), no color change on handling—or merely more brownish. Gleba pallid becoming olivaceous to dark olive but drying dingy ochraceous to Isabella-tan. Odor none or in age disagreeable.

Spores 6–7.5 × 2.2–2.7 (–3) μ, oblong to ellipsoid, hyaline to yellowish in KOH singly, more ochraceous in masses along the hymenium, in Melzer's sol. yellowish singly and more so in groups, smooth, thin-walled, mostly lacking a false septum and sterigmal scar not conspicuous. Basidia 6- and 8-spored, 16–25 × 7–9 μ, clavate or nearly so, thin-walled, hyaline in KOH. Paraphyses subglobose to ellipsoid, 15–30 × 7–12 μ, hyaline, thin-walled. Tramal plates of refractive-gelatinous hyphae subparallel to interwoven, smooth and thin-walled; subhymenium ramose, subgelatinous, cellular only at base of hymenial elements. Peridium "duplex", the outer layer poorly developed and consisting of a thin coating of smooth thick-walled more or less cinnamon brown-walled cells and hyphal segments, the cells versiform: Elongate, knee-joint-like, ovate, angular, or globose to subglobose and up to 40 μ wide, walls thin or up to 2 μ thick, flagellate hyphae

rare, in some mounts nearly all the hyphae cylindric; inner layer (context) of hyaline hyphae either coated with brown incrusting pigment or this material in pockets or both, the amorphous pigment and debris usually green to olive in KOH and this color often most noticeable near the outermost locules, the context-layer brown in KOH or pink showing faintly, enlarged cells scattered in context as well as in epicutis, large hyaline oleiferous hyphae usually readily demonstrated; in Melzer's sol. the context layer showing numerous brown to orange-brown globules, amyloid particles or granules scattered along some hyphae. All tissues nonamyloid. Clamp connections none.

Caespitose-gregarious in an old corral under lodgepole pine, Bear Springs, Mt. Hood National Forest, Ore. Oct. 24, 1954. Coll. Nancy Jane Smith and Donald Goetz (A. H. Smith 49480, TYPE).

R. hawkeri is close to this species but stained red quickly from handling, and has a distinct vinaceous tint when dried. Sections revived in KOH also show this color distinctly. In addition, the peridial epicutis is better developed than in *R. colossus*. Zeller (5513, O.S.C. Campus, Corvallis, from under fir trees) is this species. In his collections it was filed under *R. vittadinii*. *R. ponderosus* has much larger spores than *R. colossus* and hence is easily separated fresh or when dried. Both of these fruit at the same time of year in the same habitat so every basidiocarp in a collection should be checked for spore size.

Material examined: CALIFORNIA: Parks, 6354, 6363. IDAHO: Smith 46703. OREGON: Goetz 13, 14, 15; Oswalds Nov. 2, 1956, Nov. 10, 1956; Smith 49480 (TYPE), 49500, 71144; Trappe, Multonomah County (MICH); Zeller colls. 6999, 7557; G. R. Hoerner 10–21–33 (NY). WASHINGTON: Kauffman Oct. 1915; Trappe 4 colls. (MICH).

63a. **Rhizopogon colossus** var. **nigromaculatus** A. H. Smith, var. nov.

Fructificationes 2–6 cm. latae, globosae vel irregulares, pallide brunneae tactu atrimaculatae. Gleba olivaceibrunnea. Sporae 6–8 × 2.3–2.8 μ, nonamyloideae, leves, oblongae. Typus: 2 nov. 1962, Mt. Adams, Wash. legit E. Wiebe, Virginia Wells, and the Oswalds (MICH).

Illustrations: Fig. 30, spores.

Basidiocarps 2–6 cm. broad, globose, irregular or compressed surface appearing fibrillose and brownish from a thin epicutis of interwoven fibrils, blackening immediately when touched, dull brown as dried ("drying with a reddish tinge"—Ruth Oswald). Odor yeast like. Gleba as dried brown with an olive-ochraceous tint; chambers distinct, empty.

Spores 6–7(–8) × 2.3–2.8 μ, oblong to narrowly ellipsoid, in KOH yellowish individually, darker ochraceous in groups, in Melzer's sol. yellowish individually and brownish in groups, smooth, basal scar not distinct, false septum often present (mount in Melzer's sol.). Basidia 6-spored, hyaline, readily collapsing. Paraphyses 7–14 μ wide and 10–28 μ long, hyaline in KOH, nearly all thick-walled, the central body not staining in Melzer's sol. Tramal plates consisting of strands of subparallel hyphae refractive-gelatinous in KOH, 3–6 μ diam; subhymenium filamentose-branched to the hymenial elements which usually have one basal isodiametric cell. Peridium with an epicutis 2–4 hyphae deep of brown-walled smooth loosely arranged hyphae with walls 0.25–1.5 μ thick (in some hyphae), no flagellate cells or thorny cells observed but some were irregular in shape (the layer is poorly differentiated, greatly inflated cells present but rare). The context layer composed of compactly interwoven hyphae with much brown debris in the layer as revived in KOH, no sphaerocysts or oleiferous hyphae ob-

served; $FeSO_4$ staining peridium and gleba dark olive in revived sections. Clamp connections absent. All tissues nonamyloid, but amyloid particles present along some hyphae.

Clustered among rocks along a road (Green Canyon) Mt. Adams, Wash., Nov. 2, 1962. E. Wiebe, Virginia Wells and the Oswalds. It is known only from the type locality.

The pale to dull brown basidiocarps staining black immediately when touched, the thin epicutis of brown-walled hyphae, small spores and numerous thick-walled paraphyses are distinctive. The glebal cavities are fairly large (0.5 mm.) in dried material and the color is an olive-ochraceous brown. *R. colossus* var. *colossus* does not stain black when touched. Zeller noted this on one of his collections which belongs there and I noted it on the type. Specimens of var. *nigromaculatus* do not stain black in drying as one might expect. As dried both varieties are indistinguishable.

64. **Rhizopogon sepelibilis** A. H. Smith, sp. nov.

Fructificationes 1–5 cm. crassae, globosae, in siccatis fuscae. Sporae 6–7.5 × 2–2.4 μ, hyaline, leves, nonamyloideae. Hyphae epicutorum latae, versiformes, ochraceae, cellulis inflatis 10–20 μ diam. Typus: Zeller Herb. 7452 (NY).

Illustrations: Fig. 23, spores.

Basidiocarps 1–5 cm. broad, globose, as dried evenly dark fuscous, no pattern or rhizomorphs evident. Gleba pallid buff as dried, chambers small, consistency firm but not bone hard.

Spores 6–7.5 × 2–2.5 μ, oblong to narrowly ellipsoid, smooth, thin-walled, hyaline in KOH, yellowish-hyaline in Melzer's sol. basal scar indistinct. Basidia clavate, 12–18 × 6–9 μ thin-walled, 6-spored (spores seen in groups). Paraphyses thin-walled, resembling basidioles. Tramal plates of hyaline somewhat refractive filaments slightly gelatinous in KOH, subhymenium with diverging filaments to the cellular area beneath the hymenial cells. Peridium with an epicutis of ochraceous (in KOH) hyphal cells with only slightly thickened walls, the cells versiform—all sorts of irregular shapes, with obtuse protrusions, irregular inflations, and often appearing to have abortive clamps or the beginnings of the development of the clamp hypha, the hyphal ends often cystidial and 10–15 μ diam, most hyphae 6–9 μ diam but greatly inflated cells up to 25 μ also present, some broadly clavate (15 μ) hyphal ends also present as well as narrow flagellate hyphae ± 2 μ diam and occasional thick-walled hyphal segments with yellow-brown walls; interior tissues (context) of thin-walled hyphae the cells often very broad (20 μ) but not always inflated, many green pockets as revived in KOH, and layer blackish olive when first revived in KOH, cells often with yellowish brown pigment but fading out in age; in Melzer's sol. with amyloid particles or granules often conspicuous. Clamps not observed with certainty.

Type collected at Mt. Rainier Nat'l. Park, Wash. Oct. 28, 1928 by Keith O'Leary (Zeller Herb. 7452) (TYPE).

This species is described with the knowledge that the data on its characters when fresh and on the chemical characters are lacking. However, it is worth putting on record because there is nothing else close to it in the sect. *Villosuli*. On the basis of my experience with *Rhizopogon* species which dry dark fuscous, I would expect the spores of this one to be amyloid, the peridium to be white when fresh and become wood-brown to drab and finally fuscous on aging. The spores are not amyloid, however, and it remains to be seen what the pattern of color change is for the basidiocarp.

The distinctive features are the color of the dried basidiocarp correlated with the large inflated cells in the peridial epicutis, the copious amount of green pigment as sections are revived in KOH, and the primitive state of development of the epicutis itself in that the cell walls are only slightly thickened. The presence of an occasional cell with thick brown walls in an otherwise typical hypha is also interesting, as are the aborted clamps at some of the cross-walls. The nearest thing to a complete clamp was on a hyphae 2 μ in diam with ochraceous walls.

It appears to be related to *R. subcaerulescens* in that as dried the two are almost identical in appearance. Microscopic features of course readily separate them.

Rhizopogon subg. **Rhizopogon** sect. **Rhizopogon.**

Rhizopogon sect. *Duplici* Svrcek in Pilat, Gastr. p. 721. 1958.
Rhizopogon sect. *Simplici* Svrcek in Pilat, Gastr. p. 721. 1958.

This section is characterized in a negative manner since it includes all species not placed in the sections previously treated. The group, however, is more homogeneous than one might expect under the circumstances. The category of stirpes as used in subsect. *Rhizopogon* is broader than for the previous sections or for subsect. *Versicolores* of this section.

Type species: As for the genus.

Key to Subsections, Series and Stirpes of Sect. *Rhizopogon*

1. Spores 3–5 μ wide. — Subsect. *Rhizopogon*
   2. Peridium staining red when injured. — Stirps Rubescens
   2. Peridium not staining red when injured but it may stain some other color. — Stirps Luteolus
1. Spores 1.6–3 μ wide. — Subsect. *Angustispori*
   3. Peridium developing yellow tones at some time in its development. — Series *Lutei*
      4. Staining red when injured. — Stirps Vulgaris
      4. Not staining as above. — Stirps Ochraceorubens
   3. Basidiocarps variously colored but not yellow. — Series *Versicolores*

Rhizopogon subg. **Rhizopogon** sect. **Rhizopogon** subsect. **Rhizopogon.**

Stirps Rubescens

Species in which the basidiocarp stains orange, pink or some shade of darker red and in which the spores (at least most of them) measure 3 μ or more broad are placed here.

Key to Species of Stirps Rubescens

1. Gleba exuding a hyaline viscous latex when cut; odor resembling that of rotten eggs. — 65. *R. succosus*
1. Not as above. — 2
   2. Basidiocarp lacking yellow colors at any time in its development. — 3
   2. Basidiocarp showing yellow at some stage. — 5
3. $FeSO_4$ on fresh peridial surface olive-black; spores 8–10 × 3.5–4 (9–11 × 5 μ).—(see *R. subaustralis* also). — 66. *R. pseudoroseolus*
3. $FeSO_4$ not giving above color change on fresh peridium. — 4
   4. Basidiocarp white when young, soon becoming entirely rose-colored. — 67. *R. roseolus*
   4. Basidiocarp dull white to brownish at maturity. — 68. *R. albiroseus*
5. Spores 9–12 × 3–5 μ or larger. — 6
5. Spores 7–10 × 2.8–3.5 (–4) μ. — 7
   6. Spores 9–12 × 3–5 μ. — 70. *R. abietis*
   6. Spores 9–13 × 6–8 μ. — 74. *R. ventricisporus*

7. Basidiocarp white to yellowish-olive to olive and with blackish stains at maturity; spores 7–9 × 2.8–3.5 μ. 71. *R. subaustralis*
7. Yellow stage of peridium more pronounced than in above choice. 8
8. $FeSO_4$ on fresh peridium dark olive (without addition of ethanol). 69. *R. luteorubescens*
8. $FeSO_4$ weakly olive to no reaction on fresh peridium (without addition of ethanol). 9
9. Gleba dark yellow-brown ("Dresden brown") mature, soft when fresh but bone-hard when dried. 72. *R. ochroleucoides*
9. Gleba olive to olive-brown fresh, not hard as bone when dried. 10
10. 8–10 × 3.2–4.2 μ, many subfusoid. 73. *R. rubescens* var. *rubescens*
10. Spores seldom over 3.5 μ wide. 11
11. Dried gleba showing paler yellowish streaks and spots; fresh specimens with a fragrant odor. *R. rubescens* var. *pallidimaculatus*
11. Not as above. 12
12. Spores capsule-shaped, 7–9 × 3–3.5 μ. *R. rubescens* var. *ochraceus*
12. Spores oblong to subfusoid, 6.5–8 × 2.5–3 μ. *R. rubescens* var. *rileyi*

65. **Rhizopogon succosus** A. H. Smith, sp. nov.

Fructificationes circa, 1 cm. crassae, globosae, ochroleucae, demum badiae. Gleba lactiflua. Odor foetidus; sporae 7–9.5(–10) × 3–4.2 μ, ellipsoideae, luteo-brunneae, leves, nonamyloideae. Typus: Coker 9889 (legit Mr. and Mrs. Wilson) (NC).

Basidiocarps about 1 cm. thick, globose or nearly so, surface glabrous but unpolished, pale cream-color becoming reddish and when dry evenly very dark bay-brown (near Vandyke-brown). Taste sweetish. Odor resembling that of rotten eggs. Gleba whitish for tramal plates, and spore mass olive-brown, exuding a hyaline viscous latex when cut, glassy-hard in consistency when dried and then almost concolor with surface. Texture soft and flabby fresh (gelatinous).

Spores 7–9(–10) × 3–4.2 μ, capsule-shaped to ellipsoid, smooth, sterigmal scar not conspicuous, wall distinctly thickened (about 0.7 μ), in KOH ochraceous singly and dingy yellow-brown in masses (near "snuff-brown"); in Melzer's sol. merely dingy yellow-brown. Basidia and paraphyses all gelatinized (no thick-walled cells evident). Tramal plates of hyaline gelatinous hyphae, subhymenium not distinct. Peridium thick, one layered, very hard when dried, as revived in KOH almost completely impregnated with dark magenta amorphous masses of pigment, the hyphal walls hyaline, pigment both in and between cells. Some sphaerocyst like cells 12–20 μ in diam scattered in the layer, most hyphae 3–8 μ diam. Clamp connections absent. All tissues nonamyloid.

The TYPE was found under a tin can, Coker 9889, (NC) Collected by Mr. and Mrs. Wilson, Oct. 12, 1934, at Chapel Hill, N. C.

Although our data are incomplete, enough information is available to distinguish this *Rhizopogon* from all others treated here. The red reaction of the peridium reminds one of *R. ochraceorubens,* but the latter has no latex. The yellow peridium obviously staining and discoloring bay-brown in conjunction with the latex are a good combination for field identification.

66. **Rhizopogon pseudoroseolus** A. H. Smith, sp. nov.

Fructificationes 10–15 mm. latae, globosae vel irregulares, albidae, fibrillosae demum tarde vinaceae, pallide maculatae. Gleba alba. Sporae 8–10 × 3.5–4 μ (9–11 × 5 μ), subfusoideae, leves, nonamyloideae. Peridium unistratosum. Typus: Smith 65349 (MICH).

Illustrations: Fig. 44, spores.

Basidiocarps 10–15 mm. broad, globose to irregular, surface white and ap-

pressed fibrillose at first, slowly becoming flushed vinaceous over all with no yellow intermediate stage, with basal rhizomorphs only; $FeSO_4$ on surface olive-blackish, but no reaction on gleba; in KOH instantly bright rose color on surface anywhere, when dried dark vinaceous-red but with pallid spots where epicutis sloughs off. Odor none. Gleba white, chambers small. Columella none.

Spores 8–10 × 3.5–4 (9–11 × 5 μ), subfusoid to narrowly ellipsoid, hyaline in KOH individually, yellowish in groups along hymenium; in Melzer's sol. yellowish in groups or individually, smooth, thin-walled, basal scar distinct. Basidia 4-, 6-spored, 14–20 × 5–7 μ, thin-walled, hyaline in KOH. Paraphyses 16–20 × 8–12 μ, thin-walled, hyaline but with 1–2 hyaline refractive globules in the interior. Cystidia none. Tramal plates of hyaline nongelatinous, scarcely refractive thin-walled smooth subparallel hyphae with highly refractive globules in the interior, subhymenium cellular and with the same refractive granules as found in hyphae of the central strand. Peridium a loosely interwoven layer of hyphae 5–15 μ in diam, much incrusting pigment and debris in the layer and as revived in KOH dark vinaceous (near "mineral-red"), in Melzer's sol. having many large droplets of orange-brown pigment. Clamp connections none. All tissues nonamyloid.

In duff under *Pinus, Abies* and *Picea,* Idaho and Michigan, spring and summer.

This is a large-spored species with the basidiocarps having a speckled appearance when dried because of the manner in which the peridium sloughs off. The combination of dark $FeSO_4$ reaction and bright KOH reaction along with the lack of a yellow stage in the pigmentation pattern are regarded as distinctive, see *R. roseolus* for further comment.

Material examined. IDAHO: Smith 65349, TYPE; MICHIGAN: Smith 66302, 66307, 66364, 66469a, 66604.

67. **Rhizopogon roseolus** Corda sensu A. H. Smith.

Illustrations: Fig. 45, spores.

Basidiocarps 1–2 cm. thick, globose, flattened or irregular, surface unpolished and with scattered appressed rhizomorphs, dingy rose color over all except in the depressions where it is faintly buff tinged; $FeSO_4$ no reaction on peridium or gleba; KOH intensifies the rose color; ethanol also intensifies the rose color. Gleba white when young, slowly becoming olive. Columella absent.

Spores 6.5–8 × 2.8–3.2 μ, narrowly ellipsoid to oblong, hyaline in KOH individually and in groups along the hymenium, in Melzer's sol. yellowish individually and in groups, smooth, often falsely septate in Melzer's sol., walls thin, basal scar present but indistinct. Basidia 6-spored, 12–18 × 5–7 μ, subcylindric to clavate, thin-walled, hyaline and readily collapsing. Paraphyses 10–20 × 6–11 μ, subglobose to ovoid or ellipsoid, thin-walled, lacking a refractive body or granule. Cystidia none. Tramal plates of subparallel nongelatinous thin-walled hyaline smooth hyphae forming the central strand, lacking refractive globules or masses; subhymenium cellular. Peridium of appressed hyphae 4–10 μ in diam and nongelatinous, with incrustations and pigment deposits near the surface, the whole layer diffused with rose pigment (sections of fresh material mounted in KOH), no nests of enlarged cells seen; as revived in KOH the layer vinaceous-brown and with much debris and incrusting material present. Clamp connections none. All tissues nonamyloid.

In duff under *Pinus contorta,* Blind Summit, Stanley, Idaho, July 23, 1962,

Collected Ed Tylutki (Smith 65485); Smith 66472 is from Michigan also under pine.

The dried basidiocarps are a vinaceous brown but with pallid spots on some where the peridium has sloughed off. No oleiferous hyphae were seen. It hardly seems proper to describe this as a new species in the face of Corda's illustration and description, which both "fit" remarkably well. It is not one of the "yellow species" (see Corda's illustration) as so many authors have interpreted it. Actually it remains to be verified as to whether *R. roseolus* in the sense of this work is the same as the *R. roseolus* of Europe. But this can hardly be done on any existing material. Zeller and Dodge stated they did not know of an authentic specimen and actually described a species I consider distinct both from Corda's and from Svrcek's (in Pilat, 1958) concept. Svrcek's concept as he indicated falls in the series of variants around *R. rubescens*. He considered them synonyms. Since Corda did not mention yellow in the coloration of the basidiocarp, and did not show it on his painting, I am assuming it did not exist. Also, Corda illustrated the spores exactly as I find them.

The large spored species, again without yellow in the color of the peridium, with subfusoid spores 8–10 × 3.5–4 (9-11 × 5) μ, which gives a strong reaction in $FeSO_4$ I have described as new, see *R. pseudoroseolus*. This differs from Svrcek's concept *(R. rubescens)* in lacking a yellow stage. We do not know about the $FeSO_4$ reaction of his material. What species has been used in mycorrhizal studies under this name I am not prepared to say. I have studied Hawker 139 (Lange 3264) from Sweden. It is about the color of my *R. pseudoroseolus* and the spores are also very similar, but the dried peridium gave a very weak $FeSO_4$ reaction. The Hawker specimen does not resemble my material of *R. rubescens* as dried, so for the present at least I am skeptical of the conclusions reached by Svrcek. If the spore characters for *R. roseolus* and *R. pseudoroseolus* vary as in *R. rubescens* it may turn out that the differences given in this work will not hold and that most emphasis should be placed on the $FeSO_4$ reactions.

68. **Rhizopogon albiroseus** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae vel angulares, sericeae, albae, tactu rubescens, in "KOH" roseae. Gleba olivaceobrunnea. Sporae 7–8(–9) × 2.8–3.3 μ. Typus: Smith 68643 (MICH).

Basidiocarps 1–3 cm. diam, globose to subglobose or versiform from external pressure, surface silky fibrillose and with appressed rhizomorphs over the surface, white, the rhizomorphs white also, staining red when bruised but stained areas soon bleaching to white instead of becoming brownish, over all color gradually duller, in age dingy gray and when decaying a brownish gray; KOH red on white surface, $FeSO_4$ no appreciable reaction. Gleba pallid to deep olive-buff to a grayish buffy-brown, darker bluish gray in Melzer's sol., chambers small. Columella none.

Spores 7–8(–9) × 2.8–3.3 μ, narrowly ellipsoid with an obscurely truncate base, yellowish in KOH fresh and revived, in Melzer's sol. weakly amyloid immature, nonamyloid and pale rusty brown when mature, smooth, relatively thin-walled. Basidia subcylindric in projecting part, 6–8-spored. Paraphyses becoming thick-walled, hyaline in KOH and weakly yellowish in Melzer's sol. Tramal plates of narrow hyaline subparallel somewhat gelatinous hyphae; subhymenium cellular and ± 2 cells deep. Peridium of appressed-interwoven clean hyphae (fresh) which become red in KOH, the color fading to hyaline, some cells short and inflated to 12–15 μ, but not sphaerocyst-like, when revived in KOH the outer

hyphae pale tawny with some incrusting debris present. Clamp connections none. All tissues nonamyloid.

Cespitose-gregarious in a road through *Abies lasiocarpa* Gisborn Mt., Priest River Exp. Forest, elev. 5000 ft, July 26, 1964, Smith 68643 (TYPE); and 68652.

In the fresh condition the wider spores distinguish it from *R. evadens*. When dried the basidiocarps are colored dull vinaceous gray. It appears to be most closely related to *R. evadens*, and so is placed in sect. *Rhizopogon*.

69. **Rhizopogon luteorubescens** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae, siccae, laete luteae, tactu rubescens. Sporae 6–8 × 3–3.5 μ, subfusoideae, vel ellipticae, leves, nonamyloideae. Typus: Smith 58778 (MICH).

Illustrations: Fig. 78, spores.

Basidiocarps 1–3 cm. broad, globose to irregular in outline, surface dry and appressed fibrillose, no appreciable number of rhizomorphs present, white at first becoming pale bright yellow (near "Baryta yellow") and almost this same color as dried, staining reddish to reddish brown slightly when injured but very little discoloration showing on dried basidiocarps. Peridium reddish in KOH, and in $FeSO_4$ rather dark olivaceous. Odor none. Gleba white becoming pallid yellowish to ochraceous (where injured or worm-eaten lemon-yellow); very soft (immature specimens).

Spores 6–8 × 3–3.5 μ, subfusoid to ellipsoid, smooth, no sign of a "cup", hyaline to yellowish in KOH and yellowish in Melzer's sol., basal scar indistinct. Basidia 6- and 8-spored, 16–25 × 7–8 μ hyaline, readily collapsing. Paraphyses 15–30 × 8–12 μ, clavate, thin-walled when young but (at least some) thick-walled in age, content homogeneous. Tramal plates of interwoven hyaline narrow (3–6 μ) only slightly refractive hyphae as seen in KOH; subhymenium cellular. Peridium 2-layered, the upper of hyaline to yellowish (in KOH) smooth-walled floccose hyphae 4–12 broad, the layer "clean," no sphaerocysts noted; lower layer pale tawny from incrusting pigment between and on the hyphae, the hyphae 4–10 μ diam with some enlarged ones present; oleiferous hyphae fairly numerous, yellow in KOH. Clamp connections none. All tissues nonamyloid.

In duff under conifers, Idaho. July and August.

This is a pale bright yellow species with a rather strong, olive $FeSO_4$ reaction, and on injury does not stain permanently as do most members of the stirps Rubescens. At maturity the spores are rather bright yellow with the result that the gleba in the oldest specimens seen was more ochraceous than olive, a feature helping to distinguish it from *R. rubescens* and varieties. Collections Smith 59047, 59043, 59683, all from Pen Basin, Idaho, have thick-walled paraphyses, but otherwise appear to belong here. The pale bright yellow basidiocarps as dried are quite distinct from those of *R. rubescens*. The wider spores distinguish it from *R. vulgaris*.

Smith 68322 represents a possibly distinct taxon. Data on it are as follows: Peridium 1–2 cm. thick, subglobose, pallid young, soon pale yellow-ocher, only the inner layer of fibrils (subcutis) staining red when bruised and this only slightly (showing best when the fresh peridium is cut), in KOH brownish, in $FeSO_4$ weakly olivaceous. Gleba saffron tinged, drying ochraceous brown, chambers large. Surface of peridium finally dingy brown from handling. Spores 7–9 × 3–3.2 μ, narrowly oblong (capsule-shaped). Paraphyses thick-walled. Peridium of interwoven hyphae 5–12 μ diam, with rusty-cinnamon intercellular pigment floccules and deposits, hyphae somewhat inflated. Clamps none.

The KOH reaction, the saffron gleba, and paler yellow peridium which is decidedly reddish as dried distinguishe this collection. It may represent a distinct taxon intermediate between *R. luteorubescens* and *R. subcitrinus* but more data are needed. The color of the fresh gleba is not typical of either.

Material examined. IDAHO: Smith 58778 (TYPE), 58905, 59043, 59047, 59150, 59683, 59693, 59750, 68322.

70. **Rhizopogon abietis** A. H. Smith, sp. nov.

Fructificationes 1–4 cm. latae, subglobosae vel irregulares, fibrillosae albae demum subochraceae, tactu rubescens. Gleba alba demum pallide olivacei-ochracea. Sporae 9–12 × 3.8–4.6 μ, ovoideae vel anguste ellipsoideae, leves, nonamyloideae. Peridium bistratosum. Typus: Smith 65348 (MICH).

Illustrations: Fig. 71, spores.

Basidiocarps 1–4 cm. broad, globose, pear-shaped or irregular, surface at first white and cottony and with a basal white rhizomorph as the point of attachment at this stage, surface soon becoming tinged lemon-yellow and then more ochraceous and soon spotted or flushed pink to vinaceous where in contact with debris or where injured, ochre-yellow or duller when mature, with reddish brown areas, at maturity with scattered rhizomorphs over the surface to nearly free of them; $FeSO_4$ somewhat olivaceous on surface; KOH vinaceous to reddish brown; peridium becoming salmon color when cut. Gleba white becoming pale olive and finally dark olive, soft in white stage, cartilaginous at maturity, chambers small.

Spores 9–12(–13) × 3.5–5 μ, versiform but mostly subfusoid, varying to ellipsoid, ovoid, narrowly clavate, or slightly allantoid (profile view), truncate at base from a broad basal sterigmal scar and a very fine tooth projecting down on either side of it (use 1.3 n A oil. im.) smooth, hyaline in KOH, yellowish in Melzer's sol. Basidia hyaline, collapsing readily, 4- and 6-spored. Paraphyses subglobose (terminal cell ovate to ellipsoid or clavate, thin-walled at first, and becoming thick-walled, having an amorphous central body, all the cells in the hymenial layer finally thick-walled. Tramal hyphae at maturity hyaline, gelatinous, refractive in KOH, smooth, interwoven, 3–7 μ diam; subhymenium cellular, the cells in age with thickened walls. Peridium of appressed-interwoven, thin-walled, nongelatinous hyphae 5–10 μ in diam with many enlarged cells in the interior up to 15 μ or more in diam; exterior layer typically a turf with the elements having clavate terminal cells up to 14 μ broad, this layer collapsing and difficult to revive; sections of dried specimens revived in KOH show a reddish to rusty brown interior zone colored from heavy deposits of pigment in pockets and along the hyphae, and an outer yellowish zone with ± hyaline debris adhering to the hyphal walls, the hyphae 4–15 μ diam. Clamp connections rare (1 in an hour's search). All tissues nonamyloid.

Gregarious in duff under fir and spruce, summer time, Idaho and Wyoming. The TYPE, Smith 65348, was collected by Nancy Jane Smith on the South Fork of Lake Fork Creek, McCall, Idaho, July 12, 1962.

The clamps are not numerous enough to count as a taxonomic feature, but are of some importance theoretically as they may indicate that, if the fungus were cultured, clamps might be found more abundantly on the mycelium. This species often grows in the same habitats as *R. rubescens* var. *rubescens* but is at once distinguished by the larger spores, more inflated cells in the peridium and usually by the much larger paraphyses.

The name *R. roseolus* Corda must be reserved for a species in which the basidiocarp lacks a yellow stage. Corda's original description and illustration

neither indicate nor show any yellow colors. The large spored Rhizopogons found under oak need to be restudied in the fresh condition by the characters emphasized in this work. The collection from Wyoming lacked notes on certain important characters but appears to belong here in spite of the large size of the basidiocarps and their dingy colors as dried. They were dried over a gasoline stove whereas the type was dried with electricity as the source of heat. Smith 69834 had spores up to 6 μ wide and 14 μ long, and the hyphae of the tramal plates were often thick-walled as were the subhymenial and hymenial elements.

Material examined. IDAHO: Smith 45801, 65220, 65341, 65428 (TYPE); 69404, 69834, 70010; WYOMING: Smith 35128 (?) (MICH); NEW YORK: S. J. Smith 28094 (NY as *R. rubescens*); TENNESSEE: Hesler 21614 (TENN); ONTARIO: Buller (7405 Zeller Herb. as *R. rubescens* NY).

71. **Rhizopogon subaustralis** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae vel subglobosae, fibrillosae, albidae tactu rubescens, demum, luteo-olivaceae. Gleba cinnamonea. Sporae 7–9 × 2.8–3.5 μ, subfusoideae, leves, nonamyloideae. Typus: Couch 7450 (NC).

Basidiocarps 1–3 cm. thick, globose to subglobose, at times somewhat flattened, sometimes kidney-shaped, sometimes lobed, fibrils absent to sparse, often absent on sides and upper surface, lower side with mycelioid rhizomorphs, fibrils or rhizomorphs scarcely visible on dried specimens, color pattern whitish young and fresh and staining pink when injured (when cut or bruised), becoming olivaceous ("Ecru-olive"—Couch) staining red when injured in this stage and at maturity with blackish areas. $FeSO_4$ on dried peridium staining the latter dark olive; basidiocarps when dried cinnamon-buff to dingy "cinnamon" with some having blackish areas. Gleba white in young material, becoming cream-color and as dried pale dingy cinnamon. Odor mild, or, in aging specimens, like rotting potatoes.

Spores 7–9 × 2.8–3.5 μ, subfusoid varying to oblong, wall very slightly thickened, smooth, in KOH hyaline singly, pale ochraceous in groups, in Melzer's sol. yellowish, basal scar indistinct. Basidia hyaline, thin-walled, readily collapsing, 25–33 × 5.5–7.4 μ, 4-, 8-spored, spores sessile. Paraphyses clavate, 6–9(–12) μ broad, hyaline, thin-walled, readily collapsing in age. Tramal plates of gelatinous interwoven hyphae; subhymenium indistinct. Peridium a single layer, as revived in KOH at first red and giving off a red pigment but this soon disappears, color of peridium when stabilized orange-brown to yellow-brown with so much amorphous pigment in the cells and between them as to obscure hyphal detail but many hyphae incrusted as well as having internal ochraceous pigment, numerous oleiferous hyphae with ochraceous content present. Clamp connections none. All tissues nonamyloid.

On ground under pine, Chapel Hill, N. C., July 22, 1924, J. N. Couch (Plants of Chapel Hill, N.C. Nos. 7450 TYPE, 7457, 7499); Povah 11–12–33.

This species is distinct from *R. couchii* by its larger more fusiform spores, and the paraphyses remaining thin-walled and finally collapsing. Here again, the gleba when mature apparently is brown rather than olivaceous. I suspect that when both of these species can be compared side by side in the fresh state certain macroscopic features will be found to readily distinguish them, I refer to the pattern of color development and possible chemical reactions with KOH. Apparently we have a stirps here distinct from *R. rubescens* on the color of the mature gleba, but with a similar series of species represented by steps in spore size.

72. **Rhizopogon ochroleucoides** A. H. Smith, sp. nov.

Fructificationes 1–5 cm. latae, globosae vel subglobosae, fibrillosae vel subglabrae, albidae demum luteolae tactu sordide vinaceae, in "KOH" vinaceo-roseae. Gleba luteobrunnea, insiccati dura. Sporae 7.5–9 × 2.8–3.3 μ, oblongae vel subfusoideae. Typus: Smith 69679 (MICH).

Illustrations: pl. VII, 6.

Basidiocarps 1–5 cm. broad, globose to subglobose or angular from mutual pressure, surface appressed matted-fibrillose to almost glabrous, almost free of rhizomorphs except for a basal patch (and attached by these), whitish when young, soon weakly yellow ("Colonial buff"), when injured reddish-tan on young ones but dingy vinaceous on old ones, $FeSO_4$ olivaceous on fresh peridium, with addition of ethanol dark olive, in KOH dull vinaceous red; peridium when cut slowly reddish on young specimens and croceus on old ones. Gleba whitish then olive-buff, then dingy ochraceous, and at maturity dark yellow-brown ("Dresden brown"), soft-cartilaginous when mature (fresh) but bone-hard as dried.

Spores 7.5–9(–10.2) × 2.8–3.3 μ, oblong to subfusoid, smooth yellowish in KOH singly, pale yellow-brown in groups, in Melzer's sol. yellow to yellow-brown, false septum often present. Basidia 8-spored, clavate. Paraphyses soon thick-walled, content not coloring in Melzer's sol. Tramal plates of interwoven subgelatinous narrow (2–4 μ) smooth hyphae; subhymenium cellular, the cells often thick-walled in age. Peridium with an inner layer dark cinnamon in KOH from amorphous pigment, some cells quite enlarged (15 μ or more), outer layer yellowish in KOH, and with much less debris and amorphous pigment, in Melzer's sol. many amyloid granules present and pigment balls not forming or very rare; all hyphae nonamyloid. Clamp connections none.

Under conifers, gregarious, Idaho, and Washington, summer and fall.

This species is close to *R. ochroleucus* but has wider and slightly longer spores, a gleba which is soon dark yellow-brown, the peridium in places retains a strong vinaceous red tinge as dried, and there characteristically is a cluster of rhizomorphs at the base.

Material examined. IDAHO: Smith 68310, 68484, 68572, 68667, 68949, 68974, 69221, 69229, 69409, 69679 (TYPE), 70454, 70468, 70469, 71096, 71207. WASHINGTON: Smith 68096.

73. **Rhizopogon rubescens** (Tul.) Tulasne, Giorn., Bot. Ital. 2: 58. 1844, var. **rubescens.**

Illustrations: Fig. 72, spores; pl. IV, 3, pl. V, 1, and pl. VI, 1 basidiocarps.

Basidiocarps 1–6 cm. thick fresh, globose, subglobose, pear-shaped, or angular from mutual pressure, when young white and cotton-fibrillose over all, soon sparsely covered with rhizomorphs, the epicuticular hyphae soon becoming compacted into a denser layer and the layer becoming yellowish, eventually appressed fibrillose and near honey-yellow to yellow-ochre, at maturity, injured or exposed areas reddish brown and when injured the surface staining vinaceous red (pink on white basidiocarps); $FeSO_4$ on fresh surface staining the latter greenish to olive—often slowly; KOH causing a vinaceous red to red-brown color change. Odor none or in age at times disagreeable, like rotten cabbage. Gleba at first white and soft in texture, becoming olive-buff and more cartilaginous, at maturity rather gelatinous and dark olive-brown; when dried (old specimens) olive-tawny to olive-buff (on less mature ones), crumbly when one sections it after moistening it with alcohol; cavities large 0.25–0.75 mm. at maturity, rarely slightly speckled as seen on sectioned basidiocarps.

Spores 8–10 × 3.2–4.2 μ, subfusoid to ovate, or oblong hyaline to yellowish in KOH and Melzer's sol. (in young basidiocarps nearly hyaline or truly hyaline, in old ones pale ochraceous individually in KOH), basal scar present but not conspicuous; walls at maturity slightly thickened. Basidia 4-, 6- and 8-spored as seen on revived material but mostly 8-spored, hyaline soon collapsing, 5–7 μ broad and clavate to cylindric. Paraphyses 10–28 × 7–12 μ, clavate, ovate to ellipsoid, thin-walled at first but becoming thick-walled from a mucilaginous internal deposit, eventually leaving only a small lumen filled by amorphous material, not coloring in Melzer's sol., the basal cells and even the subhymenial elements finally becoming thick-walled. Tramal plates of hyphae at first floccose but becoming gelatinous, interwoven, smooth, narrow (3–8 μ broad); subhymenium cellular. Peridium consisting of an epicutis (distinct in revived sections, but not in fresh material) of appressed hyaline to pale yellow hyphae 4–12 μ in diam, with the cells of various lengths from isodiametric to over 10 times as long as broad (filamentose), pigment deposits or wall incrustations absent to inconspicuous (not cluttering up the layer), the hyphal walls thin and not refractive or gelatinous; lower layer as revived vinaceous-brown to fulvous as seen in KOH because of much amorphous debris between and on the hyphae, the hyphae equal in diam for the most part and 5–12 μ in diam, but inflated cells up to 20 μ occur at times, oleiferous hyphae absent to rare and usually ochraceous in KOH. Clamp connections none. All tissues nonamyloid.

Solitary to caespitose under conifers, especially 2-needle pines but not limited to this group or the genus *Pinus;* summer and fall, often very abundant in lodgepole pine forests of our Rocky Mountains in late July and August, but known across the continent.

This is a variable species and in the concept presented here is collective. I I have used the spore size given by Hawker (1954) and others as characteristic of the type variety. Svrcek (in Pilat, 1958) lists *R. rubescens* as a synonym of *R. roseolus*. Since Corda made no mention of yellow colors in his description of *R. roseolus (Splanchomyces roseolus)* I cannot accept this synonymy.

I have noted a number of interesting variations in this species in North American populations. In one such growing under Scot's Pine at the Proud Lake Recreation Area, Oakland County, Michigan (Smith 66451) old specimens had paraphyses in which the amorphous central body colored orange-brown to orange-red in Melzer's sol. This is found only in the oldest basidiocarps. In this collection, which contained about a peck of basidiocarps, the youngest (those with the softest gleba) had thin-walled paraphyses; in those in which the peridial epicutis had become matted down and honey-yellow the gleba was more cartilaginous, and many of the paraphyses had a wall at least somewhat thickened but as revived in Melzer's sol. the central body did not become colored. In the majority of the specimens, obviously mature, the paraphyses were almost all thick-walled, and the central body often colored very slightly in Melzer's sol.—being dingy ochraceous to brownish. In the oldest carpophores the red pigment was prominent in some areas not only in the central body of the paraphyses but also in the hyphae of the tramal plates in limited places. This pattern of color change has been noted only in material from this one pine plantation. The basidiocarps where injured or exposed become dull yellow-brown instead of red-brown; and the lower of the two color zones of the peridium is rusty brown in KOH, and no pockets of enlarged cells were noted. Oleiferous hyphae are easily found in some specimens and in some appear to be lacking. The basidiocarps dry a dingy-sulphur yellow except for the discolored areas which often dry blackish. In typical *rubescens* similar areas are more vinaceous brown on dried basidiocarps. No formal designation has

been given to this population because the characters obtained by the use of Melzer's sol. seem to me to be more in the nature of chemical changes associated with the early stages of tissue decomposition. It remains to be seen whether old specimens of the other variants ever give similar color changes. In collecting, the tendency is to throw out the specimens which are not going to dry well. Hence specimens as preserved at present in herbaria do not furnish a valid sample for comparison.

In McKnight 2317 and 2512 the yellow stage was apparently not of long duration. McKnight's notes say "white, tan, staining red when bruised."

In a small number of collections from the western states the spores are mostly 7–8.5 × 3.3–4 μ. These are: IDAHO: Smith 59478, 59690, 59504, 59704, 59895, 59032, 60152, 60613, 66106, 68004; WYOMING: Smith 35130. The difference in spore size appears to be too slight to justify any formal recognition as a taxon.

R. roseolus sensu Coker & Couch (1928) appears to be a form of *R. rubescens* with spores small as in certain collections from our western states cited above. The spores are 6.5–8.5 × 3–3.7 μ, and in 7207 (NC) they are subfusoid exactly as in *R. rubescens*. This form may be worthy of taxonomic recognition when it is better known. Apparently it is not too uncommon for a *Rhizopogon* in North Carolina. These data are from No. 7207 in the Coker and Couch collections. No. 7214 seems to be the same as 7207.

Material examined. ALABAMA: Underwood 1896 (3 colls.) (NY); IDAHO: Smith 45079, 45227, 45627, 59031, 59040, 59042, 59044, 59046, 59053, 59214, 59215, 59303, 59479, 59480, 59488, 59495, 59502, 59516, 59573, 59596, 59628, 59629, 59634, 59682, 59687, 59691, 59694, 59698, 59699, 59700, 59706, 59754, 59846, 59919, 59947, 59972, 60080, 60252, 60402, 60404, 60427, 60485, 60578, 60580, 60604, 60724, 60803, 65585, 65651, 65668, 65873, 65951, 66032; Trueblood 447, 517. (MICH); MICHIGAN: Shaffer 1969; Smith 38814, 42649, 43947, 43948, 51110, 51112, 58188, 62031, 62182, 66140, 66409, 66438, 66451, 66463, 66469, 66471, 66474, 68002, 69012, 69063, 69136, 69172, 69218, 69226, 69228, 69230, 69353, 69355, 69356, 69397, 69412, 69521, 69583, 69584, 69661, 69665, 69739, 69753, 69765, 69761, 69805, 69823, 69884, 69956. VERMONT: Bigelow 14164. (MICH); NEW JERSEY: Ellis, N. A. Fungi 943, 1879, (NY); NEW YORK: Fitzpatrick (N.Y. State coll. Ag. 598 (NC); S. H. Smith 27820 (NY); UTAH: McKnight F1102, F1300, F2317, F2418, F2463, F2512 (BYU); WASHINGTON: Smith 68094, 68415, 71323; Wier 1553 (NY); WYOMING: Smith 35489, 35511, 35524; CANADA, Nova Scotia: Harrison 15–10–52, 23–10–52, 5–10–53; Quebec: Smith 61800.

Rhizopogon rubescens var. **pallidimaculatus** A. H. Smith, var. nov.

Fructificationes 1–3.5 cm. crassae, globosae, fibrillosae, luteae. Odor fragrans. Gleba olivacea, pallide maculata. Sporae 6.5–9 × 2.8–3.5 μ, subfusoideae, leves, nonamyloideae. Typus: Smith 58821 (MICH).

Illustrations: Fig. 73, spores.

Basidiocarps 1–3.5 cm. thick, globose to subglobose, some angled from mutual pressure, surface cottony-fibrillose becoming glabrous by maturity, rhizomorphs inconspicuous to lacking, pallid when young, soon pale yellow and evenly pale dingy sulphur-yellow as dried (not with discolored areas as in *R. rubescens*); $FeSO_4$ pale olivaceous on peridium; KOH vinaceous-brown becoming dark brown; when bruised the peridial surface staining orange-pink. Odor fragrant. Gleba olive-ochraceous to olivaceous but pale yellow as dried and with paler yellow streaks and spots giving the cut surface a spotted appearance in at least some of the specimens of a collection.

Spores 6.5–9 × 2.8–3.5 μ, subfusoid to narrowly ovate, smooth, basal scar not conspicuous, hyaline to yellow in KOH and in Melzer's sol. merely yellowish in masses. Basidia 6-spored, hyaline, readily collapsing. Paraphyses clavate, ellipsoid to subglobose, thin-walled, 7–12 μ broad. Cystidia occasional in cavities next to gleba, about 40 × 12 μ and fusoid-ventricose with obtuse apices, thin-walled. Tramal plates of interwoven gelatinous refractive smooth hyphae; subhymenium cellular. Peridium with an epicutis of pale yellow thin-walled nongelatinous hyphae with smooth walls or some small particles of hyaline debris present, the hyphae 4–12 μ in diam and the cells extremely variable in length from isodiametric to 20 times as long as broad; subcutis rusty brown in KOH from copious amorphous rusty brown pigment in and on the hyphae or between them, enlarged cells present in the layer. Clamp connections absent. All tissues nonamyloid.

In duff under fir, and pine, Idaho and Michigan, summer and fall.

The distinguishing combinantion of characters for this variety is the pale yellow colors fresh and when basidiocarps are dried, the speckled gleba as seen in cut specimens, the fragrant odor, the thin-walled paraphyses and the orange-pink color-change on bruising. The spores are like those of *R. rubescens* var. *rubescens* but average smaller. Specimens dried whole and then cut open did not show the speckled gleba. The cavities of the gleba are large and when dried the consistency is crumbly under the razor when one tries to cut sections. Also, at times, some indications of a speckled gleba are found in the type variety of *R. rubescens*. The basidiocarps were old enough to have thick-walled paraphyses had there been any tendency for thickenings to develop. However, in typical *R. rubescens* the paraphyses may remain thin-walled for some time. Hence the collections are assigned to *R. rubescens* as a variety at least until further collections indicate otherwise.

Material examined. IDAHO: Smith 58821 (TYPE); MICHIGAN: Smith 43946.

Rhizopogon rubescens var. **rileyi** A. H. Smith var. nov.

Fructificationes 1–3.5 cm. latae, globosae vel irregulares, siccae, fibrillosae, pallide luteae demum sordide vinaceo-brunneae, tactu rubescens. Gleba pallida demum olivacea vel olivacei-brunnea. Sporae 6.5–8 × 2.5–3 μ, anguste oblongae, leves, nonamyloideae. Peridium subduplex. Typus: Smith 65401 (MICH).

Illustrations: Fig. 75, spores.

Basidiocarps 1–3.5 cm. diam globose to irregular, compressed, or lobed, surface dry, appressed fibrillose, dingy pale honey-color (yellow) on the smallest specimens found (in the depressed protected areas yellowish white), surfaces exposed to light becoming dark vinaceous-brown ("natal-brown"), the yellow areas slowly staining dingy vinaceous where handled, dried specimens with dingy vinaceous areas where there had been previous injury or exposure to daylight, the other parts drying dingy colonial-buff to pale Isabella-color. $FeSO_4$ not causing a color change on fresh peridium; KOH causing a change to vinaceous-fuscous; ethanol causing a change to pinkish brown. Gleba pallid, then pale olivaceous and finally olive-brown, when dried pale dingy olive to clay-color (paler than mature fresh gleba), rather spongy in consistency, rarely with a sterile streak of tissue inward, cavities up to 0.5 mm. broad in longest dimension (broad). Rarely with a basal attachment by a few rhizomorphs.

Spores 6.5–8 × 2.5–3 μ, narrowly elliptic to oblong, smooth, hyaline singly in KOH but pale yellowish in groups, yellowish in Melzer's sol. and in this medium many showing a false septum or a thickened internal more or less medial ring dividing the spore into two parts. Basidia 5–7 μ broad, 4- and 6-spored, hyaline,

readily collapsing. Paraphyses numerous, terminal cell subglobose to elliptic 14–20 × 7–12 μ, lower 2–3 cells more or less isodiametric giving the cellular subhymenium, some of the cells (especially the apical one) with mucilaginous thickened walls and a small central cavity. Cystidia rare, fusoid-ventricose and up to 35 × 12 μ, hyaline, thin-walled. Tramal plates of gelatinous hyaline thin-walled interwoven hyphae diverging slightly to the subhymenium. Peridium with an epicutis of loosely interwoven hyphae with incrusting debris (brownish in KOH), thin-walled; context a thin layer reddish as revived in KOH, the cells mostly short and broad (20 × 10 μ, 25 × 15 μ, etc.) often in groups, when crushed out having thin hyaline walls. Clamp connections none.

In clusters under lodgepole pine, Riley's Ranch, Stanley, Idaho, July 16, 1962, Nancy Jane Smith, (A. H. Smith 65401, TYPE).

The lack of a distinctive $FeSO_4$ reaction and the positive KOH reaction (dark vinaceous) coupled with scattered cystidia, especially in the locules near the peridium, the consistent yellow colors and the change to red are distinctive. The central body in the thick-walled paraphyses did not stain in Melzer's sol. It is recognized as a variety of *R. rubescens* because the spores are typically under 3 μ, wide and the $FeSO_4$ reaction is negative.

R. vulgaris gives a strong $FeSO_4$ reaction, lacked cystidia, and had thin-walled paraphyses.

Material examined. CALIFORNIA: Parks 1980; Zeller Herb. 1379 (as *R. rubescens*) (NY). IDAHO: Smith 45424, 49485, 59051, 65401 (TYPE), 65402, 66316, 68001, 68487, 68497, 68512, 68515, 69142, 69231, 69313, 69315, 69317, 69354, 69669, 69751. OREGON: Smith 71173. WASHINGTON: Smith 68074, 68095.

Rhizopogon rubescens var. **ochraceous** A. H. Smith, var. nov.

Fructificationes 1–5 cm. crassae, globosae, vel irregulares luteae tactu rubescens; sporae 7–9 × 3–3.5 μ, oblongae, leves, nonamyloideae. Typus: Smith 59496 (MICH).

Illustrations: Fig. 74, spores– pl. II, 1, basidiocarps.

Basidiocarps 1–5 cm. thick globose to pear-shaped or variously misshapen from mutual pressure, at times clustered and appearing to have a basal attachment, surface soft-fibrillose and white at first, becoming appressed fibrillose and yellow (pale yellow or "colonial buff" gradually more ochraceous to straw yellow and finally amber-yellow) when dried ("ochraceous-buff" of paler) and with rusty to reddish brown discolored areas; with scattered rhizomorphs often extending up from around the base; $FeSO_4$ no reaction to pale olive, KOH pinkish to vinaceous-brown; when injured staining red to red-brown. Gleba white to buff to olivaceous, chambers large in age, firm but in old specimens crumbly when one tries to make sections.

Spores 7–9 × 3–3.5 μ, narrowly ellipsoid to oblong (capsule-shaped), smooth, basal scar not conspicuous but distinct, hyaline in KOH singly or in groups ochraceous, in Melzer's sol. yellowish. Basidia 6- and 8-spored, hyaline in KOH, readily collapsing. Paraphyses clavate to ellipsoid, 12–25 × 7–12 μ, thin-walled but in age thick-walled and with an amorphous central body not coloring in Melzer's sol. Tramal plates of hyaline refractive gelatinous hyphae; subhymenium cellular and the cells becoming thick-walled like the paraphyses finally. Peridium as revived in KOH with a reddish brown to rusty brown lower region (layer) with copious brown pigment deposits changing into large orange-brown globules in Melzer's sol.; epicutis a layer of floccose-interwoven thin-walled hyphae greenish yellow in KOH and with some debris adhering on the walls but no characteristic

pigment deposits present, the hyphae 5–14 μ in diam, and some of the cells enlarged. Clamp connections absent, all tissues nonamyloid.

Solitary to clustered in duff, typically under *Pinus albicaulis,* July and August, Idaho.

The basidiocarps in this variant often dry rusty-ochraceous and the discolored areas more rusty than red-brown, so that dried specimens can usually be distinguished at a glance. Under the microscope the spores are more oblong or capsule-shaped, rather than subfusoid as in the type variety. Smith 60079, from near Stolle Meadows on the south fork of the Salmon River is a collection placed here that was not clearly under white-bark pine.

Smith 69679 apparently belongs here but the gleba was "Dresden-brown" (dark yellow-brown) mature and dried hard, as in, *R. luteolus.* The peridium stained reddish to reddish-tan, but when cut turned red in young basidiocarps and croceus in old ones. The dried specimens are duller than in the type. They are assigned here because the structure of the peridium and spore features check with the type, as does the "rubescens aspect." Smith 69790 apparently goes here also. In it the gleba was "snuff-brown" fresh. The peridium ocher-yellow fresh, the outer layer separable. The cut peridium did not stain but the surface stained vinaceous when injured. $FeSO_4$ was negative and KOH reddish.

Material examined. IDAHO: Smith 59007, 59052, 59474, 59476, 59481, 59483, 59484, 59486, 59489, 59492, 59496 (TYPE), 59497 59501, 59503, 59507, 59511, 59512, 59513, 59514, 59520, 59632, 59703, 60079, 60487, 60503, 69682, 69666, 69790; UTAH: McKnight F3021.

74. **Rhizopogon ventricisporus** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae vel irregulares, siccae, fibrillosae, ochraceae, tactu tarde rubescens. Gleba demum mellea. Sporae versiformes, ovatae, 9–13 × 6–8 μ, fusoide ventricosae, 13–22 × 5–7 × 3–5 μ, subcylindricae, 22 × 4 μ, nonamyloideae, tenuitunicatae. Typus: Smith 69165 (MICH).

Basidiocarps 1–3 cm. thick, globose to irregular, surface dry and appressed-fibrillose, ochre-yellow with occasional red areas but only staining red slowly in bruising and not always changing (different areas of the same basidiocarp tested); peridium near saffron-yellow when cut, drying with an ochraceous ground color and a dull rose flush pervading large areas; rhizomorphs inconspicuous. Gleba grayish to honey-yellow, where eaten by larvae the tunnel walls rusty ochraceous, drying dingy buff.

Spores variable as to shape, basic shape broadly ovate and 9–13 × 6–8 μ, most common variation is to fusoid-ventricose (cystidium like) and 13–22 × 4–7 × 3–5 μ (ventricose near point of attachment and neck elongated from original spore-apex), rarely subcylindric and up to 22 × 4 μ, ochraceous in KOH, nonamyloid (pale ochraceous-brown), thin-walled (rarely subglobose or obscurely angular). Basidia as such none seen. Paraphyses a chain of 2–4 enlarged cells, the uppermost 1–2 becoming thick-walled and globose to ovate (7–11 μ diam). Subhymenium filamentous, hyaline, gelatinous; hyphae of tramal plates narrow (3–6 μ), becoming gelatinous, becoming thick-walled in age at least in part. Peridium with a surface layer of loosely interwoven hyphae reddish cinnamon in KOH from both coagulated intracellular pigment masses and encrusting pigment, hyphae 4–8 μ diam, some hyphae with inflated cells up to 12 μ or more; more compactly arranged and interwoven hyphae in the interior and next to gleba with groups of enlarged cells (rudiments of glebal chambers). All hyphae nonamyloid. Clamp connections none.

Gregarious under spruce and white-bark pine, Heaven's Gate Ridge, Seven Devils Mts., Nez Perce Nat'l. Forest, Idaho, Aug. 11, 1964, coll. H. Burdsall (Smith 69165, TYPE).

Aside from spore features this species is a typical member of subsection *Rhizopogon*. Here again it is very doubtful if the cystidium-like spores are actually basidiospores. The question is whether or not both conidia and basidiospores are found produced on the same hymenium. Cytological evidence is needed. The lack of a differentiated epicutis of brown-walled hyphae distinguishes this species from *R. clavitisporus* and *R. subclavitisporus*.

Stirps Luteolus

Basidiocarps not staining orange or red when bruised; spores 3 μ or more wide; basidiocarps variously colored when fresh but most often yellow. This stirps intergrades with sect. *Fulviglebae*.

Key to Species of Stirps Luteolus

1. Cystidia 40–80 × 7–12 μ, abundant at least in the glebal cavities near the peridium. *R. pannosus*
1. Cystidia absent (occasional large clavate cells observed in glebal cavities near the peridium. 2
2. Basidiocarp golden yellow with inner layer brick-red; gleba bone-hard when dried. 76. *R. brownii*
2. Not as above. 3
3. Spores 5.5–7.5 μ long. 4
3. Spores 7–10 μ long. 6
4. Giant inflated cells present in peridium (as in *R. colossus* but thin-walled); peridium sublateritious as dried; spores 6–7.5 × 3.5–4 μ. 75. *R. subalpinus*
4. Not as above. 5
5. Spores 4.8–5.6 × 2.8–3.5 μ; peridium pale cinnamon-brown as dried. 77. *R. oregonensis*
5. Spores 6–7.5 × 3.3–3.5 μ; peridium blackish as dried. 78. *R. reaii*
6. Peridium when fresh staining olive where handled; gleba dark olive and hard as bone dried. 79. *R. subolivascens*
6. Not as above. 7
7. Peridial hyphae in epicutis densely coated with minute colorless granules (mounts in KOH). 80. *R. baxteri*
7. Not as above. 8
8. Basidiocarp pale yellow but becoming yellow-brown from handling. 9
8. Not staining as in above choice. 10
9. Gleba hard and firm when fresh. 81. *R. brunneicolor*
9. Gleba soft and almost sticky fresh. 82. *R. molligleba*
10. Basidiocarp when young covered by a heavy white conspicuous tomentum; gleba blackish brown and bone-hard when dried. 83. *R. oswaldii*
10. Not as above. 11
11. Gleba marked out into distinct patches when fresh; spores 7–11 × 2.9–3.7 μ, obscurely angular to variously shaped. 84. *R. piceus*
11. Not as above. 12
12. Peridium pale yellow fading to whitish in age; duplex. 85. *R. luteoalbus*
12. Not as above. 13
13. Peridium a single layer; gleba bone-hard as dried; rhizomorphs copious over the peridium when fresh; spores 7–10 × 2.5–3.5 μ. 88. *R. luteolus*
13. Not as above. 14
14. When dried the gleba spotted with pallid yellowish areas and its consistency not bone-hard; spores 6.5–9 × 3–4 μ. 87. *R. laetiflavus*
14. Gleba not speckled and not hard as dried; basidiocarps small (mostly 2–5 mm.); spores 8–10 × 3–3.5 μ; peridium duplex as seen in fresh condition. 86. *R. parasiticus*

75. **Rhizopogon subalpinus** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. crassae, globosae, siccae, fibrillosae, in siccatis sub-

lateritae. Gleba argillacea, firma. Sporae 6–7.5 × 3.5–4 μ, ovatae vel ellipsoideae, rare subangulares, nonamyloideae. Typus: Oswald #3 (MICH).

Basidiocarps 1–2.5 cm. broad, globose or nearly so, surface matted-fibrillose and as dried distinctly sublateritious (dingy vinaceous-red) with some areas dull brown, peridium when dried soon olive-black when treated with $FeSO_4$, no appreciable development of rhizomorphs visible. Gleba of dried material firm but not hard, lacunose, cutting readily in dried condition and cinnamon-buff in color. Columella none.

Spores 6–7.5 × 3.5–4 μ, ellipsoid to ovate, rarely obscurely angular, walls thin to slightly thickened, yellowish to hyaline in KOH, pale cinnamon in Melzer's sol., none seen with a false septum. Basidia 8-spored, clavate, 6–8 μ broad, hyaline, thin-walled. Paraphyses thin-walled, clavate, 8–12 μ broad. Hyphae of tramal plates interwoven and gelatinous, hyaline, smooth, subhymenium cellular, the cells about the width of the base of the basidia. Peridium with *some* thick-walled brown hyphae over surface but these not forming an epicutis, some inflated cells present as in *R. colossus* but these thin-walled and hyaline to slightly ochraceous, in lower region rusty-brown pigment deposits present (in KOH) in the hyphae (as in *R. vulgaris*), masses of blackish granules present in places (in KOH but not in Melzer's sol.); hyphae of the context thin-walled, interwoven, much branched, more or less incrusted to smooth, in Melzer's sol. showing large orange-brown pigment balls in lower (heavily pigmented) zone. Clamp connections absent, no amyloid particles present along hyphae of the peridium.

On the ground near cabins, Breitenbush Hot Springs, Oregon, July 8, 1963. R. Oswald #3 (TYPE).

This species has spores shaped as in many species of sect. *Fulviglebae* but they are not as dark colored. It thus falls in this stirps. It appears to be close to *R. maculatus* but has broader spores. In fact the spores are as broad as given by Zeller and Dodge for *R. maculatus,* but this is not what I found on an examination of the type. *R. maculatus* has a bone-hard gleba when dried as in *R. luteolus.*

76. **Rhizopogon brownii** A. H. Smith, sp. nov.

Fructificationes 8–30 mm. crassae, subglobosae, aureae tactu fulvescens, fibrillosae. Gleba olivacea. Sporae 7–9(–10) × 3–4(–4.5) μ, ellipsoideae vel subfusoideae, leves, nonamyloideae. Peridium crassum, bistratosum. Typus: C. A. Brown, Dec. 16, 1927, Louisiana, U. S. A. (NY).

Illustrations: Fig. 49, spores.

Basidiocarps 8–15 mm. as dried, up to 3 cm. fresh, globose to subglobose or elliptic, color when fresh golden-yellow with inner layer brick-red, turning rusty brown when bruised, when dried dull rusty brown and with dingy ochraceous areas showing, with faint rhizomorphs extending from the base upward in dried specimens. Gleba pallid to olive-buff as dried (probably whitish when fresh). Chambers large and irregular, dried specimens not of hard bone-like consistency.

Spores 7–9(–10) × 3–4(–4.5) μ, ellipsoid to subfusoid, hyaline in KOH and in Melzer's sol., smooth, wall thin to slightly thickened, no basal scar visible at maturity but young spores slightly truncate at base. Hymenium not reviving well enough to study but spores seen in groups of 4 are clearly borne on either basidia or conidiophores. Tramal plates of closely packed, very interwoven, gelatinous-cartilaginous hyphae (the details of the hyphae not clear in revived material). Peridium a very thick layer with a dark red-brown outer zone and a paler ochraceous to hyaline inner zone, no structural details were clear.

In a pine wood, Denkham Springs, Livingston Parish, Louisiana, Dec. 16, 1927, (NY), C. A. Brown (TYPE).

C. A. Brown, to whom we dedicate this species, said of the peridium, "Peridium in two indistinct layers, 130–250 μ. Inner layer brick-red and shows as patches of red when outer layer is removed."

In Melzer's sol. the hymenial zone is orange-red. This species is described here in spite of the lack of important details because I believe it will be easy to recognize it on the data available. The peridium as dried is glassy-hard and almost impossible to section. There is a deep red-brown outer layer on the specimen as sectioned but no structural detail could be made out. The gleba is easy to section though the hyphal elements revive poorly. This is a curious contrast not encountered in any other *Rhizopogon*. The large nonamyloid spores, golden-yellow color of the fresh surface, its staining to rusty brown on handling and the reddish inner layer of the peridium should allow the species to be readily identified in the field. In the features of the gleba it closely resembles *R. olivaceotinctus* and when it can be restudied from fresh material a careful comparison of the two should be made.

77. **Rhizopogon oregonensis** A. H. Smith, sp. nov.

Fructificationes 2–7 cm. crassae, globosae, subglobosae, ovatae vel pyriformes, reticulatae, in siccatis subfulvae. Gleba mollis. Sporae 4.8–5.6(–6) × 2.8–3.5 μ ellipsoideae, leves, nonamyloideae, nontruncatae. Peridium unistratosum. Typus: Takilma, Oregon, 11–30–25, C. H. Kauffman (MICH).

Illustrations: Fig. 52, spores.

Basidiocarps 2–7 cm. broad, globose to pyriform or ovoid, with numerous rhizomorphs (almost netted fresh) but when dried the peridium and rhizomorphs all the same color—a dull dark ochraceous tawny to dingy pale cinnamon-brown; $FeSO_4$ and KOH not staining the dried peridium distinctively, as dried the peridium chipping off in small areas leaving pallid yellowish spots. Gleba pinkish-buff as dried in young specimens and near umber-brown in old ones (typical of the colors of the *R. rubescens* group as dried and hence assumed to be olivaceous when fresh); consistency when dried fragile but easy to section, mature gleba almost crumbly.

Spores 4.8–5.6(–6) × 2.8–3.5 μ, ellipsoid to ovoid, smooth, thin-walled, sterigmal scar inconspicuous, hyaline in KOH singly and usually with a hyaline highly refractive globule or body, and in groups scarcely ochraceous, yellowish in Melzer's sol. Basidia clavate. Basidia 6- and 8-spored, 4.5–6 μ diam, 14–18(–26) μ long and subcylindric, hyaline, thin-walled, readily collapsing. Paraphyses 6–8 μ broad, 12–18 μ long, clavate to oval, thin-walled, with very minute refractive granules in some. Tramal plates of slightly refractive, interwoven, irregular hyphae hyaline in KOH; subhymenium cellular. Peridium a single layer of interwoven nongelatinous hyphae 4–10 μ diam and some inflated irregularly and 15 μ or more in diam, in KOH with a yellow-brown pigment in the cell sap and much debris in the layer but hyphal outlines remarkably clear, color (of layer revived in KOH under microscope) in the ochraceous tawny series. Clamp connections none. All tissues nonamyloid.

In the duff under conifers, Takilma, Oregon, Nov. 30, 1925, C. H. Kauffman and C. A. Brown (TYPE).

This species was identified as *R. occidentalis* by Kauffman, but it lacks the conspicuous rhizomorphs of that species in the dried state, is dark dingy ochraceous-tawny as dried, and the peridium tends to chip off readily leaving pallid

yellowish areas. Microscopically it has shorter broader spores, and in old specimens the paraphyses are not thick-walled. In the dried condition KOH and $FeSO_4$ fail to stain the peridium distinctively. There is much more amorphous material in the peridium both in and between the hyphae than one finds in *R. occidentalis*. Data on the color of the gleba when fresh, and color changes taking place on injury to the peridium when fresh are not known. *R. luteoalbus* seems to be the most closely related species but has spores 7–9(–10) × 2.8–3.5 μ, paraphyses which become thick-walled and its peridium is olivaceous where in contact with $FeSO_4$. Also its peridium is truly 2-layered.

78. **Rhizopogon reaii** A. H. Smith, sp. nov.

Fructificationes 1.5–3 cm. crassae, globosae vel irregulares, fibrillosae, subargillaceae, in siccatis atrisepiae. Gleba fragilis, luteibrunnea. Sporae 6–7.5 × 3–3.5 μ, leves, ellipsoideae; nonamyloideae. Typus: Rea 1434 (MICH).

Illustrations: Fig. 53, spores.

Basidiocarps 1.5–3 cm. thick, globose to subglobose, or somewhat irregular, surface appressed fibrillose, pale tan ("cinnamon-buff"), gradually blackening and bister to sepia or blackish as dried, more or less covered with numerous black rhizomorphs. $FeSO_4$ on dried peridium olivaceous but soon fading and not leaving a stain; KOH not leaving a permanent stain on dried peridium. Gleba whitish at first, becoming olive-brown, chambered, consistency when dried almost crumbly but sectioning easily and in color pale "tawny olive" to "Brussel's brown" (ocher-brown). Odor "rather strong"—Rea.

Spores 6–7.5 × 3–3.5 μ, ellipsoid hyaline to yellowish in KOH, in Melzer's sol. darker yellowish, smooth, walls scarcely thickened, basal scar indistinct (base rounded). Basidia clavate 6–8 μ broad, thin-walled and collapsing. Tramal plates of hyaline subparallel hyphae with thin to slightly thickened (mucilaginous) walls; subhymenium of enlarged cells highly refractive in KOH. Peridium a thick single layer of appressed-interwoven hypha 4–11 μ diam, but as revived in KOH with much amorphous material in the interior as well as incrusted on the walls, the pigment yellow-brown (in masses dark sepia), some inflated cells present but no groups of sphaerocysts located. Clamp connections none. All tissues nonamyloid.

Superficial, on ground under oak, caespitose, Santa Barbara Co., California, March 19, 1945. Paul and Marion Rea 52 and 1434 (TYPE).

Rea's field notes are: "They were soft and felt as if they might be viscid but we are not sure of this . . . They had a rather strong odor." "Plant irregularly globular, rooting at base, deeply cracked and fissured on under side, pinkish-white covered with dirt and fibrillose scales which are raised and dark in the center. Gleba white, turning brown in spots."

The basidiocarps in the dried state could easily be confused with those of *R. nigrescens*. It differs from the latter in wider more ellipsoid spores, in growing under oak, in not having a red pigment dissolving into the mounting medium from sections revived in KOH, and in having an olive-toned gleba. In Rea H52 the spores are about 1 μ shorter than in the type and more ovoid, but this was an immature specimen as judged by the pale gleba.

79. **Rhizopogon subolivascens** A. H. Smith, sp. nov.

Fructificationes circa 15 mm. crassae, ovoideae, siccae, fibrillosae, sordide ochracei-brunneae, tactu olivascens. Sporae 7–8.5 × 3.5–4 μ, ovatae vela angulariovatae, leves, nonamyloideae. Peridium unistratosum. Typus: Smith 65273 (MICH).

Illustrations: Fig. 54, spores.

Basidiocarps about 15 mm. thick, ovoid, surface dry and appressed fibrillose, dull rusty ochraceous when fresh, staining olive where handled; KOH staining peridial surface causing a dingy vinaceous stain, $FeSO_4$ slowly dark olive but fading, no reaction on dried material. When dried the peridium dingy vinaceous brown. Odor none. Gleba dark olive and retaining this color dried, consistency when dried hard and cavities minute.

Spores 7–8.5 × 3.5–4 μ, ovate to angular-ovate, smooth, truncate at base from a slight sterigmal scar, no distinct teeth (as seen in optical section) projecting down on either side, ochraceous in KOH and in Melzer's sol. but in mass along hymenium rusty red in Melzer's sol. Basidia 4-, 6-, and 8-spored, clavate, hyaline, collapsing. Paraphyses 7–12 μ wide, thin-walled, context homogeneous. Tramal plates of gelatinous hyaline refractive hyphae 3–5 μ diam, interwoven, subhymenium cellular. Peridium a single layer of hyphae 4–10 μ diam, but with so much dingy vinaceous debris in the layer as to obscure all details. No sphaerocysts seen. Clamp connections none. All tissues nonamyloid.

In duff under conifers, Brundage Mt., McCall, Idaho, July 9, 1962, Smith 65273 (TYPE).

This species is closest to *R. ochraceisporus,* but the gleba is olive instead of russet, and when dry it is hard and difficult to section (by comparison). Also, the peridium stains olive when bruised and when revived in KOH is dark dingy vinaceous-brown.

80. **Rhizopogon baxteri** A. H. Smith, sp. nov.

Fructificationes 5–12 mm. crassae, globosae, incarnati-argillaceae. Odor alliaceus. Gleba subargillacea. Sporae 8–9.5 × 3–3.8 μ, subfusoideae, leves, nonamyloideae. Typus: Baxter 2578 (MICH).

Illustrations: Fig. 48, spores.

Basidiocarps 5–12 mm. as dried globose to ovoid or variously irregular, surface dry and appressed fibrillose but lacking distinct rhizomorphs, when young and fresh "clay-color" flushed "light vinaceous-cinnamon", in age becoming "tawny-olive" and when dried pale "buckthorn-brown" to dingy ochraceous-cinnamon, unpolished as dried and staining olivaceous with $FeSO_4$, but the stain soon fading, with KOH staining slightly more fulvous. Gleba firm but sectioning easily, chambers relatively large as dried (readily distinct under a hand lens), cinnamon-buff to dull cinnamon (apparently not olivaceous when fresh). Odor of leeks when fresh.

Spores (7–)8–~~9.5~~(–10.5) × 3–3.8 μ oblong to subfusoid, ochraceous in KOH, in groups ochraceous-tan; in Melzer's sol. pale ochraceous (to ochraceous-brown in groups), smooth, basal scar very inconspicuous. Basidia often ventricose below with a narrowed neck and 4–6 spores at apex sessile or nearly so. The basidioles resemble fusoid-ventricose cystidia as they mature from their originally clavate stage. Paraphyses globose to ellipsoid, 7–12 μ broad, thick-walled, central content not staining in Melzer's sol. Tramal plates of refractive-hyaline subgelatinous hyphae 3–6 μ diam, interwoven to subparallel; subhymenium cellular and the cells often thick-walled like the paraphyses. Peridium a thin layer of loosely interwoven hyphae 4–8 μ diam with walls densely covered with granular incrustations (as in *Mycena osmundicola*), the layer ochraceous-tawny in KOH and no truly inflated cells present. Clamp connections none. All tissues nonamyloid.

Densely gregarious on and in the soil in the Packard St. Nursery of the School

of Forestry and Conservation, U. of M., Ann Arbor, Michigan, Oct. 17, 1927. D. V. Baxter. This material was identified as *R. rubescens* by Zeller.

Baxter's notes describe strands of mycelium at base of the fruiting body but not strands over the fruiting body—merely fibrils. The largest fruiting body measured when fresh was 2.5 × 1.2 cm. and the average was 1.2 × 0.8 cm.

Although this species keys out to *R. rubescens* if one assumes that it stains red, there is little resemblance when one compares specimens, or studies the structure of the peridium. Its true relationships appear to be in stirps Luteolus near *R. parasiticus,* but that species, on the basis of the descriptions, should be a much brighter yellow when fresh and should have a duplex peridium. Although I examined the material of *R. parasiticus* cited by Coker and Couch and discussed by Coker and Totten, the basidiocarps had collapsed so in drying that details were difficult to get. However, on none of the peridial hyphae did I find the dense coating of granules found on the peridial hyphae of *R. baxteri.* Since Baxter did not state that the specimens actually stained when handled, I am assuming this did not happen, and that Zeller identified the collection as *R. rubescens* on the assumption that it stained. Baxter gave the colors as matched in Ridgway. Hence if a color change had been present it would have been noted. Baxter (1928) reported on this species as infecting rootlets of Scotch Pine.

Material examined: MICHIGAN: Baxter 2578 (TYPE); 10–17–27, (both determined as *R. rubescens* by Zeller).

81. **Rhizopogon brunneicolor** A. H. Smith, sp. nov.

Fructificationes 1–2 cm. latae, globosae vel irregulares, pallide luteae, tactu lutei-brunneae, fibrillosae, siccae. Gleba sordide lutei-brunnea, dura. Sporae 7–9 × 2.8–3.8 μ, anguste ellipsoideae, leves, ochraceae, nonamyloideae. Peridium bistratosum. Typus: Smith 66092 (MICH).

Illustrations: Fig. 41, spores.

Basidiocarps 1–2 cm. broad, globose to subglobose or variously irregular; young and old specimens alike "ochraceous-buff" (pale yellow) or duller over all, where handled slowly changing to dark yellow-brown ("Brussel's brown" or "buckthorn-brown"), surface dry to moist but not lubricous or viscid, appressed fibrillose, no coarser rhizomorphs present. Odor none. $FeSO_4$ on fresh peridium pale gray, KOH on yellow surface staining it cinnamon-brown. Gleba dark yellow brown moist ("Brussel's brown"), very hard when fresh. Columella none.

Spores 7–9 × 2.8–3.8 μ, narrowly ovoid to narrowly ellipsoid, smooth, pale yellow in KOH fresh and when revived, yellow ochraceous in masses along the hymenium, yellow in Melzer's sol. and most of them with a false septum, lacking a distinct basal scar. Basidia 4-, 6- and 8-spored, thin-walled and readily collapsing. Paraphyses mostly with ultimate cell thick-walled and with a small central lumen, at times the whole chain of 3–4 cells with walls thickened, hyaline in KOH (including the lumen), yellowish-hyaline in Melzer's sol. and with the central body in the lumen merely yellowish hyaline. Tramal plates of hyaline refractive boldly defined hyphae with smooth walls, 3–6 μ broad and mostly uninflated; subhymenium cellular and the cells either thin-walled or walls thickened as described for the paraphyses. Peridium in section with an olive-black layer next to the gleba in $FeSO_4$, the same layer reddish in KOH. Epicuticular layer ochraceous as revived in KOH and with inflated cells in it, most hyphae 4–12 μ in diam and thin-walled; lower layer as revived in KOH with reddish pigment deposits and a reddish tone pervading the layer; all tissue nonamyloid, orange-

brown pigment globules present in the lower layer as seen in Melzer's sol. Clamp connections absent.

Under conifers, in Idaho, summer rare, Smith 66092 (TYPE); also 68039, 68666, 68668, 69170, 69171, 69403, 69410, 69824, 70447.

The distinctive features of this species are the ochraceous colors, staining to brown when handled, the thick-walled hymenial elements with a noncolored central body as seen revived in Melzer's sol., the clearly duplex peridium, and the fact that it is the inner layer which reacts with both KOH and $FeSO_4$. Also, the consistency of the gleba is exceptionally hard for this genus in the fresh condition.

82. **Rhizopogon molligleba** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. latae, globosae vel angulares, siccae, fibrillosae, ochraceae, tactu tarde luteo-brunneae, in "KOH" pallide brunneae. Gleba luteo-brunnea. Sporae 7–9 × 2.8–3.5 μ. Typus: Smith 69154 (MICH).

Basidiocarps 1–2.5 cm. diam, globose to angular-globose or angular-ellipsoid, surface dry and appressed fibrillose, with a few rhizomorphs present over the basal part but no basal attachment evident, color "ochre-yellow" becoming yellow-brown from handling and finally this color over all, when dried some areas near cinnamon-brown others remaining dingy ochraceous, surface merely brownish with KOH (fresh), $FeSO_4$ scarcely olivaceous (but if ethanol is added to the spot the color changes quickly to dark olive); peridium very thin and when sectioned merely ochraceous changing to dull yellow-brown. Gleba dark yellow-brown ("Dresden brown") mature, soft and moist (almost sticky when cut); in drying the younger specimens with firm gleba, the older ones with gleba having a cheesy consistency (not bone-hard as in *R. luteolus*). Columella none.

Spores 7.7–9 × 2.8–3.3 μ, oblong to narrowly ellipsoid, smooth, hyaline in KOH singly, yellowish in groups (revived in KOH), in Melzer's sol. yellowish singly and groups merely yellow-brown, a false septum usually present. Basidia 6–8-spored. Paraphyses ellipsoid to clavate and all thick-walled with a small central inclusion. Subhymenium cellular and the cells with walls thickened as in the paraphyses; hyphae of tramal plates thin to thick-walled but filamentous 2–5 μ diam, interwoven. Peridium of appressed-interwoven hyphae, as revived in KOH with some intercellular debris in epicuticular region, much rusty brown pigment intra-cellular in inner region, some hyphae inflated to 15 μ but no groups of sphaerocysts seen. Clamp connections none. All tissues nonamyloid though some dark violet particles present in the layer (in Melzer's sol.).

Gregarious under *Pinus albicaulis* and *Abies,* Heaven's Gate Ridge, Seven-Devil's Mts., Idaho, Aug. 11, 1964. Coll. H. Burdsall, Smith 69154 (TYPE), 69156.

This species is closest to *R. brunneicolor,* but the spores are a little narrower, the gleba is almost sticky when fresh specimens are cut in half, the peridium is thin and not obviously duplex, and in Melzer's sol. sections allowed to stand for an hour did not show any orange-brown pigment globules.

83. **Rhizopogon oswaldii** A. H. Smith, sp. nov.

Fructificationes 2–5.5 cm. crassae, 2–8.5 cm. latae, subglobosae vel compressae, saepe turbinatae, sulcatae vel nodulosae, ad basin melleae, sursum luteibrunnea; juventate albifibrillosae demum subolivaceae. Gleba sordide luteibrunnea. Sporae 7.5–9 × 3–3.6 μ, subfusoideae vel oblongae, saepe abscure angulares. Typus: Mt. Adams, Wash. Oswald No. 1 (MICH).

Illustrations: Fig. 55, spores.

Basidiocarps 2–5.5 cm. high and 2–8.5 cm. wide, globose, subglobose, compressed or turbinate, often creased or furrowed, surface more or less nodulose, color over upper part near "raw umber" with some areas darker, around the base near honey-yellow, where covered by debris olive-green to greenish brown, when fresh and young covered by a heavy white conspicuous tomentum, dried basidiocarps near "mummy-brown" but dingy yellowish areas showing in places, basal rhizomorphs prominent, elsewhere covered by a network of fine brownish fibrils. Gleba "mummy-brown" as dried, apparently olive when young and fresh, texture firm; cavities mostly open and rather small, angular; oozing a gelatinous liquid when cut, hard when dried. Odor at first earthy, becoming pungent, finally offensive and reminding one of spoiled garlic.

Spores 7.5–9 × 3–3.6 μ, subfusoid to oblong, many obscurely angular, smooth, greenish-hyaline singly in KOH, in masses pale "'snuff-brown." In Melzer's sol. pale snuff-brown or in masses darker, often showing a false septum in Melzer's sol. Basidia clavate and 5–8 μ broad, when sporulating developing a long neck 9–15 × 3–4.5 μ, 4- and 6-spored, spores sessile or nearly so, basidial walls thin and not gelatinous. Paraphyses not distinct from basidioles, thin-walled, not gelatinous. Tramal plates of closely packed crooked very interwoven gelatinous hyphae 3–5 μ in diam, subhymenium of branched gelatinous hyphae, no laticifers seen. Peridium separable from gleba and easily removed, 2-layered, on the dried specimens the layer which was originally white-floccose is dingy ochraceous as revived in KOH, the hyphae are appressed-interwoven and lack the pigment granules found in the lower layer; lower layer fuscous in KOH from numerous pigment granules and incrustations on the hyphae, hyphae appressed-interwoven, thin-walled and individually hyaline as revived in KOH, no greatly inflated cells observed, the hyphae 4–11 μ diam and cells equal in width to slightly inflated at either end or in the middle, nongelatinous, clamp connections none. All tissues nonamyloid.

Cespitose-gregarious in sandy soil under mixed conifers, Washington and Oregon, in the fall, rare.

The specimens tend to dry dark brown but a close examination shows dingy yellow areas. The extremely gelatinous interwoven hyphae of the tramal plates are distinctive along with the snuff-brown spores and macroscopic features. One can hardly crush out sections of the gleba. The contrast between the gelatinous texture of the gleba and the nongelatinous hyphae of the peridium is very sharp. Immature spores in some mounts appear weakly amyloid.

Material examined. OREGON: Smith 25065 (MICH). Zeller 8215 (NY). WASHINGTON: Oswald No. 1 (TYPE) (MICH).

84. **Rhizopogon piceus** B. & C. sensu Coker & Couch, Gasteromycetes Eastern U. S. and Canada. p. 34. 1928.

Basidiocarps irregularly globose, up to 1.5 cm thick, glabrous, greenish yellow when first dug, soon sordid yellowish and then brown to blackish on exposure and handling; fibrils abundant and netting the surfaces all over, inherent and only sparingly free below, dark brown, several entering the ground and there branching and holding a ball of earth. Peridium 300–500 μ thick, single, mottled with dark and light areas, in section under microscope seen to be composed of small threads about 3.7 μ thick and dark colored, subspherical to oblong or irregular bodies up to about 10 μ long which turn reddish brown in large part when fresh upon application of 7% KOH. When dry a section in KOH becomes largely black, mottled with pale areas. Gleba brownish yellow, toughish and

elastic, the chambers small, remarkable in being blocked out into small groups by obvious plates, empty at first becoming filled with spores. Odor distinct but not strong, suggesting walnuts or wine.

Spores 7.2–8(–11) × 2.9–3.7 μ, brown in mass, olivaceous individually, smooth, subelliptic, many obscurely angular to subtriangular or slightly constricted. Numerous "highly gelatinized thick-walled cells" in the hymenium.

North Carolina, in the winter, under pines. Coker 6059, Coll. H. R. Totten (NC).

The distinctive features are the irregular spores, greenish yellow peridium soon brown on bruising and the reddish brown laticiferous (?) or oleiferous hyphae (in KOH) in the trama. The spores of Coker 6059 are ochraceous singly in KOH, measure 8–11 × 3–4 μ and many are angular though the basic shape is oblong. The paraphyses are thick-walled in age, and the gleba is hard as dried much as in *R. luteolus*. The context of the peridium is filled with amorphous masses of rusty brown to yellow-brown pigment.

85. **Rhizopogon luteoalbus** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae vel irregulares, glaber vel subfibrillosae, pallide luteae demum griseo-albidae. Gleba olivaceo-brunneae. Sporae 7–9 (–10) × 2.8–3.5 μ, subfusoideae vel oblongae, leves, nonamyloideae. Typus: Smith 60027 (MICH).

Illustrations: Fig. 51, spores.

Basidiocarps 1–3 cm. thick, globose to oval or irregular, appearing glabrous beneath the few scattered rhizomorphs, pale yellow when fresh gradually fading out to grayish white or when old dingy Isabella-color as the gleba color shows through, dried peridium staining olivaceous when $FeSO_4$ is applied, KOH staining the dried surface brownish and ethanol staining it vinaceous, fresh specimens not changing color when bruised. Gleba dingy ochraceous to finally olive-brown, mature gleba crumbly in the dried condition when one attempts to section it, chambers small.

Spores 7–9(–10) × 2.8–3.5 μ, subfusoid to oblong, smooth, thin-walled, hyaline to yellow in KOH, pale yellow in Melzer's sol., basal scar small but distinct. Basidia 4- and 8-spored hyaline, collapsing readily. Paraphyses thin-walled at first, becoming thick-walled but content not coloring in Melzer's sol., entire hymenial hyphae becoming thick-walled, and in age often including the subhymenial elements. Tramal plates of gelatinous smooth hyaline refractive interwoven hyphae; subhymenium filamentous to the basal cells of the hymenial layer. Peridium 2-layered as revived in KOH, the outer or epicuticular layer of interwoven pale sulphur to hyaline hyphae with smooth to faintly roughened walls; the inner layer rusty brown in KOH from incrusting debris and intercellular deposits, no inflated cells (sphaerocyst-like) seen in either layer. Clamp connections none. All tissues nonamyloid.

Under lodgepole pine, central Idaho, summer and early fall, not common. The type was collected near Burgdorf, Aug. 13, 1958.

This species is close to *R. luteolus* but the gleba of dried specimens in *R. luteolus* is bone-hard and difficult to section for that reason. In the material we have placed in *R. luteolus* the color of the peridium deepens in age instead of fading to whitish.

Material examined. IDAHO: Smith 59745, 59903, 60027 (TYPE), 60069.

86. **Rhizopogon parasiticus** Coker & Totten, Jour. Elisha Mitchell Sci. Soc. 39: 101. 1923.

Basidiocarps up to 1.5 cm. broad and high, but typically smaller, mostly 2–5 mm., globose to lobed, or convoluted, attachment various to rhizomorphs, color of both mycelium and the fruit-body varying from a light ochraceous-salmon to a warm-buff at all stages until decay sets in. Peridium at maturity duplex 50–130 μ thick, the outer layer a spongy mass of loosely woven threads that collapse when the basidiocarp is cut or bruised; the inner layer more closely woven, lighter in color and intimately connected to the internal hyphae; threads of the peridium soft and delicate, 2.6–10.4 μ thick, in young plants more closely woven. Gleba of minute cavities 20–200 μ broad, empty, lined with the hymenium; septa 40–115 μ thick, delicate and intimately connected with the peridium, the threads much branched, segmented, thin-walled, without clamp connections, 2.6–10.4 μ wide, and having much the appearance of those of the peridium. Hymenium with fusiform bodies not seen to bear spores.

Spores brown, fusiform, smooth, 7.8–10.4 × 3–3.5 μ. Basidia 5 × 17 μ, 2- and 4-spored sterigmata 2.5–3.5 μ long.

On pine roots. North Carolina.

Authentic material collected by H. R. Totten (6057) Jan. 28, 1923 was studied. The spores were 8–10 × 3–3.5 μ and oblong to subfusoid and merely ochraceous in KOH, not brown in the usual sense of the word. The peridium was made up of loosely arranged hyphae 2–5 μ diam and with some yellowish amorphous pigment in the interior. The data taken from fresh specimens are to be relied upon here as the fruiting bodies when dried are too small to be studied effectively by the techniques used for other *Rhizopogon* species.

Hatch, in a letter to Zeller (March 5, 1937) questioned whether or not *R. parasiticus* was actually parasitic on pine roots. His view was that it was parasitic on a mycorrhiza-forming fungus. Doak (letter of March 19, 1937) confirmed the view expressed by Hatch in his letter. I have suspected a similar relationship in some collections of *R. abietis* (which for a time I had tentatively regarded as an additional new species).

Material examined: Collections from U. N. C. Herbarium.

87. **Rhizopogon laetiflavus** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. crassae, globosae vel irregulares, siccae, fibrillosae, laete flavidae, immutabiles. Gleba subochracea vel olivaceo-ochracea, pallide maculata. Sporae 6.5–9 × 3–4 μ, subfusoideae vel ovoideae, leves, nonamyloideae. Typus: Smith 45808 (MICH).

Illustrations: Fig. 50, spores.

Basidiocarps 1–2.5 cm. thick, globose to subglobose as well as variously angular from external pressures; surface dry and appressed fibrillose, rhizomorphs absent to rare, color at first yellowish, but by maturity canary yellow, not staining when injured but in drying dingy yellow (near "warm buff") or some areas dingy reddish brown, peridium of dried specimen vinaceous with alcohol and with KOH darker reddish, with $FeSO_4$ slightly olivaceous. Odor of fresh young specimens none, in age at times reminding one of sauerkraut. Gleba olivaceous to olivaceo-ochraceous, with pallid yellowish areas producing a spotted effect; cavities small, consistency when dried firm.

Spores 6.5–9 × 3–4 μ, subfusoid to ovoid, smooth, basal scar not distinct, walls thin, hyaline to yellow in KOH, yellowish in Melzer's sol. singly and in

groups. Basidia 6-spored, clavate, 6–8 μ broad, collapsing. Paraphyses oval to clavate, soon with greatly thickened walls, 8–12 μ broad, often the subhymenial hyphae also with thickened walls, amorphous central body not colored in Melzer's sol. Tramal plates of interwoven, smooth, refractive-gelatinous hyphae; subhymenium cellular to filamentous. Peridium with an epicutis of appressed hyaline to greenish-yellow hyphae 4–12 μ diam, and with very little debris adhering to them, both short and long cells present and some inflated; subcutis rusty brown in KOH from amorphous pigment which in Melzer's sol. forms large orange-brown pigment balls. Clamp connections none. All tissues nonamyloid.

In groups in the duff, under conifers (*Abies* and *Pinus* near by) South Fork of Lake Fork Creek, McCall, Idaho, Aug. 3, 1954. D. E. Stuntz and A. H. Smith (Smith 45808, TYPE). Additional collections from the same area are: Smith 45799a; 45800; 45802.

This species has the same speckled gleba as *R. rubescens* var. *pallidimaculatus,* but lacks a fragrant odor, does not change color on injury, and the paraphyses become thick-walled before the basidiocarps are mature. It is close to *R. luteolus* but rhizomorphs are lacking to rare, the gleba is speckled and not as hard when dried.

88. **Rhizopogon luteolus** Fries & Nordholm, Symb. Gast. 1: 5. 1817.

Illustrations: Fig. 56, spores.

Basidiocarps up to 4 cm. broad, globose to compressed and irregular in outline, surface dry and fibrillose and covered over all by appressed rhizomorphs, when fresh and uninjured yellow-ochre but soon deepening to golden-yellow or golden-tawny, the rhizomorphs often tawny at first; $FeSO_4$ and KOH producing no color change on the fresh peridium or slowly slightly brownish, ethanol no color change. Gleba white (all specimens young), chambered with very minute cavities (olivaceous at maturity according to European authors). Columella absent.

Spores 7–9(–10) × 2.5–3.5(–4) μ, narrowly oblong, wall slightly thickened, smooth, hyaline in KOH, yellowish in Melzer's sol. Basidia 16–20 × 6–7 μ, 4- and 6-spored, hyaline, thin-walled. Paraphyses subglobose to elliptic and only a few seen with mucilaginous inner-wall thickenings, 7–9 μ broad. Cystidia none. Tramal plates of hyaline refractive smooth hyphae in KOH, somewhat interwoven, subhymenium cellular from the basal and near basal cells of the hymenial elements. Peridium of appressed hyphae the walls bright ochraceous in KOH fresh (vinaceous-red as revived in KOH but slowly fading to fulvous), much debris in the layer and this material ochraceous when fresh and reddish brown revived in KOH, the hyphae 5–12 μ in diam with pockets of larger cells present or these cells more or less scattered throughout the layer, in Melzer's sol. many orange-brown globules present. All tissues nonamyloid. Clamp connections none.

Solitary in duff under fir trees, Idaho, summer, rare.

I have studied a number of European collections of *R. luteolus* and invariably at maturity the gleba dries bone-hard to almost glassy. The species or at least the type variety from Sweden has small spores 6–8 × 2.8–3.5 μ, the sterigmal scar is very indistinct, and the peridium, when well revived does have enlarged cells scattered or in groups. It remains to be seen whether the American collections cited here and the type form from Europe are both unreactive to $FeSO_4$ and KOH when fresh. The concept of Zeller & Dodge is a collective one; they give the spore size at 7–16 × 3–5 μ. Morton Lange (1956) gives the spore size as

smaller than in American collections but close enough to the specimen from Sweden.

Smith 45808 was canary yellow and unchanging and dried pale ochraceous. Very few rhizomorphs were present. The peridium has a darker line or ochraceous-fulvous area next to the glebal chambers. The remainder is free of pigment deposits, the cells are often somewhat enlarged, but no sphaerocysts were seen.

R. luteolus sensu Hawker (see extralimital species) is not the same as the collection in the Zeller Herbarium from the "type locality" in Sweden. This is a problem for European mycologists to settle. There is probably more to it than appears at first glance. The concept for *R. luteolus* which I have used here is very close (I think identical) with the Scandinavian specimens I have seen, and with the account published by M. Lange, so I have used the name in a sense that is consistent with at least some previous usage. After all the species is the type of the genus so considerable effort is justified in an attempt to establish an accurate concept for it. The hyphae in the Lloyd specimen from Sweden clearly have thinner walls than those from the Hawker specimen, and in addition it lacks the conspicuously thickened paraphyses, as well as having smaller spores.

Material examined. IDAHO: Smith 45711, 59493, 65254, 65631, 66110, 66179, 68923, 69222, 69817; Trueblood 543. ENGLAND: Reid 8–30–55. SWEDEN: (Zeller Herb. 1669) sent by Lloyd as authentic and apparently collected by Elias Fries. SWITZERLAND: Favre 8–17–43.

Rhizopogon luteolus (Smith 68046).

Basidiocarps 9–14 mm. broad, globose, surface with a thin layer of pale honey-yellow fibrils, these soon matted down and the dull brown color of the gleba predominant, $FeSO_4$ on surface slightly olive, KOH no reaction, surface when bruised not staining but cut peridium pale saffron. Gleba dark yellow-brown when mature ("Dresden brown"), cavities minute and labrynthiform, drying dark yellow-brown and hard as bone.

Spores 7–9(–10) × 2.8–3.5(–4) μ, narrowly ellipsoid to oblong, lacking a distinct basal truncation, smooth, hyaline in KOH, yellowish in Melzer's sol. Paraphyses all thick-walled (specimens all young). Tramal hyphae 2–3.5(–5) μ, thin- to thick-walled, hyaline, interwoven, subhymenium cellular. Peridium of interwoven hyphae 4–8 μ diam, the layer reddish brown in KOH fresh, hyphae all thin-walled; as revived in KOH with rusty cinnamon amorphous pigment deposits intercellular, in Melzer's sol. clearing somewhat but many hyphae with intercellular amyloid particles along them singly or in groups. Clamp connections none. Hyphal walls nonamyloid.

Three together under *Pinus contorta,* near Blanchard Washington but in the state of Idaho, July 1, 1964 (Smith 68046).

The basidiocarps became very dark reddish brown except for places where the floccose hyphae had not collapsed. The paraphyses readily became free in mounts of fresh as well as dried material. No rhizomorphs of any consequence were present. This is here considered as a variant of *R. luteolus,* using that name in a collective sense.

Rhizopogon subg. **Rhizopogon** sect. **Rhizopogon** subsect. **Angustispori** A. H. Smith, subsect. nov.

Sporae 1.6–3 μ latae; fructificationes demum luteae vel ochraceae. Typus: *R. ochraceorubens.*

Rhizopogon subg. **Rhizopogon** sect. **Rhizopogon** subsect. **Angustispori** ser. **Lutei** A. H. Smith, ser. nov.

Fructificationes demum lutei. Typus: *R. ochraceorubens.*

Stirps Ochraceorubens

Species with yellow tones in the basidiocarp at some stage of development; spores less than 3 μ broad; peridial surface not staining red when injured. This group connects to stirps Luteolus, but the species all have narrower spores.

Key to Species of Stirps Ochraceorubens

1. Hyphae of tramal plates thick-walled. 2
1. Hyphae of tramal plates thin-walled. 3
   2. Gleba dark yellow-brown; peridium clay-colored. 89. *R. argillaceus*
   2. Gleba olive to olive-gray; peridium olive-yellow. 90. *R. isabellinus*
3. Peridium subviscid fresh, staining orange to reddish brown before becoming black, blackish when dried. 91. *R. nigrescens*
3. Not with above combination of features. 4
   4. Peridium dull orange, drying vinaceous-brown; as revived in KOH the hyphae of epicuticular region with ochraceous incrustations. 92. *R. aurantiacus*
   4. Not as above. 5
5. Spores 5.5–6.5 × 2–2.5 μ (see R. *sordidus* also). 6
5. Spores 6–10 × 2.2–3 μ. 7
   6. Ground color of peridium dull lemon-yellow; basidiocarp typically with a basal short-rooting group of rhizomorphs, KOH yellow to brownish (see *R. occidentalis* also). 94. *R. subradicatus*
   6. Peridium grayish tan fresh; not rooting. 93. *R. libocedri*
   6. Peridium yellow; in KOH dull purplish red. 95. *R. flavofibrillosus*
7. Peridium a single thick layer of greatly inflated cells (practically pseudoparenchymatous). 96. *R. sipei*
7. Peridium not as above. 8
   8. Peridium staining russet when bruised, readily separable in flakes. 97. *R. separabilis*
   8. Not as above. 9
9. Dried peridium with lemon-buff ground color overlaid by blackish rhizomorphs; spores 6–7.5 × 2.5–3 μ. 98. *R. fuscorubens*
9. Not as above. 10
   10. Spores 7–9 × 1.8–2.3 μ, rod-shaped; peridium lacking sphaerocysts; rhizomorphs inconspicuous. 99. *R. burlinghamii*
   10. Not as above. 11
11. Not staining brown when handled. 12
11. Soon staining brown when handled. 15
   12. KOH soon staining fresh peridium rusty brown. 103. *R. alpestris*
   12. KOH staining fresh peridium red to ferruginous or scarcely staining it at all. 13
13. Basidiocarp bright yellow overlaid with brown rhizomorphs; KOH on fresh peridium maroon-red becoming maroon-brown. 102. *R. arenicola*
13. Basidiocarp white then slowly pale ochraceous or slowly lateritious, KOH on peridium ferruginous to carmine-red. 14
   14. Basidiocarp slowly becoming ochraceous; KOH on fresh peridium carmine-red; spores 6–8.5 × 2.5–3 μ. 101. *R. monticola*
   14. Basidiocarp slowly lateritious with yellow showing in a few places at times; KOH on fresh peridium ferruginous. 100. *R. sublateritius*
15. Peridial ground color bright yellow to ochraceous when young and overlaid with brown rhizomorphs; sections of peridium revived in KOH magenta for the hyphal incrustations. 104. *R. ochraceorubens*
15. Not as above, mostly without conspicuous rhizomorphs. 16
   16. Fresh peridium when cut dingy saffron-yellow. 105. *R. ochraceobrunnescens*
   16. Not as above. 17
17. Spores 6.5–7.5 × 2.2–2.4 μ; pockets of inflated cells occurring in the peridium. 108. *R. sordidus*
17. Not as above. 18

18. Peridial surface dull yellow-brown in KOH fresh. 106. *R. olivaceoluteus*
18. Peridial surface when fresh red with KOH. 19
19. $FeSO_4$ no reaction on fresh peridium; gleba soft and wet when fresh, drying hard. 107. *R. luteoloides*
19. $FeSO_4$ quickly olive-black on peridium; gleba firm-cartilaginous fresh and sectioning easily after drying. 109. *R. argillascens*

89. **Rhizopogon argillaceus** A. H. Smith, sp. nov.

Fructificationes 1–4 cm. latae, globosae, ovatae vel irregulares; subrugulosae, argillaceae demum sordide luteo-brunneae, fibrillosae. Gleba luteo-brunnea. Sporae 6.5–8 × 2.8–3 μ, anguste ellipsoideae, leves, in aggeris luteo-brunneae. Peridium tristratosum. Typus: Smith 66081 (MICH).

Illustrations: Fig. 39, spores; pl. IV, 2 basidiocarps.

Basidiocarps 1–4 cm. broad, globose, oval, more or less irregular; surface uneven and with irregular pits and depressions, surface dark "cinnamon-buff" to "buckthorn-brown" or "bister" (dark yellow-brown), with numerous white rhizomorphs over surface but not closely appressed (remains of mycelium?), when dried the peridium bister to nearly olive-brown. Gleba "Dresden brown" (dull yellow brown) moist when cut and exuding hyaline drops, chambers minute. Columella none.

Spores 6.5–8 × 2.8–3 μ, narrowly ellipsoid, smooth, pale olive in KOH singly but in masses along hymenium near "snuff-brown" (dingy yellow-brown), merely brownish in Melzer's sol. but in this medium often showing a false septum, wall very slightly thickened. Basidia 4- and 6-spored, subcylindric to clavate, 5–8 μ broad, hyaline and readily collapsing. Paraphyses vesiculose to clavate, up to 18 μ broad. Cystidia none. Tramal plates of interwoven hyaline thick-walled "glassy" hyphae (in KOH) yellowish-hyaline in Melzer's sol.; subhymenium cellular but rather indistinct as revived in KOH. Peridium thick (up to 1 mm.), white in section and not discoloring appreciably when cut; epicutis a layer 25–50 μ thick of appressed hyphae 8–12 μ in diam, the walls ochraceous in KOH and somewhat incrusted; subcutis of two regions, one containing pockets of enlarged cells (sphaerocyst-like) surrounded by "connective tissue," the enlarged cells 20 μ or more in diam, and between all hyphae (in KOH) many olive blackish to bluish black deposits of pigment present; lowest region purplish in places in KOH and the hyphae broad and nearly parallel in arrangement. Clamp connections absent.

Gregarious under spruce, Payette Lakes, Idaho, Aug. 21, 1962, Robert Jeanne, collector (Smith 66081, TYPE), and Broadbanks, near Naches, Wash. 7–10–47.

The basidiocarps even when well dried are very hard and difficult to cut or break. The peridium and gleba alike are dark bister, and thin sections in KOH appear dark gray-brown to the naked eye. This species has more than its share of outstanding features. The dark brown spores in masses along the hymenium, the thick-walled glassy tramal hyphae, the thick more or less 3-layered peridium with large pockets of sphaerocysts in the central region, the colors when fresh, and the dark olive color-change in both $FeSO_4$ and KOH are among these. Yet there appears to be no good reason for excluding the species from the genus.

90. **Rhizopogon isabellinus** A. H. Smith, sp. nov.

Fructificationes 2–3 cm. crassae, globosae, siccae, fibrillosae, isabellinae, tactu immutabiles. Gleba olivacea, firma, sordide olivacea. Sporae 5.5–7 × 2.3–3 μ, non-amyloideae, oblongae. Typus: Smith 71169 (MICH).

Basidiocarps 2–3 cm. broad, globose or nearly so, surface dry and fibrillose,

over this is a coating of appressed rhizomorphs Isabella-color fresh and practically unchanging in drying (dried in silica jel), rhizomorphs not conspicuous because they are the same color as the peridium, not staining red when bruised, with KOH slightly more yellow-brown, $FeSO_4$ slightly more olivaceous. Gleba dull olive drying olive-gray, consistency firm but not hard. Columella none.

Spores 5.5–7 × 2.3–3 μ, ellipsoid to oblong, smooth, hyaline to yellowish in KOH, yellowish in Melzer's sol. and often with a false septum. Basidia at least some of them 6-spored. Paraphyses hyaline in KOH and yellowish in Melzer's sol., becoming thick-walled but central body not staining. Tramal plates of hyaline highly refractive somewhat gelatinous narrow interwoven hyphae with walls of many at least somewhat thickened in age; subhymenium cellular and the cells becoming thick-walled like the paraphyses. Peridium of appressed-interwoven hyphae olive-yellow in KOH, the layer clean, inflated cells present here and there throughout the layer or in groups, in Melzer's sol. merely more yellowish and with scattered yellow pigment balls in the mount. Clamp connections none. All tissues nonamyloid.

This collection was made near Portland, Oregon and brought in to the annual mushroom show of the Oregon Mycological Society Oct. 11, 1964 (Smith 71169, TYPE).

This species is related to *R. ochraceorubens* but differs markedly in color (Isabella-color) and in the KOH reactions of the peridium as well as lack of pigment deposits in the latter.

91. **Rhizopogon nigrescens** Coker & Couch, Gasteromycetes of Eastern U.S. and Canada, p. 30. 1928.

Illustrations: Fig. 36a, spores.

Basidiocarps 2–6 cm. diam, subglobose or compressed (1.5–4 cm. high in largest specimens); pure white when young and fresh, becoming mottled with several colors when maturing, about "light-cadmium" beneath, shading to russet on top, turning orange below or reddish brown above when rubbed and finally almost black, blackish as dried or with chestnut to bay color also showing; fibrils numerous but slender, quite conspicuous on fresh basidiocarps, innate-appressed above, becoming more conspicuous below, passing into several rhizomorphous strands, reddish when fresh, becoming concolorous with the peridium and so appressed above and on sides on drying as to be quite inconspicuous, usually remaining free and conspicuous below; when fresh slightly sticky; purplish in 7% KOH on fresh surface (in dried specimens, the pigment is burnt-orange in 2% KOH), dark olive on revived sections in 15% $FeSO_4$. Gleba pure white when fresh, turning light clay-color, sometimes olive tinged on drying (in the specimens I studied the gleba was dull fulvous—A.H.S.).

Spores 6–7.5(–9) × 2–2.5 μ (5.5–7.4 × 2–2.7 μ, Coker & Couch), oblong to subellipsoid, yellowish in KOH singly, light brownish yellow in masses along the hymenium; yellowish to dingy yellow in Melzer's sol.; smooth, basal scar very inconspicuous. Basidia 15–30 × 5–8 μ (4.8–6.8 × 16–35 μ, Coker & Couch), mostly 8-spored but 6- and 4-spored seen, thin-walled and collapsing. Paraphyses basidium-like or up to 10 μ broad and many becoming thickened interiorly leaving only a small central cavity with amorphous material in it which does not stain in Melzer's sol. Cystidia none. Tramal plates of hyaline interwoven highly refractive-gelatinous hyphae branching to give rise to a nongelatinous cellular subhymenium. Peridium of appressed interwoven hyphae 4–10 μ in diam with numerous brown pigment deposits becoming red in KOH and pigment dissolving;

no inflated cells seen in the layer but its structure as revived in KOH is obscured by the pigment deposits, bright red in Melzer's sol. on standing for a short time. Oleiferous hyphae occasionally present. No clamp connections seen. All tissues nonamyloid.

This species is southeastern in distribution and occurs during spring, summer and winter, under pines, Florida, South Carolina and North Carolina.

Sharp's collection from Mt. LeConte is some other species (Fungi of the Great Smoky Nat'l. Park, 16679). It is not in condition to be identified. Smith 16034 from Idaho has amyloid spores. Zeller identified it as *R. nigrescens*. *R. nigrescens* was excellently described by its authors, and is distinct by a series of features such as the white peridium when young gradually staining rusty brown and finally drying blackish brown, the purplish color change with KOH, the dark olive with $FeSO_4$ and the slight viscidity when fresh. Not many species of *Rhizopogon* give the impression of being even slightly subviscid. Certain collections of this species are parasitized by a yellow imperfect (F. A. Wolfe, Duke Forest, Nov. 5, 1938).

There is no indication on the original packet of Coker 8168 to indicate that it is the type so the part of it in the Zeller collections is not to be regarded as type material. Since no type collection was designated, I have designated Couch 7582, one of the best collections in the N. Carolina Herbarium, as a neotype.

Material examined. FLORIDA: Miller 4487 (NY, as *R. rubescens*); Murrill 1942, 1943, 1945; Rea 1401 (MICH), 1944 (NC), 1943, 1945 (NY); West 11128, 2–27–36 (NY); Seaver, 930; Shuttleworth 14654 (NC). NORTH CAROLINA: Coker 976, 7277, 8168 (NC); Couch 7177, 7198, 7210, 7227, 7372, 7478, 7566, 7569, 7582 (LECTOTYPE), 9073, 9325; Totten 591, 1011, 1910 (all NC). SOUTH CAROLINA: Coker, 12–29–26. TENNESSEE: Smith 9918, 10288 (MICH).

92. **Rhizopogon aurantiacus** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. diam, globosae vel irregulares, siccae, fibrillosae, pallide aurantiacae, tactu immutabiles, in "KOH" tarde rubescens. Gleba alba demum luteola. Sporae 6.5–8 × 2.2–2.5 μ, oblongae. Typus: Smith 69546 (MICH).

Basidiocarps 1–2.5 cm. diam, globose to subglobose-nodulose, surface dry, with appressed dull brownish rhizomorphs which blacken in drying, beneath the rhizomorphs a thin fibrillose epicutis pale orange in color (about like an orange *Tricholoma aurantium*), drying to vinaceous-brown, cutis separating to expose small patches of the whitish subcutis; KOH slowly reddish to reddish brown, $FeSO_4$ gray to blackish; not staining when cut or bruised. Gleba white to honey yellow (in oldest one), texture dry when fresh, chambers small but distinct. Columella none.

Spores 6.5–8 × 2.2–2.5 μ oblong to ellipsoid, smooth, hyaline in KOH singly, in groups pale ochraceous (revived in KOH), in Melzer's sol. yellowish-hyaline singly, distinctly yellowish in groups, basal truncation very obscure. Basidia cylindric when sporulating, 6–8-spored. Paraphyses thin-walled. Subhymenium cellular; the hyphae of the tramal plates narrow (2–4 μ), hyaline, smooth, scarcely gelatinous as revived in KOH. Peridium when fresh with an outer layer of appressed-interwoven ochraceous-incrusted hyphae; inner layer red in KOH, no sphaerocysts present; as revived in KOH the whole layer or only the epicutis vinaceous-red (pigment both intercellular and intracellular), in Melzer's sol. the layer full or orange-red pigment balls, the hyphae thin-walled, clean of debris. Clamp connections none. All tissues nonamyloid.

Gregarious under spruce-fir, Twenty-Mile Creek, Upper Payette Lakes, Idaho, August 18, 1964, Smith 69546 (TYPE).

The orange color is the most distinctive field character, but the blackened rhizomorphs against a vinaceous brown background are distinctive of dried material. It is related to *R. ochraceorubens.*

93. **Rhizopogon libocedri** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae vel ovatae vel irregulares, siccae, fibrillosae, griseo-alutaceae. Sporae 5.5–6 × 2.2–2.5 μ, oblongae vel ellipsoideae, leves, nonamyloideae. Typus: Parks 6352 (NY).

Illustrations: Fig. 63, spores.

Basidiocarps 1–3 cm. thick, globose to obovate or somewhat irregular, surface dry, with many fibrils radiating from a basal point, grayish tan fresh, drying dingy cinnamon to near pinkish buff; $FeSO_4$ staining dried basidiocarp dark green to inky black, KOH staining dried peridial surface merely a darker brown. Gleba chambered, about concolorous with the peridium as dried (dingy pinkish-buff), chambers empty and variable as to size (dried specimens).

Spores 5.5–6 ×2.2–2.5 μ, oblong to ellipsoid, with a truncated basal scar, nearly hyaline in KOH, in Melzer's sol. slowly dextrinoid (at least in groups), yellowish to dextrinoid individually as seen in Melzer's sol. lacking a false septum, smooth, thin-walled. Basidia 4-, 6-, 8-spored, hyaline, 5–7 μ broad, thin-walled and readily collapsing. Paraphyses thin-walled, resembling basidioles, the outlines as revived in KOH indistinct but walls not gelatinous. Tramal plates of hyaline thin-walled gelatinous-refractive hyphae more or less interwoven, subhymenium very indistinct, not more than a single layer of isodiametric cells present. Peridium thin, of appressed hyphae 4–10 μ diam with thin walls but in sections the layer ochraceous tawny, little or no debris or pigment incrustations on the walls, no sphaerocysts in the layer; yellow oleiferous hyphae (as observed both in KOH and in Melzer's sol.) present. Clamp connections none. All tissues nonamyloid.

In duff under *Libocedrus decurrens,* Darlingtonia, Del Norte Co., Calif., Smith River Canyon, Nov. 2, 1939. H. E. Parks 6352 (TYPE).

The gleba is somewhat friable as dried but easy to section. The small spores are distinctive. It may very likely be true that this species forms mycorrhiza with *Libocedrus decurrens,* at least it was clearly restricted to this tree in the locality where Parks discovered it. *R. evadens* var. *subalpinus* has small spores but is different in nearly all other respects as indicated in the description.

94. **Rhizopogon subradicatus** A. H. Smith, sp. nov.

Fructificationes 3–9 cm. crassae, versiformes, siccae, fibrillosae, luteae vel flavae, rhizomorphis brunneis et ad basin radicatis. Sporae 5.5–6.5 × 2–2.5 μ, ellipsoideae. Typus: Smith 71317 (MICH).

Illustrations: pl. VIII, 1.

Basidiocarps 3–9 cm. broad and 2–6 cm. deep, globose, depressed-globose, flattened, pear-shaped, or variously irregular, surface dry and fibrillose, over this a network of appressed rhizomorphs dull cinnamon-buff in color to darker clay-color, extending upward from a definite short root-like point of attachment; ground color dull lemon-yellow to dingy sulphur where exposed to light, long remaining whitish where covered by soil, finally fading to dingy cinnamon-buff over portions exposed to light, not staining where injured (bruised areas merely becoming dingy slowly), KOH on epicutis dingy yellowish then yellow-brown;

$FeSO_4$ no reaction to slightly olive-yellowish, cut surface of peridium not staining but with application of KOH slowly dingy reddish brown next to the gleba. Gleba dry and spongy, chambers small to medium (± 1 mm.) and labrynthiform, staining ochraceous around damaged areas (worm holes etc.), KOH and $FeSO_4$ both no reaction, color pallid to grayish to olive-buff to grayish olive or finally olive-brown (when liquified), columella none.

Spores 5.5–6.5 × 2–2.5 μ, ellipsoid to oblong, often with a false septum, hyaline to yellowish in KOH and Melzer's sol., smooth, walls not appreciably thickened. Basidia 6–8-spored, cylindric when sporulating. Paraphyses thin-walled, yellowish hyaline in KOH. Subhymenium cellular to subfilamentose; tramal central strand of narrow hyaline subparallel hyphae. Peridium of appressed interwoven pale ochraceous (in KOH) hyphae 3–10 μ diam, and with greatly inflated cells 20–40 μ diam scattered throughout the layer, in Melzer's sol. merely ochraceous-tawny and with some "amyloid" granules, some granular debris in epicuticular region. Clamp connections absent, all hyphae nonamyloid.

Under *Pinus ponderosa*. San Poil Creek, Roosevelt Lake, Wash., Oct. 18, 1964, Smith 71317 (TYPE), and 71318.

This species is closely related to *R. occidentalis* but differs by the inflated cells in the peridium, lack of a positive $FeSO_4$ reaction, and lack of red stains when injured. It has numerous rhizomorphs and ellipsoid spores, both features distinguishing it from *R. bacillisporus*. The most conspicuous field character, however, is the definite basal attachment in the form of a short subradicating projection ending in a cluster of rhizomorphs. It is one of the largest species in the genus.

95. **Rhizopogon flavofibrillosus** A. H. Smith, sp. nov.

Fructificationes 3–5.5 cm. latae, globosae, pallidae, luteo-fibrillosis tectae, demum roseo-tinctae. Gleba pallida demum olivacea. Sporae 5.5–6.5(–7) × 2.5–2.8 μ, leves, oblongae, nonamyloideae. Peridium bistratosum. Typus: Smith 66021 (MICH).

Illustrations: Fig. 61, spores.

Basidiocarps 3–5.5 cm. broad, globose to depressed-subglobose or irregular in shape, largest one 5.5 cm. wide, 2.2 cm. deep; surface dry and uneven, pallid when very young but soon overlaid with "straw-yellow" fibrils and rhizomorphs, at maturity variously colored, greenish yellow over some areas and rose tinted over others but remaining pallid in the most protected places, virgate from appressed fibrils, attached by a basal cluster of rhizomorphs which extend up toward the surface; KOH on fresh peridium dull purplish red, $FeSO_4$ slowly pale olivaceous, ethanol no reaction; sectioned peridium not staining when cut. Gleba whitish becoming pale olivaceous, chambers becoming large in age (up to 0.5 mm.). Columella lacking.

Spores 5.5–6.5(–7) × 2.5–2.8 μ, narrowly elliptic to nearly oblong and with a faint basal truncation from the sterigmal scar, smooth, walls very slightly thickened, hyaline in KOH and very weakly yellowish in Melzer's sol. Basidia mostly 6-spored, 16–20 × 6–7 μ, hyaline, thin-walled collapsing readily. Basidioles resembling basidia, thin-walled throughout. Cystidia none. Tramal plates of refractive hyaline narrow hyphae 2–4 μ diam, and subparallel to interwoven in arrangement, appearing non-gelatinous in fresh material; subhymenium narrow, usually the basal cell of an hymenial element and the short branch from the tramal hypha. Peridium at first with an epicutis in the form of a trichodermium of short branched hyphae with end cells 26–40 × 5–9 μ and subcylindric to clavate, hya-

line and thin-walled; subcutis of appressed parallel to interwoven hyphae reddish in KOH from a dissolved pigment, some incrusting pigment present on surface or near it; scattered groups of enlarged cells present (indicating cut hyphal ends of groups of hyphae at right angles to the general direction of the remainder of the hyphae). Clamp connections none. All tissues nonamyloid.

Under conifers, Smith's Ferry, Idaho, Aug. 20, 1962, Ellen Trueblood, (Smith 66021, TYPE; 66023).

The trichodermium over the peridium apparently soon collapses, as it was not demonstratable on the dried specimens but was clear on fresh young material. When dried, the basidiocarps are a dingy Isabella-color.

96. Rhizopogon sipei A. H. Smith, sp. nov.

Fructificationes 3–9 cm. thick, globosae vel irregulares, glaber vel impolitae, insiccatis "bister" vel "mummy-brown" (atro-brunneae). Sporae 6–7.5 × 1.8–2.2 μ, cylindraceae, leves, hyalinae, nonamyloideae. Typus: Legit F. P. Sipe (NY).

Illustrations: Fig. 37, spores.

Basidiocarps large, 3–9 cm. thick globose to subglobose or lobed, surface glabrous to unpolished, colors when fresh not known but as ascertained from dried material pallid to dingy tan becoming "bister" to "mummy-brown" in drying, apparently lacking any conspicuous development of rhizomorphs, chemical reactions unknown but no green or olive anywhere when revived in KOH. Gleba as dried dingy ochraceous-brown.

Spores 6–7.5 × 1.8–2.2 μ, cylindric to oblong, basal scar distinct, smooth, thin-walled, hyaline in KOH singly to pale ochraceous in groups, yellowish to hyaline in Melzer's sol. Basidia clavate, hyaline, thin-walled, readily collapsing, 6- to 8-spored, elongated at time of sporulation. Paraphyses 8–11 μ broad, resembling basidioles, thin-walled in age. Tramal plates of hyaline interwoven to subparallel refractive hyphae 4–8 μ diam and not truly gelatinous as revived in KOH, large oleiferous hyphae seen in the trama; subhymenium distinctly cellular, the walls sharply defined as seen in KOH. Peridium a single thick layer of hyphae with greatly inflated cells (almost pseudoparenchymatous in sections) in the lower region and more filamentose toward the exterior but the cell outlines all but obscured by masses of yellowish brown amorphous pigment filling most of the cells. Clamp connections absent. All tissues nonamyloid but amyloid masses scattered widely in the peridial layer and some pieces of hyphae having an amyloid content.

TYPE collected by Frank P. Sipe Oct. 21, 1939 near Clear Lake in the Upper McKenzie River Valley, Oregon, under Douglas fir (in the Zeller Herbarium as *R. pachyphloeus,* unnumbered).

Someone has annotated the packet to the effect that the largest specimen weighed "126 ozs." Grams must have been meant as it is impossible to imagine a *Rhizopogon* fruit body weighing 7.5 lbs.; or possibly a decimal point was omitted! The species appears to be closely related to *R. nigrescens* in the color of the dried basidiocarps and in the heavy pigment deposits in the context of the peridium, but is at once distinct because of its narrow rod-shaped spores. The spores distinguish it at once from *R. oswaldii* which it closely resembles in general appearance when dried. *R. bacillisporus* is distinguished at once by the characters of the peridium.

97. Rhizopogon separabilis Zeller, Mycologia 31: 3. 1939.

Illustrations: Fig. 62, spores.

Basidiocarps 1.5–4 cm. broad, globose to subglobose or irregular in outline; surface rather smooth, sparsely covered with inconspicuous fibrils; white to cartridge buff with vinaceous pink spots, becoming pale yellow ("cream-buff"), changing to russet where bruised, drying dingy cinnamon to dingy vinaceous-brown (not fuscous), separable. Gleba white becoming buffy-citrine and drying Isabella-color (more olivaceous as revived in $FeSO_4$), cavities small, empty. Columella none. Odor resembling that of raw potatoes to somewhat farinaceous.

Spores 6.5–8 × 2.5–3 μ, narrowly ellipsoid to subfusoid, hyaline in KOH singly, yellowish in groups, in Melzer's sol. yellowish singly and deeper yellow in groups, smooth, basal scar distinct under oil. Basidia 4- and 6-spored, 9–15 × 4–6 μ, cylindric, soon collapsed. Paraphyses 6–12 μ broad, with interior wall-thickenings but no central body staining in Melzer's sol. Tramal plates of gelatinous refractive interwoven hyphae giving rise to a cellular nongelatinous subhymenium. Peridium as revived in KOH fulvous in the outer zone, nearly hyaline next to the gleba and there having many cells enlarged up to 20 μ or more causing a weak connection to the gleba, hyphae in the highly colored zone 3–7 μ diam, pigment in pockets and on the hyphal walls. Clamp connections none. All tissues nonamyloid.

During the summer and fall under *Pinus contorta* in Oregon, Smith 8236 (NY & MICH).

This species is pale yellow staining rusty brown and the peridium flakes off. In *R. argillascens* the heavy pigment deposits are in the zone next to the gleba, not in the epicuticular zone as in *R. separabilis,* and in the latter the inner zone does not stain red when the fresh peridium is cut. However, the two are close enough to justify further critical study of their differences as indicated to date.

98. **Rhizopogon fuscorubens** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. crassae, globosae, reticulato-fibrillosae; in siccatis fibrillis attratis. Gleba pallide ochracea, maculata. Sporae 6–7.5 × 2.5–3 μ, oblongae, leves, nonamyloideae. Typus: Oswald, 10–10–63 (MICH).

Basidiocarps 1–3 cm. broad, globose to subglobose, surface covered by a network of rhizomorphs as in *R. occidentalis* only in drying becoming black causing surface to be black or with lemon buff areas showing between, upper area ochraceous with fuscous streaks, $FeSO_4$ on dried peridium staining ochraceous areas olive. Gleba pale ochraceous as dried, firm but cutting easily, olivaceous in age, as dried some with slightly pallid spots as in variants of *R. rubescens.*

Spores 6–7.5 × 2.5–3 μ, oblong, to narrowly ellipsoid, smooth, base obscurely truncate, yellow in Melzer's sol. hyaline to yellowish in KOH. Basidia 8-spored, 12–15 × 5–7 μ narrowly clavate. Paraphyses thin-walled, 12–15 × 6–11 μ, subvesiculose. Subhymenium cellular, the cells hyaline and thin-walled. Tramal plates of nongelatinous hyphae subparallel to interwoven, some cells enlarged to 9–15 μ. Peridium of rhizomorphs and interwoven much-branched hyphae, as revived in KOH dark magenta to fuscous-red including rhizomorphs, with plate like incrustations of pigment to nearly smooth, hyphae cylindric and 4–12 μ diam, no sphaerocysts present. In Melzer's sol. large orange-brown pigment globules present. Clamp connections none, all tissues nonamyloid.

This species was brought into the annual mushroom show of the Oregon Mycological Society Oct. 20, 1963, and again in 1964 (Smith 71172) at Portland, Oregon and communicated by Ruth Oswald.

It is most closely related to *R. ochraceorubens* but dries black with yellowish areas visible, instead of red as in the latter.

99. **Rhizopogon burlinghamii** A. H. Smith, sp. nov.

Fructificationes circa 2–4 cm. latae, compressae, 1–2 cm. crassae, glaber, siccae, rufo-fulvae. Gleba subargillacea. Sporae 7–9 × 1.8–2.2 μ, oblongae vel cylindricae, leves, nonamyloideae. Typus: Zeller Herb. 8244, legit G. S. Burlingham (NY).

Illustrations: Fig. 60, spores.

Basidiocarps 2–4 cm. broad and 1–2 cm. thick (estimated dimensions fresh from dried material), surface glabrous, dull and unpolished, when dried reddish-tawny but paler than in *R. ochraceorubens*; $FeSO_4$ on dried peridium no reaction, some rhizomorphs present but very inconspicuous on dried specimen. Gleba near pale pinkish buff dried and though firm in consistency sectioning very easily.

Spores 7–9 × (1.8–)2–2.3 μ, rod-shaped to narrowly ellipsoid, smooth, thin-walled, hyaline in KOH individually and faintly ochraceous in groups, in Melzer's sol. mostly yellowish but some groups with a bluish-gray tone indicating a very weak amyloid reaction in places, smooth, base scarcely truncate from basal scar. Basidia 6-spored, spores on very short sterigmata, hyaline, thin-walled, 5–7 μ diam. Paraphyses resembling basidioles, remaining thin-walled but a few with a small refractve granule. Tramal plates of interwoven subgelatinous hyphae of variable diameter as revived in KOH; subhymenium cellular. Peridium an interwoven single layer of appressed hyphae 3–8 μ diam and many with cinnamon to yellowish amorphous content as revived in KOH, no amyloid granules seen in mounts in Melzer's sol. and no enlarged cells observed (sphaerocyst-like), some hyphal cells irregular in diameter and up to 12 μ broad; in sections revived in KOH fulvous at first but slowly becoming "clean" and nearly hyaline at least in places. Clamp connections none. All tissues nonamyloid.

Type collected at Pacific Grove, Calif. of G. S. Burlingham, Zeller Herbarium 8244 (TYPE).

This was identified as *R. occidentalis* by Zeller. It lacks the ochraceous color and rhizomorph pattern of that species, gives a negative $FeSO_4$ reaction and has narrower spores. It is most closely related to *R. ochraceorubens* but the peridium lacks the characteristic magenta colors of that species as revived in KOH, and the basidiocarps are a paler color dried. The faint amyloid reaction noted is only of theoretical interest—unless future collections show it to be more pronounced at some other stage of development. There were no notes on the macroscopic features when fresh or on the habitat situation.

100. **Rhizopogon sublateritius** A. H. Smith, sp. nov.

Fructificationes 1–6.5 cm. latae, globosae vel irregulares, siccae, rhizomorphis numerosae, albae, tarde sublateriteae. Gleba sicca, firma, olivaceobrunnea; sporae 5–6 × 2.2–2.6 μ, nonamyloideae. Typus: Smith 71176 (MICH).

Illustrations: pl. VIII, 8.

Basidiocarps 1–6.5 cm. broad, globose to globose-angular or angular-ovate, surface dry and unpolished beneath a coating of coarse to often loosely appressed rhizomorphs often forming a wide meshed reticulum and at the base often in a cluster at place of attachment, white with yellowish areas at times but slowly becoming flushed pale lateritious in places or almost over all, not changing on bruising and lacking distinctly yellow colors when fresh; KOH on peridium slowly ferruginous; $FeSO_4$ very slightly olive yellowish, $FeSO_4 + C_2H_5OH$ (on same spot) quickly olive. Peridium very thin and unchanging when cut. Gleba white becoming pale olive-gray, dry in consistency when fresh, chambers very small. Columella absent.

Spores 5.5–7.5(–8) × 2–2.3 μ, oblong to ellipsoid, hyaline in KOH singly, pale dingy cinnamon-buff in masses, hyaline to yellowish singly in Melzer's sol. and in masses cinnamon-buff, smooth, typically with two large oil droplets as seen revived in KOH. Basidia cylindric to clavate when sporulating, mostly 6-spored. Paraphyses hyaline in KOH, thin-walled at first, *slowly* becoming somewhat thick-walled. Tramal plates of interwoven narrow gelatinous hyaline hyphae as revived in KOH, subhymenium filamentous and diverging from central strand and ending in enlarged cells at base of basidium. Peridium of interwoven-appressed mostly hyaline hyphae 4–10 μ diam with some groups of enlarged cells up to 18 μ diam, in epicuticular region the walls tawny to brick-red both in KOH and Melzer's sol., at least over most areas and some incrusting debris present, but interior region almost lacking debris (clean) and unpigmented. Clamp connections absent. All tissues nonamyloid.

In arcs under a solitary *Pinus ponderosa,* Priest River Experimental Forest, Idaho, Sept.-Oct. 1964. Smith 70455, 70474, and 71176 (TYPE). All the specimens are to be regarded as coming from a single mycelium.

This species is clearly related to *R. ochraceorubens,* but the color pattern differs sharply, and there is scarcely any color change in drying, a feature which separates it at once from *R. ochraceorubens.* It is easy to misread the color reactions in KOH and $FeSO_4$ on this species at least to the extent of reporting both as negative. In the type, which consisted of the most mature specimens, these reactions were recorded as negative, but younger specimens gave them as indicated in the description. In the oldest specimens a slight change to yellow was noted in the ground color but this is to be expected in view of the color changes in the gleba and because of the relatively thin peridium. As revived in Melzer's sol. there were no orange to red "pigment balls" (large drops) as in so many species. However, a few indications of these were seen in the colored area at the surface.

101. **Rhizopogon monticola** A. H. Smith, sp. nov.

Fructificationes 2–5 cm. crassae, globosae vel angulares, albida, tarde ochraceae, in "KOH" rubescens. Gleba grisea demum olivacea, cartilaginea. Sporae 6–8.5 × 2.5–3.2 μ, oblongae. Typus: Smith 69612 (MICH).

Basidiocarps 2–5 cm. diam, globose or nearly so or subglobose, compressed, or angular from mutual pressure, surface white when young and matted-fibrillose, slowly yellowish to ochraceous, mostly with dingy lilaceous to reddish stains at time of collection but not staining these colors when injured, more or less covered with yellowish to clay-color appressed rhizomorphs, with KOH the surface carmine-red, $FeSO_4$ olivaceous gray slowly, when dried dingy yellowish with vinaceous areas. Odor none. Gleba grayish olive (olive-buff), chambers minute, cartilaginous. Columella none.

Spores 6–8.5 × 2.5–3 μ, smooth, oblong to obscurely fusoid, lacking a basal truncation, yellowish in KOH singly and dingy yellow-brown in masses, in Melzer's sol. yellowish, singly and in masses pale tawny, often becoming distinctly colored (merely yellowish) in Melzer's sol. Paraphyses oblong to elliptic, 6–9 μ diam, thick-walled, and with a central mass merely yellowish in Melzer's sol. Tramal plates of interwoven hyphae 2–6 μ diam, thin-walled, hyaline in KOH and subgelatinous. Peridium a thin layer of appressed-interwoven hyphae as an epicutis, this layer clean and hyaline to yellowish in KOH; subcutis as revived in KOH dull red and with amorphous pigment in the layer (appearing "clean" when fresh), many hyphal cells inflated but no sphaerocysts in groups evident. Clamp connections none. All tissues nonamyloid.

Hypogeous under *Abies* and *Picea,* Black Tip Ridge, McCall, Idaho, Aug. 22, 1964, H. Burdsall collector (Smith 69612, TYPE).

This species is similar to *R. rubescens* var. *ochraceus* but does not stain red when injured, has a stronger KOH reaction on fresh material and duller colors on drying.

102. **Rhizopogon arenicola** A. H. Smith, sp. nov.

Fructificationes 1.5–2.5 cm. latae, siccae, flavae, demum brunneae, in "KOH" rubescens. Gleba griseo-olivacea. Columella filamentosa. Sporae 6–8 × 2.2–2.5 μ. Typus: Smith 70855 (MICH).

Basidiocarps 1.5–2.5 cm. broad, globose or nearly so, surface dry, ground color bright yellow, this overlaid with brown rhizomorphs (almost reticulate), not staining when injured but slowly becoming dull brown on standing overnight, KOH on cutis maroon-red and slowly darkening to maroon-brown, $FeSO_4$ no reaction to slightly brownish. Gleba pallid becoming olive-buff to olive-gray, firm-cartilaginous, chambered, chambers minute. Columella distinct as a thread-like structure about 1 cm. long and 0.7 mm. wide, watery avellaneous in color and coming from a basal rhizomorph (in no way is it an invagination of the peridium as not infrequently found in groups of basidiocarps of other species).

Spores 6–8 × 2.2–2.5 μ, oblong to narrowly obovate, smooth, yellowish in KOH singly (both fresh and revived), dingy yellow-brown in masses, in Melzer's sol. yellowish singly and lacking a false septum, in groups pale orange-tawny, base obscurely truncate. Basidia clavate, 6–8-spored. Paraphyses thin to thick-walled. Subhymenium cellular; tramal hyphae narrow (2–6 μ), hyaline in KOH, subgelatinous. Peridium of sections of rhizomorphs and appressed-interwoven hyphae, orange-tawny in KOH fresh and magenta as revived in KOH, when fresh with a vinaceous red inner layer in KOH and much incrusting pigment and pigment debris present, as revived in Melzer's sol. developing large orange-red pigment balls. Clamps none. All tissues nonamyloid.

In fine sand near lodgepole pine, north end of Priest Lake, Idaho, Sept. 27, 1964, Ken Harrison collector (Smith 70855, TYPE).

The dried basidiocarps are dull red to vinaceous-brown much as in *R. ochraceorubens* to which it is most closely related. However, we have never observed a columella in that species. As in many species of *Martellia,* by the time the specimens are dried it is no longer evident. However, in this collection, it was a true columella and not a mere invagination of the peridium. The KOH and $FeSO_4$ reactions on fresh material are also different from those of *R. ochraceorubens.*

103. **Rhizopogon alpestris** A. H. Smith, sp. nov.

Fructificationes 1–3.5 cm. crassae, globosae vel subglobosae, siccae, fibrillosae rhizomorphis brunneae, pallidae demum ferrugineae vel ferrugineo-brunneae. Gleba pallida vel olivaceo-grisea demum luteo-brunnea. Sporae 6–8 × 2.3–2.8(–3) μ, oblongae vel subfusoideae. Typus: Smith 69611 (MICH).

Basidiocarps 1–3.5 cm. diam, globose to subglobose, surface dry and appressed fibrillose with an overlay of brown rhizomorphs closely appressed and in some practically forming a reticulum, pallid when young, slowly becoming dull ferruginous and finally dingy brown, drying (in silica jel) dingy vinaceous, as dried over heat, pallid yellowish with vinaceous areas in older ones, rhizomorphs inconspicuous as dried, KOH on cutis rusty brown, $FeSO_4$ slowly gray to grayish

black. Gleba pallid, becoming olive-gray and in age near "Dresden-brown" (dark yellow brown), cartilaginous, chambers small. Columella lacking.

Spores 6–8 × 2.3–2.8(–3) μ, smooth, thin-walled, oblong to subfusoid, hyaline in KOH singly, dingy ochraceous in masses, in Melzer's sol. yellowish singly to dingy ochraceous in masses, basal truncation not evident. Basidia 6–8-spored. Paraphyses thin-walled or finally thick-walled, central inclusion hyaline to yellowish in Melzer's sol. Tramal plates of thin-walled narrow (2–5 μ) subgelatinous hyphae more or less interwoven, sections crushing out readily and easily broken up; subhymenium cellular. Peridium a thin layer of appressed hyphae mostly dark reddish brown in KOH fresh and dark magenta as revived in KOH, masses of amorphous pigment in the layer, in Melzer's sol. numerous red pigment-balls present, lacking sphaerocysts but many hyphal cells inflated. Clamp connections none. All tissues nonamyloid.

Hypogeous in thin soil under *Abies* and *Picea,* Black Tip Ridge, McCall, Idaho, Aug. 22, 1964, Smith 69611 (TYPE).

This species is easily distinct from *R. ochraceorubens* and *R. aurantiacus* by the color of the fresh basidiocarps. *R. sublateritius* differs in color fresh and dried and in narrower spores, though the latter difference is slight. When dried, basidiocarps of *R. alpestris* are dark vinaceous-brown with the rhizomorphs showing obscurely as blackish lines.

104. **Rhizopogon ochraceorubens** A. H. Smith, sp. nov.

Fructificationes 2–8 cm. latae, globosae, ellipsoideae vel irregulares, saepe fibrilloso-subreticulatae, croceae, ochraceae, demum subfulvae vel fulvae, fibrillis fulvis vel rufofulvis. Gleba pallida demum olivacea denique olivaceo-brunnea. Sporae 6.5–8 × 1.7–2.3(–3) μ, leves, anguste oblongae nonamyloideae. Peridium unistratosum, subseparabili. Typus: Smith 59643 (MICH).

Illustrations: Fig. 59, spores; pl. VI, 2, basidiocarps; pl. VIII, 6.

Basidiocarps 2–8 cm. broad, variously shaped, from globose to subglobose, ellipsoid, lobed, flattened, or variously irregular; pale lemon-yellow to yellow-ochre to golden-yellow to tawny yellowish or finally cinnamon to russet, sometimes unchanging when bruised but usually tending to stain tawny to fulvous from handling, usually covered with a network of rhizomorphs which are conspicuous at first but less so in age (as the surface becomes the same color as the rhizomorphs), when dry the surface vinaceous-red to vinaceous-brown, peridium in some collections showing a tendency to flake off—especially on dried specimens—exposing pale ochraceous areas; $FeSO_4$ greenish to dark olive (rarely scarcely reacting) on surface, KOH slowly tawny to reddish brown or no reaction (reaction usually slow). Gleba white becoming olivaceous to olive-brown but near cinnamon-buff as dried, chambers moderately large, consistency when dried somewhat friable and easy to section. Odor none at first, in age acid to acid metallic at times.

Spores 6–8 × (1.7–)2–2.5(–3) μ, narrowly oblong, smooth, thin-walled, hyaline when young, yellowish at maturity (in KOH), in Melzer's sol. yellowish hyaline to ochraceous and none seen with a false septum, basal scar small and indistinct. Basidia 6- and 8-spored, 12–20 × 5–7 μ, ellipsoid to slightly clavate, thin-walled, collapsing, hyaline or in cavities near peridium occasionally somewhat vinaceous in KOH. Paraphyses resembling basidioles, thin-walled, hyaline, collapsing. Cystidia none. Tramal plates of smooth thin-walled gelatinous-refractive subparallel to interwoven hyphae, subhymenium very indistinct and refractive, cellular layer

consisting of basal cells of the hymenial elements. Peridium of appressed-interwoven hyphae and rhizomorphs, the fundamental peridial hyphae usually dark vinaceous-red as revived in KOH from pigment deposits and wall incrustations, the rhizomorphs basically ochraceous in KOH but in some sections entirely vinaceous-red, or in others some red and some merely ochraceous (where there are no pigment pockets, some only red around the periphery); no sphaerocysts present but occasional inflated cells up to 15–20 μ present on some hyphae, hyphae mostly 3–10 μ diam and cells uninflated and thin-walled. All tissues nonamyloid. Clamp connections absent.

Solitary to clustered in duff under pine, mostly under lodgepole, during the summer and fall in Oregon and Idaho.

The basidiocarps dry vinaceous red to vinaceous-brown, which is in strong contrast to those of *R. occidentalis* and *R. luteolus*. The peridium is basically thin but many rhizomorphs become interwoven with it so that in some sections it is rather thick. The rhizomorph in cross section resembles a cable of wires cut crosswise. The hyphae in the rhizomorphs vary from 2 to 12 μ in diam, but mostly 2–5 μ in diam. The surface when fresh is typically subreticulate from the numerous rhizomorphs but as these and the ground color gradually merge to the same shade they become less conspicuous and in the dried condition are often easily overlooked. I have seen no other *Rhizopogon* in which the rhizomorphs become incorporated into the peridium in the manner shown by this fungus. No oleiferous hyphae were seen in any of my mounts.

Material examined. OREGON: Smith 19336, 20052; IDAHO: Smith 16016, 45811, 46396, 46507, 47134, 58872, 58889, 58999, 59000, 59028, 59029, 59037, 59048, 59054, 59057, 59422, 59470, 59471, 59643 (TYPE), 59724, 59854, 59877, 59955, 60029, 60253, 60324, 60328, 60421, 60403, 60422, 60489, 60517, 60567, 60568, 60738, 65409, 65415, 65451, 65483, 65497, 65698, 65758, 65918, 65950, 65991, 66075, 66087, 66114, 66140, 66144, 66165, 66166, 66188, 66333, 66360, 66336, 68970, 69044, 69045, 69072, 69233, 69300, 69318, 69414, 69576, 69699, 69378, 70433, 71142, 71167, 71168, 71350 (MICH).

105. **Rhizopogon ochraceobrunnescens** A. H. Smith, sp. nov.

Fructificationes circa 15 mm. crassae, globosae, ochraceae tactu sordide brunneae, in "KOH" badiae. Gleba griseo-olivacea. Sporae 6.5–7.5 × 2.5–3 μ, oblongae. Typus: Smith 68578 (MICH).

Basidiocarps about 15 mm. in diam, globose, surface moist and matted-fibrillose, ochre-yellow, becoming dingy brown where handled, lacking any appreciable rhizomorphs, the cut peridium dingy saffron-yellow in section, when dried dull ochraceous except for the areas that were stained brown, KOH on surface dingy reddish brown; $FeSO_4$ merely brownish. Gleba when mature grayish olive, chambers distinct to the naked eye, consistency cartilaginous when fresh and hard when dry.

Spores 6.5–7.5 × 2.5–3 μ, oblong to ellipsoid or subventricose, smooth hyaline to yellowish in KOH, yellowish in Melzer's sol., often with a false septum, not truncate. Basidia collapsed. Paraphyses thick-walled including the basal cells of the subhymenium, central content hyaline to yellowish in Melzer's sol. Tramal plates of narrow (3–6 μ) hyaline filamentose hyphae branching divergently to the cellular layer beneath the hymenium. Peridium two-layered in sections, the outer layer ochraceous in KOH, the hyphae 4–10 μ diam, thin-walled, smooth. The inner layer red in KOH and with intercellular pigment pockets rusty brown, the hyphae in the upper layer merely yellowish hyaline, in Melzer's sol. with many

orange-brown pigment balls and some large as well as small globules dark violet black.

Solitary in conifer duff, Priest River, Idaho, July 24, 1964, Smith 68578 (TYPE), Heaven's Gate, Seven Devils Mts., 8–11–64, Smith 69223.

This species is very close to *R. separabilis* but has a hard gleba like *R. luteolus* dried, the peridium is not separable, and in sections revived in Melzer's sol. large droplike dark violaceous bodies (solid droplets) are found in or along the peridium.

106. **Rhizopogon olivaceoluteus** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. crassae, subglobosae, olivaceo-luteae, udae, tactu brunneae, in "KOH" luteo-brunneae. Gleba luteo-brunnea demum cinnamomea. Sporae 7–9 × 2.6–3 μ, oblongae. Typus: Smith 68365 (MICH).

Basidiocarps 1–2.5 cm. broad, globose to subglobose, surface dull greenish yellow fresh and matted fibrillose, wet to the touch and in drying much debris adhering to surface, exposed peridium soon dull brown where handled, rhizomorphs fine and closely appressed over the surface; surface dull yellow-brown in KOH, in $FeSO_4$ olive-brown. Gleba "snuff-brown" (dingy yellow-brown) fresh, becoming near "Sayal-brown" in drying (dull cinnamon), cartilaginous, bone-hard when dry, chambers minute. Columella absent.

Spores 7–9 × 2.6–3 μ, oblong (capsule-like), pale yellowish singly in KOH, yellow-brown in groups, in Melzer's sol. yellowish singly, and pale tawny in groups, smooth, base obscurely truncate. Basidia (none found sporulating). Paraphyses all thick-walled at maturity, central body not staining in Melzer's sol. Tramal plates of interwoven narrow (3–6 μ), gelatinous, hyaline smooth hyphae; subhymenium cellular and most cells thick-walled. Peridium of appressed-interwoven hyphae, much amorphous pigment (dull cinnamon revived in KOH) in and between the hyphae; some enlarged hyphal cells present (up to 15 μ) but most hyphae 4–10 μ diam, no nests of sphaerocysts seen; in both KOH and Melzer's sol. violet-black granules and amorphous masses present (intercellular). Clamp connections none. All tissues nonamyloid.

In conifer duff, under *Abies,* Gisborne Mt., Priest River Exp. Forest, Idaho, July 15, 1964. Smith 68365, TYPE.

This species is close to *R. subcitrinus* and may be only a form of it, but the peridium does not stain red at first, it is greenish yellow when uninjured, there are copious amounts of pigment in the layer in sections revived in KOH, and the gleba dries dull cinnamon.

107. **Rhizopogon luteoloides** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. latae, globosae, ochraceae, udae, tactu luteo-brunneae in "KOH" rubescens. Gleba mollis, uda, luteo-brunnea. Sporae 7–9(–10) × 2.7–3 μ. Typus: Smith 69167 (MICH).

Basidiocarps 1–3 cm. diam, globose, ellipsoid or angular from external pressure, often compressed, yellow-ochre fresh, and wet in appearance (even when collected in relatively dry duff), quickly staining yellow-brown from handling and when dry the bruised areas dull cinnamon with unbruised areas dull ochre, KOH on cutis red, $FeSO_4$ no reaction, almost no rhizomorphs present. Gleba soft and becoming wet in consistency at maturity but drying bone-hard and crumbly when one tries to section it, pallid brownish young, then "Dresden-brown" to "argus-brown" at maturity, dull cinnamon as dried. Columella none.

Spores 7–9 × 2.7–3 μ, oval to narrowly elliptic or oblong, yellowish in KOH singly, yellow-brown in masses, in Melzer's sol. yellow singly and pale rusty brown in masses, smooth, basal scar scarcely visible, thin-walled. Basidia none seen sporulating. Paraphyses oval to elliptic 7–11 μ diam, soon thick-walled with a central amorphous body not colored in Melzer's sol. Tramal plates of interwoven hyaline subgelatinous hyphae 3–5 μ diam which became thick-walled; subhymenium of thick-walled cells connecting to paraphyses as a chain of such elements (cellular type). Peridium as revived in KOH a loosely interwoven outer layer of thin-walled pale ochraceous hyphae the cells 4–12 μ diam, and often enlarged, some granular intercellular material present; lower layer rusty brown in KOH from amorphous pigment as revived in KOH and hyphal cells mostly at least somewhat inflated. Clamp connections none. All tissues nonamyloid.

Under *Pinus albicaulis,* Heaven's Gate Ridge, Seven-Devils Mts., Nez Perce Nat'l. Forest, Idaho. Aug. 11, 1964. H. Burdsall collector, Smith 69167 (TYPE), also 68112, 69144, 69166, 69168, 69821, 69822.

108. **Rhizopogon sordidus** A. H. Smith, sp. nov.

Fructificationes 1–3.5 cm. latae, globosae, siccae, fibrillosae, ochraceae, tactu tarde brunneae, in "KOH" incarnato-cinnamomeae. Gleba demum luteo-brunnea. Sporae 6.5–7.5 × 2.2–2.4 μ, oblongae. Typus: Smith 68529 (MICH).

Basidiocarps 1–3.5 cm. diam, globose, ellipsoid, or irregular in outline from mutual pressure, surface dry and matted-fibrillose, mostly lacking any appressed or loosely enveloping rhizomorphs, color when fresh a dingy but rich ochre-yellow, slowly becoming dingy brown from handling and when dried a dull sordid brown, no white stage observed, KOH on cutis pinkish cinnamon and soon fading, $FeSO_4$ no distinct reaction; peridium thick, two layered, the outer somewhat separable, the inner pallid but "pinkish-cinnamon" or redder when cut. Gleba rather dry when cut, chambered, white becoming dingy yellowish to olive yellowish and finally near buckthorn-brown, easily sectioned when dry. Columella none.

Spores 6.5–7.5 × 2.2–2.5 μ, oblong, smooth, not truncate, hyaline or nearly so in KOH, merely yellowish in Melzer's sol., many with a false septum as seen in Melzer's sol. Basidia cylindric 4–6 μ diam, hyaline 4- 6- 8-spored. Paraphyses soon thick-walled. Content more or less colorless in Melzer's sol. Hyphae of tramal plates hyaline, gelatinous, interwoven, subhymenium cellular (1–2 cells deep). Peridium with the epicutis of appressed interwoven hyaline hyphae with very little incrusting pigment fresh but a considerable amount in dried material revived in KOH, hyphae filamentose, 3–5(–8) μ, in diam, inner layer or subcutis containing a heavy concentration of yellow-brown pigment and debris (intercellular) and with pockets of enlarged to inflated cells. Clamp connections absent. All tissues nonamyloid.

Under *Pinus ponderosa* near Blanchard, Washington but in Idaho, July 20, 1964, Smith 68529 (TYPE), 68532 (collected by Nancy Jane Smith).

This species is close to *R. rubescens* var. *rileyi* but KOH did not produce a change to vinaceous-fuscous, in fact the opposite happened, the tested areas faded back to the color of the rest of the surface. The inner layer of the peridium was not red on sections of revived material and the dried basidiocarps are a dull sordid brown, not colonial-buff to Isabella-color. *R. vulgaris* gives a strong positive $FeSO_4$ reaction. Since there is a slight reddish tint on the cut surface of the fresh peridium this species is intermediate between this and stirps Vulgaris.

109. **Rhizopogon argillascens** A. H. Smith, sp. nov.

Fructificationes 1–3.5 cm. crassae, globosae vel angulares, lutei-cinereae, tarde luteo-brunneae, tactu tarde brunneae, in "KOH" rubescens, in "$FeSO_4$" nigro-olivaceae. Gleba lutei-brunnea. Sporae 6–8 × 2.3–3 μ, oblongae. Typus: Smith 68531 (MICH).

Illustrations: pl. VII, 4.

Basidiocarps 1–3.5 cm. diam, globose to ellipsoid or angular from mutual pressure, surface matted-fibrillose and an even grayish "pinkish-buff", gradually becoming dingy yellow-brown from handling and dingy clay-colored as dried, staining reddish slightly if outer layer is rubbed off but not becoming red from ordinary handling, attached at base by a cluster of rhizomorphs, lacking any appreciable number of rhizomorphs over the surface; KOH on peridial surface dark magenta, $FeSO_4$ soon olive-black; peridium in section with a reddish inner and a pallid outer layer, outer layer peeling away readily. Gleba at maturity dingy yellow-brown, and as dried near "buckthorn-brown" or more ochraceous, firm but not hard (sectioning readily).

Spores 6–8 × 2.3–3 μ, oblong to narrowly ellipsoid, smooth, nearly hyaline singly in KOH, ochraceous in masses along hymenium, in Melzer's sol. yellowish singly to pale tawny in groups and most with a false septum, base at most very obscurely truncate. Basidia 6- to 8-spored. Paraphyses hyaline, thin-walled young, thick-walled with a central hyaline amorphous body in age. Tramal plates of interwoven gelatinous hyaline hyphae 3–6 μ diam, diverging to a filamentous subhymenium the only isodiametric cells small and at base of hymenial element, nowhere does the trama appear truly bilateral. Peridium thick (about 1 mm. fresh), 2-layered, lower layer with indistinct areas of inflated cells, and this layer staining heavily in KOH (as dried with many amorphous intercellular masses of dull rusty brown pigment giving thin sections a spotted appearance), outer layer of interwoven-appressed hyphae (3–) 6–10 μ diam with pale ochraceous walls (as revived in KOH) and with relatively little intercellular debris. Clamp connections none. All tissues nonamyloid.

Gregarious under *Pinus contorta* near Blanchard, Wash. but in Idaho, July 20, 1964, Smith 68531 (TYPE), 68541.

The distinguishing features of the species are the grayish pinkish-buff color of fresh young basidiocarps and the slow change to brown, the basal cluster of rhizomorphs, the peridium staining reddish in the subcutis, magenta reaction to KOH and olive-black change with $FeSO_4$. It is close to *R. sordidus* but the color of the latter is rich ochre-yellow. Both were compared fresh. In *R. sordidus* the KOH reaction was pinkish cinnamon and this color soon faded; $FeSO_4$ gave no distinct reaction. Both have a separable epicutis not sharply differentiated anatomically, similar spores, and the same dingy clay-color of the basidiocarps as dried, except that the dull magenta stains from KOH are still evident on the dried specimens of *R. argillascens*.

Stirps Vulgaris

Fresh peridium showing yellow at some stage of development; peridium staining red when injured (cut the fresh peridium and observe the cut surface); spores 3 μ wide or less. This stirps is to be regarded as a continuation of stirps Rubescens into the narrow-spored series.

Key to Species of Stirps Vulgaris

1. Spores 10–13 × 2–2.5 μ. — 110. *R. cylindrisporus*
1. Spores shorter. — 2

2. Fresh basidiocarps subviscid to lubricous. 3
2. Fresh basidiocarps with an essentially dry fibrillose surface. 5
3. Peridium staining orange to reddish and then blackish on handling. see *R. nigrescens*
3. Not as above. 4
4. $FeSO_4$ on peridium dark olive. 111. *R. butyraceus*
4. $FeSO_4$ not causing a color change on peridium. 112. *R. udus*
5. KOH on fresh peridium causing no color change. 113. *R. defectus*
5. KOH on fresh peridium causing a color change. 6
6. KOH staining peridium brown. (see *R. sordidus* also). 7
6. KOH staining peridium lilac to red. 8
7. Pockets of enlarged cells present in lower zone of peridium. 114. *R. ochroleucus*
7. Peridium not as above. 115. *R. subcitrinus*
8. Paraphyses with 1–2 highly refractive globules as revived in KOH; fresh peridium apricot color. 116. *R. subcroceus*
8. Not as above. 9
9. Peridium lacking groups of inflated cells in the interior zone though individual hyphal cells may be more or less inflated. 10
9. With groups of inflated cells in inner region of peridium (usually like sphaerocysts). 15
10. Gleba cheesey fresh, bone-hard as dried. 117. *R. deceptivus*
10. Gleba subcartilaginous fresh, when dried firm but sectioning readily. 11
11. Basidiocarps with a basal cluster of rhizomorphs; copious pigment in peridium as revived in KOH. 118. *R. vulgaris*
11. Not as above. 12
12. Hymenial elements 4–6 μ diam; most narrowly clavate. 119. *R. cusickiensis*
12. Hyemenial elements 6–11 μ broad. 13
13. Basidiocarps salmon-buff to apricot-buff or pallid and with vinaceous-buff rhizomorphs. see *R. subsalmonius*
13. Not as above. 14
14. Basidiocarps yellow, covered with brown rhizomorphs. 120. *R. occidentalis*
14. Basidiocarps pallid to sublateritius or showing yellow in some places in addition; rhizomorphs copious. see *R. sublateritius*
15. Peridium separable at maturity, usually with a basal cluster of rhizomorphs. (see *R. argillascens* also). 121. *R. pseudoaffinis*
15. Not as above. 16
16. Gleba pinkish where cut or bruised. 122. *R. couchii*
16. Gleba not staining when cut. 17
17. Spores 5–6.5 μ long; young peridium with an epicutis in the form of a trichodermium. see *R. flavofibrillosus*
17. Spores 6–9 μ long; young peridium without any structural differentiation in epicuticular region. 18
18. Gleba avellaneous fresh; but peridium when fresh staining ochraceous to pinkish ochraceous. 123. *R. luteoalboides*
18. Gleba olive to olive-brown fresh; cut peridium staining reddish. see *R. rubescens* var. *rileyi*

110. **Rhizopogon cylindrisporus** A. H. Smith, sp. nov.

Fructificationes 3–5 cm. crassae, subglobosae, ochraceae tactu rubescens. Sporae 10–13 × 2–2.5 μ, cylindratae, leves, nonamyloideae. Typus: Trueblood 790 (MICH).

Illustrations: Fig. 70, spores.

Basidiocarps large 3–5 cm. thick, subglobose and irregular in outline, ochraceous overall but becoming reddish where bruised and these places drying reddish, the remainder drying very dingy ochraceous, rhizomorphs fairly numerous, peridium somewhat separable leaving distinct pallid yellowish spots where it falls off; $FeSO_4$ not giving any color reaction on dried peridium; KOH a darker red-brown than the dried surface. Gleba olivaceous, when dry the typical olive-buff to yellow-brown of the *R. rubescens* group.

Spores 10–13 × 2–2.5 μ, cylindric to slightly allantoid, pale ochraceous in groups in KOH, nearly hyaline singly, yellowish in Melzer's sol. in groups, hyaline or nearly so singly, basal scar distinct, walls smooth and thin, some with a false

septum. Basidia 2- and 4-spored, clavate, 6–7 μ broad. Paraphyses clavate to ellipsoid, becoming thick-walled. Tramal plates of hyaline interwoven gelatinous hyphae; subhymenium cellular. Peridium similar to that of *R. ochraceorubens*—the outer layer of the rhizomorphs and the context of the peridium magenta in KOH. Clamp connections absent. All tissues nonamyloid.

In duff, Mullan, Idaho. Oct. 8, 1959, Mr. Baptist (Trueblood 790, TYPE). Known only from type locality.

The KOH reaction on the sections of the peridium, and its structure, relates the species to *R. ochraceorubens* from which the long narrow spores readily distinguish it. The difference between 6–8 μ and 10–13 μ long is sufficient for the recognition of the species even allowing for the difference in the number of spores borne on a basidium. In addition, at least in the material studied to date, the lack of any color change in $FeSO_4$ is a second possibly important character.

111. **Rhizopogon butyraceus** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. latae globosae vel irregulares lubricae, nitens, ochraceae. Gleba pallide griseo-olivacea demum olivacea. Sporae 7–8.5 × 2–2.5 μ, anguste oblongae, leves, nonamyloideae. Subhymenium filamentoso-ramosum. Peridium unistratosum. Typus: Smith 65457 (MICH).

Illustrations: Fig. 80, spores.

Basidiocarps 1–3 cm. broad, globose to irregular from mutual pressure; surface wet and shiny when collected, rich ochre-yellow over all, slowly staining dingy vinaceous on handling, with few scattered rhizomorphs over the surface and dirt adhering to surface as though the latter were subviscid; $FeSO_4$ on fresh peridium dark olive, KOH dull vinaceous and ethanol vinaceous-brown. Odor none. Gleba of minute chambers, pale olive-buff young, dark olive in age, moist and spongy, firm when dry but not bonelike in consistency.

Spores 7–8.5 × 2–2.5 μ, narrowly oblong, hyaline individually and barely tinted yellowish in masses along the hymenium, yellowish in Melzer's sol. and masses of spores merely deeper yellowish, no basal scar visible. Basidia 6- and 8-spored (spores seen adhering in groups). Paraphyses thin-walled, terminal cells subglobose to elliptic, 2–3 septate below, hyaline in KOH. Cystidia none. Tramal plates of hyaline refractive hyphae 3–5 μ in diam, loosely arranged and much-branched, giving rise to a ramose subhymenium which in turn gives rise to the hymenial palisade composed mostly of septate elements. Peridium of appressed-interwoven, nongelatinous hyphae 4–12 μ in diam, the cells short in the broadest hyphae, as revived in KOH vinaceous-red down to a narrow hyaline zone above the glebal chambers, some cells up to 18 μ wide present; amorphous masses of reddish pigment numerous; in Melzer's sol. with the upper half pale yellow and the lower half red, the red fading as orange-red pigment globules form in this layer. Clamp connections absent. All tissues nonamyloid.

In a group in the duff near a Douglas fir tree, Cascade Lake, Idaho, July 22, 1962, Smith 65457 (TYPE), and from Heaven's Gate Ridge, Seven-Devils Mts., Smith 69210.

This is the only species I have collected to date which might be called subviscid when fresh, but the peridial epicutis is not gelatinous in KOH. The reactions of the peridium in KOH and in Melzer's sol., on revived sections are peculiar, but the peridium can hardly be described as duplex in the usual meaning of the term. The filamentous-branched subhymenium is a further distinguishing feature in this stirps.

112. **Rhizopogon udus** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. latae, globosae udae vel lubricae, ochraceae; gleba olivacea vel olivaceo-brunnea, in siccis duro; fragrans; sporae 7–8 × 2.5–3 μ, nonamyloideae. Typus: Smith 68912 (MICH).

Basidiocarps 1–3 cm. diam, globose to irregular, the surface often very uneven, with a lubricous to wet feeling (dug from dry duff), no rhizomorphs present, color rich ochre-yellow overall, inner layer of peridium staining red when bruised but surface showing a red-brown stain, KOH on epicutis red then rusty brown, $FeSO_4$ no reaction; peridium when cut soon orange-cinnamon to reddish orange in the inner zone; odor fragrant. Gleba olive to olive-brown, watery cartilaginous (hard as bone when dried), chambers very minute (3–4 per mm.). Columella absent.

Spores 7–8 × 2.5–3 μ, oblong to narrowly oval, hyaline to yellowish in KOH, smooth; in Melzer's sol. usually with a false septum and yellowish singly to pale tawny in groups, base not distinctly truncate. Basidia none found revived well enough to study. Paraphyses and subhymenial cells all thick-walled, central content not staining in Melzer's sol. Peridium of appressed-interwoven hyphae with variously enlarged cells up to 23 μ (mostly 8–12 μ in diam), walls yellowish in KOH and Melzer's sol., sections of fresh material in KOH showing an inner red layer and the outer zone yellow, some granular incrusting pigment present along the hyphae but the inner region containing cells with dark rusty brown interior pigment deposits (in KOH); in Melzer's sol. with large orange-brown pigment balls in this region. Clamp connections absent. All tissues nonamyloid.

In dry duff under *Picea* and *Pinus contorta,* Idaho, summer (Smith 68912, TYPE; 68913, 67891, 69791).

In the moist somewhat lubricous peridial surface this species is similar to *R. butyraceus,* but possessed a fragrant odor fresh, did not give a positive $FeSO_4$ reaction, and has thick-walled paraphyses readily separating into units of 2–4 cells under pressure. Also, the gleba is bone hard as dried.

113. **Rhizopogon defectus** A. H. Smith, sp. nov.

Fructificationes circa 36 mm. in diam globosae vel irregulares, sordide ochraceae, tactu rubescens, ad basin rhizomorphis subradicatae, in "KOH" immutabiles. Gleba cartilaginea, pallide olivacea. Columella circa 8 mm. longa, tactu rubescens. Sporae 6.5–8 × 2.2–2.7 μ, oblongae. Typus: Smith 68487 (MICH).

Basidiocarps up to 36 mm. diam, globose to irregular in shape, surface dingy ochraceous, soon red when bruised, finally brownish, when dried dingy ochraceous with vinaceous areas, glabrous and free of rhizomorphs except for a basal patch somewhat rooting in the soil, KOH no reaction, $FeSO_4$ faintly olivaceous slowly; peridium 0.5 mm. thick fresh, pallid when cut but soon reddish. Gleba rubbery fresh, firm but sectioning easily after drying (almost crumbly in places), olive-pallid and staining yellow around worm holes; chambers very small. Columella short (8 mm.) and unbranched, staining red when cut and dull vinaceous-red as dried, connected to a rhizomorph.

Spores 6.5–8 × 2.2–2.7 μ, oblong to narrowly ellipsoid, smooth, hyaline to yellowish in KOH, in groups along hymenium pale yellowish brown as revived in KOH, in Melzer's sol. yellowish singly or in groups, no false septum present. Basidia 4–6-spored (possibly 8-spored), hyaline in KOH, clavate to elongate, 10–13 × 4–5 μ. Paraphyses thin-walled, 12–16 × 6–9 μ. Tramal plates of subgelatinous hyaline narrow hyphae subparallel to interwoven and occasionally a hypha about 15 μ in diam also present—apparently laticiferous—branching to the

inconspicuous but cellular subhymenium about 2 cells deep. Peridium of appressed-interwoven clean hyphae (fresh but mounted in KOH), the hyphae 4–9(–15) μ in diam, scattered large (± 15 μ) oleiferous hyphae present, lacking distinct groups of inflated cells (sphaerocyst-like) but many hyphae with slightly inflated cells, as revived in KOH the epicuticular layer ochraceous and hyphae with some debris between them, inner layer dark red to red-brown revived in KOH and color caused by large pockets and amorphous masses of pigment both intracellular and intercellular. Clamp connections none. All tissues nonamyloid.

Solitary under conifers, Priest River Exp. Forest July 19, 1964, Smith 68487 (TYPE), (Coll. Jerry Motta), and Smith 68466.

This species differs from *R. vulgaris* in becoming vinaceous pink in some areas as dried, in the presence in some basidiocarps at least, of a columella, lack of a KOH color change of fresh peridium and only a very weak to lacking $FeSO_4$ reaction. In sections revived in KOH the distribution of pigment in the peridium lacked any distinctive pattern other than as pointed out in the description. This species has as much of a basal attachment as *Gautieria graveolens.*

114. **Rhizopogon ochroleucus** A. H. Smith, sp. nov.

Fructificationes 2–6 cm. crassae, globosae, fibrillosae, pallidae, demum ochroleucae, tactu tarde roseolae. Gleba sordide ochracea. Sporae 6–8 × 2.3–3 μ, anguste oblongae, leves, nonamyloideae. Typus: Smith 53613 (MICH).

Illustrations: Fig. 81, spores.

Basidiocarps 2–6 cm. thick, globose to subglobose, surface appressed fibrillose but lacking conspicuous rhizomorphs, pallid when young, slowly becoming yellow and drying a pale dull ocher-buff, staining pinkish slightly when fresh, in age not becoming generally reddish brown as in *R. rubescens;* $FeSO_4$ no reaction on fresh peridium, olivaceous on dried peridium and with KOH dull rusty brown. Odor none. Gleba of large chambers and moderately hard as dried, olivaceous fresh, *dingy ochraceous* as dried or nearly pale ochraceous tawny in places.

Spores 6–8 × 2.3–3 μ, narrowly ellipsoid to oblong, smooth, basal scar inconspicuous, yellowish in KOH individually and in masses more ochraceous; in Melzer's sol. yellowish singly as well as in masses. Basidia none found with spores attached but the latter found in groups of 6. Paraphyses clavate to oval or ellipsoid, 6–9 μ broad, wall with conspicuous internal thickening and an amorphous central body not coloring in KOH or in Melzer's sol. Tramal plates of gelatinous hyaline interwoven refractive hyphae branching to form a filamentous to cellular subhymenium. Peridium a thick single layer of appressed-interwoven hyphae yellowish in KOH and an inner region pale fulvous to dark fulvous from incrusting pigment, pockets of enlarged cells present in the lower zone, and the entire peridium composed of ground hyphae 8–15 μ in diam with the cells often at least somewhat inflated, in the upper zone the walls free or nearly so from incrusting pigment. Clamp connections none. All tissues nonamyloid.

In duff in a camp ground, and under conifers, late summer and fall, Idaho and Oregon.

This is a large species which dried dull ochraceous and shows a slight tendency to stain pinkish but does not retain this color on drying. The peridium consists mainly of enlarged thin-walled, nongelatinous hyphae. The spores are smaller than in typical *R. rubescens. R. ochroleucus* is closest to *R. luteolus* but the European specimens of the latter have a hard "glassy" gleba as dried and over the exterior rhizomorphs obviously were present. Neither of these features

apply to *R. ochroleucus;* in addition the latter stains pink slightly and has spores under 3 μ wide.

Material examined. IDAHO: Smith 45170, 53615 (TYPE), 59499, 59521, 68967; OREGON: Smith 19321.

115. **Rhizopogon subcitrinus** A. H. Smith, sp. nov.

Fructificationes 8–15 mm. latae, globosae, siccae, fibrillosae, ochraceae, tactu rubescens. Gleba pallid olivacea demum grisei-olivacea dura. Sporae 7.5–9 × 2.5–3 μ, oblongae, leves, nonamyloideae. Peridium unistratosum. Typus: Smith 66123 (MICH).

Illustrations: Fig. 79, spores.

Basidiocarps 8–15 mm. broad, globose to more or less subglobose, surface dry and appressed-fibrillose, no obvious rhizomorphs present, color dull ochre-yellow, staining pink slightly when injured, drying olive-buff or in places dark reddish brown (where chemicals have been applied), $FeSO_4$ pale dingy brownish (no olive tone at all) on fresh peridium, KOH slowly dingy brown on peridial surface but finally becoming rusty brown. Gleba pale olive young, darker olive in age, chambers minute, bone-hard when dried. Columella absent.

Spores 7.5–9 × 2.5–3 μ, smooth, thin-walled, hyaline in KOH or groups pale ochraceous, yellowish in Melzer's sol., often with internal local wall thickenings and many appearing as if secondarily septate, wall only very slightly thickened. Basidia mostly 6-spored. Hymenium mostly of chains of inflated cells 14–25 × 8–15 μ, hyaline, thin-walled at first but in age some developing an interior wall thickening. Subhymenium not truly present (represented by the basal cells of the structural elements of the hymenium). Tramal plates of subgelatinous hyaline thin-walled branched hyphae 3–4 μ diam (revived in KOH), no oleiferous elements seen. Peridium of interwoven hyphae (3–) 4–9 μ diam and hyaline (yellowish in Melzer's sol.), when revived in KOH the layer dull rusty brown, many of the hyphal cells short and of irregular shape and also enlarged at the septa, some incrusting debris present, no sphaerocysts noted. Clamp connections absent.

In groups in the duff under conifers, Warm Lake, Idaho, Aug. 26, 1962, Nancy Jane Smith (A. H. Smith 66218).

The distinguishing features of this species are the brown KOH and $FeSO_4$ reactions, the thick-walled cells that develop in the hymenium and the apparent lack of a white stage in the development of the basidiocarp. In Smith 59520 the basidiocarps, stained pink slightly when injured. It differs from *R. rubescens* in smaller size and when dried in having a bone-hard consistency.

Material examined. IDAHO: Smith 59631, 65482, 65495, 65620, 65778, 65797, 65815, 66111, 66113, 66123 (TYPE), 66168, 66219, 66232; Trueblood 1459.

116. **Rhizopogon subcroceus** A. H. Smith, sp. nov.

Fructificationes 5–30 mm. latae, globosae, siccae, fibrillosae subcroceae. Gleba pallida demum olivacea vel olivaceo-brunnea. Sporae 5.5–6.5(–7) × 2–2.5 μ, oblongae, levae, nonamyloideae. Peridium crassum, unistratosum. Typus: Smith 65619 (MICH).

Illustrations: Fig. 58, spores; pl. III, 1, basidiocarps.

Basidiocarps 5–30 mm. diam globose, subglobose or angular from mutual pressure, surface dry and marked by lines from the fine rhizomorphs, color evenly apricot-buff except for the darker rhizomorphs, surface not staining when injured but when fresh peridium is sectioned it changes to apricot-salmon, in $FeSO_4$ on fresh peridium pale olive but dark olive in revived sections; in KOH magenta

and in ethanol pinkish-tan. Odor none. Gleba pallid becoming olive and finally dark olive-brown, the chambers small and irregular, sections revived in $FeSO_4$ slowly becoming dark-olive. Columella absent.

Spores (5.5–)6–7(–8.5) × 2–2.7 μ, oblong to narrowly oval, smooth, yellowish in KOH singly, pinkish-buff to cinnamon-buff in masses along the hymenium; yellowish in Melzer's sol. singly but dextrinoid as seen in groups, wall thickened to thin and in Melzer's sol. at times with a false septum; basal truncation present but inconspicuous. Basidia 4- and 6-spored, 6–7 μ broad, hyaline, readily collapsing. Paraphyses 15–22 × 7–11 μ, mostly subclavate, hyaline with slightly thickened walls but in the interior one or two highly refractive globules present (amorphous bodies) as revived in KOH, the amorphous bodies merely yellowish in Melzer's sol. Tramal plates of narrow hyaline smooth gelatinous-refractive hyphae 2.5–5 μ in diam, some inflated cells up to 10 μ diam which are barrel-shaped or versiform, hyphal arrangement subparallel. Peridium in section about 1 mm. thick fresh, consisting of appressed-interwoven hyphae 3–5(–10) μ in diam and some with incrusted walls but very little debris or pigment in sections revived in KOH, hyaline to ochraceous in KOH fresh, interior or lower region a layer of cells up to 15 μ or more broad, interwoven and magenta in KOH fresh (hyaline as revived in KOH). Clamp connections none.

Gregarious under pine, Boulder Creek, Pollock Mt. New Meadows, Idaho, July 30, 1962. Robert Jeanne collector (Smith 65619, TYPE).

From the stirps Subsalmonius this species is distinguished by its thick peridium with the enlarged cells in the lower region, the olive $FeSO_4$ reaction in dried material, the color change in the peridium when cut and the amorphous granule in the hymenial elements. The gleba dries to a "light brownish-olive" (dull olive color) and the cavities in dried specimens are extremely small. A feature of the entire *R. subsalmonius* group of species is that in revived sections of the peridium there is almost no amorphous debris and the cell walls are pale ochraceous tan to hyaline. In *R. subcroceus* they are nearly hyaline except for a poorly defined surface layer where they are pale ochraceous-tawny. The enlarged cells in the lower region as seen in sections are not sphaerocysts but rather merely the cut ends of rather wide hyphae. In young material the gelatinous-refractive feature of the hyphae of the tramal plates does not show and is sometimes so late in developing as to give the impression the hyphae are merely dry and "floccose". Sections are very easily made from dried basidiocarps; the consistency is not crumbly as in some species.

In Smith 45630 some basidiocarps showed a rudimentary columella and in this same collection some thick-walled ochraceous (in KOH) hyphae were present with clamps at their septa. I regard these as hyphae from a foregin mycelium, but in this case, in contrast to other similar situations, there is a possibility that they belong to the rhizomorphs. The presence of the rudimentary columella and clamped hyphae of the rhizomorph system could indicate a distinct taxon but I am not confident as yet that either character is all it seems to be at first glance. Very often when two basidiocarps in a cluster fuse the remains of the wall along the surface of contact will appear in a section of the compound basidiocarp, to be a columella.

Material examined. IDAHO: Smith 45630, 65618 (TYPE), 65629, 65684, 65759, 65805, 65806; Trueblood 725.

117. **Rhizopogon deceptivus** A. H. Smith, sp. nov.

Fructificationes 8–20 mm. latae, globosae vel irregulares, mollis, demum sub-

cartilagineae, albae demum sordid ochraceae, tactu tarde rubescens. Gleba pallide olivacea demum sordide luteo-brunnea. Sporae 6–7.5 × 2.6–3 μ, leves, anguste ellipsoideae, nonamyloideae. Peridium unistratosum. Typus: Smith 65586 (MICH).

Illustrations: Fig. 83, spores; fig. 84, paraphyses.

Basidiocarps 8–20 mm. diam, globose to subglobose, or angular from mutual pressure, surface white and cottony when young, the fibrils matted down in aging and color slowly changing to cream color or yellower, finally dingy ochraceous, slowly reddish when bruised, and usually attached to substratum by a rhizomorph; $FeSO_4$ on fresh peridium dark olive-brown along the inner layer of the cut section, KOH pale dingy vinaceous along the inner layer of the cut peridium, ethanol no reaction. Gleba pallid olive-buff becoming dark sepia, soft and cheesy in age but drying to the consistency of bone, chambers minute 3–4 per mm. Columella lacking.

Spores 6–7.5 × 2.6–3 μ, oval to narrowly ellipsoid, smooth, yellowish in KOH fresh and along hymenium as revived, hyaline individually as revived, in Melzer's sol. pale yellow and masses of spores along the hymenium orange-ochraceous (clearly nonamyloid at all stages), basal scar not distinct. Basidia 5–6 μ broad when sporulating, hayline, thin-walled, collapsing. Paraphyses 8–11 μ broad and up to 20 μ long, subglobose to ellipsoid, thin-walled in young basidiocarps, many thick-walled ones with a central body but this not staining in Melzer's sol. Tramal plates in mature specimens gelatinous in KOH, of hyaline smooth subparallel to interwoven hyphae 3–6 μ in diam and walls slightly thickened, subhymenium cellular and the cells at times with thickened walls as in the paraphyses. Peridium white in section but soon stained pinkish; epicutis of interwoven to suberect hyphae (suggesting a weak trichodermial arrangement), the hyphae 4–9 μ in diam, as revived in KOH the entire layer vinaceous-brown from copious pigment masses readily separated from the hyphae under pressure, some of the cells barrel-shaped and about 15 μ diam (enlarged), no evidence of trichodermial structure visable on revived material. Clamp connections absent.

Gregarious in duff under conifers, summer, Idaho: Pollock Mt. New Meadows coll. Lilian Hawker (Smith 65586, TYPE), Priest River 68346, Burgdorf, 68973, Heaven's Gate, Seven Devils Mts., Smith 69169, 69202.

The consistency of the dried basidiocarps is that of bone, the colors are dingy sulphur-yellow, the versiform thick-walled elements (cells of hymenial layer or hyphal fragraments of tramal plates) are numerous and their central body never stains in Melzer's sol., the spores are small, the gleba dark sepia at maturity and the peridium slowly stains vinaceous. The dried specimens closely resemble those of *R. subcitrinus* but the spores are slightly smaller, and KOH stains the peridium a dingy vinaceous rather than a rusty brown. The color of the gleba at maturity approaches that of some species in sect. *Fulviglebae*. The spores are relatively broad for their length. *R. subaustralis* has a peridium that stains olive in $FeSO_4$, subfusoid larger spores, and thin-walled paraphyses readily collapsing in age. *R. luteolus* is close but has larger spores and its peridium does not stain red on injury.

In Smith 68346 the basidiocarp was white becoming pale cream-color and in age dingy brown. KOH on white stage reddish, on yellow stage no reaction; $FeSO_4$ did not cause a color change. As dried the gleba is sepia at maturity. The peridium when cut stained red in the yellow stage but only the white stage was red on the peridial surface from bruising. The collection is placed here in spite of the lack of data on the $FeSO_4$ reaction.

118. **Rhizopogon vulgaris** (Vitt.) M. Lange, Dansk, Bot. Ark. Bd. 16, nr. 1. p. 56, 1956, pl. V. fig. 78, spores.

Hysteriomyces vulgaris Vitt. No. Nat. Ci. Lombardia I: 341. 1844.
Rhizopogon provincialis Tulasne, Fung. Hypog. p. 88. 1851.
Rhizopogon rubescens var. *vittadinii,* Tulasne, Fung. Hypog. p. 89. 1851.
Rhizopogon vittadinii (Tul.) Zeller, Mycologia **31**: 3. 1939.

Illustrations: Fig. 77, spores; pl. VII, 1.

Basidiocarps up to 4 cm. broad, globose, ovate, or somewhat flattened, large specimens may be lobed; cream color when young, becoming yellowish tan with slight olivaceous flush (parts exposed to daylight darker brown), turning pink where bruised; surface minutely felty-fibrillose, often cracked, rhizomorphs inconspicuous and few on upper side, forming 1–3 rootlets below, brownish. Gleba pallid almost to maturity, chambers empty, deliquescent when mature. Odor faint, like *Scleroderma* or in some mature specimens strong and offensive.

Spores 5.5–8 × 2–2.6 μ, narrowly subfusoid to ellipsoid varying to oblong, in KOH hyaline individually, only yellowish in groups, in Melzer's sol. yellowish individually and in groups, smooth, with an inconspicuous basal scar. Basidia 14–17 × 4–5 μ, subcylindric, readily collapsing, 4- and 8-spored. Paraphyses 10–18 × 4–10 μ broad, subglobose to clavate or vesiculose and thin-walled. Cystidia none. Tramal plates with gelatinous highly refractive hyphae more or less interwoven, subhymenium poorly developed and individual cells indistinct in revived material. Peridium of appressed-interwoven hyphae at first red in KOH but soon fading out to fulvous and with orange-brown pigment globules in upper region (in Melzer's sol.), no pockets of vesiculose cells noted, the portion next to the gleba finally nearly hyaline. Clamp connections none. All tissues nonamyloid.

This is a European species reported in this country under the names *R. provincialis* and possibly as *R. vittadinii.* Specimen 2509 Kryptogamae Exsiccatae editae O Museo Hist. Natur. Vindobonense, legit Sydow, preserved in the Zeller collections (NY) and a collection by Lilian Hawker were studied.

In the Sydow specimens and Hawker H-134 the cuticle and gleba quickly became dark blackish green in $FeSO_4$, the peridium red in KOH but the red soon faded to rusty brown. The characters of distinction, then, appear to be the chemical characters in addition to the basic pale yellow ground color of fresh basidiocarps, the lack of thick-walled hymenial elements, and the narrow spores.

The American collections cited below are tentatively assigned to this species. Most reports for North America in the literature probably apply to other species. In Hawker H-134, the peridium as revived in KOH has many cells with an amorphous rusty brown pigment mass in them. These are in sufficient quantity to give the section a spotted appearance at least in places. They were not observed in most American collections but are present in Hesler 6609 and 21068. *R. provincialis* has been reported for North America but the collections under this name at N.Y. represent a number of species. Suksdorf, Wash. 814 appears to be the same as Hawker H-134, but the pigment masses are larger and less sharply defined. It remains to be seen whether these make a reliable "herbarium" character. DAOM 60018 from Oliver, B. C. has thick-walled paraphyses that disarticulate but otherwise apparently belongs here.

Material examined. IDAHO: Smith 65966, 66025, 66167, 68162, 68582. TENNESSEE: Hesler 6609(?), 21068. EUROPE: Hawker H-134 Sydow. Kryp. Exs. 2509; Lange 1969. CANADA, Nova Scotia: Harrison 26–7–63, B. C. DAOM 60018.

119. **Rhizopogon cusickiensis** A. H. Smith, sp. nov.

Fructificationes 10–15 mm. crassae, globosae vel angulares, glaber, ochraceae, tactu tarde roseolae, in "$FeSO_4$ olivaceae, in "KOH" ferrugineae. Gleba demum mellea, dura. Sporae 7–9(–10) × 2.2–2.8(–3) μ, anguste ellipsoideae, leves nonamyloideae. Typus: Smith 68078 (MICH).

Basidiocarps small, 10–15 mm. thick, globose to versiform and angular from external pressures, "ochre yellow" fresh, staining pink slowly when bruised, with KOH peridium slightly reddish, with $FeSO_4$ olivaceous, when dried dull ochraceous to yellow-brown, rhizomorphs few and mostly basal. Gleba white becoming more honey color than olive, rather hard when dried, chambers small and labrynthiform. Columella none.

Spores 7–9(–10) × 2.2–2.8(–3) μ, narrowly elliptic or tapered slightly at both extremities, at maturity some with a slight suprahilar depression on one side causing spores to appear slightly inequilateral in one view, smooth, hyaline to yellowish in KOH and also in Melzer's sol. Basidia 6- to 8-spored, 14–17 × 4–5 μ, narrowly clavate. Paraphyses 10–16 × 4–6 μ, narrowly ovate (the end-cell) to narrowly clavate, thin-walled. Subhymenium of branched filaments about the diameter of the base of the hymenial element (2–5 μ diam), gelatinizing. Hyphae of tramal plates soon gelatinous, narrow, branched and interwoven, smooth, hyaline in KOH. Peridium of interwoven hyphae, no epicutis differentiated, the hyphae 3–8 (–12) μ in diam, some knots of inflated cells present, as revived in KOH the region next to the gleba with rusty cinnamon intercellular and intracellular pigment masses, in Melzer's sol., these deposits forming orange-brown pigment balls. Clamp connections none. All hyphae nonamyloid and no amyloid granules noted.

Under Douglas-fir, near Cusick, Wash. July 2, 1964, Smith 68078 (TYPE).

This, apparently, is an early-season *Rhizopogon* featuring very narrow elongated hymenial elements, and yellow ochre colors. The surface of the peridium is dry and appressed fibrillose, which distinguished it at once from *R. butyraceus* and *R. udus* both of which have wider paraphyses. It is close to *R. deceptivus* and *R. vulgaris* but again the hymenial elements distinguish it.

120. **Rhizopogon occidentalis** Zeller & Dodge, Ann. Missouri Bot. Gard. 5: 14. 1918.

Illustrations: Fig. 82, spores.

Basidiocarps 1–6 cm. diam, globose to irregular, oval, pear-shaped, etc., surface dry and fibrillose beneath a conspicuous coating of buff to tawny-brown rhizomorphs, and these standing out distinctly on the dried specimens, colors beneath the rhizomorphs whitish at first, slowly becoming yellow (finally nearly lemon-yellow), when dried retaining the color of the fresh state (hence whitish to pale lemon color); the rhizomorph layer drying to a cinnamon-tan, peridium staining red when cut, and surface staining yellow to orange or reddish brown slowly on handling; $FeSO_4$ on dried peridium staining it olive. Odor none or slight. Gleba pallid becoming grayish olivaceous to olive and drying to a cinnamon-buff, chambers large, when dried rather brittle and crumbly.

Spores 5.5–7 × (2–)2.3–2.6(–3) μ, oblong, yellowish to hyaline singly in KOH and deeper ochraceous to dingy cinnamon-buff in masses in Melzer's sol. yellowish, to yellowish tan in groups, smooth, nonamyloid, often with 2 oil drops. Basidia mostly 6- and 8-spored, clavate, 14–20 × 7–9 μ, hyaline and thin-walled. Paraphyses like the basidioles but in age developing thickened walls but central body not dextrinoid. Tramal plates of interwoven smooth, finally gelatinous-

refractive, hyaline hyphae, 2.5–6 μ diam, subhymenium more or less cellular and 1–3 cells deep, not gelatinous in KOH. Peridium one layered, of appressed hyphae 3–8 μ broad, if the rhizomorph-layer is included the content and/or walls are both more or less cinnamon, beneath this the hyphae with yellow to hyaline walls (revived in KOH). Oleiferous hyphae present as well as enlarged hyphal cells in some of the fundamental hyphae (10–20 μ diam). All tissues nonamyloid. Clamp connections absent.

The type was collected by Henderson near Moscow, Idaho (Henderson 5168, NY). The species is known from California, Oregon, and Idaho.

If the brown outer rhizomorphic layer is not included, sections of the peridium show only the yellow to hyaline hyphae and no appreciable incrusting pigment or debris is evident.

This is a characteristic species readily recognized, if properly dried, even in the dried condition. The spores are consistently small (5.5–7 × 2.2–2.6 μ) and nonamyloid, the paraphyses finally become thick-walled at least in some specimens, and the peridium is essentially clean in the region of the subcutis though at or near the surface, as pointed out above, there may be more amorphous debris. The hyphae of this region may have brown contents also. The color pattern starts out like that of the *R. rubescens* group—white at first, ground color slowly bright yellow as maturity approaches, but instead of becoming dark brown it definitely tends to retain the bright yellow color against which the rhizomorphs stand out prominently. When cut the peridium tends to stain reddish, but it does not stain red on bruising but instead goes to yellow to orange to reddish brown, and not all collections will show this change readily. Dried specimens vary in the tone of the ground color from pallid to lemon-yellow, apparently depending on the stage at which they are collected. The gleba in older specimens has large cavities (0.5–1 mm.) and is often crumbly in texture.

R. luteolus differs in having distinctly wider (2.5–3.5 μ) spores, and in Melzer's sol. its peridium shows many orange-brown globules, but in KOH is vinaceous red at first slowly fading to reddish brown. Also, there is much amorphous "debris" in the layer.

Zeller Herb. 9312 identified as *R. occidentalis* has spores about 9 × 3 μ and the basidiocarps as dried are browner than normal for the species. No data are with the specimen. I am considering this to be a large spored variety of the species but prefer to see it fresh before naming it.

Material examined. CALIFORNIA: Gardner, Dec. 1925 (NY as *R. rubescens*); H. Lanphere 3 colls. Arcata (MICH); Morse 441 (NY as *R. rubescens*); Parks, Oct. 1938, Trinidad (NY). IDAHO: Henderson 5168, TYPE (NY); Trueblood 528, 528a, 1323 (MICH). OREGON: Goetz 16 (MICH); Oswald 3 and 11 (MICH); Smith 19301, 27674, 49483; Florence 10–31–56, Wemme Nov. 1937 (MICH). Zeller Herb. 2438, 6933, 6973, 7180, 8312 (NY). WASHINGTON: Zeller Herb. 1476, 1500, 1501, 1504, 2438, 2551, 6353, 6933, 7180, 8290, 9312, (?) (NY); Wier Herb. 16095, 16096 (NY); Oswalds 10–3–64 (MICH).

121. **Rhizopogon pseudoaffinis** A. H. Smith, sp. nov.

Fructificationes 1–4 cm. latae, globosae vel irregulares, candidae tarde luteolae, tactu purpurascens. Gleba candida demum olivaceo-lutea. Sporae 6.5–8 × 2.5–3 μ, oblongae, leves, nonamyloideae. Peridium unistratosum. Typus: Smith 66020 (MICH).

Illustrations: Fig. 85, spores; pl. II, 3, and pl. III, 4, basidiocarps.

Basidiocarps 1–4 cm. diam globose, subglobose or irregular in outline; sur-

face at first snow-white and cottony, slowly becoming yellowish and where injured purplish red, usually attached by a more or less basal cluster of white rhizomorphs, rhizomorphs also appressed to surface in various places (in the creases or depressions especially), $FeSO_4$ slowly pale olivaceous on the white surface, peridium separable at maturity, KOH and ethanol both dingy vinaceous. Gleba snow white and soft, slowly becoming olive-buff or olive-yellowish and then more rigid-cartilaginous in texture, chambers small to medium large (up to 0.5 mm. in age). Columella none.

Spores 6.5–8 × 2.5–3 μ, oblong, hyaline in KOH individually but yellowish along hymenium in groups, yellowish in Melzer's sol. but in 2–5% of cases where spores were attached a faint greenish blue tint is present indicating a possible weak amyloid reaction, nonamyloid when mature. Basidia 6- and 8-spored, 14–18 × 6–7 μ, hyaline, thin-walled, collapsing. Paraphyses basidioid and thin-walled. Cystidia none. Tramal plates of hyaline thin-walled smooth subparallel hyphae nongelatinous in white stage of gleba but "glassy" in old specimens as revived in KOH; subhymenium cellular, non-gelatinous, and all cells thin-walled. Peridium very soft and difficult to section in the fresh white state, about 1 mm. thick, young, 0.5 mm. thick in age, rather easily separable from the gleba (one-layered) of parallel-interwoven appressed hyphae loosely arranged at first and more compactly so in age; hyphae 4–11 (–20) μ in diam, and groups of inflated cells present near the gleba and some barrel-shaped cells up to 18 μ present in the colored-layer which is vinaceous in KOH both when fresh and revived but fades to rusty brown on standing; all tissues nonamyloid. Clamp connections absent.

In clusters in the debris under fir and spruce, Brundage Mt., McCall, Idaho, summer.

This species has a readily separable peridium in mature material, stains purplish-red, possibly has a weakly amyloid phase in the development of the spores, groups of inflated cells present near the gleba, and the color pattern is from white to yellow and when dried yellowish with vinaceous areas.

Smith 65777 apparently belongs here. The hyphae of the epicutis are up to 20 μ wide at times, the vinaceous-brown layer is characteristic and the spores 7–8.5 × 2.8–3 μ. However, when fresh it was negative in $FeSO_4$, KOH and ethanol. In the dried state, however, it slowly became dark olive in $FeSO_4$ and the vinaceous-brown subcutis is typical for a positive KOH reaction. Fresh material did stain red.

Material examined. IDAHO: Smith 65180 (?), 65685, 65775, 65780, 65966, 66020 (TYPE), 69011.

122. **Rhizopogon couchii** A. H. Smith, sp. nov.

Fructificationes 2–5.7 cm. latae, 4 cm. altae, vel 7 × 6.5 × 4.5 cm., globosae, subglobosae, pyriformes vel turbinatae, leves vel sulcatae, albidae tactu roseae, demum ochraceae et fulvomaculatae. Gleba sordide brunnea, tactu rosea. Sporae 5.5–7.5 × 2–2.5 μ, leves, oblongae, nonamyloideae, tenui-tunicatae. Typus: Coker 6003 (NC).

Basidiocarps large about 2–6 cm. thick, globose, subglobose, pyriform, turbinate or irregular in shape, surface nearly smooth except for ridges, channels and depressions, usually somewhat flattened above, not viscid, young under-ground basidiocarp pure white when fresh, turning a distinct rosy pink when bruised, exposed basidiocarps pure white at first, then yellow with a tint of olive (about "citron-yellow," "amber-yellow" or "buffy-citrine") showing russet areas where bruised, remaining whitish below, in age earthy tan and on drying with brown

to blackish areas; fibrils very few, usually absent above, innate-appressed on the sides, becoming free below and merging into one or several rhizomorphs. Gleba pure white fresh, pinkish where bruised or finally becoming dull brown, when dried near "pinkish-buff" or "cinnamon-buff" (dull tan), friable as dried, sectioning easily.

Spores 5.5–7.5 × 2–2.5 μ, oblong to narrowly ellipsoid in KOH yellowish to hyaline singly but in groups pale ochraceous, in Melzer's sol. merely yellow and most with a false septum, basal scar not prominent. Basidia 16–35 × 4.8–6.8 μ (Coker and Couch), soon collapsing, 4- and 8-spored (appearing gelatinous in KOH as revived and outlines not distinct). Paraphyses clavate to oval, 6–11 μ broad, thin-walled at first but appearing to become partly filled with a mucilaginous substance (inner wall thickening, if it can be so termed, not as clearly defined as in other species). Tramal plates of hyaline refractive-gelatinous hyphae, subhymenium gelatinous and soon indistinct (apparently 1–2 isodiametric cells deep). Peridium a single layer of appressed-interwoven hyphae at first ochraceous tawny to tawny throughout from some pigment deposits but mostly in the form of pigment-filled hyphal cells, the peridium relatively "clean" as revived in KOH, hyphae mostly 3–9 μ diam but enlarged cells up to 15 μ also present scattered especially near the glebal chambers. Clamp connections absent. All tissues non-amyloid.

Caespitose to solitary under pines, North Carolina and adjacent states. It fruits late in the season. It is known from the collections in the Coker & Couch collections at the University of North Carolina.

As in many species, the odor and taste apparently become more pronounced and often obnoxious as the specimens reach old age. The spore size and shape at once exclude this species from *R. rubescens* in the sense that the species is characterized here. I was at first inclined to identify the above collections with *R. vulgaris* but in that species, at least as based on the European specimens I have studied, the peridium is duplex to the extent of the pattern of pigment distribution giving a two-layered effect on sections revived in KOH. In both the $FeSO_4$ reaction on the dried peridium is olive, but in *R. couchii* it fades out in a short time. The gleba, in *R. couchii,* from all the information available changes color from white to brown, and retains this latter color on drying. In *R. vulgaris* we can't be sure but the assumption is that it becomes olivaceous. In addition, *R. couchii* is the only species I have seen with the indistinctly delimited mucilaginous interior thickenings of the paraphyses. In the stirps Rubescens one expects the usual thick-walled type. Actually *R. couchii* is most closely related to *R. evadens* but the latter lacks a distinct yellow phase in the color of the basidiocarp. The clean yellow brown peridium as revived in KOH is characteristic of *R. evadens,* and *R. subsalmoneus.*

Material examined. ALABAMA: Earle 12–15–1900 (NY as *R. rubescens*), 1515 (NY as *R. rubescens*); Underwood No. 1. FLORIDA: Singer F-1675. NORTH CAROLINA: U. N. C. Herb. 58, 1932, 6043, 6049, 7204, 7212, 7213, 7218, 7223, 7563, 7564, 7565, 7567, 7570, 7573, 7579, 7583, 8268, 8287, 8296, 14067 (NC). TENNESSEE: Univ. Tenn. Herb. 15913 (NY as *R. rubescens*).

123. **Rhizopogon luteoalboides** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. diam, globosae, tactu roseae, luteae demum ochraceae, in "KOH" roseae, "$FeSO_4$" brunneae. Gleba cartilaginea, subargillacea demum avellanea. Sporae 7–9 × 2.4–3 μ, oblongae vel subfusoides. Typus: Smith 69160 (MICH).

Basidiocarps 1–3 cm. diam, globose or nearly so, staining pinkish when handled or bruised but stained part soon fading, color wax-yellow to ochre-yellow but more buff colored as dried, KOH pinkish on cutis fresh, $FeSO_4$ dull brown, when ethanol is added to the spot quickly olive-black, very few rhizomorphs present; cut peridium ochraceous to pinkish-ochraceous. Gleba a grayish cinnamon-buff to avellaneous but pale dingy ochraceous as dried, cartilaginous, chambers fine. Columella none.

Spores 7–9 × 2.4–3 μ, oblong to subfusoid, basal truncation scarcely evident, yellowish singly in KOH, dingy yellow-brown in masses, in Melzer's sol. yellowish, pale tawny in masses, some with a false septum. Basidia 6–8-spored. Paraphyses mostly thin-walled, slowly becoming thick-walled, hyaline in KOH, 8–12 μ diam, clavate to ellipsoid. Tramal plates of interwoven narrow filaments 2–4 μ diam, subgelatinous and hyaline in KOH, thin-walled. Peridium of a layer of ochraceous interwoven hyphae 4–12 μ diam as an epicutis and a rusty brown (revived in KOH) layer of hyphae 8–18 μ diam, some of the enlarged cells in groups, oleiferous hyphae 8–14 μ diam also present. Clamp connections none. All tissues non-amyloid.

Hypogeous under *Pinus albicaulis, Abies lasiocarpa* and *Picea engelmanni,* Heavens Gate Ridge, Seven Devils Mts., Nez Perce Nat'l. Forest, Idaho, Aug. 11, 1964 (H. Burdsall collector), Smith 69160 (TYPE), 69826.

This species is nearest *R. luteoalbus* but has brighter more persistent colors, a pinkish KOH reaction which soon fades, and a dull brown $FeSO_4$ reaction, and when fresh a differently colored gleba.

Rhizopogon subg. **Rhizopogon** sect. **Rhizopogon** subsect. **Angustispori** ser. **Versicolores** A. H. Smith, ser. nov.

Sporae 1.6–3 μ latae; fructificationes versicolores sed non ochraceae vel luteae. Typus: *R. evadens* Smith.

Key to Stirpes of Series *Versicolores*

1. Basidiocarps pale to bright peach-pink to salmon pink or white, often fading to white, at times pinkish-ochraceous; with at least some rhizomorphs present and these salmon buff to dingy vinaceous buff. Stirps Subsalmonius
1. Not as above. 2
   2. Peridium dark cinnamon, blackish brown from handling and black and shiny as dried. Stirps Brunneiniger
   2. Not as above. 3
3. Spores 5–6.5 μ long. Stirps Bacillisporus
3. Spores 6–8 μ or longer. 4
   4. Peridium staining red when injured. Stirps Evadens
   4. Peridium, if staining, then becoming some other color. 5
5. Basidiocarp grayish vinaceous to vinaceous brown. Stirps Maculatus
5. Not as above. 6
   6. Basidiocarps white to whitish and drying gray to whitish. Stirps Albidus
   6. Not as above (basidiocarps variously colored). Stirps Brunnescens

Stirps Subsalmonius

Color changes are left out of the diagnosis of this stirps for the obvious reason that they appear to be in a rather generalized state both as to degree and as to type. The key to the variants as given below serves well as a summary of the condition found here. The pivotal character of the stirps after the color of the peridium has been ascertained is the color of the rhizomorphs.

Key to Species and Varieties of Stirps Subsalmoneus

1. No color change showing on bruised portions of peridium; KOH pinkish lilac on parts of fresh peridium tinged pink or salmon. 124. *R. subsalmonius* var. *subsalmonius*
1. Not with above combination of features. 2
2. Peridium staining pinkish at least slightly when injured. 3
2. Peridium not staining as above. 4
3. Some pockets of enlarged cells in peridium; sections of peridium revived in KOH with debris in the epicuticular zone; spores ± dextrinoid. *R. subsalmonius* var. *similis*
3. Peridium lacking pockets of inflated cells. *R. subsalmonius* var. *persicinus*
4. KOH slowly pale lilac-gray on peridial surface. *R. subsalmonius* var. *griseolilascens*
4. KOH causing no color change on fresh peridium. *R. subsalmonius* var. *roseitinctus*

124. **Rhizopogon subsalmonius** A. H. Smith, sp. nov. var. **subsalmonius.**

Fructificationes 1–6 cm. crassae, globosae vel irregulares, siccae, vel impolitae, roseolae, persicinae vel subsalmoneae demum sordide albidae vel subolivaceae; rhizomorphae subvinaceae. Gleba albida demum olivacea vel olivaceo-grisea. Sporae 6–8 × 2–2.5 μ, leves, oblongae, nonamyloideae. Typus: Smith 65350 (MICH).

Illustrations: Fig. 68, spores, pl. III, 2, 3, basidiocarps; pl. VIII, 4.

Basidiocarps 1–6 cm. diam, globose to subglobose or variously irregular in outline, often angular from mutual pressure, surface appressed fibrillose, dry and unpolished, typically with scattered salmon-buff rhizomorphs over the surface, color pale rose to peach-red to pale salmon-color young, but soon fading to salmon-buff to pale buff or whitish, in age often whitish to olivaceous where exposed and pinkish on under ground parts, the rhizomorphs remaining with some pinkish tones even if the surface is whitish to pale buff or olivaceous; peridium not changing color when cut or bruised or staining very lightly, fresh surface in $FeSO_4$ slowly pale olivaceous but dried surface soon olive-black, KOH staining the pink surface pinkish lilac but usually no reaction on white or buff areas, ethanol negative to pinkish or pinkish brown. Gleba pallid to olivaceous to dark olive, dark yellow brown in age, firm-cartilaginous fresh, sectioning easily when dry, chambers minute, empty. Columella none.

Spores (5.5–) 6–8 × 2–2.5 μ, oblong, smooth, hyaline, in KOH individually but pinkish buff in masses along the hymenium, in Melzer's sol. yellowish or in groups more yellowish, basal scar indistinct. Basidia 6- and 8-spored, 6–7 μ broad, thin-walled and readily collapsing. Paraphyses 16–20 × 8–12 μ or more wide, thin-walled, or rarely developing wall thickenings, hyaline in KOH. Tramal plates of narrow (2–6 μ) hyaline refractive-gelatinous hyphae, subparallel in central strand, the walls thin to slightly thickened; subhymenium cellular, 2–3 cells deep. Peridium thin, single layered, of appressed interwoven hyphae, the cells at first 2–6 μ wide but at maturity 10–20 μ wide in single cells, with some amorphous pigment present in the epicuticular region and the walls ochraceous in KOH. Clamp connections none. All tissues nonamyloid.

Under balsam and spruce, central Idaho, summer, not rare.

I may have included more than one species in this concept but for the present at least am satisfied to include all the following variants under the one binomial: The following collections as studied fresh lacked distinctive reactions with chemicals: Smith 45296, 45360, 45361, 45544, 45548, 45558, 45560, 45563, 45577, 45585, 45704, 45710, 45807, 45809, 45914, 58834a, 65350 (TYPE), 65351, 65680, 66033, 66234. In these the basidiocarps were dingy white to pale olive-buff. In collections, Smith 45745, 65345, 65352, 65353, 65681 from Idaho; Smith 28154, from Oregon; and Smith 35606 from Wyoming ethanol gave a reddish brown reaction on the fresh peridial surface, and the latter was pale-olive in $FeSO_4$. The

basidiocarps were pallid and became tinged with apricot buff. In collections, Smith 44997, 45576, 45593, 58789, 58800, 59554, 59078, 65301, 65215, 65692, 65774, 65801, 65826, 65957, 66121, and 66233 from Idaho, and Smith 35644 from Wyoming, the fresh peridium stained dull purplish in KOH, and $FeSO_4$ stained it pale olivaceous. Some of these differences could be caused by the age of the basidiocarps, their degree of drying out *in situ,* or by the length of time allowed to elapse before the reactions were noted. It is here regarded as significant that as dried they all look about alike, and that the details of the spores and peridium, allowing for differences in age all check rather well. McKnight F2049 from Utah, apparently belongs in this complex but data on the characters when fresh are lacking.

Smith 69352 from Duck Lake, near McCall, Idaho contained cystidium-like inflated cells in the hymenium which measured 20–30 μ in diam. These originated at the level of the paraphyses. Some thick-walled typical paraphyses were seen as well as the common thin-walled type. The basidiocarps had dingy vinaceous rhizomorphs over a whitish to salmon-buff ground color, and $FeSO_4$ stained the surface olivaceous, KOH was negative to slightly pinkish, and there were no stains from cutting or bruising the peridium. Some enlargement beyond the normal of an occasional paraphyses has been observed in many collections of this species, so no taxon is based on this feature.

Material examined in 1964. IDAHO: Smith 68165, 68181, 68182, 68183, 68185, 68186, 68187, 68363, 68368, 68369, 68371, 68445, 68486, 68494, 68805, 68840, 68892, 68942, 68946, 68963, 68965, 68971, 68975, 69153, 69236, 69238, 69239, 69240, 69241, 69242, 69243, 69244, 69336, 69352, 69359, 69386, 69388, 69389, 69390, 69381, 69392, 69393, 69394, 69398, 69401, 69411, 69413, 69525, 69539, 69540, 69632, 69634, 69635, 69636, 69637, 69643, 69644, 69645, 69646, 69647, 69649, 69650, 69651, 69656, 69657, 69658, 69686, 69694, 69697, 69819, 69941, 69943, 69945, 69946, 69948, 69955, 69960, 70448, 70449, 70450.

Rhizopogon subsalmonius var. **roseitinctus** A. H. Smith, var. nov.

Fructificationes 1–2.5 cm. crassae, globosae vel irregulares, fibrillosae, albidae demum roseolae. Sporae 5–6 × 2–3 μ, leves, ellipsoideae. Typus: Smith 59552 (MICH).

Illustrations: Fig. 69, spores.

Basidiocarps 1–2.5 cm. diam, globose to subglobose or compressed or angled from mutual pressure, surface unpolished from the matted-fibrillose nature of the epicutis, over this are appressed fine fibrils and very fine rhizomorphs; color white when collected but soon after exposure to air developing over all a flush of pale shell pink, but not staining when handled and drying a dingy pallid, lacking a yellow state in the pigmentation pattern; $FeSO_4$ on surface dull olive; KOH, no reaction; ethanol, no reaction. Gleba pallid becoming ochraceous-olivaceous and retaining an ochraceous flush on drying, chambers large (0.5–1 mm.) in oldest basidiocarps. Columella none.

Spores 5–6 × 2–2.3 μ, ellipsoid to narrowly oblong, hyaline in KOH individually, pale buff in masses along the hymenium in KOH, in Melzer's sol. yellowish individually and rusty brown in masses, with an inconspicuous basal scar, smooth, thin-walled. Basidia 15–18 × 4–5 μ clavate, hyaline, thin-walled. Paraphyses 15–20 × 6–8 μ, oval to clavate, hyaline, thin-walled. Cystidia none. Tramal plates of interwoven smooth hyaline, highly refractive (in KOH) hyphae with slightly thickened walls (0.3 μ ±) ; subhymenium cellular and cells not refractive. Peridium of appressed-interwoven hypha 4–10 μ in diam, ochraceous tawny in

surface region in KOH but pigment present in the wall of the hyphae, little or no debris in the layer or on the hyphal walls, hyphae in the interior hyaline and loosely interwoven, the cells enlarged near the septum or equal in diam throughout. Clamp connections absent. All tissues nonamyloid.

In duff under *Pinus albicaulis* and *Abies lasiocarpa,* Heaven's Gate Ridge, 7-Devils Mts., Idaho (Nez Perce National Forest) . Aug. 2, 1958, Nancy Jane Smith (A. H. Smith 59552, TYPE).

This variety is distinct by its very small spores, large laticiferous hyphae, the pallid basidiocarps as dried, the fact that when fresh the peridium becomes flushed pink and yet KOH applied to it gives no color reaction, although ethanol does. *R. rosellus* has larger spores and KOH intensifies the rose color. Also, the basidiocarps of *R. roseolus* are distinctly dingy pale rose as dried, not pallid. *R. subsalmonius* var. *salmonius* and var. *roseitinctus* resemble each other closely in the dried condition.

Rhizopogon subsalmonius var. **persicinus** A. H. Smith, var. nov.

Fructificationes 10–25 mm. latae, globosae vel irregulares, siccae, albidae demum persicinae, tactu sordide vinaceae. Gleba alba demum olivaceo-tincta. Sporae 6–7 × 2–2.2 μ, anguste oblongae, nonamyloideae leves. Typus: Smith 65694 (MICH).

Illustrations: Fig. 86, spores.

Basidiocarps 1–2.5 cm. broad, irregular in outline, subellipsoid or varying to globose; surface dry and appressed-cottony, whitish at first but soon a delicate peach color to salmon buff, with darker appressed rhizomorphs over the surface, epicutis not sloughing off in patches, surface vinaceous pink in ethanol; in $FeSO_4$ slowly dark olive near gleba, on surface pale olive, in KOH no reaction on whitish or pale areas, lilac-pink on salmon colored area; slowly staining more vinaceous over all on handling but merely dingy pinkish buff as dried or pale pinkish avellaneous indistinctly over some areas. Odor none. Gleba white becoming pale olive-buff and retaining this color in drying, cavities small, consistency when dried cheesy and not difficult to section; sections revived in $FeSO_4$ slowly dark olive.

Spores 6–7 × 2–2.2 μ, narrowly oblong or nearly so, hyaline in KOH both along hymenium and individually, yellowish in Melzer's sol. singly but along the hymenium weakly dextrinoid as seen in groups, smooth, basal scar small and indistinct. Basidia mostly 6–8-spored, 14–17 × 4–5 μ, cylindric, some projecting when sporulating, hyaline, thin-walled, readily collapsing. Paraphyses 6–10 μ diam, subglobose to oblong or subclavate, thin-walled, hyaline. Cystidia none. Tramal plates of interwoven moderately refractive (in KOH) thin-walled hyaline hyphae; subhymenium cellular, the cells not gelatinous. Peridium one-layered, pallid when cut but soon tinged salmon, of appressed interwoven hyphae yellowish in KOH near the surface and some of these with encrusting pigment; some areas faintly pinkish or a pinkish flush pervading the section, the hyphae 2–8 μ in diam, with scattered cells up to 15 μ. Clamp connections none. All tissues nonamyloid.

In clusters in duff under spruce, Squaw Meadows, Valley County, Idaho, Aug. 3, 1962, Smith 65693, (TYPE).

The small narrow spores, red stains on handling, olive $FeSO_4$ reaction, the peach color of the basidiocarps and thin-walled paraphyses are distinctive along with no KOH reaction when fresh. It differs from *R. couchii* in drying whitish to salmon-buff and does not show russet areas where bruised. The negative KOH reaction is an interesting character. It is very likely that a positive (reddish)

KOH reaction is characteristic of *R. couchii,* but this remains to be verified. *R. couchii* is colored more like *R. rubescens* to judge from the colors quoted from Ridgway. *R. subsalmonius* var. *subsalmonius* is very similar in the dried condition but when fresh it did not stain vinaceous distinctly. Since this is an important feature in *Rhizopogon* it has been given some taxonomic emphasis here at the level of variety though ones impression in the field is that this whole complex characterized by buffy-salmon rhizomorphs is just a variable species.

Material examined. IDAHO: Smith 68826, 68850, 68939, 68940, 68941, 68944, 69004, 69006, 69007, 69008, 69009, 69010, 69013, 69129, 69137, 69158, 69173, 69242, 69246, 69345, 69387, 69633.

Rhizopogon subsalmonius var. **similis** A. H. Smith, var. nov.

Fructificationes 1–3 cm. diam, globosae vel irregulares, saepe, compressae, glaber, albidae tactu pallide roseolae. Gleba albida demum olivacea. Sporae 6–7 × 2 μ, anguste oblongae, leves, nonamyloideae. Peridium unistratosum. Typus: Smith 65953 (MICH).

Illustrations: Fig. 65, spores.

Basidiocarps 1–3 cm. diam, globose to irregular, compressed or lobed; surface glabrous or nearly so (with a few vinaceous-tan rhizomorphs), unpolished, white to whitish but on handling a thin incomplete epicutis staining vinaceous to vinaceous-tan and the intervening areas whitish; $FeSO_4$ olive on surface generally; KOH no reaction on white areas but pale lilac on stained areas; ethanol pinkish tan to dull lilaceous; when dry the peridium dingy pale buff with pale vinaceous-brown areas here and there. Odor none, taste mild. Gleba white to olive, of minute empty chambers. Columella absent. One basidiocarp was attached by a basal rhizomorph.

Spores 6–7 × 2 μ, narrowly oblong, hyaline in KOH individually but brownish-ochraceous in masses along the hymenium, in Melzer's sol. yellow to rich rusty brown individually and rich dark rusty brown in masses along the hymenium, smooth, wall thin to slightly thickened, basal scar inconspicuous. Basidia 8-spored, 13–17 × 6–7 μ, hyaline, thin-walled readily collapsing. Paraphyses 14–20 × 6–9(–11) μ, (terminal cell), thin-walled, readily collapsing. Cystidia none. Tramal plates of interwoven gelatinous hyaline smooth hyphae 4–8 μ in diam; subhymenium cellular with the cells nearest the tramal hyphae highly refractive in KOH. Peridium with a thin epicutis yellowish in KOH (sub mic.) and with debris and incrusting material in the region, the hyphae 3–10 μ diam, and thin-walled; the subcutis of appressed to interwoven hyphae hyaline and with some pockets of enlarged hyphal cells 10–18 μ diam, as revived in KOH there is little incrusting material and no appreciable debris in either region. Clamp connections none. All tissues nonamyloid.

In duff under spruce and fir, California Lake, Payette Nat'l. Forest, Idaho County, Idaho. Aug. 16, 1962, Smith 65953 (TYPE).

As revived in KOH the clean peridium with the yellow-brown cuticular layer, the small spores many of which show a distinct dextrinoid reaction, and the color change to pale lilac in KOH appear to be distinctive. I was at first inclined to regard this as an autonomous species, and it may well be one, but more collections are needed. I take this means of putting it on record.

Rhizopogon subsalmonius var. **griseolilascens** A. H. Smith, var. nov.

Fructificationes 1–3 cm. diam, globosae vel versiformes, fibrillosae, albidae

vel pallide olivaceae, in "KOH" griseo-lilascens. Gleba alba, tarde olivacea. Sporae 5.5–7 × 2.1–2.5 μ. Typus: Smith 68362 (MICH).

Illustrations: pl. VIII, 7.

Basidiocarps 1–3 cm. diam, globose to subglobose or variously lobed, surface thinly fibrillose and with an overlay of closely appressed pale vinaceous rhizomorphs, when perfectly young and fresh dull whitish with an olive to bluish reflection, the olive tone more evident as gleba darkens, peridium whitish as dried with some very pale vinaceous areas showing; KOH slowly pale lilac-gray on peridial surface, $FeSO_4$ slowly olivaceous. Gleba white, slowly becoming pale dull olive, often with pallid areas, but these less evident when dried, some bluing present when fresh, orange-brown with Melzer's sol. fresh, when dried firm but not hard.

Spores 5.5–7 × 2.1–2.5 μ, oblong, hyaline in KOH singly, dingy ochraceous in KOH, in Melzer's sol. yellowish singly to pale tawny in groups, many showing a false septum, base obscurely truncate under highest power. Basidia 8-spored, with a cylindric neck from a clavate base when sporulating. Paraphyses thin walled, 7–12 μ diam, subhymenium cellular and 3–4 cells deep, walls not gelatinous; hyphae of tramal plates subgelatinous, hyaline, narrow (3–6 μ), smooth walled. Peridium of loosely appressed-interwoven, thin-walled hyphae 4–10 μ in diam, no groups of sphaerocysts or greatly enlarged hyphal cells seen. Clamp connections none. All tissues nonamyloid.

Gregarious in duff under *Abies lasiocarpa,* Gisborn Mt. Priest River, Experimental Forest, Priest River, Idaho. July 14, 1964. Nancy Jane Smith (A. H. Smith 68361, 68362, TYPE).

This variant has the vinaceous buff rhizomorphs clean peridium and spores of *R. subsalmonius* var. *subsalmonius* but KOH is lilac-gray on the peridium, and there are pallid spots in the gleba which when studied under the microscope on sections of fresh material appeared to be sterile or semi-sterile areas. Immature spores may be dark rusty brown in Melzer's sol.

Stirps Brunneiniger

125. **Rhizopogon brunneiniger** A. H. Smith, sp. nov.

Fructificationes 1–2 (–3) cm. latae, globosae vel subglobosae, glaber, saepe lacunosae, fulvae demum atribrunneae, in siccatis nigris. Gleba alba demum olivacea, in siccatis argillaceis, cartilaginea demum dura. Sporae 5–6.5(–7) × 1.8–2.3(–2.5) μ. Typus: Oswald & Goetz, Sept. 17, 1964 (MICH).

Basidiocarps 3 × 2 × 1 cm. or 1–2 cm. diam, globose to subglobose and some ellipsoid; surface glabrous and shiny as dried, lacunose at times, "Mars brown" (dark cinnamon) to "Mummy-brown" (blackish-brown), blackening completely in drying, with a basal group of rhizomorphs or a single basal rhizomorph attaching the basidiocarp to the substratum. Gleba white at first, becoming "Medal-bronze" to "bronze-citrine" (olivaceous), drying pale sepia to olive-clay color, consistency firm-cartilaginous, hard when dried. Columella absent (as seen on dried material).

Spores 5–6.5(–7) × 1.8–2.3(–2.5) μ, cylindric to narrowly oblong, smooth, wall not appreciably thickened, hyaline singly in KOH, in groups yellow-brown; in Melzer's sol. yellowish singly and slightly darker in groups and typically with a false septum. Basidia 8-spored. Paraphyses hyaline, becoming thick-walled amorphous content not darkening in Melzer's sol. Tramal plates of interwoven hyaline gelatinous smooth narrow hyphae; subhymenium cellular and cells becoming

thick-walled like the paraphyses. Peridium a single layer of very closely interwoven hyphae with hyaline walls but much blackish coagulated content as in species giving a green to olive fuscous reaction with KOH but no green visible in mounts revived in KOH, in Melzer's sol. the pigment rounding into large rusty brown to fuscous-brown pigment balls. No sphaerocysts seen. Clamp connections none. All hyphae nonamyloid.

Under alder and hemlock (*Alnus* & *Tsuga*), Barlow Forest Camp, Mt. Hood, Oregon, Sept. 17, 1964, collected Ruth Oswald and Crystal Goetz (TYPE); Trappe 194, Douglas County.

The basal attachment of the rhizomorphs is conspicuous in even dried material, and the glabrous black shiny peridium is nothing like that of other species of this section. The colors when fresh and the change taking place on drying are a peculiar set of color characters. One would expect a green to olive KOH reaction on this species but there was no suggestion of it on sections revived in KOH so the species is placed here, with, however, some reservations.

Trappe's notes are as follows: Peridium whitish with brown patches, turns sepia where bruised in handling. Gleba firm Marguerite yellow (Maertz & Paul). Odor not distinctive. The specimen dried black.

Stirps Bacillisporus

The white to pallid basidiocarps with the very small phalloid-like spores distinguish the stirps.

Key to Species of Stirps Bacillisporus

1. Basidiocarp white drying to cinereous; peridium readily separable in flakes. 127. *R. cinerascens*
1. Not as above. 2
   2. Peridium pallid fresh but fuscous as dried; paraphyses becoming thick-walled. 126. *R. nitens*
   2. Peridium pallid fresh, merely dingy buff as dried; paraphyses remaining thin-walled. 128. *R. bacillisporus*

126. **Rhizopogon nitens** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. diam, globosae vel subglobosae, pallidae, in siccatis atratae. Gleba albida demum sordide argillacea vel ligneo-brunnea. Sporae 5–6(–7) × 2 μ, subcylindraceae. Typus Smith 31855 (MICH).

Basidiocarps 1–2.5 cm. diam, globose to subglobose, pallid when fresh, drying fuscous-black, attached by a basal rhizomorph, surface as dried wrinkled and glabrous, somewhat shining as if it had been subviscid fresh (data on fresh material lacking). Gleba lacunose, white, becoming pale tan where dried but varying to wood-brown.

Spores 5–6(–7) × 2 μ, hyaline in KOH, yellowish in Melzer's sol., smooth, thin-walled, often with a false septum as seen in Melzer's sol. Basidia clavate. Paraphyses clavate, 13–20 × 7–12 μ, hyaline in KOH, with internal wall thickenings as in *R. rubescens* but the thickenings occur before gleba becomes colored. Subhymenium more or less filamentous-interwoven, many of the hyphae with thickened walls. Hyphae of tramal plates subparallel, hyaline, somewhat gelatinous and some with slightly thickened walls, oleiferous hyphae present. Peridium with heavy incrustations of pigment-debris obscuring hyphal detail, the pigment also within the cells, slowly becoming dark olive to olive-brown in KOH. In Melzer's sol. the layer orange-brown in color but pigment balls not forming. Clamp connections absent as far as observed.

Gregarious under moss, Longmire, Washington, Sept. 27, 1948 (Smith 31855, TYPE, 30700, 31355, Rampart Ridge, Mt. Rainer National Park, Wash.).

This species is keyed out in both sect. *Rhizopogon* and sect. *Amylopogon* because data on the KOH reaction on fresh peridia is lacking, and from dried specimens there are indications the reaction may be positive (olive). *R. nitens* is most closely related to R. *brunneoniger,* but differs in the color of the gleba, the color and color changes of the peridium, and in lacking pigment balls as revived in Melzer's sol.

127. **Rhizopogon cinerascens** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. latae, globosae, glaber, siccae, albidae demum tarde brunneae, in siccatis cinereae. Gleba albida demum subolivacea. Sporae 5–6 × 2–2.3 μ, oblongae. Typus: Smith 68555 (MICH).

Basidiocarps 1–2.5 cm. broad, globose to subglobose, or ovate, surface dull, glabrous, dry, dull white and slowly brownish when handled but becoming cinereous on drying (in silica gel); cut peridium staining red, no obvious rhizomorphs visible; KOH on surface rose-red, $FeSO_4$ no reaction; peridium readily separable in sheets or flakes. Gleba white at first, at maturity olive-buff, consistency rather dry and cavities both large and labrythiform and empty to fairly well filled with spores.

Spores 5–6 × 2–2.3 μ, oblong, hyaline singly in KOH, dull brownish along the hymenium, yellowish to yellowish brown (in groups in Melzer's sol.), smooth, not truncate. Basidia small, 12–15 × 4–8 μ, neck cylindric, 4-6-spored. Paraphyses 10–15 × 4–8 μ, ellipsoid to clavate, mostly thin-walled (some with thickened walls), central area not colored with Melzer's sol. Subhymenium cellular but cells small and about 2 deep; tramal plates of narrow (2–4 μ) hyaline smooth gelatinous hyphae. Peridium thick, as revived in KOH the epicuticular zone containing amorphous bodies or patches of pigment dull cinnamon in KOH, beneath this the hyphae hyaline and some patches of inflated cells present (the layer clean). Clamp connections none. All tissues nonamyloid.

In duff under mixed conifers, Priest River, Idaho, Priest River Exp. Forest, July 10, 1964. Smith 68291, 68317, 68555 (TYPE).

This species differs from *R. evadens* in its slightly smaller spores, gray rather than brown color as dried, and in not staining readily on the surface when the fresh peridium is injured.

128. **Rhizopogon bacillisporus** A. H. Smith, sp. nov.

Fructificationes circa 5 cm. crassae, subglobosae, glaber, pallidae, tactu immutabiles. Gleba olivacea. Sporae 5–6 × 1.7–2 μ, cylindratae, leves, hyalinae nonamyloideae. Typus: Smith 27136 (MICH).

Illustrations: Fig. 57, spores.

Basidiocarps about 5 cm. thick subglobose, glabrous, lacking rhizomorphs as far as could be observed, pallid when collected and scarcely changing (dingy buff) in drying, not staining when injured, peridium somewhat separable, $FeSO_4$ olive on the dried peridium and KOH pale dingy vinaceous-brown. Gleba olive-buff fresh, ochraceous-buff as dried, chambers large, consistency friable and easy to section.

Spores 5–6 × 1.7–2 μ, rod-shaped, hyaline in KOH, yellowish in Melzer's sol. smooth, thin-walled, basal scar very indistinct. Basidia 16–20 × 4.5–6 μ, clavate becoming subcylindric, 6- and 8-spored, sterigmata fine and short. Paraphyses clavate 5–8 μ broad, all thin-walled (specimen past maturity). Tramal plates of

somewhat refractive hyphae 3–5 μ diam of equal diameter throughout and subparallel; subhymenium cellular but cell outlines indistinct. Peridium a single layer of appressed-interwoven hyphae ochraceous tawny in KOH, 4–9 μ diam with some cells somewhat enlarged; golden-ochraceous pigment deposits present on the hyphae in the layer (often drop-like as revived in KOH). Clamp connections none. All hyphae nonamyloid.

Along a road at Tilly Jane Forest Camp, Mt. Hood, Oregon, Oct. 1, 1947, Smith 27136 (TYPE), 35597, North Fork of Little Laramie, Medicine Bow Mts., Wyoming, Albany Co., Aug. 12, 1950.

This species is close to *R. separabilis* but has distinctly smaller spores. The material was mature so both the spore size and the lack of thick-walled paraphyses are considered distinctive. It is also close to *R. occidentalis* but lacks both the rhizomorphs and the bright yellow pigment. A collection by H. and Ruth Oswald Oct. 18, 1964 from Mt. Adams, Wash. showed 1–2 small oil droplets in the paraphyses and basidia. This collection is placed here provisionally.

Stirps Evadens

The whitish basidiocarps readily staining red when bruised or cut in conjunction with the narrow spores characterize it.

Key to Species of Stirps Evadens

1. Spores 8–10 × 2.2–3 μ.	2
1. Spores 5–8 × 2–2.5 μ.	3
2. $FeSO_4$ on fresh peridium slowly pale olive.	129. *R. obscurus*
2. $FeSO_4$ on fresh peridium "fuscous" (bluish-black).	131. *R. proximus*
3. KOH and $FeSO_4$ neither one causing a color change on fresh peridium.	133. *R. masonae*
3. KOH and/or $FeSO_4$ causing a color change on peridium.	4
4. Odor sweetly fragrant fresh; gleba olive-fuscous mature.	130. *R. odoratus*
4. Odor if present metallic-disagreeable; gleba olive-buff to dark olive (but not olive-fuscous). (see *R. thaxteri* also.)	132. *R. evadens* and variants
4. Odor none; spores 5–6 × 2–2.3 μ.	see *R. cinerascens*

129. **Rhizopogon obscurus** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. latae, globosae, vel irregulares, albidae, impolitae, tactu tarde rubescens. Gleba alba, demum subolivacea. Sporae 8–10 × 2.5–3 μ, anguste subfusoideae, leves, nonamyloideae. Typus: Smith 65481 (MICH).

Illustrations: Fig. 64, spores.

Basidiocarps 1–2.5 cm. broad, globose or angular from mutual pressure; surface glabrous and dull white, rhizomorphs very few and attachment usually basal, surface slowly staining red on bruising; in KOH peridial surface quickly pink to vinaceous, in ethanol slowly vinaceous, in $FeSO_4$ slowly pale olive. Odor none. Gleba white, chambers minute, slowly becoming pale olivaceous, greenish in $FeSO_4$, pinkish in KOH. Columella none.

Spores 8–10 × 2.5–3 μ, narrowly subfusoid to oblong (usually tapered at both ends), hyaline in KOH individually as well as in masses along the hymenium, yellowish in Melzer's sol. in groups, nearly hyaline singly, smooth, thin-walled, basal scar indistinct. Basidia 14–20 × 6–8 μ, clavate, 4- to 6-spored. Paraphyses resembling immature basidia, thin-walled. Cystidia none. Tramal plates of narrow (2–6 μ) hyaline smooth refractive-gelatinous hyphae more or less interwoven; subhymenium of inflated nonrefractive thin-walled cells. Peridium with an epicutis of nongelatinous hyphae 4–12 μ in diam, and those near surface with ochraceous incrustations as seen in KOH both fresh and revived; nests of enlarged cells present in subcutis and this region in fresh material having

a diffuse reddish pigment as observed in mounts in KOH, sections revived in KOH are hyaline in lower region, scattered ochraceous oleiferous hyphae present, many large hyaline plate-like crystals scattered in the layer (as revived in KOH). Clamp connections none. All parts nonamyloid.

Gregarious under *Pinus contorta,* Penn Basin, Idaho, July 23, 1962, Ed Tylutki collector (Smith 65481, TYPE), July 30, 1962, Smith 65627 (MICH).

This species is characterized by the oleiferous hyphae of the peridium, the nests of sphaerocysts in the lower region of the peridium, the dingy white color of the basidiocarp which slowly stains reddish on handling, and the fact that the gleba as well as the peridium gives positive reactions with the chemicals tested. It differs from others around *R. evadens* in having larger more subfusoid spores. The crystals in the peridium, as observed on dried specimens, appear to be at least a good "herbarium" character.

130. **Rhizopogon odoratus** A. H. Smith, sp. nov.

Fructificationes 2–6 cm. diam, compressae, angulares vel subglobosae, fibrillosae, siccae, albidae tactu tarde rosaceae. Odor fragrans. Gleba albida tarde olivacea. Sporae 6.5–7.5 × 2–2.5 μ, oblongae, nonamyloideae. Typus: Smith 71319 (MICH).

Basidiocarps 2–6 cm. long or wide and 2–4 cm. thick, flattened and irregular in outline, surface closely appressed fibrillose when young and fresh, dry to the touch, with loosely appressed whitish rhizomorphs over lower half, color a dead white and drying whitish except for adhering dirt, when handled slowly staining red and stains slowly discoloring to brown, peridium thick (1 mm. fresh) but not readily separable, white when cut but slowly staining red, with KOH slowly red on fresh peridium, $FeSO_4$ no reaction. Gleba whitish with a flush of tan when young but at maturity dark olive to olive-fuscous, chambers distinct. Columella absent. Odor sweetly fragrant on cut fresh specimens (like that of drying *Suillus subolivaceus*).

Spores 6.5–7.5 × 2–2.5 μ, oblong, smooth, base in many with a fairly distinct truncation, singly hyaline to yellowish in KOH, in groups dingy yellow-brown, in Melzer's sol. merely yellow to yellow-brown and with a false septum. Basidia clavate, 6–7 μ broad, 6–8-spored. Paraphyses thin-walled. Tramal plates of narrow (2–5 μ) hyaline smooth gelatinous hyphae somewhat interwoven; the subhymenium cellular, the cells thin-walled. Peridium a thick layer of hyaline hyphae with no incrusting pigment (as revived in KOH and Melzer's sol), a few surface hyphae with somewhat brownish walls as revived in KOH, no nests of sphaerocysts seen but some groups (cut ends of hyphae) seen, entire layer clean as revived in KOH. Clamp connections none. All hyphae nonamyloid.

Under *Pinus ponderosa,* San Poil Creek, Rooseveldt Lake, Washington, Oct. 18, 1964 (Smith 71319, TYPE).

This species is near *R. evadens* but has a pleasant, not an objectionable odor, old basidiocarps have a very dark olive gleba, and the peridium dries whitish, (not brown), also the gleba is dark olive as dried. There is also an ecological difference, since it is clear that *R. odoratus* is associated with ponderosa pine; there were no other woody plants within fifty yards of the type locality. *R. evadens* is characteristically under *P. contorta.*

131. **Rhizopogon proximus** A. H. Smith, sp. nov.

Fructificationes 2–2.8 cm. latae, globosae vel pyriformes, siccae, fibrillosae albidae demum brunneae, tactu rubescens, in "$FeSO_4$" fuscae. Gleba albida

demum grisea. Sporae 8–10 × 2.2–2.4 μ, oblongae vel suballantoideae, nonamyloideae. Typus: Smith 71322. (MICH).

Basidiocarps 2–2.8 cm. diam, globose to pear-shaped, surface dry, appressed-fibrillose (matted down like felt), dry, dull white, slowly brownish on exposed areas, staining red when injured and a strong red tinge pervading the pallid superficial layer in dried specimens; peridium thin, white when cut but soon turning red; KOH on cutis red, $FeSO_4$ "fuscous" (very little olive evident). Gleba white to grayish (all somewhat immature), chambers very fine, firm but sectioning readily as dried, not staining when cut. Columella none; odor none.

Spores 8–10 × 2.2–2.4 μ, oblong to suballantoid or subfusoid, thin-walled, hyaline in KOH singly, yellowish in masses; in Melzer's sol., yellowish to hyaline-yellowish singly, slightly more yellowish in masses; no basal scar evident. Basidia 6-spored, clavate, thin-walled. Paraphyses oval to clavate, 8–12 μ, thin-walled, hyaline. Tramal plates of subparallel-interwoven hyphae, hyaline, 3–6 μ diam, thin-walled, scarcely gelatinous; subhymenium cellular; throughout the tramal plates and hymenium occur (as revived in KOH) many minute hyaline drops or granules apparently both intercellular and intracellular. Peridium of appressed interwoven filaments 3–9 μ diam, mostly of equal diameter, large laticifers (8–12 μ) also present, no groups of sphaerocysts seen, dingy cinnamon as revived in KOH with some fine particles of amorphous pigment, many fine granules also present and adhering to cells. Clamp connections absent, all tissues nonamyloid.

Under larch and Douglas fir, near Pend Oreille State Park, Washington, Oct. 19, 1964, 1964 Smith 71322 (TYPE).

This species is close to *R. obscurus* but differs in the fuscous $FeSO_4$ reaction, in the lack of nests of sphaerocysts in the peridium, and in lacking plate like hyaline crystals in mounts revived in KOH.

132. **Rhizopogon evadens** A. H. Smith, sp. nov. var. **evadens.**

Fructificationes 1–2.5(–3) cm. latae globosae vel irregulares, glaber, impolitae, albidae demum sordidae, tactu tarde rubescens. Gleba albida, demum olivacea. Sporae 6–8 × 2–2.3 μ, anguste oblongae, leves, nonamyloideae. Peridium unistratosum, subseparabile. Typus: Smith 65484 (MICH).

Illustrations: Fig. 66, spores; pl. II, 2, basidiocarps; pl. VII, 3.

Basidiocarps 1–2.5 (–3) cm. broad, globose to subglobose, often plicate-folded or wrinkled, surface unpolished becoming glabrous and appressed-silky as seen under a lens, snow white when young and fresh but soon merely whitish to grayish vinaceous to pinkish-buff and remaining so to old age when it is more or less olive-buff, peridium somewhat separable, very few rhizomorphs present, flushed reddish from handling; $FeSO_4$ on surface slowly distinctly olive, on dried specimens slowly dark olive, KOH quickly pinkish to red. Gleba white becoming olive-buff to darker olivaceous; chambers small. Odor in age often acid to somewhat metallic-disagreeable.

Spores 6–8 × 2–2.3 μ narrowly oblong, smooth, nonamyloid, hyaline singly in KOH but in groups yellowish; in Melzer's sol. pale yellowish singly and in groups, basal scar very inconspicuous even under oil immersion. Basidia 4-, 6-, and 8-spored, 16–22(–26) × 5–6 μ, subclavate, hyaline, thin-walled, soon collapsing. Paraphyses like basidioles or wider, 15–20 × 6–12 μ, hyaline, thin-walled. Tramal plates of refractive-gelatinous interwoven hyphae 2.5–6 μ in diam, hyaline in KOH; subhymenium cellular from inflated cells of the lower part of the hymenial elements. Peridium basically one-layered but a poorly differentiated epicutis of appressed hyphae 3–6 μ diam can be made out, this intergrading into a subcutis

of hyphae 8–20 μ diam, and often almost cellular in sections (from viewing cut ends), both layers or only the epicutis with ochraceous to ochraceous tawny pigment encrusted on the walls, or lower layer almost devoid of pigment, the hyphae walls thin but not gelatinous. All tissues nonamyloid, clamp connections absent.

Mostly under lodgepole pine, Oregon, Idaho, and Nova Scotia, summer and fall.

This is a distinctive species in that the peridium gives a red reaction in KOH but the sections revived in KOH show none of the vinaceous tints or vinaceous to vinaceous-brown debris in the layer which usually accompanies this character in other species. There is no yellow intermediate stage in this species as in *R. rubescens* or *R. separabilis*. Its color pattern is white, dull white to pale buff or olive-buff or vinaceous in places where injured. The dried basidiocarps are dingy alutaceous for the peridium and yellowish for the gleba. The spores are distinctly narrower than in *R. rubescens* and those of *R. separabilis* are more fusoid, but the latter species resembles *R. evadens* closely in the dried condition and in having an ochraceous to rusty brown peridium as revived in KOH. *R. separabilis* changes to russet where bruised, which is what one would expect from the color of the peridium in section as revived in KOH. *R. evadens* also lacks the odor of *R. separabilis* and the peridium is much less readily separable. Both, however, have yellow oleiferous hyphae in the peridium.

Smith 65481 is a variation with spores 8–10 × 2.5–3 μ, and yellow oleiferous hyphae readily demonstrated in the peridium. The peridium slowly stained red on bruising and the colors were a dingy white with no trace of yellow. The gleba as well as the peridium was olive-greenish in $FeSO_4$, and pinkish in KOH. This may represent a distinct variety, but more collections are needed to check the constancy of the differentiating characters. It is close to *R. albiroseus*.

In some collections the $FeSO_4$ reaction is so slow to develop that one can easily conclude it is negative. In Smith 66112 the $FeSO_4$ test was negative and the specimens had a metallic odor such as often obtained from *Melanoleuca* (Agaricales). In Smith 65952 the peridium was distinctly separable. Smith 65666 had a sour odor, and the KOH test was brownish as was ethanol also. The basidiocarps, however, were whitish and the peridium turned red when cut. Smith 65587 gave the same ethanol and KOH reaction as 65666—pinkish tan. Smith 65670 also gave a brown test in KOH, in ethanol more reddish brown, and it also had a sour smell. In Smith 60073 the spores were 7–9 × 2–2.4 μ, ochraceus oleiferous hyphae were present, KOH test was red, $FeSO_4$ olivaceous, and cut peridium soon stained red. The color of the basidiocarps was pale olive-buff to white.

All of these variations however seem to be too slight to deserve taxonomic emphasis in the present classification but should be kept in mind in future studies. The problem rests on the question of what chemical changes take place in the basidiocarp from youth to old age. I am convinced that in some species this is important in relation to changes when bruised, or color changes with the application of chemicals. In *R. evadens* it is the older specimens which have the odor and in which the KOH reaction seems to be changing from red to pinkish tan to pale brown (but not russet as in *R. separabilis*).

Material examined. IDAHO: O. K. Miller 243; Paul Miller 34, 37; Smith 45565, 59035, 59208, 50216, 59217, 59222, 59538, 59564, 59565, 59566, 59567, 59568, 59569, 59570, 59656, 59703, 59731, 59732, 59733, 59734, 59735, 59737, 59738, 59739, 59847, 59885, 59886, 59887, 59888, 59889, 59890, 59891, 59892, 59918, 59948, 59960, 59961, 60021, 60022, 60023, 60024, 60025, 60026, 60028, 60030, 60031, 60033, 60035, 60048, 60050, 60051, 60052, 60055, 60056, 60057,

60058, 60059, 60060, 60061, 60062, 60065, 60068, 60074, 60075, 60077, 60264, 60265, 60266, 60331, 60423, 60426, 60502, 65303, 65354, 65355, 65402, 65403, 65481, 65484 (TYPE), 65486, 65496, 65496a, 65498, 65496, 65499, 65501, 65502, 65584, 65587, 65673, 65666, 65670, 65683, 65697, 65760, 65952, 66071, 66073, 66074, 66076, 66112, 66170, 66175, 66254, 66361, 67896, 67899, 67909, 68038, 68047, 68218, 68234, 68286, 68325, 68326, 68348, 68397, 68493, 68513, 68537, 68693, 68843, 68844, 68847, 68852, 68883, 68886, 68945, 68948, 68951, 68959, 68960, 68964, 68966, 68969, 68972, 68976, 68977, 68979, 68980, 69046, 69047, 69048, 69138, 69139, 69160, 69174, 69175, 69176, 69177, 69188, 69189, 69190, 69191, 69192, 69193, 69194, 69195, 69197, 69198, 69199, 69200, 69201, 69203, 69204, 69205, 69206, 69207, 69208, 69287, 69308, 69736, 69787, 69799, 69820, 69872, 70068, 70069. Trueblood 1835. OREGON: Sipe 316 (Zeller colls. NY) (?) CANADA, Nova Scotia: Harrison 1215 (KM), published as *R. rubescens* Wehmeyer (1959).

Rhizopogon evadens var. **subalpinus** A. H. Smith, var. nov.

Fructificationes 10–30 mm. latae, globosae, vel irregulares, siccae, albae, fibrillosae, tactu ochraceae demum vinaceae. Gleba alba demum olivaceae. Sporae 6.5–7.5 × 2 μ, anguste oblongae, leves, nonamyloideae. Peridium subseparabile, unistratosum. Typus: Smith 65871 (MICH).

Illustrations: Fig. 67, spores.

Basidiocarps 10–30 mm. in diam, globose, subglobose or irregular in outline; survace dry, white when fresh, fibrillose under a lens (but not the soft cottony type), when handled staining ochraceous and then reddish, in age near "natal-brown" but merely dark "wood-brown" as dried, with appressed rhizomorphs over the surface, in age specimens that have remained uninjured are merely dingy pallid; KOH on surface dark red, ethanol slowly pinkish brown and $FeSO_4$ distinctly olive. Odor none. Gleba white becoming pale and then darker olivaceous, chambers small. Columella absent.

Spores 6.5–7.5 × 2 μ, narrowly oblong, hyaline in KOH individually and in groups, in Melzer's sol. yellowish singly and in groups, smooth, wall thin, basal scar inconspicuous. Basidia 6–8-spored, subcylindric, hyaline, thin-walled. Paraphyses 6–12 μ broad, subglobose to oval, all thin-walled and nonrefractive. Cystidia none. Tramal plates of smooth hyaline refractive gelatinous hyphae as revived in KOH, the subhymenium cellular and the lower (inner) cells also refractive. Peridium somewhat separable, when cut at first pallid but soon reddish, of appressed-interwoven hyphae 4–12 μ in diam, many scattered inflated cells present, pinkish next to gleba on fresh sections mounted in KOH, when sections of dried material are revived in KOH the layer is evenly about "snuff brown" and amorphous pigment deposits numerous. Clamp connections none. All tissues nonamyloid.

Under *Pinus albicaulis*, Heaven's Gate Ridge, 7-Devils Mts., Idaho, Aug. 10, 1962, Smith 65871 (TYPE), 65874, 70366.

The small narrow spores, yellow-brown pigmentation of the peridial layer, the yellow and then red reaction of the fresh peridium when injured, and the inflated cells in the lower region of the peridium are distinctive. The color change separates it at once from *R. evadens* var. *evadens*. The association with *Pinus albicaulis* may also be an important feature.

Smith 70366 has spores 7–9 × 2.2–2.3 μ, hyaline in KOH singly, a strong peculiar odor when fresh, stains red when bruised, red with KOH and olive with $FeSO_4$. The cutis stained red when cut. The color is whitish fresh but slowly de-

velops a yellowish cast from handling. This collection is placed here with some reservations.

133. **Rhizopogon masonae** A. H. Smith, sp. nov.

Fructificationes 2–4 cm. crassae, circa 3.5 cm. altae, ellipsoideae vel pyriformes vel subglobosae, albae, fibrillosae, siccae, subreticulatae tactu rubrae, in "KOH" immutabiles. Gleba alba demum olivacea. Columella brevis. Sporae 6–7 × 2–2.3 μ, oblongae. Typus: Smith 71143 (MICH).

Basidiocarps 2–4 cm. diam and up to 3.5 cm. high, ellipsoid, pear-shaped or subglobose, surface dull white and covered by numerous coarse rhizomorphs extending up from the base and branching, the rhizomorphs loose at the base but closely appressed above and then surface subreticulate in places from branching of the main rhizomorphs, surface staining red when bruised or when the peridium is cut, when dried a dingy clay-color, $FeSO_4$ and KOH no reaction fresh, C_2H_5OH reddish to reddish brown. Gleba white, becoming pale olive, chambers labrynthiform and up to 1 mm. or more long, consistency when dried firm but not hard. Rudimentary columella present and distinct in some basidiocarps.

Spores 6–7 × 2–2.3 μ, oblong, hyaline in KOH and Melzer's sol. both fresh and revived, smooth, with 1–2 oil drops. Basidia cylindric, mostly 6-spored. Paraphyses hyaline in KOH, thin-walled. Subhymenium cellular, 2–4 cells deep and cell walls not gelatinous; central strand of tramal plates of narrow (2–4 μ) subparallel hyaline gelatinous to subgelatinous hyphae. Peridium with a separate outer layer, sections of fresh material showing many vinaceous-brown (rusty brown as revived in KOH) intra-cellular pigment deposits, enlarged cells present in lower layer (the two layers not clearly differentiated anatomically), the entire peridium of appressed-interwoven hyphae). Clamp connections absent. All tissues nonamyloid.

On humus, lower Still Creek, Mt. Hood National Forest, Oregon, Oct. 11, 1964. Miss Marjorie Mason, collector (Smith 71143, TYPE).

This species, named in honor of Miss Mason of the Oregon Mycological Society, is close to *R. evadens* from which it differs in the distribution and type of pigment in the peridium and in the copious development of rhizomorphs. The rudimentary columella is its most interesting feature.

The columella is not an infolding of the peridium—a feature frequently encountered in many species—but a true columella as in many species of *Martellia*. However, I would not think of placing *R. masonae* in any genus other than *Rhizopogon*. It is peculiar that no distinctive KOH reaction was present on fresh material in view of the pigmentation as seen in sections of fresh as well as dried material mounted in KOH. Because some artifac is suspected here the character is not emphasized.

Stirps Albidus

The species placed here differ from those in stirps Evadens by not staining red when the peridium is cut or bruised.

Key to Species of Stirps Albidus

1. Gleba when dry hard and when one tries to section it rather crumbly; odor when fresh reminding one of *Calvatia fumosa*. 135. *R. pseudoalbus*
1. Not as above. 2
   2. White becoming pale or distinctly lateritious and surface more or less reticulate from rhizomorphs. see *R. sublateritius*
   2. White drying pallid (never lateritious), rhizomorphs loosely adhering to peridial surface. 134. *R. albidus*

134. **Rhizopogon albidus** A. H. Smith, sp. nov.

Fructificationes 1–3 cm. diam, globosae vel subglobosae, siccae, fibrillosae, albidae, tactu immutabiles, in "KOH" aurantiae, in "$FeSO_4$" olivaceae. Gleba olivacei-brunnea. Sporae 6.5–7.5 × 2.2–2.8 μ. Typus: Smith 69634 (MICH).

Basidiocarps 1–3 cm. diam globose to subglobose or angular-subglobose, surface dry and silky fibrillose beneath numerous pallid (whitish) rhizomorphs, dull white over all and drying a dingy pallid, the rhizomorphs, for the most part coarse, adhering to peridial surface but easily removed, not staining a different color when peridial surface injured or when fresh peridium is cut, with ethanol orange-reddish on cutis, $FeSO_4$ olivaceous. Gleba pallid then pale grayish, then olive-gray and in oldest one olive-brown, cartilaginous and dry in consistency when fresh, firm and sectioning easily when dried, chambers minute, ochraceous around worm holes.

Spores (6–)6.5–7.5(–8.2) × (2.2–)2.3–2.8(–3) μ, oval to oblong, with the base obscurely truncate, smooth, thin-walled, hyaline in KOH, in masses along hymenium ± ochraceous, in Melzer's sol. merely yellowish or in masses pale rusty brown. Basidia 6–8-spored. Paraphyses hyaline in KOH and yellowish to hyaline in Melzer's sol., thin-walled but becoming thick-walled. Tramal plates of hyaline subparallel to interwoven hyphae 3–8 μ diam; subhymenium one or two cells below hymenial elements. Peridium of appressed-interwoven hyphae in a single layer, enlarged cells only in area where hymenial cavities are forming, hyphae 3–12 μ diam, hyaline in KOH and yellow in Melzer's sol., and in the latter medium some yellowish hyaline "pigment balls" form, incrusting debris present only along surface and possibly of foreign origin, the debris dingy ochraceous to tawny in KOH. Clamp connections none. All tissues nonamyloid.

Under *Pinus albicaulis* and *Abies,* Black Tip Ridge, McCall, Idaho, Aug. 22, 1964. Smith 69634 (TYPE), 69642, 69648, 69655, 69659, 69660.

This species is closely related to *R. subsalmonius* but differs in the presence of numerous loosely adhering pallid rhizomorphs which in age become merely dingy brown, in the dull white unchanging peridium, and slightly broader spores. Both were compared in the fresh condition.

135. **Rhizopogon pseudoalbus** A. H. Smith, sp. nov.

Fructificationes 1–2.5 cm. crassae, globosae, siccae, fibrillosae, sordide albidae, in "KOH" roseae. Gleba gelatinosa, olivaceo-brunnea. Odoratae (subfoetidae). Sporae 6–7 × 2–2.2 μ, oblongae. Typus: Smith 68834 (MICH).

Basidiocarps 1–2.5 cm. broad, globose to subglobose, surface dry, dull and matted-fibrillose but with only a few inconspicuous rhizomorphs, dull white both when young and in age and drying pallid, when injured no appreciable color change but when peridium is cut a slight reddish tinge was evident (scarcely of taxonomic value), KOH pink on fresh peridial surface, $FeSO_4$ olive. Gleba of exceedingly small chambers, soon decidedly gelatinous and olive-brown ("olive-brown"), drying to a hard consistency but crumbly when one tries to section it; Columella none. Odor resembling that of *Calvatia fumosa.*

Spores 6–7 × 2–2.2 μ, mostly oblong to suboblong, hyaline in KOH singly, in masses near "buckthorn brown" (sub mic.), in Melzer's sol. dark yellow-brown to dull cinnamon in masses, merely dingy ochraceous singly to hyaline, typically with a false septum, smooth. Hymenium and tramal plates so gelatinous that little detail is visible in mounts of revived material, in Melzer's sol. the paraphyses in the locules next to the gleba clavate and thin-walled and the tramal hyphae nar-

row hyaline and smooth. Peridium a clean layer (KOH or in Melzer's sol.) of appressed interwoven hyphae (yellowish brown in KOH), 5–12 μ diam, lacking any groups of sphaerocysts, in Melzer's sol. with few yellowish to hyaline pigment balls present. Clamp connections none. All hyphae nonamyloid.

Under spruce-fir, Brundage Mt. McCall, Idaho, Aug. 2, 1964, Smith 68834 (TYPE).

This species appears to be a good intermediate to *Hysterangium* in-so-far as the glebal features go, only a columella is absent and the spores are typical of *Rhizopogon*. The odor of young basidiocarps is a good field character since it is not associated with liquification and decay of the gleba. The impression one gets from this species is that it is a primitive phalloid.

Stirps Maculatus

136. **Rhizopogon maculatus** Zeller & Dodge, Ann. Missouri Bot. Gard. 5: 4. 1918.

Basidiocarps 1–2 cm. broad, subglobose to olive-shaped; pale grayish vinaceous to vinaceous-brown, drying dark vinaceous-brown, mottled with pallid patches due to partial sloughing off of the peridial layer; fibrils few and conspicuous, rhizomorph-like below to innate-appressed over the sides, disappearing above, vinaceous-brown or darker. Gleba white when fresh to grayish, when dry grayish and with the consistency of bone, cavities narrow, irregular and empty (from Zeller & Dodge).

Spores 7–9 × 2–2.5 μ, oblong, hyaline individually and yellow in masses in KOH, in Melzer's sol. yellowish, smooth walls thin, basal scar inconspicuous. Basidia and paraphyses too far gelatinized in the type to observe details accurately (but no thick-walled paraphyses present). Tramal plates of hyaline interwoven highly gelatinous hyphae branching out to a filamentous gelatinous subhymenium. Peridium as revived in KOH with an orange-brown layer near the gleba, upper region of paler yellowish to brownish (in KOH) interwoven nongelatinous to subgelatinous hyphae. No clamp connections found. All tissues nonamyloid.

In sand under conifers, California in the spring.

The label on the type reads: "Growing in sand under pine trees, Golden Gate Park, San Francisco, Calif. Coll. N. L. Gardner. There are no notes in the Zeller collections though a notation on the label states 'see notes inside.'"

This is a truly gelatinous species as is evidenced by the extreme shrinkage and bone-like consistency of the basidiocarps in their present state of preservation. Zeller and Dodge gave the spore width as 3–4 μ, but I could find none over 2.5 μ wide. However, spores are not abundant in the sections I made. This is an important difference in spore width for this genus, however, and deserves further study. No distinctive chemical reactions were obtained on the dried material, but this does not exclude there being present on fresh basidiocarps. The grayish vinaceous colors should be distinctive. However, the dried specimens are neither particularly dark nor particularly vinaceous and the slight mottling of the surface I observed did not appear to come from the chipping off of the epicutis or the whole peridium. A detailed restudy of this species from fresh material is highly desirable.

Collection 2015 in the Zeller Collections, from Oregon is not this species at all since the spores are rusty brown in KOH, 7–9 × 3.5–4.5μ, and the gleba is fulvous and the peridium near cinnamon.

Stirps Brunnescens

137. Rhizopogon brunnescens Zeller, Mycologia 33: 196. 1941.

Basidiocarps small, 10–15 mm. diam, globose to elongate, surface dull (unpolished), even, felty, white to pinkish when fresh, oxydizing to yellow-fulvous or cinnamon-brown in drying; fibrils scanty. Gleba white and remaining so or only slightly buffy at maturity. Columella none.

Spores 6.5–8 × 2.5–3 μ, narrowly ellipsoid varying toward oblong, hyaline in KOH, yellowish in Melzer's sol., smooth, basal scar inconspicuous. Basidia and paraphyses not reviving well, highly refractive in KOH but sections breaking up readily under pressure. Tramal plates of interwoven refractive but fragile hyphae; subhymenium indistinct. Peridium deplex: Outer layer of dark brown interwoven hyphae; inner of lighter brown prosenchyma and pseudoparenchyma intermixed (600 μ thick, Zeller). Clamp connections none. All hyphae nonamyloid.

In conifer duff, Mt. Shasta, California at Horse Camp, July 5, 1939, Wm. B. Cooke 13306 and 13305 (NY).

I have examined both collections. The gleba is bone hard and sections with great difficulty. The hymenial elements and tramal hyphae though refractive in KOH are not gelatinous. Sections break up under pressure rather than spreading out. I could not find the epicutis (outer layer) as described by Zeller, but my spore measurements agree well enough. The species should be distinct by its small nonamyloid spores, white to pinkish color fresh but becoming ochraceous to rusty brown. Very few spores are present in the type.

EXTRALIMITAL SPECIES

Rhizopogon aestivus Fries. Europe. Cannot be clearly delimited on the information available.

Rhizopogon albus Berkeley in Smith. This is an *Hymenogaster* according to Zeller and Dodge.

Rhizopogon albus Corda. Not a *Rhizopogon* according to Zeller and Dodge.

Rhizopogon angustisepta Zeller & Dodge. Extralimital. The type was from Germany. The spores are "average" for a *Rhizopogon*. The color of the gleba would place it in sect. *Fulviglebae*. The following data were obtained from the type. The spores are exactly as described by Zeller and Dodge and yellowish in Melzer's sol. Large oleiferous hyphae yellowish in Melzer's sol. and 8–14 μ diam were fairly numerous, and amyloid granules were found along a few hyphae. The peridium was pale fulvous in KOH and inflated hyphae were present in the lower layer. The hymenium was badly gelatinized; no thick-walled paraphyses were evident.

Rhizopogon aurantius Harkness. Zeller and Dodge transferred this to *Hydnangium*.

Rhizopogon borealis Karsten. Finland. Cannot be clearly delimited on the data available.

Rhizopogon briardi Boudier from France. The description reminds one of *R. pseudoaffinis*.

A study of a good specimen in Roumeguere, Fung. Gal. exsicc. 3661 gave the following data: Spores (6–)7–9 × 3–3.6 μ, ellipsoid to oblong, ochraceous in KOH and paler yellowish in Melzer's sol., smooth, basal scar indistinct to absent, walls very slightly thickened and smooth. Basidia cylindric when sporulating, thin-walled at maturity. Paraphyses thick walled at maturity and central body not stained in Melzer's sol.; subhymenial cells also becoming thick-

walled. Tramal plates of hyaline smooth gelatinous subparallel hyphae; subhymenium cellular. Peridium in KOH and Melzer's sol. with blackish granular debris in places resembling in appearance the amyloid particle characteristic of sect *Villosuli;* the hyphae are ochraceous to ochraceous tawny in KOH and in the region next to the locules inflated cells occur but not in groups, the hyphae 4–9 μ broad for the most part, the lower half of the peridial context more deeply colored than the upper half and with more inflated cells, hence the peridium is obscurely "duplex," no masses of pigment between the hyphae but some pigment in the walls and in the cell content (the layer "clean"). Clamp connections none. All tissues nonamyloid.

The basidiocarp was well dried and where unstained from previous application of chemicals was near "cinnamon-buff" as was the gleba also. In no place was it "Hay's russet." Also the "septa" (tramal plates) were not composed of pseudoparenchyma in the sections I made. In the locules near the peridium some cystidia were seen measuring 25–34 × 9–13 μ. These showed a tendency to develop mucilaginous thickenings like those of the paraphyses and originated in the same way. The gleba as dried is firm in consistency but not hard, and it sections easily.

In the present work it would appear to be in sect. *Rhizopogon.* It would key out near *R. brownii* with which it has little in common, and *R. reaii* which has much amorphous pigment in the peridium, shorter spores, and dries dark much as do specimens of *R. nigrescens.* I have been unable to recognize *R. briardi* among the North American collections of *Rhizopogon* I have studied. Chemical characters are not given for the above specimen because of the possibility that the specimen was previously treated with poison to repell insects. Certainly the "amyloid" particles as observed in KOH mounts in my slides are not comparable to those observed for other species.

Rhizopogon clelandii Cunningham.

From South Australia and described as having spores short pedicellate, 7–8.5 × 4.5–6 μ, and hyaline. Cunningham uses the term "cells" to replace cavities or locules referring to the gleba.

Rhizopogon dubius (Corda) DeToni. Not enough data for the recognition of the species.

Rhizopogon graveolens (Vitt.) Tul. Included in Zeller and Dodge (1918) but excluded from the present work because of the lack of critical data on the species as it occurs in Europe.

Rhizopogon induratus Cooke. Included by Zeller and Dodge (1918) but excluded from this work for lack of accurate data.

Rhizopogon lapponicus Karsten. Finland. Zeller and Dodge commented that there was little in the original descriptions to separate it from *R. rubescens.* I can do no better on the data available.

Rhizopogon leonis Payer. Not a *Rhizopogon* according to Zeller and Dodge.

Rhizopogon luteolus sensu Hawker #1106.

Basidiocarp 17 mm. thick, globose, surface conspicuously coated with loose to appressed dark colored rhizomorphs, ground color dingy ochraceous to pale fulvous; $FeSO_4$ on peridium weakly olivaceous. Gleba pale cinnamon-brown, friable in old one, hard in the young specimen, the cavities large (all data taken from well-dried specimens).

Spores 7.5–9 × 3–3.8 μ, oblong to narrowly ellipsoid, some obscurely to distinctly angular, smooth, pale ochraceous, in KOH, pale ochraceous-tawny but not dextrinoid, basal scar inconspicuous. Basidia 7–9 μ broad, soon subgelatinous and some with interior mucilaginous thickening. Paraphyses 12–18 × 7–12

μ, ellipsoid to clavate, soon with interior thickenings to almost filling the lumen. Tramal plates of narrow gelatinous hyaline hyphae; subhymenium somewhat cellular and the cells highly refractive in KOH. Peridium with an epicutis of hyphae with fulvous incrustations in KOH and the hyphae with thickened hyaline to yellowish walls (in KOH), some cells enlarged to 25 μ and often irregular in shape; some hyphae thin-walled; context of ± hyaline thick-walled smooth hyphae 5–9 μ diam and some cells + 20 μ diam, no debris or incrustations in this region. No amyloid granules, no green in KOH, no amyloid hyphae present. Clamp connections absent.

The fungus redescribed here is featured by the large very "thick-walled" paraphyses, ochraceous-brown (fulvous) spores in groups and a peridial structure approaching that of subg. *Rhizopogonella*. The thick-walled filamentose hyphae of the peridium are distinctive. This species is not the same as the one I examined from Sweden in the Zeller collections. It belongs in sect. *Fulviglebae* but is a connection to subg. *Rhizopogonella*. In sect. *Fulviglebae* it is close to *R. argillaceus* but is at once distinguished by the features of the peridium. *R. brunneicolor* is also very close but it stains brown when handled, and lacks coarse rhizomorphs over the surface. If for some reason it is found that *R. luteolus* sensu Hawker is the "true" *R. luteolus* a change in sectional names in this work would be necessary. However, most European authors ascribe an olivaceous color to the gleba.

Rhizopogon marchii (Bres.) Zeller & Dodge.

This species was collected at Trieste under *Pinus nigra* and first described in *Hysterangium*. It had a branched columella and truncate spores 8–11 × 4–5.5 μ ochraceous in color.

Rhizopogon niger (Lloyd) Zeller & Dodge.

This is from South Africa. The spores are 7–9 × 2–3 μ and brown in mass. The peridium is black and the gleba dark yellow-brown. The basidia are described as "filaform" mostly 3-spored.

Rhizopogon provincialis Tulasne.

See *R. vulgaris*.

Rhizopogon reticulatus Hawker.

Basidiocarp globose to compressed, about 2 cm. thick, soft, at first white, later covered with fine black reticulate hyphae, when dried dingy vinaceous (type). Gleba at first white later olive-yellow to greenish brown, blackening when bruised, dingy pinkish-buff as dried and sectioning easily.

Spores 6–7.5 × 2–2.5(–3) μ, smooth, subfusoid to narrowly ellipsoid or oblong, basal scar indistinct, in KOH nearly hyaline individually, in groups pale dingy ochraceous, in Melzer's sol. pale ochraceous, light olive-green in mass (Hawker) and in revived sections in KOH those in cavities near the peridium often dull green. Basidia 12–15 × 4–5.5 μ, 4-, 6-, or 8-spored (as judged both by spores attached and as they adhere in groups). Paraphyses resembling basidioles and thin-walled. Tramal plates of subgelatinous interwoven hyaline smooth hyphae many of irregular diameter (3–7 μ), subhymenium not distinct (from gelatinization). Peridium with a thin coating (absent in places) of pale to dark dull fulvous hyphae (revived in KOH) 5–8 μ diam, walls ± smooth and usually somewhat thickened (up to 2 μ), end-cells clavate 9–12 μ diam, but some tapered to an acute apex and only 2–3 μ in diam (somewhat like flagellate cells); context of thin-walled smooth to slightly encrusted hyphae 3–8 μ diam, and with pale fulvous intercellular pigment, lower (inner region) olive in places as revived in KOH. With amyloid granules in peridium and hymenium. Clamp connections none.

Under spruce, Burrington, Somerset, England, Sept. 1953. Hawker 847.

This species is typical of sect. *Villosuli* and in the key would come out to *R. colossus* var. *nigromaculatus* but the two do not resemble each other otherwise except for the characters of the section—the green reaction in KOH, the amyloid particles as seen in material revived in Melzer's sol., and the rather rudimentary epicutis which apparently is represented by the reticulum described by Dr. Hawker.

Rhizopogon rodwayi MacAlpine. Tasmania and Australia. The small spores (3–4 × 1 μ) are not like those of any species known to me.

Rhizopogon roseus Bresadola. Nomen nudum?

Rhizopogon rubrocorticeus Zeller & Dodge. From Mauretius, an island east of Madgascar in the Indian Ocean. The spores are ellipsoid and 5–6.5 × 3–4 μ according to Zeller and Dodge. I found a fair number 7 × 3.3 μ and oblong. They are yellowish in Melzer's sol. no thick-walled paraphyses were found. There were so many melanin-colored pigment bodies in sections of the peridium that detail was obscured. Also, some Fungi Imperfecti had infected the specimens at one time so a number of spore types can be found in mounts. On the information available this species is not known from North America.

Rhizopogon suavis Quélet, from France. It cannot be accurately identified with the information available. It is yellow changing to brown and has an odor of honey. The spores are said to be pruniform. It probably falls in sect. *Fulviglebae.*

Rhizopogon violaceus Cooke & Massee. Described by Zeller and Dodge (1918) but extralimital and clearly not any of the species I have described here.

Rhizopogon virens (A. & S.) Fr. Europe. Not recognizable on the available information. Zeller and Dodge suggest it is identical with *R. luteolus* but this cannot be proven. I think they have chosen wisely to retain the epithet *luteolus.*

Rhizopogon virescens Karsten. Finland. This species may be a candidate for subsect. *Megaspori,* but on the meagre data available does not appear to be like any of the North American species treated here.

Rhizopogon vittadinii (Tul.) Zeller, see *R. vulgaris.*

Rhizopogon webbii Tulasne. Europe. Cannot be clearly delimited on the data available.

LITERATURE CITED

Baxter, Dow V. 1929. Mycorrhiza on Scotch pine in the University of Michigan Forest Nursery. Pap. Mich. Acad. **9**: 509-516.

Bottomley, A. M. 1948. Gasteromycetes of South Africa. Bothalia **4**: 473-810.

Coker, Wm. C. & Couch, J. N. 1928. The Gasteromycetes of the Eastern United States and Canada. p. 26-36. Univ. North Carolina Press, Chapel Hill, N. C.

Corda, A. J. 1831. *In* Sturm, Die Pilze Deutschlands. *Splanchnomyces.* Deuts. Fl. Pilze **3**: 3-4.

Cunningham, G. H. 1942. Gasteromycetes of Australia and New Zealand. p. 42-46. Dunedin, New Zealand.

Dodge, Carroll W. & Zeller, Sanford M. 1934. *Hymenogaster* and related genera. Ann. Missouri Bot. Gard. **21**: 625-708.

Fries, E. 1817. Symbol. Gast. **1**: 1-8.

Hawker, Lillian E. 1954. British hypogeous fungi. Philos. Trans. Roy. Soc. London B. **237**: 429-546.

————. 1955. Hypogeous fungi IV and V. Brit. Mycol. Soc. Trans. **38**: 73-77.

Hoseney, Florence. 1963. The silica gel method for drying mushrooms. Mich. Botanist **2**: 125-126.

Lange, Morton. 1956. Danish hypogeous macromycetes. Dansk. Bot. Ark. **16**: 1-82.

————. 1957. *Rhizopogon melanogastroides* n. sp. Sydowia II Beihefte **1**: 255, 256.

Linder, David H. 1924. A new species of *Rhizopogon.* Rhodora **26**: 195-197.

Malençon, M. G. 1938. *Dodgea occidentalis* Malençon nouveau genre et nouvelle espèce de Rhizopogoneae. Bull. Soc. Mycol. Fr. **54**: 193-203.

Miller, Orson K. 1963. The Gomphidiaceae, a monograph of the genera and species and their world distribution. Doctoral thesis, University of Michigan, May 1963.

————. 1964. Monograph of *Chroogomphus (Gomphidiaceae)*. Mycologia **56**: 526-549.

Singer, Rolf. 1962. The Agaricales in modern taxonomy. J. Cramer, Weinheim. 913 p., 71 pl.

Smith, Alexander H. 1964. *Rhizopogon,* a curious genus of false truffles. Mich. Botanist **3**: 13-19.

———— **& Reid, Derek A.** 1962. A new genus of the Secotiaceae. Mycologia **54**: 98-104.

———— **& Thiers, Harry D.** 1964. A contribution toward a monograph of North American species of *Suillus*. Privately published. Ann. Arbor, Michigan. 116 p., 48 pl.

———— **& Singer, Rolf.** 1959. Studies on Secotiaceous fungi IV. *Gastroboletus, Trumcocolumella* and *Chamonixia*. Brittonia **11**: 205-233.

Svrcek, M. 1958. *In* Pilat, A. et al. Gasteromycetes. p. 123-140 and 721-723. Praha.

Totten, H. R. 1923. Development of the fruit-body of a new parasitic *Rhizopogon*. Jour. Elisha Mitchell Soc. **39**: 101-109.

Tulasne, Louis René & Tulasne, Charles. 1851. Fungi hypogaei. Paris. 222 p.

Wehmeyer, Lewis. 1950. The fungi of New Brunswick, Nova Scotia and Prince Edward Island. Nats. Res. Counc. Can. p. 1-150. Ottawa.

Zeller, Sanford M. 1939. New and noteworthy Gasteromycetes. Mycologia **31**: 1-32.

————. 1941. Further notes on fungi. Mycologia **33**: 196-214.

———— **& Dodge, Carroll W.** 1918. *Rhizopogon* in North America. Ann. Missouri Bot. Gard. **5**: 1-36.

Description of Figures

The drawings of spores and hymenial cells were made with the aid of a camera-lucida and as reproduced are magnified approximately 1200 ×.

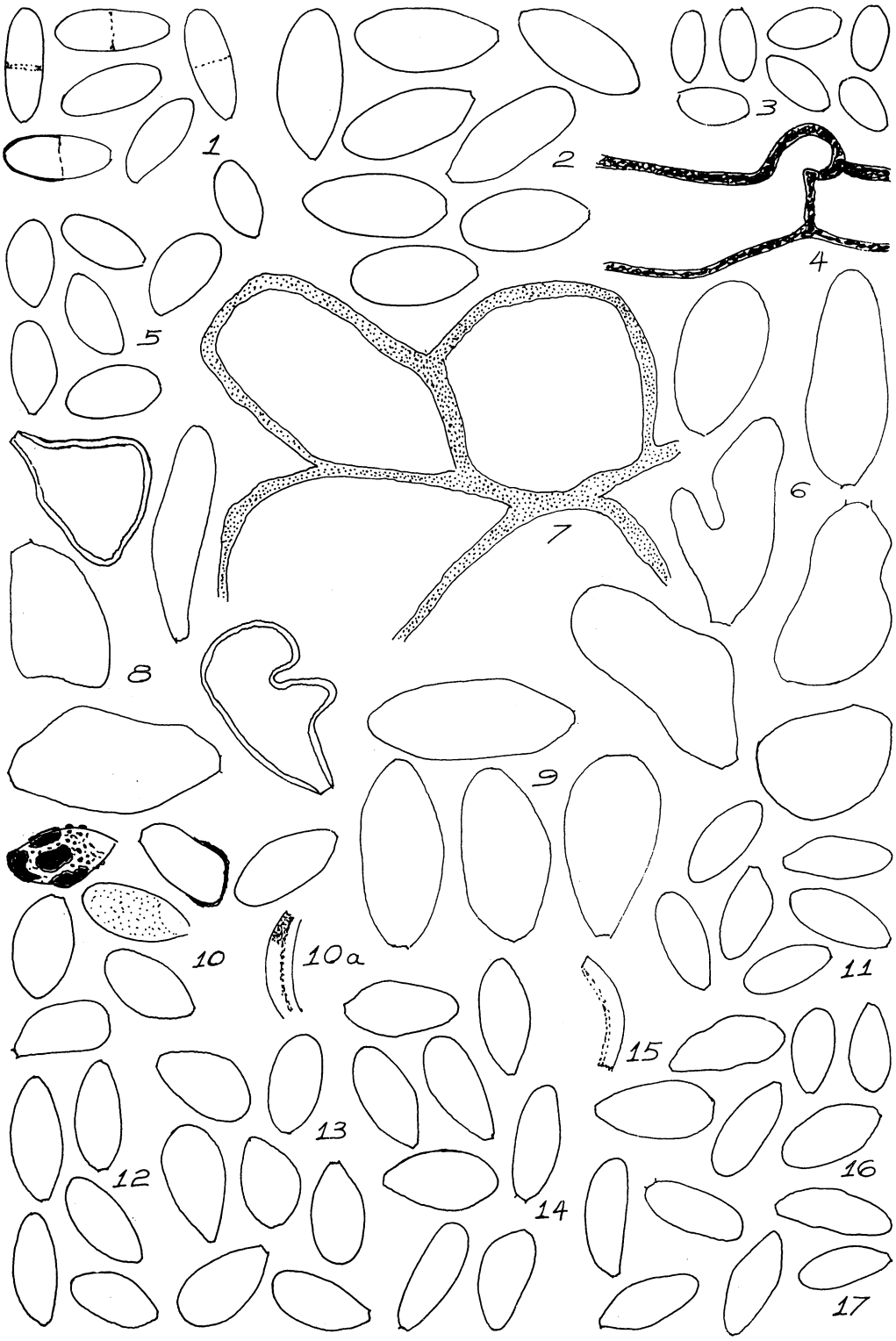
Figs. 1–17: Fig. 1, 6 spores of *R. olivaceoniger;* fig. 2, 7 spores of *R. olivaceotinctus;* fig. 3, 7 spores of *R. diplophloeus;* fig. 4, peridial hyphae of *R. diplophloeus* showing clamp connection; fig. 5, *R. pachyphloeus;* fig. 6, 6 spores of *R. variabilisporus;* fig. 7, pseudoparenchyma from peridium of *R. pachyphloeus;* fig. 8, 5 spores of *R. griseogleba;* fig. 9, 4 spores of *R. clavitisporus;* fig. 10, 6 spores of *R. anomalus;* fig. 10a, wall detail in spore of *R. anomalus,* the shading indicates amyloid parts; fig. 11, 6 spores of *R. arctostaphyli;* fig. 12, 5 spores of *R. atroviolaceus;* fig. 13, 7 spores of *R. kauffmanii;* fig. 14, 8 spores of *R. subpurpurascens;* fig. 15, spore detail in wall of spore of *R. subpurpurascens,* the dotted lines indicate amyloid areas; fig. 16, 6 spores of *R. fallax;* fig. 17, 5 spores of *R. pedicellus.*

Figs. 18–37; Fig. 18, 6 spores of *R. ellenae;* fig. 19, 6 spores of *R. idahoensis;* fig. 20, 7 spores of *R. subcaerulescens;* fig. 21, 5 spores of *R. subgelatinosus;* fig. 22, 5 spores of *R. subbadius;* fig. 23, 7 spores of *R. sepelibilis;* fig. 24, 8 spores of *R. hawkeri;* fig. 25, 5 spores of *R. rogersii;* fig. 26, 6 spores of *R. zelleri;* fig. 27, 6 spores of *R. ponderosus;* fig. 28, 6 spores of *R. subareolatus;* fig. 29, 6 spores of *R. colossus* var. *colossus;* fig. 30, 7 spores of *R. colossus* var. *nigromaculatus;* fig. 31, 7 spores of *R. parksii;* fig. 32, 6 spores of *R. villosulus;* fig. 33, sterile elements of hymenium in *R. villosulus;* fig. 34, 5 spores of *R. fragrans;* fig. 35, 6 spores of *R. gilkyae;* fig. 36, 6 spores of *R. viridis;* fig. 36a, 5 spores of *R. nigrescens;* fig. 37, 8 spores of *R. sipei.*

Figs. 38–57: Fig. 38, 7 spores of *R. lutescens;* fig. 39, 7 spores of *R. argillaceus;* fig. 40, 6 spores of *R. exiguus;* fig. 41, 6 spores of *R. brunneicolor;* fig. 42, 7 spores of *R. ochraceisporus;* fig. 43, 6 spores of *R. tsugae;* fig. 44, 4 spores of *R. pseudoroseolus;* fig. 45, 8 spores of *R. roseolus;* fig. 46, 6 spores of *R. atlanticus;* fig. 47, 7 spores of *R. truncatus;* fig. 48, 6 spores of *R. baxteri;* fig. 49, 6 spores of *R. brownii;* fig. 50, 6 spores of *R. laetiflavus;* fig. 51, 5 spores of *R. luteoalbus;* fig. 52, 5 spores of *R. oregonensis;* fig. 53, 6 spores of *R. reaii;* fig. 54, 7 spores of *R. subolivascens;* fig. 55, spores of *R. oswaldii;* fig. 56, 5 spores of *R. luteolus;* fig. 57, 6 spores of *R. bacillisporus.*

Figs. 58–82: Fig. 58, 6 spores of *R. subcroceus;* fig. 59, 6 spores of *R. ochraceorubens;* fig. 60, 6 spores of *R. burlinghamii;* fig. 61, 7 spores of *R. flavofibrillosus;* fig. 62, 6 spores of *R. separabilis;* fig. 63, 6 spores of *R. libocedri;* fig. 64, 7 spores of *R. obscurus;* fig. 65, 9 spores of *R. subsalmonius* var. *similis;* fig. 66, 7 spores of *R. evadens* var. *evadens;* fig. 67, 7 spores of *R. evadens* var. *subalpinus;* fig. 68, 7 spores of *R. subsalmonius* var. *subsalmonius;* fig. 69, 6 spores of *R. subsalmonius* var. *roseitinctus;* fig. 70, 5 spores of *R. cylindrosporus;* fig. 71, 6 spores of *R. abietis;* fig. 72, 6 spores of *R. rubescens* var. *rubescens;* fig. 73, 7 spores of *R. rubescens* var. *pallidimaculatus;* fig. 74, 4 spores of *R. rubescens* var. *ochraceus;* fig. 75, 5 spores of *R. rubescens* var. *rileyi;* fig. 76, 5 spores of *R. vinicolor;* fig. 77, 7 spores of *R. vulgaris;* fig. 78, 5 spores of *R. luteorubescens;* fig. 79, 4 spores of *R. subcitrinus;* fig. 80, 3 spores of *R. butyracea;* fig. 81, 4 spores of *R. ochroleucus;* fig. 82, 6 spores of *R. occidentalis.*

Figs. 83–95: Fig. 83, 6 spores of *R. deceptivus;* fig. 84, paraphyses of *R. deceptivus* × 1200; fig. 85, 6 spores of *R. pseudoaffinis;* fig. 86, 6 spores of *R. subsalmoneus* var. *persicinus;* fig. 87, 3 cells from epicutis of *R. villosulus;* figs. 88–92, "flagellate-cells" from epicutis of *R. villosulus* × 900; figs. 89, 90, 91, 93, × 900, cells and hyphae from epicutis of *R. villosulus;* figs. 94 & 95, cells from epicutis of *R. colossus* var. *colossus* × 900.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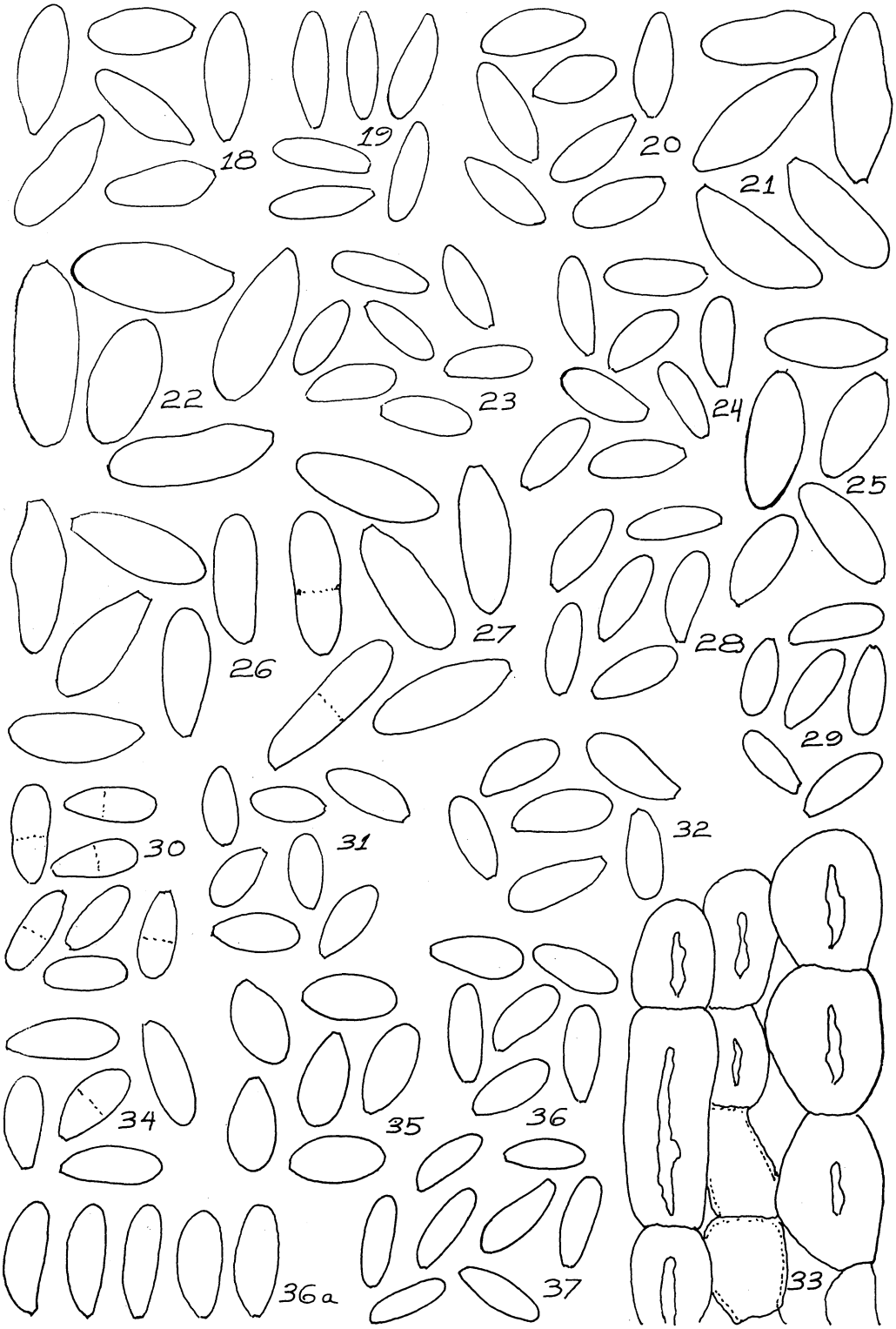
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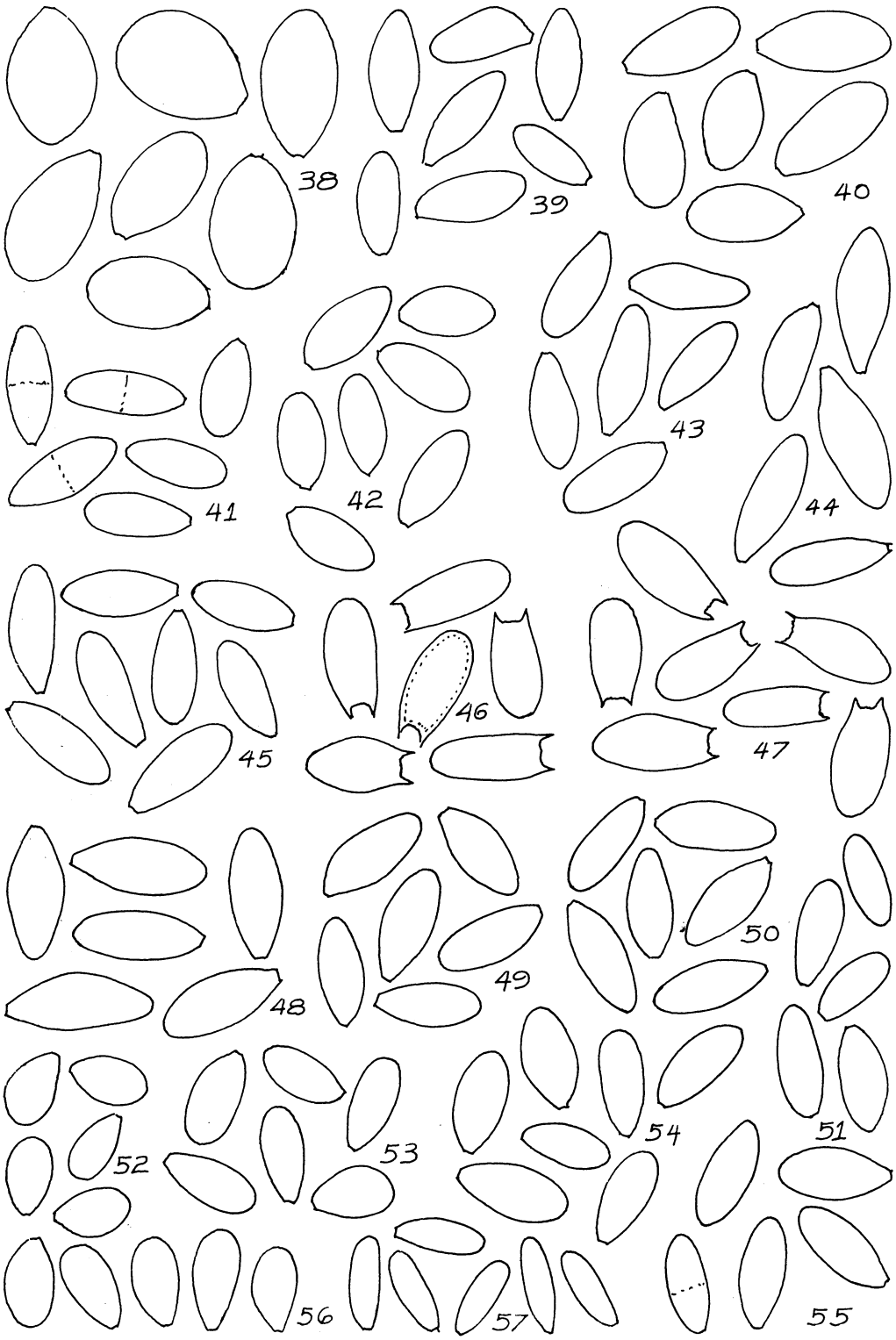
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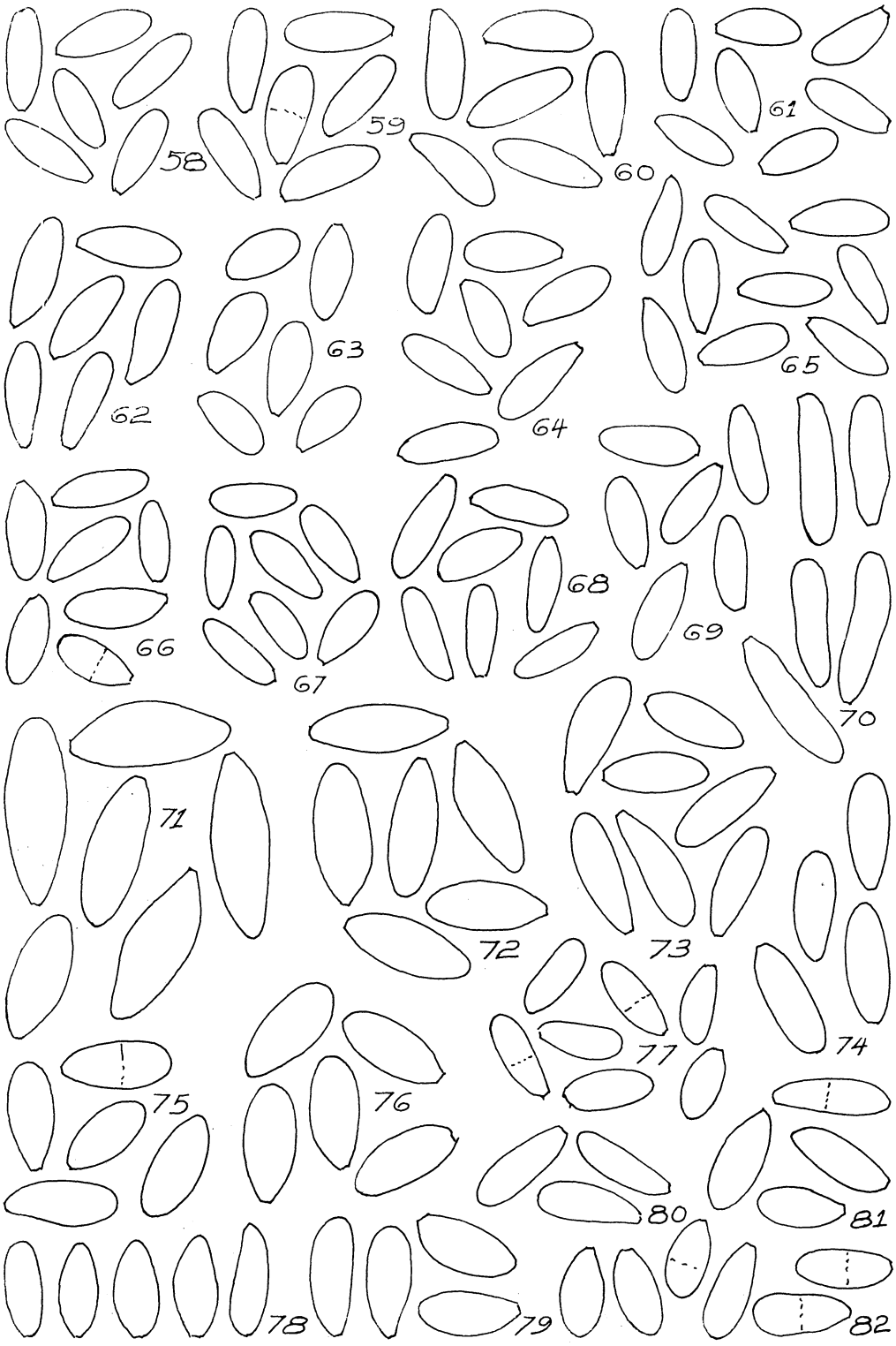
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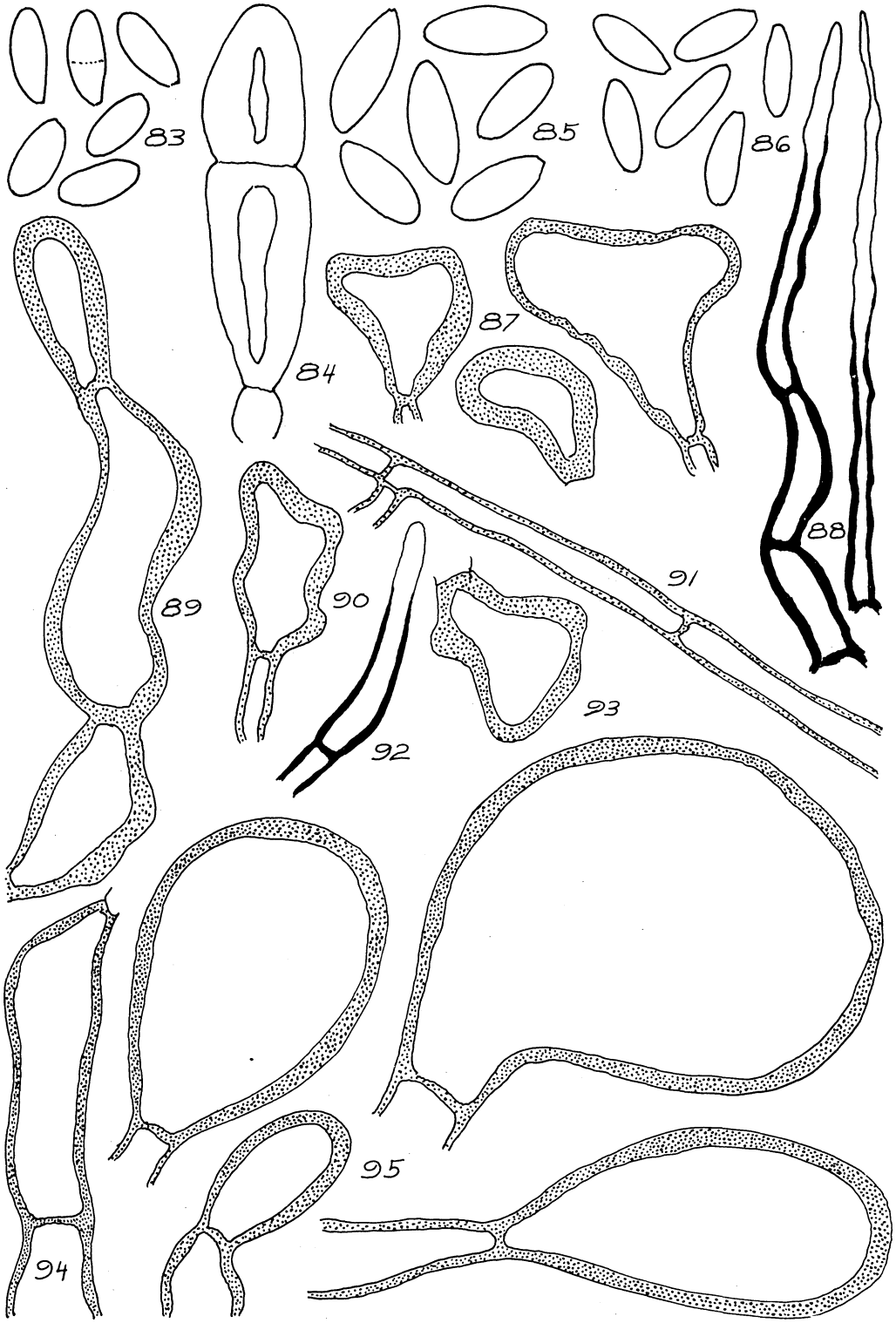
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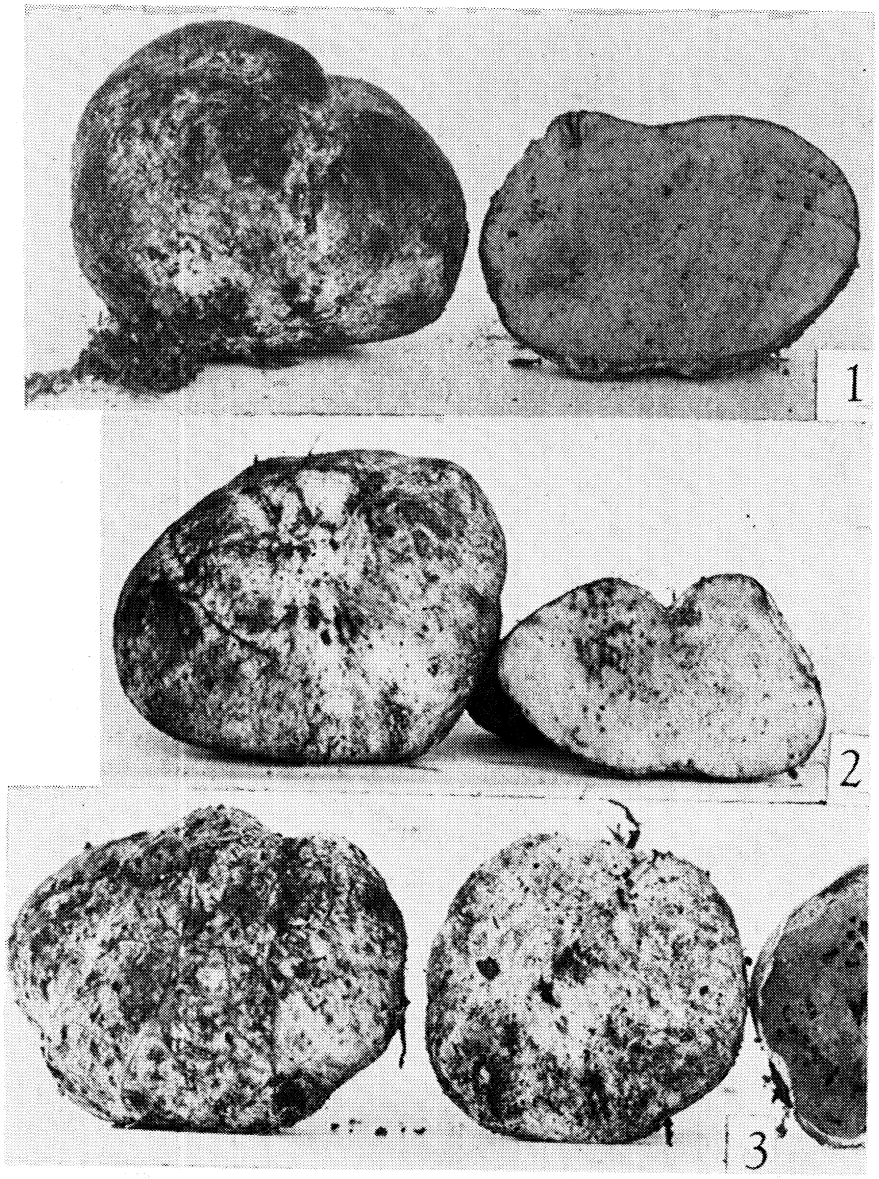

PLATE I

Fig. 1. *Rhizopogon atroviolaceus* (Smith 58888) ×1.
Fig. 2. *Rhizopogon idahoensis* (Smith 66022) ×1.
Fig. 3. *Rhizopogon ellenae* (Smith 60676) ×1.

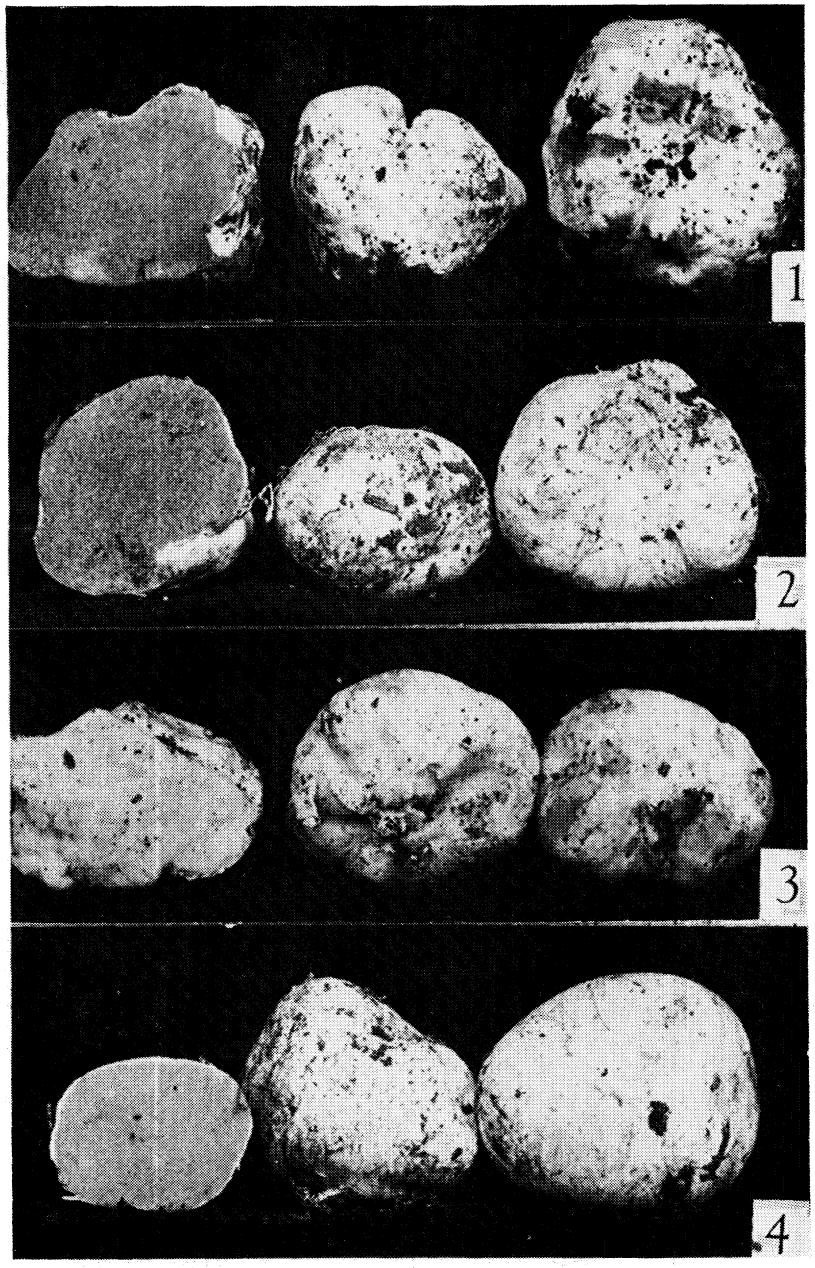

PLATE II

Fig. 1. *Rhizopogon rubescens* var. *ochraceus* (Smith 65651) ×1.
Fig. 2. *Rhizopogon evadens* var. *evadens* (Smith 65695) ×1.
Fig. 3. *Rhizopogon pseudoaffinis* (Smith 65780) ×1.
Fig. 4. *Rhizopogon subpurpurascens* (Smith 65398) ×1.

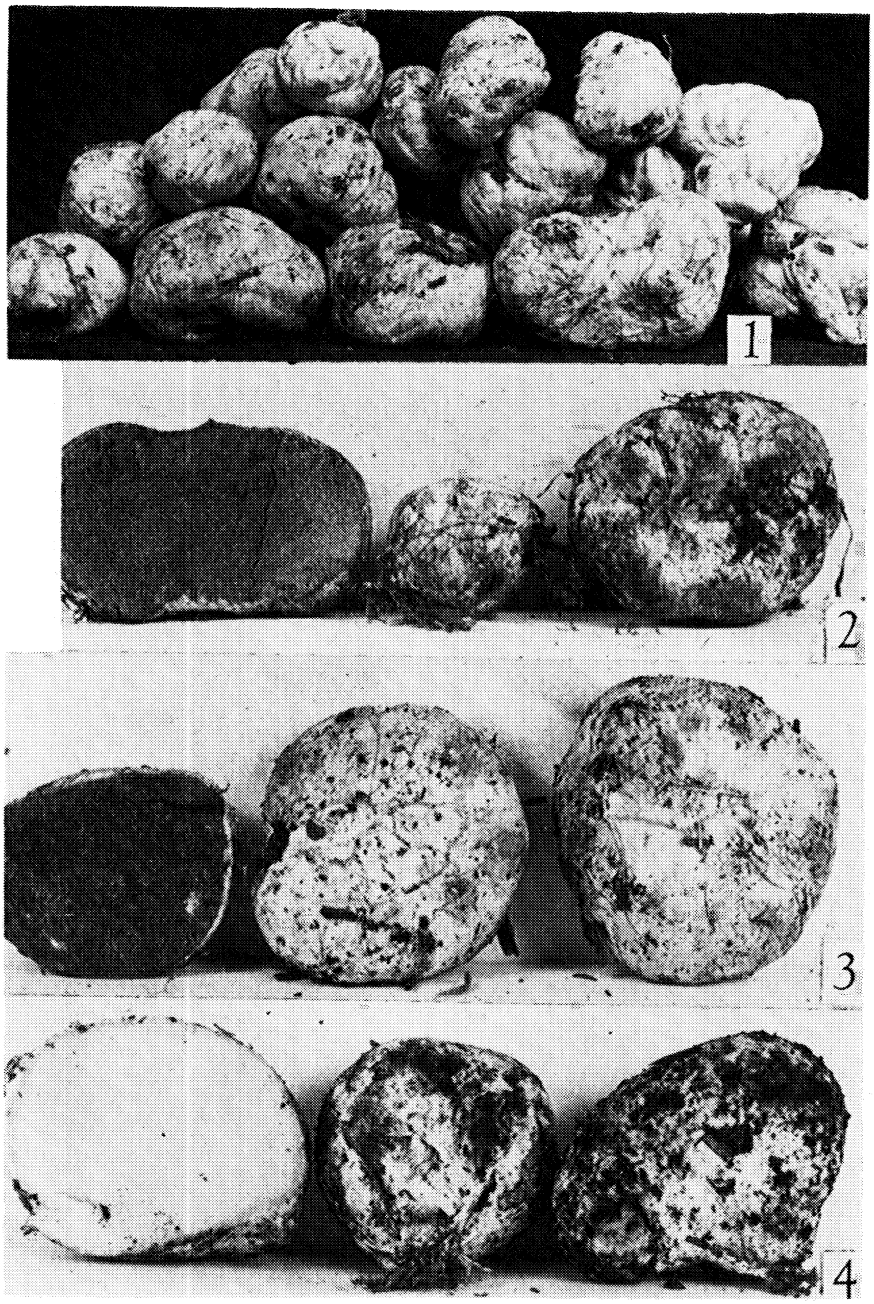

PLATE III

Fig. 1. *Rhizopogon subcroceus* (Smith 65619) ×1.
Fig. 2. *Rhizopogon subsalmonius* (Smith 45593) ×1.
Fig. 3. *Rhizopogon subsalmonius* (Smith 44997) ×1.
Fig. 4. *Rhizopogon pseudoaffinis* (Smith 66020) ×1.

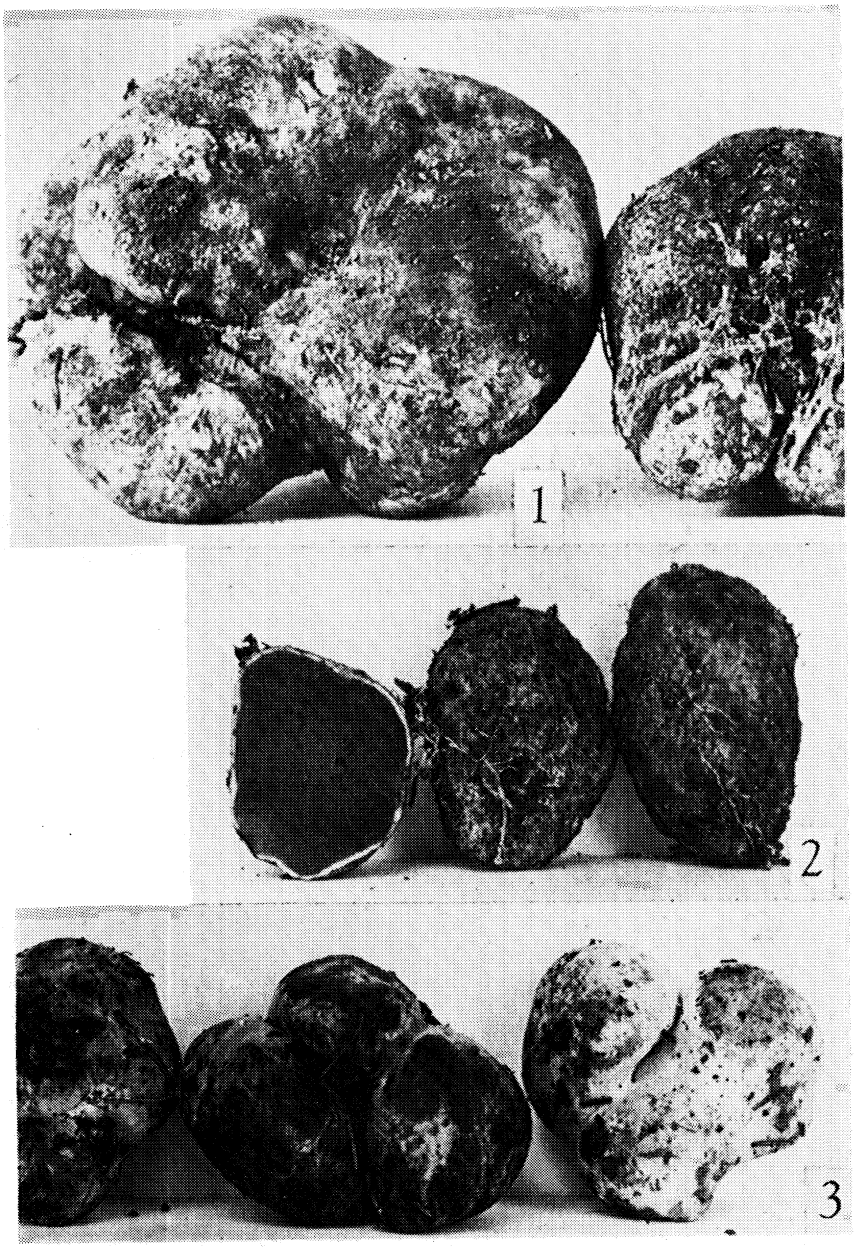

PLATE IV

Fig. 1. *Rhizopogon colossus* (Smith 49480) ×1.
Fig. 2. *Rhizopogon argillaceus* (Smith 66081) ×1.
Fig. 3. *Rhizopogon rubescens* var. *rubescens* (Smith 66438) ×1.

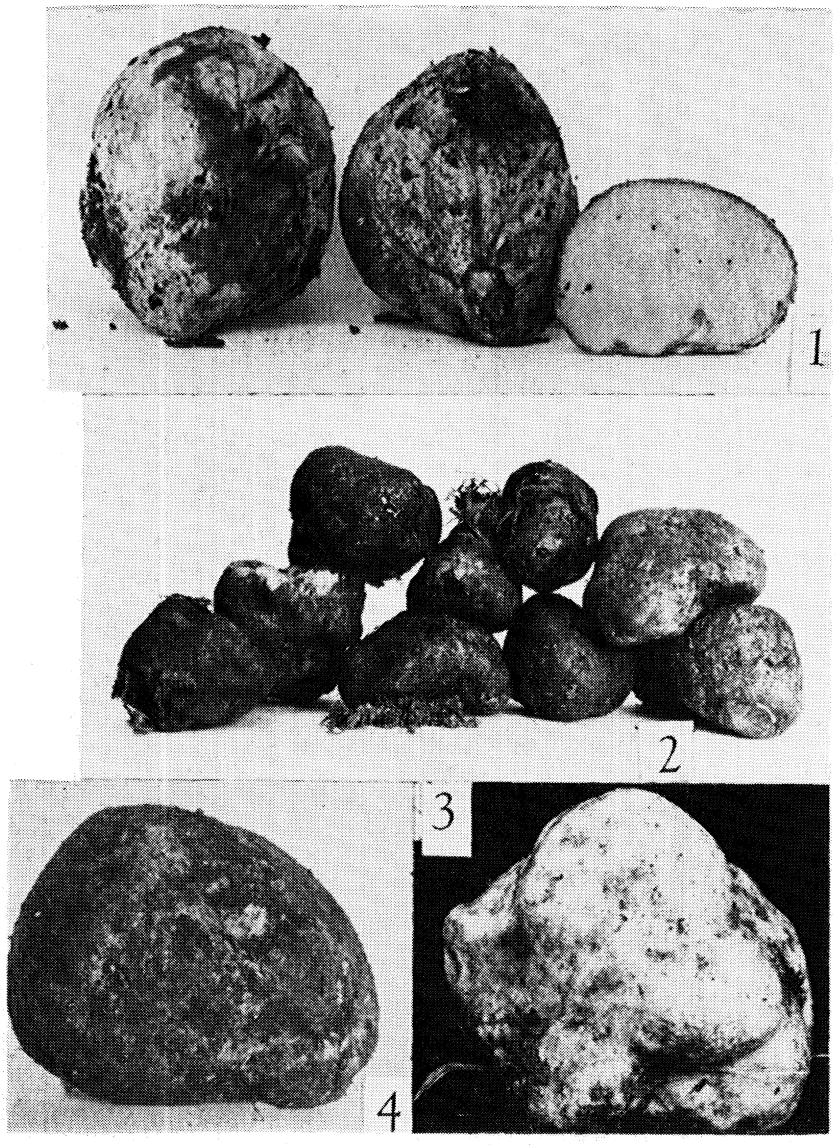

PLATE V.

Fig. 1. *Rhizopogon rubescens* var. *rubescens* (Smith 60604) ×1.
Fig. 2. *Rhizopogon vinicolor* (Smith 66209) ×1.
Fig. 3. *Rhizopogon atroviolaceus* (Smith 58888) ×1.
Fig. 4. *Rhizopogon fallax* (Smith 65650) ×1.

PLATE VI

Fig. 1. *Rhizopogon rubescens,* (form with dextrinoid mass in paraphyses in age). (Smith 66451) ×1.

Fig. 2. *Rhizopogon ochraceorubens* (Smith 59643) ×1.

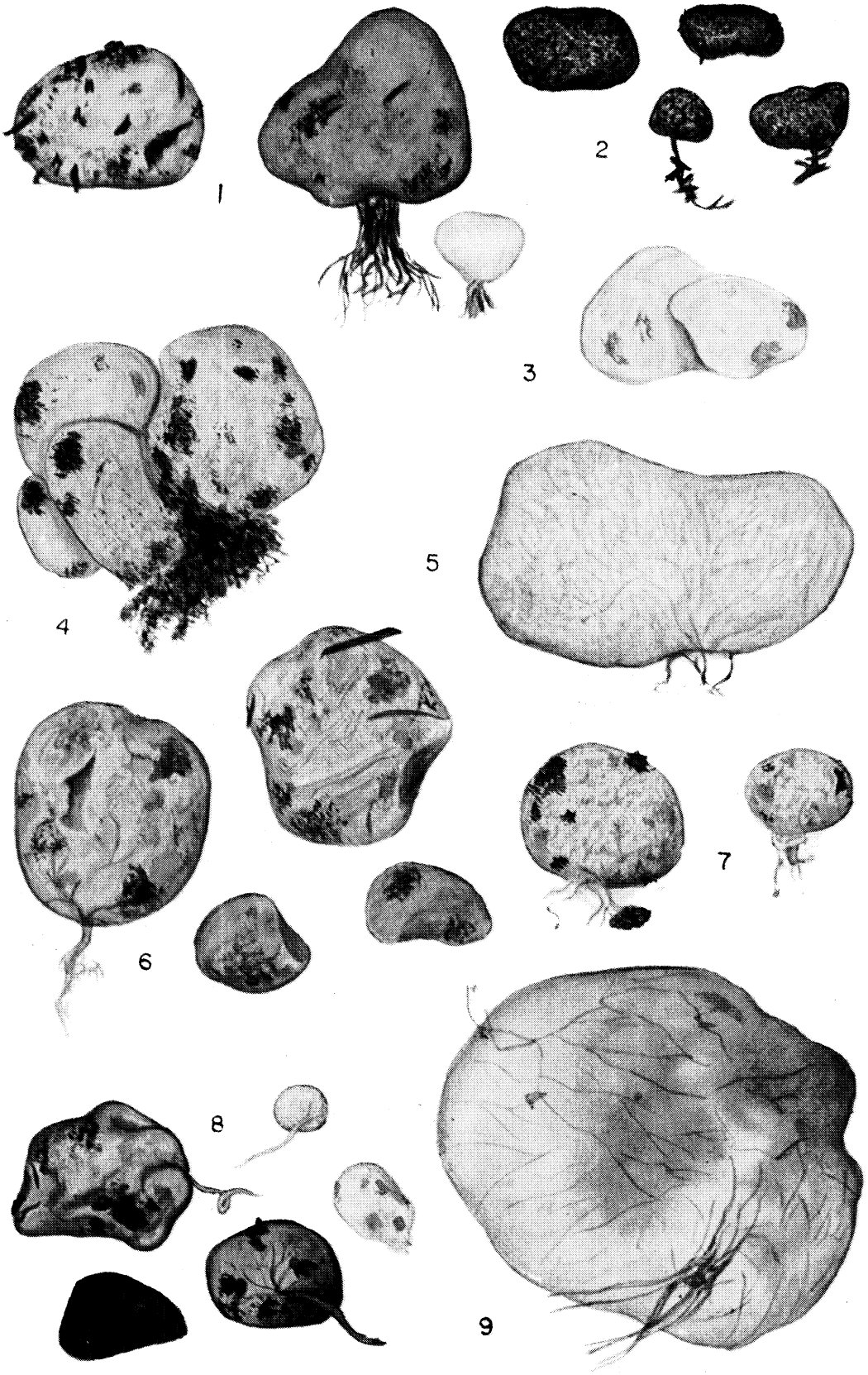

PLATE VII

Fig. 1. *Rhizopogon vulgaris,* 3 basidiocarps; Fig. 2. *R. villosulus,* 4 basidiocarps; Fig. 3. *R. evadens* var. *evadens,* a compound basidiocarp; Fig. 4. *R. argillascens,* a cluster of basidiocarps; Fig. 5. *R. subcaerulescens* var. *subpannosus;* Fig. 6. *R. ochroleucoides,* 4 basidiocarps; Fig. 7. *R. subcaerulescens* var. *subcaerulescens,* 2 basidiocarps; Fig. 8. *R. vinicolor,* 5 basidiocarps; Fig. 9. *R. ellenae,* one basidiocarp.

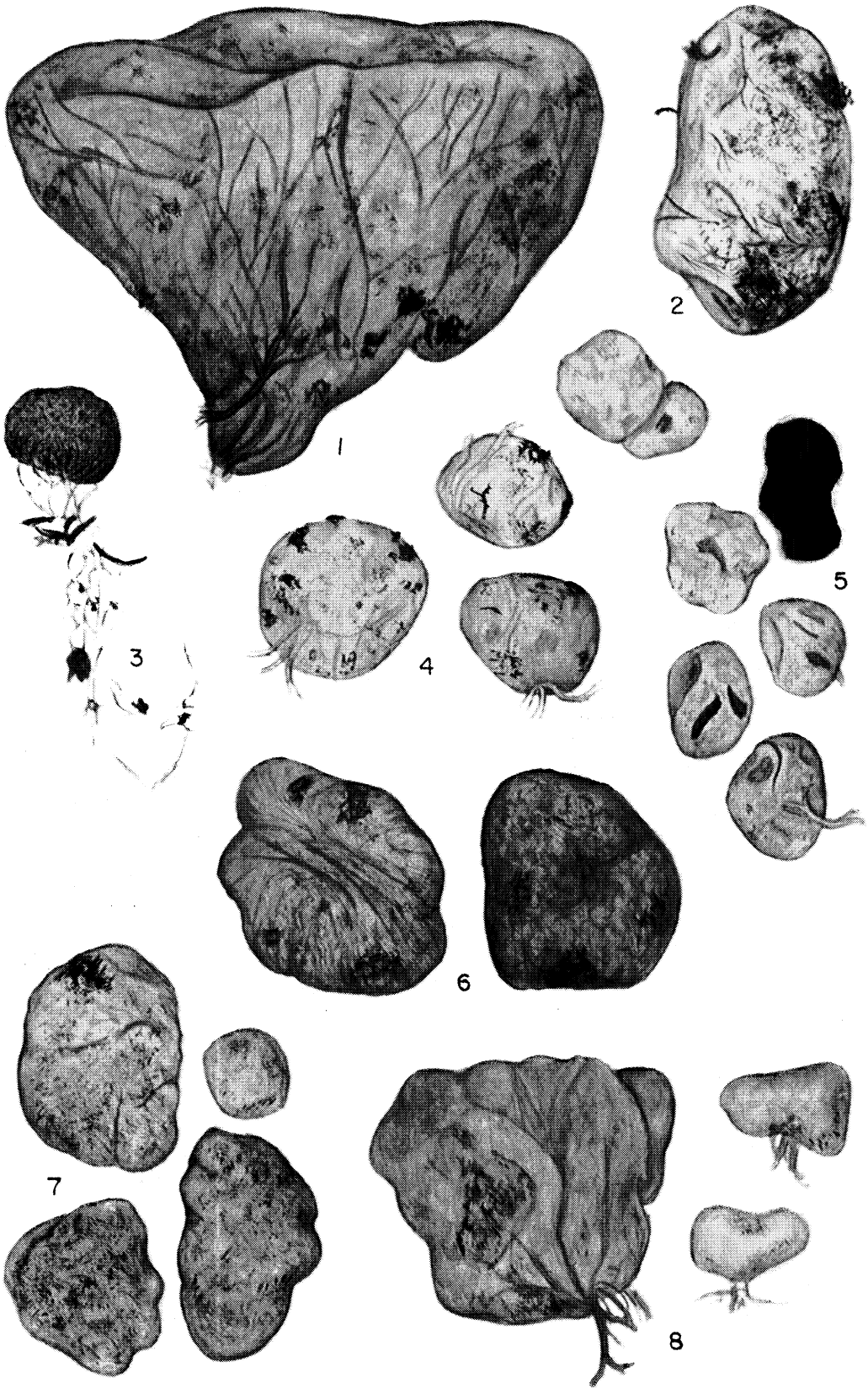

PLATE VIII

Fig. 1. *Rhizopogon subradicatus;* Fig. 2. *R. idahoensis;* Fig. 3. *R. subbadius;* Fig. 4. *R. subsalmonius* var. *subsalmonius,* 3 basidiocarps; Fig. 5. *R. cokeri,* 7 basidiocarps; Fig. 6. *R. ochraceorubens,* 2 basidiocarps; Fig. 7. *R. subsalmonius* var. *griseolilascens,* 4 basidiocarps; Fig. 8. *R. sublateritius,* 3 basidiocarps.

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