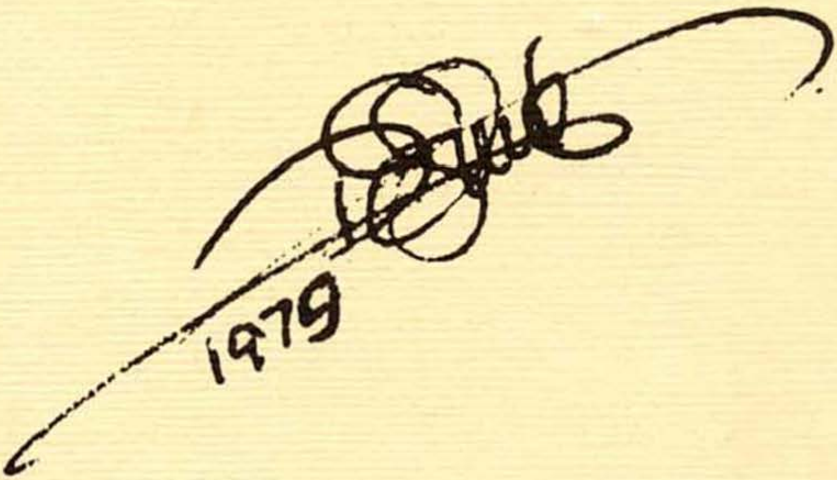
MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Volume IX June 12, 1979 No. 1



ISSN 0093-4666 *MYXNAE 9(1) 1-364 (1979)*

Library of Congress Catalogue Card Number 74-7903

Published quarterly by MYCOTAXON, Ltd., P.O. Box 264, Ithaca, NY 14850
For subscription details and availability in microform,
see inside back cover

MYCOTAXON is a quarterly journal devoted to all phases of mycological and lichenological taxonomy and nomenclature. It seeks to publish all papers within 4 months of acceptance, using photo-offset lithography. All articles are reviewed by specialists prior to acceptance. Publication is open to all persons. Papers may be in French or in English.

SUBSCRIPTION INFORMATION

Each issue of MYCOTAXON may vary in number of pages. Each volume, beginning with volume 3, consists of at least 512 pages, and consists of an irregular number of quarterly issues depending only upon the amount of copy received from authors. Subscriptions are on a per volume basis, *not* on an annual basis. If only one bill during each year is a requirement, please pay for 2 volumes, which will normally cover one year's issues. Personal subscriptions are available at a substantially reduced subscription rate for *individuals* who agree not to deposit their copies in another library than their own within three years of publication or receipt. Prices for each volume, beginning with volume 3, are:

REGULAR *(multi-user)*: $32.00 PERSONAL *(individuals)*: $14.00

(Vols. 1 & 2 are available at *half* the above rates per volume.)

(*Complete runs*, vols. 1 through the latest complete volume, are subject to a 10% *discount*.)

MYCOTAXON is also available in *MICROFORM* (microfiche, microfilm) from University Microfilms, 300 North Zeeb Road, Ann Arbor, MI 48106, from whom prices may be obtained.

MYCOTAXON may also be obtained on a journal-exchange basis. This may be arranged with journals, institutions, or individuals who have difficulty in obtaining foreign currencies. For details and journal exchange forms, write to a Co-Editor.

EDITORIAL SERVICES AND INFORMATION FOR PROSPECTIVE AUTHORS

Authors prepare their own camera-ready-copy after having received comments from pre-submission reviewers. Detailed *Instructions to Authors* appeared in MYCOTAXON 1: 3-12. 1974, and 6: 370. 1977. A copy of each will be sent upon request to one of the Co-Editors.

We are able to provide prospective authors with two aids to publication. Both are sold at no profit, and are shipped postpaid from MYCOTAXON, LTD., P.O. Box 264, Ithaca, NY 14850 USA.

SPECIAL MANUSCRIPT PAPER is available in packages of 50 sheets, and is ruled in blue, non-photoreproducing ink for each of the two sizes of typeface called for in the instructions to authors (elite, pica). It is a convenience to typists, but certainly not an essential, since the appropriate sized rectangles can be prepared on any paper using a non-photoreproducing blue pencil. Each package of 50 sheets is sent *postpaid* for $1.60.

BIOPLATE is a special sheet of transfer letters for the use of authors in the preparation of plates and graphs for publication. It is manufactured specifically for us, and is available in both black and white. Each sheet is approximately 30 × 39 cm., with a wide assortment of characters (some shown at left in actual size). Our cost is $3.75 per sheet, mailed *postpaid* (black will be sent unless white is specified).

CONTENTS

Guest Editor: DAVID L. LARGENT

Guest Co-Editor: DAVID R. HOSFORD

PREFACE

The concept for this volume in honor of Daniel E. Stuntz was initiated during discussions at the AIBS meetings in Corvallis in 1975. Basically we felt that every one of Dan's students have had their lives personally and professionally enriched by Daniel. Therefore, we felt some expression of our gratitude should be presented to him and hopefully this volume which contains articles by his students as well as his professional colleagues serves such a purpose.

Our function in this endeavor was simply to initiate and coordinate this project. We hasten to point out that we did not act as editors but were responsible for compiling the finished papers, numbering the pages of the volume and completing the index. Contextual or editorial errors are the responsibility of each contributing author.

We would like to acknowledge our appreciation for the numerous ideas and suggestions from Dan Stuntz's many students, particularly in the formative stage of this project. We would also like to thank Dr. Richard P. Korf for his assistance and his cooperation in allowing *Mycotaxon* to function as the publishing outlet for this commemorative volume.

Finally, we would like to thank you, Dan Stuntz, for your encouragement, guidance and kindness. Stand proud, Dan, you have every right to do so.

DAVID LARGENT
Arcata, California

DAVID HOSFORD
Ellensburg, Washington

MYCOTAXON

Vol. IX, No. 1, pp. 3-16 June 12, 1979

DANIEL E. STUNTZ--A DISTINGUISHED PROFESSOR AND FRIEND

by
David Ramon Hosford
Department of Biological Sciences
Central Washington University
Ellensburg, WA 98926

An Apology:

I would like to confess that I gathered much of the following from Dr. Stuntz without his approval or knowledge. Several means were used, but the most productive and, perhaps, most subversive were the wine sessions we shared sporadically over the last thirteen years. I sincerely hope memory of what was said during those occasions was not influenced too greatly by the exquisite wines imbibed. If so, my apologies, Dr. Stuntz, but let me assure you that I will never forget the friendship and details of vintages we shared.

Daniel E. Stuntz was born in Milford, Ohio, but moved at an early age to Seattle, a move never regretted largely because of the hot, muggy summers which adversely effected his health as a child. The family lived in the beautiful Magnolia district overlooking the Puget Sound, a place which offered nearby woods and chilly, sparkling waters in which to play. Surviving a normal childhood, one tale of his youth particularly gives us a glimpse of his inventiveness. He and his cousin loved to experiment in the kitchen (likely, in secrecy). On one occasion they developed a most unusual concoction which he still gladly shares. It is called "Stuntz's All Service Spice" with the following recipe: take one tsp. of celery seed, one tsp. (±) of baking soda, and mix liberally with an adequate amount of vanilla extract to produce a "drinkable" slurry; serve, if you dare! Having tried this, you'll find that it is particularly useful as an emetic. In hindsight, these trial and error experiments must have helped "mould" him into the connoisseur we know today.

Daniel's interest in botany was influenced by his father's business in sugar cane. His father spent much time on plantations in Cuba and the southern United States and, at least once, took him to Cuba. Daniel vividly recalls this experience, particularly the processing of the canes and the futile attempts of rats trying to escape from the hopper of the sugar cane press. Today, he is mildly amused at the mentioning of "pure," unrefined cane sugar so popular with the "organic" generation. While his father was away during the school year, Daniel often stayed with his aunt in Seattle. In later years, his parents moved to Pateros in north central Washington where his father established a business processing apples into concentrate.

In 1931, Daniel enrolled at the University of Washington. His choice of forestry was apparently influenced to some degree by a family friend and occulist. He advised Daniel to consider forestry, presumably for reasons relating to Daniel's near-sightedness (reportedly, equivalent to 40X hand lens) and the supposed non-eyestraining, outdoor life-style of the forester. Although his freshman courses in forestry, physical sciences, math, and engineering design were far from an outdoor experience, he excelled in them. It was later in that year or the next that he took his first botany course on the fungi (as we all know, pronounced fun-gee). The course in general mycology, taught by Dr. J. W. Hotson, convinced him that he had chosen the wrong major. Seeking to correct his mistake, he met with Dr. Frye, the stern chairman of the botany department. Dr. Frye's first reply to his request to enter botany was, "Young man, I do not seem to remember what your aspirations are." Daniel cautiously made his aspirations clear and was accordingly accepted into the program. Needless to say, he had found his niche and, in 1935, received a Bachelor of Science degree in botany. Afterwards he commenced work on a Masters degree under the supervision of Dr. Hotson.

His interest in the taxonomy of agarics was sparked by Hotson, a rust specialist, who loved agarics but apparently had little time to do research on them. As an undergraduate, Daniel began collecting mushrooms and occasionally had the opportunity to meet visiting mycologists. One of the most memorable meetings was in 1935 with Alexander Smith. They collected in the Olympic Mountains together and became lifelong friends.

His choice of graduate thesis came about through an innocent attempt to key out a mushroom, with angular-nodulose spores, to the genus *Cortinarius*. Mildly frustrated, Dr. Hotson came to his rescue and gently suggested that he try *Inocybe*. Becoming aware of the horrendous number of unidentifiable *Inocybe* species, he bravely began a floristic survey. However, just before completing his thesis, he received an opportunity which abruptly changed his immediate plans. In 1937, Dr. Frye approached him with the possibility (he stressed 'possibility') that, if he would get a Ph.D. at Yale under the famous forest pathologist, John S. Boyce, he might be considered as a replacement for Dr. Hotson, whose health was rapidly failing. Fully aware of the shortage of academic positions at that time, he quickly applied to Yale and was accepted by Dr. Boyce.

In spite of New Haven, he quickly adjusted to Yale and a course of study in forest pathology under Boyce. For his doctoral thesis, he proposed to expand his work on *Inocybe*, particularly since he now had better access to North American types in eastern herbaria. Dr. Boyce received the idea enthusiastically but quickly proclaimed, "I don't know an agaric from a battleship." Undaunted, however, he began the monographic work. He gratefully recalls receiving taxonomic help from Alexander Smith who extended an invitation to visit and use the herbarium and mycological library at the University of Michigan. He accepted the offer and "slithered" by auto to Ann Arbor one Christmas recess. He completed his thesis and Ph.D. in 1940 and, in the same year, accepted Dr. Hotson's vacated position at the University of Washington.

Hired as an instructor in botany, he initially taught Forest Pathology, General Mycology, and a plethora of bread 'n' butter courses such as Economic Botany. His earlier apprenticeship as a graduate teaching assistant apparently prepared him well. In 1959, he was promoted to full professor and in 1974 received the honorary title of Distinguished Professor, an immense honor, considering the number of faculty he was chosen from and the number of students attending the University (approximately 2,400 and 35,000, respectively). His courses were always of the highest quality, providing a thorough background in historical and current developments and literature, and uniquely organized with original illustrations and taxonomic keys. Lectures were never flamboyant or pretentious, but instead eloquent presentations sprinkled with humorous comments (seemingly missed by all but the most attentive) and beautiful color drawings in chalk.

During his years at the University, he enlarged the mycology offerings to include: Basidiomycetes (excluding the Rusts and Smuts); Ascomycetes (excluding the Yeasts); Yeasts and Related Forms; and Rusts, Smuts, and Fungi Imperfecti. During his tenure, Dr. Howard Wisler joined the staff and a course in Phycomycetes was added. Therefore, due to Daniel's presence, the University of Washington became a major center for mycological training and research.

The assessment of the total influence of such a man is impossible, particularly while he is still actively working. Leaving the impossible undone, I will mention only some of his more obvious accomplishments. Notable is his legacy of mycologists (Fig. 1), many of whom are active in teaching and research. Those at universities are likewise producing a second generation of mycologists. Another important contribution that should be noted is his extensive work with the amateur. For years, he has taught evening and weekend mushroom identification courses (gratis). He revised and enlarged the popular field guide to northwest species, *The Savory Wild Mushroom.* In 1963, he helped organize, and still advises, the huge Puget

Sound Mycological Society. This organization has spawned at least a dozen smaller groups around the northwest.

In the 1967 edition of *American Men of Science*, he listed his specialties as morphology and taxonomy of Basidiomycetes and Ascomycetes. His published work in these areas, often co-authored, is extensive and covers a wide range of fungi. Over the years, he has steadfastly worked on *Inocybe*. Although he would be the last to admit it, progress on the monograph has been impeded by relatively heavy teaching responsibilities and large numbers of graduate students (Table I). Yet, he has published new species and has completed a manuscript (unpublished) on Sect. *Inocybium* (*sensu* Stuntz) of Subg. *Inocybium* (Earle) Singer. This section, at last count, includes 455 species, 29 varieties, and 18 forms, and contains only the smooth spored species with pleurocystidia. In the near future, he hopes to finish the "rough" spored section of Subg. *Inocybe* and publish the complete monograph.

Finally, I would like to list a few personal memories, many of which his students will certainly remember. I recall: his unselfish sharing of time and unbelievable patience; his incredible mycological library and facility with the literature; his occasional catnaps late at night or during seminars; his Louisiana coffee breaks; his legendary supply of exotic pastries (thanks for those scrumptuous maple bars, Dr. Stuntz!), luscious fruit, cheeses, breads, and beverages; his shopping excursions for pastries to supply the day's lab; his surprise gifts of expensive books, autographed in his unforgeable style (see cover); his occasional expressions of frustration (like ". . . 40,000 tons of inspissated Emeu . . . ."); his evenings at the symphony; the incessant ringing of his telephone during the mushroom season; his Friday Harbor excursions and the Stuntz Foray; and Friday evening wine sessions. Best, though, is the memory of having experienced the stimulating intellect of this gentle and kind man.

It is for these reasons, and many more, that his students and colleagues wish to dedicate this issue of *Mycotaxon* to Daniel E. Stuntz, now Professor Emeritus.

- -

Figure 1. D. E. Stuntz's mycological descendants, restricted to those teaching in colleges and universities and/or active in research. For a more complete listing of graduate students refer to Table I.
*deceased

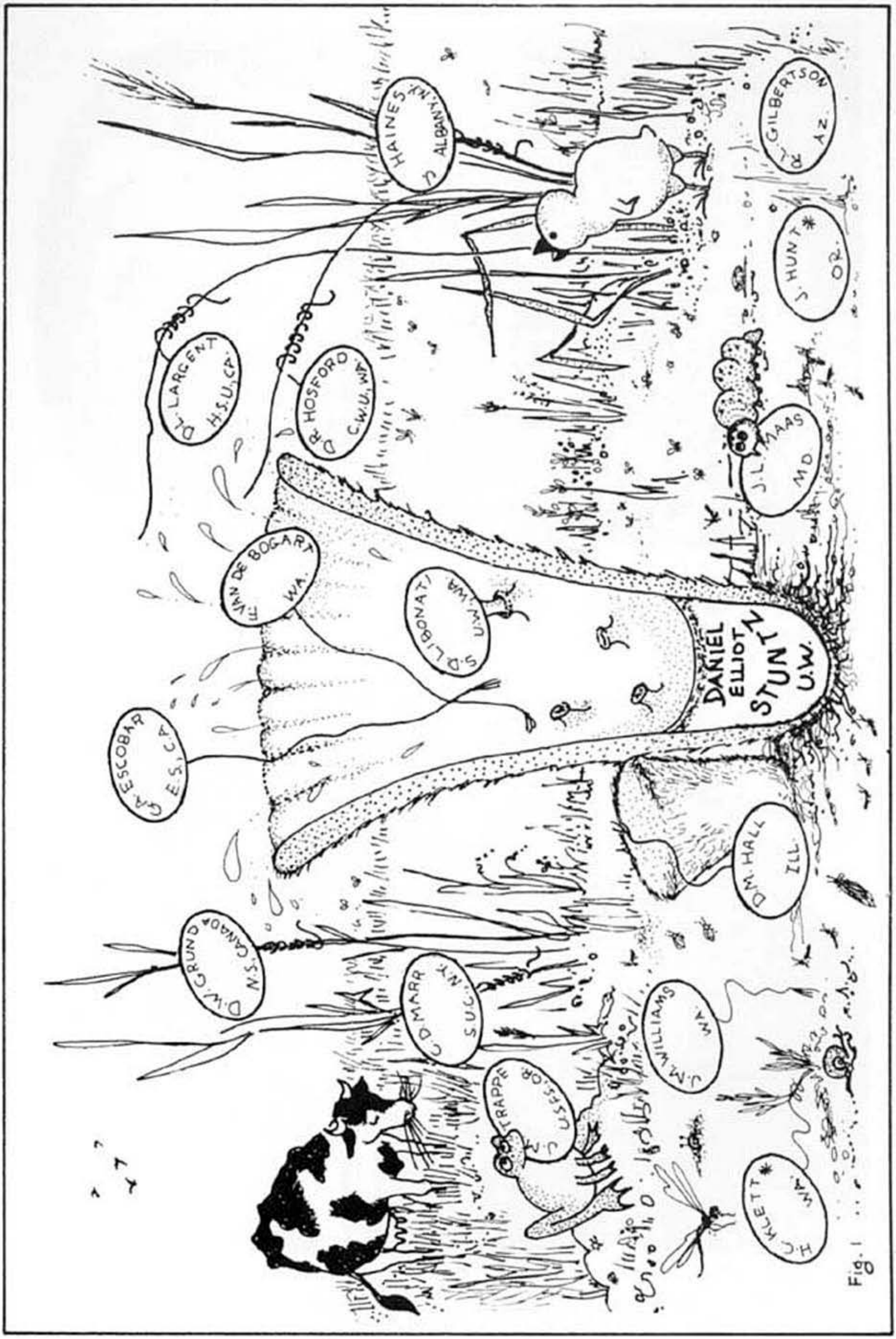
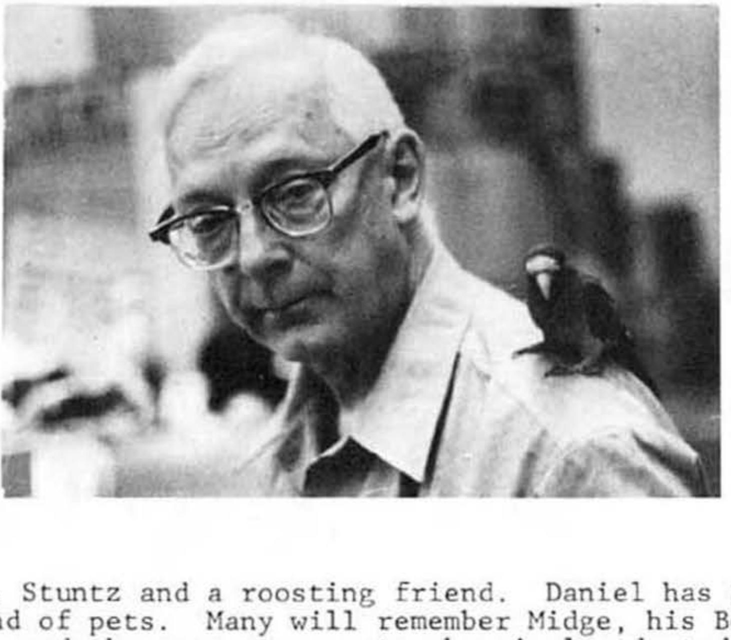

DANIEL ELLIOT STUNTZ U.W.
D.L. LARGENT H.S.U. CA
D.R. HOSFORD C.W.U. WA
F. VAN DE BOGART WA
S.D. LIBONATI U.W. WA
G.A. ESCOBAR E.S. CA
D.W. GRUND N.S. CANADA
C.D. MARR S.U.C. N.Y.
J.M. TRAPPE USFS OR
J.M. WILLIAMS WA
D.M. HALL ILL
H. KLETT* WA
J.L. MAAS MD
J. HUNT* OR
R.L. GILBERTSON AZ
J. HAINES ALBANY N.Y.

Fig. 1

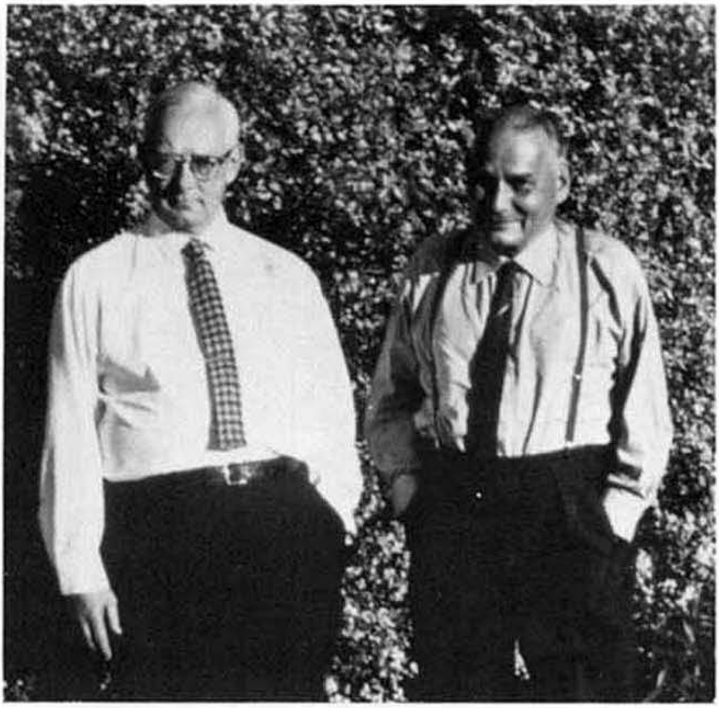
Left - Daniel, about 4 years old. Photo taken in Ohio.
Right - Daniel, about 10 years old. Photo taken in Seattle.



Dr. Stuntz and a roosting friend. Daniel has always been fond of pets. Many will remember Midge, his Boston terrier, and the many stray cats who wisely adopted him (his "cat" food is reportedly the best in Seattle). He has also been the recipient of a number of unusual pets: Caligula the *Iguana* (may he rest in Peace!); a nest of praying mantes; and an assortment of snakes and turtles.

From left to right, L. R. Hesler, A. H. Smith, R. Singer, and D. E. Stuntz. Photo was taken in the early 1950's at the University of Michigan Biological Station.

Left - Dr. Stuntz collecting in the field, 1950.
Right - Dr. Stuntz and friends arriving at Friday Harbor (San Juan Island) for a weekend of gourmet meals and mushroom collecting. About Nov. 1974.



Daniel Stuntz and his friend Albert Pilát, together in Seattle during the 1969 International Botanical Congress.

Dr. Stuntz examining an *Inocybe* at (typical) close range.

Dr. Stuntz relaxing in Oneonta, N. Y., just after the 1977 Peck Foray. Swinging with Gloria Hosford and Currie Marr.

Dr. Stuntz in his Johnson Hall laboratory, U.W., 1978.

Table I

GRADUATE DEGREES COMPLETED UNDER THE SUPERVISION OF

DANIEL E. STUNTZ

1951	M.S. Robert Lewis Gilbertson Department of Plant Pathology University of Arizona Tucson, AZ 85721	Polyporaceae of Flathead Lake region of western Montana
1951	M.S., Forestry John Hunt Pacific Northwest Regional Experiment Station, Forest Service Portland, OR (Died 1959 en route to assume Dr. Boyce's position at Yale)	An investigation of two species of fungi associated with Bark-Beetles on Pacific Silver Fir
1957	M.S. Harvard Lyman address unknown	The ontogeny of the laticiferous system of *Lactarius aurantiacus* (Fr.) Fries
1957	Ph.D., Forestry James Martin Trappe Forestry Science Laboratory 3200 Jefferson Way Corvallis, OR 97331	*Cenococcum graniforme* - its distribution, ecology, mycorrhiza formation, and inherent variation
1962	M.S. Darryl William Grund Department of Biology Acadia University Wolfville, N.S. Canada	*Pholiota* of Washington State
1962	M.S. Hubert Cliffort Klett Department of Biology Olympic College Bremerton, WA 98310 (Died 1976)	A survey of the Tremellales of the Pacific Northwest

1963 M.S.

Dennis Melvin Hall

Department of Biology
Northeastern Ill. University
Bryn Mawr at St. Louis
Chicago, IL 60625

A survey of the pileate Hydnaceae of western Washington

1963 M.S.

Theodore Charles Hoffman

Mason Lake, WA
(deceased)

A survey of Boletaceae of Washington

1963 M.S.

Bill Forgust Isaacs

Tewa Enterprises
Sante Fe, N.M. 87501

A survey of *Agaricus* in Washington, Oregon, and California

1964 Ph.D.

Hurbert Clifford Klett

Department of Biology
Olympic College
Bremerton, WA 98310
(Died 1976)

North American Species of *Exidia*

1964 M.S.

John Lewis Maas

Fruit Laboratory
BARC-W
Beltsville, MD 20705

A survey of the macrofungi on serpentine and non-serpentine soils in the upper Teanaway River Valley, Washington

1965 Ph.D.

Darryl William Grund

Department of Biology
Acadia University
Wolfville, N.S. Canada

A survey of *Russula* occurring in Washington State

1965 M.S.

Phyllis Margaret Hicks

College Biological Supply
Bothell, WA

A taxonomic survey of *Peziza* in western Washington

1965	M.S. Naoshi Nakamura Okinawa	A survey of *Amanita* in western Washington
1967	M.S. Betty Ann Alder Bremerton, WA 98310	A survey of genus *Guepiniopsis* with comparison of genera *Guepiniopsis* and *Dacrymyces*
1967	M.S. John H. Haines, Ph.D. New York State Museum Albany, N.Y. 12234	A survey of the genus *Dasyscyphus* and related genera in western Washington
1968	Ph.D. Dennis Melvin Hall Department of Biology Northeastern Illinois University Bryn Mawr at St. Louis Chicago, IL 60625	A survey of the pileate Hydnaceae of western Washington
1968	Ph.D. David Lee Largent Department of Biology Humboldt State University Arcata, CA 95521	*Leptonia* and related genera of the west coast with a preliminary revision of the Rhodophylloid fungi
1968	Ph.D. Currie Daniel Marr Science-Biology Department State University College Oneonta, N.Y. 13820	*Ramaria* of western Washington
1971	Non-thesis Masters R. L. Holman Seattle, WA	"A study of *Histoplasma* in the Pacific Northwest"
1971	Non-thesis Masters Fred Van De Bogart, Jr. Seattle, WA 98133	A taxonomic survey of the coprophilous taxa of *Coprinus* (Agaricales) in western Washington

1972 Ph.D. — *Rhizopogon* of the northwestern United States

David Ramon Hosford

Department of Biological Sciences
Central Washington University
Ellensburg, WA 98926

1974 M.S. — Algunos Hongos de El Salvador Tremellales, Thelephorales y Discomycetes

Gustavo A. Escobar

Apartado Postal #05-50
San Salvador, El Salvador
Central America

1975 Non-thesis Masters — Studies on the Bird's Nest Fungi of Washington State

Carol Sue Davis

Everett, WA

1975 Ph.D. — The genus *Coprinus* in Washington and adjacent western states

Fred Van De Bogart

Seattle, WA 98133

1975 Ph.D. — The Collybioid fungi of western Washington

Joanne Helen Williams
(Lennox)

Issaquah, WA 98027

1978 Ph.D. — Contribution towards a monograph of neotropical species of *Hymenochaete*

Gustavo A. Escobar

Apartado Postal #05-50
San Salvador, El Salvador
Central America

1979 Ph.D. (to be completed) — "Selected Pleurotoid genera of western Washington"

Susan D. Libonati
(Barnes)

Department of Botany
University of Washington
Seattle, WA 98195

ACKNOWLEDGEMENTS

The author appreciates the editorial comments of Professor Curt A. Wiberg, C.W.U., and suggestions from his wife Gloria Beth. I'm also grateful to Fred Van De Bogart and Susan Libonati-Barnes for double-checking some of the facts. Finally, I wish to thank Julia Duskin for her delightful rendition of my original sketch (Figure 1) and Robert Gilbertson, Harry Thiers, Joanne Williams-Lennox, and Fred Van De Bogart for loaning some of the included photos.

MYCOTAXON

Vol. IX, No. 1, pp. 17-37 June 12, 1979

ON THE MASSARIACEAE IN NORTH AMERICA

MARGARET E. BARR

Department of Botany, University of Massachusetts
Amherst, Massachusetts 01003

SUMMARY

The family Massariaceae of the Melanommatales comprises taxa with medium to large ascocarps, a peridium composed of numerous layers of small compressed cells, thick-walled bitunicate asci, trabeculate pseudoparaphyses, and large, symmetric, distoseptate ascospores. Six genera are recognized in the family and are distinguished by ascospore septation, perithecioid or cleistothecioid ascocarps or presence of stromatic tissues. *Dothivalsaria megalospora* with one-septate ascospores and *Aglaospora profusa* with three-septate ascospores have ascocarps grouped beneath stromatic tissues that form coarse sulcations at the substrate surface. Species of *Caryospora* and *Zopfia* produce one-septate ascospores that develop thin secondary septa near the tips. Cleistothecioid ascocarps are formed by species of *Zopfia*. The species of *Massaria* have three-septate ascospores; ascocarps are separate with or without clypeal tissues. Species of *Titanella* form many transverse and vertical septa in the ascospores.

In a forthcoming article, expanded from a poster presentation prepared for IMC2 in 1977, Barr (1979) presents a classification of the Loculoascomycetes. The families of Pleosporales in the classification of Luttrell (1973) or the suborder Pseudosphaeriineae of the Dothideales according to von Arx and Müller (1975) are rearranged and expanded into two orders (Barr, 1976); a key to families and notes on representative genera are given. It is my intention to enlarge on the outline with descriptions of genera and species of the various families known from temperate North America, even though the numbers of species and details of their distribution are incomplete at present. This contribution presents information on the family Massariaceae of the order Melanommatales.

The distinguishing features of members of the Massariaceae are: ascocarps large (500 µm or more diam), peridium of numerous compact layers of small cells, asci thick walled, pseudoparaphyses trabeculate, branched and anastomosing, embedded in a gelatinous matrix, ascospores large, symmetric, distoseptate, and usually surrounded by a gelatinous coating. Somewhat similar species whose peridia are coarsely pseudoparenchymatous, pseudoparaphyses cellular, and ascospores asymmetric are segregated into a parallel family belonging in the Pleosporales and will not be discussed here.

Massariaceae Winter in Rabenh. Krypt.-Fl. 1(2): 534. 1886.

Zopfiaceae Arnaud, Bull. Soc. Mycol. France 29: 259. 1913.

Ascocarps medium to large, perithecioid or cleistothecioid, globose or depressed or bases flattened and applanate, immersed, erumpent or almost entirely superficial; apex short papillate, rounded or sometimes compressed, at times papilla dehiscent leaving an excavated rounded pore, or entirely closed; peridium composed of compressed layers of small cells, usually broad but narrow and forming cephalothecoid plates in some taxa, with dark reddish or vinaceous brown pigment encrusted on walls of outermost cells; stromatic tissues sparse or well developed, forming at times a coarsely sulcate surface above ascocarps, grown together with substrate cells as pseudostroma at times, then often delimited by a dark marginal zone, clypeal in most species. Asci bitunicate, arising from base of locule, wall thick, often with broad blunt apical region surrounded by refractive ring, often less than eight spored; pseudoparaphyses trabeculate, narrow, distantly and inconspicuously septate, conspicuously branched and anastomosing above the asci, embedded in a gelatinous matrix. Ascospores large, symmetric, ellipsoid or fusoid, distoseptate in the majority of species, hyaline or brown, pigment in cell contents and/or in cell walls, contents often forming thick-walled endospores, one or three septate or muriform; wall smooth or roughened, usually surrounded by a gelatinous coating, at times forming appendages at tips of spores, at times drying down to form reticulated roughenings on spore surface.

Saprobic or weakly parasitic, on branches or roots of trees and shrubs, hard endocarps of fruits, culms of large monocots.

Anamorphic states poorly known; where known coelomycetous, conidia small, apparently spermatial.

Genera of Massariaceae

1. Ascospores one septate or secondary septa thin and near tips of ascospores 2
1. Ascospores three septate or muriform 4
   2. Ascocarps immersed, grouped and surrounded by stromatic tissues forming coarse sulcations at surface of substrate . . . . *Dothivalsaria*
   2. Ascocarps erumpent or superficial, separate, stromatic tissues if formed closely appressed to peridium 3
3. Ascocarps with papillate apex, opening by pore . . . . *Caryospora*
3. Ascocarps with rounded apex, without preformed pore, opening by splitting of peridium . . . . *Zopfia*
   4. Ascospores multiseptate, with both transverse and vertical septa; ascocarps immersed, erumpent or superficial, separate . . . . *Titanella*
   4. Ascospores transversely three septate; ascocarps immersed 5
5. Ascospore wall hyaline or pallid, contents as thick-walled endospores, brown, mid cells approaching length of end cells; ascocarps usually grouped and surrounded by stromatic tissues, often forming coarse sulcations at surface of substrate . . . . *Aglaospora*
5. Ascospore wall and contents either brown or hyaline, mid cells shorter than end cells; ascocarps usually separate, stromatic tissues as clypeal region at surface of substrate or closely appressed to peridium . . . . *Massaria*

Aglaospora de Not. Giorn. Bot. Ital. 2: 43. 1844.

Ascocarps large, immersed, several grouped and erumpent together, short beaked; stromatic tissues blackened and often forming coarsely sulcate tips above small group of ascocarps, intermixed with host cells around ascocarps and forming whitened areas, circumscribed by blackened marginal zones; peridium composed of numerous layers of compressed cells, darkened toward surface. Asci cylindric, bitunicate, with thick walls and broad shallow cytoplasmic protrusion in apex, surrounded by refractive ring, usually eight ascospore initials formed but typically four ascospores maturing; pseudoparaphyses trabeculate, narrow, branched and anastomosing in gelatinous matrix. Ascospores pallid or light brown with dark brown endospores, ellipsoid, symmetric, tapering to rounded tips, three distoseptate, endospores rhomboid (in mid cells) or conoid (in end cells), wall smooth, surrounded by gelatinous coating.

Weakly parasitic on woody branches.

Conidial state said to be *Cytispora leucosperma* Fr. (Tulasne and Tulasne, 1863).

Type and single species: *A. profusa* (Fr.) de Not.

Shoemaker and Kokko (1977a) provided a description of *A. profusa* as an unitunicate ascomycete. The peculiar ascus tip -- with a "shoulder like ridge near apex" (Shoemaker and Leclair, 1975) and the presence of a refractive ring surrounding this ridge of cytoplasm suggest unitunicate nature. However, the ascus apices of *A. profusa* and of the species of *Massaria* are quite similar in structure. The asci are not typically bitunicate, but in water mounts of fresh material the exoascus will break and the endoascus elongate so that I consider them to be bitunicate. A refractive ring surrounding the apical cytoplasmic protrusion is found elsewhere in the Loculoascomycetes, notably in species of *Leptosphaerulina, Pyrenophora* and *Wettsteinina*.

When isolated on agar medium, *A. profusa* grows slowly to form a colony of rose-tinged hyphae. The agar beneath a colony becomes darkened. After 1 yr in culture, large irregular stromatic masses of pseudoparenchymatous hyphae were produced but these remained sterile.

Aglaospora profusa (Fr.) de Not. Giorn. Bot. Ital. 2: 43. 1844. Figs. 1-3

Sphaeria profusa Fr. Syst. Mycol. 2: 392. 1823.
Valsa profusa (Fr.) Fr. Summa Veget. Scand. p. 411.1849.
Pseudovalsa profusa (Fr.) Winter in Rabenh. Krypt.-Fl. 1(2): 785. 1887.
Massaria profusa (Fr.) Petrak, Ann. Mycol. 39: 347.1941.
Sphaeria anomia Fr. Syst. Mycol. 2: 381. 1823.
Aglaospora anomia (Fr.) Lamb. Fl. Mycol. Belg. 2: 250. 1880.
Massaria anomia (Fr.) Petrak, Ann. Mycol. 21: 114. 1923.
Sphaeria amorphostoma Schw. Trans. Amer. Philos. Soc. II, 4: 201. 1832.
Sphaeria capitella Klotsch in Rabenh. Deutschl. Krypt.-Fl. 1: 182. 1844.
Aglaospora ocellata de Not. Giorn. Bot. Ital. 2: 43. 1844.
Massaria seiridia Berk. & Curt. Grevillea 4: 155. 1876.
Pseudovalsa irregularis (DC.) Schroet. in Cohn, Krypt.-Fl. Schles. 3(2): 445. 1897.
Aglaospora irregularis (DC.) O. Kuntze, Rev. Gen. Pl. 3(2): 441. 1898.

Ascocarps 600-1100 µm diam, immersed or occasionally erumpent in small groups, rarely separate, surrounded by yellow brown or dark brown pseudostromatic tissues mixed with substrate cells, stromatic tissues above ascocarps darkened, erumpent and often forming coarsely sulcate peaks over short beaks, stroma often delimited by a darkened marginal line around sides and base; peridium dark brown externally, paler toward interior, composed of numerous layers of compressed cells, 60-70 µm wide. Asci 180-200 x 18.5-28 µm, broadly cylindric, with refractive ring around broad apical protrusion of cytoplasm; pseudoparaphyses trabeculate. Ascospores 36-54(-60) x 13-15(-17.5) µm, ellipsoid, wall hyaline to light brownish, endospores dark brown, three distoseptate, not constricted at septa, primary septum median, secondary septa nearly median in each half, endospore thick walled at maturity, ascospore wall smooth, surrounded by narrow gelatinous coating.

On branches of *Robinia pseudacacia*.

Material examined: CANADA: Ontario: London, 24 Mar 1890, J. Dearness; USA: New Hampshire: Barr 3878; Massachusetts: Barr 5100, 5269, 5327, 6028, 6305, 6416; New Jersey: Ellis NAF 172; Kansas: Fungi Col. 1566 (all MASS). EUROPE: Herb. Barbey-Boissier 246, 643; D. Saccardo, Mycol. Ital. 1487 (NY).

Caryospora de Not. Micromyc. Ital. Dec. 9: 7. 1856.

Ascocarps large, dull black, erumpent superficial, base rounded or flattened and applanate, leaving circular black line in substrate when removed, separate, apex papillate, opening by broad pore; peridium carbonaceous or firm, composed of numerous layers of slightly compressed cells, pigment heavily encrusted externally, base narrower than sides. Asci relatively few from base of locule, oblong or inflated in middle, nearly cylindric at times, bitunicate, (one) two to eight spored; pseudoparaphyses trabeculate, numerous, narrow, branched and anastomosing above asci, in gelatinous matrix, extending into apical pore. Ascospores rich reddish brown to dark brown, often opaque in age, symmetric, broadly ellipsoid, tapering to pointed or rounded tips, often paler at tips, primary septum median, usually constricted, distoseptate (young), at times one or more secondary septa near one or both ends, with large globule in each cell, wall thick, surrounded by narrow gelatinous layer when young and this drying down to form reticulate or striate or irregular roughenings on surface.

Saprobic on woody substrates, decorticated wood, stony endocarps of fruits, woody stems or arborescent grasses.

Conidial states coelomycetous where known, species of *Asterostomella* according to von Arx and Müller (1975).

Type species: *C. putaminum* (Schw. ex Fr.) de Not.

Jeffers (1940) examined and briefly described the species of *Caryospora*. Of the North American species described in the genus, neither *C. cariosa* Fairman nor *C.minor* has distoseptate ascospores. The medium to large superficial ascocarps and light reddish brown, simply septate ascospores of these two species suggest a generic position in *Trematosphaeria* (Melanommataceae).

Species of *Caryospora*

1. Ascospores very large (over 50 μm long), becoming opaque in age 2
1. Ascospores medium large (up to 50 μm long), rich reddish brown but not usually opaque in age 3
   2. Ascospores one, two, four (rarely eight) per ascus, (50-)80-120(-150) x (35-)40-54(-65) μm, length:width ratio ca. 2:1; usually on peach endocarps . . . . *C. putaminum*
   2. Ascospores eight per ascus, (60-)85-117 x (20-)32-52(-57) μm, length:width ratio ca. 2.5:1; on rotting wood . . . . *C. callicarpa*

3. Ascospores with thickened secondary septa near tips, 32-50 x 15-20 µm; on canes of *Arundinaria* . . *C. langloisii*
3. Ascospores one septate, secondary septa if formed thin walled 4
   4. Ascospores 40-50 x 14-15 µm, length:width ratio ca. 3:1; on woody stems of *Artemisia* . . . . *C. striata*
   4. Ascospores 30-50 x (13-)17-20(-30) µm, length:width ratio ca. 2:1; on peach endocarps . . . . *C. minima*

Caryospora callicarpa (Currey) Nitschke in Fuckel, Symb. Mycol. p. 163. 1870. Fig. 4
Sphaeria callicarpa Currey, Trans. Linn. Soc. London 22: 321. 1859.

Ascocarps 800-1000 µm in diam or larger, bases applanate, conic, apex papillate, dehiscent and leaving large rounded pore; peridium firm, dark brown, composed of numerous layers of compressed cells. (Asci, according to literature: ca. 250 x 65 µm, eight spored.) Ascospores (60-)85-117 x (20-) 32-52(-57) µm, dark brown, opaque in age, broadly ellipsoid, tapering abruptly to elongate tips, tips somewhat paler than main body, primary septum median, not or slightly constricted, at times one or two septa in ends, wall thick, surrounded by a narrow gelatinous coating that dries down as irregular roughenings on surface.

Saprobic on decorticated decaying wood.

Material examined: USA: New York: Long Island, Zabriskie (Ellis Herb., NY); South Carolina: S. J. Smith 43991 (NY).

These collections are both overmature and asci are no longer evident. The ascospores are dark brown or opaque and the contents are not recognizable. Several ascospores had germinated, with germ tubes emerging from the thinner pallid tips. Ellis and Everhart (1892) provided ascospore measurements of 75-85 x 20-25 µm becoming 100-112 x 40-50 µm. The ascospores of *C. callicarpa* in European collections, as in those of *C. putaminum*, are smaller -- 60-75 x 28-32 µm according to Dennis (1978).

Caryospora langloisii Ell. & Ev. J. Mycol. 4: 79. 1888. Fig. 5

Ascocarps up to 1 mm diam, immersed beneath, raising and finally rupturing thin epidermal layer of cells, bases applanate, conic, apex short papillate; peridium firm, dark brown encrusted externally, paler toward interior, ca. 50 µm wide at base, up to 78 µm wide at sides. Asci 110-170 x 40-45 µm, broadly oblong, eight spored; pseudoparaphyses trabeculate. Ascospores 32-50 x 15-20 µm, rich reddish brown, ellipsoid fusoid, primary septum median, slightly constricted, secondary septa near each tip, not constricted, with one large globule in each cell, surrounded by narrow gelatinous coating, smooth, some showing wrinkling of surface especially at tips.

On dead canes of *Arundinaria* (probably *A. macrosperma* Michx.).

Material examined: USA: Louisiana: Point a la Hache

P.O., 27 Mar 1888, A. B. Langlois, Flora Ludoviciana 1238 (type, NY).

The secondary septa of the ascospores might suggest a species of *Massaria*, but the shape and position of septa, as well as the ascocarp, are typical of species of *Caryospora*.

Caryospora minima Jeffers, Mycologia 32: 561. 1940. Fig. 6

Ascocarps 495-700 µm diam, superficial, thickly scattered, base applanate, conic, apex bluntly papillate, rounded pore visible at maturity; peridium brittle, dark brown externally, paler toward interior, composed of numerous layers of compressed cells. Asci 150-180 x 35-50 µm, clavate cylindric, eight spored; pseudoparaphyses trabeculate. Ascospores 30-50 x (13-)17-20(-30) µm, rich brown, broadly ellipsoid, primary septum median, constricted, with one large globule in each cell, wall thickened, smooth.

On peach endocarps, *Prunus persica*, on the ground.

Material examined: USA: Maryland: Harrison's Orchards, Berlin, 6 Aug 1938, W. F. Jeffers (type, NY).

Jeffers (1940) obtained ascocarps in culture of this species, just as he did in *C. putaminum*. He observed that *C. minima* differed from *C. putaminum* in smaller sizes and in less tapered ascospores. The ascospores in the type material do not show additional septa at this time, but Jeffers described a septum in each tip.

Caryospora putaminum (Schw. ex Fr.) de Not. Micromyc. Ital. Dec. 9: 7. 1856. Figs. 7,8

Sphaeria putaminum Schw. ex Fr. Syst. Mycol. 2: 461. 1823.

Ascocarps 495-1000 µm or more in diam, superficial, scattered, base applanate, conic, apex papillate, dehiscent at maturity, leaving rounded pore; peridium reddish brown externally, paler toward interior, composed of numerous layers of compressed cells, up to 100 µm wide. Asci 125-260 x 50-70 µm, oblong, ellipsoid or clavate, usually less than eight spores maturing (one, two, three or four); pseudoparaphyses trabeculate. Ascospores (50-)80-120(-150) x (35-)40-54(-65) µm, reddish brown, dark brown, finally opaque except for pallid tips, broadly ellipsoid or biconic, primary septum median, constricted, occasionally with thin septa in the tips, one large globule in each cell, wall thick (3-4.5 µm wide), surrounded by gelatinous coating 8-12 µm wide, surface smooth or roughened with granular deposit that may be reticulate.

On peach endocarps, *Prunus persica*, on the ground.

Material examined: USA: Massachusetts: Barr 2672, 5301, 5524, 6213; South Carolina: Ellis NAF 898 (all MASS).

For European collections, Scheinpflug (1958) described ascospore dimensions as 40-70 x 20-24 µm, considerably smaller than those in North American collections.

Jeffers (1940) cultured *C. putaminum* and obtained ascocarps on a peachstone-malt-extract agar. The most favorable pH was between 5.0 and 6.0, optimum temperature was 25-28 C, and ascocarps formed in partial or complete darkness but were fewer in number in full light. Ascocarps originated as a small hyphal knot which was surrounded by a pseudoparenchymatous layer. After about 1.5 mo, larger cells were visible within the young ascocarp and soon after asci developed and extended into the pseudoparaphyses. Ascospores germinated by a germ tube from the pallid tips. Jeffers obtained spermogonia containing minute spermatia in culture; the spermatia did not germinate.

Caryospora striata (Niessl) Scheinpflug, Schweiz. Bot. Ges. Ber. 68: 368. 1958. Fig. 9
Amphisphaeria striata Niessl, Hedwigia 15: 117. 1876.
Trematosphaeria striata (Niessl) Holm, Symb. Bot. Upsal. 14: 159. 1957.

Ascocarps ca. 660 µm diam, nearly globose, immersed in substrate with broadly papillate apex erumpent; peridium firm, dark brown, composed of several layers of compressed cells, ca. 30 µm wide, thickened toward exposed apex. Asci 240 x 18-22 µm, eight spored; pseudoparaphyses trabeculate. Ascospores 40-50 x 14-15 µm, dark reddish brown, ellipsoid, primary septum median, constricted, no additional septa seen, contents with one large and one small globule in each cell, wall finely roughened.

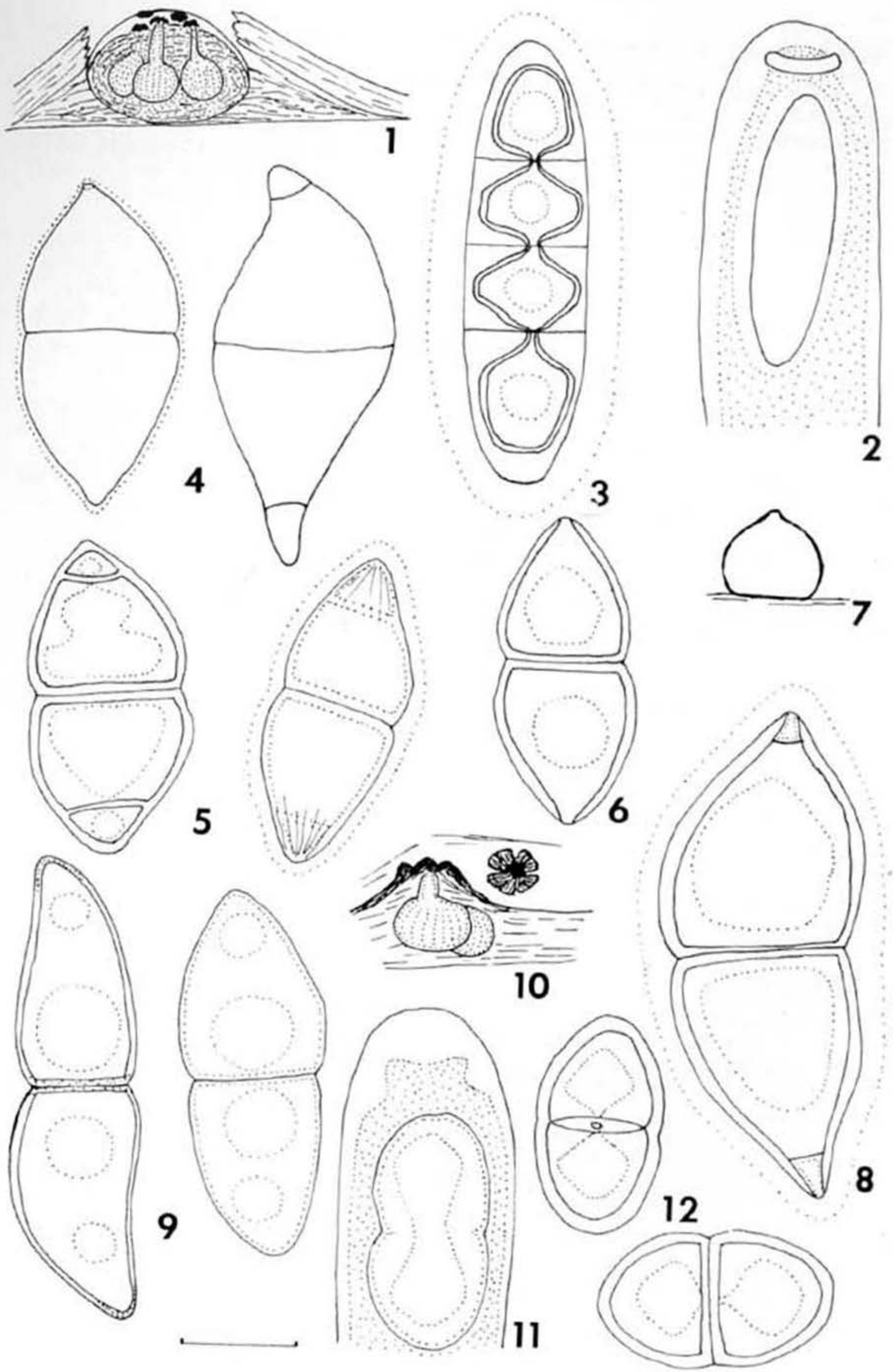
On *Artemisia tridentata*, large weathered stem.

Material examined: USA: Utah: Barr 6154A (MASS).

This collection is placed in *C. striata* with some reservations. The fungus is surely a species of *Caryospora* and it agrees quite well with descriptions of *C. striata* except for longer ascospores (Holm, 1957, gave 33-36 x 14-15 µm, Scheinpflug, 1958, 32-36 x 10-13 µm for European material of this species). *Caryospora striata* is known in Europe on wood of *Fraxinus* and *Quercus* and I have not seen it recorded from North America. My reservation lies in the disparate substrate and ecological situation of the Utah collection.

According to the description in North American Pyrenomycetes, p. 183, *Sphaeria sulcata* Ellis(*Melanomma sulcata* (Ell.) Ell. & Ev.), described from Utah on sagebrush, could be identical with my collection. Upon examination of NAF 1663 (MASS), this fungus proved to be a species of *Leptosphaeria* subgen. Syncarpella, related to *L. tumefaciens* (Ell. & Harkn.) Petrak by similarities of ascospores but differing from that species by possessing a large blunt, occasionally sulcate apex to the ascocarp.

Figs. 1-3. *Aglaospora profusa*: 1. Habit of ascocarps in stroma. 2. Ascospore. 3. Ascus apex showing refractive ring and uppermost ascospore. Figs. 4-9. Species of *Caryospora*: 4. *C. callicarpa*, ascospores. 5. *C. langloisii*, ascospores. 6. *C. minima*, ascospore. 7 and 8. *C. putaminum*, 7. Habit, 8. Ascospore. 9. *C. striata*, ascospores. Figs. 10-12. *Dothivalsaria megalospora*: 10. Habit of ascocarps in stroma. 11. Ascus apex. 12. Ascospores. Figs. 1, 7, 10, ca. X10. Standard line = 15 µm for remaining Figs.


1
2
3
4
5
6
7
8
9
10
11
12

Dothivalsaria Petrak, Sydowia 19: 283. 1966 (1965).

Ascocarps medium to large, globose or compressed, short beaked, immersed, usually several grouped together beneath blackened stromatic tissues that coalesce to form black, coarsely sulcate erumpent tips, pseudostroma intermixed with substrate cells, brownish around ascocarps; peridium brown externally, hyaline toward interior, composed of several layers of compressed cells, 12-30 μm wide. Asci cylindric, eight spored; pseudoparaphyses trabeculate, narrow, numerous, branched and anastomosing in gelatinous matrix. Ascospores brown, symmetric, broadly ellipsoid, ends rounded, septum median, not or slightly constricted, thickened, with one large rhomboid globule in each cell, wall thick, at times surrounded by narrow gelatinous coating.

On woody branches.

Type and single species: *D. megalospora* (Auersw.)Petrak

Dothivalsaria megalospora is a rare species that presents some problems in classification. Petrak (1966) created *Dothivalsaria*, based upon Kunze's exsiccati specimen (n. 364) of *Myrmaecium megalosporum*, stating that the genus was dothideal in contrast to *Massariovalsa sudans* (Berk. & Curt.) Sacc., which is diaporthaceous. While the habits of the two fungi are similar, they differ in stromatic tissues, paraphysoid tissues and details of ascospores. The genus *Massariovalsa* belongs in the Melanconidaceae of the Diaporthales (Barr, 1978) and is quite distinct from *Dothivalsaria*. None of the material of *D. megalospora* that I have seen was recently collected, but the asci are surely bitunicate, with thickened endoascus and a somewhat raised ridge of cytoplasm protruding in the apical region. Immature ascospores are distoseptate in aspect. The species resembles *Aglaospora profusa* by grouping of ascocarps surrounded by pseudostromatic tissues and especially by forming coarsely sulcate peaks of stromatic tissue erumpent from the substrate. The aspect of locules of both is comparable, while differences in ascospore pigmentation, shape and septation separate the two.

Dothivalsaria megalospora (Auersw.) Petrak, Sydowia 19: 283. 1966 (1965). Figs. 10-12

Valsaria megalospora Auersw. Lepizig Bot. Tauschver. 5. 1866.

Myrmaecium megalosporum (Auersw.) Niessl, Verh. Naturf. Ver. Brünn 12: 215. 1876.

Massariovalsa megalospora (Auersw.) Müller in Müller & von Arx, Beitr. Kryptogamenfl. Schweiz 11(2): 730. 1962.

Diatrype angulare Peck, Bot. Gaz. (Crawfordsville) 5:36. 1880.

Valsaria angularis (Peck) Sacc. Syll. Fung. 1: 745. 1882.

Ascocarps (220-)385-660 μm diam, usually in small circinate groups beneath blackened stromatic tissues, stromata up to 1.5 mm wide and deep, dark brown or blackened on surface as coarsely sulcate tips; peridium 12-30 μm wide. Asci 170-200 x 24-25 μm, eight spored; pseudoparaphyses trabeculate, extending into apical region. Ascospores 28-32(-42) x 13-15 µm, bright brown, septum median, wall smooth or sometimes finely punctate, at times surrounded by narrow gelatinous coating.

In woody branches of various dicotyledonous trees.

Material examined: USA: Vermont: on *Tilia americana*, New Haven, 17 May 1879, C. G. Pringle (type of *Diatrype angulare* Peck, NYS); Texas: on *Ungnadia speciosa*, Houston, H. W. Ravenel 65 (in specimen of *Parmentaria astroidea* Fee, MASS). EUROPE: J. Kunze, Fungi sel. exs. 364 on *Alnus* (BPI, two collections).

Massaria de Not. Giorn. Bot. Ital. 1: 333. 1844; Atti Sci. Ital. 1844: 485. 1845.

Saccothecium Fr., Summa Veget. Scand. 2: 398. 1849.

Ascocarps large, globose or depressed, immersed, apex erumpent, broadly papillate, stromatic tissues often forming a darkened clypeus above ascocarps or mixed with substrate cells as pseudostromatic tissues, at times circumscribed by blackened marginal zones; peridium firm, composed of numerous layers of compressed cells, darkly pigmented externally, paler toward interior. Asci cylindric or broadly oblong, bitunicate, apex with broad cytoplasmic plug that is often surrounded by a refractive ring, four or eight spored; pseudoparaphyses trabeculate, narrow, numerous, branched and anastomosing above asci in a gelatinous matrix. Ascospores narrowly or broadly ellipsoid, hyaline or brown, symmetric, distoseptate, primary septum median, not or slightly constricted, secondary septa closer to primary than to ends of ascospore, contents as lenticular (mid cells) or conoid (end cells) endospores, wall smooth, surrounded by gelatinous coating.

Saprobic or weakly parasitic on woody branches.

Conidial states where known coelomycetous; *Phoma* species (Tonolo, 1956).

Type species: *M. inquinans* (Tode ex Fr.) de Not.

Shoemaker and Leclair (1975) clarified the generic concept and provided synonyms and considerable other information about various species of *Massaria*. In the early compilation of descriptions, Ellis and Everhart (1892) included species that are now segregated into various genera in other orders of the Loculoascomycetes, e.g., *Asteromassaria*, *Splanchnonema* and *Trematosphaeria* in the Pleosporales, *Wettsteinina* in the Dothideales. These taxa are not considered here.

The four species of *Massaria* included in this treatment are quite similar in all respects. *Massaria inquinans* forms a well-developed clypeus and often blackened marginal zones delimiting the stromatic tissues. The ascospores tend to be wider than those of the other species. *Massaria xanthoxyli*, with eight-spored asci, is separated from *M. inquinans* by inconspicuous stromatic tissues and shorter ascospores. The two species with four-spored asci are also separated mainly on ascospore size.

Species of *Massaria*

1. Ascospores brown; asci usually eight spored 2
1. Ascospores hyaline, becoming yellowish or light or dull brownish in age; asci usually four spored 3
   2. Ascospores 46-66(-76) x 13-18 µm; blackened clypeal tissues inconspicuous or absent . . *M. xanthoxyli*
   2. Ascospores 64-96 x (12-)16.5-19(-27) µm; blackened clypeal tissues conspicuous . . . . . *M. inquinans*
3. Ascospores 48-64(-78) x 12-18 µm; blackened clypeal tissues present at times, sparse and indistinct at times . . . . *M. pyri*
3. Ascospores 73-90 x 13-21 µm; blackened clypeal tissues inconspicuous . . . . *M. lantanae*

Massaria inquinans ((Tode) Fr.) de Not. Giorn. Bot. Ital. 1: 333. 1844. Figs. 13-15

Sphaeria inquinans (Tode) Fr. Syst. Mycol. 2: 486. 1823. (*Sphaeria inquinans* Tode, Fungi Mecklenb. 2: 17. 1791.)

Sphaeria gigaspora Desm. Pl. Crypt. France Ed. 1, n. 2065. 1851 (Ed. 2, n. 1765; Ann. Sci. Nat., Ser. 3, 18: 363. 1852.)

Massaria gigaspora (Desm.) Berk. Grevillea 4: 156. 1876 (non Fuckel, 1873).

Massaria vomitoria Berk. & Curt. Grevillea 4: 155. 1876.

Ascocarps globose, 750-1500 µm diam, immersed, usually separate, at times two together, apex broadly papillate, protruding slightly beyond substrate surface; stromatic tissues forming blackened clypeus between periderm and wood, indistinct or pallid or darkened around ascocarps as pseudostroma, often forming dark marginal zone; peridium brown externally, paler toward interior, composed of numerous layers of compressed cells, 40-50 µm wide. Asci 210-350 x 40-44 µm, eight spored; pseudoparaphyses trabeculate. Ascospores 64-96 x (12-)16.5-19(-27) µm, brown, ellipsoid, three distoseptate, slightly constricted at median primary septum, with lens-shaped or conoid endospores, wall smooth, surrounded by gelatinous coating.

On branches of *Acer*, especially *A. saccharum*.

Material examined: USA: Maine: Barr 5799; Vermont: Barr 4197; Massachusetts: Barr 4130, 4905, 5187, 5264, 6000, 6031; New York: Ell. & Ev. NAF 2927; Shear's New York Fungi 152; Seaver, Ascomycetes and lower fungi 37; Washington: Fungi Col. 3140 (all MASS).

Shoemaker and Kokko (1977b) illustrated and described *M. inquinans* from Canadian material. *Massaria inquinans* is common on recently fallen sugar maple branches. After a year or more, decorticated branches bear large black circles, the remnants of ascocarp peridium and surrounding stromatic tissues.

The apex of the ascus usually has a refractive ring surrounding protruding cytoplasm, as does that of *Aglaospora profusa*. Ascospores of the two species are similar at first glance, but those of *A. profusa* have pigmented endospores and more nearly equal cells than those of *M. inquinans*.

Massaria lantanae (Otth) Shoemaker & Leclair, Canad. J. Bot. 53: 1583. 1975. Fig. 16

Cladosphaeria lantanae Otth, Mittheil. Naturf. Ges. Bern, 1868: 51. 1869.

Massaria plumigera Ell. & Ev. North Amer. Pyrenomycetes p. 404. 1892.

Massaria inquinans forma *viburni* Jaczewski, Bull. Herb. Boissier 2: 680. 1894.

Massaria plumigera var. *tetraspora* Dearn. & House, New York State Museum Bull. 188: 35. 1916.

(*Massaria gigaspora* auct. non (Desm.) Berk., non Fuckel).

Ascocarps 495-1500 µm diam, globose or depressed, immersed, separate, with broadly papillate apex protruding slightly beyond substrate surface; stromatic tissues forming a clypeus in periderm of substrate and extending along wood surface, loosely interwoven or indistinct around ascocarps; peridium dark brown, composed of numerous layers of compressed cells, 37-78 µm wide. Asci 140-285 x 32.5-45 µm, usually four spored; pseudoparaphyses trabeculate. Ascospores 73-90 x 13-21 µm, hyaline, becoming light yellowish or dull brown in age, narrowly ellipsoid, three distoseptate, not constricted at median primary septum, with lens-shaped or conoid endospores, surrounded by gelatinous coating.

On branches of species of *Corylus, Hamamelis, Viburnum.*

Material examined: CANADA: Ontario: Fungi Col. 4826. USA: New York: Shear's New York Fungi 356 (both MASS); Albany, 22 Feb 1915, H. D. House (type of *M. plumigera* var. *tetraspora* Dearn. & House, NYS); 5 June 1915 (NYS).

Shoemaker and Leclair clarified the synonymy of this species (1975) and Shoemaker and Kokko (1977c) described and illustrated Canadian specimens. The four-spored asci of both *M. lantanae* and *M. pyri* separate these two species from *M. inquinans* and *M. xanthoxyli.*

Massaria pyri Otth in Tulasne & Tulasne, Sel. Fung. Carp. 2: 237. 1863. Fig. 17

Cladosphaeria pyri (Otth in Tul. & Tul.) Otth, Mittheil. Naturf. Ges. Bern, 1868: 51. 1869 (as *C. pyri* Otth).

Massaria inquinans forma *pyri* (Otth) Jaczewski, Bull. Herb. Boissier 2: 680. 1894.

Pseudovalsa occulta Ell. Proc. Acad. Sci. Phila. 1895: 27. 1895.

Aglaospora occulta (Ell.) Farlow, Bibl. Index North Amer. Fungi 1(1): 166. 1905.

Massaria pruni Wehmeyer, Univ. Michigan Stud. Sci. Ser. 14: 131. 1941.

Ascocarps 600-900 µm diam, immersed, globose with broadly papillate apex protruding slightly beyond substrate surface; stromatic tissues forming narrow blackened clypeus, often connecting adjacent ascocarps, reddish brown or whitish pseudostromatic tissues around ascocarps; peridium brown externally, paler toward interior, composed of several layers of compressed cells, 24-40 µm wide, thickened toward apex. Asci 150-240 x 20-35 µm, four spored; pseudoparaphyses trabeculate. Ascospores 48-64(-78) x 12-16(-18) µm, hyaline becoming yellowish or light to dull brown in age, narrowly ellipsoid, three distoseptate, slightly constricted at median primary septum, with lens-shaped or conoid endospores, wall smooth, surrounded by gelatinous coating.

On branches of species of *Malus, Prunus, Pyrus*.

Material examined: CANADA: Ontario: Ell. & Ev. NAF 2613; Fungi Col. 1936. USA: New York: Shear's New York Fungi 153, 357; New Jersey: Ell. & Ev. NAF 97, 1954 (all MASS).

Shoemaker and Leclair (1975) provided the synonymy cited here.

Massaria xanthoxyli (Peck) Petrak, Ann. Mycol. 23: 138. 1925. cf. Fig. 17

Massariella xanthoxyli Peck, Annual Rep. New York State Museum 46: 116. 1893.

Ascocarps 300-700 µm diam, globose with broadly papillate apex protruding slightly beyond substrate surface; stromatic tissues scarcely formed, as hyphae intermixed with cells of substrate; peridium brown externally, paler toward interior, composed of numerous layers of compressed cells, (20-)30-40 µm wide. Asci 100-190 x 33-53 µm, eight spored; pseudoparaphyses trabeculate. Ascospores 46-66(-70) x 13-18 µm, yellowish to dark brown, narrowly ellipsoid, three distoseptate, not or very slightly constricted at median primary septum, with lens-shaped or conoid endospores, wall smooth, surrounded by gelatinous coating.

On branches of species of *Morus, Ulmus, Xanthoxylum*.

Material examined: CANADA: Ontario: Ell. & Ev. NAF 2611 (MASS). USA: New York: Mechanicsville, May 1892, C. H. Peck (type, NYS); Alabama: Fungi Col. 1543 part (with *Massaria epileuca* Berk. & Curt. = *Trematosphaeria epileuca* (Berk. & Curt.) Shoemaker & Leclair) (MASS).

Petrak (1925) described the species in detail from a North Dakota collection. Shoemaker and Kokko (1977d) described and illustrated the fungus from Canadian specimens.

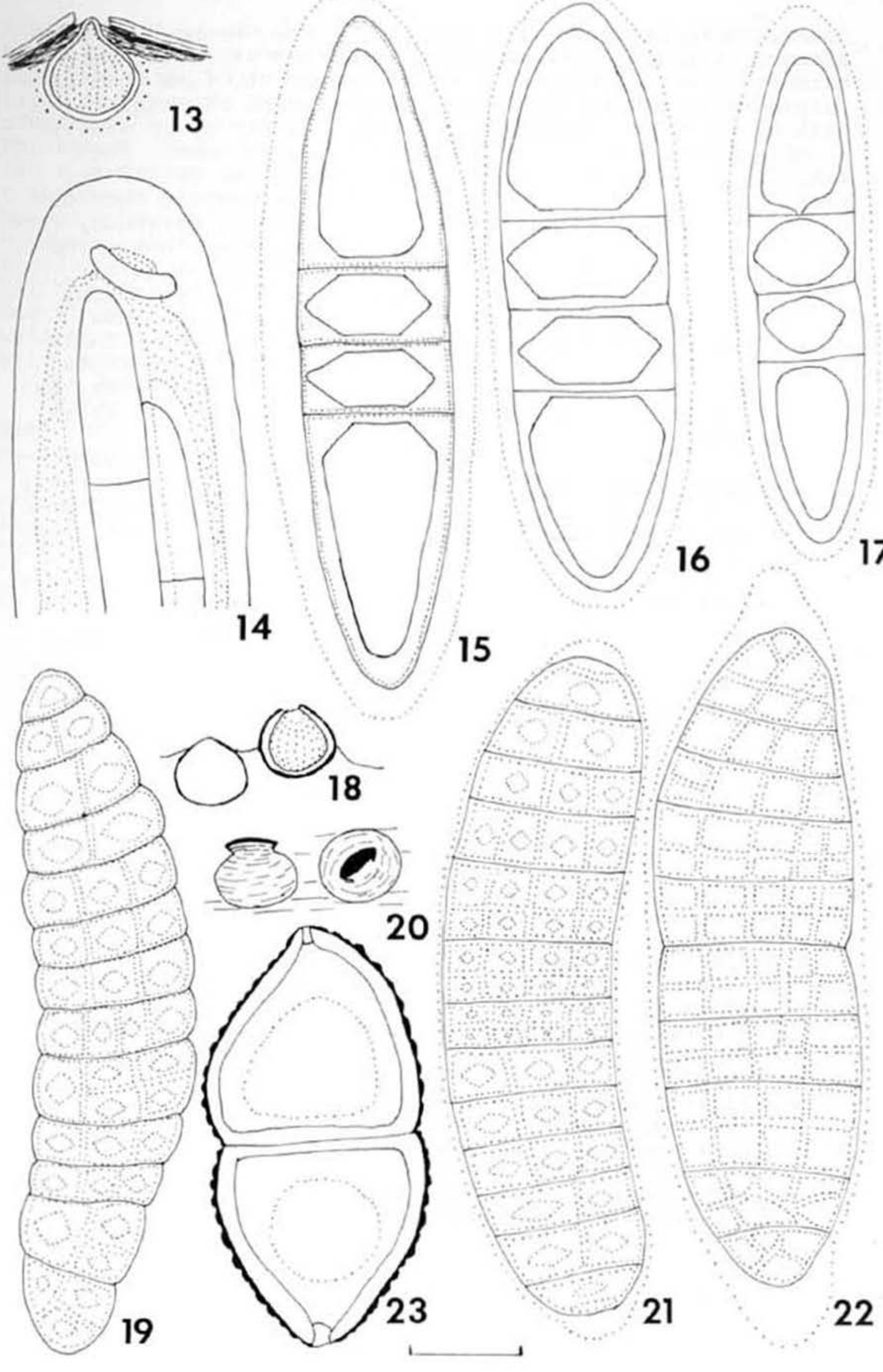
Titanella H. & P. Sydow, Ann. Mycol. 17: 36. 1919 (31 May).

Pleamphisphaeria v. Höhnel, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 128: 576. 1919 (26 June).

Ascocarps large, dull black, immersed erumpent or superficial with rounded bases embedded in substrate, separate or

---

Figs. 13-17. Species of *Massaria*: 13-15, *M. inquinans*, 13. Habit of ascocarp. 14. Ascus apex. 15. Ascospore. 16. *M. lantanae*, ascospore. 17. *M. pyri (cf. M. xanthoxyli)* ascospore. Figs. 18-22. Species of *Titanella*: 18 and 19. *T. luzonensis*. 18. Habit of ascocarps. 19. Ascospore. 20 and 21. *T. macrospora*. 20. Habit of ascocarps. 21. Ascospore. 22. *T. pelorospora*, ascospore. Fig. 23. *Zopfia rhizophila*, ascospore. Figs. 13, 18, 20, ca. X10. Standard line = 15 µm for remaining Figs.


13
14
15
16
17
18
19
20
21
22
23

connected by brown hyphae, apex papillate, rounded or compressed, opening by broad pore, excavated at times; peridium carbonaceous when ascocarps widely erumpent, firm when ascocarps immersed, composed of numerous layers of reddish to dark brown cells, pigment encrusted, heavily so on widely erumpent peridium, peridium narrowed toward base. Asci relatively few from base of locule, oblong or cylindric, bitunicate, two to eight spored; pseudoparaphyses numerous, narrow, branched and anastomosing above asci, extending into apical pore, in gelatinous matrix. Ascospores large, reddish brown or dark brown, elongate, cylindric or fusoid, tips rounded or tapered, often paler at tips, symmetric, (1-3-5-)17-23-septate, with one to five vertical septa, distoseptate in young stages, not obviously so when fully mature, often constricted at primary and secondary septa, with large globule in each cell, wall thick, surrounded by narrow gelatinous coating, surface smooth or finely rough.

Saprobic on woody substrates.

Type species: *T. luzonensis* (P. Henn.) H. & P. Sydow

The genus *Pleamphisphaeria* was also based on Hennings's species, and according to the dates imprinted on the issues of the two journals, is antedated by *Titanella* by less than one month.

Titanella has been relegated to synonymy with *Pleospora* by Clements and Shear (1931), with *Teichospora* by von Arx and Müller (1975), but differs from both genera in many respects. Fungi with large ascocarps and large copiously muriform ascospores, similar to species of *Caryospora* and *Massaria* in most features, find a position in *Titanella*. The presence of a large papillate apex is consistent in the species placed in this genus. However, the apex is rounded in the type species, compressed in *T. macrospora*, and variable even within a collection in *T. pelorospora*.

Species of *Titanella*

1. Ascospores ellipsoid fusoid, tapering to ends, relatively broad, (67-)80-117 x (18-)24-33 µm; ascocarp apex rounded or at times compressed . . . . *T. pelorospora*
1. Ascospores narrowly ellipsoid cylindric, ends rounded . 2
   2. Ascocarp apex rounded; ascospores 70-130 x (16-)18-26 µm . . . . *T. luzonensis*
   2. Ascocarp apex compressed; ascospores 80-110 x 20-26 µm . . . . *T. macrospora*

Titanella luzonensis (P. Henn.) H. & P. Sydow, Ann. Mycol. 17: 36. 1919. Figs. 18, 19

Julella luzonensis P. Henn. Hedwigia 47: 257-258. 1908.

Pleamphisphaeria luzonensis (P. Henn.) v. Höhnel, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 128: 576. 1919.

Ascocarps up to 1.5 mm diam, globose, with very short broad apical papilla, becoming excavated and leaving rounded pore, immersed erumpent becoming nearly superficial, thickly scattered or in small groups; stromatic tissues slight, as brown hyphae extending into substrate, not forming clypeus; peridium firm, with dark brown narrow external layers and light brown inner layers, composed of numerous layers of compressed cells, ca. 50 µm wide at base and lower sides, thickened (up to 130-165 µm or more) over apex. Asci 195-260 x 30-65 µm, two, three, or four spored; pseudoparaphyses trabeculate. Ascospores 70-130 x (16-)18-26 µm, hyaline becoming vinaceous brown with paler end cells, narrowly ellipsoid cylindric, straight or often slightly curved, (10-)13-17 distoseptate, with one (two) vertical septa in all but end cells, slightly constricted at primary median and at several of secondary and tertiary septa, septa as well as walls thickened and darkened, endospores lenticular, wall smooth, surrounded by narrow gelatinous coating.

On dead unknown trees.

Material examined: PHILIPPINES: Luzon, Prov. Benguet, Mar 1904, A. D. E. Elmer n. 5937 (isotype, NY), 5957; Fungi Malayana, C. F. Baker 34 (NY).

Although this species lies beyond the range of the fungi recounted in this presentation, a description and figures are included for comparison with the species of *Titanella* that do occur in North America.

Titanella macrospora (Speg.) Barr, comb. nov. Figs. 20, 21

Lophiostoma macrosporum Speg. Michelia 1: 466. 1878.
Platystomum macrosporum (Speg.) Chesters & Bell, Mycol. Pap. 120: 46. 1970.

Ascocarps up to 1 mm or more in diam, globose, immersed erumpent, apex prominent, compressed, broad, with brown hyphae at sides forming a slight subiculum; peridium dark brown externally, paler toward interior, composed of numerous layers of small cells, 52-78 µm wide. Asci 275-350 x 50-60 µm, four or eight spored; pseudoparaphyses trabeculate. Ascospores 78-110 x 20-26 µm, yellowish brown to dark brown, narrowly ellipsoid cylindric, tapered slightly to rounded ends, end cells usually paler than main body, (7-9-)19 distoseptate, with one to three vertical septa in all but end cells, endospores lenticular or rhomboid, wall thick, dark, finely roughened at maturity, with traces of gelatinous coating.

On old wood of *Quercus*.

Material examined: USA: New Jersey: Newfield, Nov 1878 (as *Sphaeria cyploxia* n.s., Ellis ined., NY); Newfield, Oct 1893 (NY).

The New Jersey material of this species agrees well with the original description of the fungus from Italy and with Berlese's illustration (1890, Tab. IX, fig. 8). Chesters and Bell (1970) referred to Ellis's collection for their description of the species, and termed the ascospore septa "pseudosepta." Ellis, in notes accompanying the specimen, observed that the ascospores resembled those of *Ostreichnion americanum* (*O. asssafras* (Schw.) Barr) as indeed they do. The elongate ascocarps that open by a long slit in *O. sassafras* distinguish that species of the Lophiaceae from this one.

Titanella pelorospora (Dearn.) Barr, comb. nov. Fig. 22

Amphisphaeria pelorospora Dearn. Mycologia 18: 247. 1926.

Ascocarps 500-1000 µm or up to 1.25 mm diam, widely erumpent, globose with rounded bases immersed in wood tissues, apex papillate, rounded or at times compressed; peridium brittle and carbonaceous when free from periderm, dark brown externally, paler toward interior, composed of numerous layers of small compressed cells, 40-60 µm wide if covered by remnants of periderm, up to 90-165 µm wide when free from periderm. Asci (130-)260-400(-550) x 32-54 µm, eight spored or less; pseudoparaphyses trabeculate. Ascospores (67-)80-117 x (18-)24-35 µm, light brown to reddish brown, ellipsoid fusoid, tapering to ends, (1-3-5-)11-23 septate, with three to five vertical septa, not in end cells or as Y-shaped septa, constricted at median primary septum, endospores rhomboid or lenticular, wall thick, smooth or finely roughened, surrounded by gelatinous coating that may be elongated over ends.

On bark of woody plants.

Material examined: CANADA: Quebec: *Betula* sp., Hull, 28 Apr 1891, Macoun, Canadian Fungi 78 (NY, two collections, as *Caryospora callicarpa*, *Trematosphaeria callicarpa*). USA: New York: *Liriodendron tulipifera*, Greenport, Long Island, 14 Mar 1924, R. Latham 1898 (NYS, as *Caryospora callicarpa*); *Nyssa*, Greenport, 27 Apr 1933, R. Latham 7631 (DAOM ex Dearness Herb., as *Amphisphaeria pelorospora*); New Jersey: *Nyssa*, Ell. & Ev. NAF 3012 (MASS, NY, as *Amphisphaeria papilla)*.

Dearness (1926) described the ascospores of *Amphisphaeria pelorospora* as "brown, 1-septate, constricted, biconic, 27-105 x 30-33 µ." The material studied from Dearness's herbarium (authentic but not type specimen) was a slide prepared and sent me by Dr. S. J. Hughes; the ascospores agree precisely with the description except that many septa are formed. True, the primary septum is darkened and constricted and most conspicuous, but even under low magnifications the additional septa are obvious. Dearness noted that *A. pelorospora* seemed to be the same as Ellis & Everhart's NAF 3012 of *A. papilla*, but that the description of that species (Ellis and Everhart, 1892, p. 178) differed by ascospores described as hyaline and 30-50 x 15-18 µm. The fungus on the copies of NAF 3012 that I examined is identical with Dearness's species. *Amphisphaeria papilla* (Schw. ex Fr.) Sacc. appears to be a different fungus entirely, both from Ellis and Everhart's (1892) concept as well as from NAF 3012. Their concept, according to the description and to a collection on white oak, Newfield, New Jersey, 6 Jul 1890 (NY) is of a hyaline-spored species that is referrable to the genus *Acrocordia*. A second collection from the Ellis herbarium, again from white oak, Newfield, Oct 1893 (NY) also bears this fungus. The brown spores that Ellis noted on the label of this collection belong to *Titanella macrospora*; the ascocarps are larger than those of the species of *Acrocordia* and have the apices compressed. Ellis (1896) examined Schweinitz's specimen of *Sphaeria papilla* and found brown, uniseptate ascospores, 25-32 x 8-12 µm (presumably a species of *Amphisphaeria*). Nonetheless, Ellis still referred the Newfield specimens to *Sphaeria papilla* Schw.

Zopfia Rabenh. Fungi Eur. n. 1734. 1874.

Ascocarps medium to large, black, erumpent superficial, globose, cleistothecioid; peridium composed of cephalothecoid plates of pseudoparenchymatous cells separated by pallid thinner areas, in section peridium composed of few layers of compressed cells, dark brown with vinaceous tinge. Asci bitunicate, broadly ovoid, few from base of locule, eight spored or less; pseudoparaphyses trabeculate. Ascospores reddish brown or dark brown, finally opaque, broadly ellipsoid, tapered to blunt ends, ends often pallid, symmetric, primary septum median, constricted, thin-walled secondary septa near each end, each cell containing a large globule, wall and primary septum thickened and dark, surface smooth or coarsely verrucose.

Type species: *Zopfia rhizophila* Rabenh.

Zopfia rhizophila seems very similar to *Caryospora putaminum*. The main differences are in the ascocarps of the two: those of *Caryospora* have an apical pore and firm, carbonaceous peridium whereas those of *Zopfia* have no apical opening mechanism and a cephalothecoid peridium. The genus is regarded in a restricted sense in this study, not in the broad sense of Hawksworth and Booth (1974). My interpretation of cleistothecioid forms places them at the ends of developmental lines. The ascospores of the various cleistothecioid taxa provide the best clue to their affinities (von Arx, 1971) and those of *Zopfia rhizophila* are certainly similar to those of species of *Caryospora*.

Zopfia rhizophila Rabenh. Fungi Eur. n. 1734. 1874. Fig. 23

Ascocarps globose, 485 µm or larger in diam, dark vinaceous brown; peridium firm, thin, ca. 15 µm wide near base, up to 30 µm wide above, composed of cephalothecoid plates separated by pallid cells. Asci 130-180 x 78-110 µm, usually less than eight spored; pseudoparaphyses trabeculate. Ascospores 48-75(-95) x 25-45(-50) µm, reddish brown to dark brown, finally opaque, broadly ellipsoid, tapering to narrow blunt ends, primary septum median, constricted, secondary septa inconspicuous at ends of cells, wall coarsely verrucose.

On roots of *Asparagus officinalis*.

Material examined: USA: Massachusetts: Barr 6395 (MASS).

Uecker (1977) provided a detailed description and illustrations of development and cytology of this species. He discussed the significance of the cephalothecoid peridium, as did Hawksworth and Booth (1974).

Zopfia albiziae Farr (Amer. Midl. Naturalist 71: 363. 1964) was described from roots of *Albizia lebbek* from Texas. The ascocarps are up to 1 mm diam, superficial, gregarious, black, wrinkled reticulate on the surface; peridium is up to 115 µm wide. The evanescent asci, 135-140 x 60-65 µm are pseudoparaphysate. The ascospores are 90-135 x 50-73 µm, ellipsoid rhomboid, black at maturity, one septate, scarcely constricted, with apiculate ends and slightly tuberculate walls. Farr (1964) was not able to obtain ascocarps in culture, nor was a conidial state formed.

Acknowledgments

I am indebted to the curators of herbaria cited in the text for loan of specimens in their keeping. In particular I thank C. T. Rogerson for reviewing the manuscript and S. J. Hughes for providing a slide from a Dearness collection.

Literature Cited

Arx, J. A. von. 1971. Testudinaceae, a new family of Ascomycetes. Persoonia 6: 365-369.

__________, and E. Müller. 1975. A re-evaluation of the bitunicate Ascomycetes with keys to families and genera. Stud. Mycol. Baarn 9: 1-159.

Barr, M. E. 1976. Perspectives in the Ascomycotina. Mem. New York Bot. Gard. 28: 1-8.

__________. 1978. The Diaporthales in North America with emphasis on *Gnomonia* and its segregates. Mycol. Mem. 7: 1-232. J. Cramer, Lehre.

__________. 1979. A classification of Loculoascomycetes. Mycologia 71: in press.

Berlese, A. N. 1890. Icones Fungorum. Fasc. 1 (Pars I): 1-28, XVII pl.

Chesters, C. G. C., and A. Bell. 1970. Studies in the Lophiostomataceae Sacc. Mycol. Pap. 120: 1-55.

Clements, F. E., and C. L. Shear. 1931. The genera of fungi. H. W. Wilson Co., New York. 496 p.

Dearness, J. 1926. New and noteworthy fungi--IV. Mycologia 18: 236-255.

Dennis, R. W. G. 1978. British Ascomycetes. J. Cramer, Lehre. 455 p.

Ellis, J. B. 1896. Notes on some specimens of Pyrenomycetes in the Schweinitz Herbarium of the Academy. Proc. Acad. Nat. Sci. Phila. for 1895, 47: 20-31.

__________, and B. M. Everhart. 1892. The North American Pyrenomycetes. Newfield, N.J. 793 p.

Farr, M. L. 1964. Mycological notes. III. New taxa, combinations, host and locality records. Amer. Midl. Naturalist 71: 363-368.

Hawksworth, D. L., and C. Booth. 1974. A revision of the genus *Zopfia* Rabenh. Mycol. Pap. 135: 1-38.

Holm, L. 1957. Études taxonomiques sur les Pléosporacées. Symb. Bot. Upsal. 14(3): 1-188.

Jeffers, W. F. 1940. Studies on *Caryospora putaminum*. Mycologia 32: 550-566.

Luttrell, E. S. 1973. Loculoascomycetes. Chapter 7, Pp. 135-219. In: The fungi. Vol. IVA. Eds., G. C. Ainsworth, F. K. Sparrow, and A. S. Sussman. Academic Press, New York.

Petrak, F. 1925. Mykologische Notizen. VIII. 495. Über *Massariella xanthoxyli* Peck. Ann. Mycol. 23: 137-138.
_________. 1966 (1965). Über *Valsaria megalospora* Auersw. und die Gattung *Massariovalsa* Sacc. Sydowia 19: 279-283.
Scheinpflug, H. 1958. Untersuchungen über die Gattung *Didymosphaeria* Fuck. und einige verwandte Gattungen. Schweiz. Bot. Ges. Ber. 68: 325-385.
Shoemaker, R. A., and E. G. Kokko. 1977a. *Aglaospora profusa*. Fungi Canadenses No. 101.
_________, and _________. 1977b. *Massaria inquinans*. Fungi Canadenses No. 104.
_________, and _________. 1977c. *Massaria lantanae*. Fungi Canadenses No. 105.
_________, and _________. 1977d. *Massaria zanthoxyli* (sic). Fungi Canadenses No. 106.
_________, and P. M. Leclair. 1975. Type studies of *Massaria* from the Wehmeyer collection. Canad. J. Bot. 53: 1568-1598.
Tonolo, A. 1956. Richerche colturali su alcune specie della famiglia delle Massariaceae. Phytopathol. Z. 26: 131-142.
Tulasne, L.-R., and C. Tulasne. 1863. Selecta Fungorum Carpologia. Vol. II. Paris. 319 p, 34 pl.
Uecker, F. A. 1977. Development and cytology of *Zopfia rhizophila*. Bot. Gaz. (Crawfordsville) 138: 420-427.

MYCOTAXON

Vol. IX, No. 1, pp. 38-47 June 12, 1979

NOTES ON *FAYODIA* SS. LATO

HOWARD E. BIGELOW

Department of Botany, University of Massachusetts
Amherst, Massachusetts 01003

In Singer's (1975) account of *Fayodia*, the genus is separated into four subgenera: Fayodia, with *F. bisphaerigera* (Lange) Kühner, the type of the genus, *F. tetrasphaerigera* Sing., *F. tenuisperma* Sing., *F. anthracobia* (Favre) Kühner & Romagnesi; Myxomphalia, with *F. maura* (Fr.) Sing., *F. invita* (Karst.) Sing., *F. marthae* Sing. & Clemencon; Heterosporula, with *F. pseudoclusilis* (Joss. & Konr.) Sing., *F. striatula* (Kühner) Sing., *Collybia albidula* Pat.; Clemenconia with *F. deusta* Sing. & Clemencon. *Fayodia campanella* Horak and *F. xerophila* Luthi & Röllin also should be included, both appearing to belong to subgenus Heterosporula. An important change in nomenclature must be noted too: Bresinsky and Stangl (1974) have determined that the correct name of *F. bisphaerigera* is *F. gracilipes* (Britzelmayr) Bsky. & Stangl.

The unique nature of the spore wall of *Fayodia gracilipes* has been observed under the light microscope by many investigators, and photomicrographs of the walls have been made with use of the electron microscope by Besson (1969) and Pegler and Young (1971). The spores are a distinct type in the Tricholomataceae, and have to be a critical diagnostic character of *Fayodia*. Singer (1975, p. 404) also has emphasized: "The fine structure of the spore wall is the ultimate diagnostic concept which infallibly separates this genus from all other genera of the Myceneae." I endorse this view enthusiastically, but add that it must be the fine structure of the spores of *Fayodia gracilipes* which has to be emphasized in the generic diagnosis. At least some taxa of *Fayodia ss. lato* do not have the same spore type and these taxa are heterogeneous elements which should be placed in other genera. The spores of *F. striatula* and *F. maura* are quite unlike those of *F. gracilipes* as shown by Figs. 3 and 4. Of course it can be argued that a difference in spore character is only worthy of emphasis at a subgeneric level, yet other genera in the Tricholomataceae have been emended freely in modern taxonomy to exclude elements which have divergent spore characters. There are a few cases (e.g., *Clitocybe*) where it can be demonstrated that there is an evolutionary sequence represented by types of spore ornamentation, but in *Fayodia* there seem to be no connections between the spore types of *F. maura* and *F. striatula* and *F. gracilipes*.

Myxomphalia Hora has been established already, and the SEM study of the spore surfaces of *M. maura* verifies the merits of its segregation. The genus *Stachyomphalina* is proposed in this paper to accommodate *F. striatula*. It has not been possible to examine all the species listed for *Fayodia*, but most in subgenera Heterosporula, Myxomphalia, and Clemenconia probably will require segregation after the surfaces of the spores are studied.

Fayodia alutacea Bigelow, sp. nov. Figs. 1, 2

Pileus usque ad 15 mm latus, pallido-alutaceus et striatus (udus), hygrophanus, albidus et opacus (decolores), convexus, glaber, levis. Odor rancido-spermaticus. Lamellae pallido-alutaceae, adnatae tum decurrentes, latae, subdistantes vel distantes. Stipes usque ad 35 mm longus, 1-2 mm crassus, pallido-alutaceus, solidus, glaber. Sporae (7.5-)8-11 µm diam, globosae vel interdum subglobosae, parietes similis *Fayodiae bisphaerigerae*, ectosporae amyloidae aliter inamyloidae. Basidia bisporae. Cheilocystidia plus minusve cylindrica. Hyphae fibuligerae. Carpophori gregarii. In solum.

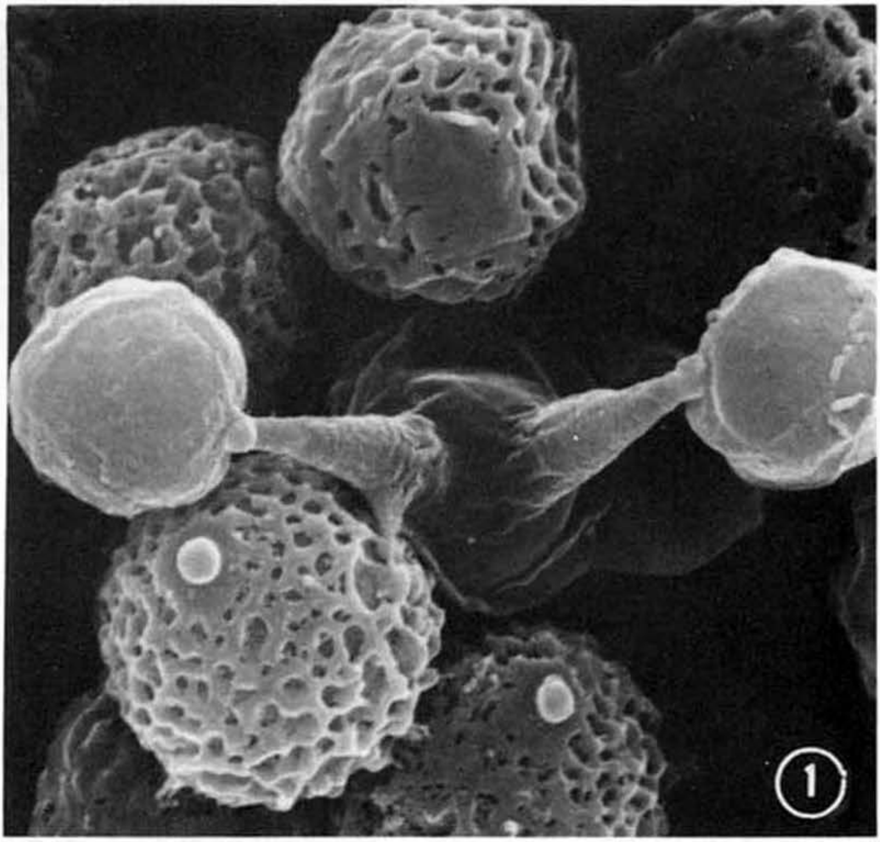
Holotypus legit H. E. & M. E. Bigelow (H. E. Bigelow, n. 13814, MASS); prope Stowe, Lamoille Co., Vermont, USA; 1 September 1964.

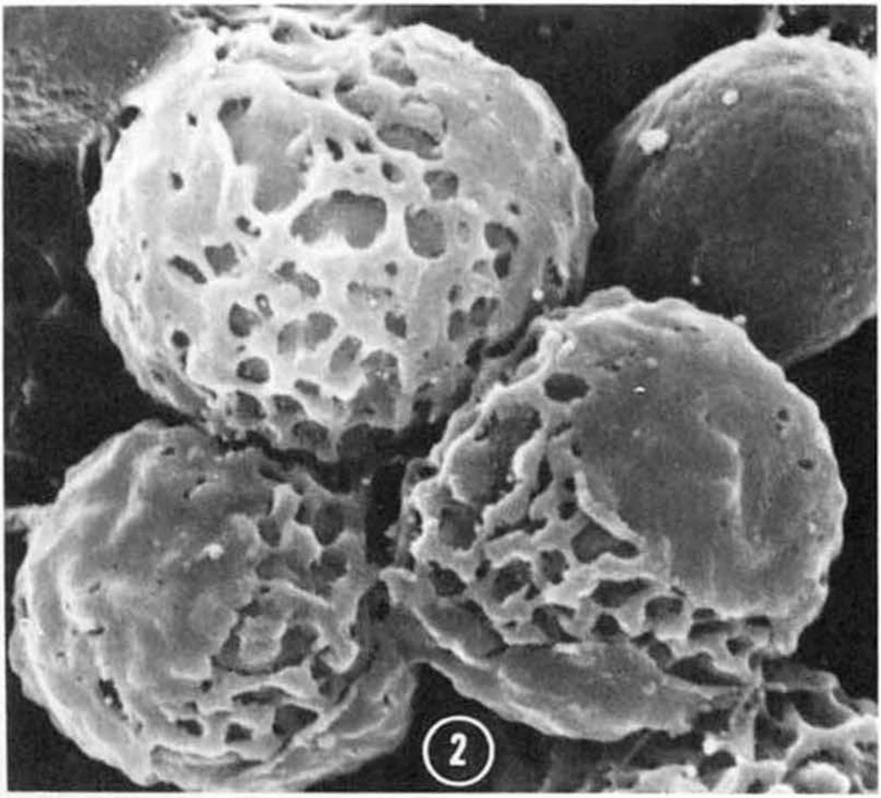
Pileus up to 15 mm broad; pale alutaceous when moist, whitish faded; convex, with a striate margin when moist, opaque when faded; surface glabrous, smooth, hygrophanous; context thin, brittle, concolorous with pileus surface. Odor rancid-spermatic when crushed. Taste not known.

Lamellae pale alutaceous (not fading with pileus); adnate to short decurrent, broad, subdistant to distant, edges fimbriate in places (under 10X).

Stipe up to 3.5 cm long, 1-2 mm thick, equal; pale alutaceous (not fading with pileus); solid, brittle, surface glabrous.

Spores (7.5-)8-11 µm diam, globose, or sometimes subglobose in lateral view, wall three layered: ectosporium smooth, amyloid, acyanophilic, discontinuous (at least in


1


2

revived material); mesosporium appearing echinulate in side view, more or less reticulate in face view, inamyloid, cyanophilic; endosporium smooth next to cell contents, inamyloid, cyanophilic. Basidia 24-30 x 6.5-9 µm, 2-spored, sterigmata up to 7 µm long. Cheilocystidia scattered, 30-60 µm long, 5-10 µm broad, more or less cylindric, sometimes slightly swollen in mid portion or basal portion, walls smooth, hyaline, thin. Pileus hyaline in KOH, surface a very thin gelatinous pellicle in KOH, cutis thin, of cylindric hyphae 3.5-7(-10) µm diam, walls smooth, thin; context hyphae cylindric or somewhat inflated, 10-15 µm diam, walls thin and smooth. Hymenophoral trama of parallel hyphae, cylindric near subhymenium, 3.5 µm diam, mediostratum of inflated or broad cylindric hyphae, 10-20 µm diam, walls thin and smooth. Clamp connections present.

Gregarious. On wet soil of drainage slope in mixed woods. Known only from the type collection.

This species differs from the others in subgenus Fayodia by the pale colors and rancid-spermatic odor. The microscopic characters are mostly not too different from those of *Fayodia gracilipes*, although descriptions of this species in the literature do not always include the presence of cheilocystidia. One interesting feature of the spores of *F. alutacea* is that the amyloid ectosporium is ruptured in the mature spores (Figs. 1, 2). This is not an artifact produced by the preparation of the spores for observation under the scanning electron microscope though, as the same discontinuous layer can be seen on spores which are only in Melzer's reagent or Cotton blue. Possibly the initial drying of the basidiocarps induced the rupturing of the ectosporium. Smith (1947; fig. 55, n. 7) has illustrated this phenomenon in *Fayodia gracilipes* in his drawing of the spores. Besson's (1969) electron photomicrographs also show a discontinuous ectosporium.

Stachyomphalina Bigelow, gen. nov.

Habitus mycenoideus vel omphalioideus. Pileus hygrophanus, pallido-brunneus vel fumosus et striatus (udus), sordido-bubalinus vel pallidus et opacus (decoloris); convexus demum planus, tandem plus minusve depressus; glaber. Caro tenuissimis. Lamellae albidae vel sordido-alutaceae vel avellaneae, adnatae vel subdecurrentes, latae, confertae vel subdistantes. Stipes cum pileus concolores vel pallidus, glaber. Sporae albae, verruculosae, haud amyloideae, ellipsoideae. Cheilocystidia et pleurocystidia subcylindrica vel subfusiformia, hyalina, laeva. Cutis pileus ex hyphae filamentosae composita, pigmentum incrustata, hyphae ad septae fibulatae. In lichenes vel solum vel muscus. Species typica: *Stachyomphalina striatula* (Kühner) Bigelow

---

Figs. 1, 2. *Fayodia alutacea* sp. nov. 1, X3,500. 2, X5,000.

Stachyomphalina striatula (Kühner) Bigelow, comb. nov. Fig. 4

Rhodocybe striatula Kühner, Bull. Soc. Linn. Lyon 2: 139. 1928.

Mycena cineraria Smith, North American Species of *Mycena* p. 450. 1947.

Omphalia striatula (Kühner) Kühner & Romagnesi, Fl. Analytique, p. 127. 1953.

Clitocybe striatula (Kühner) Orton, Trans. Brit. Mycol. Soc. 43: 174. 1960.

Fayodia striatula (Kühner) Singer, Beih. Nova Hedwigia 29: 146. 1969.

Pileus 1-3.5(-4) cm broad; pale watery brown or pale dingy yellow brown (smoky brown, pale "buckthorn brown," pale "snuff brown"), hygrophanous and fading to a pale dingy tan or brownish gray or pallid; convex at first with an incurved margin, becoming broadly convex, finally plane with the disc shallowly depressed, sometimes deeply depressed in age; margin long striate when moist, opaque in faded specimens; surface typically glabrous, surface fibrils sometimes becoming diffracted in age and then appearing squamulose; context thin and fragile, pallid. No odor or taste.

Lamellae broadly adnate to short decurrent, moderately broad to broad (up to 4 mm), close or subdistant, white or becoming dingy tan or avellaneous in age.

Stipe 1-3(-6) cm long, apex 1-3 mm thick, equal, surface glabrous, translucent, concolorous with pileus or pallid, solid.

Spores 5.5-7 x 4-4.5 µm (4-spored basidia; up to 11 x 7 µm from 2-spored basidia), ellipsoid, verruculose, deposit white. Basidia 19-27 x 4-8 µm, usually 4-spored but sometimes also 2-spored. Cheilocystidia numerous on some lamellae but rather scattered on others, 33-62(-100) µm long, protruding 15-47 µm beyond hymenium, 5.5-11 µm diam; subcylindric or rather fusoid ventricose, apices obtuse, rounded or subcapitate, smooth, hyaline, walls thin. Pleurocystidia of same type as cheilocystidia but less numerous and very scattered along faces of lamellae. Pileus: cutis brownish in KOH, pigment very finely encrusted on hyphal walls, hyphae cylindric or slightly inflated, 1.5-7 µm diam; context brownish or hyaline in KOH, hyphal walls finely encrusted or more often smooth, hyphae cylindric or inflated, 2.5-20 µm diam. Hymenophoral trama of parallel hyphae, hyaline in KOH, hyphae cylindric or inflated, 6-13(-27) µm diam, walls usually smooth. Clamp connections present.

Gregarious or subcespitose. On or near *Peltigera* and other lichens, in sandy soil or moss. In the open or under spruce. June to October.

Material examined: USA: Alaska: V. Wells and F. Kempton, 20 Sept 1962 (MASS); Miller 7718 (VPI); Colorado: Smith 52049, 52053, 52054, 52055, 52056, 52076, 52107, 52325, 53044 (MICH); Idaho: Smith 68315, 70970, 70972, 71249 (MICH); Michigan: M. Lange 929 (MICH); Smith 6450, 38559, 43619, 75451 (MICH); Oregon: Smith 27595 (MICH); Washington: Smith 17099 (type of *Mycena cineraria* Smith) (MICH);

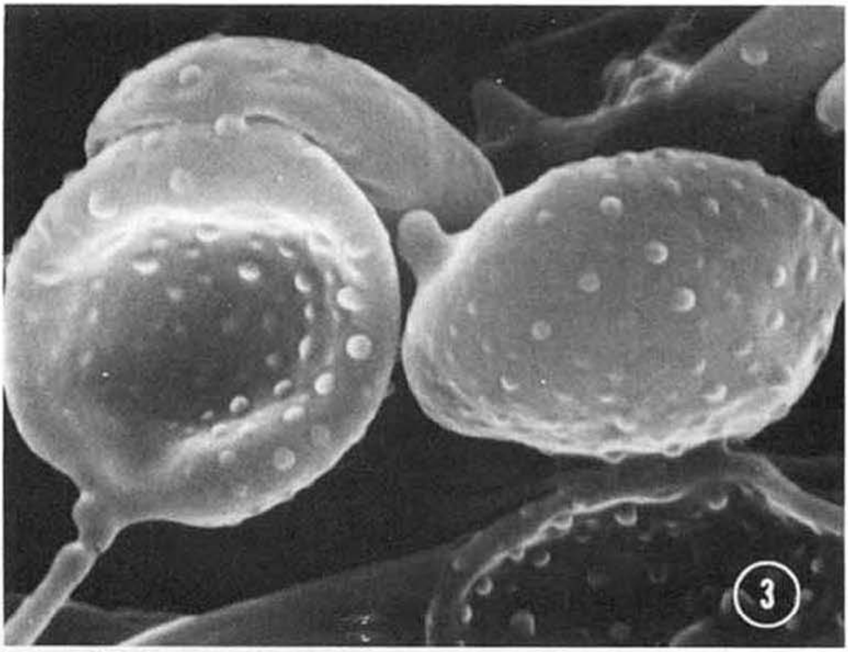
Wyoming: McKnight 10167 (BPI); Smith 34636, 34938, 34941 (MICH). CANADA: Manitoba: DAOM 55724 (DAOM); Northwest Territories, District of Keewatin: DAOM 25872 (DAOM). NORWAY: Horak 76/82 (ZT). SWITZERLAND: Horak 70/578 (ZT). UNITED KINGDOM: Orton 1948, 2549 (E).

The genus *Stachyomphalina* is proposed to accommodate *Rhodocybe striatula* Kühner and any other small species of the Tricholomataceae which have inamyloid verruculose spores. The presence of clamp connections, lamellar cystidia, and encrusted pigments are considered to be of secondary importance.

As illustrated by Figs. 1, 2, and 3, there is a distinct difference between the spore surfaces of *Fayodia* and *Stachyomphalina striatula*. Not only does *S. striatula* lack an ectosporium but the ornamentations are as dissimilar as between a *Russula* and a *Melanoleuca*! There has not been an examination of the wall in section of *S. striatula* as far as I have been able to determine, but under the oil immersion objective the wall below the ornamentation appears thin and without the multiple layers found in *F. gracilipes* by Besson (1969). While it is not difficult to relate *F. gracilipes* and *S. striatula* on most features of the basidiocarp, it seems to me that the different spore morphologies do not support either a direct relationship to one another or a common ancestry.

The spores of *S. striatula* are likewise not like the irregular nodulose spores known for *Mycenella* nor the smooth thick-walled spores of *Myxomphalia*. *Omphaliaster* has nodulose spores with narrow ridges between the protuberances (Bigelow and Rowley, 1968, Fig. 7, as *Clitocybe asterospora*) and *Rhodocybe* has spores which are angular in end view and undulate-pustulate in side view (T. Baroni, personal communication). In *Clitocybe* (*ss. meo*, *Lepista ss. aut auct.*) some species have spores with inamyloid verruculae which are larger, and it would not be difficult to postulate some relationship if only the spores were considered. However, the basidiocarps of Clitocybes which possess ornamented spores are much fleshier in the pilei and stipes than *S. striatula*. There are pigment differences as well, and the type of cystidia found in *S. striatula* is very atypical of Clitocybes.

The ornamentation of *S. striatula* appears to be finely echinulate under the oil immersion objective, but Fig. 3 (Horak 70/578) illustrates that the ornamentation actually consists of verruculae. The spores of several other collections of *S. striatula* and the type of *Mycena cineraria* were studied with the scanning electron microscope and found to be identical to those of the European specimen. Singer (1972) reported that the outer spore layer and ornamentation (as *Fayodia striatula*) were distinctly cyanophilic. This is possible, but I am uncertain of the localization of the stain from tests on the spores of several collections. Unfortunately, the contents of the spores pick up the stain readily and obscure the amount which may be concentrated in the wall. Even in spores which were ruptured or with



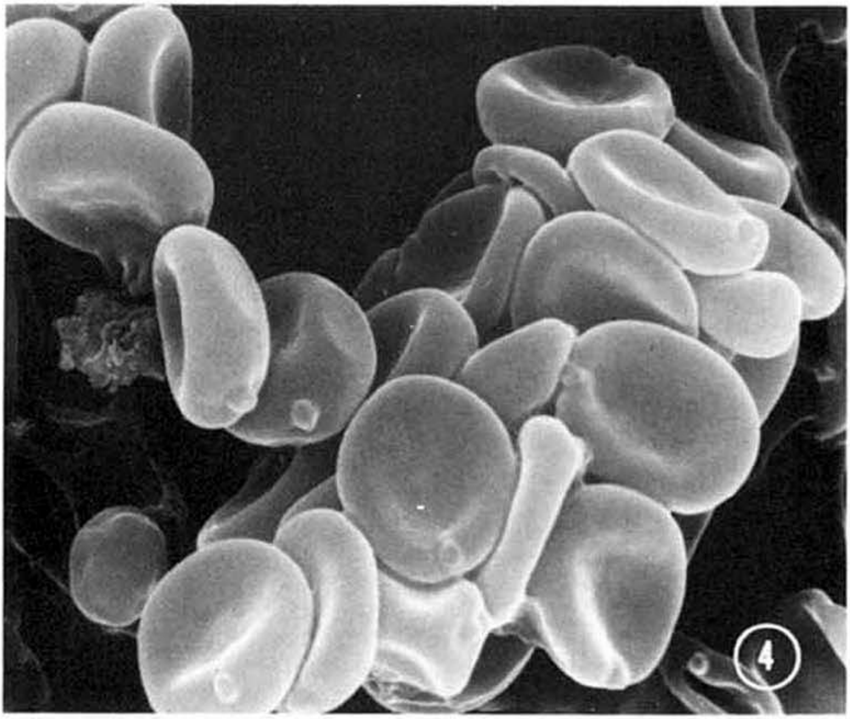


Fig. 3. *Stachyomphalina striatula* (Kühner) Bigelow, X9,000. Fig. 4. *Myxomphalia maura* (Fr.) Hora, X4,000.

plasmolyzed contents, the tests were indecisive due to the thin walls and minute verruculae.

Stachyomphalina striatula is sometimes found under the name *Fayodia leucophylla* (Gillet) M. Lange & Sivertsen. It is debatable if the latter epithet is applicable to the species described here as *S. striatula*. The situation has been discussed by Lange and Sivertsen (1966).

Myxomphalia maura (Fr.) Hora, Trans. Brit. Mycol. Soc. 43: 453. 1960.

This species has been described previously by Smith (1949) and Bigelow (1975). On present records, it is more common in northwestern states than in the northeast. To the collections cited in Bigelow (1975) can be added: Nova Scotia: Harrison 8442 (MICH), and Maine: Litten 844 (MASS). The latter was not typical because of a paler pileus ("greyish yellowish brown" -- ISCC-NBS) and a very weak amyloid reaction to the spores. The other features of this variant were those to be expected for *M. maura*.

In the literature there is disagreement about the spore walls of *M. maura* and this situation provoked a detailed study of the spores of the available North American specimens. Several collections were studied using the scanning electron microscope, and all were rechecked under oil immersion lens. All the spores viewed were smooth as illustrated in Fig. 4. The walls appear thickened under the phase microscope, amyloidity varied in intensity and appeared to be restricted to the outermost portion of the thick wall, and cyanophily was not present in the walls according to several tests. Questions arise -- is more than one species being called "Myxomphalia maura," or is *M. maura* merely variable in some characteristics? The spore surface is reported by Josserand (1937), Horak (1968), and Moser (1978) as being smooth, while Kühner and Romagnesi (1953), Hora (1960), and Pegler and Young (1971) give the spores as smooth or with scattered amyloid verruculae. Singer (1975) has the spores "strongly amyloid, slightly but distinctly heterogeneous, firm and smooth to slightly uneven." Besson (1972, plate 5, fig. 1) has illustrated the spore walls in section under the transmission electron microscope and conical protuberances are evident from the wall. However, she notes that the appearance of ornamentation can differ (1972, p. 23).

Apparently I was mistaken about verruculose spores occurring in North American specimens as well as smooth ones (Bigelow, 1975). Even if ornamentation on a spore collapses after years in the dried state, some remnant should be detectable with the scanning electron microscope.

Other disparities exist in comparing the descriptions of various investigators. Fries (1821) did not record an odor for *Agaricus maurus*, but a farinaceous odor and taste are reported by Moser (1978). On the other hand, Josserand (1937) gives the odor and taste as not farinaceous but clearly fruity (like *Cortinarius paleaceus*), and Kühner (1938) has the odor as slight, "herbacee ou rappelant celle des *Inocybe*, mais jamais farineuse ou rance." None of the North American specimens had an odor; Smith (1949) has noted a farinaceous taste to be present at times. There are also differences to be found in the literature about the length of cystidia, and the substrate of *M. maura*. While it is premature to conclude that modern concepts of *M. maura* actually include more than one species, clearly the collections thought to be *M. maura* need thorough attention.

Acknowledgments

I would like to thank Dr. Robert L. Shaffer, Director, Herbarium, University of Michigan and Dr. Alexander H. Smith, former Director, for the loan of specimens. Dr. Smith also generously contributed field notes and reviewed this manuscript. Others who kindly loaned specimens were: Dr. Egon Horak, Institut für Spezielle Botanik, Zürich, Switzerland; Dr. D. M. Henderson, The Regius Keeper, and Dr. Roy Watling, Royal Botanic Garden, Edinburgh, U.K.; Walter Litten, Ellsworth, Maine.

Grateful appreciation is expressed to Timothy Baroni who provided the critical point drying of the spores of *Fayodia alutacea*. The scanning electron micrographs were made with a JEOL Scanning Microscope Model JSM-35, purchased by National Science Foundation Grant BMS75-02883.

With nostalgia, Dan Stuntz is thanked profusely for his friendship, mycological advice, and gourmet cuisine during the unforgettable years of 1953 and 1954.

Literature Cited

Besson, M. A. 1969. La paroi sporique de *Fayodia bisphaerigera* (Lange) Kühner en microscope électronique et photonique. Compt. Rend. Hebd. Séances Acad. Sci., ser. D: 3167-3169.

__________. 1972. Contribution à la connaisance de l'infrastructure de la paroi sporique des Hyménomycètes. Thèse. L'Universite Claude Bernard de Lyon.

Bigelow, H. E. 1975. Studies in the Tricholomataceae: *Hygrophoropsis, Cantharellula, Myxomphalia, Omphaliaster*. Beih. Nova Hedwigia 51: 61-77.

__________, and J. R. Rowley. 1968. Surface replicas of the spores of fleshy fungi. Mycologia 60: 869-887.

Bresinsky, A., and J. Stangl. 1974. Beitrage zur Revision M. Britzelmayrs "Hymenomyceten aus Südbayern." Z. Pilzk. 40: 69-104.

Fries, E. M. 1821. Systema Mycologicum. I. Lundae.

Hora, F. B. 1960. New check list of British agarics and boleti. Part IV. Validations, new species, and critical notes. Trans. Brit. Mycol. Soc. 43: 440-459.

Horak, E. 1968. Synopsis generum Agaricalium XIII. Beitr. Kryptogamenfl. Schweiz: 9-741.

Josserand, M. 1937. Notes critiques sur quelques champignons de la Région lyonnaise (2° Serie). Bull. Soc. Mycol. France 53: 173-230.

Kühner, R. 1938. Le genre *Mycena*. Encyc. Mycol. 10: 1-710.

__________, and H. Romagnesi. 1953. Flore analytique des champignons supérieurs. Masson et Cie, Paris. 556 p.

Lange, M., and S. Sivertsen. 1966. Some species of *Lyophyllum*, *Rhodocybe*, and *Fayodia* with rough spores. Nomenclature and taxonomic position. Bot. Tidskr. 62: 197-211.

Moser, M. 1978. Die Röhrlinge und Blätterpilze. Kleine Kryptogamenflora IIb/2. Basidiomyceten. 2 Teil. Gustav Fischer, Stuttgart. 532 p.

Pegler, D.N., and T. W. K. Young. 1971. Basidiospore morphology in the Agaricales. Beih. Nova Hedwigia 35: 1-210.

Singer, R. 1972. Cyanophilous spore walls in the Agaricales and agaricoid Basidiomycetes. Mycologia 64: 822-829.

__________. 1975. The Agaricales in modern taxonomy. J. Cramer, Vaduz. 912 p.

Smith, A. H. 1947. North American species of *Mycena*. Univ. Michigan Press, Ann Arbor. 521 p.

__________. 1949. Mushrooms in their natural habitats. Sawyers, Portland. 626 p.

MYCOTAXON

Vol. IX, No. 1, pp. 48-50 June 12, 1979

LIMNOPERDON, A CYPHELLACEOUS FUNGUS WITH GASTEROID BASIDIA?

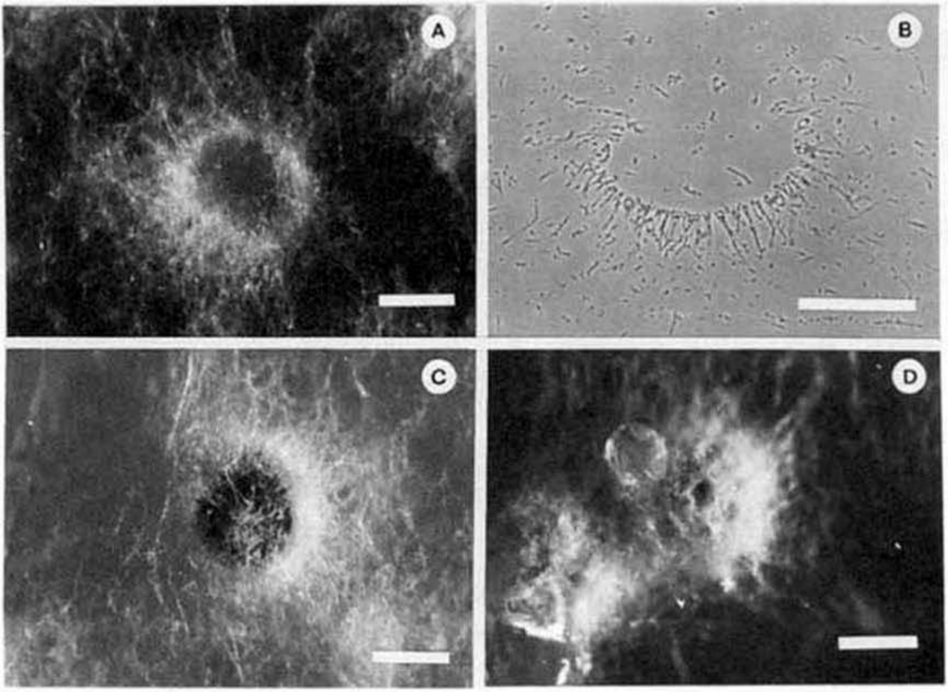
Gustavo A. Escobar and Dennis E. McCabe

Department of Botany, University of Washington
Seattle, Washington 98195

Limnoperdon incarnatum was reported as an unusual uniloculate gasteromycete found floating in dishes containing twigs from a marsh in Washington (Escobar, McCabe and Harpel, 1976). Tubaki (1977) has recovered L. incarnatum on wood blocks submerged in brackish waters in Japan. Dr. Tatsuo Yokoyama has kindly provided us with many isolates of L. incarnatum that he has repeatedly obtained from rice paddy fields also in Japan. All of these reports agree on the morphology of the fungus and it appears, therefore, that L. incarnatum is a well defined and constant organism with at least two widely separated populations.

At the time of our publication of Limnoperdon (1976) we were unaware of the sporocarp development of this fungus, but later studies on this subject by the second author revealed some interesting results. McCabe has observed that Limnoperdon passes through a cup stage before closing completely. At this cup stage the hymenium is still inmature (Figs. A and B) and spores are only found after the sporocarp is fully closed. But under certain circumstances, which at this time are not fully understood, the sporocarps stop their development at the cup stage and the hymenium continues its normal development resulting in a cupulate sporocarp with an exposed layer of basidia bearing normal and mature spores (Fig. C). The normal fruiting body, in contrast, has a completely enclosed hymenium at maturity (Fig. D).

The abnormal, but fully mature cups, resemble the sporocarps of the cyphellaceous fungi in every respect except for the orthotropic attachment of the spores and the lack of their violent discharge. Oberwinkler (1977a, 1977b) has pointed out that the presence of gasteroid basidia is a common occurrence in many groups of the Hymenomycetes but we are unaware of any cyphellaceous fungus with orthotropically attached basidiospores.



Figures A-D. Limnoperdon incarnatum. A. Early "cup" stage of developing sporocarp. B. Cross section of normal "cup" stage sporocarp. C. Aborted sporocarp bearing mature hymenium. D. Normal mature sporocarp. Bar = 0.25 mm.

The aquatic habitat of Limnoperdon would not be an obstacle to the placement of this fungus on an evolutionary line with the cupulate Basidiomycetes, since these fungi have adapted, at least in the case of Halocyphina (Ginns & Mallock, 1977), to a marine environment. The smooth reddish spores of Limnoperdon, however, do present a problem in connecting this fungus with any known genus of the cyphellaceous Basidiomycetes because there are no known genera in this group of fungi with spores that resemble those of Limnoperdon. One species in the genus Rhodoarrhenia, R. pezizoides (Speg.) Singer, has smooth reddish spores but this fungus has a long stipe and a meruliaceous hymenophore (Singer, 1964).

Just as it is apparent that there are no known genera of cupulate Hymenomycetes that are in a direct evolutionary line with Limnoperdon, it is also true that there are no known Gasteromycetes related to our marsh "puffball". We are of the opinion that a cyphellaceous hymenomycete could have evolved into a uniloculate gasteromycete by the loss of its violent spore discharge as a result of the cupulate sporocarp closing at maturity. This latter characteristic is apparent in several publications on the cupulate Basidiomycetes. After looking at illustrations from Cunningham (1963) and Agerer (1973), we are impressed by the relatively close morphological resemblance of many cyphellaceous fungi to Limnoperdon.

LITERATURE CITED

Agerer, H. 1973. Rectipilus. Eine neue cyphelloider Pilze. Persoonia 7: 389-436.

Cunningham, G.H. 1963. The Thelephoraceae of Australia and New Zealand. New. Zeal. Dept. Sci. & Agr. Res. Bull. #145. 359 pp.

Escobar, G.A., D.E. McCabe & C.W. Harpel. 1976. Limnoperdon, a floating gasteromycete isolated from marshes. Mycologia 68(4): 874-880.

Ginns. J. & D. Malloch. 1977. Halocyphina, a marine basidiomycete (Aphyllophorales). Mycologia 69(1): 53-58.

Oberwinkler, F. 1977a. Das neue System der Basidiomyceten, p. 59-105. in H. Clémençon (ed.). Species Concept in Hymenomycetes. Bibliotheca Mycologica 61. J. Cramer, Vaduz.

Oberwinkler, F. 1977b. The morphology of the basidium and its significance for the phylogeny of the Basidiomycetes. IMC 2 Abstracts: 483.

Singer, R. 1964. New genera of fungi XIII.- Rhodoarrhenia. Sydowia 17: 142-145.

Tubaki, K. 1977. Brackishwater fungi and their relationships to marine fungi. IMC 2 Abstracts: 681.

MYCOTAXON

Vol. IX, No. 1, pp. 51-89 June 12, 1979

THE GENUS PHELLINUS (APHYLLOPHORALES: HYMENOCHAETACEAE) IN WESTERN NORTH AMERICA[1]

R. L. Gilbertson

Department of Plant Pathology, University of Arizona, Tucson 85721

SUMMARY

Twenty-nine species of *Phellinus* are reported to occur in the western United States and Canada. *Phellinus sonorae* is described as a new species causing a root rot of *Dodonaea viscosa* Jacq. in the Sonoran Desert. One new combination, *Phellinus prunicola*, is proposed. Dichotomous and synoptic keys to the species, descriptions, and line drawings of important microscopic structures are provided.

Species of the genus *Phellinus* Quél. are lignicolous Hymenomycetes in the order Aphyllophorales. They have perennial basidiocarps with a hymenophore in the form of united tubes and have brown tissue that gives a darkening or xanthochroic reaction in KOH solution. Hyphae may have simple septa but lack clamp connections. Setae are present in the hymenium of most species and setal hyphae occur in tramal or context tissue of a few. Basidiospores are pigmented or hyaline and negative or dextrinoid in Melzer's reagent. Cultures of many species have been studied and all give a strong positive oxidase reaction on gallic and tannic acid media or with gum guaiac solution. All species of *Phellinus* cause a decay of the white rot type. In major North American taxonomic works these fungi have been placed in the genera *Fomes* (Fr.) Kickx emend. Teix. (Overholts, 1953; Lowe, 1957) and *Poria* (Pers.) S. F. Gray (Lowe, 1966) in the family Polyporaceae. Contemporary workers recognize the genus *Phellinus* in the family Hymenochaetaceae. More information on the historical and taxonomic aspects of this genus may be found in Bondarzew (1953), Domanski et al. (1967), Donk (1960, 1964, 1974), and Jahn (1967).

Many of the western species of *Phellinus* cause decay in living trees and are important factors in the pathology and management of their hosts. Most of the species that decay wood in living trees are confined to the non-living heartwood but a few are actively pathogenic, invading and killing living sapwood. The most important of these pathogens is *Phellinus weirii*, the cause of yellow laminated root rot of Douglas fir. The species included in *Phellinus* in this paper are mostly circumglobal in distribution and generally considered to comprise a natural generic grouping.

Free hand sections were mounted in 4% KOH solution and phloxine and also in Melzer's solution and cotton blue in lactophenol for microscopic studies. Drawings were made with a camera lucida on a Leitz Dialux microscope. Capitalized color names are from Ridgway (1912). Dimensions of microscopic structures are given in µm.

[1] University of Arizona Agricultural Experiment Station Journal Article No. 2965.

PHELLINUS Quél., Ench. Fung. p. 172. 1886.

Basidiocarps perennial, resupinate, effused-reflexed, or sessile; upper surface glabrous, tomentose or hispid, often blackened and deeply rimose with age; context yellowish brown to reddish brown or purplish brown, spongy to corky or woody, darkening permanently in KOH solution; pore surface yellowish brown to purplish brown, the pores circular to daedaloid; contextual and tramal hyphae thin- to thick-walled, simple-septate or aseptate, clamp connections absent; setal hyphae present or absent; hymenial setae present or absent; basidiospores cylindric to globose, hyaline or pigmented, negative or dextrinoid in Melzer's reagent; lignicolous on living or dead conifers and hardwoods; causing white rots and giving positive oxidase reactions. Type species: *Phellinus torulosus* (Pers.) Bourd. et Galz.

DICHOTOMOUS KEY TO SPECIES OF PHELLINUS IN WESTERN NORTH AMERICA

1. Basidiospores yellowish to dark reddish-brown 2
1. Basidiospores hyaline 6
   2. Setae frequent to abundant 3
   2. Setae absent or extremely rare 4
3. Basidiospores dark reddish-brown; setae up to 25 µm long; on *Quercus* . . . . 5. *P. everhartii*
3. Basidiospores pale yellowish; setae up to 50 µm long; on *Juglans* . . . . 28. *P. weirianus*
   4. Context duplex, with a black layer between spongy upper part and corky lower part . . . . 20. *P. ribis*
   4. Context homogeneous, no black layers present 5
5. Pores 7-8 per mm; on *Robinia* . . . . 21. *P. robineae*
5. Pores 2-5 per mm; on *Prosopis* or *Acacia* . . . . . . 2. *P. badius*
   6. Basidiospores cylindric to cylindric-ellipsoid 7
   6. Basidiospores ovoid to subglobose 11
7. Setal hyphae abundant in tramal tissue and projecting into tubes . . . . 7. *P. ferrugineofuscus*
7. Setal hyphae lacking or confined to context or marginal tissue 8
   8. Context with one or more thin-layers of black tissue that show as black lines on vertical surfaces; basidiospores attenuated at one end . . . . 13. *P. nigrolimitatus*
   8. Context without black layers; basidiospores cylindrical, straight or curved 9
9. Basidiospores curved, 1.5-2 µm wide . . . . 27. *P. viticola*
9. Basidiospores straight, 2-3.5 µm wide 10
   10. Basidiospores 2-2.5 µm wide; setae up to 30 µm long . . . . 6. *P. ferreus*
   10. Basidiospores 3-3.5 µm wide; setae up to 65 µm long . . . . 8. *P. ferruginosus*
11. Setae projecting 20-50 µm or more 12
11. Setae projecting less than 20 µm or absent 18
   12. Setae projecting 50 µm or more. 13
   12. Setae projecting 20-35 µm 16
13. Setal hyphae abundant in context and tramal tissue and projecting into tubes . . . . 29. *P. weirii*
13. Setal hyphae absent 14
   14. Setae few; on *Crataegus* only . . . . . . 14. *P. occidentalis*
   14. Setae abundant; on conifers. 15

15. Basidiocarps becoming thick; upper surface becoming blackened and deeply rimose . . . . 15. *P. pini*
15. Basidiocarps thin; upper surface remaining hispid or densely hirsute . . . . .3. *P. chrysoloma*
    16. Pore surface dark purplish brown . . . . 9. *P. gilvus*
    16. Pore surface yellowish brown 17
17. Basidiocarps becoming large and thick; at base of living conifers in Arizona . . . . 25. *P. torulosus*
17. Basidiocarps thin; on dead hardwoods . . . . . . .4. *P. conchatus*
    18. Basidiospores subglobose, 6-8.5 µm in diam 19
    18. Basidiospores ovoid, up to 5 µm long 27
19. Basidiospores up to 8.5 µm in diam, dextrinoid in Melzer's reagent; context bright yellowish brown 20
19. Basidiospores up to 6.5 µm in diam, negative in Melzer's reagent; context reddish brown. 24
    20. Basidiocarps sessile, ungulate to applanate, developing on trunks of various desert plants, junipers, or oaks . . 21
    20. Basidiocarps resupinate, or slightly reflexed 22
21. Basidiocarps developing near base of living oaks .22. *P. robustus*
21. Basidiocarps developing near base of numerous desert plants and junipers . . . . 24. *P. texanus*
    22. Basidiocarps bright golden yellow; at base of *Dodonaea* . . . . 23. *P. sonorae*
    22. Basidiocarps colored otherwise; on other substrata 23
23. Basidiocarps developing beneath branch crotches on living conifers . . . . 10. *P. hartigii*
23. Basidiocarps on dead hardwoods and conifers . . .18. *P. punctatus*
    24. Basidiocarps becoming large, up to 20 cm wide 25
    24. Basidiocarps small, up to 5 cm wide 26
25. Pore surface horizontal; basidiocarp ungulate in longitudinal sections; on various hardwoods . . . . . 11. *P. igniarius*
25. Pore surface at about a 45 degree angle; basidiocarps triangular in longitudinal sections; on *Populus* only . . . . 26. *P. tremulae*
    26. On fruit trees . . . . 16. *P. pomaceus*
    26. On *Arctostaphylos* . . . . .1. *P. arctostaphyli*
27. Setae rare; on conifers . . . . .19. *P. repandus*
27. Setae abundant; on hardwoods 28
    28. Pores 6-8 per mm; associated with a uniform white rot of *Prunus* . . . . 17. *P. prunicola*
    28. Pores 8-10 per mm; associated with a white laminated rot, commonly of *Betula* . . . . 12. *P. laevigatus*

SYMBOLS FOR SPECIES IN SYNOPTIC KEY

1. *Phellinus arctostaphyli*; 2. *P. badius*; 3. *P. chrysoloma*; 4. *P. conchatus*; 5. *P. everhartii*; 6. *P. ferreus*; 7. *P. ferrugineofuscus*; 8. *P. ferruginosus*; 9. *P. gilvus*; 10. *P. hartigii*; 11. *P. igniarius*; 12. *P. laevigatus*; 13. *P. nigrolimitatus*; 14. *P. occidentalis*; 15. *P. pini*; 16. *P. pomaceus*; 17. *P. prunicola*; 18. *P. punctatus*; 19. *P. repandus*; 20. *P. ribis*; 21. *P. robineae*; 22. *P. robustus*; 23. *P. sonorae*; 24. *P. texanus*; 25. *P. torulosus*; 26. *P. tremulae*; 27. *P. viticola*; 28. *P. weirianus*; 29. *P. weirii*.

SYNOPTIC KEY TO SPECIES OF PHELLINUS

Habit of basidiocarp
a. resupinate 6, 7, 8, 9, 10, 12, 17, 18, 19, 27, 29
b. sessile 1, 2, 3, 4, 5, 9, 11, 13, 14, 15, 16, 19, 20, 21, 22, 24, 25, 26, 27, 28
c. effused-reflexed 3, 4, 9, 10, 13, 14, 15, 19, 20, 27

Pileus characters
a. applanate 3, 4, 9, 14, 15, 20, 21, 25, 27
b. ungulate 1, 2, 5, 9, 11, 14, 15, 16, 21, 22, 24, 25, 26, 28
c. dimidiate 1, 2, 3, 4, 5, 9, 11, 14, 15, 16, 20, 21, 22, 24, 25, 26, 27, 28
d. elongated 3, 4, 9, 13, 14, 15, 19, 27

Upper surface
a. becoming blackened and rimose 1, 2, 5, 11, 21, 22, 25, 26, 28
b. glabrous or crustlike 1, 4, 11, 16
c. hispid to tomentose 3, 4, 9, 13, 14, 15, 19, 20, 24, 27
d. sulcate 1, 3, 4, 5, 13, 14, 15, 20, 21, 25

Pore surface
a. yellowish brown 2, 3, 4, 5, 6, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28
b. reddish brown 1, 5, 8, 11, 12, 16, 17, 21
c. purplish brown 7, 9, 26, 29
d. pores 6-10 per mm 4, 6, 7, 8, 9, 12, 13, 16, 17, 18, 20, 21, 22, 23, 25, 26, 28, 29
e. pores 1-6 per mm 1, 2, 3, 5, 8, 11, 14, 15, 19, 24, 27

Context
a. woody 1, 2, 5, 10, 12, 16, 18, 21, 22, 23, 24, 25, 26, 28
b. fibrous 3, 4, 6, 7, 8, 9, 13, 14, 15, 17, 19, 20, 27, 29
c. duplex (with spongy upper layer) 13, 20
d. with thin black layers 13, 19, 25
e. granular core present at base 1, 2, 11, 26

Setae and setal hyphae
a. setae absent 2, 18, 20, 21, 22, 23, 24
b. setae up to 20 μm long 16, 17, 26
c. setae 20-100 μm long 1, 3, 4, 5, 6, 8, 9, 11, 12, 13, 14, 15, 19, 24, 25, 27, 28, 29
d. setal hyphae in context 8
e. setal hyphae in trama and projecting into tubes 7, 29

Basidiospores
a. hyaline 1, 3, 4, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 22, 23, 24, 25, 26, 27, 29
b. pigmented 2, 5, 20, 21, 28
c. allantoid 7, 27
d. cylindric to narrowly ellipsoid 6, 8, 13
e. ovoid to globose 1, 2, 3, 4, 5, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29
f. dextrinoid in Melzer's reagent 10, 18, 22, 23, 24

Type of rot
a. white pocket rot 3, 13, 15, 19, 25
b. uniform white rot 1, 2, 4, 5, 6, 8, 9, 10, 11, 12, 14, 16, 17, 18, 20, 21, 22, 23, 24, 26, 27, 28
c. white or yellow laminated rot 7, 12, 29

Substratum
a. heartwood of living trees 1, 2, 3, 5, 9, 10, 11, 13, 14, 15, 16, 20, 21, 22, 23, 24, 25, 26, 28, 29

b. dead trees, stumps, logs, slash 3, 4, 6, 7, 8, 9, 12, 13, 17, 18, 19, 27, 29
c. on conifers 3, 6, 7, 8, 10, 13, 15, 19, 25, 27, 29
d. on hardwoods 1, 2, 4, 5, 6, 8, 9, 11, 12, 14, 16, 17, 18, 20, 21, 22, 23, 24, 26, 27, 28
e. on oaks 5, 9, 22
f. on hawthornes 14
g. on black locust 21
h. on aspen 26
i. on walnut 28
j. on manzanita 1
k. on fruit trees 16
l. on mesquite or acacia 2, 9

Location in living tree
a. trunk rot 1, 2, 3, 5, 10, 11, 14, 15, 16, 21, 24, 28
b. root and butt rot 2, 9, 13, 20, 22, 23, 24, 25, 29

1. *PHELLINUS ARCTOSTAPHYLI* (Long) Niemalä, Ann. Bot. Fenn. 12:120. 1975.
Fomes arctostaphyli Long, N. Mex. Chap. Phi Kappa Phi Papers 1:2. 1917.
Basidiocarps perennial, sessile, applanate to ungulate, dimidiate, 1-9 cm wide and 1-3.5 cm thick; upper surface quickly becoming glabrous and crustose, grayish, sulcate, becoming blackened and rimose with age; margin concolorous to light brown, rounded; pore surface pale grayish brown to dark rusty brown, smooth, the pores circular, 5-6 per mm, dissepiments thick, tomentose, entire; context reddish brown, azonate, fissile, firm, woody, up to 2 cm thick, with a core of tissue near the attachment that has pockets of white mycelium and dark granular masses in a mass of tough, felty mycelium, this core often poorly developed to absent in small specimens; tube layers indistinctly stratified, older layers becoming stuffed with pale mycelium, up to 1 cm thick.
Hyphae of fibrous context parallel, skeletal hyphae thick-walled, aseptate or with occasional simple septa, with rare branching, 2.5-5 diam; core with aggregates of much-branched, interlocked hyphae, some contorted, swollen, often lobed (core setae), thick-walled, dark brown in KOH, up to 10 diam; core also with fibrous tissue made up of interwoven hyaline to golden hyphae, thin- to thick-walled, aseptate, with frequent branching, 1.5-2.5 diam.
Hyphae of trama parallel, skeletal hyphae thick-walled, dark brown in KOH, aseptate, or rarely simple-septate, with rare branching 2.5-5 diam; generative hyphae hyaline to pale yellow, thin-walled, with simple septa and occasional branching, 2-4 diam.
Setae infrequent, subulate, thick-walled, 30-50 x 6-8.5.
Basidia broadly clavate to ellipsoid, 4-sterigmate, 10-12 x 7-8.5.
Basidiospores ovoid, flattened on one side, hyaline, smooth, with slightly thickened walls, negative in Melzer's reagent, cyanophilous, 5-6 x 3.5-4.5.
Type of rot - White rot of heartwood of living manzanita, known on other hosts from a single collection on mountain mahogany in Arizona.
Cultural characteristics - Canfield & Gilbertson (1978).
Substrata - *Arctostaphylos* and *Cercocarpus*.
Distribution - AZ, CA, NM, OR.
Voucher specimens - RLG 7846; RLG 7773 (ARIZ).
Remarks - *Phellinus arctostaphyli* was considered a synonym of *P. igniarius* by Overholts (1953) and Lowe (1957). However, it is morphologic-

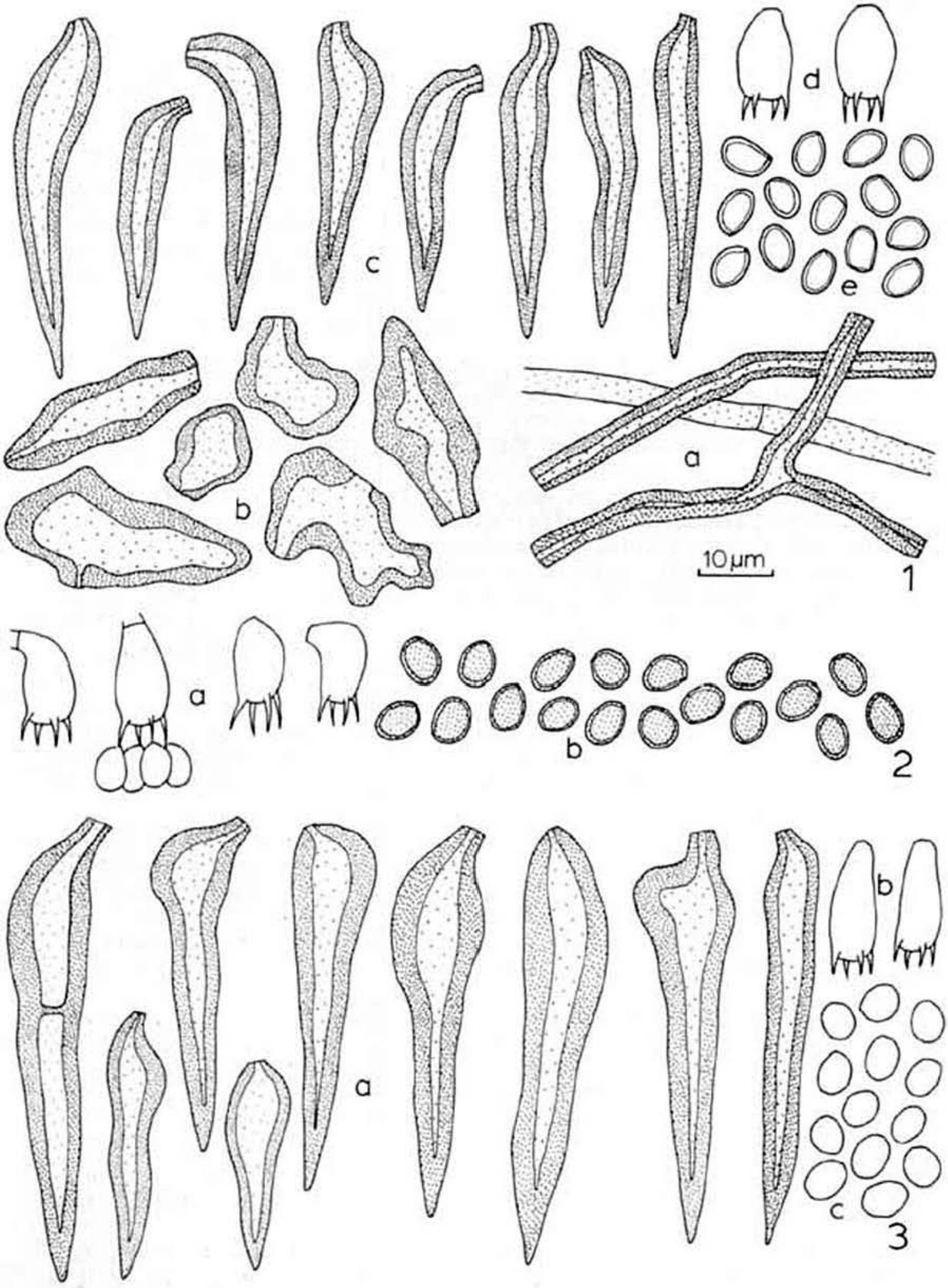


Fig. 1. *Phellinus arctostaphyli* (RLG 7773). a, tramal hyphae; b, core setae; c, setae; d, basidia; e, basidiospores. Fig. 2. *P. badius* (RLG 7737). a, basidia; b, basidiospores. Fig. 3. *P. chrysoloma* (JPL 607). a, setae; b, basidia; c, basidiospores.

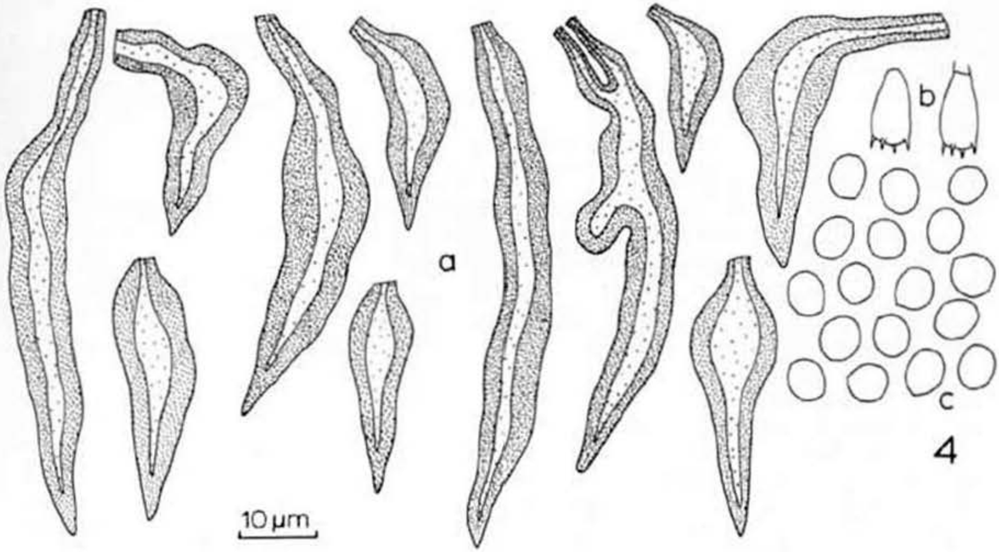
ally distinct with longer setae and cyanophilous spores as pointed out by Niemalä (1974).

2. *PHELLINUS BADIUS* (Berk.) G. H. Cunn., N.Z. Dept. Sci. Ind. Res. Bull. 164. p. 233. 1965.
Polyporus badius Berk., Ann. & Mag. Nat. Hist. 7:453. 1841.
Fomes badius (Berk.) Cke., Grevillea 14:18. 1885.
Basidiocarps perennial, sessile, ungulate, up to 16 x 11 x 9 cm; upper surface at first pale brown, tomentose, quickly becoming blackened and rimose; margin yellowish brown, tomentose, up to 1.5 cm wide; pore surface yellowish brown, smooth, glancing, the pores circular to angular, 4-6 per mm, with smooth, entire dissepiments; context bright, lustrous yellowish brown, firm, fissile, faintly zonate, up to 2 cm thick, with a granular core; granular core under 30 X lens consisting of dull yellowish brown, soft, felty mycelium with patches of white mycelium and dark reddish brown, hard, glassy granules scattered throughout; tube layers concolorous, not distinct from context, not distinctly stratified, up to 2 cm thick.
Contextual hyphae of fibrous context compacted in parallel arrangement, simple-septate, thin- to moderately thick-walled, almost hyaline to pale brown in Melzer's reagent, dark brown in KOH, with infrequent branching, 4-6 in diam, some thick-walled, dark brown, 3-9 in diam; tramal hyphae mostly thick-walled, with rare branching, 2-3 diam, rarely septate; hyphae of granular core a mixture of several types; some hyaline to pale yellow, much-branched, thin-to thick-walled, 1-2 diam; dark granules composed of brown swollen hyphal segments aggregated into a sclerotium like mass, shattering into irregular broken fragments under a cover glass.
Setae or other sterile hymenial elements lacking.
Basidia broadly clavate to ellipsoid, 4-sterigmate, 12-14 x 6-7, sterigmata 5-6 long.
Basidiospores ovoid, smooth, dark reddish brown in KOH, negative in Melzer's reagent, thick-walled, 5-7 x 4-6.
Type of rot - White rot of heartwood of living acacia and mesquite in the Sonoran Desert, rarely on other associated hardwoods.
Substrata - Acacia greggii, Chilopsis linearis, Prosopis juliflora.
Distribution - AZ, NM, MEXICO.
Voucher specimens - RLG 7834; RLG 7042 (ARIZ).
Remarks - *Phellinus badius* has a circumglobal distribution in the tropics and subtropical regions. It is most similar to *Phellinus robineae* which is found only on *Robinia*.

3. *PHELLINUS CHRYSOLOMA* (Fr.) Donk. Proc. K. Ned. Akad. Wet. (C) 74:39. 1971.
Polyporus chrysoloma Fr., Ofvers. K. Vet. Akad. Forh. 18:30. 1861.
Basidiocarps perennial or sometimes developing for only one season, effused-reflexed to sessile, often resupinate in early stages of development, imbricate in clusters on standing trees and stumps or often in rows on fallen trees, pilei usually thin and applanate, dimidiate to elongated, up to 5 cm wide; upper surface tomentose to hispid, sulcate, zonate, dull reddish brown to bright yellowish brown at the margin; margin usually undulate, slightly lobed, acute, narrowly sterile below; pore surface bright yellowish brown at first, darkening in older specimens, glancing, the pores angular to slightly daedaloid, 1-3 per mm in most specimens but much smaller (4-6 per mm) in others; dissepiments thin, entire to lacerate; context reddish brown, tough-fibrous,

with a thin black layer separating the softer upper tomentum, dense lower layer up to 3 mm thick, upper tomentum up to 1 mm thick; tubes indistinctly stratified, inner surface ochraceous, paler than trama and context, entire tube layer up to 1 cm thick.
Hyphae of fibrous context thin-walled and almost hyaline to thick-walled and bright reddish brown in Melzer's reagent, septate, occasionally to often branched, closely interwoven into a compact tissue, 2-4 diam; hyphae of upper tomentum thin-walled and yellowish to thick-walled and bright reddish brown, septate, with rare branching, 2-5 diam; dark layer between lower context and tomentum composed of dark, closely interwoven hyphae; basidiospores usually abundant on upper surface and in tomentum; tramal hyphae hyaline to yellowish brown thin- to slightly thick-walled, septate, with rare to occasional branching, 2-3 diam.
Setae abundant, subulate, thick-walled, bright reddish brown in KOH, 25-60 x 7-10.
Basidia clavate, 4-sterigmate, 10-12 x 5-6.
Basidiospores ovoid to subglobose, hyaline, becoming pale yellowish brown (particularly those trapped in upper tomentum), smooth, negative in Melzer's reagent, becoming slightly thick-walled, 4-5.5 x 4-5.
Chlamydospores - Scattered in tramal tissue of some specimens; subglobose to ovoid, thick-walled, yellowish brown, 5-5.5 diam.
Type of rot - White pocket rot of living and dead conifers. *Phellinus chrysoloma* also is pathogenic in true firs, killing sapwood, and causing stem cankers in which basidiocarps develop (Owens, 1936).
Cultural characteristics - See Owens, 1936.
Substrata - *Pinus, Picea, Abies, Larix.*
Distribution - Probably present in all western states and provinces.
Voucher specimens - JPL 607; RLG 11508 (ARIZ).
Remarks - This has been considered a variety of *Phellinus pini* but is now recognized as a distinct species by Donk (1974), Ryvarden (1977) and others. The resupinate to effused-reflexed, thin basidiocarps, the upper tomentum separated by a thin dark layer from the lower context, and the narrower, shorter setae are diagnostic characters of *P. chrysoloma.*

4. *PHELLINUS CONCHATUS* (Pers. ex Fr.) Quél.,Ench. Fung. p. 173. 1886.
Polyporus conchatus (Pers. ex Fr.), Syst. Myc. 1:376. 1821.
Fomes conchatus (Pers. ex Fr.) Gill. Champ. France, p. 685. 1878.
Basidiocarps sessile, effused-reflexed, or sometimes resupinate; pilei solitary to imbricate, dimidiate or irregular in shape, up to 11 x 15 x 4 cm; upper surface light brown to black with age, glabrous, incrusted, azonate, sulcate, rough; margin concolorous, rounded to acute; pore surface yellowish brown (Saccardo's Umber), the pores circular, 6-8 per mm with thick, entire dissepiments; context yellowish brown, woody, azonate, with one or more thin black layers, up to 4 mm thick; tube layers concolorous with the context, indistinctly stratified, each layer up to 2 mm thick.
Contextual hyphae brown in KOH, thick-walled, rarely branched, rarely simple-septate, 2.5-4 in diam, also some thin-walled, hyaline, simple-septate, 2-3 in diam; tramal hyphae similar.
Basidia clavate, 4-sterigmate, 10-12 x 6-7.
Setae abundant, ventricose to subulate, thick-walled, 20-50 x 7-9.
Basidiospores ovoid to subglobose, hyaline, smooth, negative in Melzer's reagent, 5-6.5 x 4-4.5.
Type of rot - Uniform white rot of dead wood of several hardwood genera.



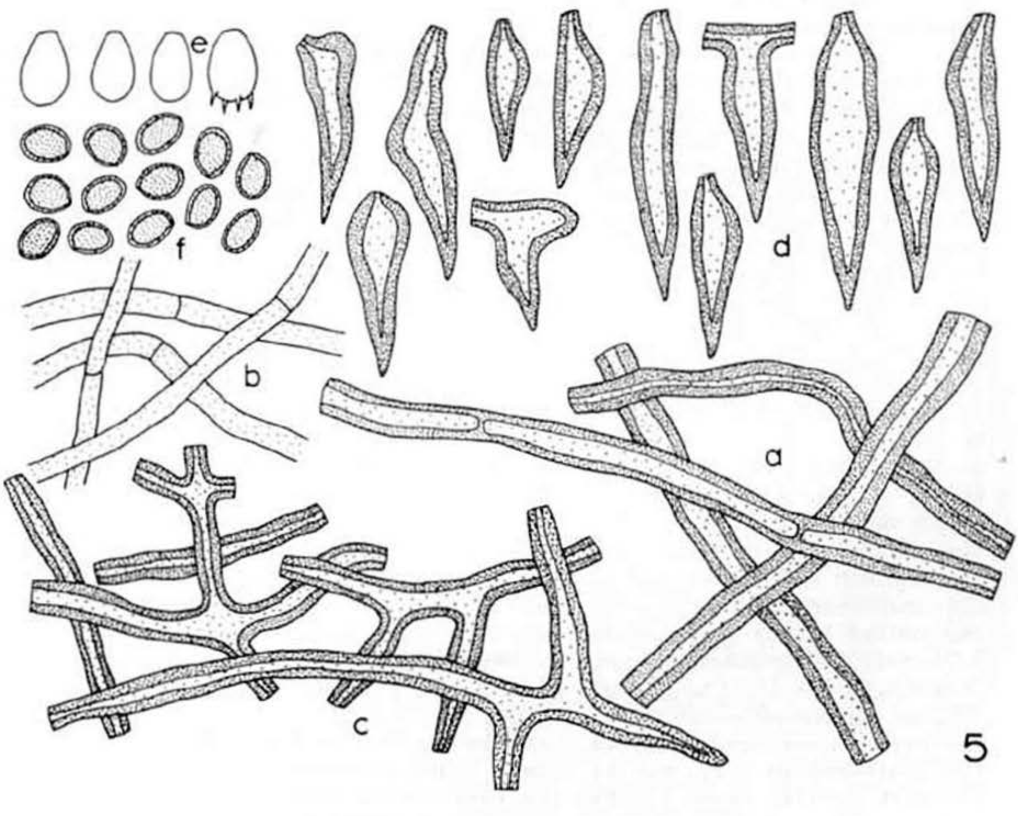


Fig. 4. *Phellinus conchatus* (RLG 9504). a, setae; b, basidia; c, basidiospores. Fig. 5. *P. everhartii* (RLG 7014). a, thick-walled contextual hyphae; b, thin-walled contextual hyphae; c. hyphae from granular context; d, setae; e, basidia; f, basidiospores.

Cultural characteristics - See Campbell (1938), and Nobles (1948, 1958, 1965).
Substrata - *Acer macrophyllum, Alnus incana, Betula papyrifera, Populus trichocarpa, Salix bebbiana,* and *S. lasiandra.*
Distribution - BC, CO, ID, MT, OR, WA, and WY.
Voucher specimens - Weir 18299; Weir 4738 (BPI).
Remarks - *Phellinus conchatus* resembles *P. pini.* The latter species is found on conifers and has pores 2-4 per mm; *P. conchatus* commonly is found on hardwood and has pores 6-8 per mm. Both may have the black layers in the context. Weir confused *P. conchatus* with the fungus later described by Overholts as *P. occidentalis*, and most of his Northwest collections labeled *P. conchatus* are the latter species.

5. *PHELLINUS EVERHARTII* (Ell. et Gall.) Ames, Ann. Myc. 11:246. 1913.
Mucronoporus everhartii Ell. et Gall., Jour. Myc. 5:141. 1889.
Fomes everhartii (Ell. et Gall.) von Schrenk et Spaulding, U.S. Dept. Agr. Pl. Ind. Bul. 149:48. 1909.
Basidiocarps sessile, ungulate, up to 6 x 13 x 8 cm; upper surface yellowish brown to blackish, sometimes very finely tomentose, becoming glabrous and incrusted with age, usually sulcate, rimose; margin concolorous, rounded; pore surface glancing with a golden luster, dark yellowish- to reddish brown (Ochraceous-Tawny, Buckthorn Brown or Cinnamon Brown), the pores circular to angular, 5-6 per mm, with thick, entire dissepiments; context reddish brown, woody, faintly zonate, up to 5 cm thick; tube layers concolorous with the context, rather distinctly stratified, each layer up to 6 mm thick; context with masses of hard granular tissue that appear under 30X lens as dark, solid or resinous areas in a matrix of paler brown interwoven mycelium; hyphae of dark masses agglutinated and hard to separate, tissue breaking out in small chunks.
Contextual hyphae mostly brown in KOH solution, thin- to thick-walled, with rare branching, simple-septate, 3-6.5 in diam, some hyphae hyaline, thin-walled, simple-septate, 2.5-4 in diam; tramal hyphae similar.
Setae frequent to abundant, subulate to ventricose, thick-walled, 16-36 x 5-9.
Basidia ovoid to broadly ellipsoid or subglobose, 4-sterigmate, 8-12 x 5.5-7, simple-septate at the base.
Basidiospores ovoid to subglobose, dark reddish brown, smooth, negative in Melzer's reagent, 4-5 x 3-4.
Type of rot - White rot of heartwood of living oaks.
Cultural characteristics - See Campbell (1938), Davidson et al. (1942), and Nobles (1948, 1958, 1965).
Substrata - *Quercus arizonica, Q. emoryi, Q. gambelii, Q. garryana.*
Distribution - AZ, CA, ID, MT, MEXICO, NM, and OR.
Voucher specimens - RLG 7014 (ARIZ).
Remarks - *Fomes everhartii* is a common species in the oak forests of the southwestern U.S., but is rarely found elsewhere in the West. The dark reddish brown spores, the thin-walled septate hyphae, and thick ungulate fruiting bodies are characteristic features. It is similar to *P. weirianus* but has smaller setae. Furthermore, *P. weirianus* is restricted to walnut.

6. *PHELLINUS FERREUS* (Pers.) Bourd. et Galz., Soc. Mycol. France Bul. 41:247. 1925.
Polyporus ferreus Pers., Myc. Europe 2:89. 1825.

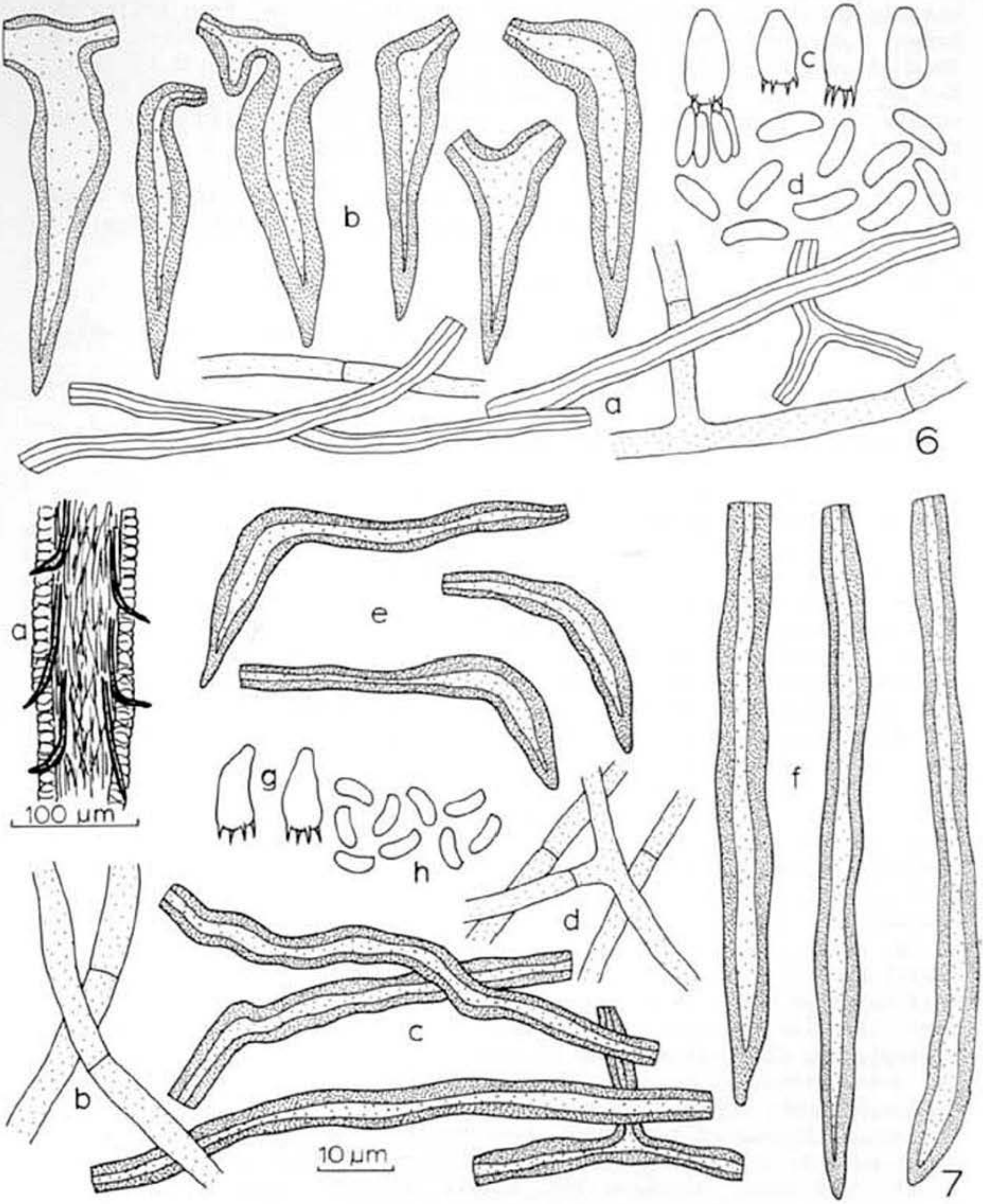


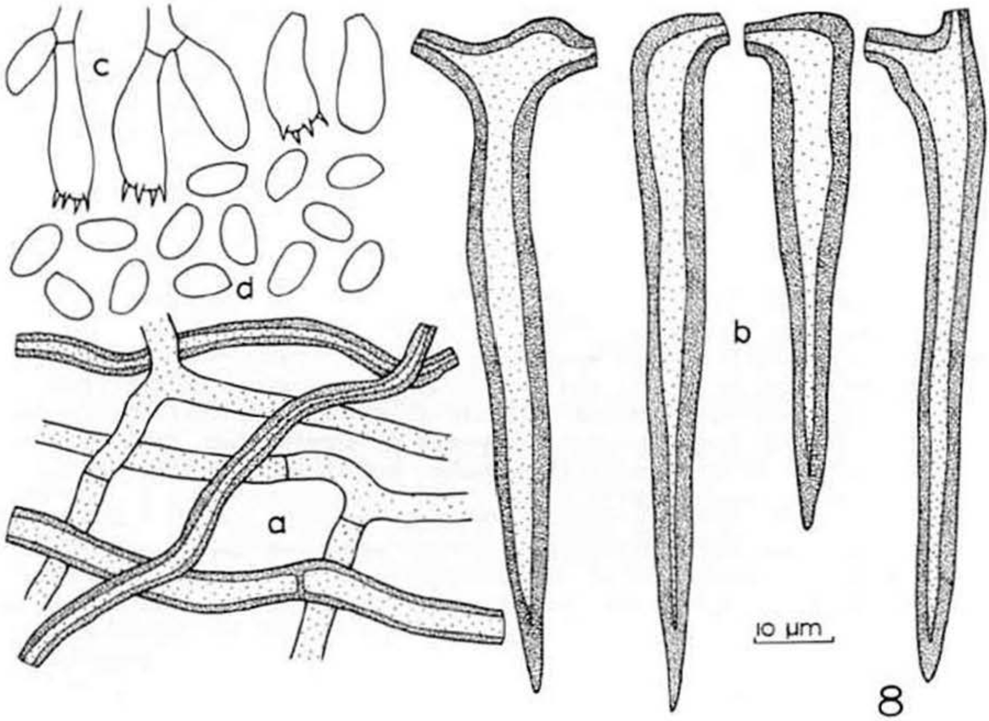
Fig. 6. *Phellinus ferreus* (RLG 3686). a, contextual hyphae; b, setae; c, basidia; d, basidiospores. Fig. 7. *P. ferrugineofuscus* (RLG 6276). a, schematic drawing of hymenial region; b, thin-walled contextual hyphae; c, thick-walled contextual hyphae; d, thin-walled tramal hyphae; e, setae, f, setal hyphae; g, basidia; h, basidiospores.

Poria ferrea (Pers.) Overh. Mycologia 23:117. 1931.
Basidiocarps perennial, resupinate, effused up to 23 cm, woody, not readily separable; margin fertile or narrowly sterile, then yellowish brown, tomentose, up to 2 mm wide; pore surface yellowish brown (Buckthorn Brown or hazel), often cracking extensively, the pores circular, 6-7 per mm, with thick, entire dissepiments; context yellowish brown, corky, azonate, up to 1 mm thick; tube layers indistinctly stratified, concolorous and continuous with the context, each layer up to 1 cm thick.
Contextual hyphae dark brown to almost hyaline in KOH, thick- or thin-walled, with rare branching, rarely simple-septate, 2-4.5 in diam; tramal hyphae similar.
Setae abundant, subulate to slightly ventricose, 22-29 x 6-7.
Basidia clavate, 4-sterigmate, 12-14 x 5-6.
Basidiospores cylindric, hyaline, smooth, negative in Melzer's reagent, 5-7.5 x 2-2.5.
Type of rot - Uniform white rot of dead wood of hardwood and coniferous species.
Cultural characteristics - See Baxter (1934) and Nobles (1948, 1958, 1965).
Substrata - *Abies, Acer, Alnus, Amelanchier, Arbutus, Arctostaphylos, Betula, Castanea, Castanopsis, Cornus, Corylus, Crataegus, Fraxinus, Gaultheria, Holodiscus, Lithocarpus, Myrica, Physocarpus, Picea, Populus, Prunus, Pseudotsuga, Quercus, Rhus, Rubus, Salix, Thuja, Tsuga, Umbellularia*, and *Vaccinium*.
Distribution - AK, AT, BC, CA, ID, NWT, MT, OR, and WA.
Voucher specimens - RLG 174 (SY-F); RLG 3394 and 3400 (SY-F).
Remarks - This species is similar to *P. ferruginosus*, another common hardwood-inhabiting fungus. *Phellinus ferruginosus* has shorter spores and usually has setal hyphae in the marginal and context tissue, features which distinguish it from *P. ferreus*.

7. *PHELLINUS FERRUGINEOFUSCUS* (Karst.) Bourd., Soc. Mycol. France Bull. 48:228. 1932.
Poria ferrugineofusca Karst., Soc. Fauna Flora Fenn. Meddel. 14:82. 1887.
Basidiocarps annual or rarely with two layers of tubes, effused up to 20 cm, tough, woody, not easily separable; margin yellowish brown (Sayal Brown) to whitish, soft tomentose, up to 7 mm wide; pore surface purplish brown (Warm Sepia, Natal Brown, or Cinnamon-Brown), the pores circular to angular or sinuous, 7-9 per mm, with thick, entire dissepiments that often split to form sinuous pores; context bright yellowish brown, azonate, tough, fissile, up to 6 mm thick; tube layer purplish brown, tubes lighter within, up to 4 mm thick.
Contextual hyphae of two types, some brownish to hyaline, thin- to thick-walled, simple-septate, with occasional branching, 2.5-5 in diam, others dark brown, thick-walled, rarely branched, rarely septate setal hyphae, 3-3.5 in diam; tramal hyphae similar, the dark, thick-walled setal hyphae projecting into the tubes.
Setae present as ends of setal hyphae, bent abruptly and projecting into the tubes.
Basidia narrowly clavate, 4-sterigmate, 12-14 x 3.5-4.
Basidiospores cylindrical, curved, smooth, hyaline, negative in Melzer's reagent, 4-5.5 x 1-1.5.
Type of rot - White laminated rot of dead wood of conifers. *Phellinus ferrugineofuscus* was reported by Kimmey and Stevenson (1957) as causing

a common heartrot of western red cedar in Alaska. However, the only Alaskan specimen in the National Fungus Collections collected by Kimmey was misidentified and should be referred to *Poria albipellucida* Baxt., a fungus known to cause heartrot in *Thuja plicata*. The wood decayed by *P. ferrugineofuscus* often has small longitudinal pits similar to those seen in wood decayed by *P. weirii*. The wood is also frequently mottled with transversely oriented whitish streaks and may have blackish flecks scattered through it.
Cultural characteristics - See Baxter (1934) and Nobles (1948, 1958, 1965).
Substrata - *Abies, Larix, Picea, Pinus, Pseudotsuga, Thuja,* and *Tsuga*.
Distribution - AK, AT, AZ, CA, CO, ID, MT, OR, UT, WA, and WY.
Voucher specimens - RLG 8975; RLG 6276 (ARIZ).
Remarks - Other species with hyaline spores and setal hyphae known from this area are *P. weirii* and *P. ferruginosus*. These differ from *P. ferrugineofusca* in the shape of their spores and the consistency and color of their basidiocarps. *Inonotus glomeratus* Peck also has setal hyphae and is frequently resupinate, but is readily identified by its yellowish, ovoid spores.

8. *PHELLINUS FERRUGINOSUS* (Schrad. ex Fr.) Bourd. et Galz., Hym. France. p. 625. 1928.
Polyporus ferruginosus Schrad. ex Fr., Syst. Myc. 1:378. 1821.
Poria ferruginosa (Schrad. ex Fr.) Karst., Rev. Mycol. 3, 9:19. 1881.
Basidiocarps annual, becoming widely effused, tough to soft-spongy, not easily separable; margin tawny, soft-spongy, often appearing setulose under a lens, up to 2 cm wide; pore surface ferrugineous, the pores circular, usually 7-9 per mm, but in some unusual specimens 2-3 per mm, with thick, tomentose dissepiments; context yellowish brown, azonate, soft-fibrous, up to 1.5 mm thick; tube layer slightly darker than the context or concolorous, continuous with the context, up to 2 cm thick.
Contextual hyphae of two types, some light brown in KOH, rather thin-walled, with rare branching, 2-4 in diam, setal hyphae darker reddish brown, very thick-walled, tapering to a setalike point, unbranched, 5-8 in diam; tramal hyphae similar to the thin-walled type.
Setae abundant, mostly subulate, 25-65 x 6-8.
Basidia clavate, 4-sterigmate, 11-14 x 4.5-6.5.
Basidiospores cylindric or short-oblong, hyaline, smooth, negative in Melzer's reagent, 5-7 x 3-3.5.
Type of rot - White laminated rot of dead wood of hardwood and coniferous species.
Cultural characteristics - See Baxter (1934) and Nobles (1948, 1958, 1965).
Substrata - *Abies, Acer, Alnus, Arbutus, Betula, Corylus, Lithocarpus, Picea, Pinus, Populus, Prunus, Pseudotsuga, Quercus, Salix, Thuja, Sequoia, Umbellularia, Vaccinium.*
Distribution - AK, AT, AZ, BC, CA, CO, ID, MT, NM, NWT, OR, and WA.
Voucher specimens - RLG 3412; RLG 3393 (ARIZ).
Remarks - Considerable variation occurs in basidiocarps of *P. ferruginosus*, especially in pore size. *Phellinus ferreus* is similar but has narrower spores and lacks setal hyphae. Other species of *Phellinus* with setal hyphae are *P. ferrugineofuscus* and *P. weirii*. In those 2 species the setal hyphae occur in the tramal tissue and project into the tubes.



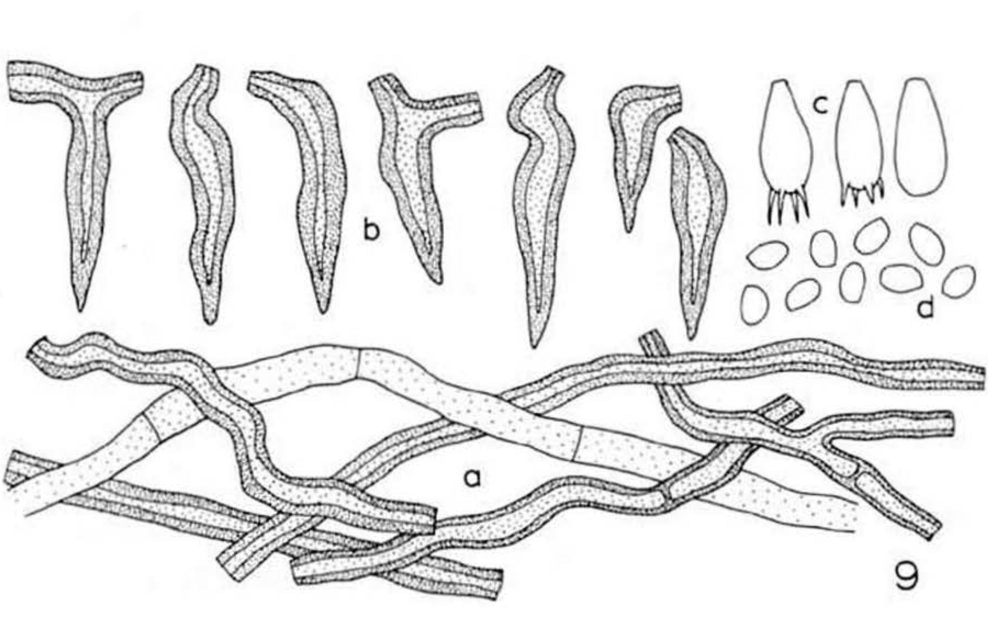
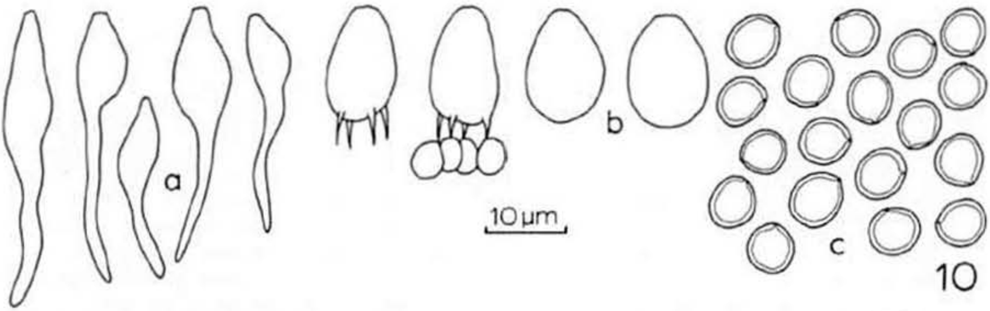


Fig. 8. *Phellinus ferruginosus* (ERC 71-25). a, contextual hyphae; b, setae; c, basidia; d, basidiospores. Fig. 9. *P. gilvus* (ERC 86). a, contextual hyphae; b, setae; c, basidia; d, basidiospores.

9. *PHELLINUS GILVUS* (Schw.) Pat., Ess. Tax. Hym. p. 97. 1900.
Boletus gilvus Schw., Schr. Nat. Ges. Leipzig 1:96. 1822.
Polyporus gilvus Schw., Schr. Nat. Ges. Leipzig 1:96. 1822.
Basidiocarps perennial or annual, sessile or slightly effused-reflexed; pilei solitary or imbricate, dimidiate, up to 7 x 12 x 3 cm; upper surface dark yellowish brown (Yellow Ocher to Tawny-Olive), tomentose to glabrous, often ruguse, zonate or azonate; margin concolorous; pore surface dark purplish brown (Natal Brown), the pores circular, 6-8 per mm, with thick, entire dissepiments; context bright yellowish brown, zonate, fibrous, up to 2 cm thick; tramal tissue concolorous and continuous with the context, tube layer white-stuffed, up to 1 cm thick.
Contextual hyphae of two types, some dark reddish brown in KOH, thick-walled, rarely branched, simple-septate, 3-7 in diam, others pale yellowish brown, thin-walled, with occasional branching, septate, 3-5 in diam; tramal hyphae similar.
Setae abundant, subulate, sharp, 20-30 x 5-6.
Basidia broadly clavate, 4-sterigmate, 8-11 x 5-7.
Basidiospores ellipsoid to ovoid, hyaline, smooth, negative in Melzer's reagent, 4-5 x 3-3.5.
Type of rot - Uniform white rot of dead wood of hardwoods and a heart rot of living trees.
Cultural characteristics - See Davidson et al. (1942), Nobles (1948, 1958, 1965), and Gilbertson and Burdsall (1972).
Substrata - Alnus, Betula, Fraxinus, Juglans, Phoenix, Platanus, Populus, Prosopis, Prunus, Quercus, and Salix.
Distribution - AZ, CA, ID, MT, NM, OR, and WA.
Voucher specimens - RLG 7736; RLG 7180 (ARIZ).
Remarks - Phellinus gilvus is a common fungus on hardwoods along streams at lower elevations in the Southwest. The purplish color of the pore surface is very characteristic. It is most similar morphologically to *P. torulosus* which occurs at higher elevations on conifers and has larger spores. The two also differ greatly in culture.

10. *PHELLINUS HARTIGII* (Allesch. et Schnabl.) Bond., Polyp. Eur. USSR and Caucasia. p. 365. 1953.
Polyporus hartigii Allesch. et Schnabl., Fungi Bavar. exs. No. 48. 1890.
Basidiocarps perennial, resupinate to effused-reflexed; when reflexed more or less triangular in longitudinal sections with upper and lower surfaces at angles of 45^{o} or greater; upper surface pale yellowish brown, tomentose near the margin, becoming glabrous and rimose, grayish brown to purplish brown, the pores circular, 5-7 per mm, with thick, entire dissepiments; context woody, yellowish brown to reddish brown, with darker zones, up to 2 cm thick; tube layers distinctly stratified, often with sterile tissue between the layers, tubes white within, layers up to 5 mm thick.
Contextual hyphae pale yellowish brown in Melzer's reagent, thick-walled, aseptate or with rare septa, 2-5 diam, with rare branching; some almost hyaline, slender, aseptate, thick-walled, much-branched hyphae also present, these 1-1.5 diam; tramal hyphae similar.
Setae lacking; ventricose, thin-walled cystidioid elements present.
Basidia broadly ellipsoid, 4-sterigmate, 12-14 x 8-9.
Basidiospores subglobose, hyaline, smooth, slightly thick-walled, strongly dextrinoid in Melzer's reagent, 5-6.5 x 6-7.5.
Type of rot - Uniform white rot of heartwood of living conifers, continuing in dead trees and logs.



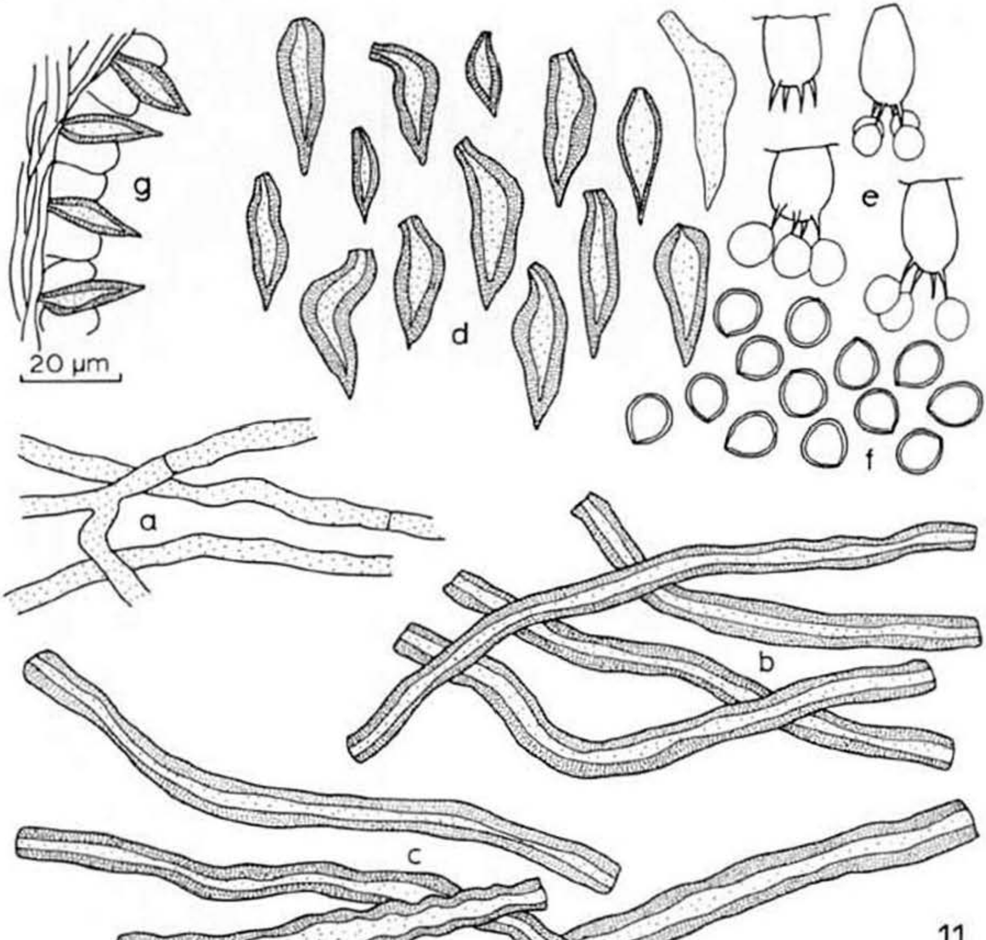
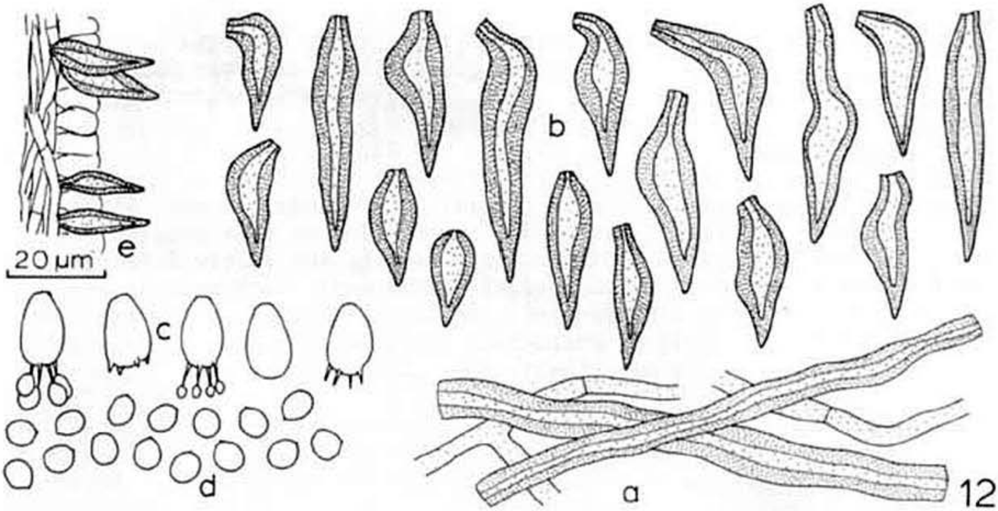


Fig. 10. *Phellinus hartigii* (FP 10557). a, thin-walled cystidioid elements from hymenium; b, basidia; c, basidiospores. Fig. 11. *P. igniarius* (RLG 8575). a, thin-walled tramal hyphae; b, thick-walled tramal hyphae; c, thick-walled contextual hyphae, d, setae; e, badisia; f, basidiospores; g, schematic drawing of hymenium.

Cultural characteristics - See Baxter (1934, 1945, as *Poria tsugina*; 1952, as *Fomes robustus tsugina*); Campbell (1938, as *Fomes robustus* var. *tsugina*); and Nobles (1948, 1958, 1965, as *Poria tsugina*).
Substrata - *Abies, Pseudotsuga, Tsuga.*
Distribution - AK, AZ, BC, CA, CO, ID, NM, WA.
Voucher specimens - FP 6034; FP89887 (CFMR).
Remarks - The *Phellinus robustus* complex is probably the most difficult taxonomic problem in the genus. Speciation in this complex has resulted from adaptation to different substrata and vastly different environmental factors. Morphological differences, both macroscopic and microscopic, have also evolved. *Phellinus hartigii* is recognized essentially on the basis of characters detailed by Lohwag (1937), Jahn (1976), and Domanski et al. (1967).

11. *PHELLINUS IGNIARIUS* (L. ex Fr.) Quél., Ench. Fung. p. 172. 1886.
Polyporus igniarius L. ex Fr., Syst. Myc. 1:375. 1821.
Fomes igniarius (L. ex Fr.) Kickx, Fl. Crypt. Flandres 2:237. 1867.
Basidiocarps perennial, sessile or rarely effused-reflexed, ungulate or sometimes applanate, up to 11 x 20 x 8 cm; upper surface gray or blackish, glabrous, sulcate, becoming deeply rimose, incrusted; margin concolorous and glabrous or yellowish brown, (Saccardo's Umber or Snuff Brown); pore surface pale cinnamon brown to dark purplish brown, the pores circular, 5-6 per mm, with thick, entire dissepiments; context dark reddish brown, zonate, woody, up to 2 cm thick; core absent or present next to substratum, with white tissue intermixed; tube layers concolorous with context, the tubes white-stuffed, in indistinct layers, each up to 4 mm thick.
Contextual hyphae of two types, some brown in KOH, thick-walled, distinct, with rare branching, aseptate, 2-5 in diam, some hyaline, thin-walled with occasional simple septa, very indistinct; tramal hyphae similar, 2-3 in diam.
Setae ventricose to subulate, abundant to rare, 14-17 x 4-6; core setae present in some specimens, irregularly lobed and branched; thick-walled, up to 15 in diam.
Basidia broadly clavate, 4-sterigmate, 9-10 x 6-7.
Basidiospores broadly ovoid to subglobose, hyaline, smooth, thick-walled, negative in Melzer's reagent, acyanophilous, 5-6.5 x 4.5-6.
Type of rot - Uniform white rot of the heartwood of living hardwoods.
Cultural characteristics - See Campbell (1938), Niemalä (1977), Nobles (1948, 1958, 1965), and Verral (1937).
Substrata - *Acer, Alnus, Arbutus, Betula, Castanopsis, Cornus, Malus, Prunus, Pyrus, Quercus, Rhamnus, Salix, Sambucus.*
Distribution - AK, AT, BC, CA, CO, ID, MT, OR, UT, WA, and WY.
Voucher specimens - RLG 8575; RLG 5844 (ARIZ).
Remarks - The *Phellinus igniarius* complex has been another difficult taxonomic problem. *Phellinus arctostaphyli* is segregated on the basis of characters detailed under that species. *Phellinus tremulae* occurs only on aspen and is morphologically distinct on the basis of basidiocarp macro- and micromorphology as well as cultural characters. *Phellinus pomaceus* is most similar and is characterized mainly by small basidiocarps on *Prunus*. Niemalä (1972, 1974, 1975, 1977) should be consulted for a detailed discussion of the *P. igniarius* complex.

12. *PHELLINUS LAEVIGATUS* (Fr.) Bourd. et Galz., Hym. France p. 264. 1928.
Polyporus laevigatus Fr., Hym, Eur. p. 571. 1874.



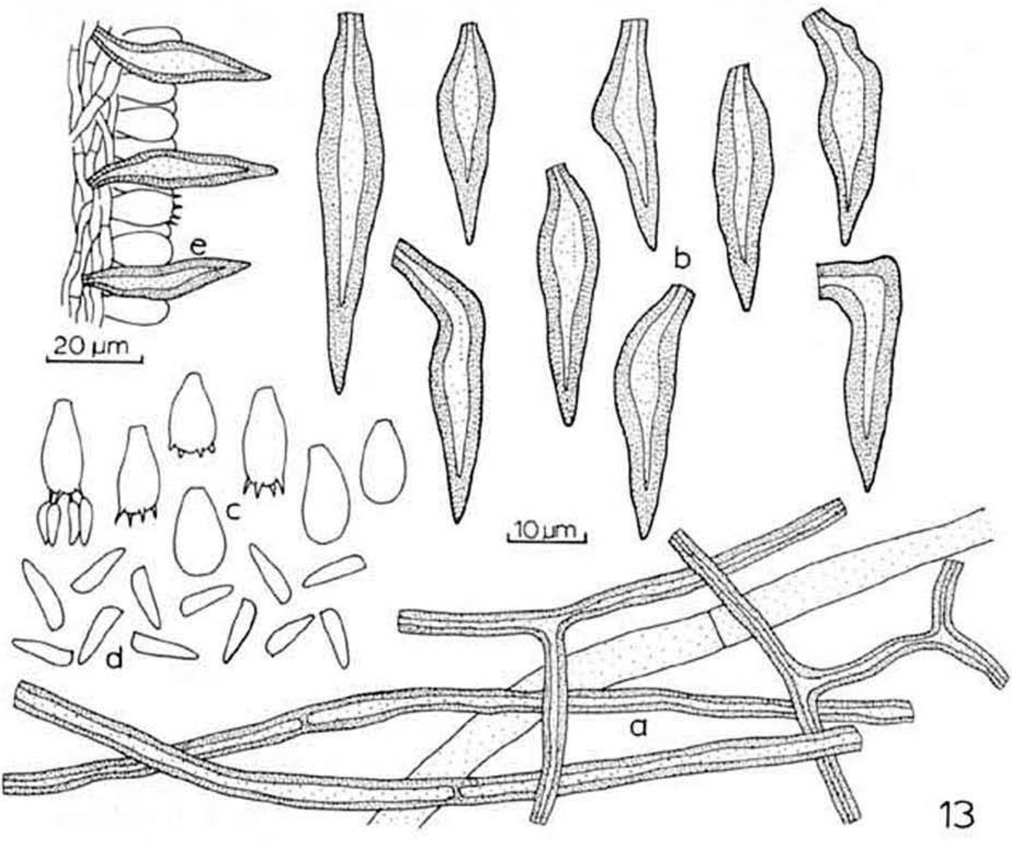


Fig. 12. *Phellinus laevigatus* IRLG 179). a, contextual hyphae; b, setae; c, basidia; d, basidiospores; e, schematic drawing of hymenium. Fig. 13. *P. nigrolimitatus* (RLG 5861). a, contextual hyphae; b, setae; c, basidia; d, basidiospores; e, schematic drawing of hymenium.

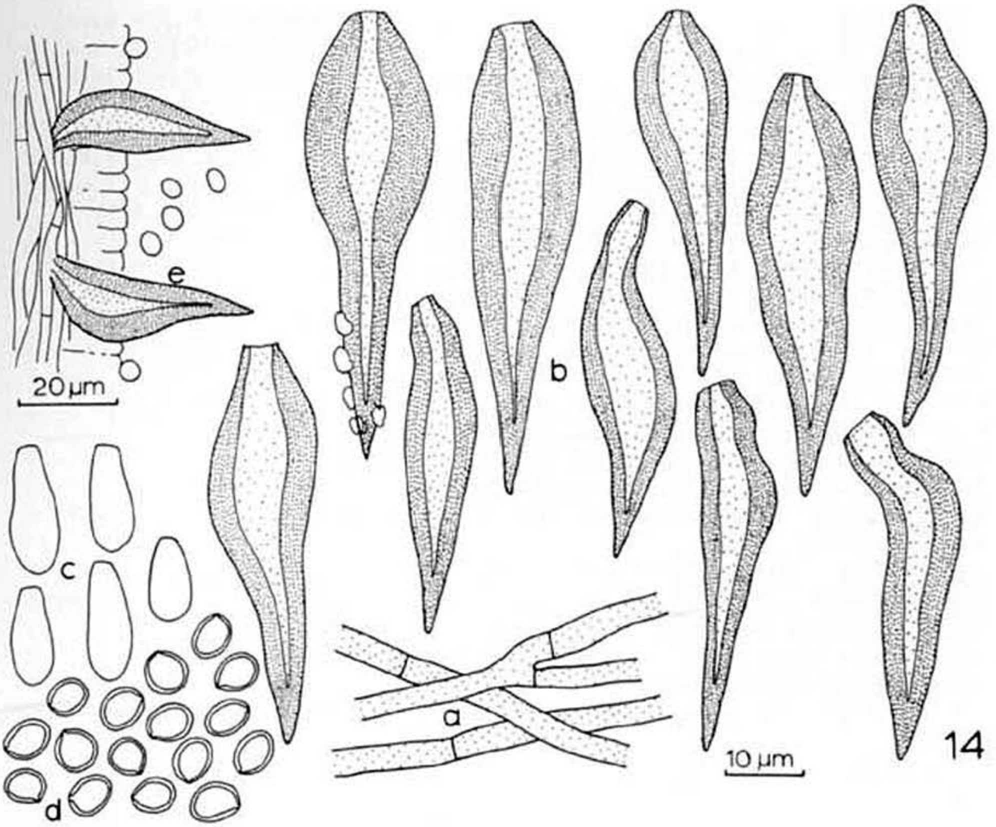
Basidiocarps perennial, resupinate, becoming widely effused, woody, adnate; pore surface dull reddish brown (Prout's Brown to Warm Sepia) often becoming deeply cracked into angular blocks with age or drying, the pores circular, 8-10 per mm, with thick, entire dissepiments; margin yellowish-brown (Ochraceous-Tawny), tomentose, up to 2 mm wide; context yellowish brown, azonate, up to 2 mm thick; tube layers indistinctly stratified, paler than context, each layer up to 1 mm thick.
Contextual hyphae of two types, some dark brown in KOH, thick-walled, rarely branched, aseptate, 2.5-5 in diam; others pale yellowish to hyaline in KOH, thin-walled, simple-septate, with frequent branching, 2-3.5 in diam; tramal hyphae similar, with parallel arrangement.
Setae abundant, subulate to ventricose, thick-walled, 17-30 x 6-9.
Basidia subglobose to pyriform, 2-4 sterigmate, 7-11 x 4-5.
Basidiospores ovoid, hyaline to pale golden yellow in older specimens, smooth, negative in Melzer's reagent, 3-4 x 2.5-3.
Type of rot - White laminated rot of dead hardwoods, especially birch. The wood in advanced stages of decay separates readily along the annual rings.
Cultural characteristics - See Campbell (1938), Baxter (1952), Nobles (1958, 1965), and Niemalä (1972).
Substrata - Alnus, Betula, and Populus.
Distribution - BC, ID, MT, OR, WA.
Voucher specimens - RLG 179; RLG 341 (ARIZ).
Remarks - Phellinus laevigatus has been considered a resupinate state of *P. igniarius* by Overholts (1953) and Lowe (1958, 1966). However it is morphologically distinct by its smaller spores and also causes a different type of rot. Niemalä (1972) has also pointed out that the arrangement of the tramal hyphae is different in the two species, being parallel in *P. laevigatus* and interwoven in *P. igniarius*.

13. *PHELLINUS NIGROLIMITATUS* (Rom.) Bourd. et Galz., Hym. France p. 622. 1928.
Polyporus nigrolimitatus Rom., Arkiv f. Bot. 11, 3:18. 1912.
Fomes nigrolimitatus (Rom.) Egeland, Mag. f. Naturvidenskaberne (Nyt.) 52:135. 1914.
Fomes putearius Weir, J. Agric. Res. 2:165. 1914.
Basidiocarps effused-reflexed or resupinate; pilei usually irregular in shape, more or less elongated and shelflike, up to 5 x 10 x 4 cm; upper surface blackish brown to yellowish or reddish brown, finely tomentose to glabrous, very irregular, often soft and spongy; margin concolorous or sometimes lighter (Snuff Brown to Buckthorn Brown), up to 3 mm wide; pore surface Cinnamon, smooth, the pores circular to angular, sometimes daedaloi in part, 5-7 per mm, with thick, entire dissepiments; context dark yellowish brown, with one or more thin black layers that appear as black lines in longitudinal sections, often zonate, corky to soft-fibrous, up to 1 cm thick; tube layers indistinct, lighter brown than context, each layer up to 2 mm thick.
Contextual hyphae brown to pale yellow or almost hyaline in KOH, thick- or thin-walled, with frequent branching, simple-septate, 2.5-6 in diam; black layers about 20-80 thick, composed of very closely interwoven and agglutinated hyphae; tramal hyphae similar to those of lower context.
Setae abundant, straight, subulate to ventricose, 25-37 x 6.5-8.5.
Basidia broadly clavate, 4-sterigmate, 10-12 x 5-6.5.
Basidiospores cylindric, straight, tapering at the apex, hyaline, smooth, negative in Melzer's reagent, 7-10 x 2-2.5.

Type of rot - White pocket rot of conifer logs and also a root and butt rot of living trees. The rot is distinctive because of the large size of the pockets, which are up to 2.5 cm long. The wood between the pockets is firm.
Cultural characteristics - See Nobles, 1948, 1958, 1965; Baxter, 1945.
Voucher specimens - RLG 8271; RLG 11511 (ARIZ).
Remarks - In North America this species is known only from the West, where it is common in many areas, especially at higher elevations in the spruce-fir zone. When entirely resupinate, the basidiocarps are easily mistaken for those of other species of *Phellinus*, particularly those of softer consistency, such as *P. weirii* and *P. ferrugineofusca*. The black layers in the context and the distinctive carrot-shaped spores are features which facilitate identification of resupinate specimens.

14. *PHELLINUS OCCIDENTALIS* (Overh.) Gilbn. in Lombard, et al., Mycopath. et Mycol. Appl. 46:352. 1972.
Fomes occidentalis Overh. in Lombard et al., ibid.
(*Fomes occidentalis* Overh., Mycologia 33:101. 1941. Not validly published - no Latin diagnosis)
Basidiocarps perennial, effused-reflexed or sessile, sometimes resupinate at first; pilei dimidiate or laterally fused and elongate, up to 2 x 6 x 4 cm; upper surface blackish to grayish, faintly sulcate and zonate, incrusted, glabrous; margin light yellowish brown (Warm Buff or Cinnamon-Buff), faintly tomentose, up to 1 mm wide, rounded; pore surface light brown (Snuff Brown or Dresden Brown), the pores angular to circular, 2-4 per mm, with thick, entire dissepiments; context light reddish brown, azonate, corky, up to 2 mm thick; the upper incrusted layer blackish; tube layers concolorous and continuous with context, up to 1.5 cm thick, the tubes lighter within.
Contextual hyphae of two types, some dark brown in KOH, thin- to thick-walled, rarely simple-septate, with rare branching, 2-5 in diam, others hyaline or pale yellowish, thin-walled, simple-septate, with frequent branching, 2-3 in diam; tramal hyphae similar.
Setae scattered, thick-walled, ventricose, 40-50 x 8-14.
Basidia clavate, 4-sterigmate, 11-16 x 5-5.5.
Basidiospores ovoid to subglobose, hyaline, in old specimens distinctly brown, smooth, negative in Melzer's reagent, 5-6 x 4-5.
Type of rot - Uniform white rot of heartwood of living hawthorne (Lombard et al. 1972).
Cultural characteristics - See Lombard, et al. (1972).
Substrata - *Crataegus columbiana, C. douglasii, C. piperi.*
Distribution - ID, MT, OR, UT, WA.
Voucher specimens - RLG 2060; RLG 4674 (ARIZ).
Remarks - *P. occidentalis* is quite similar to *P. chrysoloma* and *P. pini*. Its restriction to hawthorn and the uniform white rot are diagnostic.

15. *PHELLINUS PINI* (Thore. ex Fr.) Pilát, Atl. Champ. Eur. III (1). p. 517. 1942.
Fomes pini (Thore. ex Fr.) Karst., Bidr. Finl. Nat. O. Folk. 37:79. 1882.
Boletus pini Thore, Chloris Dept. Landes, p. 487. 1803.
Daedalea pini Brot. ex Fr., Syst. Myc. 1:336. 1821.
Trametes pini Thore ex Fr., Epicr. Syst. Myc., p. 489. 1836-1838.
Cryptoderma yamanoi Imazeki, Forsch. auf. dem. Geb. Pflanzenkrank (Japan) 4:176. 1951.



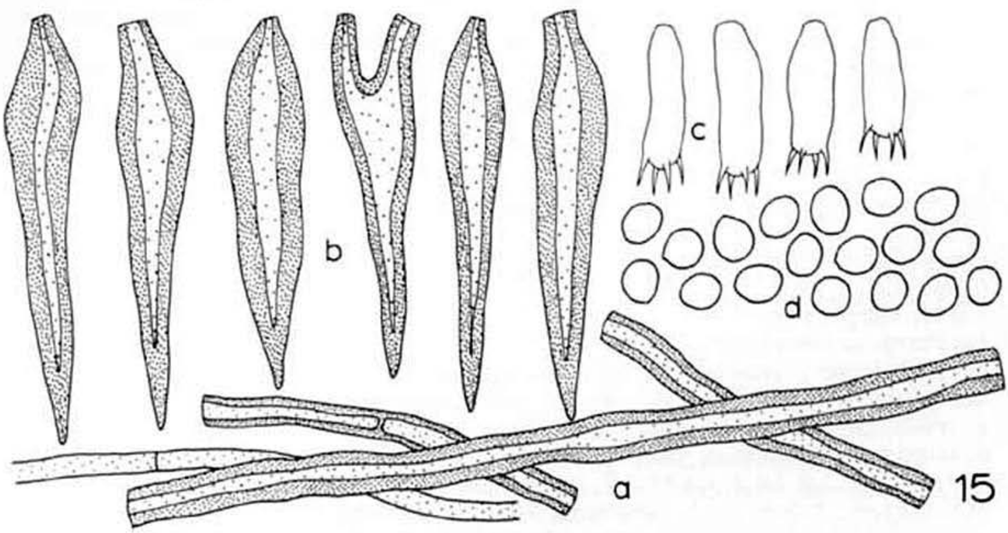


Fig. 14. *Phellinus occidentalis* (RLG 4674). a, thin-walled tramal hyphae; b, setae; c, basidia; d, basidiospores; e, schematic drawing of hymenium. Fig. 15. *P. pini* (RLG 9407). a, tramal hyphae; b, setae; c, basidia; d, basidiospores.

Basidiocarps sessile, effused-reflexed, or sometimes entirely resupinate; pilei solitary or imbricate, ungulate to applanate, up to 9 x 13 x 8 cm; upper surface light reddish-brown to blackish, hirsute toward the margin, becoming glabrous and incrusted with age, zonate and sulcate; margin reddish-brown and hirsute, or sometimes yellowish-brown (Antimony Yellow) and tomentose, rounded; pore surface yellowish-brown (Tawny-Olive to Yellow Ocher), the pores circular to angular or daedaloid, 2-3 per mm, with thick, entire dissepiments; context reddish-brown or yellowish-brown, lustrous on cut surface, corky, usually with one or more thin black layers, in younger specimens often appearing duplex because of the hirsute upper layer, up to 3 cm thick; tramal tissue continuous and concolorous with context, tubes light colored within, indistinctly stratified, each layer up to 6 mm thick.
Contextual hyphae rarely branched, simple-septate, of two types, some brown in KOH, thick- or thin-walled, 3.5-7.5 in diam., others hyaline, thin-walled, 2-3 in diam; tramal hyphae similar.
Setae abundant, subulate to ventricose, 40-50 x 10-14.
Basidia broadly clavate, 4-sterigmate, 12-14 x 5-6.
Basidiospores ovoid, hyaline, smooth, negative in Melzer's reagent, 4.5-7 x 3.5-5.
Type of rot - White pocket rot of the heartwood of living conifers.
Cultural characteristics - See Campbell (1938), Fritz (1923), Davidson et al. (1938), Nobles (1948, 1958, 1965), and Owens (1936).
Substrata - *Abies, Chamaecyparis, Larix, Libocedrus, Picea, Pinus, Pseudotsuga, Taxus, Thuja,* and *Tsuga*.
Distribution - AK, AT, AZ, BC, CA, CO, ID, MT, NM, OR, SASK., WA, WY, and UT.
Voucher specimens - RLG 9407; RLG 6630 (ARIZ).
Remarks - *P. chrysoloma* is closely related and has been referred to as *Fomes pini* var. *abietinus* (Karst.) Overh. *P. occidentalis* is similar and can be distinquished by its host, *Crataegus*, and the associated uniform white rot. Boyce and Wagg (1955) have reported the pathogenic relationship of *P. pini* in stands of Douglas fir and a cyclic pattern of decay over a 450 year rotation.

16. *PHELLINUS POMACEUS* (Pers. ex S. F. Gray) Maire, Fungi Catal. I. p. 37. 1932.
Boletus pomaceus Pers. ex S. F. Gray, Nat. Arr. Brit. Plants 1:642. 1821.
Fomes pomaceus (Pers. ex S. F. Gray) Lloyd, Mycol. Writings C. G. Lloyd 2:8. 1908.
Basidiocarps perennial, sessile or effused-reflexed; pilei ungulate, solitary or imbricate, up to 5 x 5 x 6 cm; upper surface at first light grayish-brown, smooth, lightly tomentose, becoming blackened, rimose and glabrous; margin light brown, rounded; pore surface dark yellowish- to reddish-brown, the pores circular, 7-9 per mm, with thick, entire dissepiments; context yellowish-brown to reddish-brown, shining, zonate, woody, up to 1 cm thick; tube layers concolorous, distinctly stratified, tubes dull, becoming whitish within.
Contextual hyphae mostly brownish in KOH, thick-walled, with rare to frequent branching, simple-septate, 2.5-5.5 in diam, some hyaline, thin-walled, simple-septate, 2-3 in diam; tramal hyphae usually similar, some thin-walled, pale brownish to hyaline.
Setae rare, subulate to ventricose, 14-17 x 4.5-7.
Basidia broadly clavate, 4-sterigmate, 9-10 x 5.5-6.
Basidiospores ovoid to broadly ellipsoid, hyaline, smooth, negative in Melzer's reagent, 4-5 x 3-4.5.

Type of rot - Uniform white rot of the heartwood of living fruit trees.
Cultural characteristics - See Campbell (1938), Nobles, (1948, 1958, 1965 as *Fomes fulvus*); and Niemalä (1977).
Substrata - *Prunus*.
Distribution - CO, ID, MT, NM, OR, WA, and WY.
Voucher specimens - WGS 07711; JFB 1001 (ARIZ).
Remarks - Niemalä (1977) has pointed out that the arrangement of skeletal hyphae in the trama of *P. pomaceus* is intermediate between parallel and interwoven and refers to this as subparallel. Similar species in the *Phellinus igniarius* complex are *P. igniarius*, which has interwoven tramal skeletals, and *P. laevigatus*, which has parallel tramal skeletals. Basidiospores on North American specimens are smaller than those on European specimens as stated by Niemalä (1977).

17. *PHELLINUS PRUNICOLA* (Murr.) Gilbn., comb. nov. (basionym - *Fomitoporia prunicola* Murr., North Amer. Flora 9:9. 1907.)
Poria prunicola (Murr.) Sacc. & Trott., Syll. Fung. 21:331. 1912.
Basidiocarps perennial, resupinate, woody, effused up to 22 cm, not readily separable; margin at first light yellowish brown, becoming blackened, glabrous and rimose with age; pore surface reddish brown (Snuff Brown to Saccardo's Umber), the pores circular, 6-8 per mm, with thick, entire dissepiments; context reddish brown, woody, azonate, up to 1 mm thick; the tube layers indistinctly stratified, becoming whitish within, each layer up to 2.5 mm thick.
Contextual hyphae mostly dark reddish-brown in KOH, thick- to thin-walled, with rare branching, aseptate, 2.5-4 in diam, some pale brownish to hyaline, thin-walled with frequent branching, simple-septate, 2-3 in diam; tramal hyphae similar, arrangement of skeletals semiparallel.
Setae abundant, mostly ventricose, 15-18 x 5-6.5.
Basidia clavate, 4-sterigmate, 11-12 x 5-6.
Basidiospores ovoid to subglobose, hyaline, smooth, negative in Melzer's reagent, 3.5-5 x 2.5-3.5.
Type of rot - Uniform white rot of dead wood of *Prunus*.
Cultural characteristics - See Baxter, 1934.
Distribution - MT.
Voucher specimen - RLG 653 (ARIZ).
Remarks - *P. laevigatus* is very similar but has slightly smaller spores and pores. Baxter (1934) believes the two are distinct in culture. Resupinate specimens of *P. robustus* differ in their larger, dextrinoid spores and lack of setae. *Phellinus igniarius* has considerably larger spores.

18. *PHELLINUS PUNCTATUS* (Fr.) Pilát, Atl. Champ. Europe 3:530. 1942.
Poria punctata (Fr.) Karst. Bidr. Finl. Natur. O. Folk. 37:83. 1882.
Polyporus punctatus Fr., Hymen. Eur. p. 572. 1874.
Basidiocarps perennial, resupinate, becoming widely effused, woody, not readily separable; margin at first yellowish brown, tomentose, up to 2 cm thick, receding, becoming black and rimose in older specimens; pore surface yellowish- to grayish brown, dull, smooth, the pores circular, 6-8 per mm, the dissepiments thick, entire, minutely tomentose;
Contextual hyphae dark brown in KOH, thin- to thick-walled, rarely branched, occasionally septate, 2.5-5 in diam, some almost hyaline, thinner walled; tramal hyphae similar.
Setae lacking; thin-walled, ventricose cystidioid elements present.
Basidia broadly clavate, 4-sterigmate, 11-12.5 x 7-8.5.

Basidiospores broadly ovoid to subglobose, hyaline, smooth, strongly dextrinoid in Melzer's reagent, 6.5-8.5 x 5.5-7.
Type of rot - Uniform white rot of dead wood of hardwoods and conifers.
Cultural characteristics - See Nobles (1948, 1958, 1965).
Substrata - *Abies, Alnus, Betula, Picea, Pseudotsuga, Salix, Tsuga.*
Distribution - AK, AT, BC, CA, CO, ID, OR.
Voucher Specimens - RLG 6677; RLG 6713 (ARIZ).
Remarks - Specimens on conifer substrata have been referred to *Poria tsugina* (Murr.) Sacc. et Trott. *Phellinus hartigii* is closely related and is differentiated by reflexed basidiocarps on living conifers.

19. *PHELLINUS REPANDUS* (Overh.) Gilbn., in Lombard, et al., Mycopath. et Mycol. Appl. 46:357. 1972.
Fomes repandus Overh., Mycologia 44:224. 1952.
Basidiocarps perennial, resupinate or rarely pileate; pileus up to 3 x 8 x 3 cm; upper surface reddish brown to blackish, tomentose near the margin, becoming glabrous and incrusted, sulcate, the margin bright yellowish or yellowish brown (Ochraceous Buff to Antimony Yellow), tomentose, up to 3 mm wide, rounded; pore surface light yellowish- or grayish brown (Drab) when fresh, becoming dark reddish brown (Cinnamon-Brown to Bister) with age, usually rough to the touch, the pores circular to angular, 4-5 per mm., with thin, lacerate dissepiments; context bright yellowish brown, azonate, very soft and spongy to corky, up to 4 mm thick; tube layers paler than the context, each up to 4 mm thick, sometimes separated by a thin layer of context tissue.
Contextual hyphae of three types, some brown in KOH, thick- to moderately thick-walled, with occasional branching, rarely simple-septate, 4-7 in diam; some hyaline in KOH, thin-walled, with occasional branching, simple-septate, 2-4 in diam; others thick-walled, much branched and contorted, pale brown in KOH, aseptate, 2.5-4.5 in diam; tramal hyphae similar.
Setae rare, scattered or often concentrated in a small area, subulate or ventricose, scarcely projecting, 20-25 x 6-7.
Basidia clavate, 4-sterigmate, 9.5-10 x 4.5-5.
Basidiospores short-ellipsoid to subglobose, hyaline, smooth, negative in Melzer's reagent, 4-5.5 x 3-4.5.
Type of rot - White pocket rot of conifer logs and slash (Lombard et al., 1972).
Cultural characteristics - See Lombard et al., (1972).
Substrata - *Abies, Larix, Picea, Pinus, Pseudotsuga, Thuja, Tsuga.*
Distribution - BC, ID, MT, OR, WA.
Voucher specimens - RLG 331; RLG 954 (ARIZ).
Remarks - *Phellinus repandus* is known only from western North America but is common in some localities such as Glacier Nat. Park, Montana and the Olympia Peninsula of Washington. J. R. Weir collected this fungus several times in Idaho and Montana and identified his specimens as *Fomes putearius* Weir. His type of *F. putearius*, however, is *Phellinus nigrolimitatus*. For a detailed comparison of similar species see Lombard et al. (1972).

20. *PHELLINUS RIBIS* (Schum. ex Fr.) Quél., Ench. Fung., p. 173. 1886.
Polyporus ribis Schum. ex Fr., Syst. Myc. 1:375. 1821.
Fomes ribis (Schum. ex Fr.) Gill., Champ. France 1:685. 1878.
Basidiocarps sessile or slightly effused-reflexed; pilei often imbricate, applanate, up to 10 x 20 x 4 cm; upper surface at first spongy, brownish (Tawny Olive to Snuff Brown), becoming blackish, glabrous,

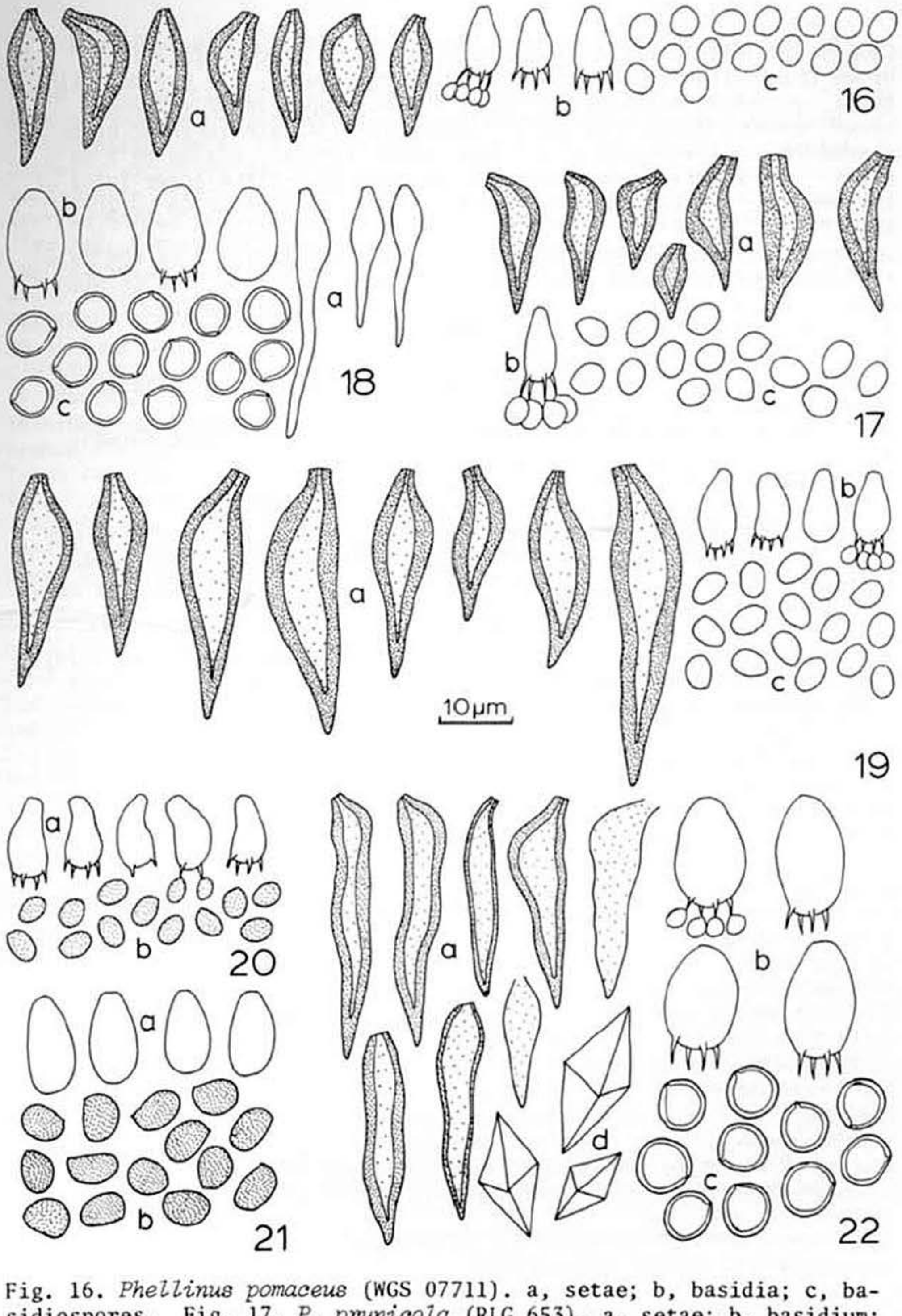


Fig. 16. *Phellinus pomaceus* (WGS 07711). a, setae; b, basidia; c, basidiospores. Fig. 17. *P. prunicola* (RLG 653). a, setae; b, basidium; c, basidiospores. Fig. 18. *P. punctatus* (RLG 6713). a, cystidioid elements; b, basidia; c, basidiospores. Fig. 19. *P. repandus* (FP 105594). a, setae; b, basidia; c, basidiospores. Fig. 20. *P. ribis* (FDJ 100). a, basidia; b, basidiospores. Fig. 21. *P. robineae* (RLG 7049). a, basidia; b, basidiospores. Fig. 22. *P. robustus* (RLG 10827). a, setae; b, basidia; c, basidiospores; d, hymenial crystals.

azonate, sulcate; margin concolorous, rounded; pore surface light brown (Snuff Brown), the pores circular to angular, 7-8 per mm, with thick, entire dissepiments; context duplex, upper layer yellowish brown, spongy, up to 2 cm thick, separated by a thin layer of black tissue from a lower pale brown layer which is corky and up to 2 mm thick; tube layers concolorous and continuous with the lower layer of the context, rather indistinctly stratified, each layer up to 2 mm thick.
Contextual hyphae of upper spongy layer of context brown in KOH solution, thin-walled, with rare branching, simple-septate, 3-6 in diam; hyphae of lower corky layer thick-walled, otherwise similar.
Setae or other sterile hymenial structures lacking.
Basidia clavate, 4-sterigmate, 9-11 x 4-5.
Basidiospores ellipsoid to ovoid, pale brownish, smooth, negative in Melzer's reagent, 3.5-4 x 2.5-3.
Type of rot - White rot of the heartwood at base of living shrubs.
Substrata - *Lonicera*, *Ribes*, and *Symphoricarpos*.
Distribution - AZ, CA, ID, MT, NM, OR, WA, and WY.
Voucher specimens - Weir 1676 (BPI) Weir 10198 (BPI).
Remarks - The duplex context with the layers separated by a thin but distinct layer of black tissue and the pale brownish spores characterize *P. ribis*. Ryvarden (1977) has placed this species in the genus *Phylloporia* Murr.

21. *PHELLINUS ROBINEAE* (Murr.) A. Ames, Ann. Mycol. 11(3):246. 1913.
Pyropolyporus robineae Murr., Bull. Torrey Bot. Club 30:114. 1903.
Fomes robineae (Murr.) Sacc. et D. Sacc., Syll. Fung. 17:117. 1905.
Basidiocarps perennial, sessile, applanate to ungulate, up to 30 cm wide; upper surface at first yellowish brown, finely tomentose, azonate, with age becoming black, deeply rimose, often appearing scaly, glabrous; margin at first yellowish brown, finely tomentose, in older specimens concolorous with the blackened, rimose upper surface, pore surface yellowish to reddish brown, the pores circular, 7-8 per mm, with thick, entire dissepiments; context tissue light reddish brown, azonate, woody, up to 2.5 cm thick; tube layers concolorous and continuous with the context, distinctly stratified, woody, each layer up to 3 mm thick.
Contextual hyphae brown in KOH solution, thin- to thick-walled, with rare branching, simple-septate, 2.5-5.5 in diam; tramal hyphae similar, 2.5-3.5 in diam.
Setae or other sterile hymenial structures lacking.
Basidia broadly clavate, 4-sterigmate, 10-12 x 5.5-6.
Basidiospores ovoid to subglobose, appearing flattened on one side, reddish-brown, smooth, negative in Melzer's reagent, 5-6 x 4.5-5.
Type of rot - White rot of heartwood of living black locust.
Cultural characteristics - See Campbell (1938) and Nobles (1948, 1958, 1965).
Substrata - *Robinia neomexicana*, *Robinia pseudoacacia*.
Distribution - AZ, CA, ID, NM.
Voucher specimens - RLG 7049; ERC 71-42 (ARIZ).
Remarks - *Phellinus robineae* is apparently present in the Southwest wherever *Robinia neomexicana* grows. Basidiocarps of *P. robineae* are similar to those of *Phellinus badius* but have smaller pores and tend to be more applanate than those of *P. badius*.

22. *PHELLINUS ROBUSTUS* (Karst.) Bourd. & Galz., Hym. France, p. 616. 1928.
Fomes robustus Karst., Finl. Basidsv., p. 467. 1889.
Basidiocarps perennial, sessile or effused-reflexed; pilei ungulate to applanate, up to 12 x 20 x 11 cm; upper surface brown to blackish, becoming incrusted and rimose, usually sulcate, glabrous; margin concolorous or yellowish brown at first, then faintly tomentose, rounded, fertile below; pore surface yellowish- or grayish brown, the pores circular, 7-9 per mm, with thick, entire dissepiments; context shining yellowish brown, zonate, hard, woody, up to 3 cm thick, core with white radial streaks present near point of attachment; tube layers distinct, light brownish, becoming whitish within, woody, each layer up to 3 mm thick.
Contextual hyphae of two types, some brown in KOH, thick-walled, rarely branched, rarely simple-septate, 2.5-4 in diam; others hyaline, thin-walled, simple-septate, 2-2.5 in diam., inconspicuous; tramal hyphae similar.
Setae lacking or occasional in some specimens, subulate to ventricose, thin- to thick-walled, 18-37 x 5-8.
Cystidia usually abundant in hymenium, hyaline, thin-walled, ventricose with narrow, tapered apex, 15-60 long and 5-7 in diam at the base, narrow apical part 1.5-2 in diam.
Basidia broadly ellipsoid, 4-sterigmate, 11-12 x 8-9.5.
Basidiospores subglobose, hyaline, smooth, thick-walled at maturity, dextrinoid in Melzer's reagent, 6-8.5 x 5.5-7.
Type of rot - White rot of heartwood of living hardwoods. On oaks in the Southwest the basidiocarps develop near the base of living trees and are associated with a butt and root rot.
Cultural characteristics - See Campbell (1938), Davidson et al. (1942) and Nobles (1948, 1958, 1965).
Substrata - *Prunus, Quercus.*
Distribution - AZ, CA, ID, NM.
Voucher specimens - RLG 10827; RLG 10782 (ARIZ).
Remarks - The distinctive ventricose cystidia with elongated slender apices are apparently characteristic of all the species in the *Phellinus robustus* complex. These rarely differentiate into setae but in most specimens setae are apparently absent. The concept of *P. robustus* presented here is based on pileate specimens on living oaks in the Southwest. *Phellinus punctatus* basidiocarps are resupinate and occur on dead hardwoods and conifers. *Phellinus hartigii* has reflexed basidiocarps on living conifers. *Phellinus sonorae* has resupinate to slightly effused basidiocarps at the base of *Dodonaea viscosa*.

23. *PHELLINUS SONORAE* Gilbn., sp. nov.

Fructificatio perennia, resupinata vel reflexa; pilei aureobrunnea, tomentosa; superficie porosum flavo-brunnea, pori rotundi vel angulatae, 5-7 per mm; contextus flavo-brunneus; hyphae 1.5-3 diam; cystidia abundanta, ventricosa; setae rara; basidia late-ellipsoidia, 10-11 x 7.5-8.5; basidiosporae subglobosae, hyalinae, dextrinoidae, 5-5.5 x 4.5-5. HOLOTYPUS: R. L. Gilbertson No. 10862, on *Dodonaea viscosa* Jacq., Sabino Canyon, Santa Catalina Mts., Coronado Nat. Forest, Pima County, Arizona; in herb. National Fungus Collections, Beltsville, MD, U.S.A. (BPI).
Basidiocarps perennial, resupinate to slightly reflexed; upper surface up to 8 mm wide golden brown, minutely tomentose, smooth; margin concolorous, rounded, sterile below; pore surface golden brown,

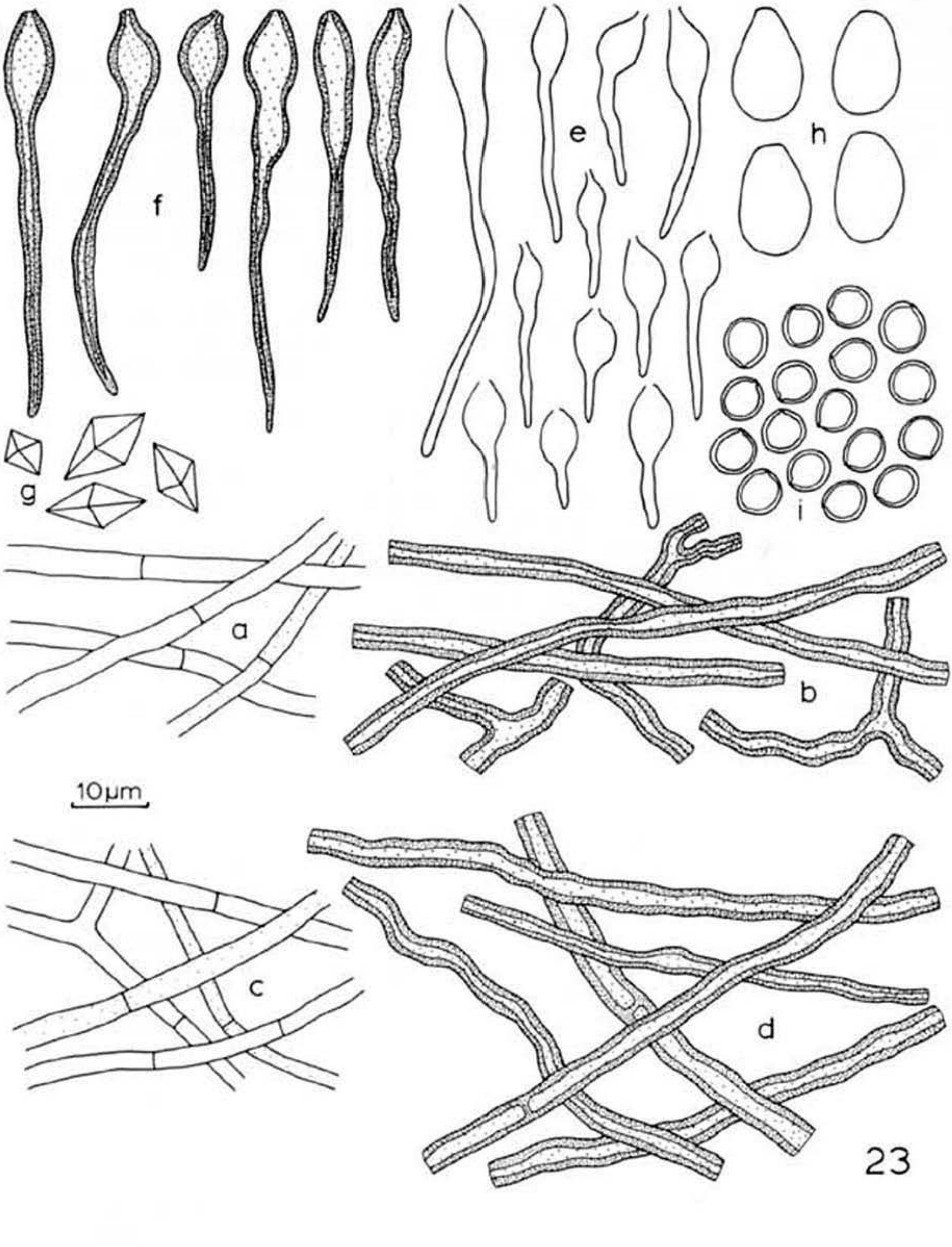


Fig. 23. *Phellinus sonorae* (RLG 10862). a, thin-walled tramal hyphae; b, thick-walled tramal hyphae; c, thin-walled contextual hyphae; d, thick-walled contextual hyphae; e, cystidioid elements; f, setae; g, crystals from hymenium; h, basidia; i, basidiospores.

smooth, glancing, the pores circular to angular, 5-7 per mm, with narrow, entire dissepiments; context bright golden brown, soft and fibrous near the margin, corky above the tube layers, azonate, up to 3 mm thick; tube layers indistinctly stratified, tubes becoming stuffed with lighter colored mycelium.

Contextual hyphae pale yellowish brown in Melzer's reagent, thin-walled to thick-walled, slender, aseptate, with rare branching, 2-7 in diam; others very inconspicuous, thin-walled, hyaline, simple-septate, 2-3 in diam; tramal hyphae closely interwoven, similar to those in context.

Setae few, developing from cystidia, ventricose with long slender apical portion, 35-55 x 5-8.

Cystidia abundant, ventricose with elongated apical portion, thin-walled, hyaline, 15-100 x 3.5-6, apical portion 1.5-3 in diam.

Basidia broadly ellipsoid, 4-sterigmate, 10-11 x 7.5-8.5.

Basidiospores subglobose, hyaline, thick-walled, smooth, dextrinoid in Melzer's reagent, 5-5.5 x 4.5-5.

Type of rot - Uniform white rot of heartwood and sapwood of hopbush (*Dodonaea viscosa*). Narrow black zone lines are conspicuous in the decayed sapwood.

Substrata - Known only on *Dodonaea viscosa* (hopbush).

Distribution - AZ. Known only from Santa Catalina Mtns., Pima County.

Voucher specimens - RLG 10862 (HOLOTYPE): RLG 10863 (ARIZ, BPI).

Remarks - *Phellinus sonorae* is a member of the *P. robustus* complex. It differs from the other species in its bright golden brown basidiocarps, smaller basidiospores, and long, narrow setae. The fact that it fruits at the base of dead or dying hopbush plants suggests it may be a root-rot pathogen.

24. *PHELLINUS TEXANUS* (Murr.) A. Ames, Ann. Mycol. 11:246. 1913.

Pyropolyporus texanus Murr., N. Amer. Fl. 9:104. 1908.

Basidiocarps perennial, sessile, ungulate, up to 15 cm wide; upper surface at first pale brown, matted-tomentose, becoming blackened and deeply rimose with age and weathering, sulcate; margin rounded, pale brown and tomentose; pore surface pale brown (Buckthorn Brown to Mummy Brown), smooth, the pores 4-6 per mm; dissepiments finely tomentose, entire; context hard and woody, yellowish brown, appearing mottled with streaks of paler tissue; tube layers stratified, Buckthorn Brown, becoming stuffed with light-colored mycelium; sections permanently darkening in KOH solution.

Contextual hyphae some thin-walled and hyaline to yellowish, with occasional septa and rare branching, 2-5 diam, others thick-walled, yellowish brown, aseptate, with rare branching, 3-5 diam; hyphae in the pale colored areas with a parallel arrangement, easily separated, hyphae in the darker areas densely interwoven, contorted, difficult to separate; tramal hyphae interwoven, pale yellowish, with slightly thickened walls and occasional septa, 2-4 diam.

Setae few, slightly thin- to thick-walled, with an inflated base to 10 diam and a slender apical portion, 25-60 long; setae apparently developing from hyaline, thin-walled cystidioid hyphal ends similar in shape and size to the setae and common in all sections.

Basidia broadly clavate to ovoid, 4-sterigmate, 17-25 x 8.5-12, the sterigmata slender, to 4 long.

Basidiospores subglobose, hyaline, strongly dextrinoid in Melzer's reagent and with distinctly thickened walls when mature, 7-9 x 6.5-9.

Type of rot - Uniform white rot of heartwood of living desert hard-

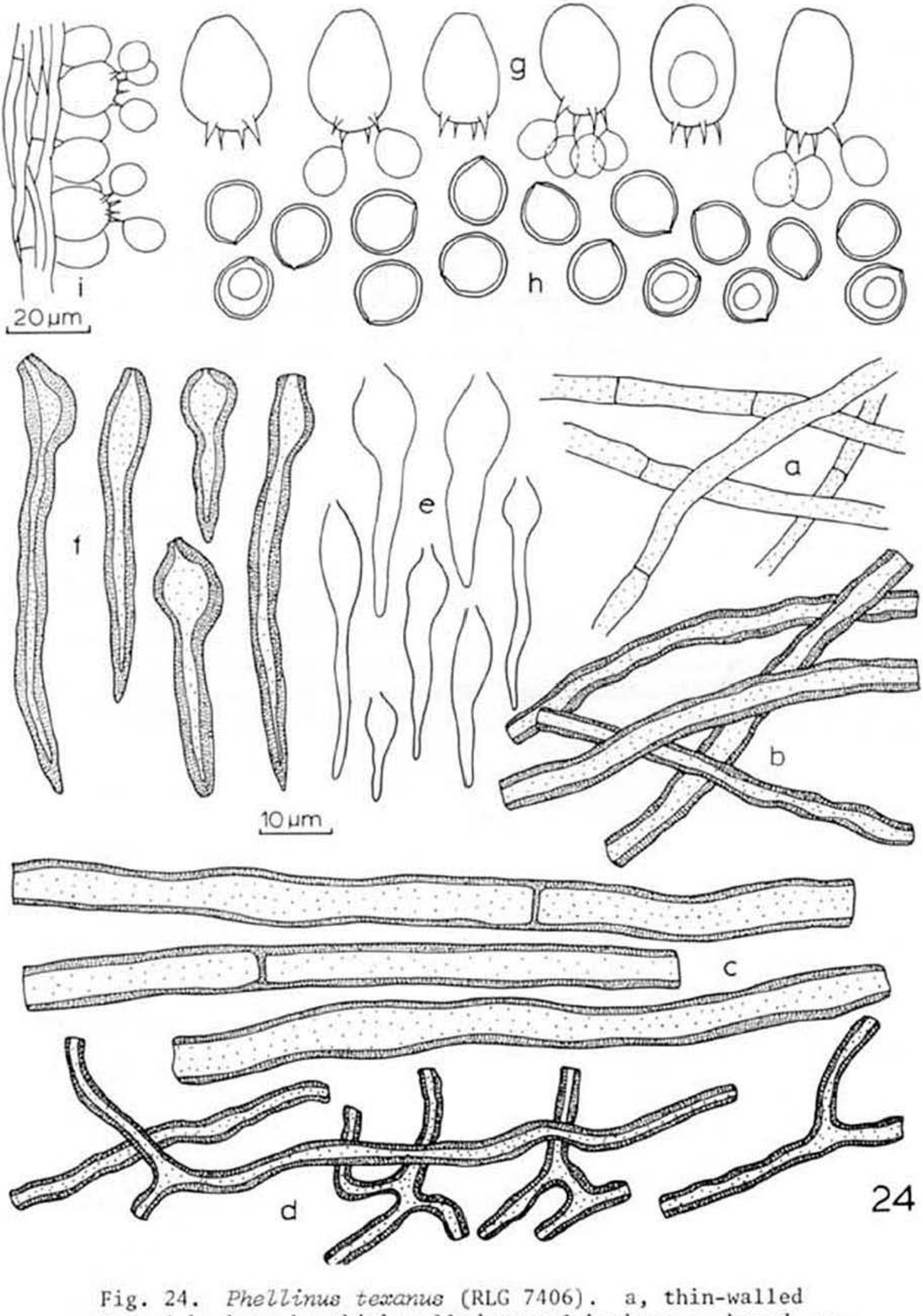
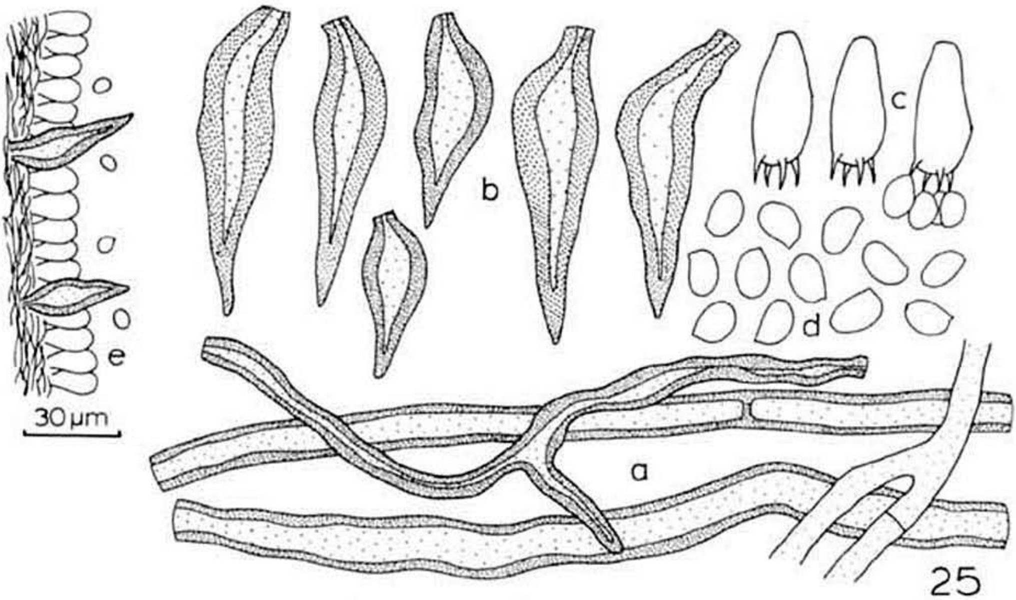


Fig. 24. *Phellinus texanus* (RLG 7406). a, thin-walled tramal hyphae; b, thick-walled tramal hyphae; c, broad, unbranched contextual hyphae; narrow, much-branched contextual hyphae; e, cystidioid hymenial elements; f, setae; g, basidia; h, basidiospores; i, schematic drawing of hymenium.

woods and junipers.
Substrata - *Canotia, Carnegiea, Celtis, Cercidium, Cercocarpus, Citrus, Cocculus, Cowania, Ephedra, Fouquieria, Juniperus, Larrea, Morus, Olneya, Opuntia, Prunus, Vauquelinia, Vitex.*
Distribution - AZ, NM.
Voucher specimens - RLG 6959; RLG 7775 (ARIZ).
Remarks - *Phellinus texanus* occurs on many Sonoran Desert trees and shrubs including cacti (Lindsey and Gilbertson, 1975; Gilbertson and Lindsey, 1975), and causes a white heartrot of living plants. Its basidiocarps are more typically ungulate than those of *P. robustus* and become more rimose with age. Setae are more frequent in *P. texanus* than in other members of the *P. robustus* complex and the basidiospores are larger.

25. *PHELLINUS TORULOSUS* (Pers.) Bourd. et Galz., Bull. Soc. Mycol. France 41:191. 1925.
Polyporus torulosus Pers., Mycol. Eur. 2:29. 1825.
Fomes torulosus (Pers.) Lloyd, Myc. Notes, Polyp. Issue No. 3:48.1910.
Basidiocarps perennial, pileate, sessile, triagular in vertical sections with the upper surface horizontal and the pore surface at approximately a 45 degree angle, applanate to thick, up to 46 cm wide, 28 cm deep, and 11 cm thick; margin obtuse, rounded, up to 2 cm thick, upper surface buff to pale brown (Cinnamon-Buff to Clay Color), glabrous to finely tomentose or slightly strigose-matted, on older portions becoming blackened, sulcate; pore surface yellowish brown (Buckthorn Brown), smooth, the pores 5-7 per mm, rounded, with thick, entire dissepiments; context yellowish brown, black in KOH solution, faintly zonate, hard and woody, up to 11 cm thick, with one or more thin, black layers that appear as fine black lines on cut or broken vertical surfaces; tube layers distinctly stratified, woody, slightly paler than context tissue.
Contextual hyphae 2.5-5 in diam, thin-walled and hyaline to moderately thick-walled and bright yellowish brown, infrequently branched, with rare septa, clamp connections absent; tramal hyphae similar;
Setae infrequent, ventricose to subulate, up to 49 long and 6-11 in diam, projecting 10-20.
Basidia clavate, 4-sterigmate, 5-6 in diam.
Basidiospores ovoid to ellipsoid, hyaline, smooth, negative in Melzer's reagent, 4-6 x 3-4.
Type of rot - White pocket rot of heartwood in roots and butt of living southwestern pine, rarely other associated conifers. The incipient stage is distinctive with bright red streaks in the normally pale heartwood.
Cultural characteristics - See Gilbertson and Burdsall, 1972.
Substrata - *Pinus ponderosa, P. strobiformis, Pseudotsuga menziesii.*
Distribution - Known in North America only from the Santa Catalina and Pinaleno Mountain Ranges in southern Arizona. In these areas it is locally common on southwestern white pine.
Voucher specimens - RLG 9385; RLG 9394 (ARIZ).
Remarks - Basidiocarps of *P. torulosus* develop at the ground line on the base of the trunk or on exposed roots. It has been confused with *Phellinus gilvus* in North America but has much different cultural characteristics, slightly larger spores, and infrequent setae (Gilbertson and Burdsall, 1972). Basidiocarps of *Phellinus nigrolimitatus* may be similar to those of *P. torulosus* and both have thin black layers in the context. However, *P. nigrolimitatus* basidiocarps typically



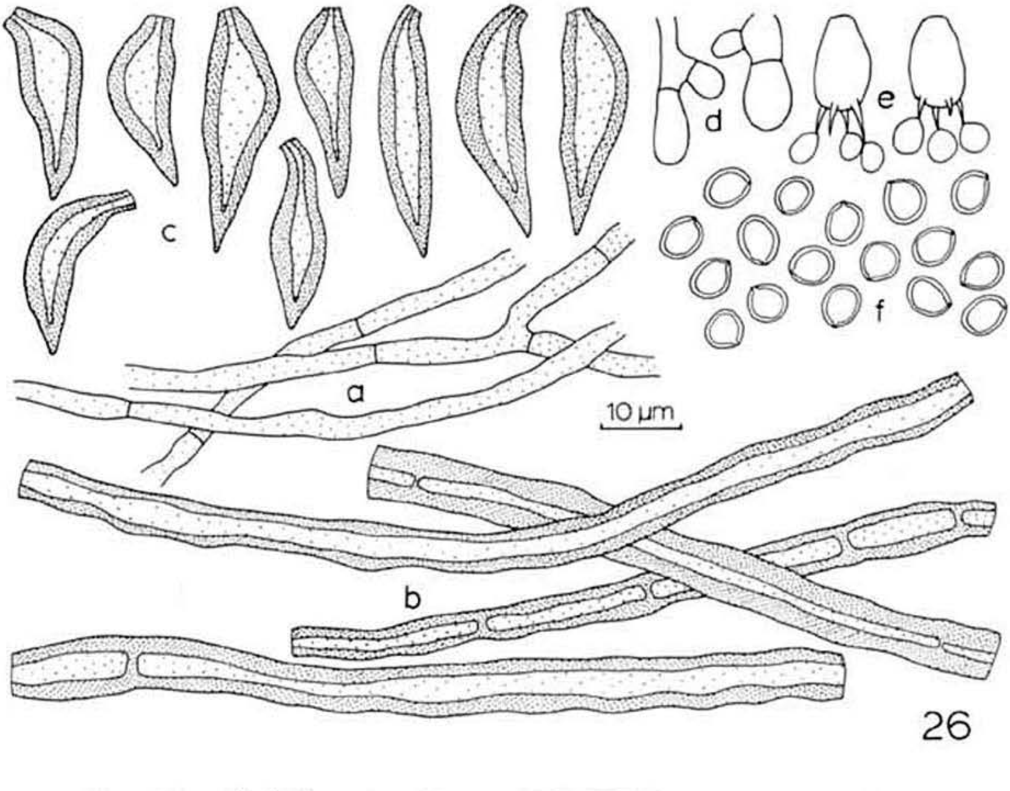


Fig. 25. *Phellinus torulosus* (HHB 1504). a, contextual hyphae; b, setae; c, basidia; d, basidiospores; e, schematic drawing of hymenium. Fig. 26. *P. tremulae* (ERC 71-92). a, thin-walled tramal hyphae; b, thick-walled tramal hyphae; c, setae; d, immature basidia; e, basidia; f, basidiospores.

develop on fallen trees and have cylindric spores and more abundant and larger setae.

26. *PHELLINUS TREMULAE* (Bond.) Bond. et Boriss., in Bond., Polyporaceae Eur., USSR and Caucasia. p. 358. 1953.
Fomes igniarius f. *tremulae* Bond., Fungi in the Bryansk Forest. p. 22. 1912.
Basidiocarps perennial, sessile, developing at branch scars, up to 20 cm wide and 15 cm thick, triangular in longitudinal section with the pore surface and upper surface at angles of about 45^o from the horizontal axis, woody, attached to the host by a granular core of tissue that is continuous into the decayed branch stub; upper surface pale brown (Wood Brown to Clay Color) near the margin, finely tomentose, soon becoming blackened, crust-like, and rimose; pore surface purplish brown (Natal Brown), the pores circular, 6-7 per mm, with thick, entire dissepiments; context dark reddish brown, woody, with a granular core at the place of attachment; tube layers indistinctly stratified, tubes becoming stuffed with white mycelium, each tube layer up to 2 mm thick.
Contextual hyphae simple-septate, thin-walled and pale yellowish to almost hyaline, 2-3 in diam, or thick-walled, dark reddish brown, 4-6 in diam; granular core composed of densely interwoven, branching hyphae with clusters of thick-walled, dark reddish brown, irregularly shaped and contorted cells; tramal hyphae with parallel arrangement.
Setae few to numerous, thick-walled, ventricose to subulate, 12-30 x 6-7, projecting to 15.
Basidia broadly ovoid, 4-sterigmate, 8-10 x 6-7, simple-septate at the base.
Basidiospores subglobose, hyaline, smooth, negative in Melzer's reagent, with thickened wall at maturity, 4.5-5 x 4-4.5.
Type of rot -White trunk rot of living trees and a major decay fungus throughout the range of aspen (Lindsey and Gilbertson, 1978). It is restricted to aspen. Wikstrom (1976) reported that *Phellinus tremulae* in *Populus tremula* spread in the inner sapwood and inner wood of living trees in the absence of other organisms, indicating that it is a primary parasite in aspen.
Cultural characteristics - See Nobles (1948, 1958, 1965, as *Fomes igniarius* var. *populinus*); Hopp (1936 as *Fomes igniarius*); Verrall (1937, as *Fomes igniarius*).
Substrata - *Populus tremuloides*.
Distribution - AK, AT, AZ, BC, CA, CO, ID, MT, NM, OR, UT, WA, WY, probably wherever aspen grows in western North America.
Voucher specimens - RLG 4877; JPL 212 (ARIZ).
Remarks - *Phellinus tremulae* has not been segregated from the *Phellinus igniarius* complex by some American authors (Overholts, 1953; Lowe 1957), and referred to by others as *Fomes igniarius* var. *populinus* (Campbell, 1938; Nobles, 1948, etc.). Niemalä (1974) gives a thorough account of the basidiocarp and cultural morphology of *P. tremulae*. Besides the macroscopic difference in basidiocarps, *P. tremulae* is microscopically different from other members of the *P. igniarius* complex included here because of the parallel arrangement of its tramal skeletal hyphae. Culturally it differs in the slow growth rate and sweet wintergreen odor.

27. *PHELLINUS VITICOLA* (Schw. apud Fr.) Donk, Persoonia 4:342. 1966.
Polyporus viticola Schw. apud Fr., Elenchus 1:115. 1828.

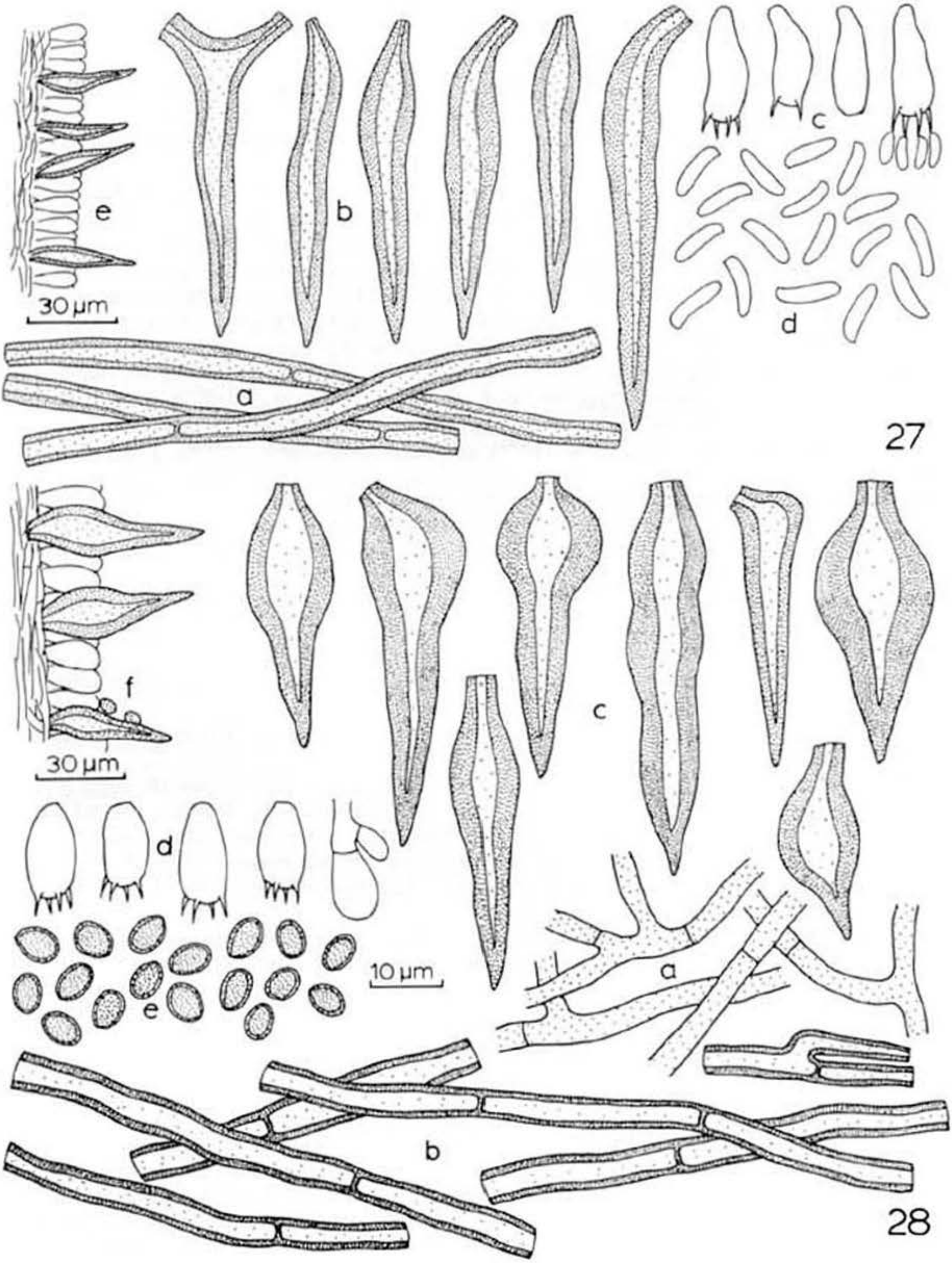


Fig. 27. *Phellinus viticola* (RLG 8026). a, tramal hyphae; b, setae; c, basidia, d, basidiospores; e, schematic drawing of hymenium. Fig. 28. *P. weirianus* (RLG 7776). a, thin-walled contextual hyphae; b, thick-walled contextual hyphae; c, setae; d, basidia; e, basidiospores; f, schematic drawing of hymenium.

Fomes viticola (Schw. apud Fr.) Lowe, State Univ. New York College of Forestry Tech. Publ. 80, p. 45. 1957.
Fomes tenuis Karst., Soc. Fauna Flora Fenn. Meddel. 14:81. 1887.
Trametes setosus Weir, Jour. Agr. Res. 2:164. 1914.
Basidiocarps perennial, usually effused-reflexed, often sessile or entirely resupinate, often developing by fusion of two or more; pilei generally dimidiate or narrow and shelflike, up to 1.5 x 6 x 1 cm; resupinate specimens often effused up to 30 cm; upper surface reddish brown to blackish, hirsute to almost glabrous, sulcate; margin usually lighter reddish brown, tomentose to hirsute, acute or rounded; pore surface yellowish brown (Brussels Brown), the pores circular to angular, 4-7 per mm, with thick, entire dissepiments; context yellowish brown, faintly zonate, corky-fibrous, up to 3 mm thick; tube layers concolorous and continuous with the context, up to 5 mm thick, the tubes usually whitish within.
Contextual hyphae of two types, some brown in KOH, thick-walled, rarely simple-septate, 2-3 in diam, others pale yellowish brown to hyaline in KOH, thin-walled, with occasional branching, simple-septate, 2-3 in diam; tramal hyphae similar.
Setae abundant, narrowly subulate, 25-75 x 5-8.
Basidia clavate, 4-sterigmate, 9-10 x 5-6, simple-septate at the base.
Basidiospores cylindric, straight or curved, hyaline, smooth, negative in Melzer's reagent, frequently biguttulate, 5.5-8 x 1.5-2.
Type of rot - Uniform white rot of dead wood of conifers and hardwoods.
Cultural characteristics - See Nobles (1948, 1958, 1965), Campbell (1938), Davidson et al. (1938) and Baxter (1937).
Substrata - Abies, Acer, Alnus, Larix, Picea, Pinus, Populus, Pseudotsuga, Quercus, Thuja, Tsuga.
Distribution - AK, AZ, BC, CA, CO, ID, NM, MT, OR, YT, WA, and WY.
Voucher specimens - RLG 6072; RLG 2058 (ARIZ).
Remarks - When entirely resupinate *P. viticola* may be distinguished from similar brown porias by its long narrow setae and narrow cylindric spores. Shope (1931) called this fungus *Trametes isabellina* Fr., and the resupinate form has been called *Poria isabellina* (Fr.) Overh.

28. *PHELLINUS WEIRIANUS* (Bres.) Gilbn., J. Ariz. Acad. Sci. 7:137.1972.
Fomes weirianus Bres., Studi Trentini 2:7(1):55. 1926.
Basidiocarps perennial, sessile, usually ungulate; upper surface becoming blackened and rimose, sulcate; margin golden brown (Antimony Yellow), finely tomentose, rounded, up to 1 cm wide; pore surface golden brown (Buckthorn Brown), smooth, the pores circular, 5-7 per mm, with thick, entire dissepiments; context yellowish brown, faintly zonate, hard, fissile, up to 4 cm thick; tube layers concolorous, not clearly distinct, up to cm thick.
Contextual hyphae pale to dark brown in KOH solution, thin- to thick-walled, frequently simple-septate, with rare branching, 3-5 in diam.
Setae frequent to scattered, subulate to ventricose, 20-52 x 7-14.
Basidia broadly clavate, 4-sterigmate, 10-12 x 6-7, simple-septate at the base.
Basidiospores subglobose to ovoid, pale yellow, smooth, negative in Melzer's reagent, 4-5 x 3-3.5.
Type of rot - White heartrot of living walnut.
Substrata - Juglans major.
Distribution - AZ, NM, MEXICO.
Voucher specimens - RLG 7353; RLG 6975 (ARIZ).
Remarks - *Phellinus weirianus* has a limited distribution but is common

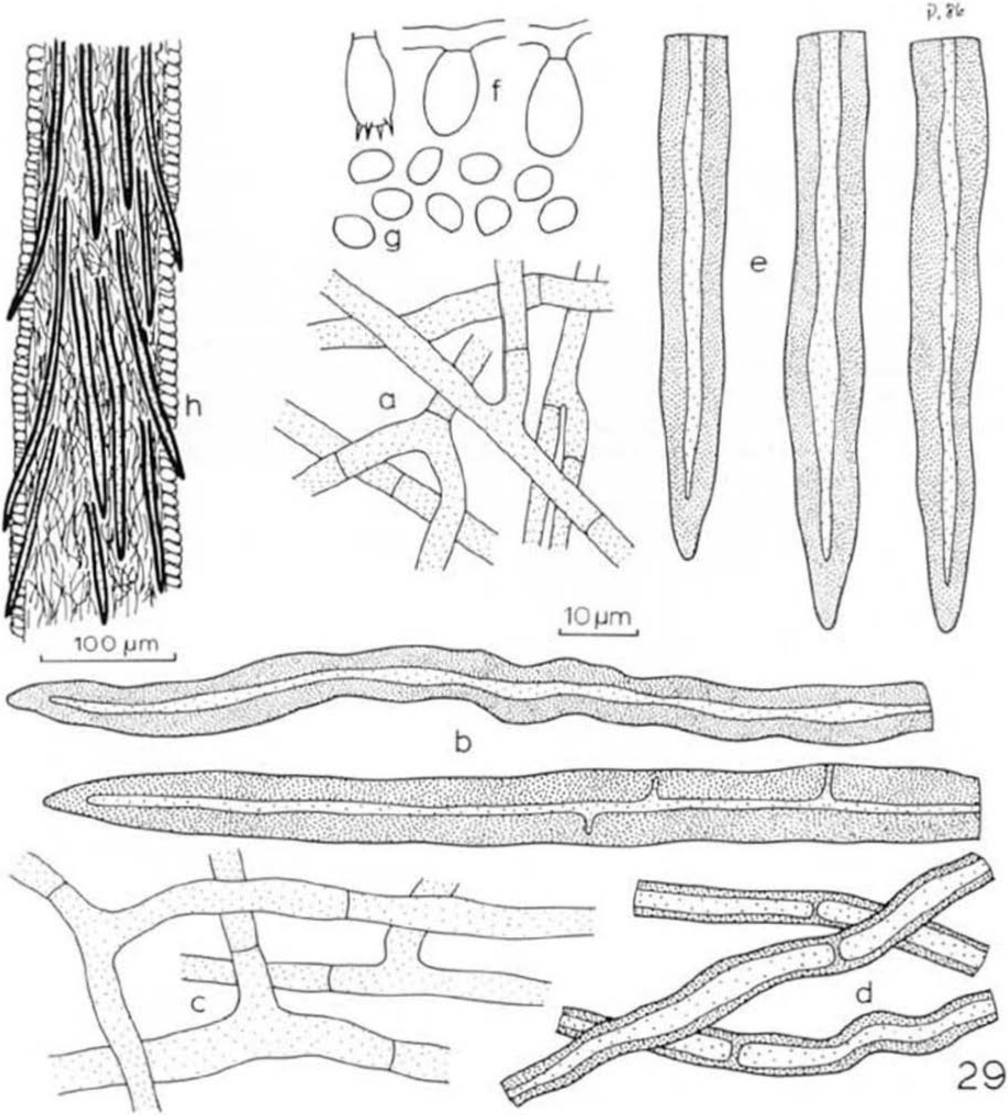


Fig. 29. *Phellinus weirii* (RLG 400). a, thin-walled tramal hyphae; b, setal hyphae; c, thin-walled contextual hyphae; d, thick-walled contextual hyphae; e, projecting tips of setal hyphae; f, basidia; g, basidiospores; h, schematic drawing of hymenium.

in southern Arizona wherever walnut grows. It is similar to *P. everhartii* which is restricted to oaks. Setae of *P. weirianus* are much larger than those of *P. everhartii*.

29. *PHELLINUS WEIRII* (Murr.) Gilbn., Fungi that decay ponderosa pine, p. 170. 1974.
Fomitiporia weirii Murr., Mycologia 6:93. 1914.
Poria weirii Murr, Mycologia 6:93. 1914.
Basidiocarps perennial or annual, becoming extensively effused, very light in weight, not readily separable; margin pale brown (Cinnamon or Sayal Brown), soft, fimbriate, up to 2 cm wide; pore surface slightly darker brown (Natal Brown or Verona Brown), the pores circular to angular, 5-7 per mm, with thick, setulose dissepiments that become thin and lacerate; context yellowish brown, soft, fibrous, spongy, azonate, up to 1 cm thick; tube layers light grayish brown, brittle, each layer up to 5 mm thick.
Contextual hyphae of three types, some pale yellowish-brown in KOH, thin-walled, with frequent branching, simple-septate, 2.5-5.5 in diam; some darker brown in KOH, thick-walled, 3-5.5 in diam; setal hyphae dark reddish brown, thick-walled, with rare branching, aseptate, traceable to a tapering, pointed tip, 6-10 in diam; tramal hyphae similar, setal hyphae projecting into tubes.
Setae abundant, formed by projecting setal hyphae pointing toward the tube opening, 6-10 thick, projecting up to 70.
Basidia clavate, 4-sterigmate, 10-11 x 5-5.5.
Basidiospores ovoid, hyaline, smooth, negative in Melzer's reagent, 5.5 x 4.5.
Type of rot - Yellowish laminated rot of the roots and butt of living conifers. Important as a heart rot of western redcedar and as a root rot of second growth Douglas fir and true firs. In the advanced stages of decay, brown mycelium becomes conspicuous between the layers of wood. Setal hyphae are abundant in this mycelium.
Cultural characteristics - See Baxter (1953), Davidson et al. (1938), and Nobles (1948, 1958, 1965).
Substrata - *Thuja, Pseudotsuga, Abies, Chamaecyparis, Larix, Picea, Pinus, and Tsuga.*
Distribution - AK, BC, ID, MT, OR, and WA.
Voucher specimens - RLG 400; ERC 75-18 (ARIZ).
Remarks - The light, soft context and marginal tissue, the hyaline, ovoid spores, and the conspicuous setal hyphae are important characters of *P. weirii*. *P. ferrugineofuscus* is similar but has narrow, cylindric spores and the tramal setal hyphae that project into the hymenium with the tips curved and perpendicular to the axis of the tube.

ACKNOWLEDGMENTS

This work was supported by McIntire Stennis funds through the University of Arizona Agricultural Experiment Station. Field work in the northern Rocky Mountains, western Canada, and Alaska was also supported by NSF Grants G24382 and GB 7120. Use of herbarium facilities and loan of specimens from the National Fungus Collections, Beltsville, MD (BPI); The New York Botanical Garden, New York, NY; and the Center for Forest Mycology Research, U.S. Forest Service, Forest Products Laboratory, Madison, WI (CFMR) is gratefully acknowledged. I have studied a number of *Phellinus* species in previous research with J. Page Lindsey, and she has contributed substantially to the preparation of figures and text material in this paper. It has been a particular privilege and pleasure to work with her on North American wood-rotting fungi. I also appreciate the association with several other colleagues with whom I have studied *Phellinus* species - particularly J. L. Lowe, H. H. Burdsall, Jr., Frances F. Lombard, E. R. Canfield, and R. W. Davidson.

LITERATURE CITED

Baxter, D. V. 1934. Some resupinate polypores from the region of the Great Lakes. V. Mich. Acad. Sci. Arts Lett., Papers 19:305-332.

________ 1937. (same title) VIII. *Ibid.* 22:275-295.

________ 1945. (same title) XVI. *Ibid.* 30:175-191.

________ 1952. (same title) XXIII. *Ibid.* 37:93-110.

________ 1953. (same title) XXIV. *Ibid.* 38:115-123.

Bondarzew, A. 1953. Pore fungi of the European part of the USSR and of the Caucasus. 1106 p. Leningrad.

Boyce, J. S. and J. W. B. Wagg. 1955. Conk rot of old-growth Douglas-fir in western Oregon. Oregon Forest Products Lab. Bull. 4. 96 p.

Campbell, W. A. 1938. The cultural characteristics of the species of *Fomes*. Torrey Bot. Club Bull. 65:31-69.

Canfield, E. R. and R. L. Gilbertson. 1978. A comparative study of three *Phellinus* species. Manuscript in preparation.

Davidson, R. W., W. A. Campbell, and D. J. Blaisdall. 1938. Differentiation of wood-decaying fungi by their reactions on gallic or tannic acid medium. J. Agric. Res. 57:683-695.

________, W. A. Campbell, and D. B. Vaughn. 1942. Fungi causing decay of living oaks in the eastern United States and their cultural identification. U.S. Dept. Agr. Tech. Bull. 785. 65 p.

Domanski, S., H. Orłos, and A. Skirgiełło. 1967. Basidiomycetes: Aphyllophorales: Polyporaceae pileatae, Ganodermataceae, Bondarzewiaceae, Boletopsidaceae, Fistulinaceae. In Flora Polska (Grzyby) 3, 398 p. 92 figs., 29 pls.

Donk, M. A. 1960. The generic names proposed for Polyporaceae. Persoonia 1(2):173-302.

________ 1964. A conspectus of the families of Aphyllophorales. Persoonia 3(2):199-324.

________ 1974. Check list of European polypores. Verhand. Kon. Nederl. Akad. Wetsch. afd. Nat. II, 62. 469 p.

Fritz, C. W. 1923. Cultural criteria for the distinction of wood-destroying fungi. Trans. Roy. Soc. Can. 17:191-288.

Gilbertson, R. L. and H. H. Burdsall, Jr. 1972. *Phellinus torulosus* in North America. Mycologia 64(6):1258-1269.

________ and J. P. Lindsey. 1975. Basidiomycetes that decay junipers in Arizona. Great Basin Nat. 35(3):288-304.

Hopp, H. 1936. Appearance of *Fomes igniarius* in culture. Phytopathology 26:915-917.

Jahn, H. 1967. Die resupinaten *Phellinus*-arten in Mitteleuropa. Westf. Pilzbr. 6:37-124.

________ 1976. *Phellinus hartigii* (All. & Schn.) Pat. und *Ph. robustus* (P. Karst.) Bourd. & G. *Ibid.* 11:1-15.

Kimmey, J. W. and J. A. Stevenson. 1957. A forest disease survey of Alaska. Plant Dis. Reptr. Supp. 247, p. 87-98.

Lindsey, J. P. and R. L. Gilbertson. 1975. Wood-inhabiting homobasidiomycetes on saguaro in Arizona. Mycotaxon 2:83-103.

________ 1978. Basidiomycetes that decay aspen in North America. Bibliotheca Mycologica, Band 63. J. Cramer. 406 p., 12 pl.

Lohwag, K. 1937. *Fomes hartigii* (Allesch.) Sacc. et Trav. und *Fomes robustus* Karst. Ann. Mycol. 35:339-349.

Lombard, F. F., R. W. Davidson, and R. L. Gilbertson. 1972. Studies of two species of *Phellinus* in western North America. Mycopath. et Mycol. Appl. 46:351-365.

Lowe, J. L. 1957. Polyporaceae of North America. The genus *Fomes*. State Univ. N.Y. Coll. Forestry Tech. Publ. 80. 183 p.

________ 1966. Polyporaceae of North America. The genus *Poria*. State Univ. N.Y. Coll. Forestry Tech. Publ. 90. 183 p.

Niemalä, T. 1972. On fennoscandian polypores. II. *Phellinus laevigatus* (Fr.) Bourd. & Galz. and *P. lundellii* Niemalä, n. sp. Ann. Bot. Fenn. 9:41-59.

________ 1974. On fennoscandian polypores. III. *Phellinus tremulae* (Bond.) Bond. et Boriss. *Ibid.* 11:202-215.

________ 1975. On fennoscandian polypores. IV. *Phellinus igniarius, P. nigricans and P. populicola*, n. sp. *Ibid.* 12:93-122.

________ 1977. On fennoscandian polypores. 5. *Phellinus pomaceus*. Karstenia 17:77-86.

Nobles, M. K. 1948. Studies in forest pathology. VI. Identification of cultures of wood-rotting fungi. Can. J. Res., C. 26:281-431.

________ 1958. Cultural characters as a guide to the taxonomy and phylogeny of the Polyporaceae. Can. J. Bot. 36:883-926.

________ 1965. Identification of cultures of wood-inhabiting Hymenomycetes. Can. J. Bot. 43:1097-1139.

Overholts, L. O. 1953. Polyporaceae of the United States, Alaska, and Canada. Univ. Michigan Press, Ann Arbor. 466 p.

Owens, C. E. 1936. Studies on the wood-rotting fungus, *Fomes pini*. I. Variations in morphology and growth habit. Amer. J. Bot. 23:144-149.

Ridgway, R. 1912. Color standards and color nomenclature. Washington, D.C. Published by the author.

Ryvarden, L. 1977. The Polyporaceae of North Europe. Vol. 2. *Inonotus-Tyromyces*. Fungiflora, Oslo. 507 p.

Shope, P. F. 1931. The Polyporaceae of Colorado. Missouri Bot. Gard. Ann. 18:287-456.

Verral, A. F. 1937. Variation in *Fomes igniarius* (L.) Gill. Univ. Minn. Agr. Exp. Sta. Tech. Bull. 117. 41 p.

Wikstrom, C. 1976. The occurrence of *Phellinus tremulae* (Bond.) Bond. et Boriss. as a primary parasite in *Populus tremula* L. Eur. J. For. Path. 6:321-328.

ADDENDUM

After this paper was completed and submitted, a pertinent publication by F. Kotlaba and Z. Pouzar (Notes on *Phellinus rimosus* complex [Hymenochaetaceae]. Acta Bot. Croat. 37:171-182. 1978) came to my attention. In this paper the authors report that the fungus included here as *Phellinus badius* is correctly named *Phellinus rimosus* (Berk.) Pilát. They propose to restrict the name *P. badius* to another species represented only by the type specimen.

MYCOTAXON

Vol. IX, No. 1, pp. 90-92 June 12, 1979

SYNAPTONEMAL COMPLEXES IN THE GAMETANGIA OF *SAPROMYCES ANDROGYNUS* (LEPTOMITALES, OOMYCETES)

DAVID GOTELLI

Department of Biological Sciences
California State College, Stanislaus
Turlock, California 95380

INTRODUCTION

Most major textbooks on mycology have assumed the Oömycetes to have a haploid vegetative state with meiosis occurring upon germination of the diploid zygote. Sansome (1961), working with *Pythium*, found evidence for meiosis in the gametangia and suggested the possibility that all Oömycetes might be diploid with only a brief haploid phase in the gametangia. Most recent investigations, especially electron microscopic studies, have supported this position (Dick and Win-Tin, 1973; Ellzey and Huizar, 1977).

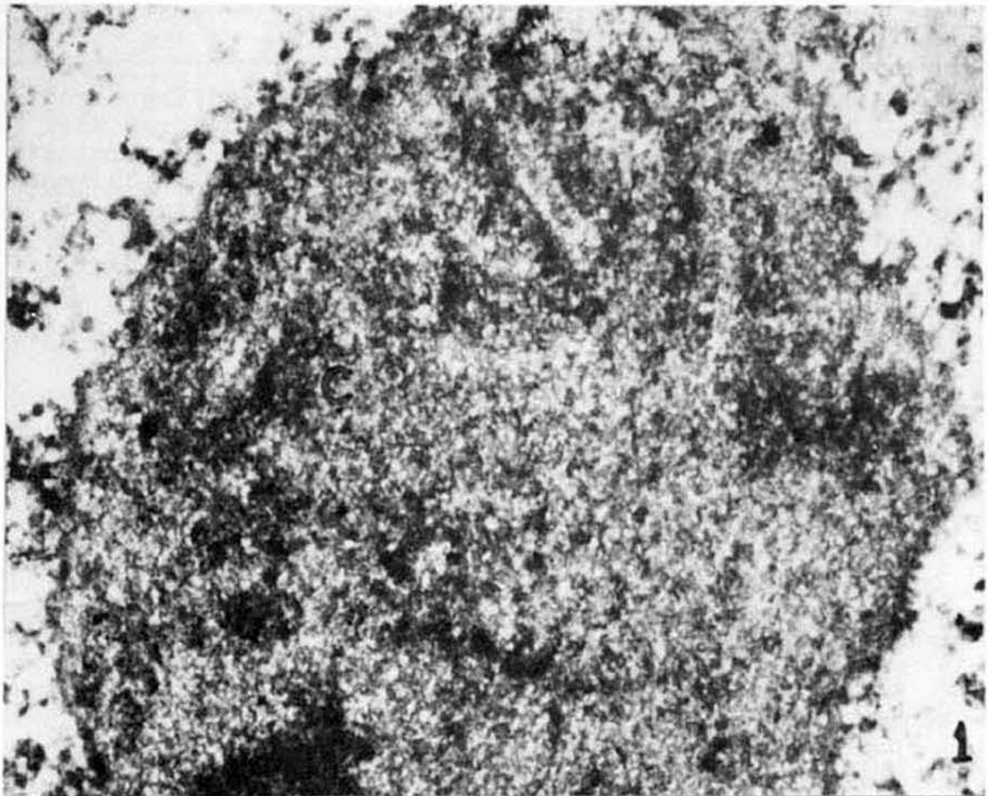
Ultrastructural evidence comes from the observation of synaptonemal complexes. These structures have been identified as being indicators of meiosis (Moses, 1964) and have been found in the gametangia of the Saprolegniales and Peronosporales (Ellzey and Huizar, 1977). This paper presents evidence of their presence in the third order, the Leptomitales, providing further support to the conclusions that the Oömycetes are diploid.

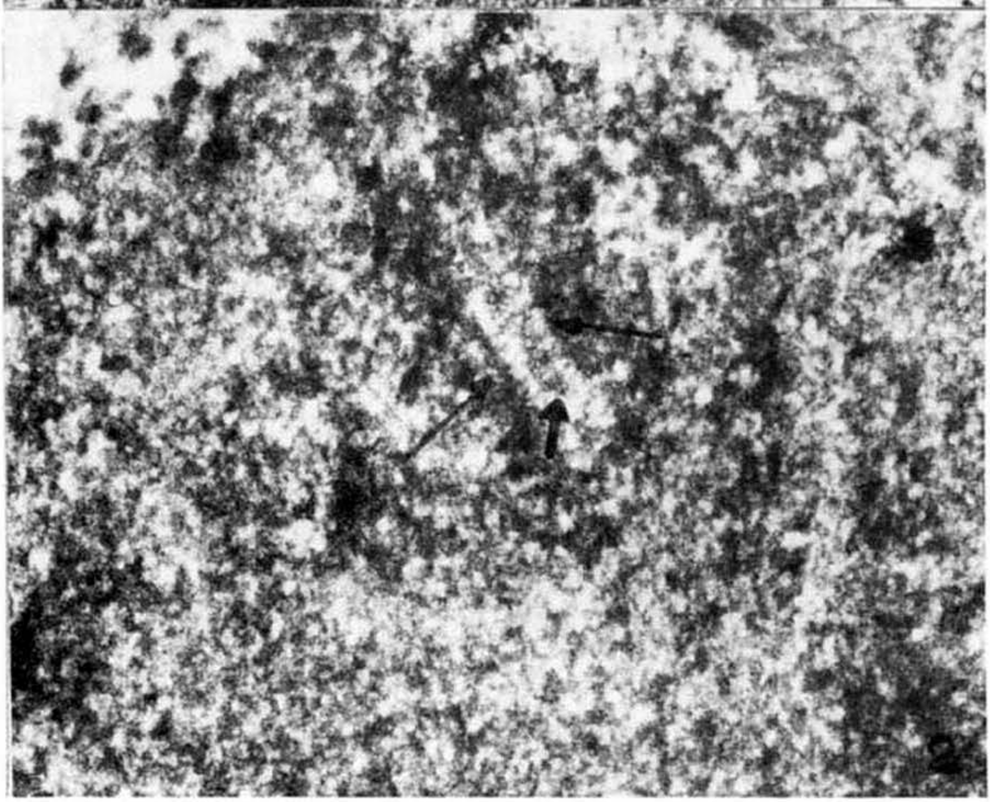
METHOD AND MATERIALS

A culture of *S. androgynus* was obtained from Ralph Emerson and the events of the life cycle were studied in detail with both light and electron microscopy (Gotelli, 1977).

Fig. 1. Nucleus in oögonium showing synaptonemal complexes and condensed chromatin (C). X 40,000.

Fig. 2. Synaptonemal complexes, one in longitudinal view showing lateral elements (long arrows) and central element (heavy arrow). X 84,000.





RESULTS

Synaptonemal complexes are found in developing oögonia (Fig. 1) of *S. androgynus*. Most of these structures are associated with condensed chromatin and appear to terminate at the nuclear membrane. Closer examination (Fig. 2) shows the classical structure of paired lateral elements and a central, slightly accentric element.

LITERATURE CITED

Dick, M. W., and Win-Tin. The development of cytological theory in the Oömycetes. Biol. Rev. 48:133-158. (1973).

Ellzey, J. T., and E. Huizar. Synaptonemal complexes in antheridia of *Achlya ambisexualis* E87. Arch. Microb. 112:311-313. (1977).

Gotelli, D. An ultrastructural study of *Sapromyces androgynus* (Thaxter). 2nd International Mycol. Congress (Abs.). (1977).

Moses, M. J. The nucleus and chromosomes: a cytological perspective. pp. 423-558. In: Cytology and cell physiology (G. H. Bourne, ed.) New York: Acad. Press, 1964.

Sansome, E. R. Meiosis in the oögonium and antheridium of *Pythium debaryanum* Hesse. Nature, Lond. 911:827-828. (1961).

MYCOTAXON

Vol. IX, No. 1, pp. 93-113 June 12, 1979

NEW AND INTERESTING TAXA OF *RUSSULA* PERS. EX S.F. GRAY OCCURRING IN WASHINGTON STATE

DARRYL W. GRUND

Department of Biology, Acadia University,
Wolfville, Nova Scotia

This paper considers three taxa of *Russula* collected in western Washington during the fall months of 1962. Two new species (*R. viridofusca*, *R. stuntzii*) and one variety (*R. rosacea* var *macropseudocystidiata*) are described as new. These three russulas are uncommon or rare in Washington State.

Species of *Russula* Pers. ex S.F. Gray occur abundantly in western Washington and are a conspicuous element of the agaric flora in the forests of the state. During the four years I examined the *Russula* flora for a Ph.D. thesis, under the supervision of D.E. Stuntz, I found a number of new and unusual taxa. The taxa included in this paper represent several of the more uncommon russulas examined during my studies.

In the descriptions, color terms are cited from three sources. Terms from Ridgway (1912) are enclosed in quotation marks, those from Kornerup and Wanscher (1962) are designated thus: 5B6, and those from the National Bureau of Standards (Kelly and Judd, 1955) are designated thus: ISCC 56. Other color terms, usually used to describe general coloration, are my own. Spore color was taken from mature spores in deposit, and color terms are those of Crawshay (1930).

Collection numbers designated ACAD refer to collections deposited in the E.C. Smith Herbarium, Acadia University. Microscopical data and camera lucida drawings, as well as the scanning electron photomicrographs were taken from the nomenclatoral type.

Scanning electron microscopes used in this study were the JEOL J.S.M. U3 located in the Electron Microprobe Analyzer Laboratory, Department of Materials and Metallurgical Engineering, University of Michigan, and the JEOL

J.S.M. 25 located in the Department of Biology, Acadia University. Secondary electron images were recorded on Polaroid Type 55 P/N 4 X 5 film. Coating was accomplished at the Electron Microprobe Analyzer Laboratory with a glow discharge coater at six minute pulse coating with 100% gold at 200-300 Angstrom units thick, and at the Acadia Electron Optics Laboratory with a Technics Hummer II coater at three-minute pulse coating with gold/palladium at 200-300 Angstrom units of thickness. Spores were mounted on adhesive copper tape (3-M) directly from the spore deposit. The tape was glued to a JEOL mounting stub with Duco cement (Dupont product).

Secondary electron images taken on the JEOL J.S.M. U3 were made with 15 KV accelerating voltage, and those taken on the JEOL J.S.M. 25 were made using 25 KV.

Russula viridofusca Grund, sp. nov.

Etym: viridi = green; fuscus = sombre brown L.

Pileus 5-11.5 cm latus, convexus, planoconvexus, deinde convexo-depressus, marginem tuberculatus striatus; viscidus diende siccus, glaber; olivaceus, viridiolivaceus, olivaceosubalinus versus olivaceo-citrinus; caro albida, mollis, mutabilis ad ferrugineus; odor suavis, gustus mitus. Lamellae adnexae, confertae, cremeae. Stipes 4.5-8.5 cm longus, 1.8-2.6 cm crassus, siccus, glaber, albus, mutabilis ad ferrugineus, basi subalbosus. Sporae (9)10-13 X 8-10 µm, in cumulo cremeae, globulosae vel ellipsoideae; ornamentatione amyloideae, 0.5-1.1 µm alta, echinatae. Subcutis pilei 100-140 µm crassi ex hyphis conjunctivis gelatinosis intertextis. Epicutis pilei 40-70(100) µm crassi, trichodermium, adpressum, implicatum formans. Pseudocystidia hymenii 66-112 X 11-14 µm, subclavatae ad subventricosa, ope sulfovanillinae atrantia.

Holotypus ACAD 12867, in sylvis coniferis prope Tahoma Creek, comitato Pierce, Washingtoni; holotypus in herbario Universitatis Acadiae (ACAD).

Figs 1, 4, 5

Basidiocarp: Pileus 5-11.5 cm broad, broadly convex when young, becoming plane and finally centrally depressed with margins broadly arched and rounded to uplifted; margins tuberculate-striate; pellicle separating from one-third to one-half the radius of cap; surface viscid, soon drying dull, glabrous overall; color variable, generally olive green or sepia to ochre colors, the center usually darker; 4F2 olive; "Dark Olive"; (ISCC 96) to 4C6 blond; "Dark Olive Green"; (ISCC 88) at center shading to 4C8 deep yellow 4E4 olive brown; "Dark Citrine"; (ISCC 95) or 4F4 sepia; "Dark Olive"; (ISCC 96) at margins; "Yellow Ochre"; (ISCC 84), context 7-15 mm thick off the disc, pallid to creamy in color, firm when young becoming soft at maturity, bruising rusty-brown, taste mild, odor not distinctive. Lamellae mostly equal, lamellulae infrequent; adnate; moderately close, rarely forking; color 4A3 pale yellow "Light Buff"; (ISCC 89). Stipe 4.5-8.5 cm long, 1.8-2.6 cm thick, flared at apex, then mostly equal or expanding at base; surface minutely longitudinally rugulose, dry, glabrous; color white, bruising bright rusty-brown when injured, staining brown when handled; context firm, solid, pallid, cream, unchanging when cut cleanly but bruising rusty-brown when injured.

Macrochemical Reactions: Pileal flesh; 40% formaldehyde - pale pink to pinkish-vinaceous, guaiac tincture - deep blue, 10% $FeSO_4$ - olive color or dull buff that darkens with time, guaiacol - rusty red, sulphovanillin - slightly lavender or negative reaction, sulphoformol - negative reaction, 10% pyrogallol - bright reddish brown, aniline water - bright red, a-naphthol - negative or sometimes lightly purple, phenol-aniline - brown becoming black, 2% phenol - deep reddish-brown. Hymenial pseudocystidia; sulphovanillin - contents of cell stained purple to purple-black.

Microscopic Structures: Spores cream ("B" Crawshay) in deposit; under optical microscope (9)10-13 X 8-10 µm, globose to subglobose, ornamentation echinate, consisting of acutely convex or conic warts and protruberances, 0.5-1.1 µm high, a few connectives and ridges between projections that do not appear to form a partial reticulum, suprahilar area usually a plage consisting of an amyloid patch of irregular surface and minute projections: under scanning electron microscope, protruberances, subcylindric, conic to low convex, laterally flattened, apices acute to rounded, ornamentation arising from a glabrous spore wall in some spores or a wall with a minute system of connectives between the bases of the projections; suprahilar area a slightly raised plage with a smooth, slightly irregular surface with an irregular lobed or slightly dentate margin. Basidia 36-52 X 11-15 µm, subcylindric, subclavate to clavate, thin-walled, 2 or usually 4-spored, hyaline to light brown in KOH, ochre in Melzer's Reagent. Hymenial pseudocystidia 66-112 X 11-14 µm subclavate, fusoid-clavate, fusoid-ventricose to subcylindric, apices acuminate to lanceolate; thin-walled; projecting 30-40 µm beyond basidioles, abundant. Subhymenium 40-50 µm thick, mostly pseudoparenchymatous. Cuticle composed of epicutal and subcutal layers; epicutis 40-70(100) µm thick, consisting of an appressed trichodermium, epicutal terminal cells sometimes pilocystidia 55-90 X 6-12 µm; subclavate to subfusoid-ventricose, apices acuminate, thin-walled, or usually short clavate cells 20-40 X 10-12 µm; subcutis consisting of a gelatinous interwoven hyphae, mostly 2-4 µm thick that form a layer 100-140 µm thick. Surface of

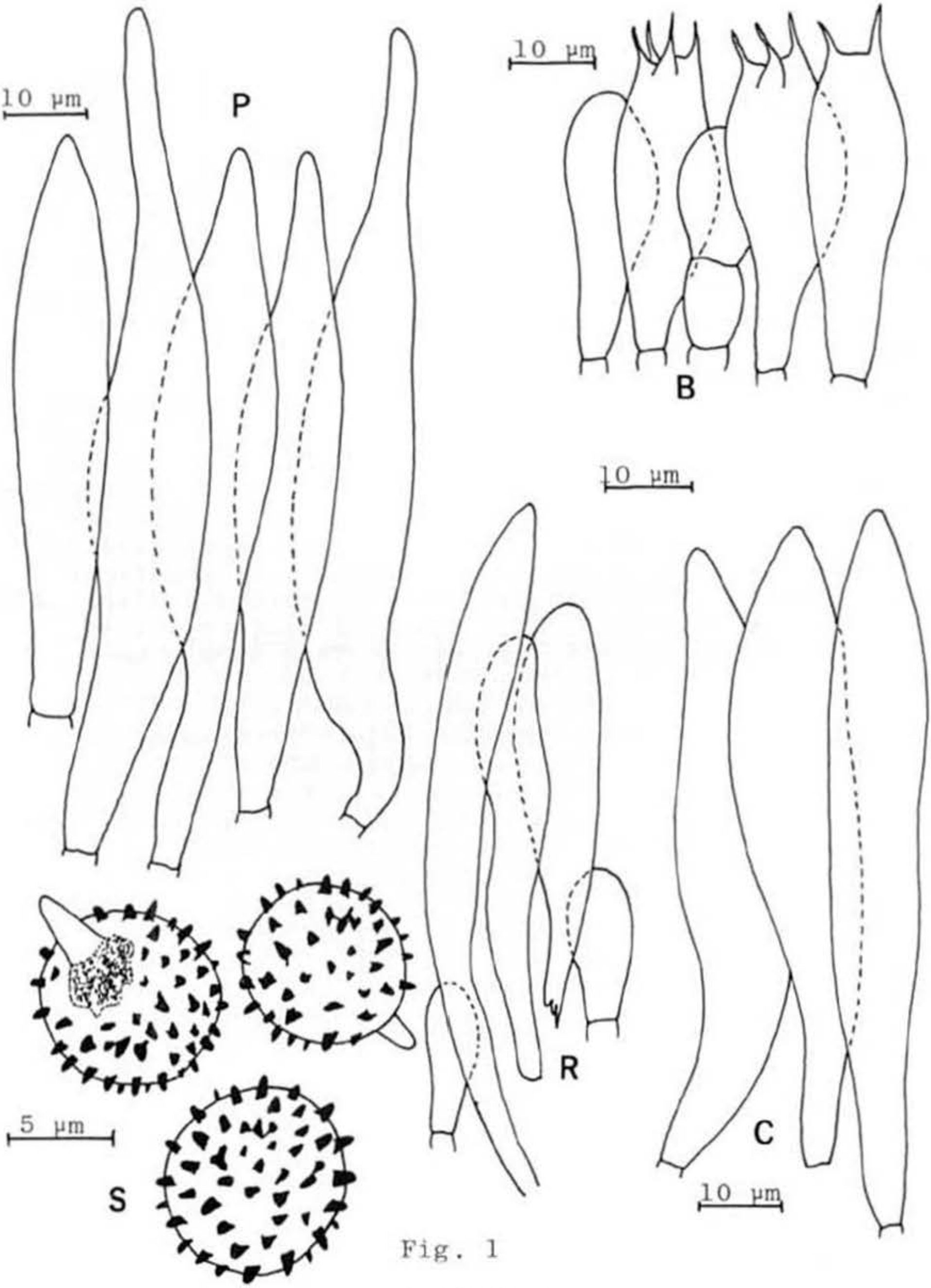


Fig. 1

R. viridofusca

Symbols for Figs. 1-3: P = pseudocystidia on sides of lamellae (pleurocystidia), C = pseudocystidia on edges of lamellae (cheilocystidia), R = epicutal pseudocystidia, B = basidia and basidioles, D = terminal cuticular hyphae of stipe (caulocystidia), S = spores.

stipe of interwoven hyphae, the terminal hyphae cylindric, hyaline, 3-5 µm thick, non-gelatinous, vascular elements not observed. Dermatocaulocystidia absent.

Habit and Habitat: Solitary, occurring in coniferous forests, especially under hemlock. *Tsuga heterophylla* (Raf.) Sarg.

Material Examined: ACAD 12867 (Holotype) Tahoma Creek, Mt. Rainier National Forest, Pierce Co.; October 21, 1962; Acad 12866, White River Valley, Washington; October 14, 1962.

Observations: *Russula viridofusca* Grund is a member of Section *Polychromae* R. Maire, Subsection *Viridantinae* Melzer-Zvara (sensu Romagnesi, 1967), and exhibits the group characteristics of echinate spore ornamentation, bruising reactions, and macrochemical reactions of $FeSO_4$ and aniline water with context. This species does not have the typical fishy-shrimpy odor of trimenthylamine so characteristic of *R. xerampelina* Sing. and its varieties. The macrochemical reaction of aniline water (aniline oil and distilled water 1:1 v/v) with context is deep red, which is distinctive as Subsection *Viridantinae* normally shows a reddish or reddish brown reaction. *R. viridofusca* is closely related to *R. cicatricata* Romagn. but differs from the later in spore size (7.7-8.5(9.2) X 6.5-7.7 µm for *R. cicatricata*), and the morphology of the cuticular terminal cells. Romagnesi (p 95, 1967) does not mention a deep-red macrochemical reaction with aniline water for *R. cicatricata*. *R. viridofusca* differs from *R. elaeodes* Bres. in that the latter has smaller spores, smaller pileus, and the typical fishy odor of the subsection. *R. furcata* (Lam. ex Fr.) Pers. ex Fr. superficially resembles *R. viridofusca* in the olive color of the pileus, but has much smaller spores (6.5-8.5 µm, Crawshay, plate 1, 1930), and differs in the sectional characteristics. *R. heterophylla* Fr. var *chlora* (Gill.) Kuhn & Romagn. is a green russula with the general appearance of *R. viridofusca* but differs in spore size and morphology, and sectional characters.

This is a rare russula in Washington and was collected twice during the three years I examined the russula flora.

Russula stuntzii Grund, sp. nov.

Pileus 3.5-8.3 cm latus, convexus, planoconvexus, diende depressus vel ascendens, marginem tuberculatus striatus; viscidus diende politus, glaber; albidus, pallidus; caro albida, firma, immutabilis; odor suavis; sapor valde acris. Lamellae adnexae, confertae, albida. Stipes 3.0-7.5 cm longus, 0.9-2.2 cm crassus, glaber, albidus, immutabilis. Sporae (7.5)8-9.5 X 7-7.5(8) µm, in cumulo albida, globosae, ornamentatione amyloideae, 0.8-1.5 µm alta, echinatae et reticulatae compositae non altae porcatae. Subcutis pilei 100-120(140) µm, ex hyphis conjunctivis gelatinosis intextis et hyphis vascularibus constans. Epicutis pilei 80-100(140) µm, e ixotrichodermium; pseudocystidia 80-140(160) X 5-8 µm, subclavatae. Pseudocystidia hymenii 36-108 X 7.5-12.5 µm, subclavatae ad subventricosa, ope sulfovanillinae atrantia.

Holotypus ACAD 12868, in sylvis coniferis prope Barlow Pass, Washingtoni; holotypus in herbario Universatis Acadiae (ACAD).

Figs 2, 6, 7, 8

Basidiocarp: Pileus 3.5-8.3 cm broad, at first broadly convex, then plane and finally depressed at center with broadly rounded or uplifted margins; margin tuberculate striate, pellicle separable at margins; surface viscid, glabrous, drying polished and shining; color pallid with a slight purplish component, more or less dingy or dull white in appearance. The center may be grayish-white overall with lighter patches (the pallid colors above not properly represented in the standard color references); context 0.3-1.0 cm thick off the disc, white, unchanging when cut or bruised, firm taste strongly acrid, odor not distinctive or absent. Lamellae adnate or slightly adnexed, moderately close, rarely forking, occasionally lamellulae interspersed; color cream to almost white. Stipe 3.0-7.5 cm long, 0.9-2.2 cm thick, mostly equal to slightly expanded at base and immediately at apex where lamellae attach; surface glabrous, longitudinally rugulose, moist; color white, not bruising but sometimes darkening slightly grayish upon handling; context white, unchanging when cut or bruised, rind firm, pith soft and not hollowing.

Macrochemical Reactions: Pileal flesh; 40% formaldehyde - negative; guaiac tincture - deep blue, 10% $FeSO_4$ - flesh color; guaiacol - dark red; sulphovanillin - purple; sulphoformol - purplish to brown, aniline water - negative to slightly yellowish; a-naphthol - deep violet; pyrogallol - rusty brown; phenol - aniline - deep reddish brown; 2% phenol - deep reddish brown. Hymenial pseudocystidia; sulphovanillin - contents of cell stained purple to purple-black.

Microscopic Structures: Spores white ("A" in Crawshay) in deposit: under optical microscope 8.0-9.5(10.0) X 7.0-7.5(8) µm, globose to subglobose or rarely short elliptic; ornamentation echinulate, consisting of conic protruberances 0.8-1.5 µm high, some connected by thin lines forming an incomplete reticulum, suprahilar area a plage that appears to be composed of amyloid granular material on a flat pane: hyaline in KOH, ornamentation strongly amyloid in Melzer's Reagent; under scanning electron microscope, ornamentation consisting of flattened or conic protruberances mostly 1-1.3(.5) µm high, connected by ridges 0.2-0.4 µm high and low connectives 0.1 µm high, that form nearly a complete reticulum, plage slightly raised above spore wall, irregular in outline, consisting of a system of shallow areolae to a submerulioid configuration, apical diverticule cylindric with rounded apex. Basidia 38-48 X 10-12 µm, subclavate to clavate, thin-walled, light brownish in KOH, mostly 4-spored. Hymenial pseudocystidia on the sides of lamellae 60-108 X 8.4-12 µm; mostly subcylindric to subclavate or sometimes subfusoid, apices rounded, mucronate to acuminate; projecting 25-40 µm beyond basidioles; slightly browning in KOH, contents highly granular; abundant. Subhymenium poorly defined when present, approximately 15-20 µm thick, consisting of subparallel hyphae 2-3 µm thick. Tramal mediostratum composed of mostly parallel hyphae with parenchymatous cells intermixed, lactiferous hyphae abundant. Cuticle composed of epicutal and subcutal layers; epicutis an ixotrichodermium, 80-100(140) µm thick, consisting of pileal pseudocystidia 80-140(160) X 5-12 µm that are mostly thin-walled subcylindric cells with rounded apices, and highly gelatinized interwoven connective hyphae and interspersed vascular or lactiferous hyphae; subcutis 100-140 µm thick, consisting mostly gelatinized hyphae 2-3(5) µm thick. Surface of stipe consisting of interwoven hyphae, caulopseudocystidia 35-80 X 5-15 µm, that are thin-walled, clavate, subcylindric to ventricose with granular contents, and vascular hyphae that are mostly 4-5 µm thick.

Habit and Habitat: Solitary, occurring in coniferous forests, typically under hemlock, *Tsuga heterophylla* (Raf.) Sarg. and Douglas fir, *Pseudotsuga menziesii* (Mirbel) Franco.

Material Examined: ACAD 12868 (Holotype), Barlow Pass, Washington, October 20, 1962; ACAD 10269, White River Valley, Pierce Co., Washington, October 14, 1962.

Observations: This new species is apparently a member of Section *Russula* Subsection *Emeticinae* Melzer and Zvara (sensu Singer, 1962). *R. albida* Pk. resembles *R. stuntzii*, but differs in its mild or slighter bitter taste, yellowish color at center of pileus, hollow stipe, and the cuticle separating halfway to center (Beardslee, 1918). *R. anomala* Pk. differs from *R. stuntzii* in spore morphology that is echinulate without connectives forming a reticulum (Singer, 1943), dry, buff pileal surface, and the macrochemical reactions of $FeSO_4$ and formaldehyde (Singer, 1947). *R. stuntzii* closely resembles *R. albidula* Pk. in color, taste, pileal surface, spore size and ornamentation except in spores of the latter which are maize yellow in

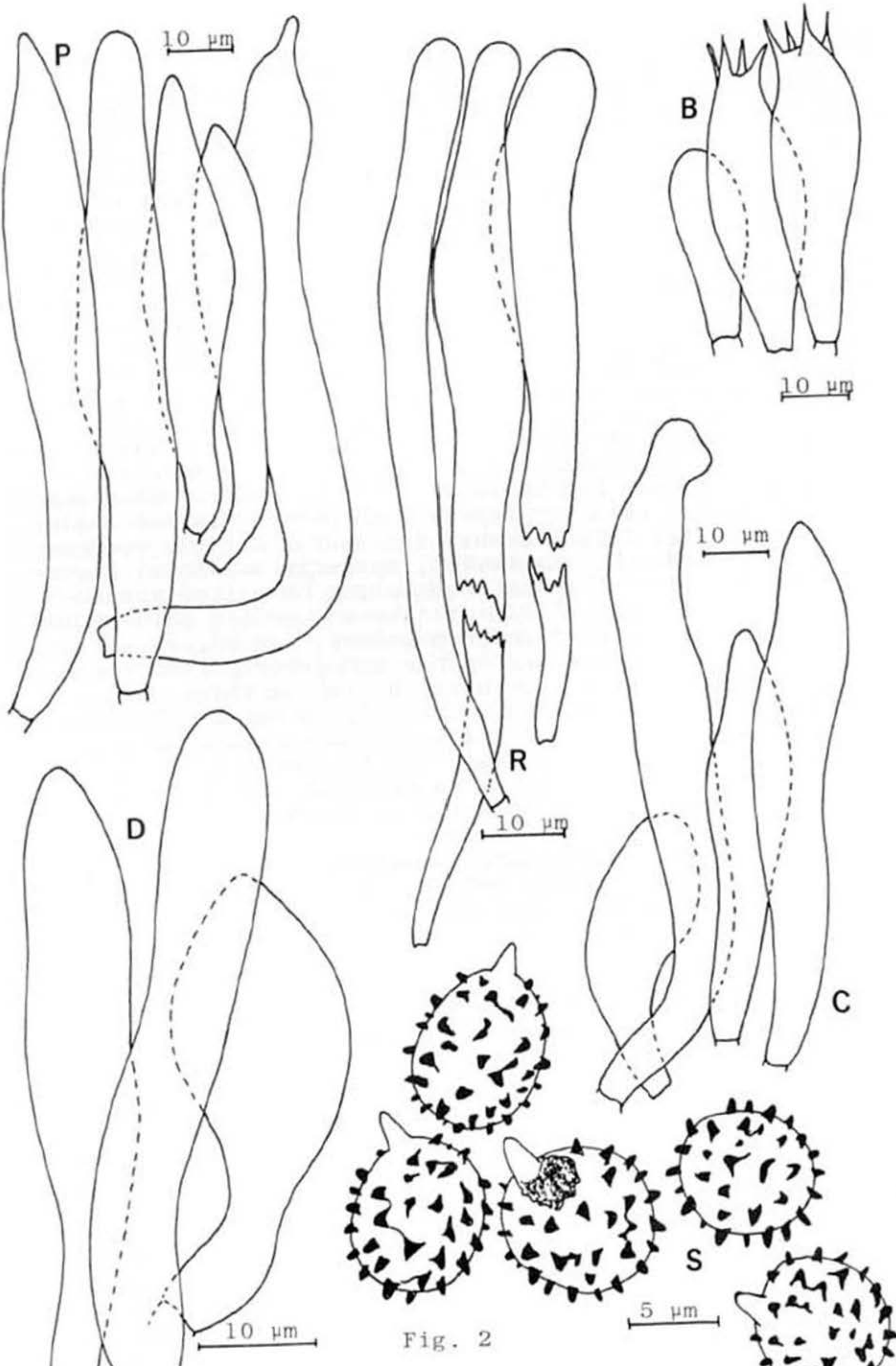


Fig. 2

R. stuntzii

deposit (Beardslee, 1918; Burlingham, 1915). Again, *R. albiduliformis* Murr. has the same basidiocarp characteristics and spore morphology as *R. stuntzii*, but differs from the latter in pale pinkish salmon spore color in deposit (near "B" of Crawshay, in Singer, 1947). *R. maculosa* Murr. usually has brownish or dark ochre colors on a cracked dry pileal surface (Singer, 1947). *R. albella* Pk. differs from this new species because of its dry pileal surface that is sometimes tinged with pink or rosy red, and its mild taste (Peck, 1897). *R. innocura* has deep colored spores (Singer, 1962) and mild taste (Singer, 1943). *R. crenulata* Burl. superficially resembles *R. stuntzii*, but differs in pileal color, spore morphology, and certain macrochemical reactions, especially a-naphthol, that shows a weak reaction.

R. pantoleuca Singer, a rare mushroom first collected on Mount Wachusetts, Mass., is phylogenetically the closest relative to *R. stuntzii*, both belonging to Subsection *Emeticinae*. *R. pantoleuca* differs in its pileal color that is apparently more yellowish white, mild taste of context, the pileal cuticle that is separable over most of the cap, odor of apples (weakly), and its occurrence under *Betula*, *Quercus*, and *Fagus* (Singer, 1958).

R. stuntzii is a beautiful and striking russula. It was collected only twice during the three years I examined the Washington flora, and I did not find any collections of it in the University of Washington herbarium. It is, like its relative *R. pantoleuca* Singer, a rare mushroom.

Russula rosacea (Pers.) Fr.

Nat. Arr. 1: 618, em. Fries, Epicrisis p. 351, 1838.

var. *macropseudocystidiata* var. nov.

Etym: macro = long, large, in Gk; pseudo = resembling but not equaling, in Gk.

Pileus 6.5 cm latus, convexodepressus, umbonatus, marginem tuberculatus striatus; viscidus diende politus, glaber; ruber; caro albida, immutabilis, odor suavis, sapor valde acris. Lamellae adnexae, confertae, cremeae. Stipes 5.0 cm longus, glaber, roseus, immutabilis. Sporae 7.5-9.5(12) X 6.5-8.5 µm, in cumulo cremeae, ornamentatione amyloideae, 0.5-0.8(1.0) µm alta, echinatae. Pseudocystidia hymenii 30-120 X 8.4-18 µm, subclavatae, ope sulfovanillinae atrantia.

Holotypus ACAD 12870, in sylvis coniferis prope Tohoma Creek, comitato Pierce, Washingtoni; holotypus in herbario Universitatis Acadiae (ACAD).

Figs 3, 9, 10

Basidiocarp: Pileus 6.5 cm broad, centrally depressed with small umbo, margins broadly rounded appearing sub-plane to nearly uplifted, tuberculate striate, pellicle separable only at edge of margin; surface viscid, drying shining and polished, glabrous; color generally straw-berry red at center, shading to currant red at the margins; 10D8 cardinal red; "Pompeian Red"; (ISCC 17) at center shading to 10C8 turkey red; "Nopal Red"; (ISCC 13) at margins; context 0.6 cm thick off the disc, white, firm, unchanging, taste strongly acrid, odor not distinctive. Lamellae adnate, rarely forking, moderately close, color cream, lamellulae infrequent. Stipe 5.0 cm long, 1.2 cm thick, expanding slightly towards base; surface glabrous, minutely longitudinally rugulose; color white at apex becoming strongly washed with red at base, appearing pinkish red to red in localized areas; context white, soft, unchanging, rind firm and rigid.

Macrochemical Reactions: Pileal flesh; 40% formaldehyde - negative; guaiac tincture - blue; 10% $FeSO_4$ - brownish; Guaiacol - vinaceous; sulphovanillin - deep purple; sul-phoformol - at first brown, then gray and finally black; pyrogallol - rusty brown; aniline water - reddish; a-naphthol - purple; phenol-aniline - vinaceous brown; 2% phenol - brown. Hymenial pseudocystidia; sulphovanillin - contents of cell stained strongly purple-black.

Microscopic Structures: Spores cream ("Cream, B" in Crawshay) in deposit; under optical microscope 7.5-9.5 (12) X 6.5-8.5(9) µm, mostly oblong to occasionally sub-globose; ornamentation echinulate, consisting of conic to round protruberances and sometimes isolated heavy ridges, mostly 0.5-0.8(1.0) µm high, amyloid; suprahilar area a plage that appears almost smooth and stained nearly solid purple by the amyloid reaction in Melzer's Reagent; hyaline in KOH: under scanning electron microscope, orna-mentation consisting of several types of protruberances, some flat and conic, some subcylindric to nearly truncate and flattened, some subcylindric with expanded and bulbous apices, and others forming irregular ridged projections that appear to be two or more protruberances that developed adnately and became fused together; most protruberances isolated and not connected by ridges or connectives, but some with definite connecting ridges forming a slight rudimentary reticulum in localized areas, ornamentation mostly 0.6-0.9(1.5) cm high; plage a flat, smooth, slightly raised platform, the edges of which are slightly inrolled, surface slightly irregular with low bosses, margin undulate to nearly entire, apical diverticule cylindric with round or truncate apices. Basidia 36-54 X 9.0-12 µm, subcylindric to subclavate, thin-walled, two or 4-spored, hyaline in KOH, brownish in Melzer's Reagent. Hymenial pseudocystidia on the sides of lamellae 60-120 X 12-18 µm, mostly subcylindric or subclavate, some almost fusoid, apices acutely rounded to subrostrate, arising from subhymenium, projecting 12-25 µm beyond basidioles; those on the edges of the lamellae 30-120 X 8.5-13.0 µm, variously shaped from cylindric to clavate, apices rounded, thin-walled; all pseudocystidia with intracellular contents grayish in KOH, those without hyaline, abundant. Subhymenium poorly differentiated, consisting of a narrow zone of mostly filamentous hyphae and some sphaerocysts approximately 8-12 µm thick; lamellar trama composed of sphaerocysts and connective hyphae, mostly 2-3 µm thick; vascular hyphae interspersed. Cuticle composed of epicutal and subcutal layers; epicutis consisting of a poorly differentiated layer of gelatinous hyphae not truely an ixotrichodermium, 100-140 µm thick, gelatinized appressed hyphae mostly 3-5 µm thick, hyaline in KOH: vascular hyphae interspersed and abundant, mostly 4-5(6) µm thick; no clamps observed; pileal pseudocystidia mostly imbedded in epicutal layer, 60-130 X 6-8 µm, mostly clavate or cylindric, apices rounded or rostrate, grayish in KOH, abundant. Subcutal layer 60-80(100) µm thick, yellowish-brown in KOH, composed of filamentous, thin-walled (3)4-5 µm thick, radially oriented; no clamps observed; entire layer not well differentiated from pileal context excepting brownish color when mounted in KOH. Surface of stipe consisting of interwoven hyphae and numerous caulopseudocystidia, mostly 40-60(80) X 6-8(10) µm, subcylindric to clavate, apices rounded, thin-walled, gray in KOH because of intracellular contents: vascular hyphae abundant, mostly 4-6 µm thick.

Habit and Habitat: Solitary, occurring in coniferous forests of mixed hemlock *Tsuga heterophylla* (Raf.) Sarg. and Douglas fir *Pseudotsuga menziesii* (Mirbel) France . This one collection was made at the upper campground on Tohoma Creek, Mount Rainier National Park, Pierce County.

Material Examined: ACAD 12870 (Holotype) Tahoma Creek, Pierce Co., Washington; October 20, 1962.

Observations: This new variety of *R. rosacea* is distinctive because of the polished and shining pileal surface when dry, and the longer hymenial pseudocystidia (53-88 X 9-15 µm for the typical variety). The typical variety may be slightly to moderately viscid when wet, but dries to a dull, glabrous surface. Singer's (p. 245, 1958) description indicates the epicutal layer of the pileus to be composed of filamentous, non-gelatinous hyphae, but does mention a "scanty gelatinous mass" in the cutis-like hypoderm. This would account for the viscidity when wet. This new variety has a reasonably thick, highly gelatinized epicutal layer and would appear to differ considerably from the typical form. Singer (loc. cit) examined numerous collections from Europe, Philippine Islands, Asia, and North America when he thoroughly described *R. rosacea* and certainly well understood the species and any variations. However, it is interesting to note that Massee (p. 36, 1902) described *R. sanguinea* Fr. (now *R.*

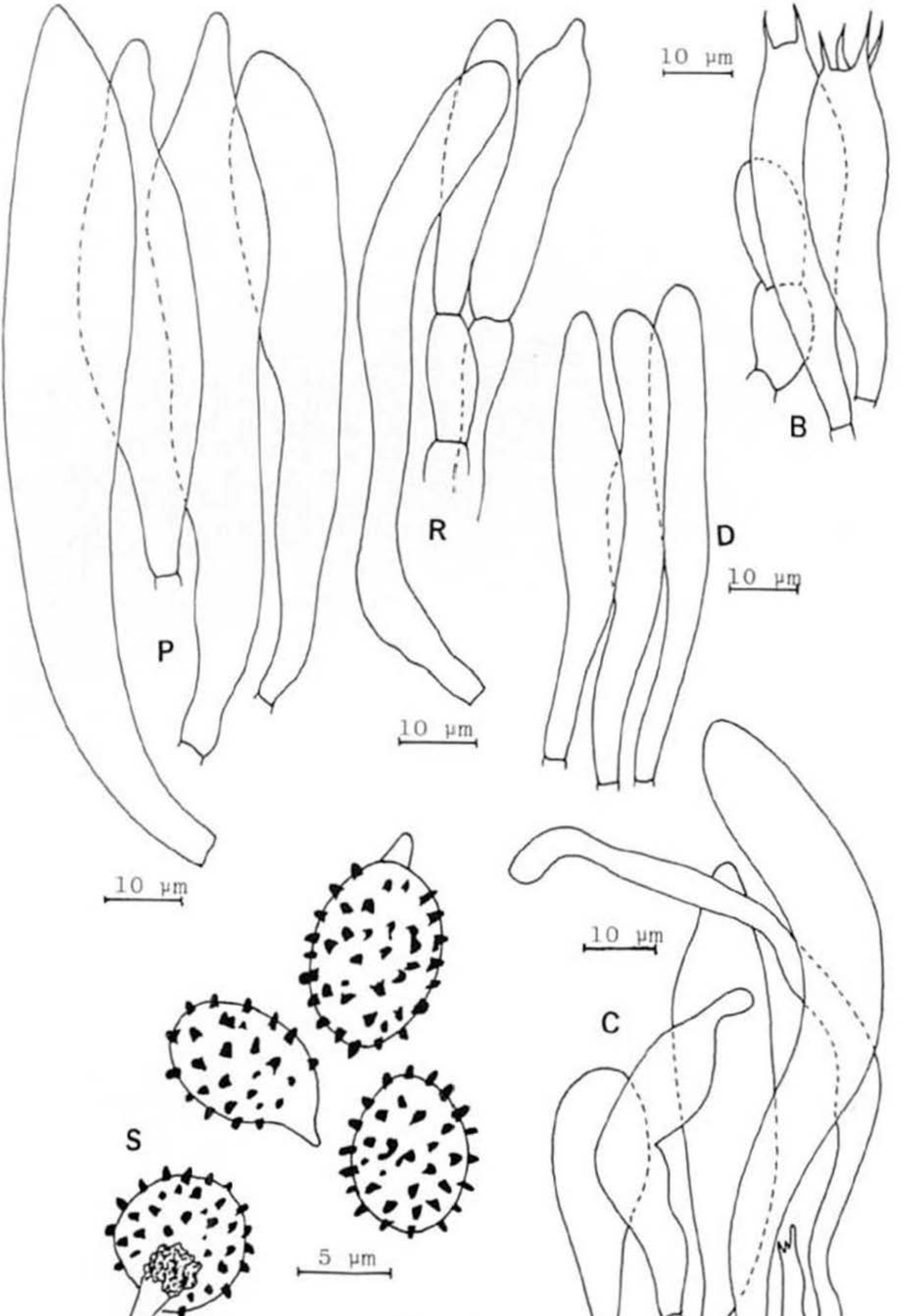


Fig. 3

R. rosacea var. *macropseudocystidiata* *rosacea*) as having a "polished" pileus.

I am hesitant to describe new taxa based on a single collection; however, several excellent examples exist where such descriptions have been most useful. One of these is *Boletus huronensis* Smith and Thiers. This taxon is rare in Michigan and was first described (Smith, p. 306, 1971) from one collection. Not until Smith's description, could we identify a common and locally abundant bolete occurring in Nova Scotia, which was *Boletus huronensis*.

ACKNOWLEDGMENT

I wish to thank Dr. Robert L. Shaffer, Professor of Botany and Curator of the Herbarium, University of Michigan, and Dr. K.A. Harrison, Research Associate, Acadia University for their review of this paper, and Dr. Harrison for his assistance in obtaining scanning electron photomicrographs. This investigation was supported by research grants (A-2826) and (E-3951) from the National Research Council of Canada, Ottawa.

LITERATURE CITED

Beardslee, C. H. 1918. The Russulas of North Carolina. J. Elisha Mitchell Sci. Soc. 33: 147-197.

Burlingham, G. S. 1915. *Russula* Pers. N. Amer. Fl. 9: 201-236.

Crawshay, R. 1930. The Spore Ornamentation of the Russulas. Baillière, Tindall and Cox. London. 174 pp.

Kelley, K. L. and D. B. Judd. 1955. The ISCC-NBS method of designating colors and a dictionary of color names. National Bureau of Standards Circ. 553. Washington, D.C. 158 pp.

Kornerup, A., and J. H. Wanscher. 1962. Reinhold Color Atlas. Reinhold Publ. Co. N.Y. 224 pp.

Massee, G. 1902. European Fungus Flora: Agaricaceae. Duckworth and Co. London. 274 pp.

Peck, C. H. 1897. Report of the State Botanist. From the 50th report N.Y. State Mus. 50: 77-159.

Ridgway, R. 1912. Color standards and color nomenclature. Publ. privately, Washington, D.C. 43 pp. and 53 pls.

Romagnesi, H. 1967. Les Russules d'Europe et d'Afrique du Nord. Bordas. Paris. 998 pp.

Singer, R. 1943. Type studies on Basidiomycetes II. Mycologia 35: 142-163.

——— 1947. Type studies on Basidiomycetes III. Mycologia 39: 171-189.

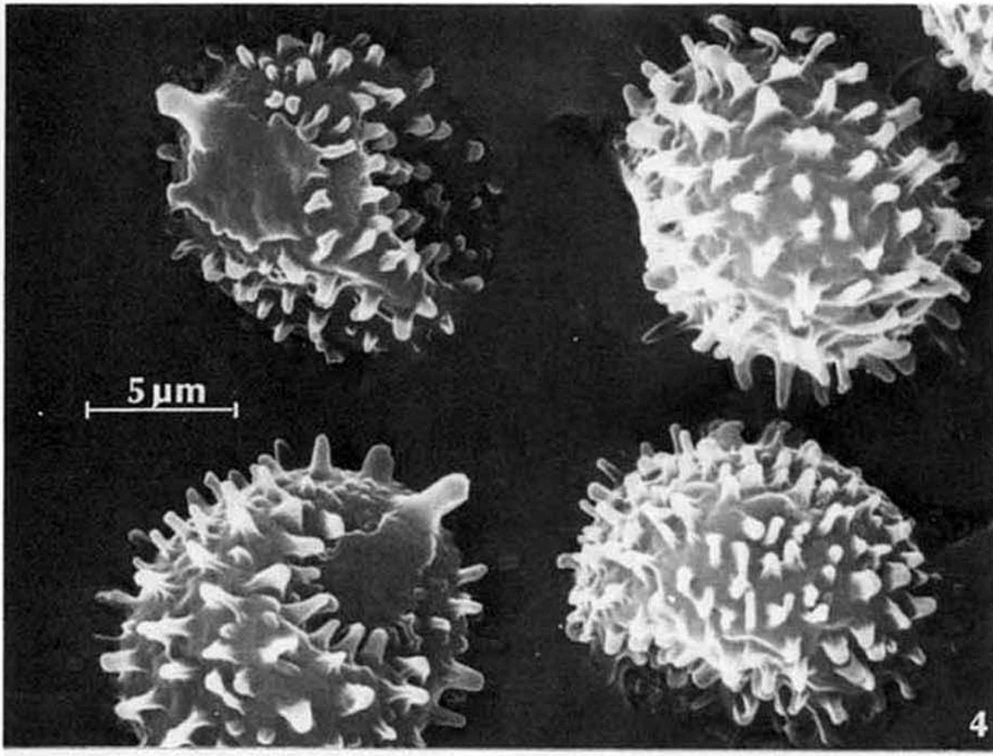
——— 1958. New and interesting species of Basidiomycetes V. Sydowia 11: 141-272.

——— 1962. The Agaricales in Modern Taxonomy. J. Cramer. Weinheim. 915 pp., 73 pls.

Smith, A. H. and H. D. Thiers. 1971. The Boletes of Michigan. Univ. of Mich. Press. Ann Arbor. 428 pp., 157 pls.

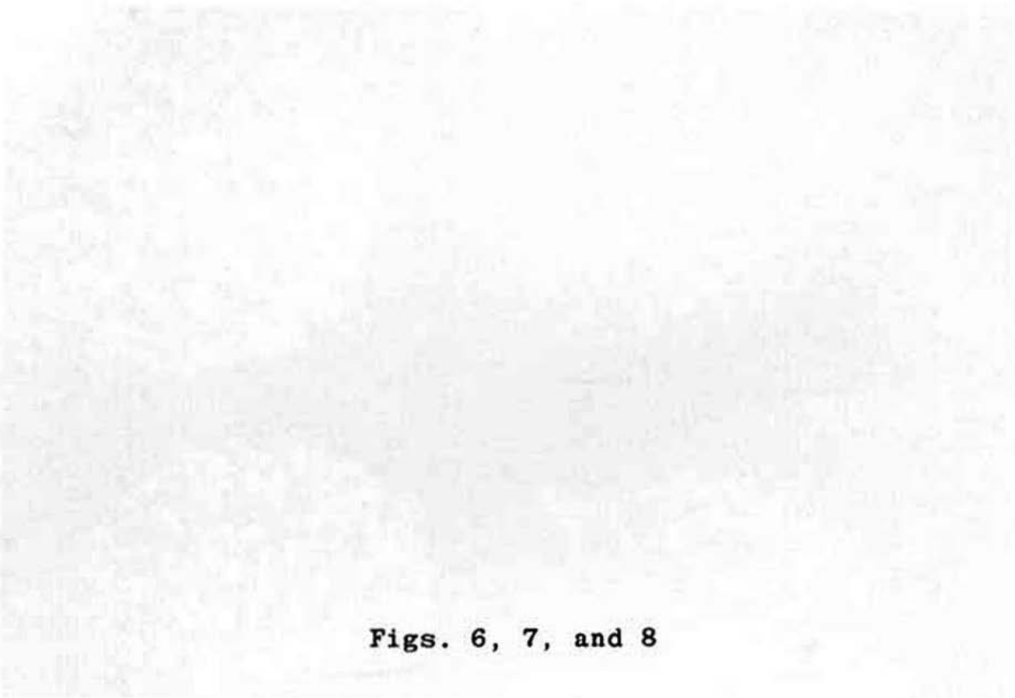
Figs. 4 and 5

R. viridofusca

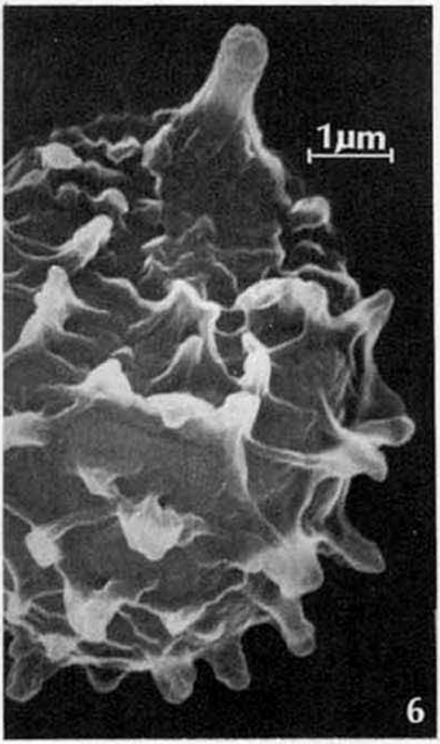


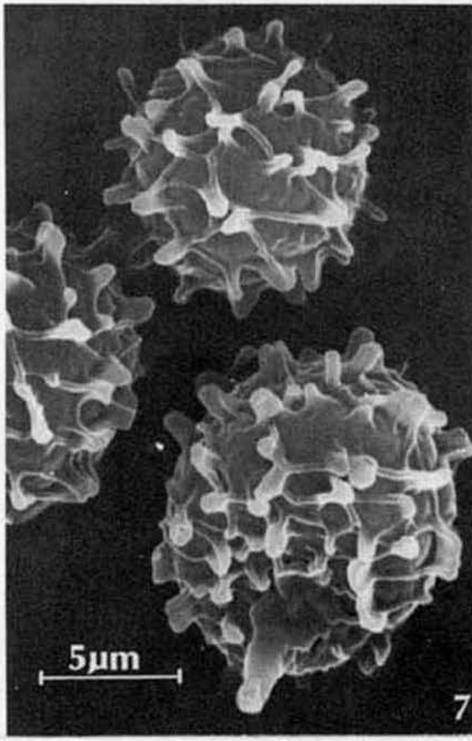
4

5

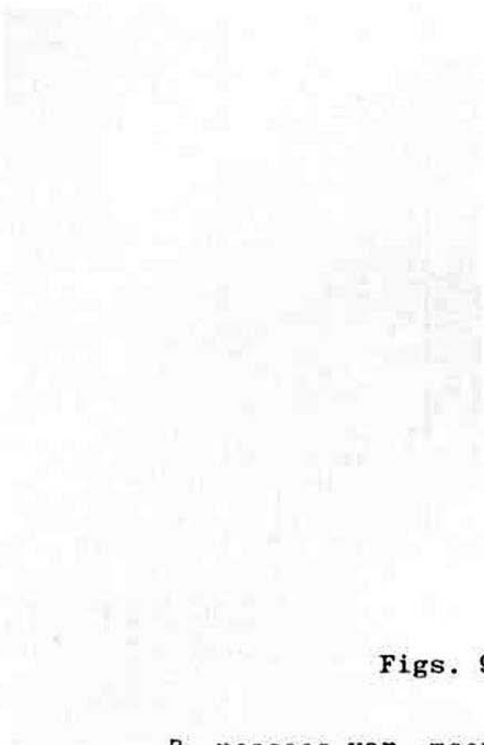


Figs. 6, 7, and 8


1µm
6

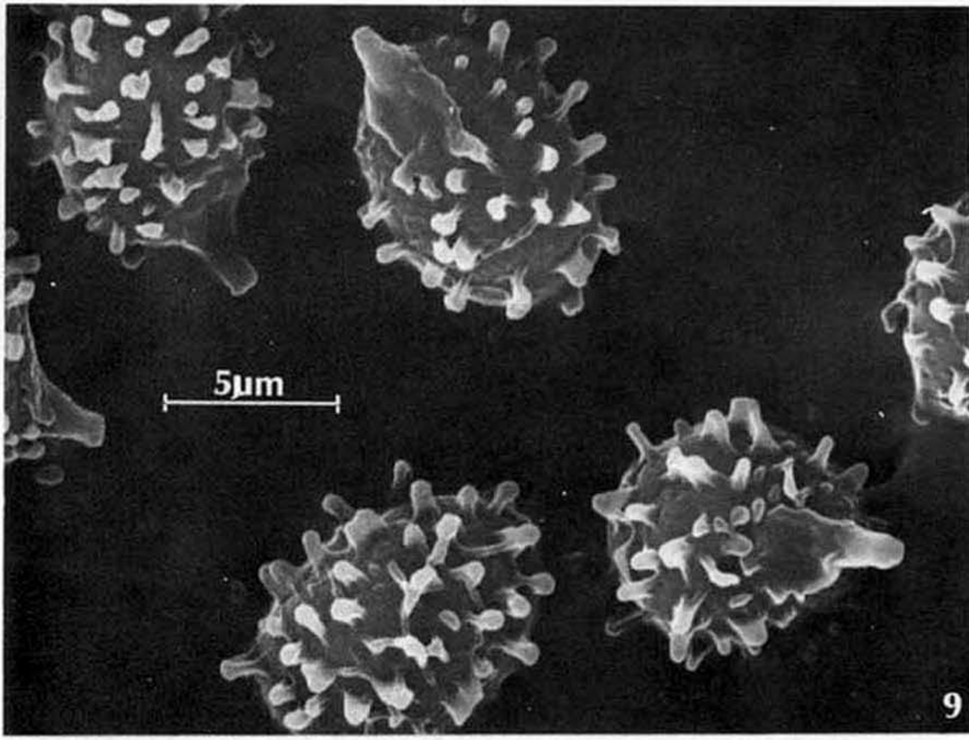

5µm
7


1cm
8

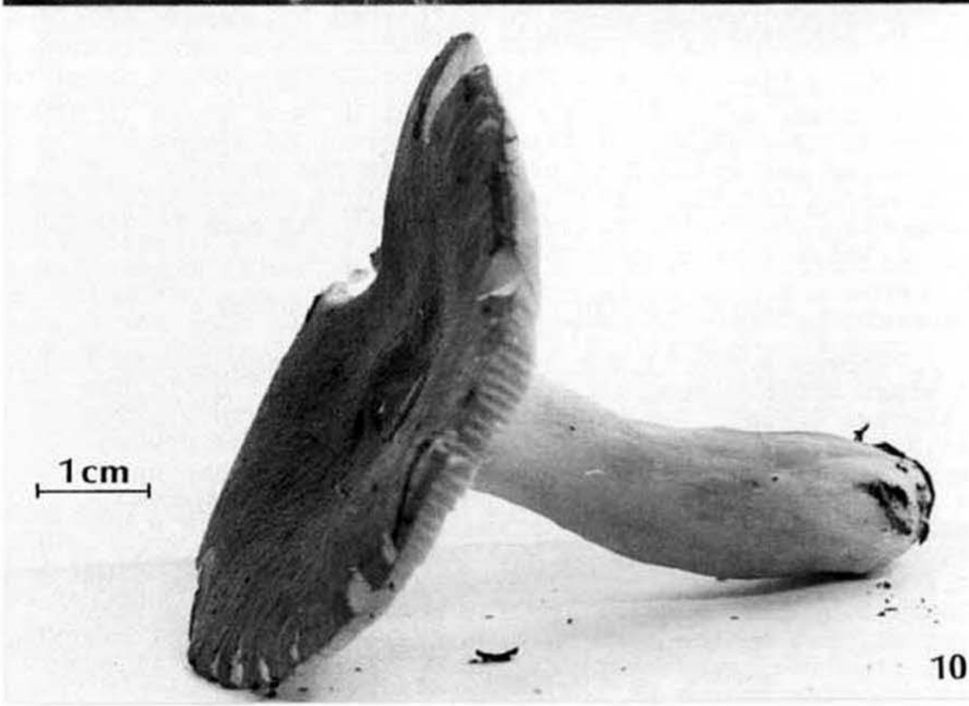


Figs. 9 and 10

R. rosacea var. *macropseudocystidiata*



9



10

MYCOTAXON

Vol. IX, No. 1, pp. 114-116 June 12, 1979

NEOTYPE SELECTION FOR *AGARICUS ASPRELLUS* FR.

DAVID L. LARGENT

Biology Department, Humboldt State University
Arcata, California 95521

Two interpretations of *Agaricus asprellus* Fr. (= *Leptonia asprella* (Fr.) Quél.) exist in agaricological literature (Orton, 1960; Kühner & Romagnesi, 1953). In order to clarify which interpretation was acceptable, I studied several authentic collections of *Agaricus asprellus* or *Leptonia asprella* at the Royal Botanic Gardens in 1973. These collections were obtained through the assistance of Dr. R. Santessan from Upsala, Sweden.

Two descriptions of these collections are provided. One is based on a collection made by O. Rob. Fries in 1860 which is the oldest, verified collection of *Agaricus asprellus* and which I am proposing as the neotype collection for that species. The second description is a composite one based on several collections made by Lundell et al between 1946 and 1948.

Neotype study of *Agaricus asprellus*

Spores 8.6 - 11.2 x 5.9 - 7.7µm, average length 9.6µm, average width 6.8µm, elongate-angular, L-D 2.0 - 4.0µm (average 2.8µm), 5-6-sided. Basidia 26.4 - 30.0 x 7.9 - 11.2µm, clavate, 4-spored. Cheilocystidia and pleurocystidia absent. Gill trama subparallel, hyphae up to 4.5µm wide. Pileipellis not observed (see comments); pileocystidia napiform to clavate, 22.4 - 51.2 x 9.6 - 17.6µm, average length 34.3µm, average width 13.8µm, Lt/Dt 1.6 - 3.8(average); penultimate cells 6.4 - 9.6µm wide, Lt/Dl 2.3 - 5.8. Stipitipellis mostly a cutis, hyphae repent, but at the apex with scattered clusters of clavate, basidia-like, caulocystidia, 32.0 - 48.0 x 8.0 - 12.8µm; stipe trama hyphae up to 16.0µm. Lactifers absent. Pigmentation vacuolar in all parts and at times in the form of dark globules. Clamp connections absent on all parts.

Material studied: NEOTYPE. Fungi Sueici. Upl. Upsaliae in campis aridis; 8/1860; leg. and det. by O. Rob. Fries - #287 (in pencil) as *Agaricus asprellus*.

This collection consists of seven carpophores glued and flattened on a card with mosses at the base of the basidiocarps. The gills were dark colored on one, tinged pinkish on the others; the pileus had a central depression and striations were apparent; the stipe appeared concolorous with the pileus. Due to the age of the collection, the pileipellis did not revive well; however, some of the hyphae of the pileipellis did revive after squashing a piece of the pileus in 3% KOH and the size and shape of the pileocystidia were observed.

Specimens that I've studied in the past which possess similarly shaped pileocystidia have a hymeniform pileipellis, at least on the pileus disc. This is also verified after studying material, identified as *Leptonia asprella* by Lundell, which match Fries' material in all features.

Leptonia asprella (Fr.) Quél. s Lundell

Spores 8.9 - 10.6 x 5.9 - 7.9µm, average length 9.8µm, average width 6.9µm, elongate-angular, L-D 2.1 - 3.3µm (average 2.9µm), 5-6-sided. Basidia 29.0 - 39.6 x 9.2 - 11.9µm, clavate, 4-spored. Cheilocystidia and pleurocystidia absent. Pileipellis of three layers; suprapellis ± hymeniform, cells forming a trichodermial palisade, often with the hyphae agglutinated, terminal cells one to two per penultimate cell, clavate to broadly clavate, 28.8 - 86.4 (-112.0) x 9.6 - 25.6(-30.4)µm, average length 56.0µm, average width 18.4µm, Lt/Dt 2.4 - 4.9(average 3.0), penultimate cells inflated, 6.4 - 11.2µm, Lt/Dl 2.6 - 11.0; mediopellis of inflated, parallel to slight entangled, anticlinally oriented (on the disc) hyphae; subpellis of anticlinally oriented hyphae but much more entangled than mediopellis, not inflated. Stipitopellis mostly a cutis but at the apex with rare to scattered clusters of clavate, basidia-like caulocystidia, 16.0 - 52.0 x 6.4 - 12.8µm. Lactifers absent. Pigmentation vacuolar in all parts, at time, particularly in older collections, very dark. Clamp connections absent on all parts.

Material Studied. Grässlänt invid landsväg. Blekinge: Augerum sn, ca 300 sw om Bastasjö gard; 13 Sept 1946; Lundell 46 (herb. #2364); Västmanland: Sala Stad, Vom Barnelund Vägkant. 1499, 25 July 1953; Lundell 55; Pa betesvall Smaland: Femsjö s:n, strax S.W. om Prägstgarden; 22 Sept 1949; S. Lundell & J. Stordal, 3072; Pagammal, mossig betesmark. Smaland: Femsjö s:n, Nyby (ödetorp); 18 Sept 1949; S. Lundell & J. Stordal, 2962; Bland kort gräs pa backsluttning. Smaland: Femsjö, s:n, Arvabergets sydöstra sluttning mot Arvamaden; 3 Sept 1948; S. Lundell & G. Hoglund, 5013.

The Lundell collections agree quite well with the Fries collection. Therefore, the pileipellis of Lundell should be the same as that of Fries. I also studied two additional collections labeled as *Leptonia asprella*, Ruth Gustafsson, 4 July 1938 and Lundell and Stordal 3049. In the former collection, caulocystidia were absent, the specimens were smaller and darker than the others studied, and the pigment was soluble in 3% KOH. In the latter, the apex of the stipe appeared almost tomentose and the stipitipellis at the apex was a dense entangled layer of hyphae. In my opinion, the identification of these collections is suspect.

Orton's concept of *Agaricus asprellus* indicated a fungus that may be similar to *Leptonia inocybeoides*. However, a comparison of the type description for *L. inocybeoides* by Largent (1977) and the neotype description herein presented for *Agaricus asprellus* demonstrate fungi with totally different pileipelli and spores.

Largent (1977, p. 215) discussed the relationships of *Leptonia asprella* and indicated that the name should apply to a fungus with the following macroscopic features: <u>Pileus</u> convex, fibrillose-squamose, livid gray except for the fuligineus-squamose pileus disc, with a translucent striate margin; <u>Lamellae</u> adnate, wide, and gray; <u>Stipe</u> 1.5 - 2.0mm wide, 25mm long, gray, bluish gray or grayish violet except for the whitish basal mycelium. The macroscopic features presented herein for *Agaricus asprellus* agree quite well with those of Kühner & Romagnesi (1953).

Literature Cited

Kühner, R. et H. Romagnesi. 1953. Flore analytique des champignons supérieurs (Agarics, Bolets, Chantrelles). Masson et C^{ie} Paris. 556p.

Largent, D. L. 1977. The Genus Leptonia on the Pacific Coast of the United States. Bibliotheca Mycologica 55. J. Cramer, Vaduz. 1977. 286p., 24 pl.

Orton, P. D. 1960. <u>in</u> Denis, R. W. G., P. D. Orton and F. B. Hora. New Checklist of British agarics and boleti. Supplement to Trans. Brit. Mycol. Soc. Cambridge Univ. Press, London. 225p.

MYCOTAXON

Vol. IX, No. 1, pp. 117-231 June 12, 1979

COLLYBIOID GENERA IN THE PACIFIC NORTHWEST[1]

JOANNE WILLIAMS LENNOX

17205 S.E. Cougar Mt. Dr.
Issaquah, Wash. 98027

SUMMARY

The collybioid agarics (Agaricales, Tricholomataceae, *Collybia* sensu Fries) in the Pacific Northwest comprise a heterogeneous collection of fungi, which are here segregated, on the basis of both microscopic and macroscopic characters, into 11 genera (*Lyophyllum*, *Rhodocybe*, *Callistosporium*, *Clitocybula*, *Baeospora*, *Flammulina*, *Strobilurus*, *Microcollybia*, *Caulorhiza*, *Rhodocollybia*, and *Collybia*). Of these, *Microcollybia* (validated) and *Caulorhiza* are new. A key to the genera is provided and each genus is discussed in turn, along with a treatment of the species of each, exclusive of *Lyophyllum* and *Collybia*. In all, 34 species and subspecies are included, 4 of which are newly described and 18 proposed as new combinations.

INTRODUCTION

Species of *Collybia* Fr. are commonly collected and have always presented difficulties to those who would try to identify them, as they intergrade with species of other genera and frequently lack distinctive microscopical structures. Nevertheless, within the genus as it is defined by Fries, there exist numerous groups that appear to be natural and lend themselves to segregation. The practice of creating segregate genera and defining *Collybia* itself more narrowly began early with Karsten in 1881 (*Lyophyllum*) and 1891 (*Flammulina*) and Spegazzini in 1881 (*Oudemansiella*), and has been carried out largely by R. Singer from 1936 to the present. While a few of these genera has been monographed in parts of the United States (*Clitocybula*, 1973 and *Strobilurus*, 1971), the modern system in collybioid fungi has never really been applied comprehensively to a taxonomic treatment of any particular region, either in Europe or the United States. The treatments in Moser and

---

[1] Portion of a dissertation submitted to the Graduate School of the University of Washington in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

Gams (1967) and Metrod (1952) of european fungi, while rudimentary, remain the only ones to have employed some concepts of the modern system to a large number of the Collybia Fr. species.

The use of segregate genera seems to closely follow "natural" groupings and is the easiest, most convenient way of handling these fungi taxonomically. Anyone becoming acquainted with the majority of collybioid fungi in the Pacific Northwest would probably, on the basis of macroscopic characters alone, group the species along precisely the same lines that the segregate genera have been created. Indeed, the addition of microscopic data has served more to confirm rather than create segregate genera. The modern system has grown out of a closer acquaintance with the species, the discovery of many tropical species, and changing values in the taxonomic hierarchy growing out of an increased need for precision in classification. In the long run then, for the person who really would seek to understand these fungi, the system of segregate genera is a clarification rather than a complication of the taxonomic system.

HISTORY OF NOMENCLATURE

In 1821 Fries in Systema Mycologicum placed all of the rather small fragile, white-spored species with a convex cap and fragile stipe in the tribe Collybia of the genus Agaricus. He divided the tribe into 2 parts: Genuinae, species with rather membranous plano-convex caps, including species which would later be earmarked as collybioid; and Omphalarie, which included species more nearly marasmioid, those with depressed, plicate-rugose, or tough-pliant caps. This treatment in terms of numbers of species was quite sketchy, but nevertheless presented for the first time a step towards distinguishing the collybioid, marasmioid, and in turn the clitocyboid and tricholomoid habits. Later, in Epicrisis (1838), Fries proposed the more comprehensive taxonomic system for classification of collybioid fungi that would serve for almost one hundred years, and that remains the broad basis upon which the modern taxonomic system is built. He created the tribe Collybiae, separating the marasmioid species into another tribe and dividing Collybiae into four sections as follows:

A. Gills white to light-colored, not greyish, flesh white.
   - I. Striaepedes - stipe rather thick, hollow to spongy-stuffed, sulcate to fibrillose-striate.
   - II. Vestipedes - stipe thin, equal, hollow or stuffed, velvety, floccose or pruinose.
   - III. Laevipedes - stipe thin, equal, hollow, glabrous (except at the base), not conspicuously striate.

B. Gills greyish or fuscous, hygrophanous.

IV. *Tephrophanae* - color fuscous or grey, allied to the tribe Tricholoma or Clitocybe, but the stipe cartilaginous.

Between 1871 and 1882, most of the species of Fries' tribe Collybia were raised to generic rank by Kummer (1871), Quelet (1872), and Karsten (1882). This change generally was one of status rather than a change in the classification system; these authors maintained the sectional divisions for the genus that Fries proposed for the tribe Collybiae.

Karsten, in addition to recognizing the genus *Collybia*, proposed two other genera: *Lyophyllum* (1881) based on a single species of *Tricholoma*, and *Flammulina* (1891), formerly *Collybia velutipes*. Both accounts remained buried in the literature, and received little recognition until the more modern system, based in part on microscopic features, began to gain acceptance. Eventually, *Flammulina* would remain monotypic and rather well defined, while *Lyophyllum* would be vastly expanded to include more tricholomoid, clitocyboid, and many collybioid species (including the Friesian section *Tephrophanae* of *Collybia* almost in its entirety). The genus *Lyophyllum*, despite its present size, remains rather poorly defined, and is held together to a large extent on the carminophilous basidia, an unwieldy feature.

At about the same time (1881), Spegazzini proposed the genus *Oudemansiella*, which Fayod in his *Prodrome d'un Histoire Naturelle* (1889) later placed in the Marasmieae, along with *Collybia* and *Marasmius*. This inclusion of a "segregate" genus in the comprehensive work marks a digression from the strict acceptance of the Friesian system.

Among the workers of the late 19th and early 20th century, there seemed a general acceptance of the genus *Collybia* sensu Fries, but there was little agreement as to the place of *Collybia* among other genera, most notably *Mycena*, *Marasmius*, *Clitocybe* and *Armillaria*.

In 1900, Patouillard proposed the "Series Collybia", to include *Mucidula*, *Mycena*, and *Collybia*. He maintained the four sections of *Collybia* that Fries had proposed while expanding the third section *Laevipedes* into two parts; without an annulus, and with an annulus (in order to include small Armillarias).

In 1932 in *Icones Selectae*, Konrad and Maublanc included among the light-gilled (Laeticolores) species of *Collybia* two more sections: *Nitellinae*, with pink verrucose spores, and *Conigenae*, small species which grow on cones of conifers and have cystidia. This seems to have been one of the first efforts towards creating a scheme of collybioid fungi which seeks more actively to include microscopic characters. The impetus to include microscopic as well as macroscopic characters as the basis for differentiating genera and species, and the delimitation of new genera on the basis of a distinct, conspicuous set of microscopic features was beginning to grow rapidly.

Singer in 1936 proposed a most comprehensive system which covered all of the Agaricales and tended not only to delimit the Friesian genera more precisely by the creation and grouping of segregate genera, but also to clarify partially the relation of genera and microscopic features to each other by the creation of families within the order Agaricales. Part of the contribution of this early work and the large number that were to follow, was the collection and organization of a large store of information on microscopic characters that once organized could be published in book form and made available to a larger number of people. Because Singer was the most forceful and widely published agaricologist of this era, the modern system is frequently referred to as the Singerian system. In his treatment of *Collybia*, Singer began (1936) by creating the family Tricholomataceae into which he put *Collybia*, as well as the segregate collybioid genera of *Lyophyllum*, *Rhodocybe*, *Crinipellis*, *Myxocollybia* (synonymous with *Flammulina*), *Oudemansiella*, *Xerula*, and *Fayodia*. This system was elaborated further in the Agaricales in Modern Taxonomy (1942, 1962) by the elaboration of Tribes within the Tricholomataceae. For *Collybia* and many of its segregates, he created the tribe Collybiae (most of the other tribes were based on "Friesian genera", except the tribes Lyophyllae and Leucopaxillae). Also, Singer expanded to eight the sections of *Collybia* itself, four of which are based on tropical species. These sections are as follows:

Section I. *Stripedes* - stipe rather thick, more or less striate or sulcate, spore print cream pink.
- Stirps *Maculata* - pseudorhiza present or absent, context of pileus thick, cuticle rather dry.
- Stirps *Butyracea* - lacking a pseudorhiza, pileus thin, pileus lubricous.
- Stirps *Fusipes* - perennial pseudorhiza, growing at the base of trees.

Section II. *Dictyoplocae* - stipe somewhat sulcate-striate, almost smooth, glabrous; spore print creamy white when fresh, pinkish cream in the herbarium; pileus white to violet, lamellae slightly to strongly venose anatomosing.

Section III. *Iocephalae* - Carpophores with a purplish pigment, becoming pink in acids, violet in alkali, lamellae not anastomosing.

Section IV. *Laevipedes* - stipe smooth, glabrous to whitish pruinose, or with a brownish strigosity at the base, spore print white, lamellae not anastomosing; epicutis strongly reduced ("partly broad, not rarely branching, but not diverticulate, not radially arranged").

Section V. Vestipedes - stipe neither glabrous or long - sulcate, partly or entirely villous, pruniate, tomentose or strigose; spore print white to pale flesh colored; epicutis well developed, narrowly filamentose, not diverticulate.

Section VI. Subfumosae - epicutis differentiated, with a distinctly developed rameales structure, nodulose-coraloid to diverticulate or with repeated thin side branches.

Section VII. Cystidiatae - species with very conspicuous cheilocystidia, stipe glabrous to subglabrous, often uneven, epicutis lacking rameales structures.

Section VIII. Collybia (Cirrhatae) - stipe not sulcate, finely pruinate pubescent, or with conidiophores, pileus white or whitish, striate on the margin, at least in moist conditions, cap very thin or membraneous; stipe racemose and/or arising from a sclerotium, more rarely neither racemose nor arising from a sclerotium; cheilocystidia none, or very inconspicuous, frequently on decaying basidiomycetes.

In addition, between the first proposal of the modern system by Singer in 1936 to the publishing of the 2nd edition of Agaricales in Modern Taxonomy (1962), seven other segregate genera were published: Baeospora Singer (1938), Pseudohiatula (Singer) Singer (1938), Lactocollybia Singer (1939), Callistosporium Singer (1944), Microcollybia Metrod nom. nudum (1952), Clitocybula (Singer) Metrod (1952), and Strobilurus Singer (1962).

Kuhner and Romagnesi (1953) in Flore Analytique des Champignones Superieurs remained more conservative than did Singer as regards the creation of new genera and the acceptance of those segregate genera already published; however, their treatment of Collybia itself in the key is quite distinct from the "Friesian sections" and from those of Singer, which rely heavily on the use of macroscopic features proposed by Fries. The key to Collybia is divided into four "sections". The characteristics of these groups are as follows:

Section A - species with a more or less thick stipe (2-4 mm or more), never filiform or branched, always without sclerotia, not found on cones or decaying mushrooms, never really violaceous, the pileal surface neither viscous nor hymeniform, spores non-amyloid (e.g. C. acervata, C. butyracea, C. maculata).

Section B - cap covered with streaks of brownish fibrils, grey or blackish shiny, more or less rimose and splitting radially in bands of fibrils of these colors, separating towards the margin and lighter, sometimes squamulose, spores 5-7 x 4-5 um or larger (e.g. C. platyphylla, C. lacerata, C. lenta).

Section C - stipe thin (1-2 mm), pruinose or ramified, gills frequently serrate, cap neither streaked or rimose, the epicutis not gelatinized or hymeniform, spores very small (3-5 x 1-3 um) or amyloid, sometimes found on cones or decaying basidiomycetes, with or without a sclerotium (e.g. C. fuliginata, C. tuberosa, C. conigena).

Section D - cap neither streaked or rimose, but either viscous or cellular-hymeniform, generally with striking pleurocystidia, spores non-amyloid. (C. tenacella, C. mucida, C. longipes).

GENERIC CONSIDERATIONS

The term "collybioid" is synonomous with the tribe Collybia of the genus Agaricus created by Fries, and in defining the tribe he used the following characteristics: cap small, convex, becoming plane, margin inrolled at first, gills not decurrent, stipe cartilaginous, and spores white. Although this definition applies to some of the fungi that Fries himself put in Collybia, it generally lacks the precision and scope to describe the majority of collybioid fungi. Consequently the definition of collybioid has been expanded on the basis of the Friesian species to include the following broader lines: cap hemispheric, convex or plane, depressed or umbonate, generally glabrous, sometimes pubescent to fibrillose; gills almost free or broadly adnate to subdecurrent, spores white to yellow or salmon pink in deposit; stipe more or less cartilaginous, generally glabrous, occasionally sulcate, striate, pubescent, or tomentose; spores smooth or roughened, amyloid or not, with or without cystidia, pileal surface hymeniform, filamentous, or subgelatinized, rarely with a subcellular hypoderm, clamps lacking or present. From this definition, the heterogeneous character of the genus Collybia Fries is readily apparent.

Generally collybioid fungi have convex to hemisphaeric caps when young, the margin is strongly inrolled and as the carpophores develop, the margin is raised and becomes unrolled giving the cap a flat or "plane" appearance. This condition is in contrast to the mycenoid condition in which the cap is conic at first and the margin straight; later in development, the margin which was adpressed to the stipe becomes raised and a rather pointed or bell-shaped aspect is maintained. The center of the mycenoid cap never really becomes flat at maturity.

Many collybias tend to be somewhat centrally depressed at maturity, especially when the margin becomes revolute and raised above the point of gill attachment, but this condition does not approach the umbilicate character so frequently found in Clitocybe in which the carpophores are strongly depressed even when young. Furthermore, the gills are never truly decurrent as they are in Clitocybe. Some collybioids have gills that are emarginate and frequently uncinate as well; a few are broadly adnate and if the cap margin is raised above the point of attachment of the gills to the stipe, these sometimes appear subdecurrent. There exist, however, a few species whose gills are shallowly emarginate-ventricose and strongly uncinate, where even close scrutiny does not further clarify the distinction between adnate and subdecurrent, or between the genera Collybia and Clitocybe sensu Fries. The distinction between these two genera must in such circumstances remain largely unresolved if there are not attendant differences in microscopic features. Given this difficulty, it is fortunate that among the smaller species of Clitocybe in this area, all but a very few are marked by strongly decurrent gills and centrally depressed caps.

Tricholoma differs from collybioid fungi, except for the genus Rhodocollybia, by its much large size and the fibrous nature of its cap and stipe. In Rhodocollybia the presence of a colored spore print, staining characters, distinctive shape and character of the stipe, and dextrinoid spores serve to delineate it from Tricholoma.

Of all the genera, separation of Marasmius from Collybia has been by far the most difficult. There is a common ground between the two genera where both macroscopic and microscopic characters intergrade somewhat, and the classical distinction of Marasmius on the basis of pliant-tough, reviving flesh, while useful, is neither consistent nor manageable enough to serve as a unique generic feature. Fortunately, the species of Marasmius in the Pacific Northwest and probably in any coniferous area, are relatively few and seem to intergrade less than those species in areas where hardwoods predominate. In this treatment, I have excluded from Collybia Fr. any species with the following characters: an insititious stipe; a stipe which is very slender, wiry or setose; one that is accompanied by black rhizomorphs; distant or intervenose gills; bilateral lamellar trama; a dextrinoid pileal context; long, thick-walled, setoid pileocystidia; fusoid spores; a pileal surface composed of diverticulate hyphae or broom cells; and a pileal surface which is hymeniform if the spores are non-amyloid and the hyphae clamped.

TAXONOMIC CHARACTERS

SIZE - Collybioid fungi range from very small mushrooms of delicate stature (less than 0.5 cm) such as those of the segregate genus Microcollybia (including the former Collybia racemosa and Collybia tuberosa) to large mushrooms (greater than 7 cm) such as some species of Rhodocollybia, which are large relative even to many other agaric genera. Nevertheless, the adjective "collybioid" encompasses the majority of species in this treatment, and by definition means that the cap size is about that of a "small coin". The stipe and lamellar size are congruent with the rather small size of the cap, and in general, these species are a little larger and somewhat tougher than most Mycenas.

CAP CHARACTERISTICS - Strongly umbonate or umbilicate caps do not characterize Collybia sensu Fries, although a few of the species included here are umbonate or umbilicate enough to be distinguished partially on this basis.

The cap is generally pale-colored to tan, or some shade of brown, and hygrophanous. Some Rhodocollybia species develop vinaceous spots with age or bruising on the gills and stipe. Species in the genus Lyophyllum generally have a grey to fuscous tone on the cap and often stain or bruise brown, bluish-black, or black. Callistosporium species in this area are olivaceous and turn vinaceous black or deep burgundy on drying. Baeospora myriodophylla has when moist a brown cap with a decided violaceous tinge, and conspicuous purple gills.

The great majority of collybias have glabrous caps which in the fresh condition may be dry to glassy-lubricous, becoming dull-matte in drying. Occasionally under very moist conditions they appear subviscid. Some of the segregate genera are characterized by surface features of the cap: Clitocybula species frequently are radiate-striate with blackish fibrils. Flammulina is viscid, and Strobilurus appears pubescent due to the presence of abundant pileocystidia. A few species are markedly translucent-striate, but this condition certainly does not exemplify the genus as it does in Mycena.

The majority of Collybias are rather membranous, and somewhat fragile; yet, in species of Microcollybia, Strobilurus, and Baeospora the flesh, though thin, may be quite firm, tough and pliant, but generally not reviving easily as in the genus Marasmius. Rhodocollybia has a thick (generally at least 1 cm), rather soft pileal context which tapers towards the margin and usually is so thin there that species of this genus sometimes have a frayed, ragged cap margin at maturity.

LAMELLAR CHARACTERISTICS - As the color of the spores is white, the gill color generally also is whitish; frequently the gills are off-white with yellowish to brownish tones. Considering mature carpophores, truly white gills are rather uncommon in the large species, although they seem to predominate in small species (*Strobilurus* and *Microcollybia*). Species of *Rhodocybe* have a pale pink to salmon brown spore print and correspondingly the gills have a characteristic "pinkish" blush at maturity. *Rhodocollybia* has yellowish gills at maturity and the spore prints of this genus range from pale orange to pink to pale salmon. Gills of the genus *Callistosporium*, which in the fresh condition are a bright yellow to yellow-olivaceous, turn deep vinaceous due to the presence of a pigment that colors on drying. Gills of other collybioids invariably are yellow in the herbarium, becoming darker with age.

The lamellae of some species of collybioids are narrowly adnexed, appearing almost free; others are emarginate and frequently uncinate as well; a few are broadly adnate.

Generally the gills are thin and rather soft, rarely thick and firm-waxy. Gills which are close or crowded seem more common than those which are subdistant or distant. The gills are never anastomosing, and an intervenose condition is very rare. In the genus *Rhodocollybia*, the lamellar edge is often serrate, even in young specimens, and at maturity eroded or frayed. This genus is also marked by ferruginous spots on the gills. *Lyophyllum* species of the section *Nigrescentes* stain blackish, rather rapidly, on the gills.

STIPE CHARACTERISTICS - The stipe of collybioid fungi is characterized as being more or less cartilaginous and fragile, equal, glabrous, and tubular. Many collybioid species differ somewhat from this "formula", but generally do not differ widely. *Strobilurus* has a chrome yellow to pale tawny stipe which is strongly but finely pubescent above and long tawny-tomentose below the substratum. *Flammulina* has a deep warm brown stipe which is conspicuously and strongly velvety. Species of *Microcollybia*, *Rhodocybe* and some of the smaller *Lyophyllums* frequently have stipes with an undulate or wavy surface. Large, stout, and often solid and fibrous stipes characterize some members of the genera *Rhodocollybia* and *Lyophyllum*. In *Rhodocollybia* the stipe also is generally enlarged towards the base, then tapered abruptly into a short root-like "tail". It is also strongly striate-grooved for most of its length, and generally stained ferruginous towards the base where it emerges from the "woody" substratum. *Microcollybia*, for the most part, is characterized by the presence of a conspicuous sclerotium (yellow, reddish brown, or black) from which the stipe arises. One species of this genus (*Microcollybia racemosa*) has certainly the most unusual of stipes: short, side branches arising at right angles from the stipe produce globose slimeheads of hyaline condia. *Caulorhiza* has a very long tapering "root" or pseudorrhiza which may be two or three times as long as the above ground portion, and the stipe is frequently clothed with a heavy powdery-pubescence.

ODOR and TASTE - Most collybioids lack strong and distinctive odors. However, as collybioids lack many distinguishing traits in general, an odor, even if faint, often can with training be of some help in the rapid and tenative identification of species. In this respect, I have tried to include whatever information I obtained regarding odor and taste, but with the qualifications that such characters are frequently rather variable and such information is highly individualistic, capable of broad interpretation, and consequently can rarely serve as a reliable basis for the taxonomy of these fungi. Nevertheless, the following species can be secondarily characterized by the presence of a strong odor which is constant from collection to collection: Collybia polyphylla smells of a mixture of garlic and radishes, the taste is very unpleasant and strong of garlic; Rhodocollybia oregonensis has an odor of almond extract or benzaldehyde, no taste accompanying the odor; Rhodocybe nitellina and many Lyophyllums smell strongly farinaceous.

MACROCHEMICAL SPOT TESTS - A great many collybioid fungi react with alpha-napthol, guaiacol, phenol, and phenol-aniline. They generally remain unreactive with formol, sulfoformol, aniline, ferric sulfate, tincture of guaiac, and PDAB (other than a faint pink reaction on the gills). Few collybioid genera are characterized or easily set apart from other genera on the basis of these spot tests, which seem most valuable in distinguishing one species of a genus from another of the same genus, especially as regards rapid and tentative identification of fresh specimens. Of the genera in this treatment, three (Microcollybia, Strobilurus and Callistosporium) are distinctive by their absence of reactivity with all or most of the macrochemical reagents. Each of these three genera however is distinctive, both in macroscopic and microscopic aspects, from other genera, and consequently their identification is not problematic. The added feature of non-reactivity to these reagents helps to support the segregation of these genera from Collybia sensu Fries, but still they are characterized most easily by other, more conspicuous traits. Lyophyllum, a genus which sometimes is easily recognized, but which includes so many varied species that positive identification is dependent on the troublesome carminophilous test, may be one collybioid genus that can best be identified through macrochemical spot tests, at least as a preliminary to the carminophilous procedure. Members of Lyophyllum react slowly with sulfoformol to produce a light mint green to olive color on the edges of the gills and flesh; they turn a solution of PDAB abruptly bright blue-green, and frequently react with aniline to give a lemon-yellow or orange color. Reactivity to the other macrochemical reagents is variable, but on the whole, species of Lyophyllum tend to be rather reactive. The combination of reactivity to sulfoformol and PDAB apparently does not exist in any other collybioid genus, or many other agaric genera for that matter, and may consequently be a rapid and tentative means of identifying the genus without the carminophilous test. These two reagents should be applied to the study of other noncollybioid agaric genera to determine whether or not the combination sulfoformol-PDAB really is indicative of carminophilous basidia or is more widely applicable.

HABITAT - Most collybioids are terrestrial and are found scattered to gregarious in dense woods during the fall season. Relatively few are lignicolous, grow in a caespitose manner, or are found in open disturbed areas. Because the majority of forests in this area are predominantly coniferous, most of the collybioid species in this study are likewise associated with coniferous conditions. Members of the genera Flammulina, Baeospora, and Strobilurus may be considered lignicolous, and the latter two are often associated with cones. Rhodocollybia is often found in much decyaed wood which might better be classified as "humus". Microcollybia is associated with the old, tarry, hardened remains of decayed agarics.

SPORES - Spores of most collybioid fungi are quite small, less than 10 µm, thin-walled, smooth, nonamyloid, hyaline, and ovate to ellipsoid. Strobilurus, Baeospora, Microcollybia, and Clitocybula have minute spores that rarely exceed 4-5 µm in length; some species of Rhodocollybia have rather long spores, reaching occasionally 10 um, but no collybioid genus is characterized by really large spores. No pip-shaped or boletoid spores occur in collybioid fungi. Spore shapes range from globose to narrowly ellipsoid, and generally the spores are rather thin-walled but with the wall thick enough not to collapse in a crush mount. The genus Rhodocybe is characterized by having ornamented spores, usually slightly angular in end view and longitundinally wrinkled in side view. Rhodocybe olympiana has coarsely echinulate spores. Occasionally the spores of Rhodocybe are so weakly ornamented that this character is overlooked in the microscopic examination of a collection. Lyophyllum ambustum, according to european workers, has verrucose spores.

While most collybioid species have spore prints that are white in the fresh condition, the print frequently becomes yellow in the herbarium or with age and drying. Members of Rhodocollybia are characterized by a pale yellow to peach colored spore print in the fresh condition, and Rhodocybe has a pale pink to dark salmon pink print. Spores of Baeospora and Clitocybula are amyloid; Rhodocollybia has a dextrinoid inner wall (endosporium) which is thickened and frequently retracts from the apicular end of the spore giving a truncated appearance. This condition is generally present only in a percentage of the spores. Sometimes the vast majority of the spores will be thick-walled and dextrinoid, while in other collections only a few spores in any one crush mount will show these characteristics. In the genus Callistosporium, the spores are hyaline in the fresh condition, but become vinaceous on drying. This peculiar feature is due to the presence of a pigment which changes from hyaline to vinaceous under certain circumstances (in alkali or drying); the pigment is present throughout the carpophore, and consequently, a herbarium specimen will be entirely burgundy-colored.

BASIDIA - The size of basidia in collybioids, as in other agaric genera, seems to vary with the spore size; the larger the spore, the larger the basidia and vice versa. Few species have basidia shorter than 15 µm or longer than 35 µm; the width varies usually from 4 to 8 µm. As mentioned above, Callistosporium and Lyophyllum have basidia with densely granular cytoplasm, the former with a pigment that turns vinaceous on drying or in KOH, and the latter with granules that stain reddish black with mordant and acetocarmine. Rarely are the basidioles or basidia distinctive enough in size or shape to be of taxonomic importance. There are no exclusively two-spored species in this treatment; however, a few species occur in the genera Collybia, Rhodocybe, Rhodocollybia, and Lyophyllum which appear regularly to have carpophores with both two and four-spored basidia.

CHEILOCYSTIDIA and PLEUROCYSTIDIA - Most collybioid fungi lack distinctive cheilocystidia, but some species have "cystidioles" either scattered or abundant on the gill edge. These are clavate to filamentous and characteristically contorted, sparsely branched, coarsely knobby, hyaline, thin-walled, non-encrusted, and rarely exceed the height of the basidia. They are inconspicuous and best observed in crush mounts of the gill edge. The abundance of these "cystiodioles", as well as their degree of branching, contortion, and knobbiness seems to vary widely from collection to collection in some species; in other species, however, these traits appear to be quite constant.

The genera Strobilurus, Baeospora, Flammulina, Caulorhiza, and Rhodocybe section Rhodocybe are characterized by abundant, well differentiated cheilocystidia of a given shape and size. Except for the species of Strobilurus, these cystidia are thin-walled, non-encrusted, generally clavate and hyaline. The cystidia of Rhodocybe aureicystidiata nom. prov. are conspicuously yellow colored and often arise from like-colored conducting elements in the gill trama. Species with well developed cheilocystida frequently have pleurocystidia as well, and of the same shape and size as the cheilocystidia. Strobilurus has cystidia on the gill edge, gill face, cap surface, and stipe. These are generally the same shape and size, although the stipe and cap cystidia tend to be slightly longer and narrower than those found on the gill. Baeospora produces an abundance of cheilocystidia which are quite short, broad, and thin-walled, and although the gill edge is entirely sterile and composed only of cheilocystidia, the gill face itself has relatively few pleurocystidia, these being most abundant near the gill edge.

PILEAL SURFACES - The majority of collybioid fungi have a cap which is covered by a thin cutis composed of narrow, radially oriented, non-encursted, and often agglutinated hyphae. This cutis normally intergrades with the contextual hyphae in size and compactness, and occasionally intergrades also in encrustation and orientation. There are relatively few species which present a narrow surface zone conspicuously different from the tissues immediately underlying it. In addition, some of the species in various of the genera form innate "dermatopilocystidia" as the upturned, rounded and inflated ends of the surface hyphae. These "cystidia" frequently are extremely variable in size, shape, and abundance, and may be very inconspicuous or even absent from some collections of the species in which they are often found.

Some members of Rhodocollybia and a few species in other genera have the upper cutis layer gelatinized; the gelatinization can vary from a slight agglutination of the surface hyphae to a more rarely encountered condition in which the entire depth of the cutis is affected. Collybia dryophila and its affiliates have surface layers composed of rather larger diameter hyphae which are more or less interwoven and not appreciably different from the context. Such surfaces have been termed "undifferentiated", and are distinct from the more common situation in which a cutis of narrow parallel, radial, hyphae overlies larger contextual hyphae. Flammulina velutipes is characterized by a viscid layer of partially gelatinized, upright hairs. And a "hymeniform" layer of inflated-clavate, pedicellate cells interspersed with conspicuous pilocystidia is a prominent feature of the genus Strobilurus. The genus Caulorhiza presents a more complex surface: a cutis layer of radial hyphae bearing scattered dermatopilocystidia, subtended by a subcellular layer, which in turn overlies the radial layers of the context.

CLAMPS - Clamps are present in the great majority of collybioid fungi. They are found easily in the cap context and gill trama since they frequently are rather large. Nevertheless, members of Strobilurus, Callistosporium, and a few species of Rhodocybe are characterized by the lack of clamps.

MATERIALS AND METHODS

Macroscopic descriptions were drawn from notes made on fresh materials, unless otherwise noted. Colors in the Kornerup and Wanscher (Methuen) Color Handbook are numbers and are cited in parentheses; those of Ridgeway are enclosed in quotation marks.

Microscopic features were generally examined using dried material. The tissue was rehydrated by first wetting with 95% ethyl alcohol, then mounting in Melzer's or 3% KOH, to which a small drop of phloxine and congo red had been added. Radial and tangential sections of the cap and cross and longitudinal sections of the stipe were generally made with a freezing microtome or occasionally by hand using elder pith. Drawings of microscopic features were made from crush mounts with the aid of a Zeiss camera lucida and a 20x eyepiece. The habit drawings were made in pencil from kodachrome slides, unless otherwise indicated.

The macrochemical reactions were done using white china spot plates with multiple shallow wells, each well containing a small quantity of the tissue being tested and two drops of one of the reagents. Due to the small and fragile nature of most collybioid fungi, portions of the entire cap (including surface, context, and gills) were tested rather than using only the pileal context. A small pie-shaped piece of fresh cap was cut into strips, and these transferred to the wells of the spot plate. The reactions were read after 20 minutes, and recorded if positive, as a series of "+"'s, relative to the strength of the reaction (depth of color). Since the reagents generally produce only one color change, the species descriptions indicate only whether a test was positive, not the actual color change; however, any variation from the normal color is indicated in the species description. The positive reaction for each of the macrochemical tests, and the composition and procedure used in making the reagents (given in parentheses) is as follows:

Aniline: pale lemon yellow to light orange or apricot.
(1:1 (v/v mixture of aniline oil and water.)
Ferric sulfate: pale greyish-green to medium olive.
(A 10% solution was made by dissolving 24 gm ferric sulfate in 240 ml water.)
Formol: pale yellow or orange.
(40% aqueous solution.)
Guaiacol: pinkish-red to dark reddish black.
(Dissolve liquid guaiacol in water to saturation.)
Alpha-Napthol: purple to purple-black.
(10 gm alpha-napthol dissolved in 70 ml of 95% ethanol, solution brought up to 200 ml volume with water.)
PDAB (p-dimethylamino-benzaldehyde), 2%: solution itself turns rapidly brilliant blue-green, rarely raspberry red. A faint pink-purple reaction of the gills was taken as a negative reaction.
(6.0 gm PDAB dissolved in 229 ml 95% ethanol, 71 ml conc. HCl added.)
Phenol, 2%: red to dark reddish black.
(4.8 gm carbolic acid dissolved in water and

the volume brought to 240 ml.)

Phenol-aniline: ferruginous to dark reddish umber. (2 drops each of the aniline water and phenol solutions.)

Sulfoformol: pale yellow or a pale mint green on the edges of the material tested. (2 drops 40% aquaeous solution of formol mixed with 2 drops 50% sulfuric acid.)

Tincture of guaiac: light blue to dark bluish-green. (Dissolve finely powdered gum guaiac in 95% ethanol to saturation, then filter.)

KEY TO COLLYBIOID GENERA

1. Basidia carminophilous, carpophores generally fuscous in some part and often staining blackish, reacting faintly with sulfoformol to give a mint green color and strongly and rapidly with PDAB to give a bright blue-green color to the solution.. Lyophyllum (p. 132)
1. Basidia without carminophilous granules, carpophores generally some shade of brown and never staining blackish, reacting neither with sulfoformol nor PDAB in the above manner................................. 2.
   2. Spores angular in polar view only, slightly roughened, spore print pink to dark salmon in heavy deposit.................. Rhodocybe (p. 134)
   2. Spore outline smooth both in side and polar views, not roughened, spore print white to cream, if pinkish in heavy deposit, then at least a portion of the spores with a dextrinoid endosporium..................................... 3.
3. Spores heavily granular, becoming vinaceous in KOH, carpophores olivaceous in the fresh condition, becoming deep vinaceous in drying.. Callistosporium (p. 147)
3. Spores sometimes guttate, not heavily granular, not becoming vinaceous in KOH, neither olivacous in the fresh condition nor changing to vinaceous black in drying.. 4.
   4. Spores amyloid, and either spores minute (5 µm or less) and globose to short-ovate or stipe radicating....................................... 5.
   4. Spores hyaline to reddish brown (dextrinoid) in Melzer's, spores generally at least 5 µm or ovate to ellipsoidal............................. 7.
5. Stipe radicating, under redwoods.. Caulorhiza (p. 154)
5. Stipe not radicating, carpophores not found under redwoods.. 6.
   6. Caps fuscous and radially streaked with blackish fibrills, generally 3 cm or more in diameter or carpophores densely caespitose, without cheilocystidia....................... Clitocybula (p. 157)
   6. Caps tan to violaceous, never fuscous, generally

less than 3 cm, not radially streaked with blackish fibrils nor densely caespitose, gill edge heteromorphous with short clavate-inflated cheilocystidia..... Baeospora (p. 162)

7. Pileus viscid, composed of brownish upright, partially gelatinized hairs, stipe velvety with brownish hairs...................... Flammulina (p. 170)

7. Pileus neither viscid nor the stipe velvety with brownish hairs.................................... 8.

8. Pileal surface hymeniform, composed of a palisade of inflated, pedicellate cells, pubescent with conspicuous cystidia on all surfaces, the stipe rooting, tawny, and long-tomentose in the lower half, growing generally on cones, more rarely on wood........... Strobilurus (p. 174)

8. Pileal surface undifferentiated or composed of a cutis but never hymeniform, cystidia absent or barely differentiated, the stipe neither rooting nor tawny and long-tomentose in the lower half, terrestrial or occurring on much decayed wood or mushrooms.................... 9.

9. Species growing on the tarry remains of decayed mushrooms, caps minute, generally less than 1 cm, white to fuscous, frequently with a conspicuous sclerotium (orange, brown, or black)............ .... Microcollybia (p. 187)

9. Species terrestrial or occurring on much decayed wood, caps medium-sized to large, generally at least 2 cm, some shade of tan or brown, without a sclerotium...10.

10. Spore print cream to pink in fresh heavy deposit, at least a portion of the spores with a dextrinoid endosporium, large species, cap diameter generally 5 cm and often more...... .... Rhodocollybia (p. 198)

10. Spore print white in fresh heavy deposit, spores lacking a dextrinoid endosporium, medium-sized species, cap diameter generally less than 5 cm.............. Collybia (p. 228)

LYOPHYLLUM Karst. Acta Fl. Faun. Fenn. 2:3. 1881, em. Singer. Agar. Mod. Tax. pg. 209-213. 1962.

Synonyms: Clitocybe pro parte Kummer. Führ. Pilzk. p. 26. 1871.
Collybia pro parte Kummer. Führ. Pilzk. p. 26. 1881.
Tricholoma pro parte (Fr.) Quél. Champ. Jura. Vosges. p. 76. 1872-3.
Hemicollybia G. Beck. 1922. fide Singer op. cit.

Type species: Lyophyllum leucophaeatum Karst.

PILEUS-collybioid, tricholomoid, or clitocyboid, flesh membranous to thick (10 mm) and generally concolorous with the cap, umbonate to centrally depressed, not umbilicate, margin enrolled at first and often straight at maturity, surface generally uniform, occasionally undulate, and glabrous to slightly fibrilar or pruinose-powdery, often moist-striate in the smaller species, generally dull-colored or fuscous, rarely white, hygrophanous and usually changing to a much lighter color, staining or not, smell and taste often distinctive and generally farinaceous in one of its forms (green bean, green corn, floury, linoleum, rancid, and fishy-cucumber odors).

The fuscous colors of cap, gills and stipe which are so distinct for this genus are lost in drying with few exceptions. The dried carpophores vary from bone white to fuscous, but are most often some shade of fulvous, buff, or medium brown.

LAMELLAE pallid to blackish, frequently staining bluish-black or black, edges even and usually concolorous, shape variable, subdecurrent to almost free, crowded to subdistant, and generally thin, never really thick.

STIPE pallid to blackish and generally concolorous with either cap or gills, rarely strikingly different from these, often equal but sometimes expanded at the base and somewhat club shaped although never with an emarginate bulb, many of species in the section Tephrophana having undulate stipes, and the base flexuous, species in the section Difformia caespitose and as such frequently connate and expanded at the base, the surface is usually glabrous and then sometimes powdery-pruinose at the apex or finely appressed fibrillar-streaked, not glabrescent; solid, stuffed or hollow; with or without a rind, sometimes staining readily black or darkening slowly with handling or age.

BASIDIA conspicuously granular and the granules stain a dark reddish-black in acetocarmine. The size of the basidia vary widely, 15-40 µm x 5-10 µm, the spores globose, ovate, cylindrical, or ellipsoidal, and rarely exceed 10 µm in length or 6 µm in diameter. They are smooth, angular, or echinulate, and inamyloid, the TRAMA parallel to subparallel with a mediostatum of large cells which intergrades with narrower hyphae next to the subhymenium, and if this feature is well developed the gill trama looks almost divergent in transverse section; tramal hyphae frequently slightly dextrinoid, quite large (3-25 µm, average about 7-8 µm), and abundantly provided with conspicuous large clamps; CHEILOCYSTIDIA generally not present or inconspicuous and rarely exceeding the height of the basidioles; PILEAL SURFACE frequently undifferentiated from the context, or composed of a cutis of varying thickness of narrow, radial, repent, tubular hyphae; occasionally both surface types becoming subgelatinized; contextual hyphae much like the hyphae found in the lamellar trama and relatively large and clamped, brownish pigments sometimes present and encrusting the pileal surface hyphae, rarely giving the cuticular hyphae a thick and patterned encrustation; in the black staining members of the section Lyophyllum the basidia usually irregularily coated with an extra-cellular pigment which appears sticky and takes on a dark dingy dextrinoid reaction in Melzer's solution.

HABITAT - The carpophores are caespitose to solitary and found most frequently on soil or mulch. They seem to be rare on wood but a group of species is characteristically found on charred wood or ground. One species, L. palustre (Peck) Singer, is encountered only in association with Sphagnum, and is apparently the only possible exception to the rule of saprophytism in the genus.

MACROCHEMICAL REACTION - The caps give a faint but distinct green reaction in sulfoformol, and a solution of PDAB turns rapidly bright blue-green when in contact with any part of the carpophore. This combination of reactions seems to be specific for Lyophyllum. In addition, many species of this genus react with aniline to give a yellow or apricot color, a reaction which is distinct and found in few of the other collybioid species studied. There is variability in the reactions with alpha-napthol, guaiacol, tincture of guaiac, phenol, and phenol-aniline and as more data is accumulated these reactions may prove helpful in delimiting certain species.

The carminophilous basidia, the reaction of the flesh with PDAB and sulfoformol, and the fuscous shades of cap, gills and stipe seem to delimit the genus from closely related genera, especially Collybia and Clitocybe. In addition, the bruising reactions, extracellular pigment on the basidia, large hyphae of trama and context, weak dextrinoid character of the trama, farinaceous odors, and reactions with aniline tend to hold the genus together, although somewhat loosely.

RHODOCYBE R. Maire sensu Singer emend. Bull. Soc. Mycol. Fr. 40:298. 1925.

Synonyms: Clitopilopsis Maire, Publ. Inst. Bot. Barcelone 3(4):82. 1937.
Hirneola Velen., Nov. Myc., p. 73. 1939. non Fr. (1849).
Pluteospora Maire, Bull. Soc. Mycol. Fr. 50:xxii. 1935.

Type species: Rhodocybe caelata (Fr.) R. Maire

HABIT variable, collybioid, mycenoid, omphalioid, clitocyboid, tricholomoid, or pleurotoid; pileus pigmented or not.

LAMELLAE adnexed, adnate, or decurrent, sometimes rounded to sinuate, sometimes initially ascending, generally rather thin, often close or crowded, edges normally even and concolorous, pallid to medium colored, generally with a pinkish tinge; spore print pink to salmon grey, very pale to the color of a Rhodophyllus print or somewhat greyer.

STIPE variable, following the habit, attachment generally central.

SPORES hyaline to pale stramineous in transmitted light, rough, warty or spinose, some almost smooth, sometimes rounded-angular to rather strongly angular in polar view (a minority of spores then also somewhat angular in profile), generally ovate to ellipsoidal, nonamyloid; BASIDIA four-spored or more rarely two-spored, without carminophilous granulation; CHEILOCYSTIDIA differentiated or absent, pleurocystidia differentiated or absent, sometimes arising from the gill trama and continuous or not with a system of conducting elements, not gleocystidioid nor macrocystidioid, not laticiferous, although often strikingly colored; GILL TRAMA strictly regular, consisting of long filamentous, parallel or sub-parallel hyphae; PILEAL SURFACE consisting of filamentous hyphae forming a cutis, these hyphae generally not at all interwoven but instead radially arranged; trama and pileal context with or without clamps; all tissues nonamyloid.

HABITAT: Terrestrial or on wood, solitary to caespitose.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap are generally quite reactive and most collections are positive to alpha-napthol, guaiacol, tincture of guaiac, phenol, phenol-aniline, and ferric sulfate. In addition, there are variable or weak reactions with aniline, formol, and sulfoformol.

Maire (1925) defines Rhodocybe very narrowly and includes only those species having nonencursted, refractive pleurocystidia, roughened spores which are pink in deposit and not angular in any view; with a clitocyboid habit, and with definitely decurrent gills (no mention was made of clamps). Singer has emended the genus to include a wide variety of habits, and more variability in spore shape and ornamentation, as well as the absence of cystidia or their type, if present. He continues to emphasize the presence of pink spores, which are roughened, although never truly angular, and adds the absence of clamps as a distinguishing feature. Unfortunately, in one of his largest sections (Nitellinae) in the genus, he includes as the type, a species with clamps. Therefore, I have included in Rhodocybe species with clamps and have followed Singer's system rather closely while emending it to include those species that are clamped. At the same time, such an emendation draws the genus very close to Lepista, which is usually distinguished from Rhodocybe by the presence of clamps, the absence of cystidia of any kind, and by spores which are always uninucleate. Since Lepista rarely approaches a collybioid habit and is so often large and fleshy, the distinction between the two genera can often be made on the macroscopic level for the size of species that are included here in Rhodocybe.

Key to the Sections of Rhodocybe

1. Species without any cystidia whatsoever, pileal flesh some shade of orange or fulvous, at least at maturity .... 2.
    2. Pileus at first "hair brown" or "mummy brown", changing to "ochraceous-tawny" and "cinnamon-brown", spores ovate to subglobose, echinuate... .... Section Echinosporae (p. 136)
    2. Pileus unchanging, some shade of rusty orange, fulvous, deep cinnamon, brownish yellow, or tan; spores generally ellipsoid, occasionally ovate to subglobose, coarsely roughened to subangular especially in end view.......................... .... Section Nitellinae (p. 138)
1. Species with pleurocystidia, often very striking and colored (rarely absent), pileus white or some shade of grey or fuliginous-fuscous........................ .... Section Rhodocybe (p. 145)

Section Echinosporae Lennox nom. nov.

Habitus collybioideus, pileus primo fuscus vel atrofuscus, in maturitate laete fulvoferrugineus, quasi "ochraceous tawny" vel "cinnamon brown"; cystidia desunt; sporae ovatae vel subglobosae, echinulatae; in reliquiis putrefactis fungorum carnosorum crescens.

Type species: Collybia olympiana Smith. Contrib. Univ. Mich. Herb. No. 5:13. 1941.

Habit collybioid, pileus some shade of grey or fuscous at first, changing gradually to rather bright reddish tones at maturity, near "ochraceous-tawny" or "cinnamon-brown"; no cystidia; spores echinulate, with rather short, coarse, blunt-pointed projections, ovate to subglobose; on decayed remains of fleshy fungi; with one species in this area.

Smith considers Collybia olympiana very closely related to Collybia tylicolor and Collybia erosa of Europe, which have the same echinulate spores and color change from fuscous to reddish tones at maturity. However, the two latter species are now frequently considered in the genus Lyophyllum (Kuhner and Romagnesi, 1953; Metrod, 1952). In contrast, at least in the dried condition, the basidia of C. olympiana are not carminophilous.

1. Rhodocybe olympiana (Smith) Lennox comb. nov. Figure 1
Basionym: Collybia olympiana Smith. Contrib. Univ. Mich. Herb. No. 5:13. 1941.
Illustrations:
Smith, Ibid., Plate I.

PILEUS 1 - 2.5 cm broad, convex or with a slight obtuse umbo when young, the margin incurved, becoming broadly convex, plane, or with a low obtuse umbo and a decurved margin in age, surface covered at first by a thin coating of silvery fibrils giving the cap a silvery appearance, "hair brown" to pale lead color beneath the fibrils, glabrescent or remaining faintly silky, the disk becoming "mummy brown" and the margin whitish or merely "avellaneous" over all, then gradually changing to brown and finally becoming "ochraceous-tawny" over the marginal area and "cinnamon-brown" (bright reddish brown or rusty brown) over the disk, translucent-striate in age and then appearing hygrophanous, fading very slowly; flesh thin, soft, concolorous with the surface, odor and taste strongly farinaceous.

LAMELLAE adnate, very pale whitish grey when young, slowly becoming sordid brown, edges even, close, 25-27 reach the stipe, two tiers of shorter individuals, broad and becoming ventricose (about 3 mm).

STIPE 4-6 cm long, 2-2.5 (3) mm thick, surface at first coated with pale silvery grey fibrils (similar to those of the pileus) and appearing greyish, sometimes minutely squamulose above, slowly glabrescent, becoming sordid tawny brown in age, base sparsely fibrillose to myceliod and deeply sunken into the substratum; equal and flexuous, cartilaginous, hollow, no sclerotium present.

SPORES 6-7 x 4.5 x 5 µm, broadly ovate to subglobose, echinulate, hyaline, rather thick-walled, nonamyloid, and white in deposit; BASIDIA 22-28 x 7-9 µm, four-spored, with large rather stout sterigmata, not carminophilous when tested in the dried condition; TRAMA of large diameter cells (7-25 µm), parallel, clamped, and slightly dextrinoid; no cystidia differentiated, PILEAL SURFACE a cutis of only slightly narrower cells and not gelatinized, sordid yellowish in iodine.

MACROCHEMICAL REACTIONS: No data available.

MATERIAL STUDIED: WASHINGTON, Clallam Co., Sm 14537 (paratype - Crescent Beach); CANADA, ONTARIO, Sm 4527 (paratype - Lake Timigami).

This apparently very rare and very distinct species is difficult to place in any of the collybioid groups. Smith remarked that "the Ontario specimens were old when collected, and the dark reddish brown colors caused me to place them tentatively near Collybia nitellina"; this resemblance is still quite evident in those same specimens in the dried condition. It was this rather striking resemblance as well as the lack of a more suitable taxonomic position, that has prompted me to place this species tentatively in the genus Rhodocybe. It, nonetheless, is strikingly different from the other species of the genus in the ornamentation of its spores, and according to Smith the spore print is white. It is conceivable that, as the carpophores are fairly small and fragile, the spore deposit was thin and any pale pinkish spore color would appear white. It is also possible that this species is closer to a Lyophyllum, and perhaps the carminophilous reaction is lost in drying and with age. Until more information is available on spore print color and carminophilous nature in the fresh condition of the basidia, this species will remain difficult to place.

Section Nitellinae (Sing.) Sing. Agar. Mod. Tax. Lilloa 22:308. 1949. (publ. 1951).

Type species: Rhodocybe nitellina (Fr.) Singer. Agar. Mod. Tax. p. 677. 1962

Habit collybioid, sometimes resembling a Hebeloma or a small Tricholoma; pileus some shade of rusty orange, fulvous, deep cinnamon, brownish yellow, or tan, not darker and with blacker tones in young specimens; no cystidia, or clavate and not exceeding the basidioles; spores coarsely roughened to subangular, especially in end view; terrestrial or on wood.

The species of this section seem somewhat heterogeneous in macroscopic character but are easily recognized by their small collybioid carpophores, pink spore print, roughened non-angular spores and lack of cystidia.

Key to the Species of Section Nitellinae

1. Carpohores fulvous or rusty colored throughout, terrestrial, solitary to scattered.. Rhodocybe nitellina (p. 139).
1. Carpohores in part some shade of warm tan to pinkish buff, never a fulvous or rusty orange, generally on wood, gregarious to caespitose.................... 2.
   2. Carpophores uniformly tan or pinkish buff, resembling a small Hebeloma, spores ellipsoid, 7-10 x 4.5-6 µm.. Rhodocybe roseiavellanea (p. 140).
   2. Carpophores not uniformly colored, having a warm tan cap, rosy-pink gills at maturity, and a pallid to yellowish stipe; collybioid, spores subglobose to ovate, 5-6.5 x 4.5-5.5 µm............................ Rhodocybe speciosa (p. 143)

2. Rhodocybe nitellina (Fr.) Singer, Agar. Mod. Tax. p. 677. 1962. Figure 3; Plate I

Basionym: Agaricus nitellinus Fries. Epic. Syst. Mycol. p. 80. 1838.
Synonyms: Collybia nitellina (Fr.) Quél. Les Champ. Jur. Vosges Soc. Emul. Montbéliard, sér. II, 5:434. 1875.
Gymnopus sublatericius Murrill, N. Am. Flora 9(5):369. 1916.
Collybia sublatericia (Murr.) Murr. Mycologia 8:219. 1916.
Rhodopaxillus nitellinus (Fr.) Singer Das System der Agar., Ann. Mycol. 41:90. 1943.
Illustrations: Fries, Icones Hymenom., tab. 65, fig. 1-2; Britz, Hymenon, tab. 100, fig. 525; Cooke, Illustr. Brit. Fungi, tab. 146.

PILEUS 1.2-3.7 cm, evenly orangish or pinkish cinnamon (7E8 to 5B6), occasionally darker centrally, hygrophanous and changing colors only slightly (7C7 or 6C7), convex becoming plane, often centrally depressed, more rarely with a broad shallow umbo, margin even, becoming frayed or almost crenate in large and old specimens; surface glabrous, moist, dull, translucent-striate for half the radius, margin becoming somewhat plicate in older specimens, context very thin (1 mm), concolorous, hygrophanous, rather tough, almost pliable; taste and smell strongly farinaceous.

LAMELLAE pinkish buff (5A4 to 5A3), or with a stronger incarnate tinge, occasionally staining faintly yellowish where bruised, edges even, adnate to emarginate-uncinate, thickish, broad, 5 mm x 11 mm, subdistant, 28 gills reaching stipe apex.

STIPE 2-6.4 cm x 2-8 mm, concolorous with the cap or only slightly lighter, uniformly colored, equal, occasionally slightly larger toward the apex, surface undulate to knobby, and with the fibers often twisted, glabrous above a fine appressed white coat of mycelium at very base, shining, terete to compressed in larger specimens, flexuous, solid with a somewhat lighter core, fragile to almost brittle.

SPORES 7-11 x 4.5-6 µm, thick walled, coarsely roughened, sometimes rather faintly so, never appearing really angular either in polar view or profile, rather dark salmon brown in deposit, ovate to ellipsoid, nonamyloid; BASIDIA 26-33 x 6-8.5 µm, elongated, expanded toward apex, rather narrow in lower half, occasionally entirely four-spored, more often mixed, some collections with only two-spored basidia; no cystidia differentiated; GILL TRAMA parallel of short, broad, clamped cells, 4-19 µm in diameter, averaging 10 µm, PILEAL SURFACE undifferentiated or with only uppermost cell layer somewhat narrower than the contextual hyphae, nonamyloid, not encrusted; CONTEXT composed of entirely radial hyphae which are rather short and broad, 10-15 x 37-50 um, nonamyloid.

HABITAT: solitary, sometimes scattered; in dense conifer woods; autumn or spring.

MACROCHEMICAL REACTIONS: Gills and the flesh of the cap react positively with alpha-napthol, and guaiacol. Reactions with tincture of guaiac and ferric sulfate are either faint or sporadic.

MATERIAL STUDIED: WASHINGTON, San Juan Co., W542, W1076, W1323, W1748 (Friday Harbor Biological Station); Jefferson Co., W1011 (Quilcene turnoff); Mason Co., W1175, (Staircase); Thurston Co., W498, W1260; Skagit Co., W1694 (Mineral Park); Snohomish Co., W1148 (S. of Darrington); King Co., W1132 (McClellan's Butte); Pierce Co., W1216 (Ipsut Creek); Okanogan Co., W637 (Early Winters Camp); Skamania Co., W1276 (Cispus); IDAHO, Bonner Co., W926 (Chase Lake).

2. Rhodocybe roseiavellanea (Murr.) Singer. Agar. Mod. Tax.:677. 1962. Figure 2; Plate I.

Basionym: Pleuropus roseiavellaneous. Murrill. Mycologia 30:367. 1938.

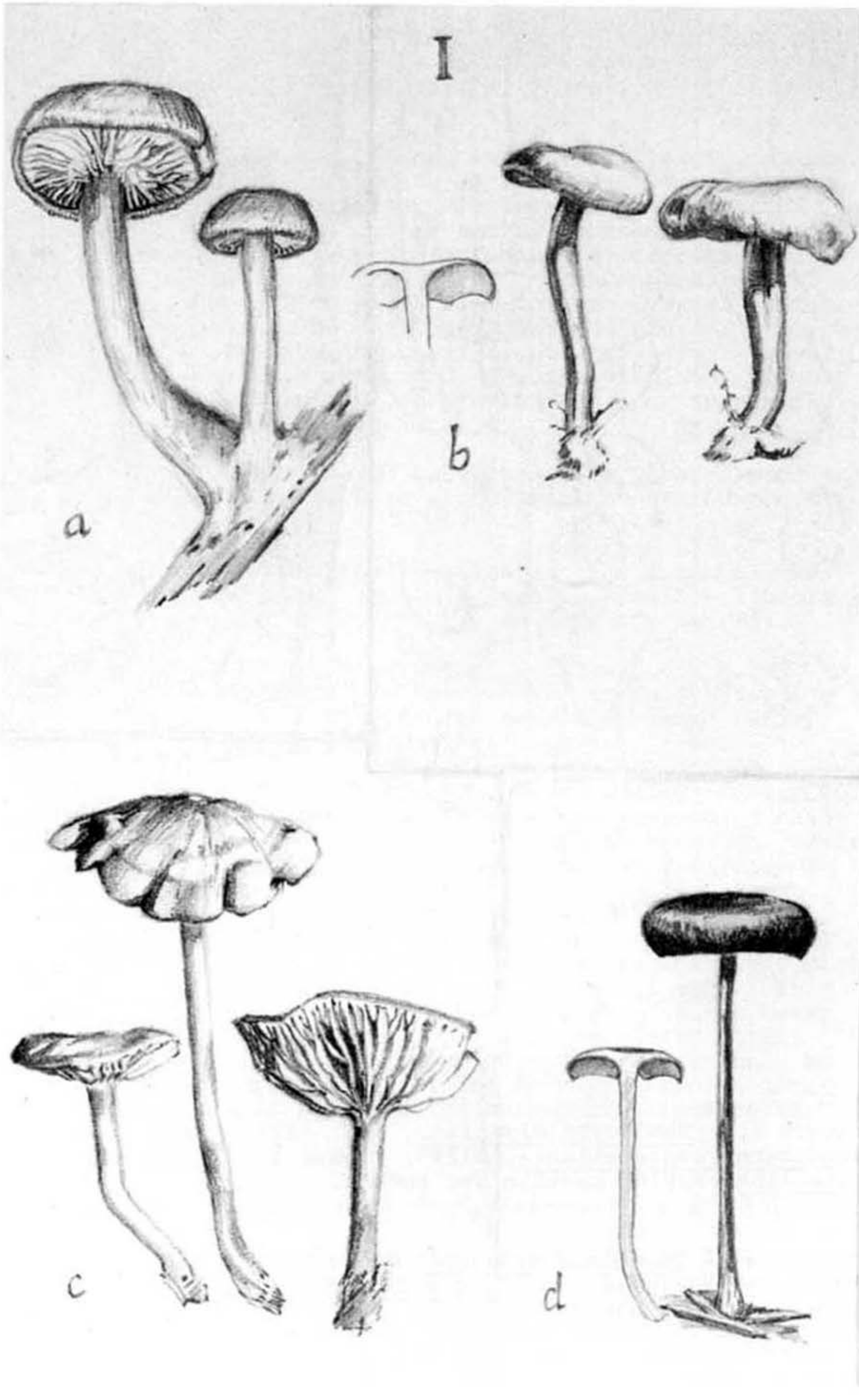
PILEUS 1.1-3.2 cm, buff to a rufous tan (5A5 to 6D5), uniformly colored or somewhat lighter toward center, subhygrophanous and hardly changing color; convex, then plane, often centrally depressed, margin regular and remaining inrolled or becoming straight; surface glabrous, never really moist or shining, dull-matte, sometimes appearing finely fibrillar under a lens, not translucent-striate, sometimes split, not frayed at the margin; context firm, tough, not pliable, somewhat corky, concolorous; odor none to aromatic, taste fruity to farinaceous.

LAMELLAE tan to pinkish buff (5A2 to 6B3), broadly adnate emarginate, insertion variable, rather broad to very broad, 6 x 10 mm, subcrowded, sometimes rather thin as well, edges concolorous and even but generally wavy and often splitting, 3-4 tiers, sharp-pointed towards the margin and blunt at the stipe, somewhat ventricose.

STIPE 3.5-7.5 cm x 2-9 mm, concolorous with the gills or somewhat darker (5A2 to 7D4), uniformly colored, equal or tapering slightly downward, terete to compressed, flexuous at the base, surface glabrous, dull, finely grooved or

---

PLATE I: a - Rhodocybe speciosa nom. prov. W1502, x1; b - Rhodocybe roseiavellanea W1294, x 1; c - Rhodocybe nitellina, W1175, W1148, x 1; d - Rhodocybe aureicystidiata nom. prov., W1319, x 1.


I
a
b
c
d

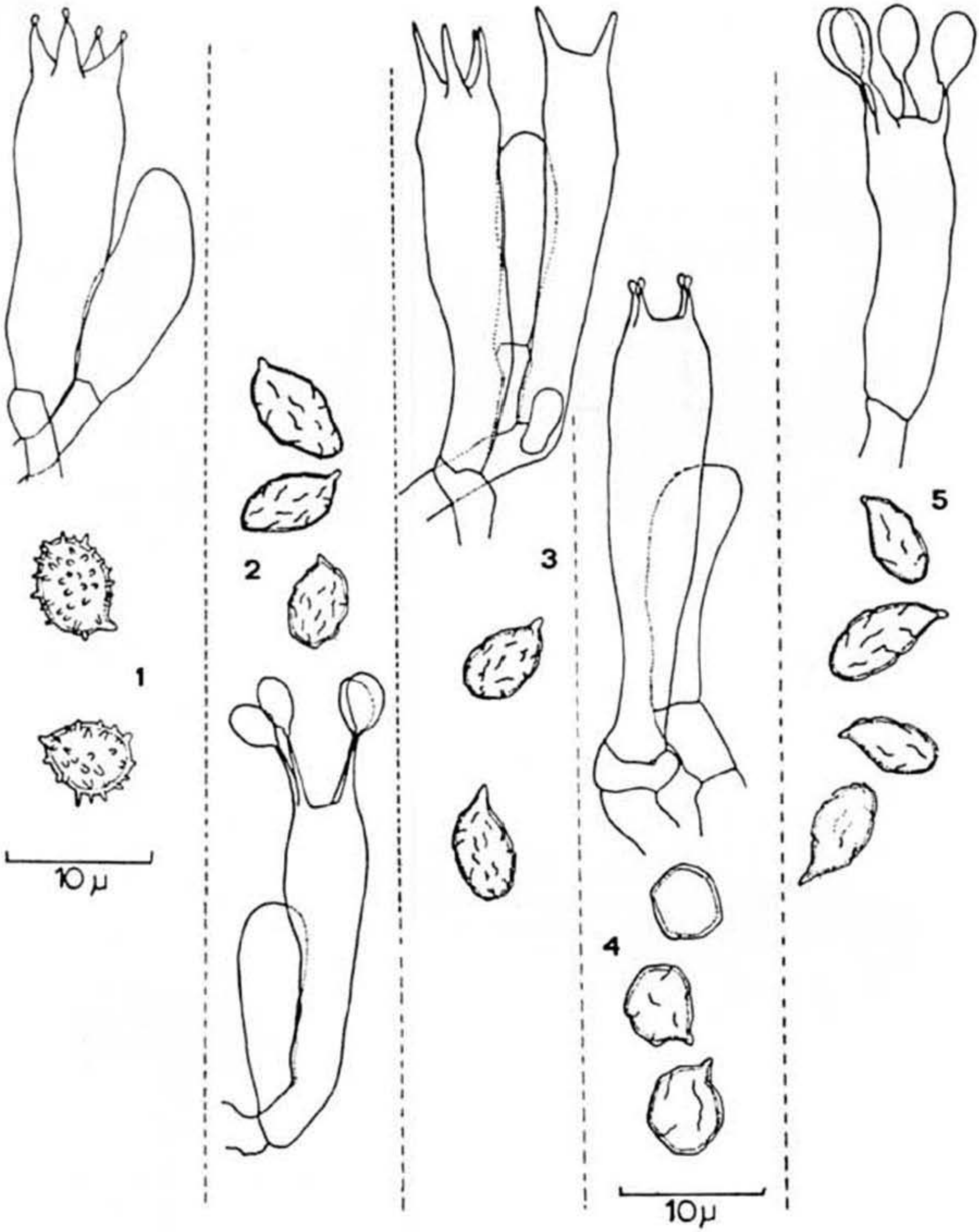


Figure 1. - Rhodocybe olympiana, AHS. 4527; Figure 2. - Rhodocybe roseiavellanea, W1295; Figure 3. - Rhodocybe nitellina, W1076. basidia and spores.

Figure 4. - Rhodocybe speciosa nom. prov., W1533, basidium and spores; Figure 5. - Rhodocybe aureicystidiata, W1319, basidium and spores.

striate occasionally, and then silky, not moist, base with a matted yellowish tomentum or without, generally very tightly adherent to the substratum by short white rhizomorphs.

SPORES (6) 7-10 x 4.5-6 µm, ovate to ellipsoid, rather coarsely roughened, a minority of the spores appearing angular in polar view, rather thick-walled, monamyloid; BASIDIA 22-31 x 5-7 µm, rather narrow, thin-walled, nonamyloid, two-spored, four-spored, or more often mixed, exceeding basidioles by 4-10 µm; GILL TRAMA parallel, without clamps, hyphae 2-15 µm in diameter; no cystidia differentiated, or present but not appreciably different than the basidioles, PILEAL SURFACE undifferentiated or with a very thin cutis, sometimes encrusted or subgelatinized, without clamps, nonamyloid, the PILEAL CONTEXT more or less radial, averaging 4-8 µm in diameter.

HABITAT: Gregarious to caespitose, on decayed wood or Douglas fir cones, sometimes terrestrial under redwood or fir.

MACROCHEMICAL REACTIONS: Gills and the flesh of the cap react faintly with guaiacol; reactions with sulfoformol (yellow) and ferric sulfate (grey-green) were sporadic.

MATERIAL STUDIED: WASHINGTON, San Juan Co., W1294 (Friday Harbor Biological Station); Kitsap Co., W950 (Symington Lake), King Co., W1060 (Snoqualmie Pass); CALIFORNIA, Mendocino Co., W1335 (Woodlands Camp).

The Washington and California material studied seem to agree fairly closely with the Murrill description of this species; it does differ in a number of characters and after examination of the type and further study of variation in the species, it may warrant being given specific status. The Murrill Florida species is described as having adnate to short-decurrent, medium-distant gills, a stipe up to 1 cm thick and bulbous at the base, and spores which are pink but smooth and ovoid; no mention of clamps is made. In addition, this species occurred under live oaks. A heavy reliance has been placed on the fact that Singer (1962) placed this species in the genus _Rhodocybe_; presumably he had examined the type material and found the spores actually to be rough-walled, and the carpophores lacking in clamps.

4. _Rhodocybe_ _speciosa_ nom. prov. Figure 4; Plate I.

PILEUS 1.4-3 cm, tan or honey-brown (5C5 to 5E5), uniformly colored, hygrophanous and drying in a streaked manner to a light warm tan (5B3 to 5C4); convex and becoming almost plane, even and symmetrical, sometimes shallowly depressed at the center, margin inrolled to parallel with the stipe, not raised above the point of gill attachment; surface even, dry, and glabrous, occasionally appearing somewhat powdery, not translucent-striate; context rather thick, 2-3 mm, concolorous, dry, firm-fibrous, almost tough; odor faint to distinct and then farinaceous with a strong sweet tone, taste delayed farinaceous, strong.

LAMELLAE almost white in young specimens, turning rapidly pink or light pinkish orange (5A3 to 6B3), edge concolorous, and even or serrulate, thinnish and subdistant, 48-56 lamellae reaching stipe apex, 4-5 tiers; broad, 7 x 13 mm, consistency rather soft, sharply sinuate but attached broadly, amost uncinate but never appearing subdecurrent, easily seceding; hardly ventricose and blunt-pointed both at the margin and stipe.

STIPE 3-4.5 cm x 3-8 mm, light yellow to pale orangish (5A4 or 5B4) at the apex, uniform or darkening slightly downward (5B5), perhaps yellowing in handling; expanded just at the top and base, equal between, surface moist but rather dull, thinly powdery-pruinose at the apex, appearing finely silvery-fibrillar streaked midway and especially in drying, with a white matted basal tomentum, flexuous, solid to hollow, terete or compressed in larger specimens, frequently connate at the base, without rhizomorphs.

SPORES 5-6.5 x 4.5-5.5 µm, subglobose to broadly ovate, coarsely roughened or wrinkled-angular, appearing angular in polar view and occasionally in profile as well, rather thick-walled, nonamyloid, deep pink to salmon brown in deposit (7C6); BASIDIA 24-31 x 7-8.5 µm, four-spored, cylindrical to abruptly expanded in upper half, nonamyloid and noncarminophilous; GILL TRAMA parallel and CLAMPED, nonamyloid, 3-12 µm in diameter, faintly encrusted (?), with a very narrow subhymenium; PILEAL SURFACE undifferentiated, surface hyphae somewhat enlarged over those of the context (6-10 µm, averaging about 7-8 µm in diameter), radial, thinly encrusted, almost cystidiate but entirely repent, nonamyloid and clamped; PILEAL CONTEXT of rather compact hyphae 3-8 µm in diameter (average about 5 µm), nonamyloid; no cystidia differentiated, basidioles sometimes appearing rather vesicular and cystidiate.

HABITAT: Gregarious to caespitose on decayed wood in coniferous woods.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with aniline (peach pink), phenol, phenol-aniline, and ferric sulfate. There was variability in reactions to tincture of guaiac, formol (gills reddish), and sulfoformol (olive).

MATERIAL STUDIED: WASHINGTON, King Co., W1533 (Denny Creek), W1502 (Snoqualmie River near North Bend); Pierce Co., W1701 (Tahoma Creek, Mt. Rainier National Park).

This is a handsome species of Rhodocybe which is easily characterized by its pink gills, yellowish stipe, fragrant-farinaceous odor and taste, subglobose subangular thick-walled spores, and its reactions with aniline, phenol, and phenol-aniline only, which is unusual since most Rhodocybes react with guaiacol, and alpha-napthol as well.

Section Rhodocybe Singer. Agar Mod. Tax.: 678. 1962.

Type species: Rhodocybe caelata (Fr.) Maire. Bull. Soc. Mycol. Fr. 40:298. 1925.

Pileus variously colored, habit collybioid to clitocyboid, pleurocystidia present, striking, colored, often continuous with a conducting system in the trama, spores roughened, not subangular, without clamps.

The species of this section probably form a natural unit, and are easily distinguished on a microscopical basis. There is one species of the section in this area.

5. Rhodocybe aureicystidiata nom prov. Figure 6; Plate I.

PILEUS 1.4-2.4 cm, dark fuscous brown, hyrophanous and drying somewhat lighter (5F5, then 5E4), stains dark red where bruised or decayed, this reaction easily overlooked due to the dark color of the carpophores; convex and then plane and then shallowly depressed, margin even and remaining inrolled at maturity, surface moist, glabrous, drying dull-matte, context concolorous, firm, rather thin, almost tough; taste and odor none.

LAMELLAE almost concolorous with the drying cap, or with a stronger pinkish tone (5C4), broadly adnate to shallowly emarginate-uncinate, not really appearing subdecurrent at maturity, easily seceding, blunt-pointed at the stipe, somewhat pointed toward the margin, rather thick and distant, 20-24 lamellae reaching stipe, broad, 7-8 mm x 4 mm, consistency brittle, edges even but somewhat lighter.

STIPE 4.5 -6 cm x 2-3 mm, darker than drying cap, fuscous brown (6F3), staining dark reddish where bruised or with age, equal, strict or flexuous, surface moist, shining and glabrous, with a white appressed fibrillose mat at the base, solid, firm, somewhat pliant, not really tough.

SPORES 7-8.5 (11) x 3.5-5.0 µm, ellipsoid, coarsely roughened, not angular in polar view or profile, nonamyloid, thick-walled, with a long, sharp apiculus; BASIDIA 27-34 x 6-7 µm, elongate, four-spored; GILL TRAMA parallel, without clamps, with laticifer-like conducting elements filled with yellowish refractive granular material, composed of hyphae 3-16 µm in diameter, with a rather deep interwoven subhymenium, nonamyloid; CHEILOCYSTIDIA and PLEUROCYSTIDIA similar, abundant, striking, occasionally continuous with the con-

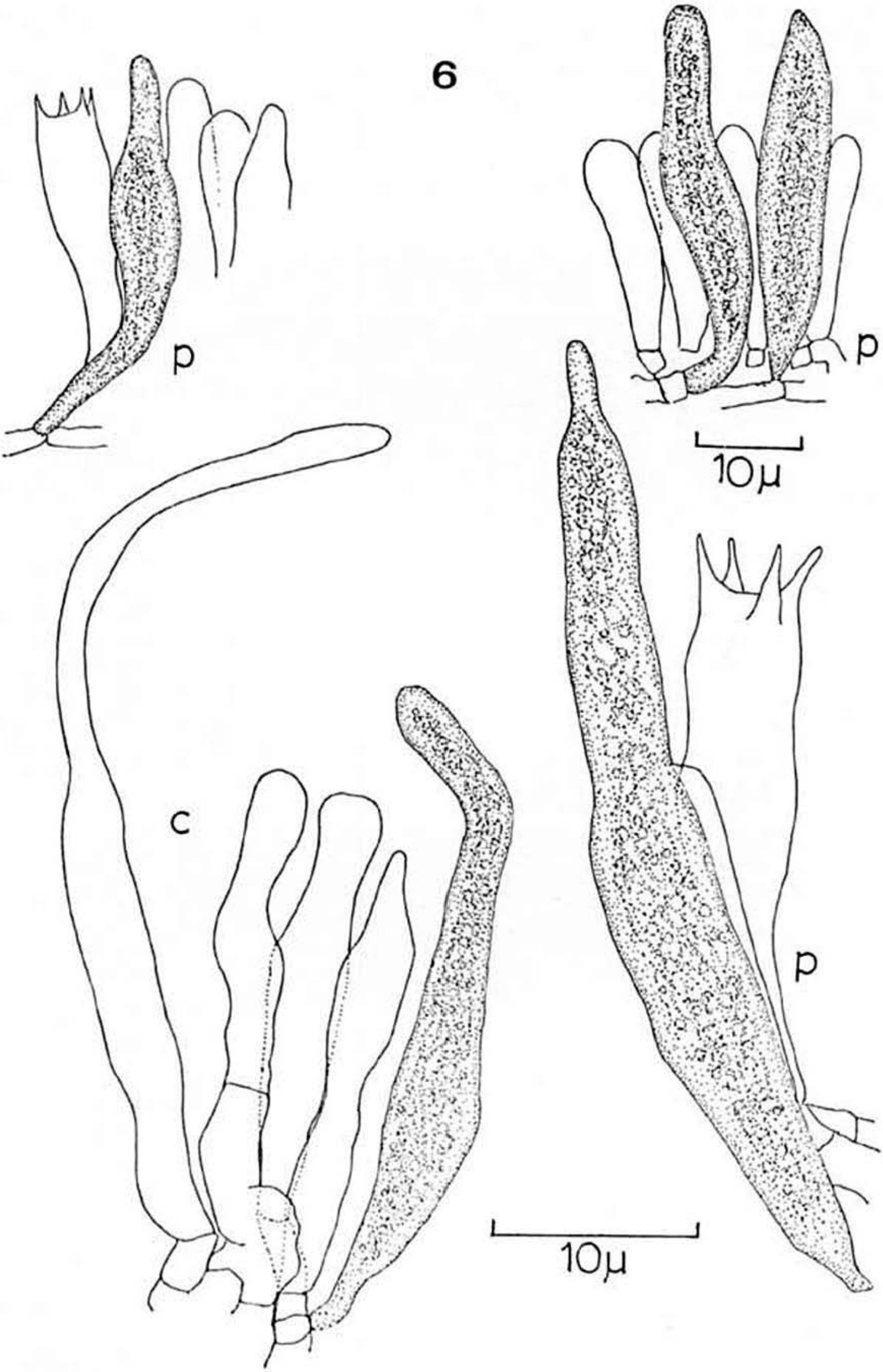


Figure 6. - Rhodocybe aureicystidiata nom. prov. W1319, cheilocystidia (c), pleurocystidia (p).

ducting system of the trama, filled with yellowish, refractive, granular material, clavate-acuminate to filamentous, 39-60 x 5-7 µm, nonamyloid; no other cystidia differentiated; PILEAL SURFACE a cutis of narrow repent, radial hyphae, intergrading with the contextual hyphae in size and compactness, encrusted in irregular patches giving the wall a beaded appearance in profile, 1-4 µm in diameter; CONTEXTUAL HYPHAE mostly radially oriented, rather compact, and composed of hyphae 4-20 µm in diameter; STIPE composed of hyphae oriented longitudinally, narrow, 2-3 µm in diameter on the outside, less compact toward the center, thin-walled (less than 1 µm), not encrusted, without clamps.

HABITAT: Scattered to solitary under conifers.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with aniline (apricot orange), alpha-napthol, guaiacol, tincture of guaiac, formol (olive green), sulfoformol (orange yellow), phenol (faint, orangish), phenol-aniline (apricot), and ferric sulfate. The cystidia and conducting elements of the trama were sulfobenzaldehyde negative.

MATERIAL STUDIED: WASHINGTON, Thurston Co., W1319 (Miller-sylvania); CALIFORNIA, Mendocino Co., W128 (15 mi. N. of Willits); Humboldt Co., W169 (Patrick Point State Park).

This species is very close to the type species of the genus, Rhodocybe caelata (Fr.) Maire, and the microscopic characters seem to differ only in one respect: the cystidia of R. caelata are much longer (60-80 x 6-7 µm). From a macroscopic view however the two species appear to diverge rather markedly: while R. caelata has greyish colors on the cap and stipe, these lack the dark fuscous, almost black tones found in R. aureicystidiata; R. caelata is also described and illustrated by Maire (1925 as being deeply umbilicate, having pinkish buff gills which are deeply decurrent even in immature specimens, lacking the dark reddish staining reaction, and occurring under hardwoods, especially Quercus - all characters distinctly different from those of R. aureicystidiata nom. prov.

CALLISTOSPORIUM Singer. Mycol. 36:363 1944.

Synonyms: Collybia Kummer pro parte. Führ. Pilzk. p. 26. 1881.
Gymnopus Roussel. Fl. Calvados ed. 2 p. 62. 1806.

Type species: Callistoporium palmarum (Murrill) Singer.

PILEUS collybioid, convex and then plane, either umbilicate or umbonate, but not strongly so; context generally thin and firm; pigmentation in the fresh condition some shade of yellow or tan with a strong olivaceous tone, hygrophanous, changing to a dark vinaceous brown in the dry condition; odor frequently farinaceous, taste generally strong.

LAMELLAE adnexed to adnate, concolorous with the cap or yellow, edges concolorous and even, often with a rather waxy appearance, thick and subdistant, spore print white, sometimes changing in drying to a faint flesh color.

STIPE concolorous with the cap, central, equal, faintly fibrillar-streaked to almost scurfy, generally rather tough, not pliant, changing like the cap to a dark vinaceous brown.

SPORES subglobose to ellipsoid, at least 4 x 3.5 µm, hyaline in the fresh condition, pigmented in the dried condition, the pigment intracellular and discrete or dispersed, stramineous to vinaceous, generally darker and more vinaceous in 3% KOH, present in a small percentage of the spores; BASIDIA four-spored, some pigmented like the spores; CHEILOCYSTIDIA general absent, if present then filamentous to clavate, generally somewhat irregular and contorted, hyaline, rarely longer than the basidia; no PLEUROCYSTIDIA; PILEOCYSTIDIA differentiated or more rarely absent, clavate to filamentous, grouped or scattered; PILEAL SURFACE a cutis of radial, repent, pigmented hyphae, somewhat smaller than those of the context; LACKING CLAMP CONNECTIONS.

HABITAT: Solitary to caespitose on much decayed wood in mixed or coniferous woods.

MACROCHEMICAL REACTIONS: The species of this region react very faintly or not at all with most spot tests employed. Ferric sulfate tends to deepen the greenish color of the carpophores, and sulfoformol makes them yellower.

This genus is easily differentiated from other genera by its collybioid, lignicolous habit, striking color change from the fresh to dried condition, the intracellular pigment, and the lack of clamp connections.

Key to the *Callistosporium* Species

1. Pileus generally smaller than 2 cm, convex, margin remaining inrolled, not centrally depressed, spores 6.5-8 x 4-5 µm............ *C. graminicolor* (p. 152)
1. Pileus often larger than 2 cm at maturity, convex and then plane, generally shallowly umbilicate to centrally depressed, spores 4-5.5 x 3.5-4.5 µm.... .... *C. luteo-olivaceum* (p. 148)

6. *Callistosporium luteo-olivaceum* (Berk. & Curt.) Singer. Lilloa 22:233. 1951. Figure 7, Plate II.

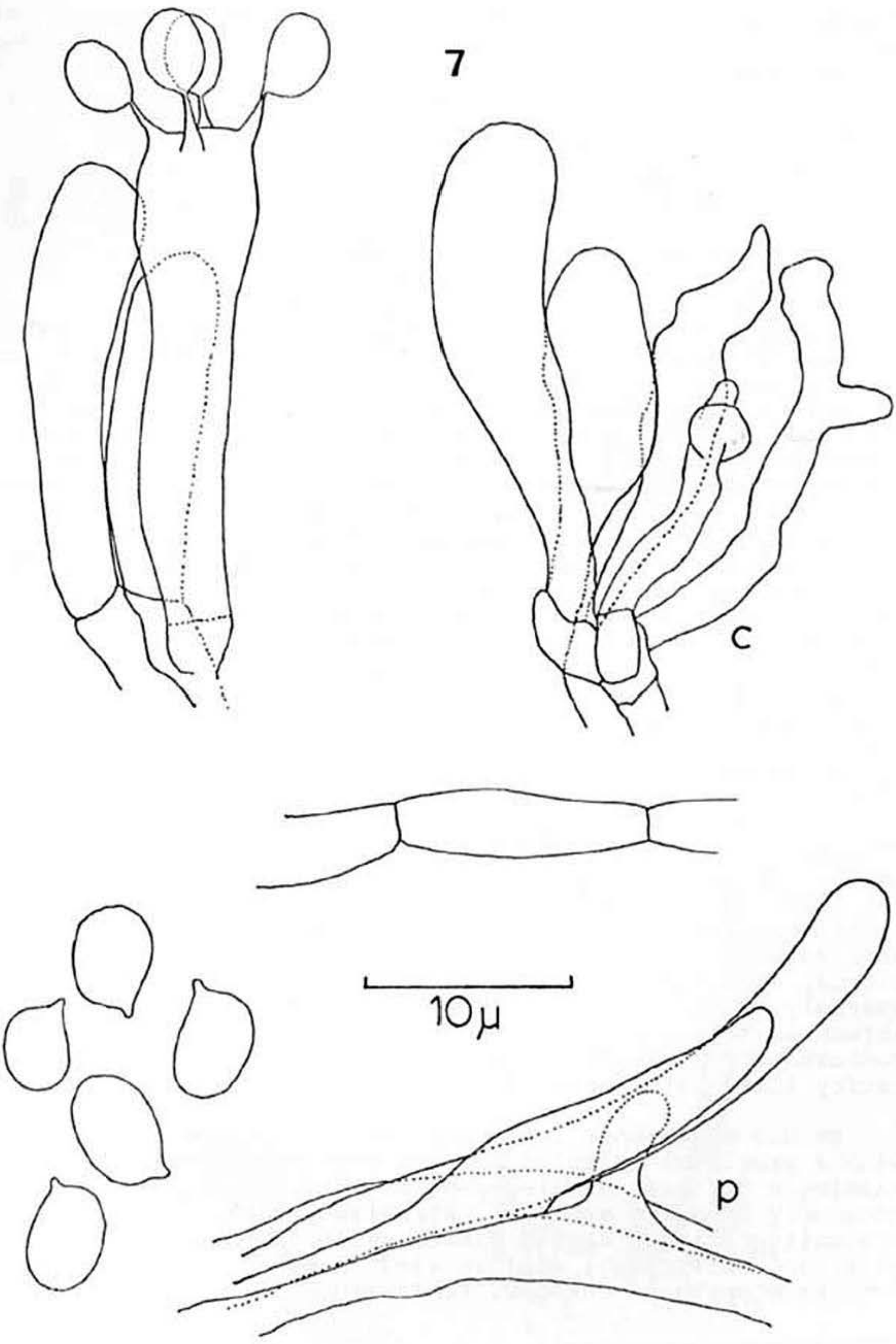


Figure 7. - Callistosporium luteo-olivaceum, Peck type, basidium, hyphae and spores; W1156, cystidia on pileal surface (p), cheilocystidia (c).

Basionym: *Agaricus luteo-olivaceus* Berk. & Curt. Ann. Mag. Nat. Hist. IV, 3:286. 1859.

Synonyms: *Collybia luteo-olivacea* (Berk. & Curt.) Sacc. Syllo. Fungorum 5:215. 1887.
Collybia colorea Peck. N.Y. State Mus. Rep. 26, 1874.
Callistosporium psilocybe Murr. & Singer. Mycologia 36:363. 1944.

Illustrations: Lloyd, Mycol. Notes 5(1900), p. 37, fig 8 (as *Collybia colorea*).

PILEUS 1.5-6.5 cm, averaging 3 cm, at first a decided dark olive green (5F7), hygrophanous and changing slowly to more brownish tones (5E6, 5E7, and 5D6), finally a golden olive to golden brown (4C5); becoming a dark vinaceous or vinaceous cinnamon (9F7) through drying; convex, becoming expanded and plane to shallowly umbilicate, more rarely shallowly umbonate, margin at first scarcely involute, soon plane, entire and even; surface at first entirely covered with a pruinose bloom of fine tomentum, soon glabrescent, smooth and even, nearly lubricous to matte when fresh and moist; context thin and firm, not pliant-tough; smell pungent, resinous to aromatic, like rotting pears or moldy cinnamon, taste mild, farinaceous-fungoid.

LAMELLAE golden yellow (4A4), abruptly sinuate, uncinate, tapered and pointed toward the margin, subventricose, sometimes moderately broad, 5-6 x 12-20 mm, somewhat close, 40-52 reaching stipe apex, 4 tiers, rather thin.

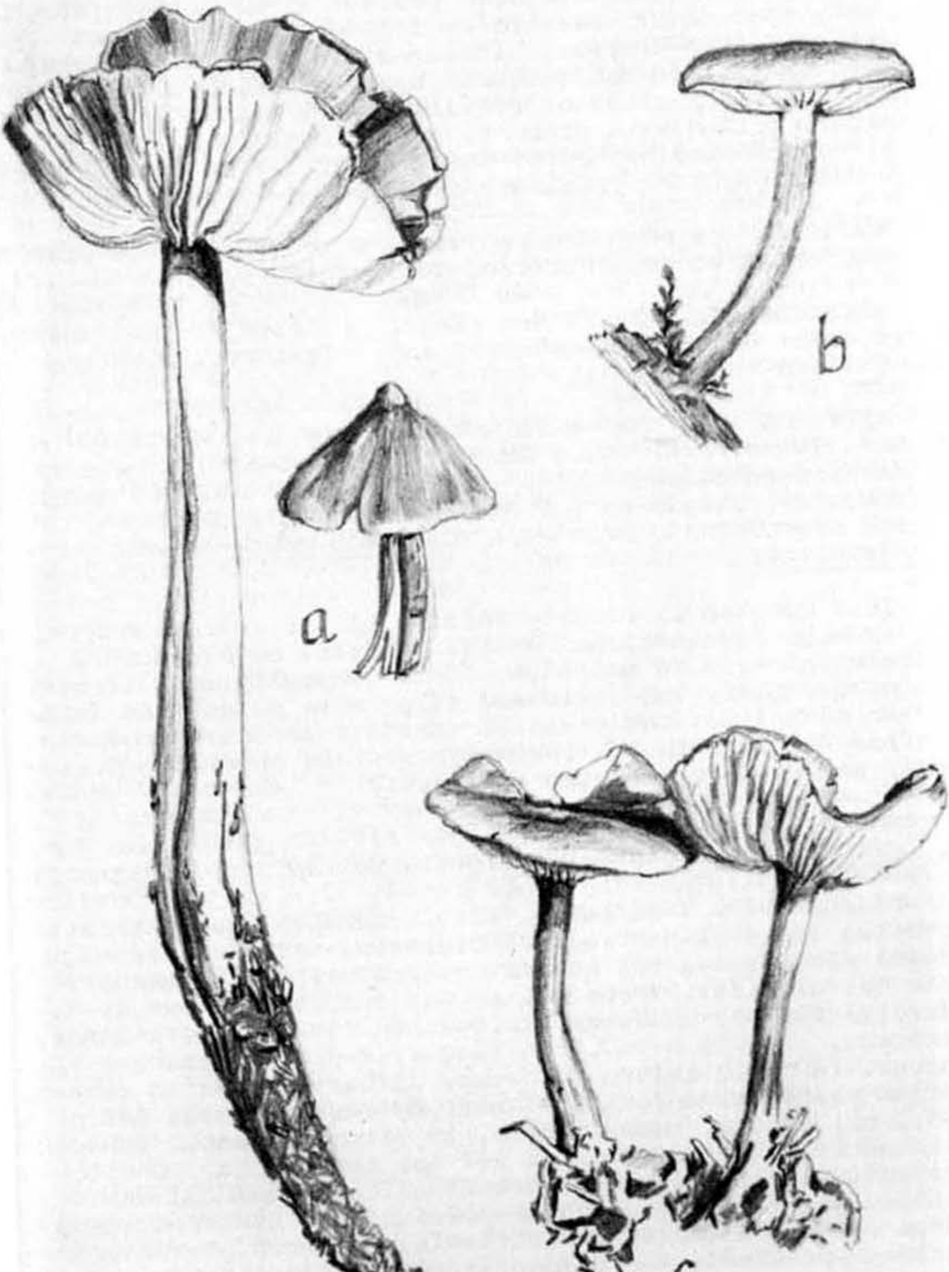
STIPE 2.7-6 (7) cm x 3-9 mm, concolorous with the cap the entire length or somewhat darker in the lower half (5E7), with a thin, appressed sulphur yellow tomentum at the very base; equal or slightly expanded at the apex, sometimes terete, usually flattened; surface even, dry, when young entirely pruinose-tomentose with a bloom like the pileus, retaining this downward, becoming glabrous or sparsely fibrillose above, hygrophanous and then becoming streaked; base concrescent with the rotten wood, hollow, context tough, elastic, hygrophanous, dark olivaceous, the cavity lined with looser bright sulphur yellow material.

SPORES subglobose to broadly ovate, 5.0-6.5 x 3-4.5 µm, with a prominent apiculus and 1-2 guttulae, a minority containing a discrete or dispersed pigment, visible in examination only of dried material, straminous to vinaceous in transmitted light, darker vinaceous in 3% KOH, noncarminophilious, nonamyloid; BASIDIA 22-30 x 6-7.5 µm, four-spored, noncarminophilous; CHEILOCYSTIDIA generally present, incon-

---

PLATE II -; a - *Caulorhiza umbonata*, W1338, x 1; b- *Callistosporium graminicolor*, W1713 x 2; c - *Callistosporium luteo-olivaceum*, W1156, x 1.

II



spicuous, clavate to filamentous, usually with a contorted appearance, sometimes sparingly branched, rarely exceeding the basidia, 10-39 x 2.5-5 µm, hyaline; PLEUROCYSTIDIA not differentiated; PILEOCYSTIDIA present or absent (especially in older specimens), clavate to filiform, hyaline, not encrusted, often grouped, arising directly from the cutis surface as swollen and upturned hyphal ends, 5-25 x 26 µm; PILEAL SURFACE a cutis of radial, repent hyphae 2-4 µm in diameter, filled with pigment, overlying larger, less compact, unpigmented hyphae of the context 3-7 µm in diameter; GILL TRAMA parallel, regular, of hyphae 4-13 µm broad.

HABITAT: On much decayed wood, often buried, in mixed or coniferous woods, scattered to caespitose.

MACROCHEMICAL REACTIONS: Ferric sulfate deepens the olive color of the carpophores, and sulfoformol lightens and yellows the color.

MATERIAL STUDIED: WASHINGTON, Grays Co., W1321 (Twin Harbors State Park); King Co., Stz 1453, 1454 (University of Washington campus), W540 (Mercer Island), W1156 (Water Main Woods); Skagit Co., W496 (Bowmans Bay); NEW YORK (North Green bush), Peck Type (Collybia colorea var. rubescentifolia).

This species is closely related to the following species and is best distinguished by its smaller, more ovate or globose spores. In addition, it is generally much larger and more robust, the gills and stipe more olive than golden, the stipe hollow, the gills are thinner and more crowded, cheilocystidia although inconspicuous are generally present, and it rarely occurs solitarily.

7. Callistosporium graminicolor Lennox sp. nov. Plate II.

Pileus 1.2-1.8 cm latus, flavobrunneus, hygrophanus, convexus, dein planus sed nec depressus nec umbilicatus, pagina pilei sicca vel humida, glabra vel pruina tenui obtecta; odor farinaceus vel aromaticus, sapor amarus; lamellae aureae, sinuatae, aliquantum latae, subdistantes, ceraceae. STIPES 2.7-3.5 cm longus, 2-3.5 mm crassus, aureus, in medio infero fuscatus, ad basim tomentum tenuem aureum praebens, aequalis, teres, solidus. sporae 6-8 x 4-5.5 mµ, ovatae, inamyloideae, in sicco pigmentum vinaceum praebentes. Basidia 20-27 x 6-7 mµ, tetraspora. Cheilocystidia et pleurocystidia desunt. Trama lamellarum parallela, efibulata. Pagina pilei e cute hypharum angustarum repentium radiantum constanti, in sicco pigmentum vinaceum praebentium. Holotypus W626, herbario Universatitis Washingtoni conservatus.

PILEUS 1.2-1.8 cm, yellow brown to fuscous yellow brown on the disc, 5E6 to 5E8, hygrophanous and becoming more yellowish and less olivaceous in drying, 4D4 to 4C6; convex and then plane, margin remaining strongly inrolled, never straight, regular and symmetrical, neither umbilicate nor umbonate; surface dry, occasionally waxy-moist, coated with a very fine pruinose bloom, appearing glabrous when quite moist and with age, smooth and even, context firm, concolorous, moderately thick, 1-2 mm. over the disc; smell farinaceous to aromatic or like eucalyptus, taste bitter or acrid, becoming farinaceous later.

LAMELLAE amber yellow to golden yellow, 4B6 to 5B7, abruptly sinuate, occasionally approaching emarginate, not uncinate, bluntly pointed both at the stipe and cap margin, ventricose, rather broad, 6 x 2.5 mm, subdistant, 28 reaching the stipe apex, 4 tiers, edge even and concolorous, consistency somewhat soft and generally waxy although not especially thick.

STIPE: 2.7-3.5 cm x 2-3.5 mm, golden yellow and concolorous with the gills for most of the length, darkening in the lower half with age and probably with handling (5E7); faintly yellow powdery at the very base with a very fine appressed scant tomentum (3A4); tapering downward or equal, terete, never compressed or flattened; surface dry, naked to sparsely clothed with a pruinose tomentum toward the base, subhygrophanous, flexuous at the base, solid and rather tough, context concolorous.

SPORES 6-8 x 4-5.5 µm, broadly ovate, lacking any marked suprahilar depression, apiculus prominent, uniguttate, nonamyloid, a minority containing a discrete or dispersed necropigment, visible in examination of dried material, stramineous to light vinaceous in transmitted light, darker vinaceous in 3% KOH, the pigment and reaction with alkaline occasionally very weak in some collections, noncarminophilous; BASIDIA 20-27 x 6-7 µm, four-spored noncarminophilous; PLEUROCYSTIDIA and CHEILOCYSTIDIA not differentiated; GILL TRAMA regular and parallel, without clamps; PILEAL SURFACE a cutis of radial, repent, narrow hyphae filled with necropigment and overlying the larger, less compact hyphae of the context, these unpigmented and rather strongly constricted near the end walls, giving a catenulate appearance to the hyphae, CLAMPS absent both in the surface and context cells.

HABITAT: On much decayed wood in mixed woods, solitary to scattered.

MACROCHEMICAL REACTIONS: Ferric sulfate deepens the olive color of the carpophores, and sulfoformol lightens and yellows the color. There were, in addition, faint and ambivalent reactions with alpha-napthol and tincture of guaiac.

MATERIAL STUDIED: WASHINGTON, King Co., W626 (Lee Forest), W1706 (Seattle, Carkeek Park), W1713 (Totem Lake).

Caulorhiza Lennox nom. nov.

Habitus collybioideus, pileus 4-8.7 mm latus, fulvus, conicus dein planus, umbonatus, plicato-striatus, glaber; odor atque sapor haud proprius; lamellae pallide ocraceae, crassae, crebrae. Stipes 4.5-23 cm longus, 8-14 mm crassus, magis pallidus quam pileo, bubalinus, supra superficiem terrae aequalis, infra superficiem angustatus, per quasi dimidium longitudinis infossus, glaber vel canescens, impolitus, cavus, fibrosus. Sporae 5.5-7.0 x 3.0-3.5 mµ, ovatae vel ellipsoideae, laeves, hyalinae, amyloideae; pleurocystidia clavata, tumida, 60-82 x 11-14 mµ; pagina pilei e cute laxa pileocystidiis clavatis, per zonam subcellulosam subtenta, fibulas praebens.

Type species: *Caulorhiza umbonata* (Peck) Lennox comb. nov.

PILEUS 4-8.7 cm broad, light tawny to tawny grey, hygrophanous, broadly campanulate or conic, expanding to almost plane, with a prominent umbo, margin frayed or split, plicate-striate, glabrous; LAMELLAE light ochraceous, deeply sinuate, broad, thick, crowded; STIPE 4.5-23 cm long, 8-14 mm broad, paler than the cap, light tawny to buff, equal above ground, tapering downward from ground level, glaucous or powdery, finely striate, hollow, fibrous, rooting for one half of its length; SPORES 5.5-7.0 x 3.0-3.5 µm; ovate to ellipsoid, smooth, thin-walled, amyloid; PLEUROCYSTIDIA 60-82 x 11-14 µm; clavate-inflated; PILEAL SURFACE a cutis with pileocystidia subtended by a subcellular layer, clamped.

8. *Caulorhiza umbonata* (Peck) Lennox comb. nov. Figure 8, Plate II.

Basionym: *Collybia umbonata* Peck. Torrey Botanical Club. Vol. 31(4):178. 1904.

PILEUS 4-8.7 cm broad, light tawny or tawny grey (6D8), darker at the center and at extreme margin (7F8), hygrophanous and drying lighter; broadly campanulate or conic, expanding to almost plane, with a sharp prominent umbo, margin at first even, later frequently frayed or split, irregularly plicate-striate for one third the radius; surface glabrous, dull-translucent when moist, sublubricous, moist-striate, drying matte; context somewhat thick, usually 2 mm over the disc, consistency rather soft and limp; odor faint, fungoid, taste none or musty.

LAMELLAE light ochraceous (4A3), narrowly adnexed, deeply sinuate, becoming emarginate, blunt-ended at the stipe, rounded towards the cap margin, broad all the way to the cap margin, thick, crowded, 80 lamellae reaching stipe, 40 x 9 mm, edge even and concolorous.

8

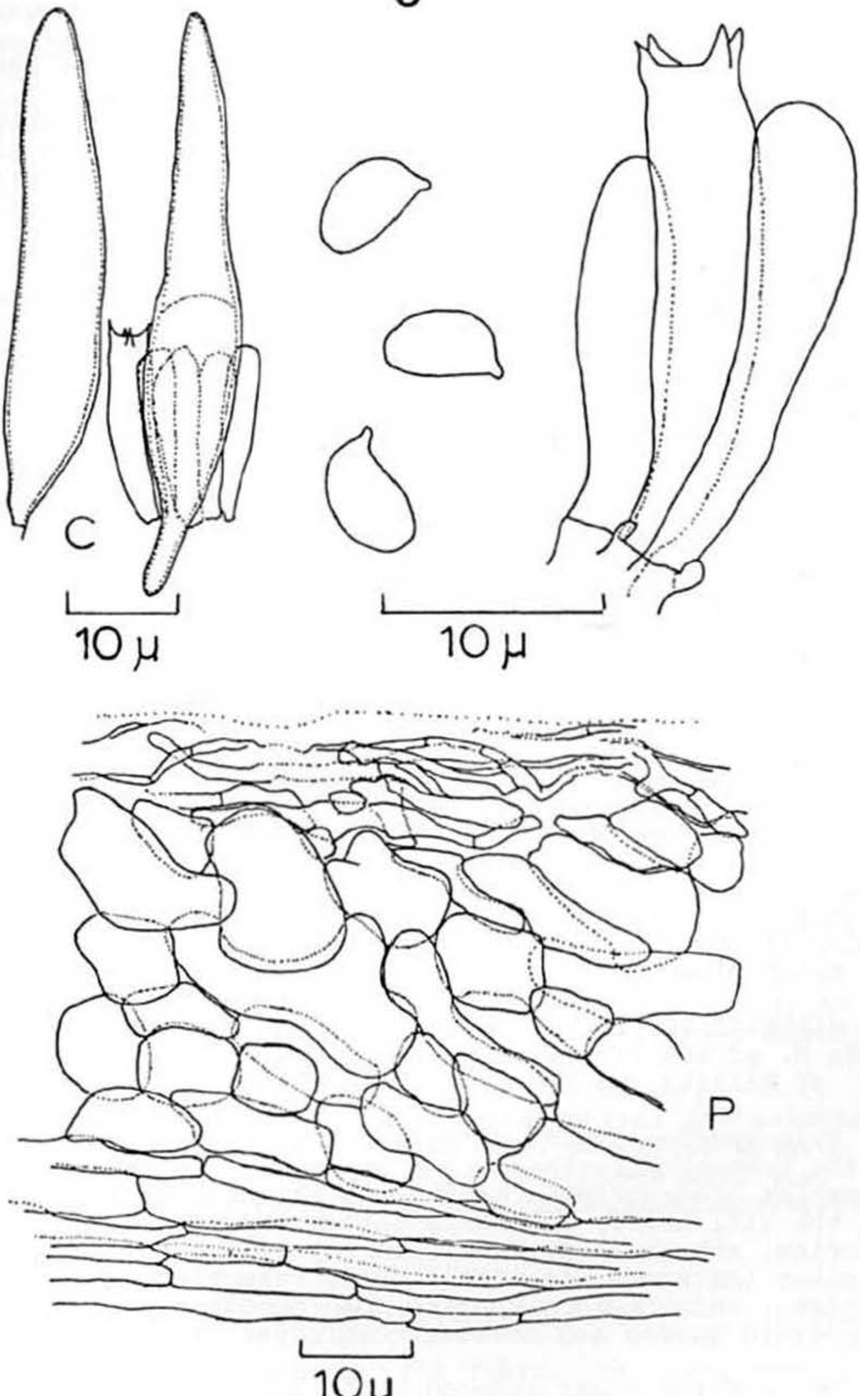


Figure 8. - Caulorhiza umbonata, Peck type, basidium and spores, cheilocystidia (c); W122, pileal surface (p).

STIPE 4.5-23 cm long, 8-14 mm broad, paler than the cap, almost the shade of the gills, light tawny to buff (4A3 to 5B3), equal above ground, then tapering downward from ground level, surface even, faintly glaucous or powdery, glabrescent with age and handling, covered by adhering soil and duff particles in the lower half, very finely striate-grooved, dull-matte; hollow, terete or somewhat compressed, quite fibrous, slightly flexuous, with a distinct rind, pallid within, rooting deeply into the soil or duff, usually buried for at least half the length, without rhizomorphs or a sclerotium.

SPORES 5.5-7.0 x 3.0-3.5 µm, ovate to broadly ellipsoid, smooth, thin-walled, hyaline, amyloid, white in deposit; BASIDIA 23-27 x 4-5.5 µm, rather long and slender, noncarminophilous, often constricted slightly below the apex as basidioles, becoming more clavate at maturity, four-spored; no cheilocystidia differentiated; PLEUROCYSTIDIA scattered to abundant, clavate-inflated, often pedicellate and arising rather deep in the trama, thin-walled, nonencrusted, hyaline, 60-82 x 11-14 µm; PILEAL SURFACE a thin cutis of narrow, repent hyphae, giving rise to dermatopileocystidia, these scattered, often inconspicuous, clavate to subclavate, hyaline, thin-walled, 25-33 x 6-10 µm; the cutis subtended by a subcellular zone appearing more or less radial; CONTEXT of radially arranged, compact hyphae, nonamyloid and clamped; GILL TRAMA parallel to slightly bilateral, composed of rather narrow compact hyphae.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with alpha-napthol, guaiacol, sulfoformol (faint, yellowish), phenol, phenol-aniline, and ferric sulfate.

HABITAT: Scattered under redwoods in very dense conifer woods; if present in Washington, probably introduced with its mycorrhizal partner.

MATERIAL STUDIED: CALIFORNIA, Marin Co., W611 (50 miles N. of San Francisco); Mendocino Co., W122 (15 miles N.W. of Willits, on Hwy. 20), W1338 (Woodlands Camp).

This species varies deceptively in color and somewhat in the robust character of cap and stipe. Sometimes it resembles Phaeocollybia kaufmannii rather closely, except for the gill color, and has a rather reddish dark fulvous coloring, robust stipe, and firm cap with a thick context. In other instances, it more closely resembles Oudemansiella radicata, which has a glycerine soap appearance on the cap, nonamyloid spores and abundant caulocystidia.

The habitat under redwoods, the long radicating stipe, presence of pleurocystidia, a complex pileal surface, and amyloid spores sets this species apart.

CLITOCYBULA (Singer) Metrod, Rev. Mycol. 17:74. 1952.

Synonyms: Fayodia subgenus Clitocybula Singer. Ann Mycol. 41:63. 1943.
Cantharellula subgenus Neocantharellula Singer. Sydowia 6:194. 1952.

Type species: Clitocybula laceratus (Scopoli per Pollini) Metrod.

HABIT collybioid to clitocyboid, PILEUS grey to tan, convex becoming plane, often centrally depressed or umbilicate, margin even or frayed, surface dry to lubricous, subglabrous to virgate-streaked with blackish fibrils, at least on the disc, generally not translucent-striate, subhygrophanous or unchanging; context thin, generally brittle, whitish; odor and taste not distinctive.

LAMELLAE generally adnate to subdecurrent, whitish to greyish, edge even or frayed, thin, usually rather close.

STIPE white to plae grey or tan, equal, generally rather slender, surface dull and clothed thinly with a powdery-pubescence, fibrous, often rather soft, not rooting and without rhizomorphs.

SPORES amyloid, smooth, globose or subglobose to ovate or ellipsoid, white in deposit; PILEOCYSTIDIA and CAULOCYSTIDIA present although frequently scant, cheilocystidia and pleurocystidia not differentiated; PILEAL SURFACE generally a cutis of radial, narrow, repent hyphae, the pileocystidia arising innately as the upturned and rounded ends of the surface hyphae, or cystidioid, context of larger diameter hyphae, freqnuently rather thick walled, clamped and nonamyloid.

MACROCHEMICAL REACTIONS: Data are available only on one of the species, which reacts with most of the reagents used.

HABITAT: The carpophores are lignicolous and associated either with hardwoods or conifers, sometimes both. They are frequently found in tight caespitose clusters, although one of the species is characterized by a gregarious habit.

Key to the Clitocybula Species

1. Cap smooth, subglabrous, not fibrillose, lubricous-moist, spores globose and 3.5-5 µm broad................................... C. familia (p.158)
1. Cap innately radiate-fibrillose with blackish fibrils, at least on the disc, grey to fuscous, dry in all stages, spores ovate (4.5-8 µm long)....... 2.

2. Pileus medium sized, 3-6 cm generally at least 4 cm at maturity or a few carpophores in any one collection attaining this size, gills greyish, cap margin conspicuously lacerate, spores 6-8 x 4.5-5 µm............. .... C. lacerata (p. 159)
2. Pileus rather small, generally less than 4 cm in diameter, gills whitish, never really pale grey, cap margin sometimes frayed in older specimens, spores 4.5-6.5 x 3.5-5.0 µm.. .... C. abundans (p. 161)

9. Clitocybula familia (Peck) Singer. Sydowia 15:53. 1961. Plate III.

Basionym: Agaricus familia Peck. Ann. Rep. N. Y. State Mus. 23:79. 1873.
Synonyms: Collybia familia (Peck) Sacc. Syll. Fung. 5:241. 1887.
Gymnopus familia (Peck) Murrill. N. Amer. Fl. 9:365. 1916.
Baeospora familia (Peck) Singer. Re. Mycol. 3:193. 1938.
Fayodia familia (Peck) Singer. Agar. Mod. Tax. p. 349. 1951.
Gymnopus denticulatus Merrill. N. Am. Fl. Vol. 9(5):368. 1916.

Illustrations: Singer, Sydowia 15:53. 1961 Figs. 2, 15, 16; Bigelow, Mycologia 65:1105. 1973.

PILEUS up to 4 cm broad, yellowish tan to honey colored (4A3 to 5D5), darkest at the center and intergrading with the margin, almost white in a narrow band on the margin, subhygrophanous and drying slightly lighter and more greyish, generally in a radially streaked fashion; convex or hemispheric, becoming plane, usually with a low broad umbo, margin at first strongly inrolled, remaining somewhat inrolled at maturity or becoming straight, even; surface regular, smooth, subglabrous, with a thin pruinosity under a lens, giving a slight frosted appearance, moist-lubricous, occasionally translucent-striate; context thin (1-2 mm on the edge of the disc), cartilaginous and brittle when moist, concolorous; odor faint, rather sweet, somewhat like tea, taste none or faintly fungoid.

LAMELLAE white, broadly adnate, then sharply sinuate and later nearly free, slightly uncinate, pointed both at the margin of the cap and the stipe, ventricose, very thin, close, 48-56 lamellae reaching the stipe, 3-4 tiers of lamellulae, rather broad, 12-16 x 3-4 mm, edge entire and concolorous.

STIPE 2.2-11 cm long, 2.0-5.0 mm broad, long relative to the cap size, narrow, pallid to pale greyish (4C3 or lighter), sometimes spotting faintly pale ferruginous, yellowing markedly on drying; markedly equal and strict for most of the length, occasionally with an undulate surface, often flared just at the apex; moist, powdery-evanescent like the cap, especially evident on drying, short strigose to appressed-tomentose in a narrow white band at the base; terete, hollow, cartilaginous, splitting easily longitudinally, concolorous within.

SPORES 3.5-5.5 x 3.5-4.5 µm, globose to subglobose, smooth, thin-walled, readily collapsing, hyaline, amyloid, white in deposit; BASIDIA 15-22 x 4.5-6 µm, four-spored; no pleurocystidia or cheilocystidia differentiated; PILEAL SURFACE a cutis of narrow (1-5 µm broad), repent, radially oriented hyphae in a zone about 10 um in depth, not encrusted; PILEOCYSTIDIA scattered on the disc, cylindrical or fusoid or clavate, 22.5-80 x 7.5-15 µm, hyaline and thin-walled; CONTEXT composed of radial hyphae of two distinct sizes, small hyphae of 5 um or less in diameter and larger inflated cylindrical thick-walled hyphae 3-10 µm broad, nonamyloid, clamped; GILL TRAMA parallel, of large diameter hyphae, 2-13 µm broad, averaging 7 µm, clamped, nonamyloid; CAULOCYSTIDIA fasciculate, subcylindrical or clavate or nearly bulbous, thin-walled, hyaline, 18-60 (100) x 2-12 µm, nonamyloid, not encrusted

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react with aniline (yellow to red), alpha-napthol, guaicaol, tincture of guaiac, sulfoformol (yellowish), phenol, and phenol-aniline (dark red to purple black).

HABITAT: Caespitose on logs and stumps of conifers.

MATERIAL STUDIED: WASHINGTON, Skagit Co., W1693 (Mineral Park Campground); King Co., W972, W1668 (Dalles Creek Campground); Pierce Co., W1703 (Tahoma Creek, Mt. Rainier Ntl. Pk.); NEW YORK, North Elba, Nov. 11, 1873 (C. H. Peck Type).

In general appearance and habit this species closely resembles Collybia acervata, but lacks the reddish colors and marked hygrophanous character of this latter species. Clitocybula familia can be most readily identified by its globose, amyloid, thin-walled spores, a character it shares with the genus Baeospora. Members of Baeospora, however, are smaller species with narrow, very crowded gills, tough-pliant tissues, and abundant cheilocystidia. Clitocybula familia is distinct from other members of the genus in lacking the characteristic blackish fibrils on the cap that give a radiate-streaked effect.

10. Clitocybula lacerata (Scop. per Pollini) Metrod. Rev. Mycol. 17:87. 1952. Plate III.

Basionym: Agaricus laceratus Scop. per Pollini, Fl.

Veronensis 3:636. 1824.

Synonyms: <u>Collybia</u> <u>lacerata</u> (Scop. per Pollini) Gillet, Les Hymenomycetes, p. 310. 1874.
<u>Fayodia</u> <u>lacerata</u> (Scop. per Pollini) Singer. Ann. Mycol. 34:331. 1936.
<u>Collybia</u> <u>platyphylla</u> ssp. <u>lacerata</u> (Scop. per Pollini) Konrad and Maublanc. Icones Selectae Fungorum, p. 242. 1939.

Illustration: Smith. Journ. Elisha Mitchell Sci. Soc: 56, 307. 1940. Plate 7; Bigelow, Mycologia 65:1973. fig. 1.

PILEUS 3-6 cm broad, dull watery grey (closest to "drab") when moist, translucent-striate or streaked with fuscous lines, hygrophanous, pallid ashy grey and opaque when faded; convex at first with an inrolled margin, expanding to broadly convex, disc soon depressed, margin very thin and soon lacerated or lobed and quite irregular; surface appressed radiate-fibrillose, at least near the disc, rimose at times, dull when moist; context very thin and fragile, pallid when faded; odor and taste not distinctive.

LAMELLAE broadly adnate to subdecurrent from a tooth, dull grey, distant to subdistant, broad, usually venose and at times anastomosed, very thin and easily broken, edges concolorous.

STIPE 1.5-5 cm long, 2-5 mm thick, concolorous with the cap or paler, dingy to pale grey, equal or tapering upward, often curved, surface faintly pruinose at first but soon naked and polished, moist, with a white cottony mycelioid base; tubular, cartilaginous, terete when immature, soon deeply furrowed or compressed.

SPORES 6-8 x 4.5-5.5 µm, broadly ovate to ellipsoid, hyaline, smooth, amyloid, thin-walled, white in deposit; BASIDIA 25-40 x 5.5-7 (-9) µm, four-spored; no cheilocystidia or pleurocystidia differentiated; PILEAL SURFACE a thin cutis of cylindrical hyphae 3.5-7 µm in diameter, hyaline or pale fuliginous; PILEOCYSTIDIA present, at least on the disc, erect or recumbent, cylindric or clavate, 25.5-38 x 6-12.5 µm, pale fuliginous in KOH, pigment intracellular and in slightly thickened walls; CONTEXT hyaline, hyphae cylindrical or somewhat inflated (4) 10-25 µm in diameter, walls usually thickened (0.5-1.0 µm thick); GILL TRAMA of parallel hyphae, cylindric to somewhat inflated, (4) 12-23 µm in diameter, walls usually thickened, clamped, with scattered oleiferous hyphae (3 µm broad); CAULOCYSTIDIA rarely present, subclavate to clavate, hyaline, smooth 24-62 x 5-15 µm; STIPE HYPHAE mostly with thickened walls, cylindric or somewhat inflated. (Composite description drawn from Smith, 1940, and Bigelow, 1973).

MACROCHEMICAL REACTIONS: No data available.

HABITAT: Scattered to gregarious on logs or stumps of conifers or hardwoods (oak or birch).

MATERIAL STUDIED: MICHIGAN, Stuntz 8373 (Tahquamenon Falls).

Bigelow (1973) reports that this species has occurred in Idaho and it is probable that it exists in Washington, although rare. Perhaps it is frequently mistaken for a depauperate Tricholoma or a somewhat aberrant Clitocybe.

It is distinguished from Clitocybula abundans, to which it is mostly closely allied, by its much larger, more ovate to ellipsoid spores, larger size, and lacerate character of the cap and gills. In addition, it is rarely found in abundance or in the large caespitose clusters of the other species of the genus.

11. Clitocybula abundans (Peck) Singer. Sydowia 15:53. (1961). 1962.

Basionym: Agaricus abundans Peck. Ann. Rep. N. Y. State Mus. 29:38. 1878.
Synonyms: Collybia abundans (Peck) Sacc. Syll. Fung. 5:241. 1887.
Fayodia abundans (Peck) Singer. Lloydia 5:126. 1942.

Illustrations: Singer, Sydowia 15:53. 1962. figs. 5-8; Kauffman, Agar. of Mich., Vol II, Plate 166.

PILEUS up to 4 cm, generally about 2 cm broad; greyish tan to light fuscous (4A3), darker fuscous on the disc (4E4), subhygrophanous and drying somewhat lighter; convex to hemispheric, becoming plane, depressed with age, margin inrolled strongly at first, remaining curved or arched at maturity, often splitting; surface moist or dry, innately radiate-fibrillose or disc densely fibrillose, only slightly or not at all translucent-striate; context thin, firm but not tough, whitish; taste and odor not distinctive.

LAMELLAE broadly adnate to subdecurrent as the margin of the cap is raised, white, rather narrow, thin, with close to normal spacing, blunt-ended both at the stipe and margin, edges even and concolorous, not fraying.

STIPE up to 5 cm long, apex to 5 mm, relatively short, whitish, evenly colored top to bottom, unchanging, equal or slightly flared at the base, generally flexuous, terete, hollow, surface with a thin whitish pubescence or only pruinose at the apex.

SPORES 4.5-6 (6.5) x 3.5-5.5 µm, subglobose to ovate, smooth, hyaline, thin-walled and collapsing readily in crush mounts, amyloid; BASIDIA 19-27 x 4-7 µm four-spored; CHEILOCYSTIDIA basidioid to subsaccate, 33-50 x 7-16 µm, smooth, hyaline, thin-walled, scattered and inconspicuous; pleurocystida not differentiated; PILEAL SURFACE a cutis of narrow (2-4 µm broad) compact hyphae, intergrading with the hyphae of the context in size and wall thickness; CONTEXT of inflated cylindrical hyphae, 2-14 µm in diameter, walls usually thickened (up to 1 µm), clamped, nonamyloid; PILEOCYSTIDIA present, more abundant on the disc, scattered elsewhere, 40-60 x 6-12 µm, broad, cylindrical to clavate, walls somewhat thickened or thin, hyaline, not encrusted; GILL TRAMA parallel, composed of large inflated hyphae (2-17 µm in diameter), nonamyloid, clamped, oleiferous hyphae present, 3-9 µm broad; CAULOCYSTIDIA subclavate to clavate-bulbous, 40-50 x 3.5(7)-13 µm, hyaline, thin-walled, scattered or in groups; STIPE CORTEX with both thin and thick-walled cells. (Description drawn in part from that of Bigelow, 1973.)

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with aniline (faint, yellowish), phenol, and phenol-aniline.

HABITAT: Caespitose on logs or stumps of conifers.

MATERIAL STUDIED: WASHINGTON, Clallam or Jefferson Co., C. H. Kauffman, Oct. 7, 1915 (Olympic Mts.); Pierce Co., Smith 47824 (Lower Tahoma Cr., Rainier Ntl. Pk.); MICHIGAN, Smith 33510 (Upper Tahquamenon Falls); W842, (Oakland Co., Haven Hill Lk.); NEW YORK, Peck, Grieg, Lewis Co., Sept.

BAEOSPORA Singer. Rev. Mycol. 3:193. 1938.

Synonyms: Collybia pro parte Kummer. Führ. Pilzk. p. 26. 1881

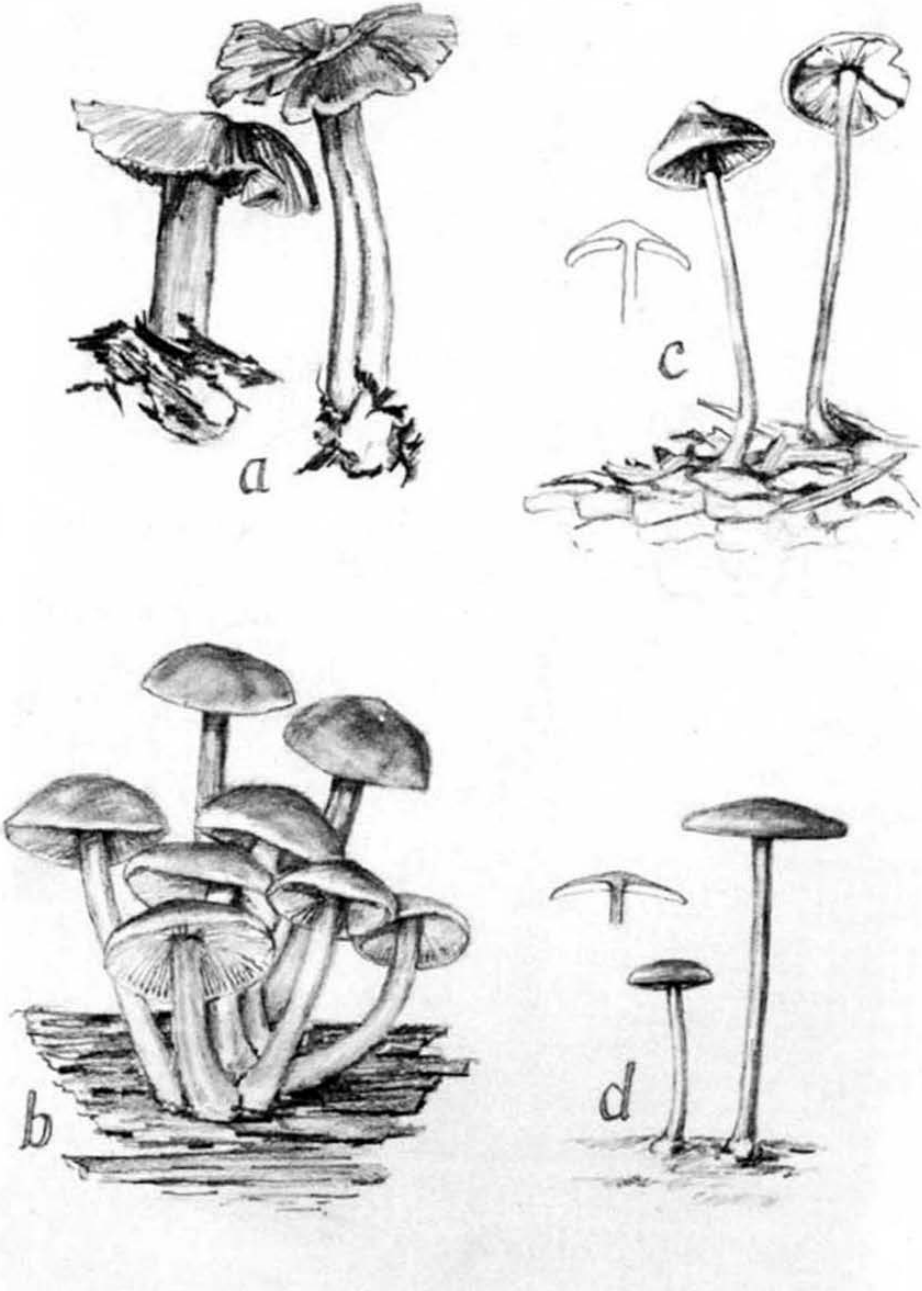
Type species: Baeospora myosura (Fr. ex Fr.) Singer.

PILEUS generally small, collybioid, tan to buff, sometimes with a violet tinge, convex becoming plane, sometimes almost conic; surface glabrous to floccose, even, regular; margin inrolled and even, context thin, concolorous, tough, pliant; smell and taste not distinctive.

LAMELLAE pallid to violet, sinuate to almost free, narrow, thin, crowded, linear, spore print white.

PLATE III -; a - Clitocybula lacerata, after Smith in Bigelow, 1973, x1; b - Clitocybula familia, W1693, x 1½; c - Baeospora myosura, W910a, x 2; d - Baeospora myriodophylla, W1644, x 1.

III



STIPE concolorous with the cap or nearly so, relatively long and narrow in relation to the size of the cap, surface floccose, almost glabrous in older specimens; equal, terete, hollow, rather tough and pliant, strigose or tomentose at the base and then white, at times partially rooting.

SPORES small, not exceeding 5 µm in length, ovate to short-cylindric, thin-walled, amyloid, hyaline; BASIDIA very small and cylindric, four-spored; GILL TRAMA of large diameter hyphae, clamped, interwoven, appearing subparallel in tangential section, nonamyloid; CHEILOCYSTIDIA abundant, gill edge hetermorphous, clavate-pointed, ventricose, pedicellate or not, thin-walled and hyaline, sometimes encrusted with an amorphous dextrinoid substance; PLEUROCYSTIDIA scattered, most abundant toward the gill edge, with the same characters as the cheilocystidia; PILEAL SURFACE a cutis with a subcellular hypoderm, encrusted or not, with pileocystidia scattered to rare, grouped, clavate to subfusiform; STIPE composed of longitudinal encrusted hyphae overlain by groups of caulocystidia, these abundant and forming clusters, thin-walled, hyaline, clavate-rostrate, ventricose, and sometimes pedicellate.

HABITAT: on cones or wood, solitary to gregarious.

MACROCHEMICAL REACTIONS: Gills and flesh react faintly with guaiacol and ferric sulfate in one of the species.

This is an easily characterized and natural grouping: The cap is thin-fleshed and quite tough, the gills are very narrow, thin, and crowded, the stipe is rather slender and floccose, the spores minute and amyloid, pileal surface a cutis with subcellular hypoderm, and the gill edge is hetermorphous with cheilocystidia. Superficially, the genus appears to be very close to Strobilurus, however, it is quite distinct from a microscopic viewpoint: Baeospora has amyloid spores and clamped hyphae, and lacks the hymeniform pileal surface as well as the distinctive subcapitate cystidia. Probably, more often the genus will be confused with a Marasmius as the general aspect and consistency are like a species of that genus. The combination of narrow, very crowded gills, small amyloid spores, nonamyloid tissue, and a subcellular hypoderm underlying the cutis, however, makes placement of these species into Marasmius difficult.

Key to Baeospora Species

1. Pileus light tan, gills white, on buried cones.... .... B. myosura
1. Pileus fulvous with a strong violaceous tone toward the margin, gills purple, on wood............... .... B. myriodophylla

12. _Baeospora_ _myosura_ (Fr.) Singer.

Figure 9, Plate III.

Basionym: _Agaricus_ _myosurus_ Fries. System. Mycol. Vol I:132. 1821.
Synonyms: _Collybia_ _myosura_ (Fries) Quélet. Champ. Jura Vosges. ser II, 5:95. 1872.

PILEUS 0.8-2.5 cm, warm buff to honey brown when moist (5E4 to 5D4), drying somewhat lighter, especially at the margin (5C4 to 5B3), subhygrophanous; convex to subconic becoming plane, occasionally shallowly umbonate, margin remaining inrolled, sometimes straight; surface over the disc almost glabrous, powdery elsewhere and appearing thinly pruinose on the margin, context thin, concolorous or pallid, tough-pliant, reviving; odor and taste not distinctive.

LAMELLAE pallid to light pinkish buff (4A2 to 5C3), thin, very narrow and crowded, linear, blunt-pointed both toward the stipe and margin, edge even and concolorous, sharply sinuate, appearing almost free, 3 tiers.

STIPE 2.5-4.2 cm. x 10-1.5 mm, concolorous at the apex, then darkening slightly, and dark buff for most of its length (5C5 at apex to 5D5), subhygrophanous, drying slightly lighter; equal or slightly tapered toward base in the upper half; surface finely pruinose to irregularily powdery, appearing almost glabrous when moist, the surface coating much more visible in drying, strigose at the base where attached to substratum, frequently with white rhizomorphs as well; flesh tough-pliant, solid to stuffed, and concolorous.

SPORES 3-5 x 2-3 µm, short-ovate to cylindrical, thin-walled, hyaline, amyloid, white in deposit; BASIDIA very small, cylindrical, 16-19 x 3.5-4 µm, four-spored, without encrustation; CHEILOCYSTIDIA very abundant, 15-24 x 4-8 µm, rather small, making the gill edge heterogeneous, broadly clavate, much wider in the lower half and tapering to an obtuse apex, thin-walled and hyaline; PLEUROCYSTIDIA similar to the cheilocystidia, most abundant toward the gill edge, scattered elsewhere; GILL TRAMA interwoven, appearing subparallel in tangential section, composed of hyphae 4-13 µm in diameter, clamped and nonamyloid, subhymenium narrow, compact and interwoven; PILEAL SURFACE a cutis of rather coarse hyphae, 3-5 µm in diameter, scarcely encrusted, in a shallow zone 7-10 µm deep, subtended by a conspicuous subcellular hypoderm; STIPE surface somewhat encrusted, covered rather densely with dermatocaulocystidia, longer and more tapered than those of the gill edge, ventricose, clavate and tapering most of the length to an obtuse apex, thin-walled, hyaline, and clustered, 18-55 x 5-9 µm.

HABITAT: Solitary to gregarious on cones of Douglas

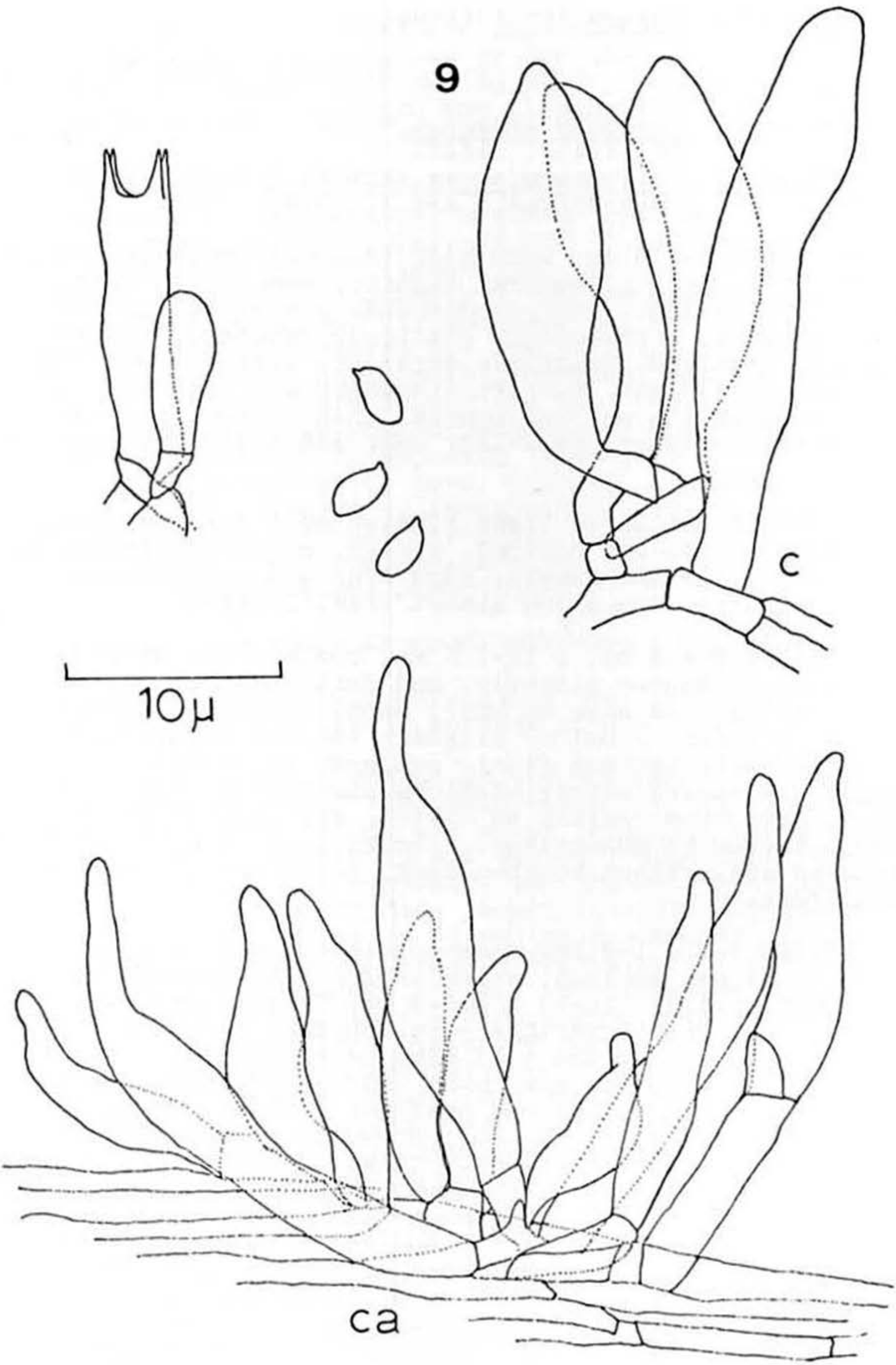


Figure 9. - Baeospora myosura, W1186, basidium, spores, caulocystidia (ca), cheilocystidia (c).

fir or spruce, these often buried.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react faintly and sporadically with alpha-napthol, guaiacol, and ferric sulfate.

MATERIAL STUDIED: WASHINGTON, San Juan Co., W1741 (Friday Harbor Biological Station); Clallam Co., W1007 (Deep Cr.); Grays Harbor Co., W1013 (Copalis); Thurston Co., W1012 (Summit Lake); Snohomish Co. W1169 (Thunderbird Campground); King Co., W1019, W1061 (University of Washington), W1166, W1186 (Water Main Woods); Pierce Co., W1218 (Ipsut Cr. - Mt. Rainier Ntl. Pk.); IDAHO, Bonner Co., W910A (Collin Swamp), W964 (Bindarch Cr.); CALIFORNIA, Mendocino Co., W1347 (Woodlands Camp).

This species may be synonymous with Baeospora conigena (Fr.) Lange or at least very close to it. The main distinctions between the two species according to Fries and Ricken are a long glabrous radicating stipe and white floccose vesture on the stipe and cap of Baeospora myosura (Fr.) Singer. The Baeospora of this region, here described as B. myosura, does have a fine powdery covering on the stipe and to some extent on the cap, and the stipe is sometimes radicating especially in the cases where specimens are encountered on buried cones, but the base is often rather heavily strigose and provided with white rhizomorphs. Since Ricken considers the glabrous stipe base as a diagnostic feature of B. myosura, it seemed best to place the present species there. Further definition of these two closely related species, is dependent on the possibility of an unexamined extant Persoon type, as B. conigena is a pre-Fresian species described by Persoon.

13. Baespora myriodophylla (Peck) Singer. Rev. Mycol. 3:193. 1938.

Figure 10, Plate III.

Basionym: Agaricus myriodophyllus Peck. N. Y. State Mus. Rep. 25:75. 1873.
Synonyms: Collybia myriodophylla (Peck) Sacc. Syll. Fung. 5:236. 1887.
Collybia lilacea Quélet. Champ. Jur. Vosges. III:434. 1875.
Mycena myriodophylla (Peck) Kühner. Le Genre Mycena: 528. 1938.
Collybia teleoianthina Métrod. Rev. Mycol. II:163. 1937.

Illustrations: Hard, Mushrooms, p. 115, fig. 85; Quélet, Champ. Vosges 3, tab. 1, fig. 1.

PILEUS 1.5-2.5 cm., convex and then plane, sometimes shallowly umbilicate or mammillate, dark warm brown (6F6) when moist, hygrophanous and drying much lighter, honey

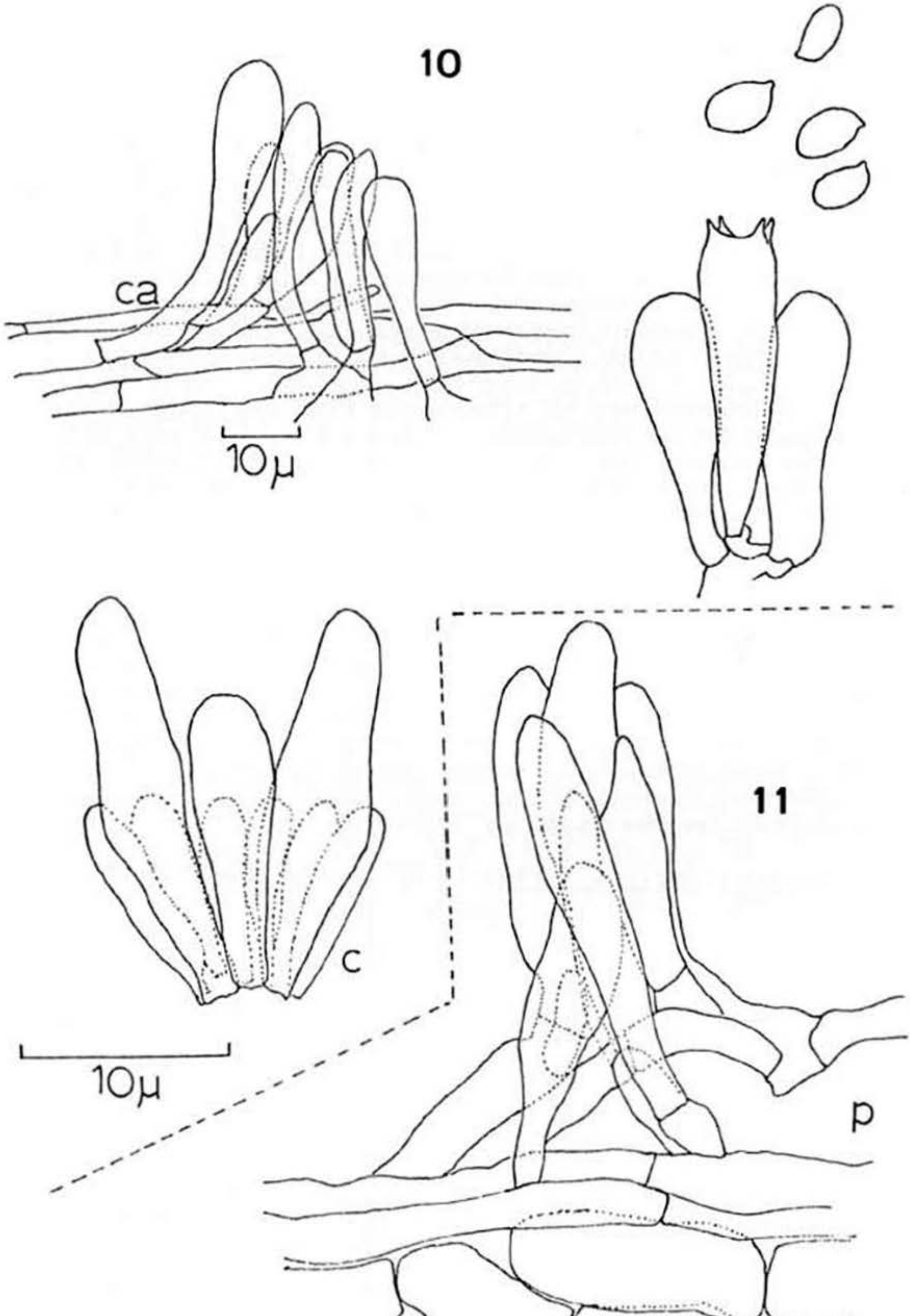


Figure 10. - Baeospora myriodophylla, W1702, basidium, spores, caulocystidia (ca), cheilocystidia (c); Figure 11. - Baeospora myosura, W1186, pileal surface and pileocystidia (p).

brown (6D6), generally with a purplish tinge toward the margin when moist; surface dull, minutely rugose, faintly floccose, especially toward the margin, margin even and remaining somewhat inrolled, context very thin, pale lilac when moist, the pallid, tough-pliant, more brittle in drying; taste and odor faint and fungoid.

LAMELLAE brick to dark purple (14E3 to 14F4), drying darker and with a fuscous tone, adnate to uncinate, linear, narrow, very thin and crowded, edge even and concolorous.

STIPE 2.5-5.5 cm long, 1-2.5 mm in diameter; lilac at the apex (15F3 or 15F2), becoming brown to reddish brown downward or in drying, equal most of length, usually somewhat expanded at base and apex; pruinose for the entire length, densely so at the base, then almost matted, darker under the covering, lighter in drying specimens; terete or compressed-furrowed, hollow, stuffed; tough, fibrous, not pliant.

SPORES minute, 2.5-4.0 x (1.5) 2-3 µm, amyloid, thin-walled, ovate to almost ellipsoid, smooth, white in deposit; BASIDIA small, 14-15 x 3-4.5 µm, four-spored, cylindrical, heavily encursted with a weakly dextrinoid amorphous substance, seeming to cement the cells together at the base; CHEILOCYSTIDIA abundant, clavate, ventricose, apex obtuse and nipple-like or broadly rounded, thin-walled, hyaline, relatively small, 18-28 x 3-7 µm; PLEUROCYSTIDIA as above but scattered, more abundant toward the gill edge; CAULOCYSTIDIA somewhat longer, broader, and more variable in shape than those of the gill edge. hyaline, thin-walled, sometimes with granular contents, strongly grouped, 12-30 x 5-9 µm, SUBHYMENIUM narrow and compact, interwoven; TRAMA parallel or slightly interwoven, composed of large diameter hyphae, 4-20 µm, thin-walled, nonamyloid, and clamped; PILEAL SURFACE a narrow cutis of agglutinated slender hyphae, 1-2 µm in diameter, in a zone 5-10 um deep, differing markedly from the underlying tissue; CONTEXT of larger diameter hyphae, 10-15 µm, the upper strata appearing like a subcellular hypoderm in tangential section, broadly rectangular in radial view, slightly encrusted in a banded pattern.

HABITAT: Scattered to caespitose on much decayed wood in moist lowland mixed woods, spring or fall.

MACROCHEMICAL REACTIONS: All reactions were negative.

MATERIAL STUDIED: WASHINGTON, Kittitas Co., W1644 (Crystal Springs); W1749 (Easton); Jefferson Co., W517 (Enchanted Valley); Pierce Co., W1702 (Mt. Rainier Ntl. Pk. - Tahoma Cr.) Stz 7564 (Mt. Rainier Ntl. Pk. - Green Lk.); NEW YORK, Peck type (Portville).

This is a very distinct species, which because of its unusual lilac tones and microscopic features could hardly be confused with any other species of its stature. Some confusion may result from the collection of partially dried specimens as the characteristic purplish colors are lost soon in drying; however, the small amyloid spores and abundant cheilocystidia will remain to set it apart.

FLAMMULINA Karst. Symb. Mycol. Fenn. 30, Meddlel. Soc. Faun. Fl. Fenn. 18:62. 1891.

Synonyms: Collybia pro parte Quél. Champ. Jura Vosges:59. 1872.
Collybidium Earle, Bull. N. Y. Bot. Gard. 5:428. 1909.
Myxocollybia Singer. Heih. Bot. Centralb., Abt. B 56:162. 1936.

Type species: Flammulina velutipes (Curt ex Fr.) Karst.

Habit collybioid, pileus viscid, with pileocystidia; lamellae usually yellowish, rounded-adnexed or adnate-sinuate, moderately thin; spore print white; spores hyaline, smooth, nonamyloid; basidia normal; cystidia present on the sides of the gills; context of the pileus fleshy; hyphae clamped and nonamyloid, lignicolous on hardwoods.

The genus is monotypic; for a more complete description see the species description which follows.

14. Flammulina velutipes (Curt. ex Fr.) Karst. Symb. Mycol. Fenn. 30, Meddlel. Soc. Faun. Fl. Fenn. 18:62. 1891. Figure 12, Plate IV.

Illustrations: Curtis, W.; Fl. Londin. 4. tab. 70; Britz. Hymenon., tab. 16, fig. 219; Gillet, Champ. Fr. Hymenon. tab. 238; Cooke, Illustr. Brit. Fungi. tab. 650; Peck, Edible Fungi, tab. 7.

PILEUS 1.7-5 cm, brownish yellow to dark warm brown (4A5 to 5C7), color may vary considerably from collection to collection, generally bright yellowish toward the margin and darker, reddish-brown on the disk, intergrading uniformly, spotting or staining dark brown (6F6); convex and then plane, margin remaining inrolled, often wavy and irregular, occasionally frayed; surface glabrous, viscid and shining, dull quickly in drying, the pellicle easily peeled from the cap, translucent-striate half to three-quarters the radius; context thin to moderately thick, yellow to dark brown just below the surface, firm, almost tough; smell and taste none.

LAMELLAE off white to yellow (5B4), emarginate to sinuate, edges even and concolorous, sharp-pointed at the margin, blunt toward the stipe, ventricose, broad, 9 x 3.5 mm, subdistant to close, up to 40 lamellae reaching stipe.

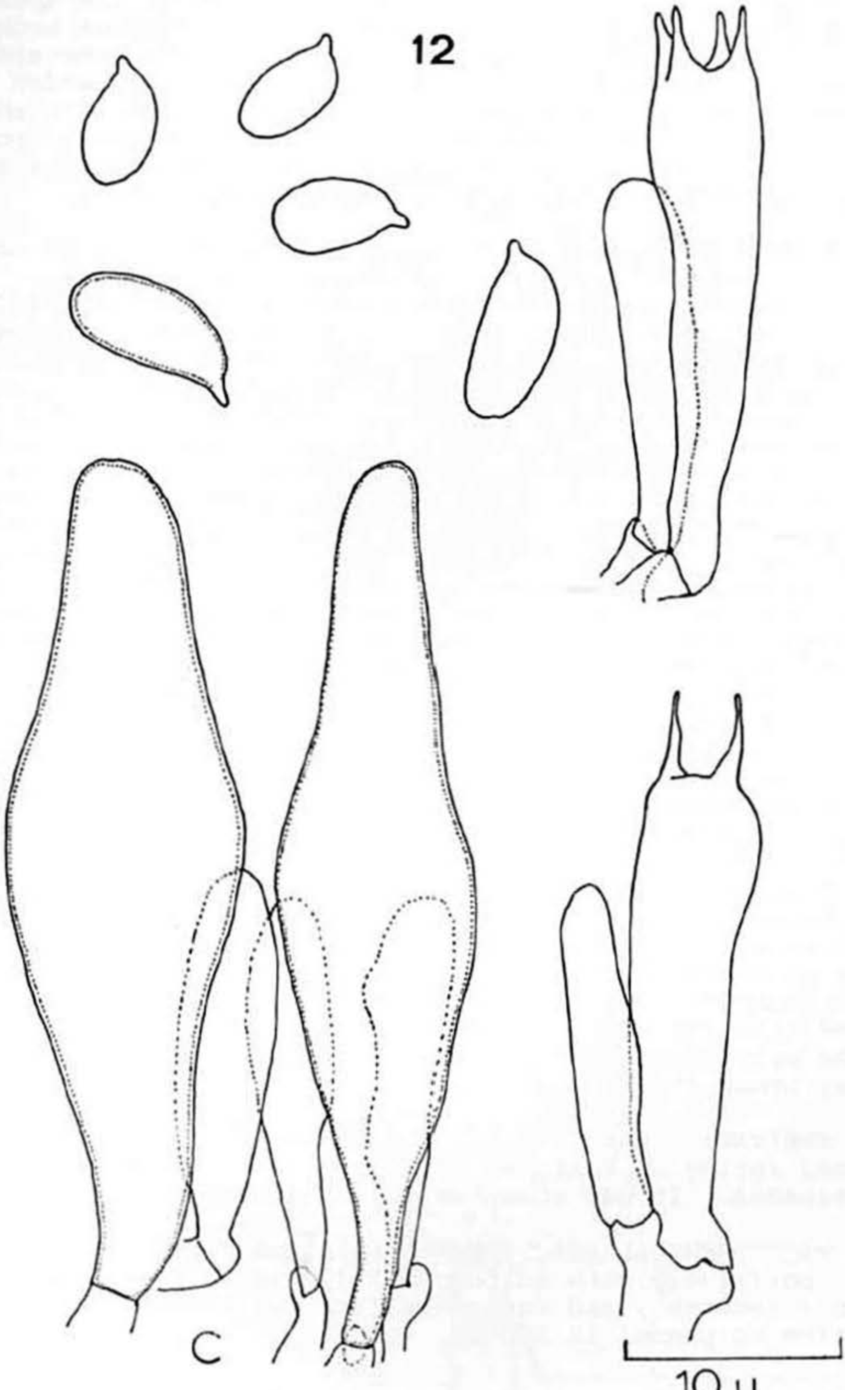


Figure 12. - Flammulina velutipes, W1688, basidia and spores, cheilocystidia (c).

STIPE 2.5-10.5 cm x 2-5 (12) mm, yellow at the apex, soon a dark yellowish brown and then a dark fulvous brown (4A4 to 5B4 to 6F4), equal and confluent at the base and appearing somewhat expanded there, terete or more often compressed and furrowed; surface densely covered with short dark fulvous hairs its entire length, dull, somewhat spotted with a darker brown tone, brown rhizomorphs at the base; hollow, with a dark brown outer rind, yellow within.

SPORES frequently in two sizes, 6.5-7.5 x 3-4 µm and 7.5-9 x 3.5-4 µm, cylindrical-ellipsoid to almost pip-shaped, smooth, generally with a somewhat thickened wall, nonamyloid; spore print pale yellow (3A2 - A3) in deposit; BASIDIA 16-24 x 4-6 µm, very elongate, shape variable, tapering gradually downward or abruptly enlarged in upper half; two-spored or four-spored mixed, or entirely four-spored, then lacking the longer, cylindrical to pip-shaped spores, nonamyloid, thin-walled; CHEILOCYSTIDIA 26-57 x 9-14 µm, abundance extremely variable, sometimes so numerour as to exclude basidioles on the gill edge, occasionally so rare as to be absent from any one crush mount, ventricose, quite large in diameter and generally widest in the lower half, often pedicellate, tapering gradually upward to an obtuse broad apex, thin-walled, arising rather shallowly from the subhymenium; frequently mixed with filamentous outgrowths from the trama, the presence and abundance of the latter being variable as well, generally equal, with a straight outline, sometimes contorted; PLEUROCYSTIDIA not differentiated; GILL TRAMA parallel and very regular to almost interwoven, of hyphae 3-10 (16) µm in diameter, nonamyloid, with very large keyhole clamps; SUBHYMENIUM narrow, compact and interwoven; PILEAL SURFACE a viscid layer of upright, partially gelatinized dermatocystidia, these clavate to filamentous, often irregular and largest in upper half, in a zone 32-65 µm in depth; PILEAL CONTEXT interwoven to nearly radially oriented, clamped, nonamyloid; STIPE TOMENTUM composed of long, dark brown, rather thick-walled, tangled hairs, of uniform diameter (3-4 µm); hyphae of the stipe encrusted in an irregular manner, clamped, and rather broad (5-12 µm in diameter).

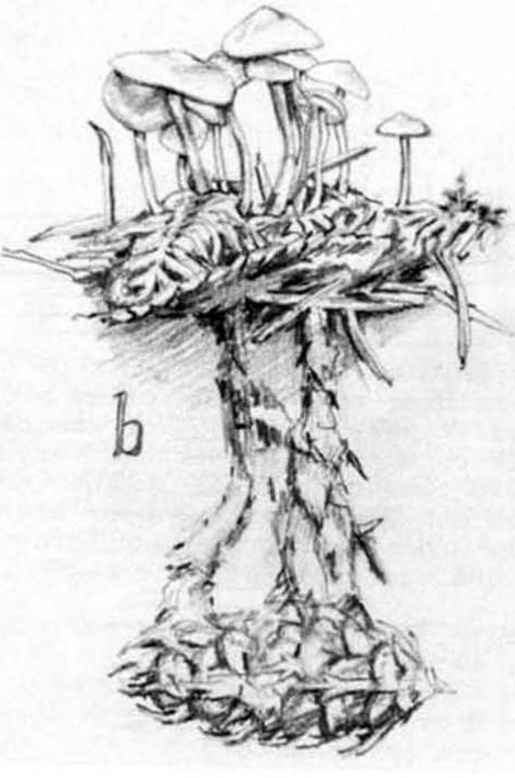
HABITAT: Caespitose on deciduous wood, often on stumps, spring or fall, in the cooler part of the collecting seasons. It may occasionally be a mild wound parasite.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with sulfoformol (yellow), phenol-aniline (faint-greenish), and ferric sulfate (yellowish to green); reaction to phenol is spotty.

PLATE IV -; a - Flammulina velutipes, W1443, x 3/4; b - Strobilurus trullisatus, W978, x 3/4.

IV

a



b

MATERIAL STUDIED: WASHINGTON, Chelan Co., W632 (E. of Stevens Pass); King Co., W607 (Seattle), W1688 (Water Main Woods), W90 (Betty's Bog); Skammania Co., W1443 (Cispus Camp).

This is a very striking collybioid fungus which remains quite distinct from other similar species and genera; its affinity is difficult to define. The densely short brown tomentose stipe, lignicolous habit, viscid dermatocystidia in a hymenium on the cap surface, and nonamyloid cylindrical spores which are a pale yellow in deposit, make an unusual set of characters that finds no counterpart in any other species.

There exists, however, within the framework of this well-defined genus, a great deal of variation. Collections vary strikingly in color, stature, general texture, staining reactions, degree and color of the stipe tomentum, and substratum. These macroscopic differences are matched by a bewildering variation in microscopic characters: spore size and shape, abundance of cystidia, presence of filamentous cystidia-like outgrowths of the trama on the gill edge, and a context that may range from being uniform and parallel to one that is interwoven and "knotty" in appearance. It may well be that there are more than one species or variety in the genus, but in the collections that I examined, I was unable to find any correlations in the data between macroscopic and microscopic variations.

STROBILURUS Singer. Persoonia 2:407-415. 1962.

Synonyms: Collybia pro parte. Kummer. Führ. Pilzk. p. 26. 1881.
Mycena pro parte S. F. Gray. Nat. Arr. Brit. Pl. 1:619. 1821.
Pseudohiatula pro parte. (Singer) Singer. in Notula syst. sect. crypt. Inst. bot. Acad. Sci. U.S.S.R. 4(10-12):8. 1938.

Type species: Strobilurus conigenoides (Ellis) Singer.

HABIT collybioid or marasmioid; PILEUS convex and then plane, margin remaining somewhat inrolled and entire, very rarely and not strikingly depressed or umbonate, white to very pale pinkish to smoky tan, surface very even, dull and unpolished, finely pubescent under a lens, margin translucent-striate when moist, subhygrophanous and not changing color; flesh thin and membranous, concolorous, tough, not reviving; smell and taste not distinctive.

LAMELLAE white, sometimes tinged yellowish or grey with age and dryness, close, narrow, thin and crowded, sinuate or rounded and then adnate, somewhat ventricose, sharp-pointed towards the margin of the pileus, edge even but pruinose from cystidia; spore print white.

STIPE generally very long relative to the cap size, pallid yellow to almost white at the apex and becoming increasingly yellow downward, yellow-tawny entire lower half; equal or seeming to expand gently downward; the surface unpolished and finely pubescent at the apex, not pruinose-powdery, becoming increasingly tomentose toward the base, often rooting to at least one half the length, and then densely wooly-tomentose and adherent to particles of the substratum; solid, tough and pliant.

SPORES ellipsoidal and generally less than 7 x 3.5 µm, smooth, thin-walled, nonamyloid; BASIDIA rather narrow and long relative to their size, about 20-22 x 5 µm average, four-spored or two-spored, noncarminophilous; GILL TRAMA subparallel; CHEILOCYSTIDIA numerous, ventricose and subacute to almost cylindrical, often subcapitate; PLEUROCYSTIDIA often the same as the cheilocystidia, or shorter, more subcapitate and cylindrical, frequently with the outer wall of the tip dissolved and capped with slime, rarely crystalline-encrusted; PILEOCYSTIDIA numerous to scattered, ventricose at the base and pedicellate and buried below, tapering and narrowly subcapitate above, rather thin-walled, and yellowish or hyaline; CAULOCYSTIDIA resembling the pileocystidia above the base, base is usually truncate, with a thin-wall, or occasionally with a yellow, thick wall, tapering to the apex and then subcapitate to rounded, not really ventricose at the base, contents hyaline or yellow; NO CLAMPS; PILEAL SURFACE a palisade of clavate to saccate-pedicellate cells, thin-walled and collapsing frequently in section, with hyaline or yellowish contents; context of pileus interwoven, of rather narrow hyphae 3-5 µm in diameter, yellow in Melzer's.

HABITAT: Solitary to caespitose on wood or cones of Douglas fir, pine, or spruce; generally in dense conifer woods.

MACROCHEMICAL REACTIONS: Gills and the flesh of the cap do not react with aniline, alpha-napthol, guaiacol, tincture of guaiac, formol, sulfoformol, phenol, phenol-aniline, and ferric sulfate.

The presence of subcapitate to cylindrical cystidia on cap, stipe, gill face and edge; the small thin-walled ellipsoid spores; the absence of clamp connections, the habit on wood and cones, the pseudorrhiza covered with a thick ochraceous tomentum, the rather tough-pliant consistency of the cap and stipe, and the non-reactive character of the flesh, set Strobilurus aside from its relatives in Collybia, Marasmius, and Mycena.

Although the above-mentioned characters seem to set Strobilurus aside from other genera, the delimitation of the species within the genus appears more difficult. This is true despite the fact that there are a large number of microscopic characters obtainable from the dried material.

The characters which have been used generally to separate the species are as follows: the shape and size of the cystidia, in particular, whether they are alike in shape on all parts of the carpophore, whether they are acute or obtuse, and whether or not they are thick-walled (2 µm); length of the pileocystidia, size of spore, color of cap, and type of substratum. These characters have been used most recently by Kempton and Wells (1971) in their treatment of *Strobilurus* in Alaska, and all three of the species that they found in Alaska were described as new. In working over my own material, I found that certain characters seemed correlated with other characters in a particular setting, but were variable and indistinct in other settings. For instance, a *Strobilurus* that is found in deep, dark, and mossy conifer woods, which has a rather large and dark smoky cap, and is attached to wood seems to fit *Strobilurus lignitilis* nicely. Likewise, a smaller form with a white to pale pink cap, found growing on Douglas fir cones in dense conifer forests with needle-litter floor matches *Strobilurus trullisatus*. There are however a distressing number of collections which fit neither of the two species well; and where cap color, habitat and substatum, and the microscopic features vary and intergrade with one another. The present treatment retains for the most part the delimitation of the species that Wells and Kempton proposed, and the species descriptions follow their own. Much more microscopic data needs to be accumulated from a wider geographic base, and a variety of different habitats and substrata. Examination of the Wells and Kempton types as well as those in Europe should help greatly in delimiting the species of this genus.

Key to the *Strobilurus* Species

1. Spores 3-4 x 1.5 - 3.0 µm, pileus white to pinkish, on cones of *Pseudotsuga menziesii*.................... .... *Strobilurus trullisatus* (p. 179)
1. Spore larger, pileus pinkish or greyish brown, on cones of other conifers or wood.................. 2.
    2. Pileocystidia 75-120 x 7.5-15 µm, pileus greyish brown, on buried decaying wood............... .... *Strobilurus lignitilis* (p. 180)
    2. Pileocystidia 30-70 x 5-11 µm, pileus greyish brown or rarely pinkish white, on cones of spruce or pine, rarely on buried wood............... 3.
3. Cheilocystidia and pleurocystidia nearly equal and shaped alike, with a ventricose base and tapering markedly to a subacute to subcapitate apex, on cones of *Picea*, rarely on buried wood.................. .... *Strobilurus occidentalis* (p. 182)
3. Cheilocystidia as above, pleurocystidia shorter, generally subcylindrical, and rounded to subcapitate at the apex, never subacute, on cones of *Pinus*......... .... *Strobilurus albipilatus* (p. 183)

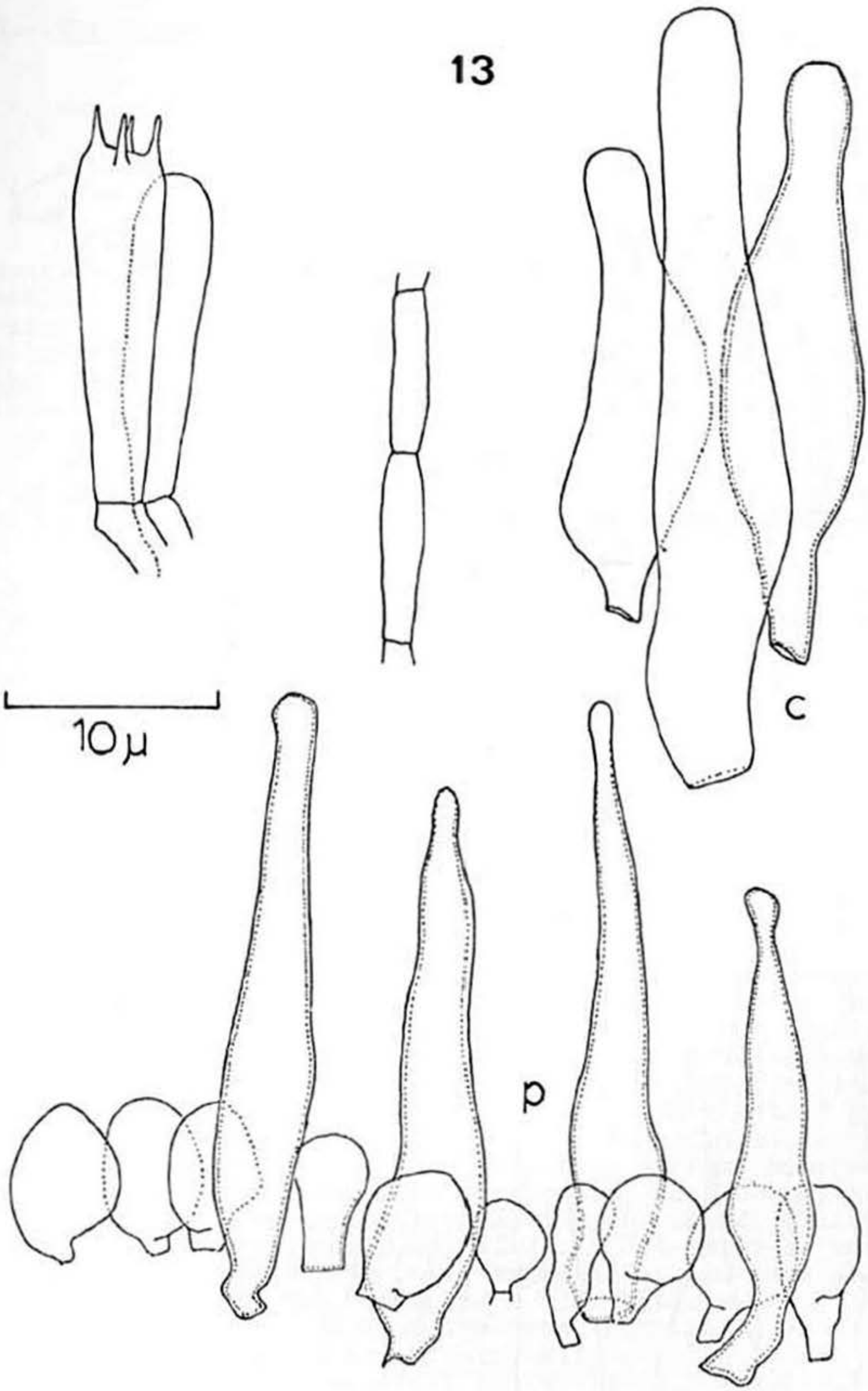


Figure 13. - Strobilurus trullisatus, Murrill type, basidium, hyphae, cheilocystidia (c), hymeniform elements of pileal surface and pileocystidia (p).

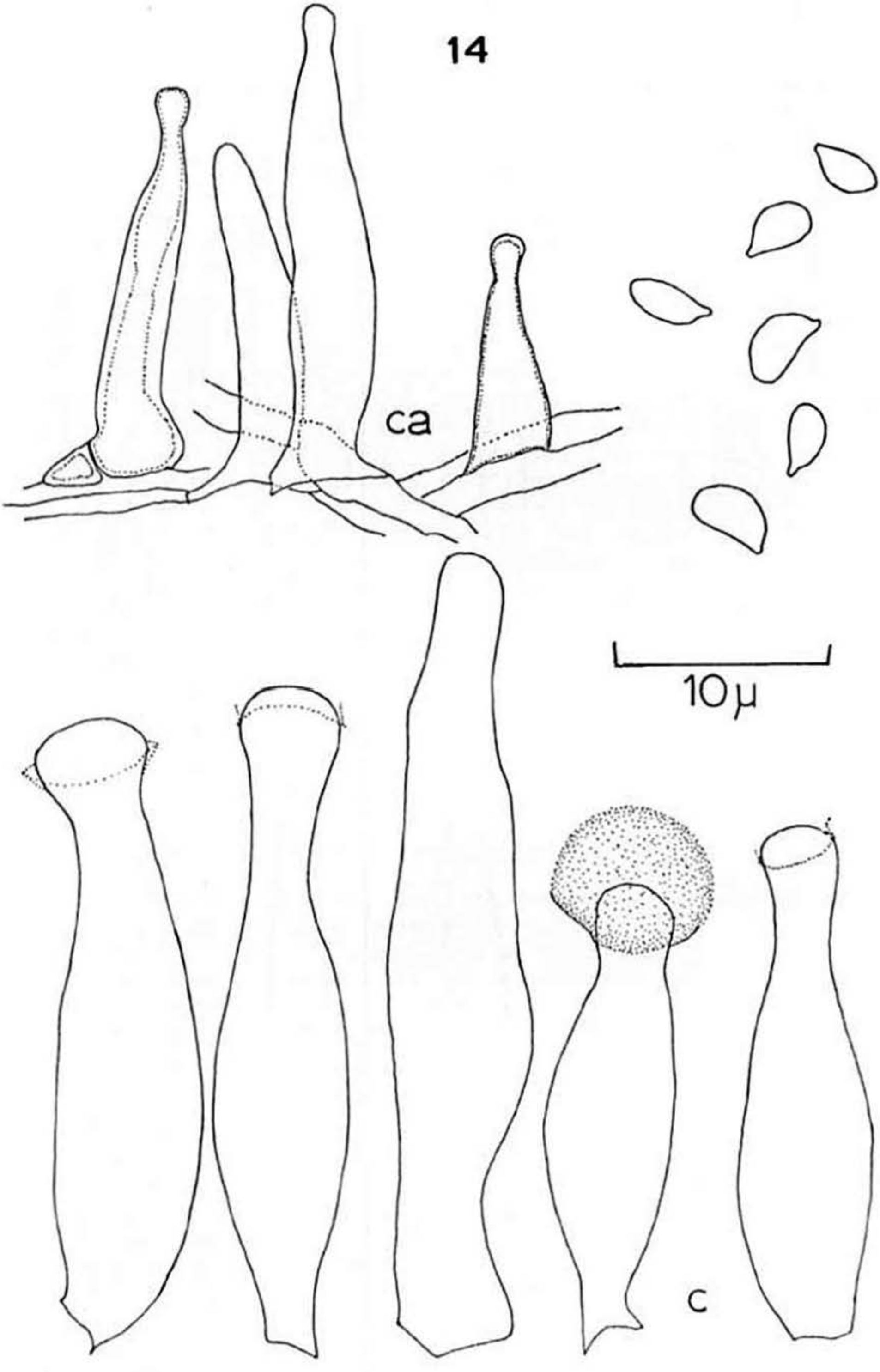


Figure 14. - Strobilurus trullisatus, Murrill type, caulocystidia (ca), cheilocystidia (c).

15. Strobilurus trullisatus (Murr.) Lennox comb nov.
Figures 13 and 14, Plate IV.

Basionym: Gymnopus trullisatus Murrill. N. Amer. Fl. 9 (pt. 5):367. 1916.
Synonyms: Collybia trullisata (Murr.) Murr., Mycol. 8:219. 1916.

PILEUS 5-13 mm broad, convex and becoming plane, not centrally depressed, sometimes umbonate, margin becoming straight or rarely somewhat revolute; white or pinkish centrally and with age, subhygrophanous and often greying or yellowing in drying, surface uniform, dull, almost bloom-like, finely pubescent under a lens, flesh thin, rather tough-pliant, and concolorous; taste and odor not distinctive.

LAMELLAE white, sometimes tinged yellowish in drying, broadly adnate to sinuate, and then subventricose, rather narrow, thin and crowded, 6 x 1 mm, edges even and pubescent.

STIPE 1.5-4.5 cm x 1-1.5 mm, white at the apex, becoming rapidly ochraceous to tawny below (5C6); equal and terete; surface unpolished, like etched glass, finely pubescent under a lens at the apex, wooly-tomentose with long, rather matted ochraceous mycelium where rooting and for about half the aerial length; rooting and with a pseudorrhiza generally equal to or greater than the aerial portion, tough-pliant.

SPORES 3-4.5 x 1.5-3.0 µm, smooth, hyaline, ellipsoid, thin-walled and nonamyloid; BASIDIA 20-26 x 3.5-5 µm, quite narrow, with conspicuous long sterigma, four-spored; GILL TRAMA of interwoven to subparallel hyphae 3.5-7.5 µm in diameter, pileal context of interwoven hyphae, nonamyloid and without clamps; CHEILOCYSTIDIA and PLEUROCYSTIDIA abundant (less so on the face), and similar, sybcylindrical to subventricose with a tapering tip, apex obtuse to subcapitate, hyaline to yellowish, frequently capped with a crown of slime, the outer wall of the apex dissolving and leaving a collarette below the slime head, rarely crystalline-encrusted, thin-walled or moderately thick (to 2 µm); PILEOCYSTIDIA rather abundant, 42-85 x 7.4-11.5 µm, ventricose-rostrate with obtuse to subcapitate apices, hyaline to yellowish, mostly thin-walled but some up to 2 um thick at the base, smooth or rarely crystalline encrusted; CAULOCYSTIDIA abundant, often grouped, 23-100 x 7.5-13 µm at the base, 4-8 µm broad at the apex, truncate at the base and tapering upward to the subcapitate tip, hyaline or yellowish, with thicker walls than the other cystidia (1-3.5 µm), smooth; PILEAL SURFACE hymeniform, with a palisade of clavate to saccate-pedicellate cells, 12-22.5 x 5.5-9.5 µm, smooth and hyaline.

HABITAT: On Douglas fir, Pseudotsuga menziesii, cones in dense conifer forests with needle-litter floors, in autumn.

MACROCHEMICAL REACTIONS: All reactions were negative.

MATERIAL STUDIED: WASHINGTON, King Co., W. A. Murrill 439, (type - Seattle), W216 (U.W. Campus), W230, W1160 (Water main Woods, Redmond), W240, W244,W867, W1127 (McClellan's Butte Trailhead); Thruston Co., W1045, W1047 (Tenino Mounds); Chelan Co., W266 (Snow Creek Trailhead); Whatcom Co. W324 (Baker Canyon Creek Rd.); San Juan Co., W563, W1740 (Friday Harbor Biological Station). IDAHO, W910 (Collin City Dump, near Priest Lake).

16. Strobilurus lignitilis Wells and Kempton Mycologia 63:375. 1971. Plate V

PILEUS 1-3 (5) cm broad, convex, becoming plane, margin remaining inrolled or becoming almost straight, white to medium or dark sooty brown, hygrophanous and drying somewhat paler, darkest centrally and fading toward the margin; surface dull, finely pubescent under a lens, not translucent-striate or only so on very margin, sometimes shallowly plicate there as well, especially in the dry condition; context thin and tough-pliant, odor and taste not distinctive.

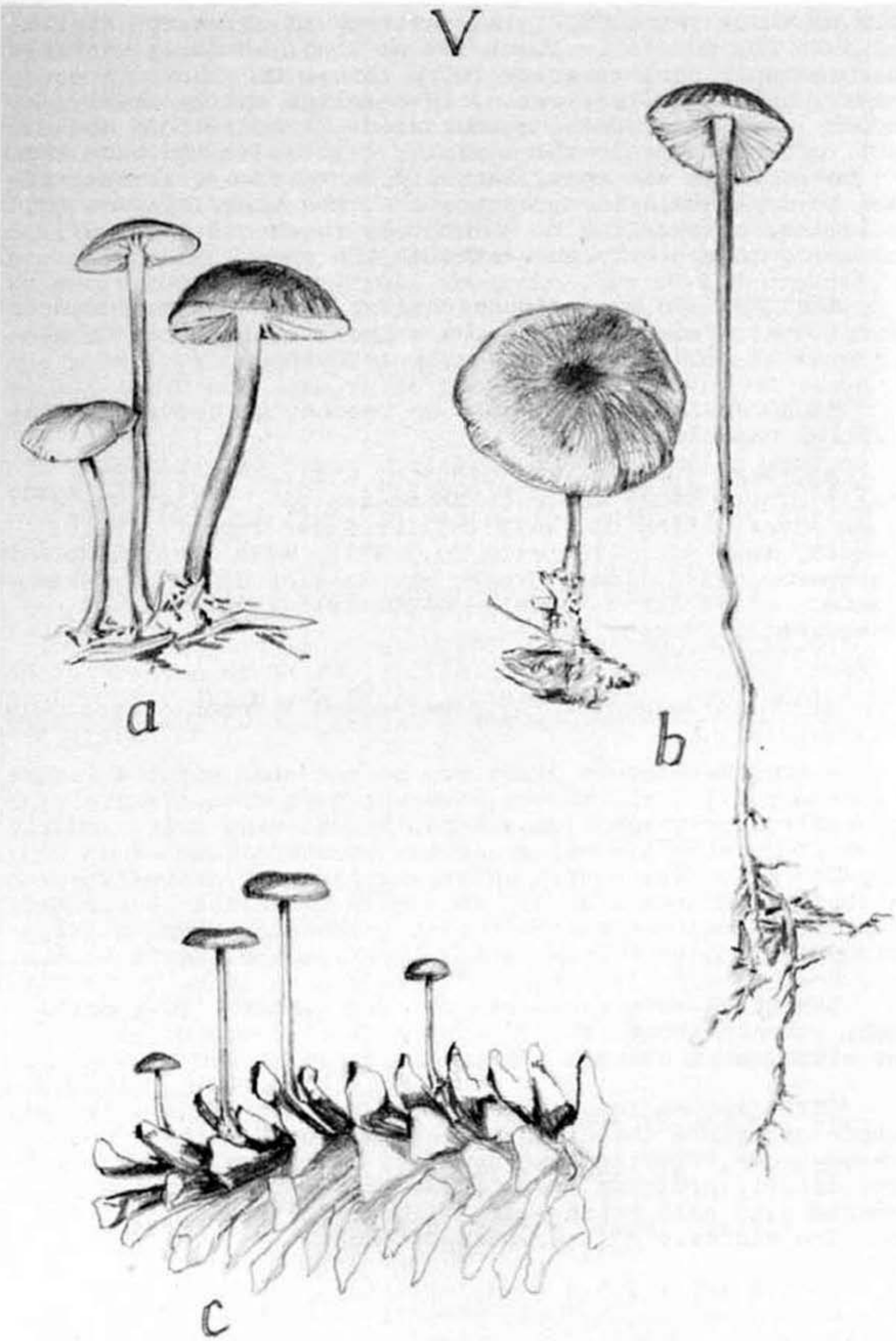
LAMELLAE white, occasionally tinged yellow in drying, sinuate to almost free, subventricose, blunt at the stipe apex, sharp-pointed towards the margin, edges even and pubescent, rather broad, 2-4 mm, thin and crowded.

STIPE 2.5-8 cm x 1-4 mm, white at the apex, becoming increasingly yellow downward, ochraceous buff mycelium covering at least the lower half, equal, surface like the cap, finely pubescent, becoming densely matted wooly-tomentose over the whole length of the pseudorrhiza (generally equal to or surpassing the aerial portion), often with humus adhering to the tomentum, sometimes naked and with rhizomorphs, hollow, and tough-pliant.

SPORES 5-7.5 x 2.5 - 3 µm, smooth, ovate to ellipsoid, hyaline, thin-walled, and nonamyloid; BASIDIA 20-25 x 3-5 µm, four-spored or two-spored (the spores then in two sizes, the larger range 7-9.5 x 2.5-3 µm), long and narrow; GILL TRAMA of subparallel, hyaline hyphae 4-15 µm in diameter; PILEAL SURFACE a palisade of clavate to saccate-pedicellate, hyaline cells 20-45 x 7.5-24 µm; NO CLAMP CONNECTIONS; PLEUROCYSTIDIA and cheilocystidia similar, the cystidia of the gill edge somewaht more abundant and longer than those on the face, more frequently subcapitate, both subcylindrical to narrowly ventricose, with obtuse to subcapitate apices, usually thin-walled, occasionally with the wall

---

PLATE V -; a - Strobilurus occidentalis, W912, x 1; b - Strobilurus lignitilis, W1458, x 1; c - Strobilurus albipilatus, W967, x 1.


V
a
b
c

to 2 µm thick; PILEOCYSTIDIA scattered to abundant, 65-175 x 7.5-15 µm, generally about 100 µm long, narrowly ventricose to ventricose-rostrate, with obtuse to subcapitate apices, hyaline to yellowish, thin-walled and generally smooth, rarely crystalline encrusted; CAULOCYSTIDIA abundant, often groupd 70-150 µm long, 7-15 µm at the base and 4-9 µm broad at the apex, narrowly ventricose with subcapitate to capitate apices, truncate at the base, hyaline to yellowish, thin-walled to moderately thickened (1-2 µm), smooth or irregularly encrusted at the apex.

HABITAT: In mossy dense conifer forests, scattered to caespitose, often then with the stipes fascicled on decaying conifer wood which frequently is buried.

MACROCHEMICAL REACTIONS: No reagent gave even a faint positive reaction.

MATERIAL STUDIED: WASHINGTON, Clallam Co., W1142 (Heart O' the Hills Cmpgr.); Snohomish Co., W1154 (White Chuck River); King Co. W873 (Miller River cmpgr.), W1133 (Dorothy Lake Rd.); Thurston Co., W976, W978 (Tenino Mounds); Pierce Co., W897 (Ipsut Creek, Mt. Rainier Nt. Pk.); Skamania Co., W1448 (Iron Butte); IDAHO, W915 (Priest River Experimental Forest, USDA).

17. Strobilurus occidentalis Wells and Kempton. Mycologia 63:372. 1971. Plate V

PILEUS 6-15 mm in diameter, convex with margins incurved becoming broadly convex to subplane, often obscurely unbonate; subhygrophanous and hardly changing color, nearly white if heavily shaded, otherwise tan to medium or dark grey-brown, margins often paler; surface dry, unpolished, smooth to subrugose, margin obscurely translucent-striate when moist; context white, thin to membranous (up to 0.5 mm), pliant, odor none or slightly of radish, taste none.

LAMELLAE white, narrowly adnate, sinuate, to almost free, subventricose, sharp-pointed at the margin, blunt at the stipe, thin, close, moderately broad, 1-2.5 mm.

STIPE 1-3 cm long, often with a pseudorrhiza which may double or triple this length, 1-2 mm broad, white, soon orange-brown from the base upwards, apex remaining white; dry, densely pruinose under a hand lens. pseudorrhiza covered with pale ochre-orange floccosity; equal, stuffed becoming minutely hollow, rather tough.

SPORES 4-7 x 2.5-3.0 µm, ellipsoid, hyaline, smooth, thin-walled and nonamyloid; BASIDIA 18-22 x 4-5.5 µm, four-spored or two-spored; GILL TRAMA of subparallel, hyaline, smooth hyphae 3.5-12 µm broad, nonamyloid; CONTEXT of the pileus of interwoven hyphae similar to those in the gill trama; PILEAL SURFACE hymeniform, a palisade of clavate to saccate-pedicillate cells, hyaline to very pale brown, 13.5-35 x 5.5-17 (25) µm; NO CLAMP CONNECTIONS; PLEUROCYSTIDIA infrequent to moderately abundant, 34-55 x 5.5-15 µm, ventricose with obtuse to subcapitate apices, hyaline to yellowish, smooth or minutely encrusted on or near the apex, usually thin-walled but wall sometimes 1-2 µm thick; CHEILOCYSTIDIA (20) 26-50 x 7.5-11.5 µm, otherwise similar to pleurocystidia though often more distinctly subcapitate; PILEOCYSTIDIA infrequent to moderately abundant, 30-70 (80) x 5-11 µm, ventricose with obtuse to subcapitate apices, hyaline to yellowish, thin-walled, smooth or rarely scantily encrusted; CAULOCYSTIDIA abundant (30) 40-115 µm long, 7.5-20 µm broad at the base, 3.5-6.5 µm at the apex, ventricose with obtuse to subcapitate apices, often truncate at the base, hyaline to yellowish, thin to moderately thick-walled (to 2 µm), smooth or irregularily encrusted on or near the apex.

HABITAT: In dense conifer woods, on buried wood or cones of spruce (*Picea stichensis* and *P. glauca*), mostly one but sometimes 2-3 fruiting bodies per cone, early spring or late autumn.

MACROCHEMICAL REACTIONS: No data available.

MATERIAL STUDIED: WASHINGTON, Whatcom Co., W325 (Baker Canyon Creek Rd.); Clallam Co., W1009 (Deep Creek); IDAHO, W919 (Bindarch Creek, Priest River), W912 (Collin Cith Dump and Swamp, Priest River).

The above description was taken almost directly from that of Wells and Kempton (1971). All the collections that I examined were not found on cones of *Picea*, but rather on wood, and seemed to match this species the closest. (Spores larger than in *S. trullisatus* and pileocystidia much shorter than those of *S. lignitilis*). Wells and Kempton use the occurrence on *Picea* cones as a fundamental distinguishing feature of the species, and since none of my collections were found on this substrata, I felt their description of the species should be followed as closely as possible.

18. *Strobilurus albipilatus* (Peck) Wells and Kempton. Mycologia 63:377. 1971

Figure 15 and 16, Plate V

Basionym: *Collybia albipilata* Peck. N. Y. State Museum Rep. 49:40. 1896.
Synonym: *Gymnopus albipilatus* (Peck) Murrill. N. Amer Fl. 9:366. 1916.

PILEUS 0.5 to 1.0 cm, light pinkish buff to brown, uniform or lighter on the margin, hygrophanous and fading to a uniform pinkish white or with a darker pinkish patch on the disc (5A2 or lighter when moist, drying to an even lighter shade, no match); convex becoming plane, sometimes centrally depressed, margin remaining somewhat inrolled or becoming straight, even; surface dull, faintly shiny when moist and translucent-striate almost to the disc then as well, finely pubescent under a lens; context membranous, rather fragile when moist, becoming tough in drying; taste and odor none.

LAMELLAE white, sinuate and rounded behind, subventricose, narrow to rather broad, very thin, close, edges even, concolorous and pubescent, 3 tiers.

STIPE 1.0-2.7 cm x 1 mm or less, white at the apex, yellowing downward, never becoming ochraceous at the base but rather a bay color (5A3); pubescent at the apex and almost all the way to the base, terminating in a fibrillose radicating base, this pseudorrhiza rarely more than a third the length of the aerial portion, equal, hollow, rather watery when moist, becoming tougher in drying, also somewhat shining under the pubescence then.

SPORES 4-5 x 2.5-3.0 (3.5) µm, ovate to ellipsoid, smooth, thin-walled, hyaline, and nonamyloid; BASIDIA slender, with long divergent sterigma, 16-21 x 3-5 µm, four-spored; NO CLAMP CONNECTIONS; PILEAL SURFACE hymeniform, a palisade of subclavate to saccate-pedicillate cells, 17-23 x 4-12 µm, smooth, hyaline, thin-walled and nonamyloid; PLEUROCYSTIDIA abundant, 42-55 x 8-9.5 µm at the base, narrowly ventricose and tapering to the apex, rounded to semiacute, thin-walled and hyaline; CHEILOCYSTIDIA infrequent to moderately abundant, differing from the pleurocystidia by being shorter on the average, more cylindrical, and having apices which are rounded to subcapitate, 33-48 x 8-11 µm, hyaline, thin-walled to moderately thickened, to 1.5 µm, neither crystalline-encrusted nor with a head of slime; PILEOCYSTIDIA infrequent to moderately abundant, 47-57 x 6.5-19 µm, ventricose with obtuse to subcapitate apices, hyaline to yellowish, thin-walled, smooth; CAULOCYSTIDIA abundant and often clustered, 48-75 long and 11-15 µm at the base, 3.5-5.5 µm broad at the apex, ventricose with subcapitate apices, sometimes obtuse, generally truncate at the base, hyaline to yellowish, wall thin or usually thick-walled, and yellow, to 2.5 µm, smooth.

HABITAT: On cones of <u>Pinus</u>, scattered to gregarious.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap negative to all macrochemical reagents.

MATERIAL STUDIED: NEW YORK, West Albany (type); IDAHO, Bonner Co., W967 (Bindarch Creek).

Wells and Kempton have separated this species from the others found in Washington or Alaska by the presence of acute caulocystidia, which were illustrated by Smith (1938) in his study of the type. In my study of the type I found only subcapitate to obtuse, never subacute, caulocystidia. In addition, this species seems very close to both <u>S. ligni-</u>

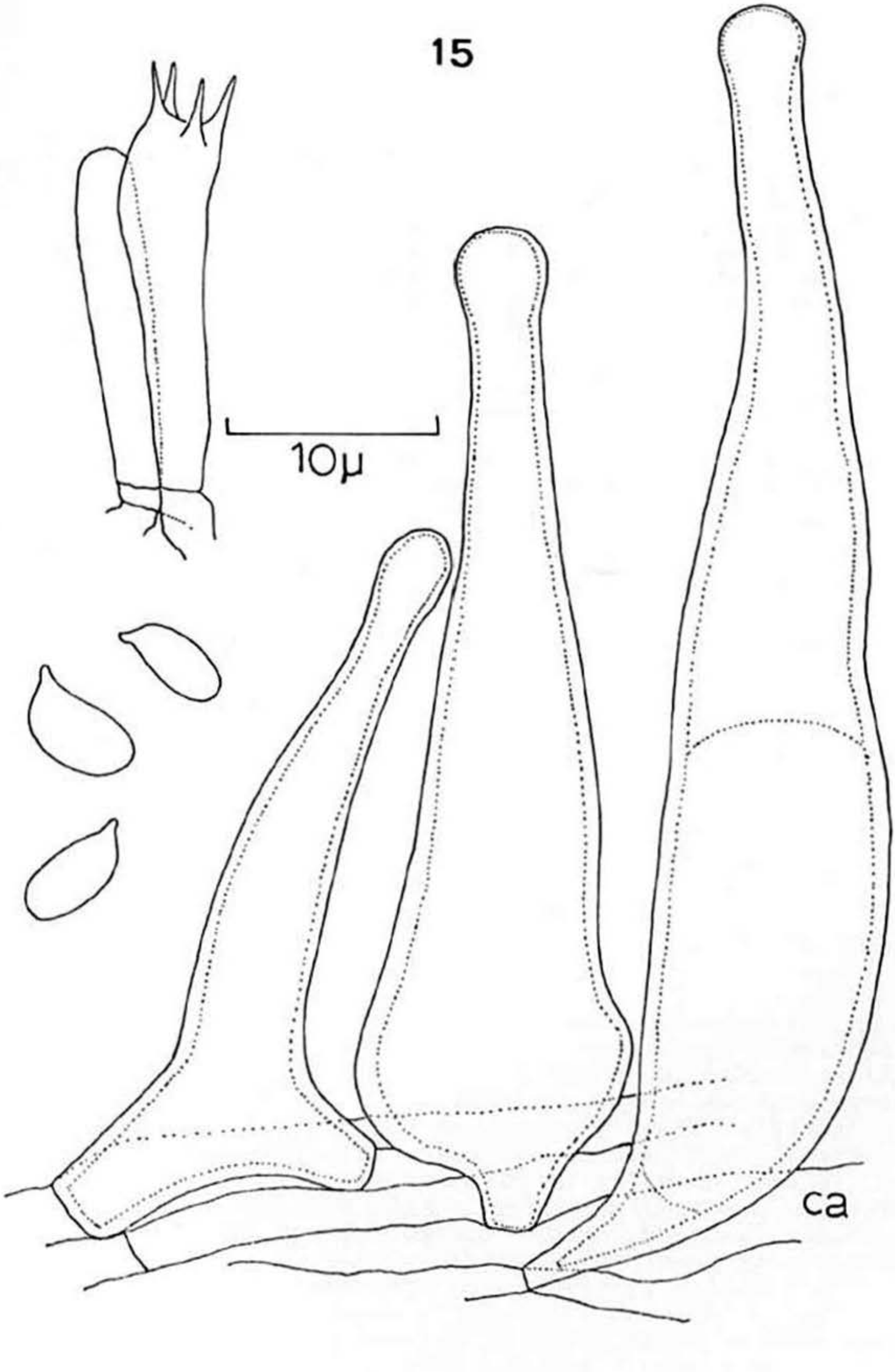


Figure 15. - Strobilurus albipilatus, Peck type, basidium, spores, caulocystidia (ca).

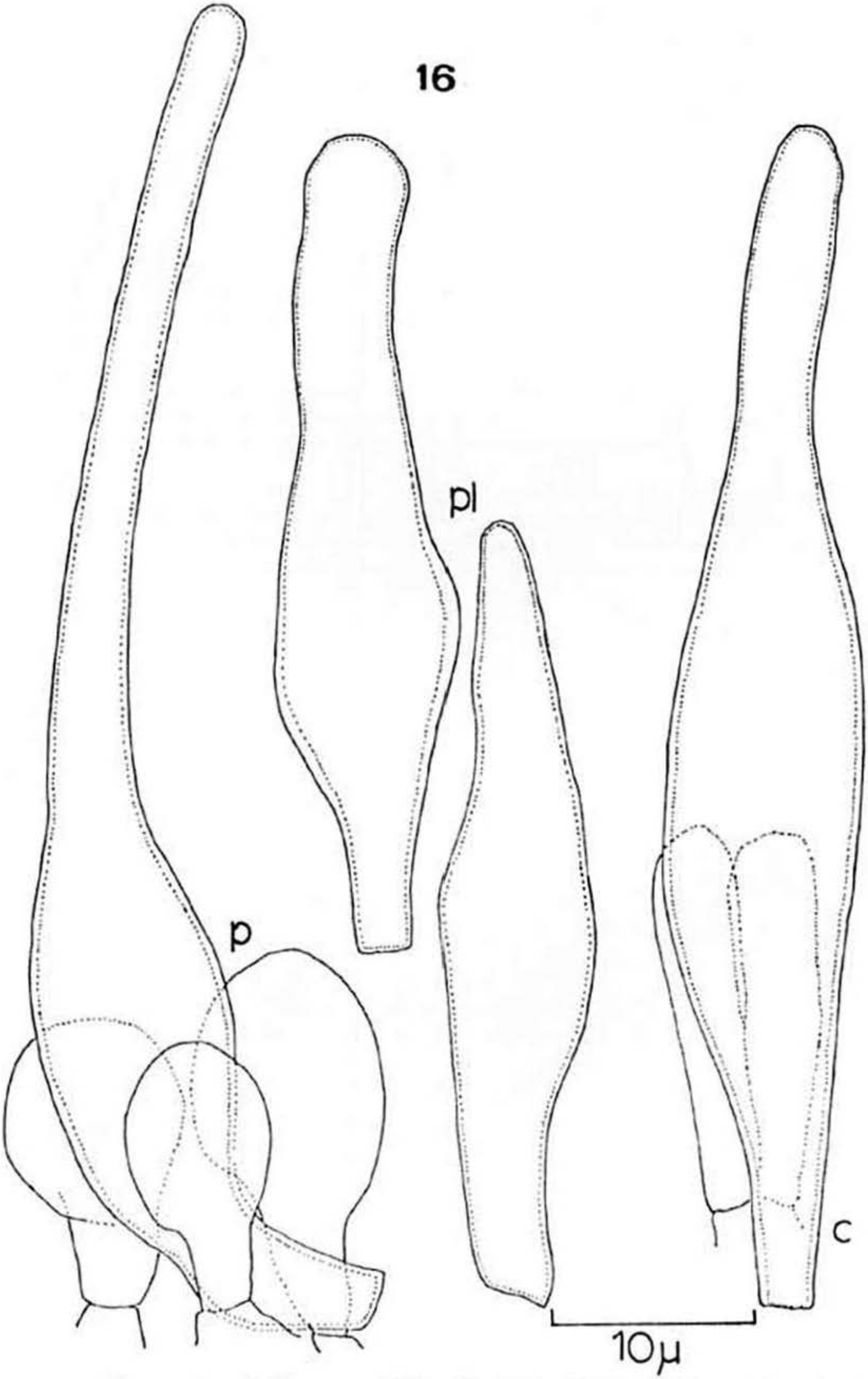


Figure 16. - Strobilurus albipilatus, Peck type, pleurocystidia (pl), cheilocystidia (c), hymeniform elements of pileal surface and pileocystidia (p).

tilis and S. occidentalis as they are described by Wells and Kempton; however, they had not been able to examine any material they considered to be representative of this species. The Idaho collection seemed to match the type quite well, but better fresh descriptions would help the delimitation of this species. At present, it appears that S. albipilatus is best distinguished by its smaller, buff or brownish, transluscent-striate cap; a shorter, paler stipe with the rooting and tomentose character less well developed than the other species; its habitat on Pinus cones, and a differentiation between cheilocystidia and pleurocystidia, the latter being longer, less cylindrical, tapering, and with apices generally obtuse to subacute, rather than subcapitate.

MICROCOLLYBIA Lennox nom. nov.

Pileus collybioideus, pusillus, convexus mox planus, ex albido ad incarnatum vel griseifulvum varians, caro membranacea et tenax, odor atque sapor haud propria; lamellae pileo concolores, anguste adnexae, tenues, confertae; stipes pileo concolor, aequalis, teres, solidus, pagina pruinosa dein tomentosa et interdum undulata, ad basim vulgo radicans, plerumque ex sclerotio luteo, badiibrunneo vel atro exoriens; sporae pusillae, 6 µm vel minus quam 6 µm longae, ovatae vel ellipsoideae, hyalinae, inamyloideae; cheilocystidia desunt; trama lamellarum subparallela, fibulas praebens; pagina pilei haud evoluta, vulgo subgelatinata, et pileocystidia filamentosa vel irregulares praebens; tomentum stipitis filamentosum.

Synonym: Microcollybia Métrod, nom. subnudum. Rev. Mycol. 17:75. 1952.
Collybia pro parte Kummer. Führ. Pilzk. p. 26. 1881.

Type species: Microcollybia tuberosa (Bull. ex Fr.) Lennox.

PILEUS and aspect collybioid, small, rarely exceeding one cm and usually less than 5 mm in diameter, convex and then plane, either somewhat umbilicate or umbonate, generally not strongly so, margin remaining inrolled or becoming straight, often furrowed or shallowly plicate; surface uniform or concentrically rivulose, with a thin pulverulent white tomentum, sometimes evanescent, silky to opaque; generally light-colored with a yellowish to flesh-colored disc, more rarely greyish brown; subhygrophanous, and unchanging in handling and in drying; flesh membranous, tough, reviving; odor and taste not distinctive.

LAMELLAE concolorous with the cap, white to grey-brown; generally sharply and narrowly adnexed, thin, crowded, rather broad, edge even and concolorous, blunt-pointed both towards the stipe and margin.

STIPE concolorous with the cap and gills, white to pinkish or greyish-brown, equal, rarely tapering somewhat upward, outline sometimes undulate, often flexuous at the base; surface pruinose-powdery, especially at the base, sometimes glabrous at the apex, base generally rooting for a short distance, then tomentose to strigose, often with abundant white to brownish rhizomorphs; almost filiform, terete, and solid; generally with a conspicuous, buried, yellow, bay-brown, or black sclerotium.

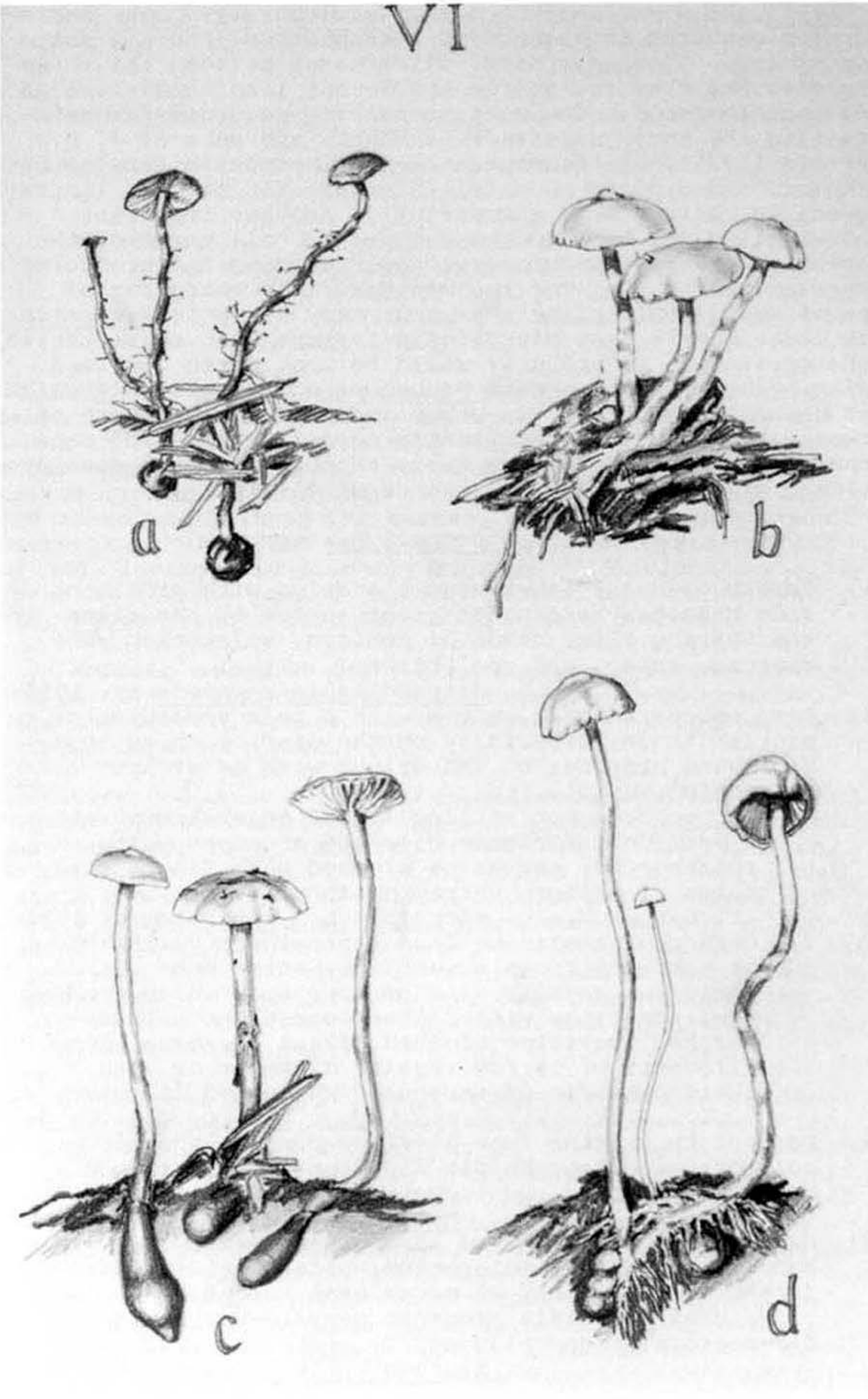
SPORES ovate to ellipsoid, thin-walled, hyaline, non-amyloid, small, generally 6 µm in length or less; BASIDIA thin-walled, four-spored and noncarminophilous; CHEILOCYSTIDIA usually not differentiated or if present than clavate to filamentous, contorted, rarely exceeding the basidia by 10 µm and quite inconspicuous; PILEOCYSTIDIA frequently present, rare to abundant, filamentous to clavate-contorted, grouped, arising directly from the surface layer, often as upturned hyphal ends. hyaline, thin-walled, sometimes septate; STIPE VESTURE similar to the cap or more often a tomentum of filamentous thin-walled cells of uniform narrow diameter, grouped and tangled, especially prominent in the lower half; GILL TRAMA subparallel, regular, loose, partially interwoven, with large prominent clamps, generally with a narrow, compact, ramose subhymenium; PILEAL SURFACE undifferentiated or a thin, amorphous, gelatinized layer cementing the upper cell layer, these cells similar to those of the context, radial to somewhat interwoven, rather coarse, loose, clamped, thin-walled, hyaline, not encrusted, and nonamyloid.

MACROCHEMICAL REACTIONS: <u>Microcollyia racemosa</u> is almost completely unreactive, while the pallid species of the genus tend to be rather widely reactive, reacting with aniline (yellow to orange), alpha-napthol, guaiacol, sulfoformol (yellowish to pink), phenol, and phenol-aniline.

HABITAT: On the much decayed carpophores of agarics and polypores, this appearing as a dried tarry substrate overlying humus or soil, occasionally without any evidence of such a substrate and thus appearing to grow directly on humus; rarely solitary, usually very abundant and somewhat crowded, then gregarious to subcaespitose.

The genus is easily recognized by its small, tough, carpohores which lack any remarkable microscopic features and which are normally found emerging from a sclerotium on the remains of much decayed agarics. The three species of whitish <u>Microcollybias</u>, <u>M</u>. <u>tuberosa</u>, <u>M</u>. <u>cirrata</u>, and <u>M</u>.

PLATE VI -; a - <u>Microcollybia racemosa</u>, W907, x 1; b - <u>Microcollybia cirrhata</u>, W1135, x 2; c - <u>Microcollybia tuberosa</u>, W905, x 2; d - <u>Microcollybia cookei</u>, W1158, x 2.


VI
a
b
c
d

cookei, are distinguished almost exclusively on the basis of the presence or absence of a sclerotium, and its shape and color. There are other differences between the three species but they are subtle and do not lend themselves as diagnostic tools. The most compelling evidence for maintaining the three species separate is the work of J. D. Arnold (1935), who demonstrated the incompatibility of both haploid and diploid mycelial interspecific matings (intraspecific matings were successful). Another important observation was made in the same work: all three of the species were capable of surviving, reviving and producing spores after drying for two months. This character of marcescense would place the genus very close to Marasmius. It lacks however any microscopic feature that characterize the marasmii. It probably would be most often confused with members of the genera Baeospora and Strobiluris which it resembles generally in color and stature, but both of these genera are found on conifer cones or wood and can easily be distinguished by their abundant, conspicuous cystidia, amyloid spores, or absence of clamps.

Key to the Microcollybia Species

1. Carpophores greyish-brown, the stipe with prominent side branches arising at right angles to the stipe and bearing slime heads of conidia, sclerotium subglobose, shiny, and coal black.. Microcollybia racemosa (p. 191)
1. Carpophores whitish, often with a pale yellowish or pinkish tinge, especially on the disc, lacking conidial side branches on the stipe, with or without a sclerotium.. 2.
   2. Carpophores not arising from a sclerotium, with a prominent strigose base and abundant white rhizomorphs, the stipe clothed with filamentous hairs of uniform narrow diameter.................................. Microcollybia cirrhata (p. 193)
   2. Carpophores arising from a prominent yellowish or mahogany brown sclerotium, stipe base not strigose, usually with an appressed white tomentum, sometimes with rather coarse white rhizomorphs, the stipe clothed toward the base with filaments of narrow regular diameter or with short cystidia of irregular shape and diameter. .... 3.
3. Carpophore arising from a yellow pumpkin-shaped sclerotium; pileocystidia differentiated, grouped, rare to abundant; cheilocystidia lacking................................ Microcollybia cookei (p. 194)
3. Carpophores arising from an apple-seed-shaped, mahogany red-brown sclerotium; pileocystidia undifferentiated, or only an occasional hair-like projection; cheilocystidia present, clavate-contorted to filamentous, inconspicuous.. Microcollybia tuberosa (p. 196)

19. Microcollybia racemosa (Pers ex Fr.) Lennox comb. nov.

Figure 17, Plate VI

Basionym: Agaricus racemosus Pers. ex Fr. Epicrisis, p. 90. 1836.
Synonyms: Collybia racemosa (Pers. ex. Fr.) Quélet. Champ. Jura. Vosges. Ser II(5):342. 1873.

Illustrations: Persoon, Tentamen, tab. 3, fig. 7-8; Brefeld, Untersuch 8(1889), tab. 4, fig. 17-19; Sowerby, Col. fig., tab. 287; Revue Mycol. 10(1888). pl. 68, and 27(1905), pl. 247, fig. 1-6.

PILEUS 3-10 mm, convex and then plane, with a broad obtuse umbo, margin strongly inrolled in the immature specimens and in drying, remaining somewhat to strongly inrolled at maturity, becoming frayed and splitting, shallowly striate-grooved, frequently slightly crenate; medium fuscous brown, darkest at the center, fading uniformly toward the margin (5D7 on the disc, 5E4 elsewhere), subhygrophanous and drying only slightly lighter (5E5); innately silky, appearing silvery toward the margin when dry; context very thin, tough-pliant, concolorous; no taste or odor.

LAMELLAE somewhat paler than the cap, greyish brown (5C4 to 5B4), very narrowly and sharply adnexed, narrow, thin, and close, 2 tiers, edges even and concolorous, consistency somewhat tough.

STIPE 3-5 cm x 0.5-1 mm, concolorous with the cap or somewhat lighter, uniformly colored (5E5); equal above the substrate, generally tapering below this point, racemose, the projections arising at right angles to the stipe, absent in the upper aerial half, 1-1.5 mm long, capped with a slime head of conidia; faintly pruinose, terete or compressed, flaccid, often prostate, frequently buried for its entire length and entwined around portions of the substrate, arising from a subglobose, shiny, coal black sclerotium, watery greyish and homogeneous inside the thin, black coat, 2-7 mm in diameter.

SPORES 4-5.5 x 2.5-3 µm, ovate, thin-walled, hyaline, contents homogeneous, faintly bluish in Melzer's solution; BASIDIA 16-20 x 3.5-4 µm, rather narrow, tapering gradually toward the base, four-spored, noncarminophilous; no cystidia differentiated; PILEAL SURFACE a cutis of radial, somewhat agglutinated, rather coarse hyphae differing chiefly in size from the underlying tissue, 1-3 µm in diameter, becoming 5-7 µm broad in context, clamped, melanized and encrusted with shallow irregular concretions, most conspicuous in the surface cells; GILL TRAMA subparallel, somewhat interwoven, clamped, with a narrow, branched compact subhymenium composed of hyphae 2-3 µm in diameter; CONIDIA 8.5-12 x 4-5 µm, peanut shaped, nonamyloid, noncarminophilous,

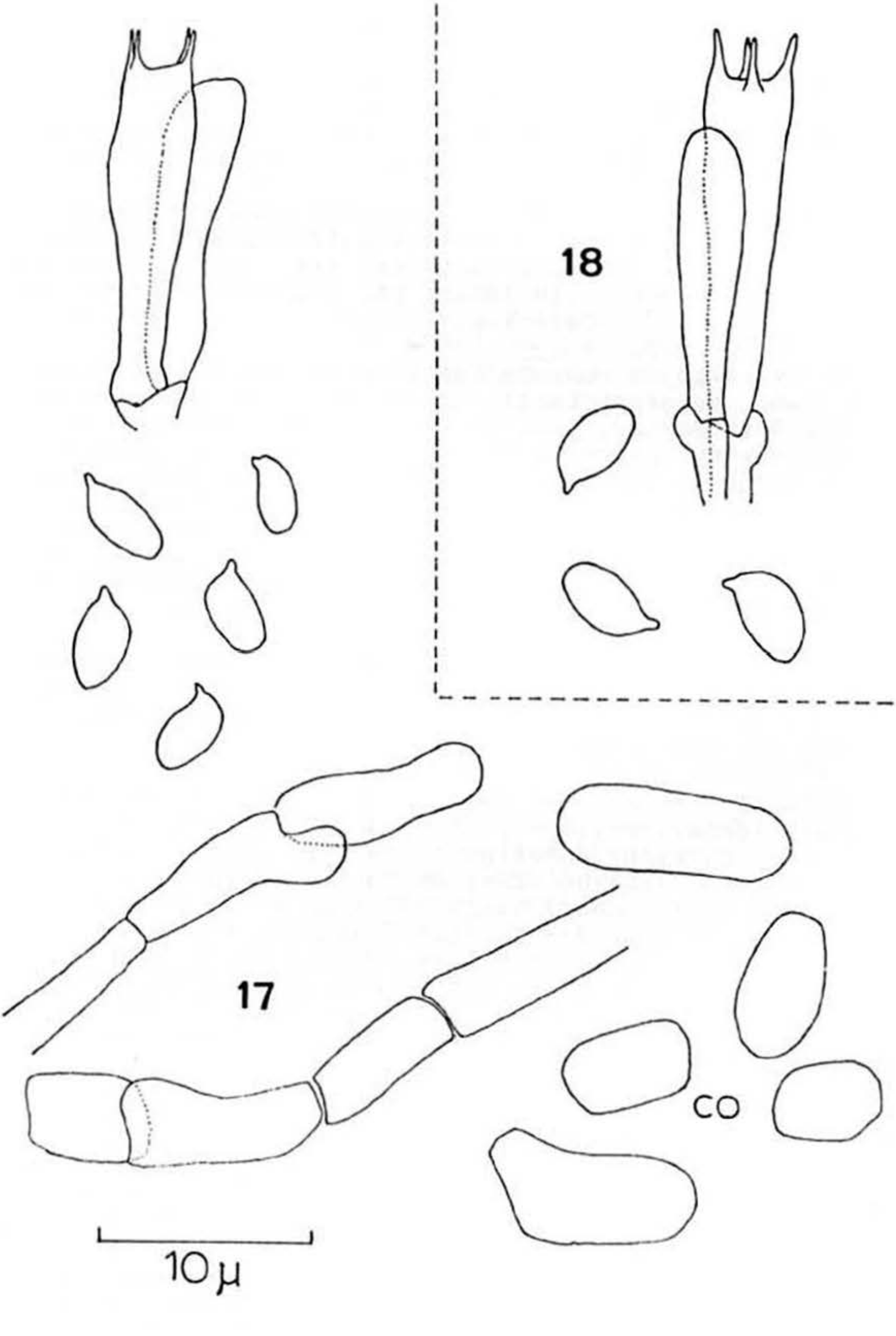


Figure 17. - Microcollybia racemosa, W907, basidium, spores, and conidia (c); Figure 18. - Microcollybia cirrhata, W1135, basidium and spores.

clamped, produced by the fragmentation of coarse mycelium.

MACROCHEMICAL REACTIONS: All reagents failed to produce color changes. The dark fuscous tones of the carpophores may mask weaker reactions with some of the reagents.

HABITAT: On the much decayed remains of agarics, or in deep coniferous duff, gregarious to subcaespitose.

MATERIAL STUDIED: WASHINGTON, Snohomish Co., W1153 (Verlot Ranger Station); King Co., W1663 (Annette Trailhead); Thurston Co., W1028 (Tenino Mounds); IDAHO, W907 (Collin City swamp).

This species is rarely collected probably due to its small size, camouflage color, and tendency to be immersed in the substrate. Once encountered, however, it usually does not present any difficulties in identification; its size, coloring, unusual side-branches on the stipe, and presence of a sclerotium set it aside from all other agarics immediately.

20. Microcollybia cirrhata (Pers. ex Pers.) Lennox comb. nov.

Figure 18, Plate VI

Basionym: Agaricus cirrhatus Pers. ex Pers. Mycol. Europea. Vol 3:125. 1828.
Synonyms: Collybia cirrhata (Pers. ex Pers.) Quélet. Champ Jur. Vosges. Sér. II(5):96. 1872.
Illustrations: Britz, Hymenon., tab. 2, fig. 4; Fries; Icones Hymenon., tab. 68, fig. 1; Gillet, Champ. Fr., Hymenon., tab. 542; Bresadola, Inconographia Mycol., tab. 205.

PILEUS 2-12 mm, white at the margin, light warm tan at the center (5B3), spotted at the disc or fading uniformly to the margin, hygrophanous and becoming uniformly colored (5A2); convex becoming plane, occasionally depressed slightly at maturity, often shallowly papillate to broad umbonate, margin either slightly inrolled or straight at maturity, moist and then striulate for one half to one quarter the radius, grooved-undulate at the edge, fraying with age; surface dry-matte, opaque, slightly powdery, minutely rugose under a lens; context thin, concolorous, rather soft and fragile; odor none, taste none or farinaceous.

LAMELLAE white or pallid, arcuate, broadly adnate to slightly sinuate, blunt-pointed at the stipe attachment, sharp-ended toward the margin, edge even and concolorous, thin, subdistant, 20 lamellae reaching stipe apex, 3 tiers of lamellulae, narrow, about 1 mm in depth.

STIPE 12-25 mm x 1 mm or less, concolorous with the disc of the cap or darker, pale warm buff (5B4), somewhat more reddish toward the base with age, equal, outline often rather wavy, especially in the lower half, flexuous; surface powdery-pubescent above, becoming tomentose below, strigose with white, bristle-like rhizomorphs near the substratum; solid with a lighter center; not arising from a sclerotium.

SPORES (5-) 5.5-7.5 x 2.5-3.5 µm, ellipsoid to cylindrical, smooth, thin-walled, hyaline, nonamyloid, white in deposit, contents homogeneous; BASIDIA 25-31 x 4-5 µm, four-spored, noncarminophilous; PILEAL SURFACE undifferentiated from the context, of rather coarse hyphae, loose, partially interwoven, clamped, nonamyloid; GILL TRAMA subparallel, loose, partially interwoven, clamped, nonamyloid; no cystidia differentiated.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react with aniline (weak, variable reaction, yellowish to pinkish), alpha-napthol, guaiacol, phenol, and phenol-aniline.

MATERIAL STUDIED: WASHINGTON, Snohomish Co., W1180 (Buck Creek campground); King Co., W251 (Snoqualmie Pass), W1131 (McClellans Butte Trailhead), W1135 (Dorthy Lake Rd), W1662 (Annette Lake Trailhead); Kittitas Co., W1120 (Blankenship Meadows Trail); Jefferson Co., W1173 (Dosewallips Campground); Clallam Co., W1136 (Heart O' the Hills).

This species seems to be much more common in this area than either of the other two whitish species of the genus. It is distinguished chiefly by the absence of a sclerotium, and its larger spores.

21. *Microcollybia* *cookei* (Bres.) Lennox comb. nov.

Figure 19, Plate VI

Basionym: *Collybia* *cirrhata* var. *cookei* Bres. Icones Mycol. Vol. 5 (suppl. 2):206. 1928.
Synonym: *Collybia* *cookei* (Bres.) J. Arnold. Mycol. 17(4):414. 1935.

Illustrations: Cooke, Illustr. Brit. Fungi, tab. 144, fig. B. (as *Collybia* *cirrhata*); Bresadola, Icones Mycol. Vol. 5 (suppl. 2):206. 1928.

PILEUS 2-9 mm, white to very pale pinkish or yellowish, uniformly colored, subhygrophanous and drying slightly pinker; convex, becoming plane, slightly depressed or umbilicate with age, shallowly papillate when young, margin somewhat inrolled or nearly straight, even, thin, moist-striatulate for one half the radius, later fraying; surface dull, somewhat shining if very moist, finely and innately fibrillose, minutely rugose under a lens; context very thin, membranous, rather tough, concolorous; no odor, taste none, or farinaceous and then delayed.

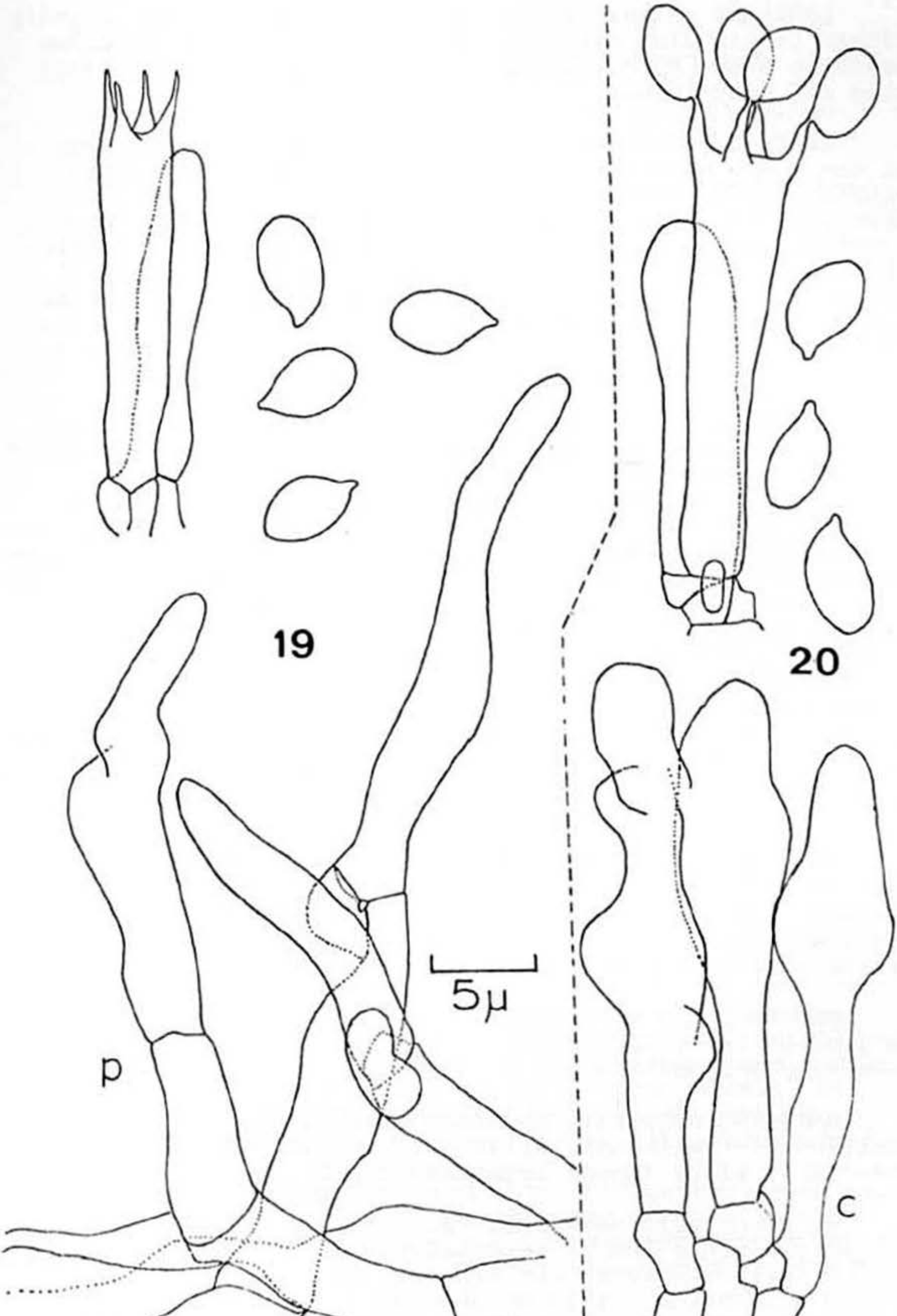


Figure 19. - Microcollybia cookei, W1158, basidium, spores, pileal surface with cystidia (p); Figure 20. - Microcollybia tuberosa, W1373, basidium, spores, cheilocystidia (c).

LAMELLAE white, drying pale pink (5A2), rather broadly adnate to sinuate, arcuate, thin, subdistant, 20 lamellae reaching stipe apex, narrow, 1 mm or less in depth, edges even and concolorous.

STIPE 0.6-6.0 cm x 1-2 mm, concolorous with the cap at the apex, generally slightly darker toward the base, pinkish (5D6), equal, outline often wavy, straight, then flexuous; surface pruinose at the top, becoming pubescent, scantily tomentose at the base, with white coarse bristle-like rhizomorphs there as well, often buried for half of the length, solid, terete, with a subhygrophanous lighter core, emerging from an orange-yellow (5A6) sclerotium that is 1-6 mm in diameter, irregular in shape, often somewhat flattened and pumpkin-shaped.

SPORES 4.5-5.5 (-6) x 2.5-3.5 µm, ovate, thin-walled, smooth, contents uniform, nonamyloid hyaline; BASIDIA 16-18 x 4-5 µm, rather small, tapering gradually to the base, four-spored, noncarminophilous; PILEOCYSTIDIA rare to frequent, arising directly from the surface layer, clavate to filamentous, contorted, grouped, 10-45 x 3-8 µm; cheilocystidia and pleurocystidia not differentiated; PILEAL SURFACE undifferentiated from the context, upper layer slightly gelatinized and agglutinated, not encrusted, composed of rather coarse hyphae averaging 3-5 µm in diameter, loose, nonamyloid; GILL TRAMA subparallel, partially interwoven, loose, clamped, composed of hyphae 4-8 µm in diameter, averaging 6 µm; STIPE VESTURE cystidioid, clavate-contorted, 5-30 x 3-10 µm, generally rather short and not exceeding 20 µm, thin-walled, not encrusted, sparingly branched and septate, hyaline, and clamped.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react with alpha-napthol, aniline (yellow to orangish), guaiacol, phenol, and phenol-aniline. Weak and ambiguous reactions also occurred with sulfoformol (pinkish), and ferric sulfate (greenish).

HABITAT: On much decayed mushroom remains, appearing as a black tarry substratum, gregarious to subcaespitose, generally very abundant.

MATERIAL STUDIED: WASHINGTON, King Co., W1128 (McClellans Butte, trailhead), W1158, W1685 (Water Main Woods); Mason Co., W1209 (Lower Lena Lake Trail).

Microcollybia cookei is very closely related to *Microcollybia cirrata* and *M. tuberosa* and is distinguished chiefly and most readily by the presence of a yellow to yellow-orange sclerotium. This sclerotium differs markedly in color from that of *M. tuberosa*, which is reddish-brown and strongly resembles an apple seed.

22. *Microcollybia tuberosa* (Bull. ex Fr.) Lennox comb. nov.
Figure 20, Plate VI

Basionym: *Agaricus tuberosus* (Bull.) Fr. Syst. Mycol. p. 133. 1821.
Synonyms: *Collybia tuberosa* (Bull. ex Fr.) Quélet. Champ. Jur. Vosges. Sér. II, 5:96. 1872.

Illustrations: Bulliard, Champ. Fr., tab. 256; Brefeld, Untersuch 8(1889), tab. 4, fig. 15-16; Britz, Hymenom., tab. 32, fig. 221; Cooke, Illustr. Brit. Fungi, tab. 144; Bresadola, Icon. Mycol., plate 207, fig. 1.

PILEUS 0.2-1.2 cm, white to pallid, center tinged a pinkish buff (5A2), subhygrophanous and drying slightly darker and more pinkish (4A3); convex becoming plane, with a shallow umbo in some immature specimens, often becoming somewhat centrally depressed with age, margin remaining slightly inrolled or becoming straight, often crenate and plicate-striate in older specimens, fraying then as well; surface moist-watery, often drier and dull, faintly pubescent, especially under a lens; context very thin, concolorous, rather soft when moist, much tougher in drying; odor faintly sweet or fungoid, taste none.

LAMELLAE white, occasionally tinged faintly pinkish, broadly adnate, appearing almost subdecurrent if the cap margin is raised far above the point of attachment, edge even and concolorous, thickish, rather broad, 1 x 2 mm, subdistant, 20 lamellae reaching the stipe apex.

STIPE 13-25 mm x 0.5-1.0 mm, at first concolorous, darkening slightly with age and handling, then pinkish (5A3), equal, flexuous at the sclerotium, surface powdery-pruinose at the apex, with a scant white tomentum below that and nearly strigose at the base; solid, or more rarely narrowly tubular, concolorous centrally, rather tough, especially in drying, never really pliant; arising from a prominent sclerotium, that is 4-13 x 2-9 mm, dark mahogany brown (8E8 to 8F8) to a light orange brown (6C6), often mottled ferruginous when lighter colored, often resembling an apple seed, the larger ones frequently bowed and narrowest toward the emergence end, white to cream within, solid and uniform, becoming longitudinally furrowed with age or drying, shiny; rarely with white bristle-like rhizomorphs.

SPORES 5-6.5 x 3-3.5 µm, ovate to cylindrical, hyaline, thin-walled, smooth, nonamyloid; BASIDIA 19-27 x 4.5-5.5 µm, long and narrow, four-spored, noncarminophilous; CHEILOCYSTIDIA not differentiated or if present then in a tight hymenium on the edge, resembling basidioles, 15-36 x 3-6.3 µm, clavate-contorted, never becoming filamentous; PILEAL SURFACE undifferentiated, composed of rather large, loose, clamped hyphae 4-8 µm in diameter, the uppermost cell layer somewhat gelatinized and compacted, not encrusted, thin-walled, nonamyloid, more or less radially oriented, somewhat interwoven; GILL TRAMA regular, subparallel to interwoven, clamped, nonamyloid, composed of hyphae 4-8 µm in diameter, subhymenium hardly differentiated, very narrow and compact, the hyphae 2-3 µm in diameter; STIPE VESTURE hair-like, uniform in diameter, 3-5 µm, nonencrusted, hyaline and thin-walled, tangled.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with alpha-napthol, aniline (reaction very weak, yellowish to pinkish), guaiacol, sulfoformol (weak, yellowish), phenol-aniline, and phenol.

HABITAT: Scattered to subcaespitose, generally very abundant, on the hard tarry pad of a much decayed mushroom, in coniferous woods.

MATERIAL STUDIED: WASHINGTON, Skagit Co., W1673 (Mineral Park Campground); King Co., W610 (Lee Forest), Pierce Co., W1373 (Tahoma Creek, Mt. Rainier Ntl. Pk); IDAHO, Bonner Co., W901 (USDA Experimental Forest, Priest Lake), W905 (Collin City dump).

This species seems to differ primarily by the presence of the apple-seed like sclerotium, and appears to be much rarer than Microcollybia cirrhata.

RHODOCOLLYBIA Singer. Schweiz. Z. Pilk, 17:71. 1939.

Type species: Rhodocollybia maculata (Fries) Singer.

HABIT tricholomoid to collybioid, PILEUS generally quite large, often 5 cm or more in diameter, convex, becoming plane, frequently shallowly umbonate, rarely centrally depressed, surface often rather uneven, lubricous and shining, dull and matte in drying; whitish to dark reddish brown, generally staining ferruginous; context quite thick over the disc, tapering abruptly just at the margin, margin often curled and fraying in age; odor generally rather faint and pleasant, occasionally strong and characteristic, taste none to unpleasant and bitter.

LAMELLAE whitish to pinkish cream, narrowly adnexed, sinuate to emarginate, often slightly uncinate and the attachment slightly irregular, ventricose, thin, crowded, generally rather broad, edge concolorous but uneven, often either serrate in young specimens or frayed or eroded in age.

STIPE rather long and thick relative to the cap diameter, often exceeding 7 cm in length and having a breadth of at least 5 mm, whitish to concolorous with the gills; slightly expanded just at the apex, equal for most of the above ground length, expanded where radicating and then tapered abruptly, frequently staining ferruginous in contact with the substratum; faintly and finely pruinose at first, glabrescent and longitudinally striate in age, the radicating portion with a white appressed cottony tomentum; occasionally compressed, solid to spongy-stuffed, context white, fibrous and easily splitting and fraying, firm, not tough.

SPORES globose to ellipsoid, hyaline in transmitted light, endosporium dextrinoid (cyanophilous as well), thin to rather thick walled (0.5 µm), yellow to dark pinkish cream in deposit; BASIDIA four-spored, noncarminophilous, occasionally dextrinoid and appearing thick-walled and then frequently septate; CHEILOCYSTIDIA present or absent, if present thin-walled, hyaline, variable in shape, and not exceeding the basidia; PLEUROCYSTIDIA not differentiated; PILEAL SURFACE a layer of loosely interwoven hyphae, 2-5 µm in diameter, often partially gelatinized, generally not incrusted, nonamyloid, less compact than the layer immediately below, clamped; the context loosely interwoven, of hyphae 5-8 µm broad, nonamyloid, clamped, occasionally encrusted in upper more compact layer near the surface.

MACROCHEMICAL REACTIONS: The carpophores seem to differ rather widely in reactivity, some species reacting with almost all of the reagents used and others reacting with just a few. In most cases, the carpophores were negative to alpha-napthol, aniline, and guaiacol, and positive to phenol, and phenol-aniline.

HABITAT: Scattered to caespitose on thick duff or much decayed wood, in coniferous forests.

This genus is characterized by the large size of its carpophores and depth of the flesh of the cap; the reddish colors of the cap; the thin, crowded, broad, adnexed, pallid gills; the pinkish spore print, a subradicating and sulcate-striate stipe. Microscopically, these species are distinct due to the partially gelatinized, relatively large and loosely interwoven hyphae of the pileal surface, and also by the presence of dextrinoid spores, and scattered, dextrinoid thick walled basidia. The latter character, however, varies a great deal and in some collections may be overlooked: some specimens have so few spores that actually are dextrinoid that any one crush mount may contain only a few, while in the majority of collections, a crush mount will often contain about 25-50% dextrinoid spores.

Key to the Sections

I. Stipe subradicating in much decayed wood, conspicuously sulcate-striate, at least with age, often staining ferruginous slowly on cap, gills, or stipe, context of cap very thick, generally as deep as the depth of the gills.............. Section Maculata (p. 200)

I. Stipe not radicating in much decayed wood, terrestrial, stipe glabrous, neither longitudinally striate nor sulcate; rarely staining rusty on any part; context of the cap relatively thin, 5 mm or less, less than the depth of the gills.. Section Butyracea (p. 218)

Section Maculata (Singer) Lennox stat. nov.

Basionym: Collybia, Section Stripedes, Stirps Maculata Singer. Agaricales in Mod. Tax., 1962.

Type species: Rhodocollybia maculata (Fr.) Singer.

Pileus very large, generally 5-12 cm, pallid to dark reddish brown; context thick, 5 mm. or more, often as deep as the gills; stipe conspicuously sulcate-striate, and subradicating; carpophores generally stained ferruginous in some part, especially in the lower part of the stipe; scattered to caespitose in much decayed wood.

Key to the Species

1. Majority of spores globose to subsphaerical, generally less than 6 µm in length, a small percentage approaching an ovate-ellipsoind shape............. 2.
1. The majority of spores ovate to ellipsoid, generally 6 µm or more in length, a very few subglobose .... 3.
    2. Stipe very dark sordid brown at maturity, cap pale to dark vinaceous or brown, odor aromatic, like benzaldehyde or almonds, taste none or mild. .... R. subsulcatipes (p. 201)
    2. Stipe white, cap pallid, blushing fulvous, spotting vinaceous, odor faint, taste bitter..... .... R. maculata var. maculata (p. 210)
3. Caps dark-colored both in young specimens and at maturity, dark vinaceous brown to fuscous (7E5 to 7F3).. 4.
3. Caps pallid, sometimes blushing fulvous centrally with age, frequently spotted ferruginous......... 7.
    4. Odor very strong, of benzaldehyde or almonds, taste bitter, cap quite large, at least 4 cm in diameter............ R. oregonensis (p. 202)
    4. Odor if strong, not of benzaldehyde or almonds, taste none, or if bitter, cap dark fuscous brown; cap 4 cm or less.................................. 5.

5. Cap dark fuscous brown to fuscous vinaceous, lacking rusty stains on the gills or stipe, cap not umbonate.. 6.
5. Cap vinaceous brown, without any fuscous tone, staining ferruginous on the gills and lower stipe, cap umbonate....... R. maculata var. fulva (p. 210)
   6. Gills yellow to light orange, cap less than 4 cm, odor faint, rather sweet, taste bitter .... R. maculata var. nigra (p. 211)
   6. Gills white, cap 4.5-6.0 cm, odor penetrating, like Vicks or moldy cinnamon, taste none..... .... R. subnigra (p. 205)
7. Gills yellow (5A2 or 4A5), cap buff to fulvous, stipe often yellow with age...................... .... R. maculata var. scorzonerea (p. 214)
7. Gills white, unchanging, not yellow at maturity; cap pallid, or blushing bay centrally or with age, stipe whitish, not yellowing..................... 8.
   8. Carpophores cream white throughout, lacking rusty stains on all parts.................... R. maculata var. immutabilis (p. 215)
   8. Carpophores pallid, generally light bay colored to fulvous on the cap with age, spotted ferruginous on cap, gills, and stipe............. .... R. maculata var. occidentalis (p. 217)

23. Rhodocollybia subsulcatipes (Smith) Lennox comb. nov.

Plate VII

Basionym: Collybia subsulcatipes Smith. Bull. Torrey Bot. Club. 71:396-7. 1944.

The description following is drawn from that of Smith (1944).

PILEUS 5.5-8.0 cm broad, when young "army-brown" to "vinaceous fawn" over all, disc becoming "russet-vinaceous" and margin "deep brownish vinaceous" (dark to pale vinaceous brown), hygrophanous and fading to a "pale vinaceous buff" (pallid vinaceous); convex, becoming plane, obtuse with an inrolled margin, becoming gibbous or plane, in age the margin recurved or elevated and frequently splitting, surface moist and polished, margin transluscent striate, hygrophanous and opaque when faded; flesh thin (2-3 mm), equal, firm and cartilaginous, concolorous with the surface of the cap; odor faint but heavy and aromatic (somewhat like that of benzaldehyde) very distinctive, taste mild.

LAMELLAE "pale greyish vinaceous" becoming "light russet-vinaceous" (grey with a tinge of vinaceous when young, becoming distinctly dull vinaceous in age), depressed adnate to nearly free, the lamellae quite irregular in arrangement, broad (1 cm ±), becoming slightly ventricose, close to nearly subdistant, 46-54 reach the stipe, 1-3 tiers of lamellulae, faces glaucous, edges thickish and even.

STIPE 6-10 (15) cm long, 10-16 mm thick at the apex, more or less concolorous with the pileus at the apex, becoming very dark sordid vinaceous brown from the base upward in age, tapering downward to a long pseudorhiza, surface pruinose but soon polished, smooth or longitudinally grooved to subsulcate, solid and fibrous within.

SPORES 5-5.5 x 4.5 x 5 µm, globose to subglobose, hyaline, smooth, not amyloid; BASIDIA 28-34 x 4.5-6 µm, four-spored, slender and subclavate; pleurocystidia and cheilocystidia not differentiated, GILL TRAMA parallel to subparallel, the hyphae more or less cylindrical; PILEAL SURFACE a narrow cutis of radially arranged subgelatinous hyphae 3-4 µm in diameter, context floccose, the hyphae 5-15 µm in diameter.

MACROCHEMICAL REACTIONS: No data available.

HABITAT: Gregarious on humus.

MATERIAL STUDIED: None (Note: the type locality and only reported collections of this species are from Storm King Mt., Clallam Co., Olympia National Park, Wash.).

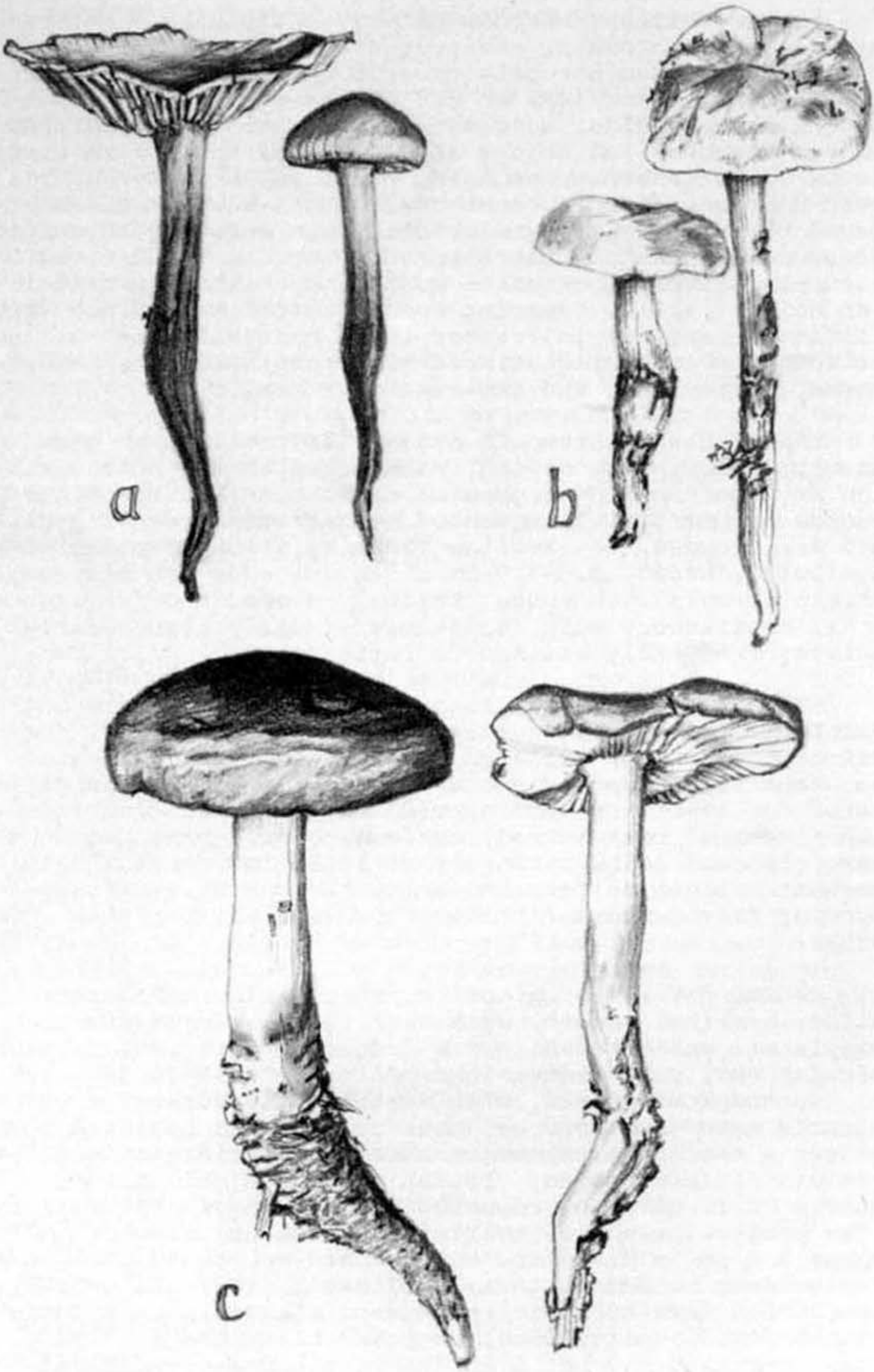
According to Smith "this species is closely related to Collybia fusipes but distinct because of its globose spores, odor, and vinaceous gills" (He examined material of C. fusipes provided by M. Josserand, Lyon). He further states that "the most obvious difference macroscopically is the color of the lamellae and their spacing. In C. subsulcatipes they are closer and more vinaceous. C. oregonensis has a similar odor but is readily distinguished by its ellipsoid spores, the color of the gills and stipe, and in general appearance. C. oregonensis is closely related to C. maculata."

24. Rhodocollybia oregonensis (Smith) Lennox comb. nov.

Figure 21, Plate VII

PLATE VII -; a - Rhodocollybia subsulcatipes, constructed from type description, x ½; b - Rhodocollybia maculata var, maculata, W1438, x ½: Rhodocollybia oregonensis, Scates 1178, x ½.

VII



Basionym: Collybia oregonensis Smith. Mycologia 29:47. 1937.

PILEUS 4-10.5 cm broad, generally at least 7 cm, very dark vinaceous brown or chestnut brown centrally, fading gradually and then abruptly towards the margin, warm buff to pale tawny there (8F7 or 8F8 at the center, 6B3 to 5A5 marginally), in older specimens colors uneven and spotted, subhygrophanous, and colors slowly losing their warm tones; convex to hemispheric, becoming plane and broadly but shallowly umbonate, margin never truly straight, sometimes frayed but even; surface subviscid when moist, glabrous or occasionally minutely fibrillose on the disc, sometimes obscurely silvery-spotted in drying; context firm-brittle when moist, pallid, tapering evenly to the margin and very thin at extreme margin, rather thick centrally, up to 1 cm, not tough, odor very distinctive, strong almond or benzaldehyde, taste faint and unpleasant or none.

LAMELLAE white to pale orange (4A3 to 5A2, no good match), yellowing in drying, sinuate-uncinate, some variation in insertion and degree of attachment, sharp-pointed towards the margin, blunt-ended at the stipe, ventricose, thin and crowded, 84 lamellae reaching stipe, 3 tiers of lamellulae, broad, 2.8-3.9 cm x 5-6 mm, edge concolorous, serrate to even when young, strongly eroded and fraying later, consistency soft, sometimes minutely transversely striate, frequently stained ferruginous.

STIPE 6.5-20 (30) cm long, 5-20 mm broad, white but staining ferruginous, especially towards base, equal for most of the length, inflated slightly in lower half and then tapering abruptly into a pseudorhiza-like prolongation, buried for about one-half of the length and covered there with pieces of rotten wood, surface powdery-pruinose at the apex, glabrous below, strongly striate-grooved; solid to somewhat hollow, uniform and white throughout, fibrous, becoming frayed and splitting, flexuous, without rhizomorphs.

SPORES 6-8 x 4-5 µm, ovate, thin-walled to thick-walled, hyaline, smooth, with dextrinoid endosporium or cytoplasmic contents which are frequently retracted from the apicular end, pale orange in deposit; BASIDIA 26-30 x 5-6 µm, two and four-spored, with dextrinoid endosporium which retracts into the upper or lower half of the basidium and creates a septate appearance; no cheilocystidia or pleurocystidia differentiated; PILEAL SURFACE a gelatinized cuticle 50-75 µm deep, composed of interwoven hyphae, with a few projecting hairs, overlying a zone of radial, tubular hyphae 4-8 µm in diameter, compact and encrusted in a short transversely banded pattern; CONTEXTUAL HYPHAE intergrading with the surface hyphae, interwoven, clamped, nonamyloid, not encrusted, quite loose, composed of hyphae 7-15 µm broad, averaging 10 µm; GILL TRAMA of tubular, parallel hyphae 3-15 µm in diameter, averaging 5 µm, subhymenium broad, 15-25 µm deep, coarse and interwoven.

HABITAT: Gregarious to caespitose on much decayed wood in dense woods.

MACROCHEMICAL REAGENTS: Gills and flesh of the cap react weakly with phenol.

MATERIAL STUDIED: WASHINGTON, San Juan Co., W1737 (Friday Harbor Biological Station); King Co., W1680 (PSMS Mushroom show); Pierce Co., W1680 (near Ohanopecosh); Skamania Co., W1439 (Cispus Training Center); IDAHO, Scates 1178 (Above Devil's Elbow Cmpgr., Coeur d'Alene River), Scates 1191 (Blue Creek Area).

The most distinctive feature of R. oregonensis is the strong aromatic almond odor; in the dried condition, however, this species can be distinguished rather easily by the large dark vinaceous cap and large ovate to ellipsoid spores. It is closely allied to the R. maculata complex by its large size, thick cap, staining reactions, serrate gills, striate-grooved stipe, enlarged base, rooting and lignicolous habit.

25. Rhodocollybia subnigra Lennox sp. nov.

Plate VIII

Pileus 4.5-6 cm latus, atrorubrobrunneus, in sicco fuscobrunneus, leviter umbonatus, humidus et lubricus, in sicco impolitus, caro crassa, incarnatocremea, odore penetranti, "Vicks Vaporub" vel cinnamoni mucidi similis; sapor nullus. Lamellae albidae, immaculatae, adnexae, sinuatae, membranaceae, confertae, in senectute serratae. Stipes 8-10 cm longus, 9-20 mm crassus, pallide aurantiacus, in parte tertia versus apicem aequalis, in parte tertia ad medium expansus et ventricosus, basim versus abrupte angustatus, striato-sulcatus, fibrosus, in dimidio inferiore infossus. Sporae 6.5-7.5 x 3-4 mµ, ellipsoideae, dextrinoideae. Basidia 27-35 x 6.5-8 mµ, tetraspora. Cystidia desunt. Trama lamellarum parallela, fibulae praebens. Pagina pilei ex stratum hypharum in parte erectarum, laxarum, fibulatarum, incrustatarium constans.

PILEUS 4.5-6 cm, dark reddish brown (7F7), subhygrophanous and drying more fuscous (fuscous brown - 7F4), darkest at the center, fading somewhat to the margin, convex, becoming nearly plane, shallowly umbonate, margin even and almost straight; surface lubricous when wet, later dry, matte, almost fibrillar; context rather thick, up to 7 mm thick, pinkish cream, somewhat soft when drying;

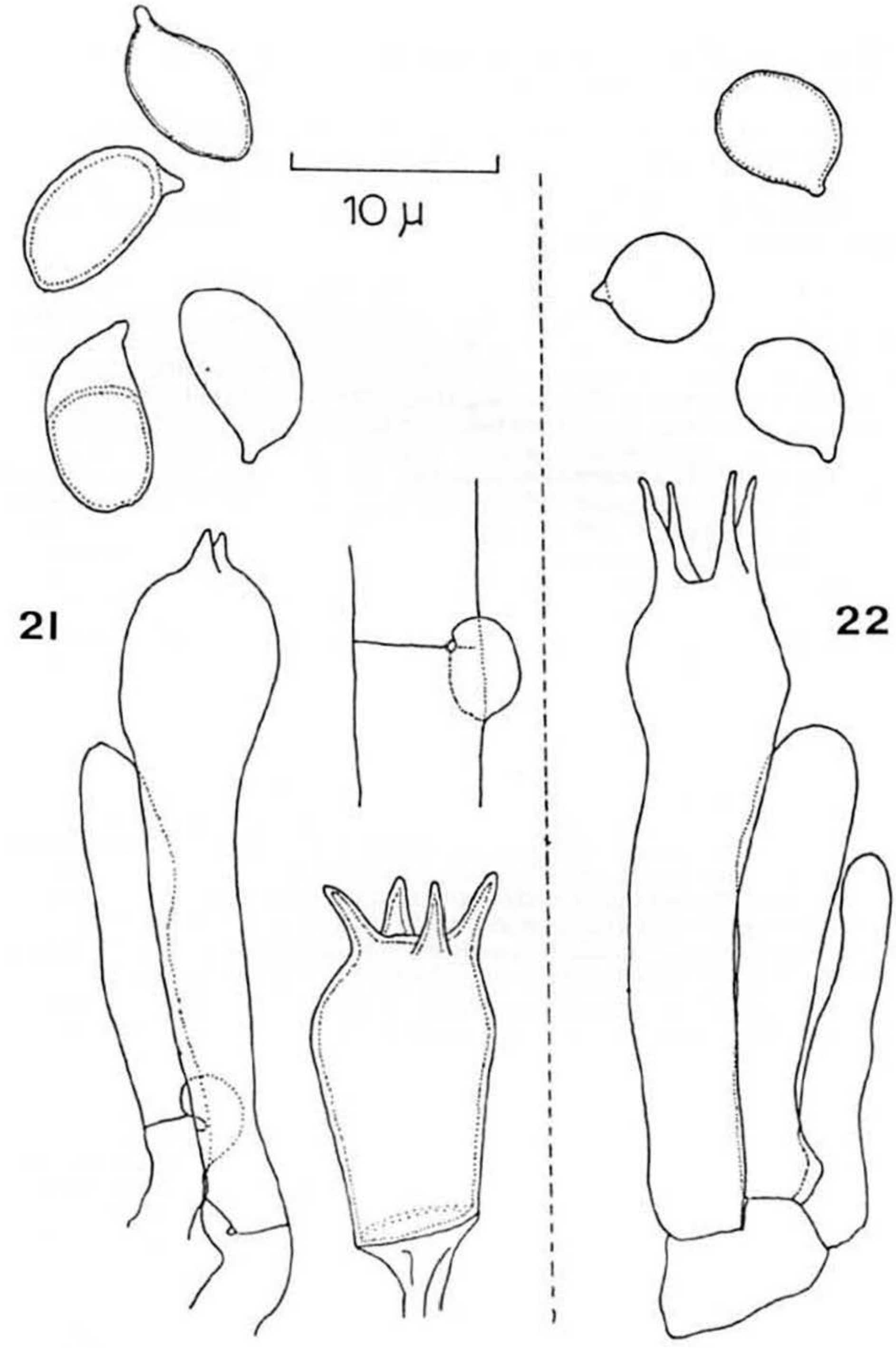


Figure 21. - Rhodocollybia oregonensis, W1736, basidia, spores, clamp; Figure 22. - Rhodocollybia maculata var, maculata, W1118, basidium and spores.

odor penetrating, like Vicks Vaporub or moldy cinnamon, taste not distinctive.

LAMELLAE white, unchanging and not staining ferruginous, narrowly adnexed, deeply sinuate-uncinate, blunt-ended both at the stipe and margin, thin and close, more or less 60 lamellae reaching the stipe, moderately broad, 25 x 5 mm, edges concolorous, even at first, later eroded and splitting transversely.

STIPE 8-10 cm long, 9-20 mm broad, light orange, pallid below substratum, equal in upper third, expanding and ventricose in the middle third, and tapering abruptly below this, buried for one-half the length; faintly powdery-pruinose at the apex, glabrous below, striate-grooved, grooves becoming deeper, wider and more numerous from the apex towards the base; not staining, stuffed, pale pinkish cream within, quite fibrous, splitting longitudinally rather readily, without rhizomorphs.

SPORES 6.5-7.5 x 3-4 µm, generally 6.5 x 3.5 µm, narrowly ovate to ellipsoid, thin-walled, smooth, dextrinoid; BASIDIA 27-35 x 6.5-8 µm, four-spored, noncarminophilous; no CHEILOCYSTIDIA differentiated, or if present, not exceeding the basidia and subclavate, PLEUROCYSTIDIA not differentiated; GILL TRAMA parallel, clamped, composed of hyphae 2-7 µm in diameter, nonamyloid; PILEAL SURFACE a layer of partially erect, loose, clamped hyphae 2-5 µm in diameter, encrusted with irregular dark spots, nonamyloid, overlying a more compact, somewhat more radial zone of hyphae 3-8 µm broad; CONTEXT interwoven, nonencrusted, nonamyloid, clamped, composed of hyphae 4-8 µm in diameter.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react very faintly with guaiacol, tincture of guaiac, phenol, and pheonl-aniline.

HABITAT: No data available.

MATERIAL STUDIED: WASHINGTON, King Co., W1717 (Seattle).

This species is distinctive by its dark blackish cap, white gills, light orange ventricose stipe, lack of any ferruginous stains, and dextrinoid ellipsoid spores.

26. Rhodocollybia maculata (Fr.) Singer. Schweiz Z. Pilk. 17:71. 1939

Figure 22 and 24; Plate VII

Basionym: Agaricus maculatus Fries, System. Mycol. 1:45. 1821.

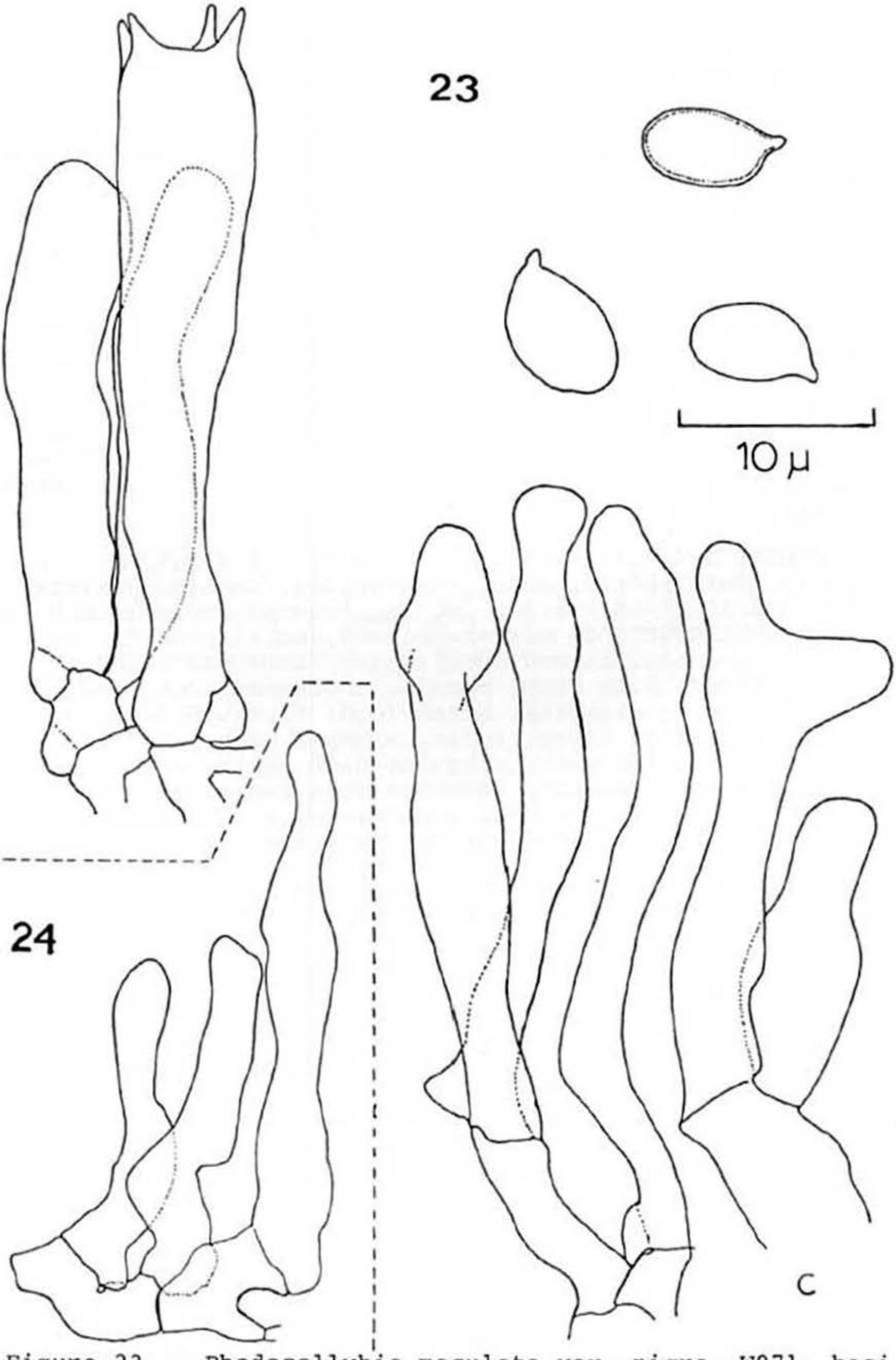


Figure 23. - Rhodocollybia maculata var. nigra, W971, basidium, spores, cheilocystidia (c); Figure 24. - Rhodocollybia maculata var. maculata, W1118, cheilocystidia.

Synonyms: Agaricus carnosus Curt. F. Lond. fasc. 5:71. 1777.
Gymnopus carnosus (Curt.) Murrill, N. Am. Flora 9(5):358. 1916.
Agaricus (Tricholoma) limonium Peck, Bull. Buffalo Soc. Nat. Sci. 1:43. 1873.
Collybia maculata (Fries) Quélet, Champ. Jura. Vosges. p. 330. 1873.

Illustrations: Sowerby, British Fungi, tab. 246 (Agaricus carnosus); Cooke, Illustr. Brit. Fungi, tab. 142; Britz, Hymenom., tab. 13, fig. 217; Lange, Flora Agaricina Danica, tab. 42, fig. c.; H. Romagnesi, Nouvel Atlas des Champignons, Pl. 106.

PILEUS 4-9 (12) cm broad; convex to obtuse, becoming plane, frequently margin is unevenly raised and the surface gently undulate, pallid to pale tan (4A3 to 5B4), occasionally darker over the disc, surface moist, neither truly hygrophanous or viscid, sublubricous in the moist condition, matte when drier, surface glabrous, stained faintly ferruginous in spots naturally or where bruised slowly; context very thick, generally deeper than the depth of the gills at their point of attachment, consistency rather brittle when moist, soft when drier; odor none or fungoid, taste bitter.

LAMELLAE white or pale pinkish buff, abruptly sinuate, appearing almost free at maturity, blunt-ended at the stipe, sharp-pointed at the margin, ventricose, thin and crowded, rather broad but generally not as broad as the context is thick, 6-9 mm x 17-23 mm, edges concolorous, often serrate at first, later becoming eroded and fraying, stained ferruginous, particularly along the edges or where bruised.

STIPE 4.2-10 cm long, 8-14 mm broad, white, later sordid whitish, especially in the lower half, narrowed gradually to the base, then subradicating and tapering abruptly in the substratum; base white-cottony-tomentose, upper portion evenly white pruinose, fibrillose or with a thin appressed tomentum, glabrescent and longitutinally striate in age; solid, concolorous within, rather firm but not tough, splitting easily longitudinally, sometimes flexuous towards the base.

SPORES 5-7 (8) x 4.5-6 (-6.5) µm, broadly ovate to globose, mostly subglobose, with a prominent apiculus, and a shallow suprahilar depression, small percentage dextrinoid, cream colored in heavy spore deposit; BASIDIA 33.37 x 7-8.5 µm, four-spored, noncarminophilous; CHEILOCYSTIDIA generally abundant but inconspicuous, rarely exceeding the basidia, 17-36 x 3-5 µm, narrowly clavate, somewhat pointed, never really filamentous, thin-walled, not encrusted; pleurocystidia not differentiated; PILEAL SURFACE a partially gelatinized, loosely interwoven layer of hyphae 2-3 µm in diameter, somewhat resembling a loose, irregular trichodermium, subtended by a more compact, interwoven mat composed of slightly larger hyphae (2.5-7 µm); context of hyphae 5-11 µm broad, clamped, nonamyloid, loosely interwoven.

MACROCHEMICAL REACTIONS: Pileal context and gills react positively but faintly with phenol, and ferric sulfate.

HABITAT: Scattered to gregarious on much decayed wood in dense coniferous woods.

MATERIAL STUDIED: WASHINGTON, Whatcom Co., W1118 (4th of July Pass, Panther Creek); King Co., W1093 (exact locality unknown); Pierce Co., W1438, W1669 (Dalles Campground); Clallam Co., W1403 (Altaire Camp); Jefferson Co., W1205 (Lower Lena Lake Trail), W1353 (along Hood Canal); OREGON, Portland, W. B. Gruber #766 (determined by Smith).

The spores in this description are somewhat larger than those Smith (1943) attributes to Collybia maculata var. typica (var. maculata). He states that the spores are #4.5-5.5 (6) x 3.5-4.5 (5) um, typically subglobose but varying either to globose or ellipsoid". Basically, the collections here studied did not differ in any other aspect but in spore size, and since the shape was the same, it did not seem that a new varietal name was necessary.

27. Rhodocollybia maculata var. fulva Lennox nom. nov.

Plate VIII

Pileus 1.7-2.7 cm latus, atrovinaceus, convexus, umbonatus, humidus dein siccus, glaber; lamellae albidae, adnexae, angustissimae, tenues, confertae, maculas ferrugineas praebentes; stipes 3.5-6.5 cm longus, 3-5 mm crassus, incarnatus, maculas ferrugineas evolvens, aequalis, haud radicatus; sporae 5.5-6.5 x 3.5-4.0 mµ, ovatae, dextrinoideae; cystidiola abundantes. Holotypus W1400, herbario Universatitis Washingtoni Conservatus.

PILEUS 1.7-2.7 cm, dark vinaceous red (7E8 or 7F7), subhygrophanous and drying to a light fuscous vinaceous (7F4 or 7F3), convex to conic, expanding somewhat, sharply umbonate, margin remaining slightly inrolled and even; surface at first moist, drying matte and unevenly, glabrous; context relatively thick over the disc (3 mm), tapering abruptly towards the margin, flesh-colored, firm and brittle, not tough; odor none, taste none.

LAMELLAE white, not changing color, narrowly adnexed, sinuate, narrow, 1.5 x 11 mm, thin and crowded, about 56 reaching the stipe, edge even and concolorous, conspicuously ferruginously spotted, linear.

STIPE 3.5-6.5 cm long, 3-5 mm broad, pallid to flesh-colored (6B3), especially in handling or when quite moist, hygrophanous, staining ferruginous, equal, striate-grooved at maturity, solid, terete, fluxuous, not radicate, with yellow and white rhizomorphs.

SPORES 5.5-6.5 x 3.5-4 µm, ovate, not varying to subglobose or ellipsoid, dextrinoid, thin-walled; BASIDIA about 28 x 8 µm, may be two-spored, noncarminophilous; CHEILOCYSTIDIA abundant, 22-35 (45) x 4-7 µm, ventricose-filamentose or clavate-contorted, generally not exceeding the basidia, thin-walled, not encrusted; no pleurocystidia differentiated; GILL TRAMA regular, parallel, clamped and nonamyloid; PILEAL SURFACE a partially gelatinized zone composed of loose, somewhat erect, more or less radial hyphae 2.5-4 µm in diameter, intergrading with a more compact, more interwoven layer of larger hyphae below 3-7 µm, surface hypahe spotted with a dark encrusted substance; CONTEXT predominantly interwoven, not encrusted, nonamyloid, clamped, composed of hyphae 4-12 µm in diameter.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react faintly with sulfoformol, and ferric sulfate.

HABITAT: Caespitose on wood.

MATERIAL STUDIED: WASHINGTON, Kittitas Co., W1400 (above Lake Kachess, Swans Lake Rd.).

This variety is easily distinguished by its small size, dark vinaceous brown cap with a rather prominent umbo, narrow white gills, ferruginous stains on gills and stipe, lack of any odor or taste, and ovate spores.

28. Rhodocollybia maculata var. nigra Lennox nom. nov.

Figure 23, Plate VIII

Pileus 2.7-4.0 cm latus, atrofuscus, immutabilis, humidus tum siccus, glaber, carne crassa, flavidula, odore fructoidea, fragranti, sapore amara; lamellae cremeae vel incarnato-aurantiacae, haud maculatae, emarginatae, angustatae et subdistantes; stipes 7-7.5 cm longus, 12-14 mm crassus, albidus, deorsum flavescens, glaber, striato-sulcatus, in dimidio inferiore radicans, supra atque infra terrarum angustatus; sporae 7-8.5 x 4.5-5.0 mµ, ellipsoideae, dextrinoideae; cystidiola inconspicua et dispersa. Holotypus W971, herbario Universatitis Washingtoni Conservatus.

PILEUS 2.7-4.0 cm, convex, becoming plane, neither depressed nor umbonate at maturity, dark brownish black (7F3 or 7F4), unchanging, shining when moist and also when dry, margin rather irregular and remaining somewhat inrolled, glabrous; context quite thick, as deep as the gills at the disc, solid, firm and rather tough, white or faintly yellowish; odor sweet, fruity, taste pleasant at first, becoming bitter.

LAMELLAE cream-colored to peach (5A4, no good match), unchanging, not staining ferruginous, emarginate, easily seceding, edges even but easily splitting, somewhat lighter than the faces, rather thick and subdistant, rather narrow, not more than 3 mm. broad.

STIPE 7-7.5 cm long, 12-14 mm broad, white, yellowing below (5A4); largest at the substrate level, tapering above and below this point, glabrous, striate-grooved at maturity, at least towards the base, dull and dry, solid above, stuffed below, concolorous within, buried for half the length in much decayed wood, bases confluent, bruising slightly and very slowly yellow, not staining ferruginous.

SPORES 7-8 (8.5) x 4.5-5 µm, ellipsoid, dextrinoid, BASIDIA 32-35 x 7-8 µm, four-spored; CHEILOCYSTIDIA inconspicuous, not exceeding the level of the basidia, 27-38 x 3.5-5.5 µm, thin-walled, clavate-contorted; PILEAL SURFACE a layer of partially erect, loosely interwoven, aggutinated hyphae 3-5 µm in diameter, spotted with a dark encrusting material, clamped, and nonamyloid.

MACROCHEMICAL REACTIONS: Carpophores negative to all reagents.

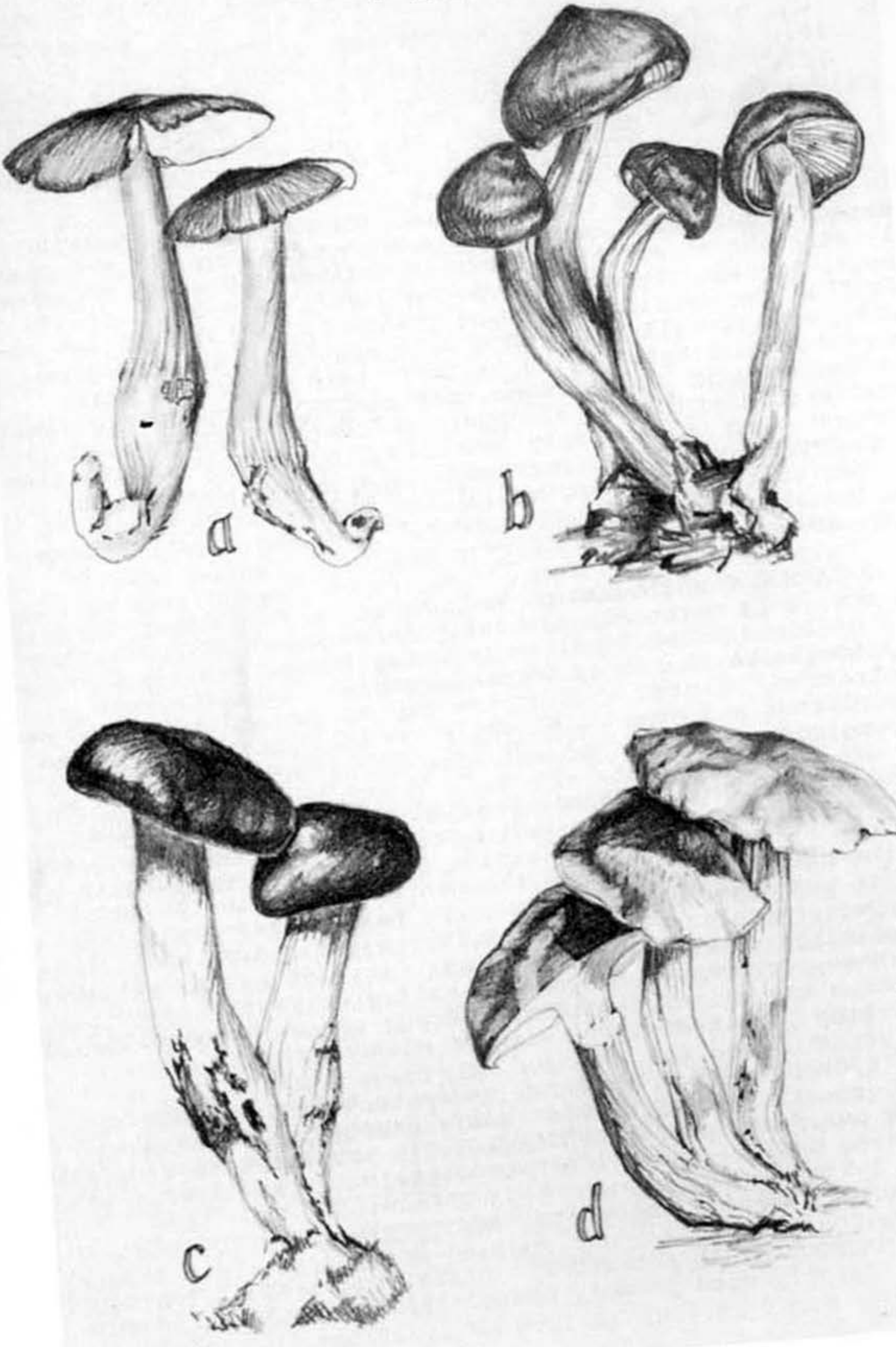
HABITAT: Caespitose on much decayed wood.

MATERIAL STUDIED: WASHINGTON, Pierce Co., W971 (Dalles Campground).

This variety is distinguished by its rather small size, dark blackish cap, narrow, yellow gills, sulcate rooting stipe, bitter taste, lack of ferruginous stains, and ellipsoid spores.

PLATE VIII -; a - Rhodocollybia subnigra, W1717, x ½; b - Rhodocollybia maculata var. fulva, W1400, x 1; c - Rhodocollybia maculata var. nigra, W971, x 3/4; d - Rhodocollybia maculata var. occidentalis, W1179, x ½.

VIII



29. Rhodocollybia maculata var. scorzonerea (Fr.) Lennox comb. nov.

Figure 25

Basionym: Agaricus maculatus var. scorzonereus Fries, Hymenom. Europael, p. 113. 1874.

Synonym: Collybia maculata var. scorzonerea (Fr.) Gillet, Champ. Fr., p. 315. 1878.

PILEUS 3.5-12 (15) cm broad, convex with the margin strongly inrolled, becoming plane at maturity, and frequently straight or slightly recurved, either depressed or umbonate, surface often shallowly undulate; pale buff (5A4 to 5A2) on the margin, darkening gradually to fulvous (6B6 to 5B5), occasionally with more yellowish colors, darkening somewhat with age, drying lighter, pale buff to a light yellowish buff (5A3 to 4A4), not really hygrophanous, with scattered circular watery spots and ferruginous stains; surface when moist nearly lubricous, not truly viscid, glabrous; context thick, reaching 1.5 cm, firm when moist, rather soft when drier, not pliant or tough, pale buff to yellowish; odor faint and somewhat fragrant, taste bitterish, sometimes delayed.

LAMELLAE yellowish or soon becoming so (4A5 or 4A6), narrow, 2-14 mm broad, generally less than 5 mm, very thin and crowded, 65-88 lamellae reaching the stipe, 2-4 tiers of lamellulae, narrowly adnexed, sinuate-uncinate, not ventricose, pointed both at the cap margin and stipe, edges concolorous and even to slightly eroded, sometimes stained ferruginous.

STIPE 3.5-17 cm long, 6-40 mm broad, pallid at the apex, darkening slightly below or with age to the color of the cap or more yellow, staining ferruginous, especially at the base; equal or more frequently widest in the medial region and tapering both above and below this point; faintly powdery-pruinose at first, glabrescent and markedly longitudinally sulcate-striate at maturity; often subradicate, flexuous, compressed or terete, hollow to stuffed, concolorous to yellowish within, fibrous-tough, but easily splitting longitudinally, with or without rhizomorphs.

SPORES 7-8.5 x 4-5.5 µm, ovate to ellipsoid, dextrinoid, smooth, creamy pink in heavy deposit; BASIDIA 26-37 x 6-8 µm, four-spored; CHEILOCYSTIDIA not strikingly different from basidia, sometimes abundant, often scattered, 16-36 x 3-5 µm, clavate-contorted; remaining microscopic characters as in R. maculata var. maculata.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react faintly with phenol, phenol-aniline, and ferric súlfate.

HABITAT: Scattered on much decayed coniferous wood in dense coniferous stands.

MATERIAL STUDIED: WASHINGTON, W1364 (locality unknown); King Co., W881 (Soda Springs); Whatcom Co., W196 (Baker River Trail); OREGON, Hood River Co., Smith 23636 (East Fork Salmon River); IDAHO, Bonner Co., W965 (Bindarch Creek).

This variety is easily distinguished by its yellow, rather narrow gills, ferruginous stains, yellowish to reddish tones of the mature cap and stipe, and the ellipsoid spores.

30. Rhodocollybia maculata var. immutabilis (Smith) Lennox comb. nov.

Basionym: Collybia maculata var. immutabilis Smith Lloydia, Vol. 6(4):260. 1943.

PILEUS 2.5-3.2 cm, pale greyish cream (4A2 to 4C3, no good match); convex, expanding to nearly plane, margin straight and even, surface appearing slightly powdery at first, neither hygrophanous nor changing color in age, context relatively thin, less than the depth of the gills, firm, not pliant, concolorous, odor faint and sweet, taste, none or mild.

LAMELLAE concolorous with the cap or slightly lighter (3A2 or 3B2, no good match), broadly adnate, emarginate-uncinate, thick, somewhat waxy and subdistant, ventricose, edges even and concolorous, not becoming eroded, not staining ferruginous.

STIPE 3.5-5 cm long, 5-10 mm broad, concolorous with the cap or somewhat darker (3C3), not staining in any part, tapering upward, surface streaked-striate, not really sulcate, with a basal white appressed tomentum; hollow and rather tough-fibrous, not at all pliant.

SPORES 6.5-8 x 4-4.5 µm, ovate to ellipsoid, dextrinoid, thin-walled, and smooth; BASIDIA 27-33 x 6.5-7.5 µm, four-spored, noncarminophilous; no cheilocystidia or pleurocystidia differentiated; remaining characteristics as in R. maculata var. maculata.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react faintly with alpha-napthol, phenol, and phenol-aniline.

HABITAT: Gregarious on conifer duff in dense coniferous woods.

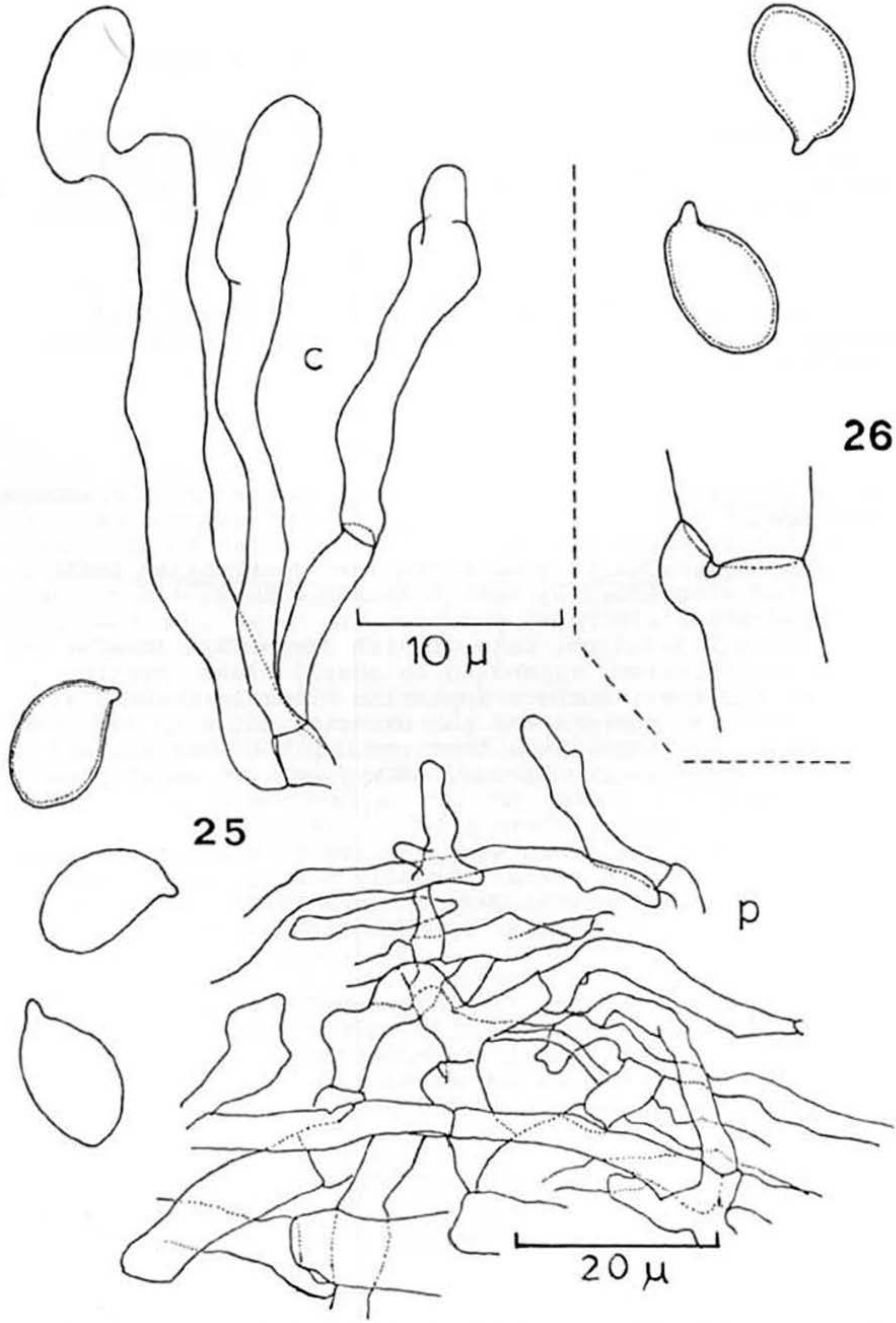


Figure 25. - Rhodocollybia maculata var. scorzonerea, W1364 spores, cheilocystidia (c), pileal surface (p); Figure 26. - Rhodocollybia maculata var. occidentalis, W1754, spores and clamps.

MATERIAL STUDIED: WASHINGTON, King Co., W633 (near Stevens Pass).

The above mentioned collection, upon which this description is based, matches most of the characters of *R. maculata* but lacks any ferruginous stain and has ellipsoid rather than globose spores, and in consideration of the latter characters best matches var. *immaculata*. The collection however was rather uncharacteristic in regards to its relatively small size and lack of a sulcate stipe. It may be either depauperate or truly distinct from the var. *immaculata*, but these differences did not seem to warrant the creation of a new variety without studying further material.

31. *Rhodocollybia maculata* var. *occidentalis* (Smith) Lennox comb. nov.

Figure 26, Plate VIII

Basionym: *Collybia maculata* var. *occidentalis* Smith, Lloydia Vol. 6(4):258. 1943.

PILEUS 2.6-11 cm broad, convex with an inrolled margin, becoming nearly plane, surface sometimes shallowly undulate; whitish or with a pale pinkish or buff tinge (5A2 or 5A4), generally darkening with age, becoming dark fulvous at the center, fading gradually to a warm buff at the margin (6D7 to 6C6 to 5A4 at the margin), becoming reddish spotted; surface faintly hoary or canescent at first, moist and dull, not viscid; context concolorous, thick over the disc, 0.5 cm or more, tapering abruptly near the margin, sometimes revolute or frayed at the extreme margin; odor rather faint, pleasant and aromatic or fruity, taste mild to faintly farinaceous.

LAMELLAE whitish to pale orange (5A4), emarginate to sinuate-uncinate, thin and rather waxy, crowded, 80-100 lamellae reaching the stipe, rather broad but generally not as broad as the context is deep, 3-8 mm x 15-37 mm, edge concolorous and at first even, later eroded.

STIPE 4.3-15 cm long, 8-21 mm broad, whitish or pale buff (5A2), staining ferruginous in the lower half; equal or ventricose at the substrate level and then tapered abruptly into a short pseudorhiza; surface at first faintly powdery-pruinose, glabrescent, and conspicuously longitudinally sulcate-striate later, solid at first, later hollow in the upper portions, often compressed or shallowly furrowed at maturity, flexuous at the base.

SPORES 6.5-11 x 4-6 µm, narrowly ovate to ellipsoid, thin-walled, dextrinoid, cream colored to pale peach in heavy deposit; CHEILOCYSTIDIA not differentiated; remainder of characteristics as in the description of R. maculata var. maculata.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with phenol, phenol-aniline, and ferric sulfate.

HABITAT: Gregarious to caespitose in thick humus or on much decayed wood in conifer forests.

MATERIAL STUDIED: WASHINGTON, W1179 (no location); Chelan Co., W1372 (Lake Wenatchee); Snohomish Co., W1152 (4 mi. up N. Fk. Sauk River); Thurston Co., W495 (near Olympia); Pierce Co., Smith 29006 (Longmire, Mt. Rainier Ntl. Pk.); Skamania Co., W1440 (Cispus Camp).

This variety differs from variety maculata in the slightly but consistently larger, more ellipsoid spores, lack of a bitter taste, the somewhat less crowded broader gills, and in the presence generally of a pinkish blush on the immature caps.

Section Butyracea (Singer) Lennox stat. nov.

Basionym: Collybia, Section Stripedes, Stirps Butyracea Singer. Agar. in Mod. Tax. 1962.

Type species: Rhodocollybia butyracea (Fr.) Lennox

PILEUS rather large, 3-7 cm, generally not more than 5 cm, light bay-colored to vinaceous brown, hygrophanous and changing color, context rather thick over the disc, generally 5 mm or less, but not as deep as the gills are broad; gills white; stipe glabrous, neither striate-sulcate, nor subradicating in decayed wood; rarely stained ferruginous in any part; scattered to gregarious on conifer duff, occasionally on much decayed conifer wood.

Key to the Species

1. Cap deep fulvous to dark vinaceous brown when moist, fading to light fulvous in drying................ 2.
1. Cap buff to warm tan or light fulvous, hygrophanous and drying only slightly lighter, changing from reddish hues to more greyish ones................ .... R. butyracea (p. 219)
    2. Spores ellipsoid to capsule-shaped, (6.5) 7-10 (11.5) x 3-4.5 µm, carpophores react rapidly with PDAB to give a magenta color to the solution. .... R. extuberans (p. 222)

2. Spores globose to very broadly ovate, 3.5-5.5 x 3-4.5 µm, gills react weakly and slowly to PDAB (faint pink)....... R. badiialba (p. 224)

32. Rhodocollybia butyracea (Bull. ex. Fr.) Lennox com. nov.

Figure 27, Plate IX

Basionym: Agaricus butyraceus Fries. System Mycol., 1:121. 1821.
Synonyms: Collybia butyracea (Bull. ex Fr.) Quélet. Champ Jura Vosges p. 93. 1872.
Gymnopus butyraceus (Bull. ex Fr.) Murrill. Mycol., 30:366. 1938.
Illustrations: Michael, Fuhrer f. Pilzfreunde (1927), Vol. I, no. 40; Cooke, Illustr. Brit. Hymenom., Pl. 189; Gillet, Champignons de France, No. 149.

PILEUS 2.7-7.0 cm broad, buff to a warm tan to light fulvous, (7F8 to 5B3), generally darker on the disc and fading towards the margin, occasionally pallid on the disc and uniformly buff elsewhere, hygrophanous and drying only slightly lighter, changing from reddish hues to more grey ones, sometimes becoming more yellowish over the disc (4B3 to 5C5/5C6 on margin); convex to conic, becoming plane, with a prominent broad umbo at maturity, margin generally becoming straight, even or sometimes fraying or lobed with age; surface glabrous, lubricous and shining at first, later dull-matte in drying; context watery-moist and then concolorous, soft, thick, up to 4 mm over the disc; taste and odor mild, fungoid or not distinctive.

LAMELLAE white with a faint pinkish or cream cast, becoming yellowish in drying, sinuate uncinate, easily seceding, blunt-ended at the stipe, rather pointed towards the margin, ventricose, thin, crowded, 48-60 lamellae reaching stipe, 5 tiers, broad, 11-27 mm x 3.5-5 mm, edge even or finely serrate at first, later strongly eroded and somewhat lighter, consistency soft.

STIPE 5-9 cm long, 5-12 mm broad, pallid or tan throughout (5A3 to 5B3), sometimes slightly darker towards the base, deep tan (5D5), subhygrophanous, conic-attentuated upwards, flexuous, subbulbous at the base, striate-grooved, subshining when moist, glabrous, short, white matted-tomentose at the base; hollow and the cuticle rigid-cartilaginous, twisted longitudinally, easily fraying, fibrous, terete or compressed.

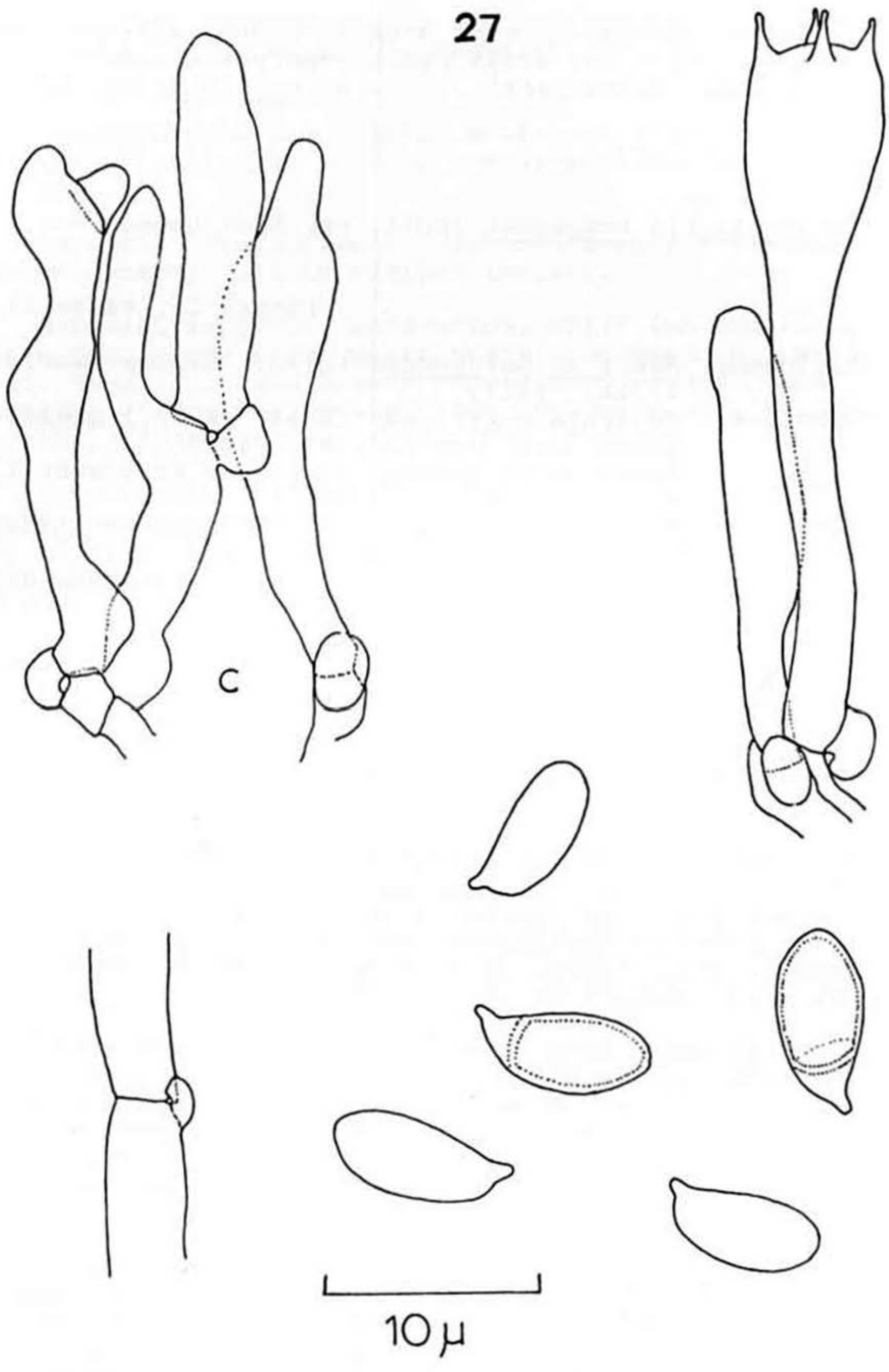


Figure 27. - Rhodocollybia butyracea, W1017, basidium, spores, clamp, cheilocystidia (c).

SPORES 6.5-9 (11) x 3.0-4.5 µm, narrowly ellipsoid to capsule shaped or ovate, smooth, the exosporium very thin, the endosporium thick (1 µm) and dextrinoid with Melzer's, often retracted from the apicular end, cream to light orange in deposit (5A3); BASIDIA 27-35 x 6-7.5 µm, narrow and expanded abruptly in the upper third, basidioles quite slender and unexpanded, four-spored, a few with the endosporium contracted into the upper or lower half of the basidia, much thickened and dextrinoid; CHEILOCYSTIDIA clavate somewhat distorted or irregular in shape, not branched or septate, not filamentous, scattered, very inconspicuous and not exceeding the basidia; pleurocystidia not differentiated; PILEAL SURFACE a cutis of compact, radial to somewhat interwoven narrow hyphae, 2-5 µm in diameter, in a zone 50-70 µm deep, the upper cells partially gelatinized and agglutinating the hyphae, scattered hyphae with banded encrustations, nonamyloid, no pileocystidia; CONTEXTUAL HYPHAE much less compact and larger than those of the surface layers, 5-25 µm in diameter, predominantly interwoven, very thin-walled and readily collapsing, clamped, nonamyloid, with scattered encrusted hyphae; GILL TRAMA parallel, composed of hyphae 4-5 µm broad, thin-walled, nonamyloid, subhymenium interwoven, rather coarse, and narrow.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with aniline (faint, yellow to pinkish), alpha-napthol, guaiacol, tincture of guaiac (faint, variable - sometimes negative), phenol, and phenol-aniline.

HABITAT: Scattered to loosely caespitose in thick duff or conifer forests.

MATERIAL STUDIED: WASHINGTON, Whatcom Co., W323 (Mosquito Lk.); King Co., W184 (Arborteum, Seattle), W237 (McClellans Butte), W403 (St. Thomas and St. Edward Seminary Woods), W413 (Water Main Woods); Thurston Co., W499, W593, W594, W982, W1041, W1239, W1240, W1241, W1102, W1535, (Tenino Mounds, near Olympia); Clallam Co., W1143 (Heart O' the Hills, Olympic Ntl. Pk.); Jefferson Co., W526 (Enchanted Valley, Olympic Ntl. Pk.).

R. butyracea is distinguished from other closely related species by the following set of characteristics: strongly reactive in the macrochemical spot tests, a light orange spore print, white to cream gills with a strongly serrate or eroded margin and ventricose broad shape, an umbonate cap which is markedly lubricous and changes from a reddish tan to a greyish tan in drying, a striate-grooved stipe with a subbulbous base, and in general, a soft nonreviving consistency throughout the carpophores.

33. Rhodocollybia extuberans (Fries) Lennox comb. nov.

Figure 28, Plate IX

Basionym: Agaricus extuberans Fries, Epicrisis System. Mycol.:93. 1838.
Synonym: Collybia extuberans (Fries) Quélet. Champ. Jura Vosges p. 97. 1872.
Illustrations: Fries, Icones Hymenon., tab. 67, fig. 1; Battarra, Fung. Arimin. Historia, tab. 28, fig. A; Britz., Hymenon., tab. 47, fig. 320; Cooke, Illustr. Brit. Fungi, pl. 202. (as Agaricus nitellinus).

PILEUS 2-5.5 cm broad, dark vinaceous brown on the disc to a deep fulvous on the margin (8F7 to 6D7 or 6E7), hygrophanous and fading to a light fulvous, remaining darker on the disc; convex to conic, becoming broadly conic-campanulate or plane with a low or prominent conic umbo, margin remaining somewhat inrolled or becoming straight and recurved; surface subviscid to lubricous when moist, drying dull and finely radially wrinkled, and obscurely fibrillose at the margin, glabrous elsewhere, occasionally moist-striatulate at the extreme margin; context rather thick, 5-8 mm, very sordid reddish brown near the pellicle, watery-translucent below when moist, later pallid, firm, fibrous-tough; odor faint, sweet, "soapy"; taste none.

LAMELLAE white or a very pale yellow in old specimens, yellowing in drying; deeply sinuate, almost free, sharp-pointed at the margin, blunt-ended at the stipe, somewhat ventricose, thin, close to crowded, 40-50 lamellae reaching stipe, 4 tiers, moderately broad, 15-22 x 4-5 mm, edge even or very finely serrate when immature, becoming serrate to strongly eroded later, consistency rather soft, becoming spotted with very sordid brownish spots.

STIPE 3.5-8 cm long, 3-20 mm broad, concolorous with the margin of the mature cap (6E7), somewhat lighter at the apex (6A2, flesh-colored), uniformly colored or darkening somewhat downward; more or less tapering at the base to a pseudorhiza-like prolongation which is buried in the substratum, generally rather markedly expanded above this and subbulbous, surface powdery-pruinose to hoary-pubescent at the apex when young, glabrescent, strongly striate-grooved the entire length, matted-tomentose below substratum; hollow to stuffed with a thin rind, fibrous, easily splitting, terete or compressed, flexuous, twisted, with or without abundant white rhizomorphs.

PLATE IX -; a - Rhodocollybia butyracea, W982, x 3/4; b - Rhodocollybia extuberans, W1172, x ½; c - Rhodocollybia badiialba, W1626, x 3/4.


IX
a
b
c

SPORES (6.5) 7-10 (11.5) x 3-4.5 µm, ovate to narrowly ellipsoid, very thin-walled to rather thick-walled, hyaline, endosporium dextrinoid and frequently retracted from the apicular end, cream to pale orange in thick deposit, becoming quite yellow with age; BASIDIA 23-35 x 6-7 µm, rather long, narrow through most of length, expanded just at apex; a very few with dextrinoid and retracted endosporium, appearing thick-walled and septate, four-spored with an occasional scattered two-spored basidium; CHEILOCYSTIDIA sometimes differentiated, scattered and very inconspicuous, clavate or subclavate, contorted, or septate, hyaline, thin-walled, not exceeding the basidia, 21-35 x 4-5.5 µm; no pleurocystidia differentiated; PILEAL SURFACE a cutis of radially arranged, narrow hyphae 2-4 µm in diameter, encrusted with conspicuous transverse bands of dark brownish pigment, in a compact layer 3-5 hyphae deep, intergrading with tissue of context in size and density of cells; CONTEXTUAL HYPHAE 3-6 µm in diameter, rather loose, radially arranged, clamped, nonamyloid; GILL TRAMA composed of parallel cylindric hyphae 4-8 µm in diameter, clamped, nonamyloid, subhymenium very thin and ramose.

MACROCHEMICAL REAGENTS: Gills and flesh of the cap react positively with alpha-napthol, guaiacol, tincture of guaiac, phenol, phenol-aniline, and PDAB (dark, rapid reaction - immediate to 5 minutes - solution turns a dark magenta).

HABITAT: Gregarious to caespitose on well decayed conifer wood, in dense moist woods.

MATERIAL STUDIED: WASHINGTON, Clallam Co., Smith 16967 (Lake Angles Trail), Smith 17800 (Olympic Hot Springs); Jefferson Co., W1172 (Dosewallips Campground); Gray's Harbor Co., Kauffman, Oct. 14, 1925 (Lake Quinault); Skagit Co., W1694A (Mineral Park); King Co., Stuntz 1012 (Campus, Univ. of Wash.); Thurston Co., W1268 (Tenino Mounds); IDAHO; Bonner Co., W918 (Priest River Experimental Station).

This species is distinguished from R. badiialba by its ellipsoid, dextrinoid spores, encrusted pileal surface which is not gelatinized, cheilocystidia, sweet odor and absence of a bitter taste, and the rapid reaction with PDAB to yield a bright magenta color to the solution. I do not agree with Smith (1944) that the colors of the cap are duller and not as red as those of R. badiialba; however, he is generally correct in stating that the gills of R. extuberans are less crowded and the stipe subradicating.

34. Rhodocollybia badiialba (Murrill) Lennox comb. nov.

Figure 29, Plate IX

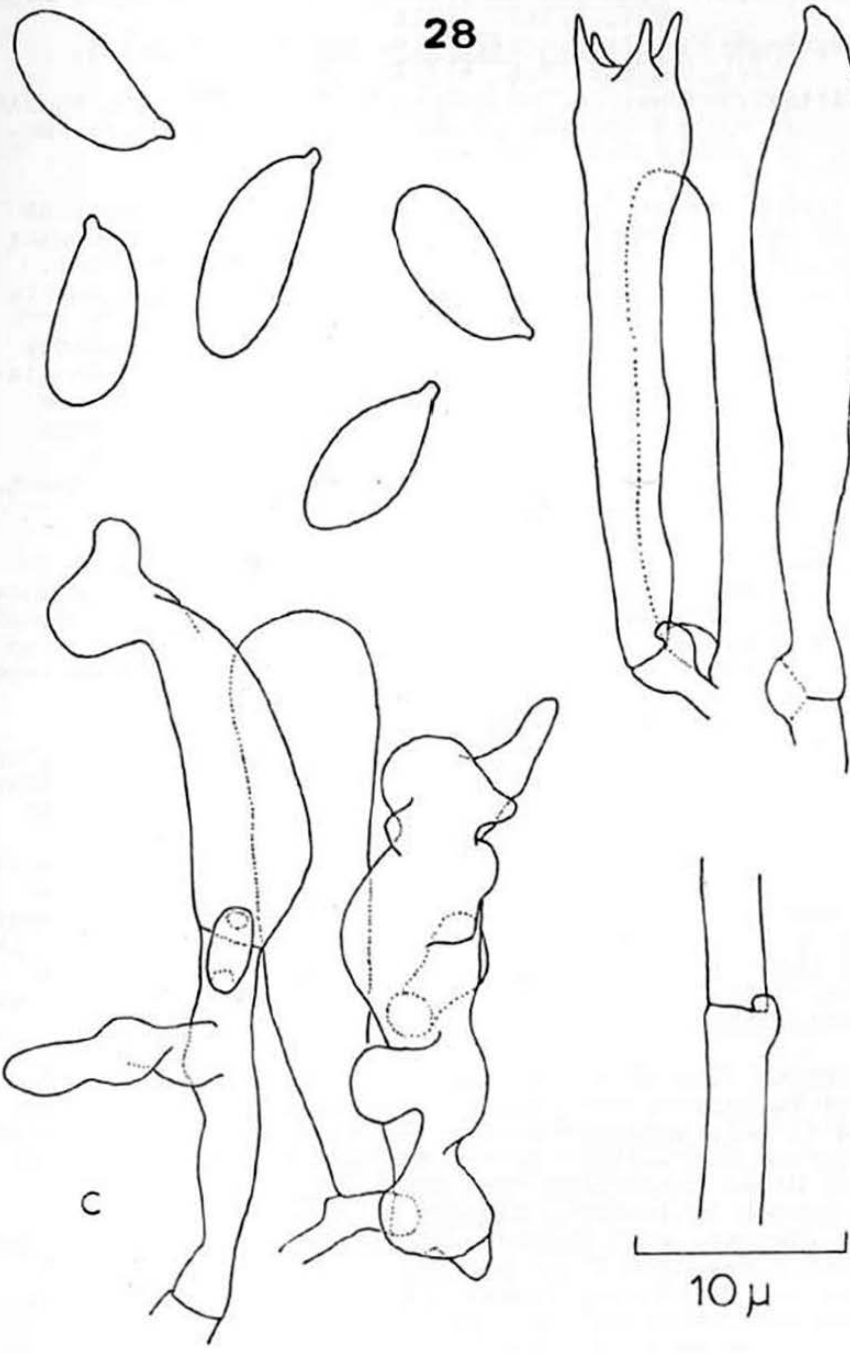


Figure 28. - Rhodocollybia extuberans, W1172, basidium, spores, clamp, cheilocystidia (c).

Basionym: Gymnopus badiialbus Murrill. N. Amer. Flora. Vol. 9:369. 1916.
Synonym: Collybia badiialba (Murrill) Murrill. Mycol. Vol. 8:218. 1916.
Illustrations: A. H. Smith, Studies of N. Am. Agarics I. Contr. of the Univ. of Mich. Herb. No. 5 Feb. 1941. Pl. II.

PILEUS 2.4-11.5 cm, generally 5-7 cm, dark chestnut (8F6 to 7D6) or dark fulvous on the disc, fading somewhat to the margin, vinaceous brown to fulvous (7D6 to 6B4), sometimes spotted vinaceous, hygrophanous and changing to a dark warm buff (6C4); convex, becoming plane, with a broad shallow umbo, margin becoming straight, frequently fraying with age, sometimes revolute as well; surface glabrous, very lubricous, not viscid, obscurely fibrillose when quite wet, occasionally undulate, matte in drying; context rather thick, up to 9 mm, white to tan, soft, rather brittle when moist; odor faint, fungoid to pungent, taste slowly becoming unpleasant and bitter.

LAMELLAE white, not changing with age, yellowing in drying, narrowly adnexed, sinuate-uncinate, sharply pointed at the margin, blunt-ended at the stipe, ventricose, broad, 2-4.5 cm x 3-8 mm, crowded, 50-80 lamellae reaching stipe, 4 tiers of lamellulae, thin, edges concolorous and serrate when young, later eroded.

STIPE 5-11 cm long, 5-9 mm broad, pallid pinkish grey at the apex, flesh-colored (5A3, no good match), darkening slowly downward to a light vinaceous tan (6D5), staining reddish brown as in R. maculata, slightly expanded at extreme apex, generally equal below this, sometimes tapering upward, often abruptly tapered in the last two cm of base, appearing to root somewhat then; surface at the apex powdery-pruinose, then glabrescent, striate-grooved for the entire length; hollow, ridgid and strict, terete or compressed, fibrous, concolorous within when water-soaked, with abundant white rhizomorphs.

SPORES 3.5-5.5 x 3-4.5 µm, a few sometimes 8 x 5 µm, globose to very broadly ovate, very thin-walled to thick-walled (1 µm), smooth, hyaline, with dextrinoid endosporium (percentage of reacting spores differs widely), the endosporium often retracting from the apicular end, cream to light orange in deposit; BASIDIA 21-25 x 4-5.5 µm, most rather slender, four-spored predominantly, some two-spored basidia, a few dextrinoid basidia with the staining endosporium retracted into either lower or upper half, appearing septate, thick-walled; basidioles slender at the apex, subventricose towards the base; CHEILOCYSTIDIA not differentiated; PILEAL SURFACE a partially gelatinized cutis composed of hyphae 2-10 µm in diameter, nonencrusted, in a zone up to 85 µm deep, radially oriented, overlying a more compact zone of hyphae of the same diameter, this layer

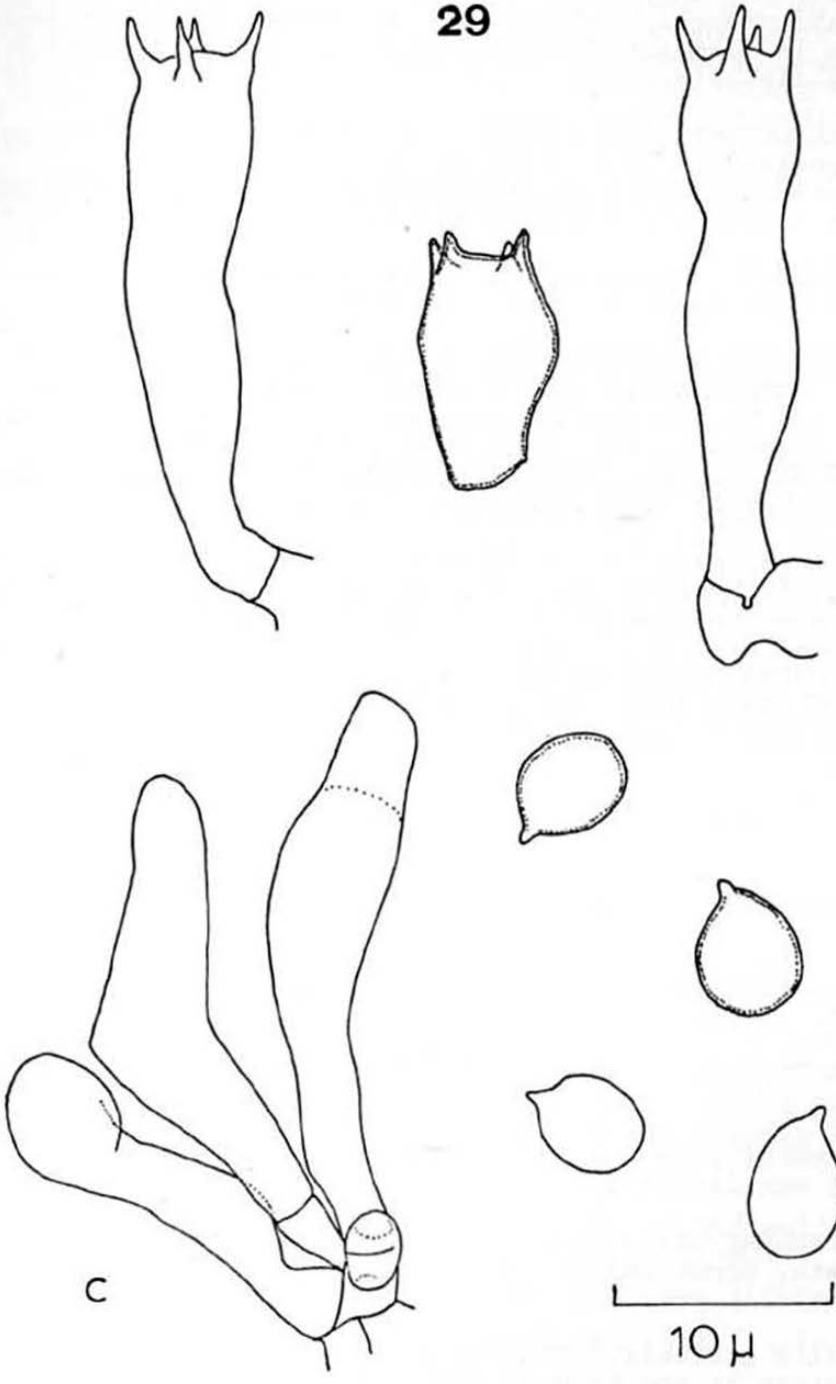


Figure 29. Rhodocollybia badiialba, W547, basidia, spores, cystidioles (c).

intergrading into the contextual hyphae; CONTEXT partially interwoven, rather loose, of large diameter hyphae, 5-15 µm broad, clamped, nonamyloid; GILL TRAMA of coarse hyphae 8-16 µm in diameter, clamped, subhymenium rather narrow and tightly interwoven.

MACROCHEMICAL REACTIONS: Gills and flesh of the cap react positively with tincture of guaiac, and phenol. Reactions occurred with alpha-napthol, guaiacol, and phenol-aniline which were sporadic and faint.

HABITAT: Gregarious to loosely caespitose on much decayed logs or thick duff, in dense conifer woods.

MATERIAL STUDIED: WASHINGTON, San Juan Co., W1072 (Friday Harbor Biological Station); King Co., W101 (St. Thomas and St. Edward Seminary Woods), W1625 (Hamilin Park), W1628 (residence, Seattle); W532 (Woodinville), W. A. Murrill 611 (Type - Seattle); Skamania Co., W1444 (Cispus Training Camp); W1059 (locality unknown).

This species is distinguished from R. extuberans, to which it is most closely related, by the relative inactivity with macro-chemical spot reagents, the absence of cheilocystidia, the presence of globose spores, the absence of encrusted hyphae on the cuticle, the gelatinized upper layer of the pileus, the darker, more vinaceous colors of the cap, and a bitter taste.

COLLYBIA (Fr.) Staude, Schwamme Mitteldeutschl. p. xxviii. 1857.

Type species: Agaricus dryophilus. Bull. Herb. Fr. pl. 434. 1789.

HABIT collybioid, PILEUS generally small, convex, becoming plane, rarely either unbilicate or umbonate; white, tan, or fuscous shades, never really brightly colored, context generally rather thin, 3 mm or less, taste and odor usually not distinctive.

LAMELLAE white to pale grey or tan, narrowly to broadly adnate, occasionally appearing subdecurrent at maturity, edges usually even and concolorous.

STIPE generally white or concolorous, equal or somewhat larger at the base or apex, usually glabrous, often with a whitish tomentum at the base, or occasionally tomentose the entire length, hollow to stuffed, neither truely radicate nor with a sclerotium.

SPORES globose to ellipsoid, thin-walled, smooth, nonamyloid, white in deposit; BASIDIA four-spored; pleurocystidia not differentiated, CHEILOCYSTIDIA generally not differentiated, if present, clavate-contorted, thin-walled, not encrusted, and not exceeding the basidia; PILEAL SURFACE a cutis of radial, narrow repent hyphae, or undifferentiated from the context, composed of rather coarse, interwoven hyphae; context radial to interwoven; GILL TRAMA regular, parallel or somewhat interwoven centrally, clamped, nonamyloid.

ACKNOWLEDGEMENTS

I am grateful to Dr. Alexander H. Smith, University of Michigan, and Dr. Daniel E. Stuntz of the University of Washington for the use of the herbaria, personal collections, and field notes. Numerous collections and type specimens were kindly made available on loan from the following institutions and individuals: New York Botanical Garden and Dr. C. T. Rogerson, New York State Museum and Dr. J. H. Haines, University of Michigan Herbarium and Drs. A. H. Smith and R. L. Shaffer. I would also like to thank Dr. Fred Van deBogart, Dr. Dave Hosford, and Susan Libonatti-Barnes for their comments in the preparation of this manuscript. Special thanks is due Dr. Daniel Stuntz whose patience, encouragement, and expertise made this study possible.

BIBLIOGRAPHY

Arnold, Jean. 1935, A comparative study of certain species of Marasmius and Collybia in culture. Mycologia 27: 388-417.

Bigelow, H. 1973. The genus Clitocybula. Mycologia 65: 1101-1116.

Fayod, M. V. 1889. Prodrome d'une Histoire Naturelle des Agaricines. Annales des Sciences Naturelles, 7, Serie. Botanique 9: 181-411.

Fries, E. M. 1821. Systema Mycologicum. Vol. I. Berling. Lund. 520 p.

______________. 1838. Epicrisis Sytematis Mycologici. Gleerup. Lund. 610 p.

Karsten, P. A. 1879. Hymenomycetes Fennici. Acta Soc. Fauna Pl. Fenn. 2(1): 140 p.

_______________. 1882. Hattsvampar. Helsinki, Finland.

_______________. 1891. Symbolae ad Mycologiam Fennicam. Medd Soc. Fauna Fl. Fenn. 18: 61-68.

Konrad, P. and A. Maublanc. 1932. Icones Sectorum. Vol. 3: pl. 200-211.

Kornerup, A. and J. H. Wanscher. 1966. Color Atlas. Reinhold. Copenhagen, Denmark.

Kuhner, R. and H. Romagnesi. 1953. Flore Analytique des Champignons Superieurs. Masson et cie Paris. 556 p.

Kummer, P. 1871. Der Fuhrer in Die Pilzkunde. Zerbst. 146 p.

Lange, J. 1936. Flora Agaricina Danica Vol. III Recato, Copenhagen.

Metrod, G. 1952. Les Collybies. Rev. Mycol. 17(1): 60-93.

Moser, M. 1967. Die Rohrlinge und Blatterpilze, in Gams, H., Kleine Kryptogamenflora II. Stuttgart, Gustav-Fischer Verlag.

Patouillard, N. 1900. Essai Taxonomique des Hymenomycetes. L. Declume, Lons-Le-Saunier. 184 p.

Quélet, L. 1872. Les Champignons de Jura et des Vosges. Mem. Soc. Emul. Montbeliard, ser II, 5: 43-332.

Ridgway, R. 1912. Color Standards and Color Nomenclature. Publ. by the author. Washington, D. C.

Singer, R. 1936. Das System der Agaricales. Ann Mycol. 34: 286-378.

_______________. 1938. Notes sur quelques Basidiomycetes. Rev. Mycol. 3: 187-199.

_______________. 1944. New genera of fungi - I. Mycologia 36: 358-368.

_______________. 1949 (publ. 1951). The Agaricales in Modern Taxonomy. Lilloa 22: 1-832.

_______________. 1962. New genera of fungi VII. Persoonia 2: 407-415.

Singer, R. 1962. The Agaricales in Modern Taxonomy. 2nd Ed. Cramer, Weinheim. 915 p.

Smith, A. H. 1935. Unusual Agarics from Michigan III. Papers Mich. Acad. Sci. Arts, Let. Vol 21: 147.

______________. 1941. Studies of N. Am. Agarics I. Contrib. Univ. Mich. Herb. no. 5: 1-73.

______________. 1944. N. Amer. Agarics. Bull Torrey Bot. Club 71: 396-7.

Smith, A. H. and Hestler. 1943. New Agarics from Tennessee. Lloydia Vol 6(4): 255-260.

Speggazini, C. 1881. Fungi Argentini. Ann. Soc. Cient. Arg. 12: 13-30.

Wells, V. and P. Kempton. 1971. Studies on the fleshy fungi of Alaska - V. The genus Strobilurus with notes on extra-limital species. Mycologia 63 (2): 370-380.

MYCOTAXON

Vol. IX, No. 1, pp. 232-238 June 12, 1979

FILOBOLETUS PROPULLULANS, A NEW POROID AGARIC FROM PANAMÁ

SUSAN D. LIBONATI-BARNES

Department of Botany (AK-10)
University of Washington
Seattle, Washington 98195 U.S.A.

SUMMARY

Filoboletus propullulans, from Barro Colorado Island, Panamá, is a new species of Filoboletus Henn. This species is delimited from Filoboletus gracilis (Klotzsch apud Berk.) Sing. by its pleurocystidia, cheilocystidia, and distinctive diverticulate cutis with subcellular hypoderm.

INTRODUCTION

The tropical genus Filoboletus consists of small mycenoid fungi with tubulose hymenophore, central stipe, and smooth amyloid spores. Filoboletus sensu Höhnel (1908) may differ from Filoboletus as originally conceived by Hennings in 1900 (Donk, 1962). Since Hennings' type has been destroyed, Singer (1976) interprets Filoboletus as did Höhnel. The interpretation of the genus for this publication is that delimited by Höhnel and followed by Singer.

Six species of Filoboletus are to be found in the literature. Five of them, F. mycenoides, F. manipularis, F. gracilis, F. luteus, and F. staudtii are discussed by Singer (1945). A sixth species, F. hanedai (Kobayasi) Hongo, first described as a Poromycena (Kobayasi, 1951) has since been recombined in Filoboletus by Hongo (1955).

This paper describes a seventh species, _F_. _propullulans_, from Barro Colorado Island, Panamá.

Color terminology is that of the Methuen Handbook of Colour, 1967.

DESCRIPTION

Filoboletus _propullulans_ LIBONATI-BARNES sp. nov. (Fig. 1-5)

Pileus convexus vel breviter conicus, aliquantum umbonatus, circularis, glabratus, 8-20 mm latus, ubi vivens pallido-cinereus, fuscatus in disco, ubi siccatus albidus vel cremeus, fuscatus in disco; caro disci 0.5 mm crassa, pallida, gelatinosa; margo pilei tenuis, aliquantum undulatus; tubi adnati, breves, 0.1 mm profundi; pori circulares vel parum angulares, 7-9 per mm, non radiatim dispositi, ubi vivens albidi, fuscati ubi siccatus; stipes centralis, cavus, longitudinaliter fibroso-striatus, leviter flocculosus, 15-25 mm longus, 2-3 mm crassus, ad apicem incrassatus (2.5-3.5 mm crassus) et ad basi incrassatus (2.5-3.7 mm crassus), ubi vivens albus, ubi siccatus cinereo-cinnamomeus, ad basim pilis parvulis aureo-brunneis.

Sporae 4.2-6 x 5.2-6.5 µm (-7.5 µm), subglobosae vel ovatae, inaequilaterales, laeves, hyalinae, amyloideae; basidia 20-23.4 x 5-8.3 µm, cylindrica, clavata, vel irregulariter tumida; sterigmata 4, ad 5.2 µm longa quorum duo plerumque longiora sunt; pleurocystidia 26-41 x 3.8-4.1 µm, filiformia, tenuitunicata, infrequencia; cheilocystidia 20-35 x 10-12.5 µm, saepe clavata, interdum lecythiformia vel obpyriformia, aliter versiformia, ad marginem tuborum abundantia; trama tuborum parallela, ex hyphis 3.8-10 µm latis, agglutinatis et gelatinosis constantes, tubi 110-140 µm profundi, pariebus 6.3-44 µm crassis hymenio excluso; subhymenium valde agglutinatum; contextus pilei ex hyphis confertis intertextis super tubos, laxe intertextis infra pagina pilei constans, hyphae aliquantum gelatinosae, inflatae, quarum aliqui angustate (3.1-6.3 µm latae) et aliae latae (10-27 µm latae) sunt, etiam cum hyphis paucis gloeopleris 3.8 µm latis; pagina pilei ex hyphis radiantibus, repentibus, diverticulatis, 6.3-18 µm latas constans, pagina strati hypharum 2-3, hypoderma ex cellularis irregulariter angularibus, 19-88 x 63-75 µm; stipes ex stratis tribus compositus: stratum extimum ex hyphis 3.8-12.5 µm latis, longitudinalibus, parallelis constans, stratum medium ex hyphis inflatis, 8.8-19 µm latis constans, stratum intimum ex hyphis laxe intertextis (5-12.5 µm latis) constans; basis stipitis ex hyphis agglutinatis intertextis 8.8-23 µm latis constans; hyphae gloeoplerae, 5-6.25 µm latae, subinde in strato extimo stipitis adsunt; caulocystidia tenuitunicata, saepe collapsa, vesiculata vel brevi-clavata, ad apicem stipis 7.5-13.8 x 15-31.3 µm, versus basem stipis elongata (6.3-13.8 x 44-106 µm), trichodermium ad basem stipitis facientia; fibulae in pileo et stipite adsunt.

Holotypus SDLB 773, in ramosis delapsis arborum frondosarum, in Insula Barro Colorado, Panamá, 16 July 1976 lectus; in herbario Universitatis Washingtoni conservatus (WTU).

PILEUS convex of shallowly conical, slightly umbonate, roughly circular, glabrous, 8-22 mm in diameter, when fresh pallid greyish white, with a darker disk, when dry becoming ivory to cream with a pale yellow to dull greyish orange disk; flesh 0.5 mm thick on the disk, narrowing evenly toward the margin, concolorous with the pileal margin, appearing gelatinous; pileal margin thin, slightly undulate.

TUBES adnate, shallow, slightly more so toward the pileal margin, 0.1 mm deep; pores round to slightly angular, 7-9 per mm, not at all radially oriented, white when fresh, cream to pale greyish brown when dry.

STIPE central, hollow, longitudinally fibrous-striate, faintly flocculose, 15-25 mm long, 2-3 mm in diameter, flaring slightly both at the apex (2.3-3.5 mm) and at the base (2.5-3.7 mm), white when fresh, drying to greyish cinnamon brown, with sienna brown at the apex; base of the stipe clothed with golden brown scurfy-pruina and also extending into an investing web of hyphae on the substratum.

SPORES 4.2-6 x 5.2-6.5 (-7.5) µm, on the average 5.3 x 5.9 µm, subglobose, or ovoid, inaequilateral, smooth, with or without granules or oil drops, hyaline, amyloid.

BASIDIA 20-23.4 x 5-8.3 µm, cylindric, clavate, or irregularly swollen, 4-spored with sterigmata up to 5.2 µm long, of which two are usually distinctly longer than the other two; basidioles noticeably rectangular.

PLEUROCYSTIDIA 26-41 x 3.8-4.1 µm, filiform, thin-walled, rare; cheilocystidia 20-35 x 10-12.5 µm, abundant at the tube mouths, many clavate, a few lecythiform or obpyriform, the rest irregular in shape.

TUBE TRAMA parallel, of hyphae 3.8-10 µm in diameter, firmly agglutinated, with walls somewhat gelatinized; tubes 110-114 µm deep, walls 6.3-44 µm thick exclusive of hymenium; subhymenium of interwoven agglutinated hyphae.

PILEAL CONTEXT of hyphae densely interwoven just above the tubes, becoming loosely interwoven toward the pileal surface; hyphae somewhat gelatinized, inflated, some narrow (3.1-6.3 µm in diameter) others broad (10-27 µm in diameter); gloeoplerous hyphae occasional, 3-7 µm in diameter, densely-staining in phloxine.

PILEAL SURFACE of diverticulate hyphae forming a cutis, i.e., radially oriented repent hyphae 6.3-18 µm in diameter, 2-4 hyphae thick, underlain by a subcellular hypoderm 1-4 layers thick of cells irregularly angular by mutual compression and 19-88 x 63-75 µm in size.

STIPE of three layers: the outermost layer of longitudinal, straight, parallel, agglutinated hyphae, 3.8-12.5 µm in diameter, a middle layer of somewhat more inflated hyphae 8.8-18.8 µm in diameter, and an inner layer of hyphae, interwoven, 5-12.5 µm in diameter, lining the lumen of the stipe. Stipe base of interwoven agglutinated hyphae 8.8-23 µm in diameter, spreading out on the substratum into an investing web of hyphae 2.5-5 µm in diameter. Gloeoplerous hyphae (5-6.25 µm in diameter) occasional in the outermost layer of the stipe.

CAULOCYSTIDIA thinwalled, often collapsed, vesiculose, short-clavate, present the length of the stipe, shorter near the apex of the stipe (7.5-13.8 x 15-31.3 µm) elongating into cystidioid processes 6.3-13.8 x 44-106 µm which form a trichodermium at the very base of the stipe.

CLAMPS present in the pileal context, occasional in the tube trama, not seen at the bases of the basidia or

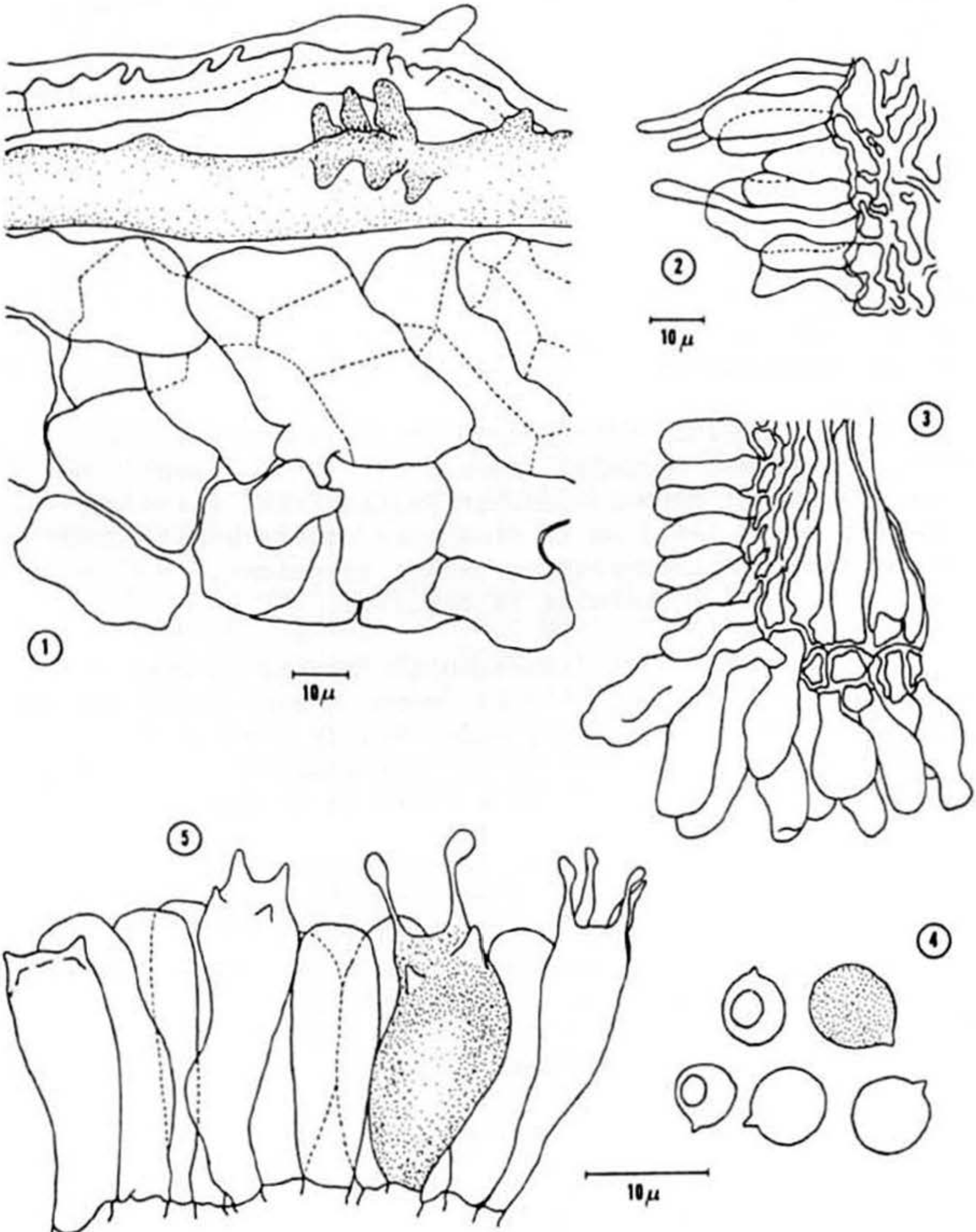


Fig. 1-5. Filoboletus propullulans, 1. pileal surface, showing diverticulate hyphae of the cutis, and the underlying subcellular layer (radial section), 2. filiform pleurocystidia, 3. edge of a tube, showing various shapes of cheilocystidia, and a segment of the hymenium, 4. spores, 5. basidia in several stages of development.

cystidia; occasional in the outer and middle layers of the stipe, abundant in the inner layer and in the investing web.

HABITAT on fallen logs of Tachigalia versicolor (Leguminosae) which were known to be dead at least nine years (Foster, 1977), and on fallen branches of other frondose trees. Carpophores solitary or in twos, single or gregarious.

MACROCHEMICAL REACTIONS: flesh of the pileus and of the tubes slowly becoming chocolate brown in 2% phenol.

MATERIAL EXAMINED: Panamá, Barro Colorado Island, HOLOTYPE SDLB 773, 16 July 1976; PARATYPE SDLB 1101, 12 August 1976.

OBSERVATIONS: This species is closely related to Filoboletus gracilis (Klotzsch ex Berk.) Sing. from which it can be distinguished by the diverticulate hyphae of the cutis, the presence of pleurocystidia, the clearly differentiated cheilocystidia, and the spores which are more globose than ellipsoidal. In addition, the tubes of F. propullulans are uniformly short, and the pores quite small.

ACKNOWLEDGEMENTS

I wish to acknowledge R. Foster of the University of Chicago and D. Janos and E.G. Leigh of the Smithsonian Tropical Research Institute for their assistance on Barro Colorado Island. I also thank R. Fogel of the University of Michigan Herbarium and D. Farr of the Bureau of Plant Industry for the loan of specimens, and especially Dr. D.E. Stuntz for his critical comments. This paper resulted from a study supported by a Noble Fellowship from the Smithsonian Tropical Research Institute.

LITERATURE CITED

Donk, M.A. 1962. The generic names proposed for Agaricaceae. Nova Hedwigia 5:1-320.

Foster, R.B. 1977. Tachigalia versicolor is a suicidal neotropical tree. Nature 268:624-626.

Hennings, P. 1900. Fungi Monsunenses II. Monsunia 1: 137-147.

Höhnel, F. v. 1908. Fragmente zur Mykologie, Mitteilung 5. Sitzungsb. k. Akad. Wiss. 117(1): 985-1032.

Hongo, T. 1955. Journal of Japanese Botany (Shokubutsu Kenkyū Zasshi) 30: 75.

Kobayasi, Y. 1951. Contributions to the luminous fungi from Japan. Journal of the Hattori Botanical Laboratory (Hattori Syokobutu Kenkyūsyo) 5: 1-6.

Kornerup, A. and J.H. Wanscher. 1967. Methuen Handbook of Colour. 2nd Ed., Methuen Co., Ltd., London. 243 p.

Singer, R. 1945. The Laschia-complex (Basidiomycetes). Lloydia 8(3): 170-230.

Singer, R. 1975. The Agaricales in Modern Taxonomy. Ed. 3, J. Cramer, Weinheim, 912 p.

MYCOTAXON

Vol. IX, No. 1, pp. 239-242 June 12, 1979

CHRYSOCONIA, A GASTEROID MEMBER OF THE CONIOPHORACEAE

DENNIS E. McCABE and GUSTAVO A. ESCOBAR

Department of Botany, University of Washington
Seattle, Washington 98195

Chrysoconia orthospora was first observed in the Spring of 1975 growing on decaying twigs and leaf matter brought into the laboratory for observation. The plant debris was collected from the bottom of a stagnant pool near the Montlake Playground on Lake Union, in Seattle. The debris was placed in petri dishes and kept submerged in distilled water by periodic replenishment of evaporated water for 4 weeks. After 4 weeks the material was allowed to dry out slowly. By 6 weeks one plate had produced a crop of golden brown tufts which, on close examination, proved to be cluster of basidia bearing orthotropically attached brown, smooth spores.

In the Spring of 1976 an attempt was made to obtain a second collection of C. orthospora. Plant debris was collected from the same location and treated as described above. Once again the fungus appeared on one plate (out of 10) after about 6 weeks of incubation in the laboratory. This time fresh specimens were transferred to culture media in an attempt to grow C. orthospora axenically. Pure cultures were obtained by succesive transfer of hyphal tips from cultures growing on Difco Corn Meal Agar. Near normal fruiting has been repeatedly obtained on cold soil extract agar. Cold soil extract medium is prepared by extracting 200 g of fresh garden soil with 600 ml of distilled water for 30 minutes at room temperature, then filtering through a Whatman #1 filter paper. The filtrate is brought to 500 ml and supplemented with 0.25 g of Difco Yeast Extract, 2 g of soluble starch, and 7.5 g of Bacto Agar before autoclaving at 15 lb/in^2 for 15 minutes.

Chrysoconia orthospora sporocarps appear to be little more than hyphal tufts 0.1-0.2 mm in diameter bearing basidia on all surfaces. The mature sporocarps are usually more or less hemispherical but can be somewhat dendritic (Fig. A). In either case, the fruiting body arises directly from the substratum with no apparent subiculum. The basidia of C. orthospora are clavate, usually bearing two spores attached orthotropically to the sterigmata (Fig. B).

The spores are brownish orange with smooth walls, an apical germ pore, and a thin-walled pedicel (Fig. D). The hyphae making up the sporocarp bear clamp connections (Fig. C) typical of those found in Basidiomycetes.

The color terms cited are from Ridgway's Color Standards and Nomenclature (1912) and determined under a dissecting microscope illuminated with a tungsten lamp.

The shape of the basidiocarp and, above all, the orthotropic attachment of the spores, suggest the creation of a new genus and we propose the name Chrysoconia for this new member of the family Coniophoraceae.

Chrysoconia, gen. nov.

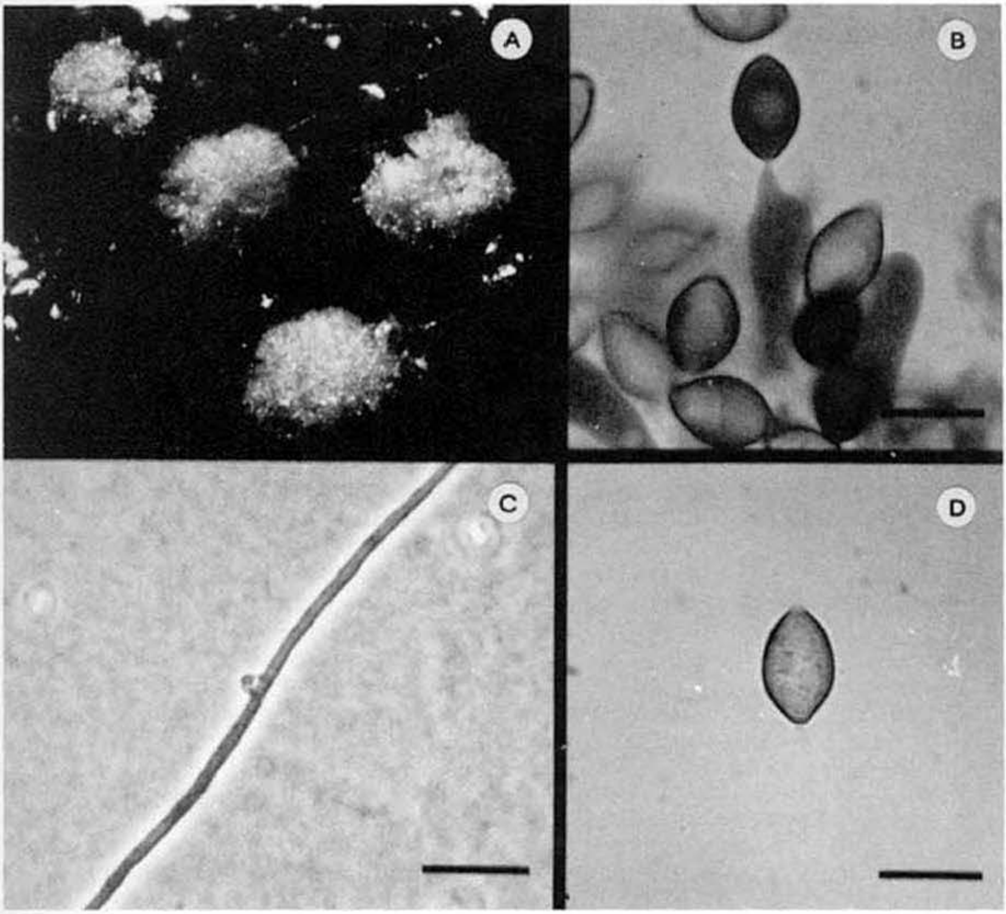
Basidiocarpo hemisphaerico vel dendritico, basidiis in omnibus superficiebus. Sporis brunneis, laevibus, orthotropice affixis, tunica strato cyanophilo.
Typus: Chrysoconia orthospora.

Basidiocarp hemisphaerical to dendritic, with basidia on all surfaces. Spores brown, smooth, orthotropically attached, with a cyanophilous wall layer.
Type: Chrysoconia orthospora.

Chrysoconia orthospora, sp. nov. Figs. A-D.

Basidiocarpo hemisphaerico vel dendritico, 0.1-0.2 mm diametro, basidiis in omnibus superficiebus. Hyphis hyalinis, fibulatis. Basidiis clavatis, bisporis, 24-28 x 7-10 µm; sporis ellipticis, laevibus, in cumulo brunneis ("Mars Yellow"), 11-14 x 7-8 µm, orthotropice affixis, tunica strato cyanophilo, pedicello laevitunicato et poro germinatione apicalibus.
In materia incubata vegetabili putrescenti in liti lacu Union lecta.
Holotypus DEM 242 in herbario Universitatis Washingtonii (WTU) conservatus.
Paratypus DEM 243 (WTU).

Basidiocarp hemisphaerical to dendritic, 0.1-0.2 mm in diameter, with basidia on all surfaces. Hyphae hyaline, with clamp connections. Basidia clavate, bearing 2 spores, 24-28 x 7-10 µm; spores elliptical, smooth, brownish ("Mars Yellow") in mass, 11-14 x 7-8 µm, orthotropically attached, with a cyanophilous wall layer, with a thin-walled pedicel and an apical germ pore.
On incubated decaying vegetable matter collected on the shore of Lake Union, Washington.
Holotype: DEM 242 deposited in the University of Washington Herbarium (WTU).
Paratype: DEM 243 (WTU).



Figures A-D. Chrysoconia orthospora. A. Mature sporocarps. X100. B. Basidium with orthotropically attached spore. Bar = 10 µm. C. Septum bearing clamp connection. Bar = 10 µm. D. Mature spore. Bar = 10 µm.

DISCUSSION

Chrysoconia orthospora is placed in the family Coniophoraceae because of its smooth brown spores, with a cyanophilous wall layer, born on an unpatterned hymenophore. Chrysoconia orthospora differs from all the other members of the Coniophoraceae in two major respects; the hemispherical to dendritic sporocarp composed of hyaline clamped hyphae and the orthotropic attachment of the basidiospores. The type of basidiocarp exhibited by the new fungus is without parallel in the Coniophoraceae, although clamp connections are known to occur in the genus Jaapia. This genus is easily recognized by its long non-septate cystidia and its spores commonly showing contraction of the cytoplasm (Nannfeldt and Eriksson, 1953). Although we accept the family Coniophoraceae in its modern sense (Donk, 1964; Talbot, 1973) we have considered it necessary to expand its limits to include this new gasteroid member. Oberwinkler (1977a, 1977b) has pointed out the occurrence of gasteroid basidia in several groups of Hymenomycetes. We report here for the first time the presence of such basidia in the family Coniophoraceae.

LITERATURE CITED

Donk, M.A. 1964. A conspectus of the families of the Aphyllophorales. Persoonia 3: 199-324.

Nannfeldt, J.A. and J. Eriksson. 1953. On the hymenomycetous genus Jaapia Bres. and its taxonomical position. Sv. Bot. Tidskr. 47: 177-189.

Oberwinkler, F. 1977a. Das neue System der Basidiomyceten, p. 59-105. in H. Clémençon (ed.). Species Concept in Hymenomycetes. Bibliotheca Mycologica 61. J. Cramer, Vaduz.

Oberwinkler, F. 1977b. The morphology of the basidium and its significance for the phylogeny of the Basidiomycetes. IMC 2 Abstracts: 483.

Ridgway, R. 1912. Color Standards and Nomenclature. Publ. by the author, Washington, D.C. 43 pp.

Talbot, P.H.B. 1973. Aphyllophorales I: General Characteristics; Thelephoroid and Cupuloid Families, p. 327-349. in G.C. Ainsworth, F.K. Sparrow and A.S. Sussman (ed.). The Fungi, Vol. IV B. Academic Press, New York.

MYCOTAXON

Vol. IX, No. 1, p. 243 June 12, 1979

THE CONTRIBUTORS AND DANIEL STUNTZ

by David L. Largent

Seventeen individuals contributed to this special FESTSCHRIFT issue dedicated to Daniel E. Stuntz. David Hosford's introductory article on Dan lists those who were or are his graduate students: David Hosford, Gustavo Escobar, Robert Gilbertson, Darryl Grund, David Largent, Joanne Williams Lennox, Susan Libonati-Barnes, Currie Marr, Jim Trappe and Fred VandeBogart. Dennis McCabe and David Gotelli were students of Howard Whisler and became associated with Dan through his infamous laboratory feasts which he always has available for the ravenous graduate students. Dennis Oliver was a student of David Hosford through whom he met Dan. Margaret Barr-Bigelow, Howard Bigelow, Harry Thiers and Alexander Smith have been close colleagues of Dan ever since the many unforgettable field trips at the Michigan Biological Station.

All the contributors were asked to write a short paragraph indicating how they met Dan. Included in these comments were several statements which summarized the feelings of each and every contributor for Dan. The comments which follow "speak" for all who have had the pleasure of Daniel Stuntz' company.

Dan Stuntz is one of the finest persons we know and one of the few people who we use as a model of the perfect academician.

Dan arrived while I was out collecting and amazed my wife by entertaining my daughter with stories from Winnie the Pooh. My daughter considered him a very special person from that day to the present.

He lets students work on their own, counting on their interest in the fungi to carry them through. His confidence in the power of a student's interest is one of the best things about him as a major professor. His teaching is superb; clear, witty (subtly so), and generous. He shares freely any of this extensive knowledge about the fungi. His ability to see the value of amateurs who like fungi is truly exceptional.

As a graduate student being introduced into the mysteries of "higher fungi", I appreciated his humor, his quiet, helpful suggestions when an agaric just would not key, and his firm attitude toward wayward fungi.

As others know well though, time plays no part in a friendship with Dan--after a period of years, when you meet again it is just like yesterday that you parted.

It should be obvious that he is a special person to me.

MYCOTAXON

Vol. IX, No. 1, pp. 244-276 June 12, 1979

LACCASE AND TYROSINASE OXIDATION OF SPOT TEST REAGENTS

CURRIE D. MARR

Department of Biology, State University College
Oneonta, N.Y. 13820

SUMMARY

In a 72 specimen sample, including sporocarp tissue of mostly Agarics, laccase and tyrosinase oxidation was evaluated for 6 spot test reagents commonly used in the taxonomy of Basidiomycetes. Oxidation effectiveness of reagents was determined by associating positive responses with enzyme occurrence. Laccase was detected by a syringaldazine spot test and tyrosinase by a L-tyrosine spot test. Results indicated that pyrogallol, guaiac and guaiacol spot test reagents are nonspecific for laccase and tyrosinase; although, guaiac and guaiacol are more effectively oxidized by laccase than tyrosinase. 1-Naphthol is laccase-specific, but some kinds of laccase activity are not detected by this reagent. Phenol and p-cresol reagents are tyrosinase-specific. For each reagent, laccase and tyrosinase oxidation curves are contrasted, and for most reagents the greatest differentiation between the two oxidases occurs within the first 15 min of the 30 min testing period. Factors discussed which influence substrate specificity are pH, isoenzymes, and potential peroxidase interference. For morphogenetic, ecological and taxonomic studies, spot tests are potentially valuable tools for studying enzyme localization among taxa and ontologically changing patterns within taxa.

INTRODUCTION

Since the discovery that tincture of guaiac turns blue when applied to some fungi and that this reaction usually denotes the presence of phenoloxidases, numerous other phenols have been used to determine the existence of the phenoloxidases, laccase and tyrosinase. Hundreds of mycelial cultures (Käärik 1965) and basidiocarps have been surveyed for these enzymes (Matsubara and Iwasaki 1972, Lamaison 1976), and results of phenoloxidative tests have been particularly useful in classifying "brown and white-rot" fungi (Davidson et al. 1938, Nobles 1971). Phenolic spot test reagents used in the taxonomy of agarics are generally prepared in the manner described by Singer (1975) and Watling (1971). Although the method of reagent preparation, particularly the factor of pH, is known to influence substrate specificity, oxidation of these reagents by phenoloxidases has not been critically evaluated. The purpose of this study is to compare the oxidation effectiveness of laccase and tyrosinase for 6 spot test reagents in common use: p-cresol, guaiac, guaiacol, 1-naphthol, phenol, and pyrogallol.

Oxidation effectiveness was determined by correlating the results of phenoloxidase identifier tests, which used syringaldazine and L-tyrosine as substrates, with the other 6 spot tests. Syringaldazine was introduced by Harkin et al. (1973, 1974) as an ideal substrate for laccase because it does not react with tyrosinase, nor does it autooxidize or produce peroxides. L-tyrosine is generally considered (Yasanobu 1959, Decker 1977) to be the most specific substrate of tyrosinase and is used in the standard assay for this enzyme. Tyrosine measures most, if not all active tyrosinase, but is neither oxidized by laccase nor peroxidase to melanins (Sarkanen 1971, Smith and Swan 1976). A basic assumption of this study is that the syringaldazine and tyrosine tests are specific identifiers for laccase or tyrosinase, and that these identifier tests can be used to detect and differentiate laccase and tyrosinase oxidation occurring in the other 6 spot tests, the correlator tests. Positive, negative, and no associations of correlator and identifier tests were determined by Chi Square.

METHODS

The preparation and characteristics of the reagents used, and the color of positive tests are given in Table I. The tyrosine spot test method utilized in this study is new. A major obstacle to using tyrosine as a spot test reagent has been its insolubility in alcohol and in water at room temperature. This problem was resolved in this study by heating the solution to 95°C and applying it at 90°C to the sample in a cold depression plate. The apparent effect of this procedure was to obtain maximum solubility of tyrosine and to destroy cellular membranes, thereby, releasing intracellular tyrosinase. The reagent cooled rapidly enough that appreciable enzyme deactivation did not occur, and a strong red-brown color developed when tyrosinase was present. In specimens devoid of laccase, peroxidase occurrence was identified by the method of Harkin et al. (1974), using syringaldazine and 0.03% hydrogen peroxide. There are many gaps in the biochemical details of the enzymatic reactions involved in spot tests, but some reaction products are known or hypothesized. Reaction products, located in the literature, are presented in Table II.

Tissue samples from the basidiocarps of all 72 specimens studied gave positive reactions with one or more of the phenolic spot tests. Specimens were collected during the summer of 1977, most of them were obtained from the 360 acre SUNY Biological Field Station at Cooperstown, N.Y. The sample was taxonomically heterogeneous represented by 60 species belonging to 38 genera and 18 families of Basidiomycetes (see results).

Small slices of tissue, about 5-10 mm dia and 2 mm thick, were removed from reactive areas of the basidiocarp, frequently from the apex of the stipe and context of the pileal disc. The slices were placed in the cavities of distilled-water rinsed, porcelain, depression plates. Two depression plates were used for a single test series, each containing 10 slices of tissue. Systematically, the eight reagents listed in Table I were added to the tissues, each tissue submerged in several drops of one reagent. Two pieces of tissue were used as controls, one being covered by distilled water and the other by 95% ethanol. A similar procedure was followed in the second depression plate, but with the addition to all 10 slices of several drops of freshly prepared, aqueous 0.03% H_2O_2 solution. Positive color reactions were recorded immediately following application of all reagents, 0 min, and subsequently at 5, 15, and 30 minutes later.

The significance of association between correlator and identifier tests was determined by Chi Square according to the formulas given by Zar (1974). The symbols

TABLE I. SPOT TEST REAGENTS: PREPARATION, CHARACTERISTICS, POSITIVE TESTS

Preparation of Reagent	REAGENT COLOR New Solution*	Old Solution**	pH OF REAGENT New Solution*	Old Solution**	Color of Positive Test
p-Cresol 1 ml of p-Cresol in distilled water, final volume 100 ml. Heat to dissolve solute.	Colorless	Colorless	pH 6.2	pH 6.6	red-brown, orange-brown, rust-red
Guaiac 2 g of Gum Guaiac powder in 95% ethanol, final vol. 100 ml. After several hrs filter solution.	Yellow-brown	Dark reddish-brown	pH 6.0	pH 5.5	deep blue
Guaiacol 2 ml of Guaiacol in distilled water, final vol. 100 ml. Shake, use aqueous phase.	Colorless	Pale red-brown	pH 5.9	pH 3.9	pink, red, red-brown
1-Naphthol 2.5 g of 1-Naphthol dissolved in 50 ml of 95% ethanol. Slowly add distilled water to 100 ml mark. Filter out precipitate.	Reddish cocoa-brown, cloudy	Same color but darker	pH 5.2	pH 4.5	violet to dark purple
Phenol 2 g of Phenol in distilled water, final vol. 100 ml.	Colorless	Colorless	pH 5.8	pH 6.6	red or violet changing to red-brown or violet-brown
Pyrogallol 10 g of Pyrogallol in distilled water, final vol. 100 ml.	Pale straw-yellow	Brownish-orange	pH 4.1	pH 3.2	orange-yellow, carrot-red to orange-brown
L-Tyrosine 0.5 g of L-Tyrosine in distilled water, final vol. 100 ml. Heat solution to 95°C to dissolve solute. Apply reagent at 90°C.	Colorless at 90°C, white precipitate at room temp.	Not determined	pH 6.2 at 90°C pH 7.0 at 28°C	Not determined	rust-red changing to red-brown and darker brown with time
Syringaldazine 0.1 g of Syringaldazine (Aldrich Co.) in 95% ethanol, final vol. 100 ml. Heat gently to dissolve solute. Cold temp. causes precipitation.	Pale greenish-yellow	Pale yellow	pH 7.1	pH 6.9	pink, red, violet-red, sometimes reaction decolorizes

*New Solution - color and pH determined 24 hrs after preparation.
**Old Solution - color and pH determined from a 7 month-old solution stored at 28 C.

TABLE II. SUBSTRATES AND REACTION PRODUCTS

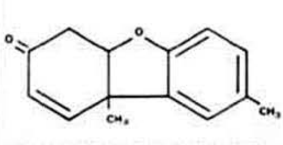
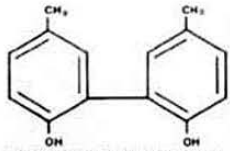
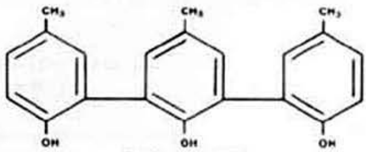
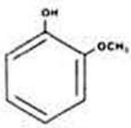
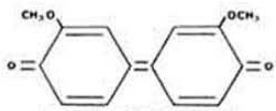
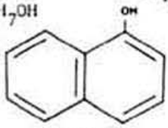
SUBSTRATES Common Name Scientific Name Type of Phenol Formulas and Molecular Weight	REACTION PRODUCTS * products of laccase oxidation ** products of peroxidation (Sarkanen 1971, Higuchi 1958 regard products similar or identical to laccase oxidation) *** products of tyrosinase oxidation
p-Cresol 4-hydroxy Toluene Monohydric phenol, -OH group 4 position $CH_3C_6H_4OH$  p-Cresol Mol. Wt. 108.14	 Pummerer's Ketone tetrahydrodibenzofurane  2,2'-dihydroxy-5,5'-dimethylbiphenyl  terphenyl derivative (*) (**) Laccase and peroxidase oxidize p-cresol to the above products, forming a white precipitate (Westerfeld and Lowe 1942, Fåhraeus and Ljunggren 1961, Benfield et al. 1964) (***) Tyrosinase oxidizes p-cresol to a dark-colored quinonoid compound (Fåhraeus and Ljunggren 1961, Küster and Little 1963)
Guaiacol 2-methoxy-phenol Monohydric phenol, -OH group 1 position $2\text{-}CH_3OC_6H_4\text{-}1\text{-}OH$  Guaiacol Mol. Wt. 124.14	 3,3'-dimethoxydipheno-4,4'-quinone (**) The above compound is a red-brown pigment, the principal product of peroxidation of guaiacol. A minor constituent of peroxidation is 3,3'-dimethoxydipheno-2,2'- quinone (Saunders 1973) (**) Formerly, the peroxidation product of guaiacol was regarded as tetraguaiacol or tetraguaiacoquinone (Maehly and Chance 1954, Demirevska-Kepova and Bakardjieva 1976)
1-Naphthol 1-hydroxy naphthalene Monohydric phenol, - OH group 1 position $C_{10}H_7OH$  1 Naphthol Mol. Wt. 144.17	Specific reaction products have not been located in the literature.

TABLE II. Continued

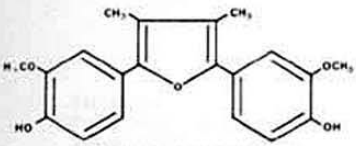
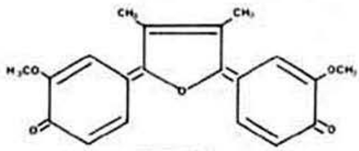
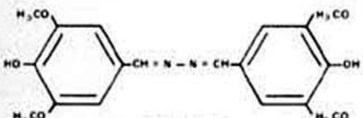
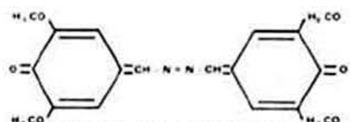
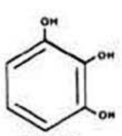
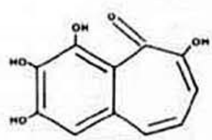
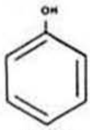
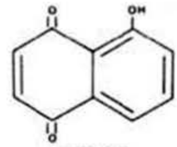
Guaiac (Guaiaconic Acid) 2,5-di-(4-hydroxy-3-methoxy-phenyl)-3,4-dimethylfuran (active compound of gum guaiac) -also known as furoguaiacin Dihydric phenol, -OH groups 4 position  1 Guaiaconic Acid, or Furoguaiacin Mol. Wt. 340.36	 Guaiacum Blue bis methylenequinone (*) (**) (***) All three enzymes oxidize furoguaiacin to guaiacum blue (Kratochvil et al. 1971)
Syringaldazine N,N'-bis-3,5-dimethoxy-4-hydroxybenzylidene hydrazine Dihydric phenol, -OH groups 4 position  Syringaldazine Mol. Wt. 360.36	 Tetramethoxy azo bis methylenequinone (*) (**) Laccase and peroxidase oxidize syringaldazine to a magenta-red pigment (Harkin and Obst 1973).
Pyrogallol 1,2,3-trihydroxybenzene Trihydric phenol, -OH groups in positions, 1,2,3 C_6H_3-1,2,3-$(OH)_3$  Pyrogallol Mol. Wt. 126.11	 Purpurogallin (*) (**) Peroxidase and laccase oxidation of pyrogallol results in a complex mixture of products, the principal product being an orange pigment, purpurogallin (Maehly and Chance 1954, Benfield et al. 1964). (***) Tyrosinase oxidation of pyrogallol presumably yields purpurogallin, but the reaction products may not have been analyzed.

TABLE II. Continued

<table>
<tr>
<td>Phenol

Phenol

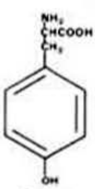
Monohydric phenol, -OH group
1 position
C_6H_5OH


Phenol</td>
<td>
Phenoquinone

Specific reaction products of enzymatic oxidation of phenol have not been located in the literature. Noller (1957) notes that a complex mixture of products are formed in aerobic oxidation of phenol, the best known product being the bright red compound, phenoquinone.</td>
</tr>
<tr>
<td>L-Tyrosine

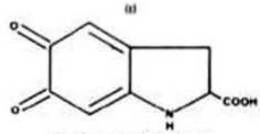
L-Tyrosine

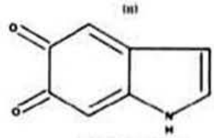
Monohydric phenol, -OH group
4 position
$4\text{-}HOC_6H_4CH_2(NH_2)COOH$

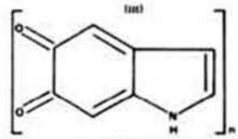

Tyrosine

Mol. Wt. 181.19</td>
<td>(*) Laccase can not oxidize L-Tyrosine (Sarkanen 1971)

(**) Peroxidase oxidizes L-Tyrosine to dityrosine [5,5'-bis(2-amino-2-carboxyethyl)-2,2'dihydroxybiphenyl] (Smith and Swan 1976)

(I)

Dopachrome, or Hallachrome

(II)

Indole 5,6-quinone

(III)

Tyrosine melanin

(***) Tyrosinase oxidizes L-Tyrosine to dopa (3,4-dihydroxyphenylalanine). This is not accomplished by laccase or peroxidase, but all three enzymes can oxidize dopa to dopa quinone (Sarkanen 1971, Smith and Swan 1976). The tyrosine-tyrosinase melanin biopathway involves intermediate pigments such as the red dopachrome (I), purple or yellow Indole 5,6 quinone (II), as well as the brown-colored melanin (III) (Lerner and Fitzpatrick 1950, Hidaka 1976).</td>
</tr>
</table>

f_1 and f_2 represent the frequencies of positive and negative tests, and n the total sample size. When sample size was 20 or less, Chi Square was corrected for continuity, X_c^2 (Guilford 1965). Statistically significant associations, $X^2 \geq 3.841$ ($P \leq 0.05$), are indicated in Tables III to VII by + or - signs, depending on the direction of association.

$$X^2 = \frac{(f_1 - f_2)^2}{n} \qquad X_c^2 = \frac{(|f_1 - f_2| - 1)^2}{n}$$

RESULTS

This study is predicated on the assumption that the parameters measured by the identifier tests are the same as those measured by the correlator tests. If this is true, positive correlator tests should accompany reactions in one or both of the identifier tests. This relationship does exist (Table III). The mean value of association varies from 74% at 0 min to 90% at 30 min, and statistically, the association is strongly positive at 5, 15, and 30 min readings. While this positive correlation does not prove that oxidation by laccase or tyrosinase causes the positive correlator tests, it adds to the support of this hypothesis.

The 72 specimen sample is divided into 4 groups on the basis of identifier test results.

A. Group I consists exclusively of specimens containing both laccase and tyrosinase as indicated by positive syringaldazine and tyrosine tests. Typically, members of this group react rapidly, and all correlator tests are significantly positive at the 5, 15, and 30 min readings (Table IV). Specimens assigned to Group I are listed below by name, collection number and family.

NAME	NUMBER	FAMILY
Agaricus campestris L. ex Fr.	2784	Agaricaceae
Grifola frondosa (Dickson ex Fr.) S. F. Gray	2876	Polyporaceae

Lactarius chrysorheus Fr.	2798	Russulaceae
L. deceptivus Pk.	2875	"
L. gerardii Pk.	2749	"
L. vellereus (Fr.) Fr.	2781	"
L. sp.	2800	"
Russula alutacea (Pers. ex Fr.) Fr.	2747	"
R. emetica (Schaeff. ex Fr.) S. F. Gray	2868	"
R. fragilis (Pers. ex Fr.) Fr.	2853	"
R. nigricans (Bull.) Fr.	2828	"
R. pectinatoides Pk.	2748	"
R. rugulosa Pk.	2746	"
R. variata Banning	2697	"
R. variata Banning	2745	"

B. Group II consists exclusively of "laccase-only" specimens as determined by positive syringaldazine and negative tyrosine tests. Significant correlator tests of this group are positive guaiac and guaiacol and negative p-cresol and phenol tests (Table V). Specimens included in Group II are:

NAME	NUMBER	FAMILY
Agaricus campestris L. ex Fr.	2791	Agaricaceae
Cantharellus lateritius (Berk.) Sing.	2823	Cantharellaceae
Entoloma sp.	2866	Entolomataceae
Ramaria flavobrunnescens var. *aromatica* Marr	2855	Gomphaceae
Hericium ramosum (Bull. ex Mérat) Letellier	2741	Hydnaceae
Hygrophorus pratensis (Fr.) Fr.	2854	Hygrophoraceae
Hypomyces lactifluorum (Schw. ex Fr.) Tul. (plus unidentified host)	712	Hypocreaceae
Coriolus biformis (Fr. apud Klotzsch) Pat.	2836	Polyporaceae
C. versicolor (L. ex Fr.) Quél.	2730	"
C. versicolor	2782	"
C. versicolor	2787	"

Hirschioporus pargamenus (Fr.) Bond. & Sing.	2860	Polyporaceae
Hypsizygus marmoreus (Pk.) Bigelow	2879	Tricholomataceae
Panellus serotinus (Fr.) Kühner	2878	"
P. stipticus (Bull. ex Fr.) Karst.	2856	"
Pleurotus ostreatus (Jacq. ex Fr.) Kummer	2738	"
P. ostreatus	2701	"
Tricholoma resplendens (Fr.) Karst.	2825	"
T. sejunctum (Sow. ex Fr.) Quél.	2846	"

C. Group III consists exclusively of "tyrosinase-only" specimens as determined by negative syringaldazine and positive tyrosine tests. Significant correlator tests associated with Group III are positive p-cresol and phenol tests, and a negative 1-naphthol test; while, associations of slight statistical significance occur with guaiacol at 5 min and pyrogallol at 30 min (Table VI). Specimens included in Group III are:

NAME	NUMBER	FAMILY
Agaricus campestris L. ex Fr.	2784	Agaricaceae
Amanita rubescens (Pers. ex Fr.) S. F. Gray	2799	Amanitaceae
A. vaginata (Fr.) Vitt.	2667	"
A. sp.	2883	"
Cantharellus tubaeformis Fr.	2874	Cantharellaceae
Clavulinopsis fusiformis (Sow. ex Fr.) Corner	2726	Clavariaceae
Clavulina cristata (Fr.) Schroet.	2844	Clavulinaceae
Merulius tremellosus Schrad. ex Fr.	2831	Corticiaceae
Hygrophorus borealis Pk.	2880	Hygrophoraceae
Calvatia sp.	350	Lycoperdaceae
Gloeoporus dichrous (Fr.) Bres.	2728	Polyporaceae
Ischnoderma resinosum (Fr.) Karst.	2881	"

Laetiporus sulphureus (Bull. ex Fr.) Bond. & Sing.	2777	Polyporaceae
Tyromyces caesius (Schrad. ex Fr.) Murr.	2848	"
T. fragilis (Fr.) Donk	2872	"
Hypholoma capnoides (Fr.) Kummer	2826	Strophariaceae
Pholiota lenta (Fr.) Sing.	2849	"
P. squarrosoides (Pk.) Sacc.	2842	"
Stropharia ambigua (Pk.) Zeller	2832	"
Clitocybe clavipes (Fr.) Kummer	2824	Tricholomataceae
C. sp. (in Section Umbilicatae)	2885	"
Collybia dryophila (Bull. ex Fr.) Kummer	2750	"
C. subnuda (Ellis ex Pk.) Gilliam	2779	"
Laccaria ochropurpurea (Berk.) Pk.	2795	"
Marasmius oreades (Bolt. ex Fr.) Fr.	2739	"
Mycena serotina (Pk.) Smith	2847	"
Oudemansiella radicata (Relhan ex Fr.) Sing.	2725	"

D. Group IV consists exclusively of specimens giving negative identifier tests, but nevertheless, exhibiting one or more positive correlator tests. Throughout the 30 min test period "no association" characterizes the reactions occurring. Specimens included in Group IV are:

NAME	NUMBER	FAMILY
Agaricus campestris L. ex Fr.	2744	Agaricaceae
Cantharellus lateritius (Berk.) Sing.	2734	Cantharellaceae
Coprinus micaceus (Bull. ex Fr.) Fr.	2865	Coprinaceae
Ramaria botrytis (Fr.) Ricken	2873	Gomphaceae
Hericium ramosum (Bull. ex Mérat) Letellier	402	Hydnaceae
H. ramosum	2801	"
Perenniporia subacida (Pk.) Donk	2736	Polyporaceae

Pseudohydnum gelatinosum (Scop. ex Fr.) Karst.	2857	Tremellaceae
Flammulina velutipes (Fr.) Karst.	2859	Tricholomataceae
Oudemansiella radicata (Relhan ex Fr.) Sing.	2803	"
Panellus stipticus (Bull. ex Fr.) Karst.	2733	"

Species of Group IV may be of particular value in exploring the potential for peroxidase interference in phenoloxidase tests. Some of the reactions occurring in this group may represent low phenoloxidase activity not detected by the identifiers; however, there is the possibility that some of the reactions represent peroxidase activity. Of the 11 specimens included in Group IV, 7 specimens gave positive syringaldazine reactions upon the addition of 0.03% hydrogen peroxide (Table VIII). These results are generally interpreted as peroxidase activity (Harkin et al. 1974), but they may merely represent laccase activity enhanced by peroxide (Blaich and Esser 1975). Because of the small number of questionable reactions represented by Group IV, 15% of the 72 specimen sample, whether or not these possibly spurious reactions are taken into account does not qualitatively alter the conclusions of this study. Nevertheless, laccase and tyrosinase oxidation levels indicated in Figures I to VI may be slightly overstated, especially for guaiac and 1-naphthol.

Frequency levels of tyrosinase and laccase oxidation are contrasted graphically in Figures I to VI for each of the correlator spot test reagents. The capacity of a spot test reagent to selectively identify one of the phenoloxidases is directly related to the separation of the two oxidation curves, the area indicated by vertical lines. In this study the pyrogallol reagent possessed the least and the p-cresol reagent the most differential capacity. In general, the greatest differentiation between laccase and tyrosinase occurs within the first 15 min of the testing period. While it is tempting to observe tested material for 30 min or longer in order to detect slow reactions, the present data indicate that this may not be justified. Furthermore, it is possible that peroxidase interference steadily increases with time (Table VIII).

As fully substantiated by literature reports (Table IX), pyrogallol and guaiac are nonspecific reagents. Of these two, pyrogallol is the least differentiating, both oxidation curves being very close throughout the 30 min test period. The guaiac reagent is more effectively oxidized by laccase than by tyrosinase, and an immediate positive test probably signifies laccase activity. However, differentiation between the two enzymes is poor during the last 15 min of the test period. A serious drawback in using either of these reagents to detect total phenoloxidase activity is that 33% of the total tyrosinase activity goes undetected by guaiac, and 37% of the laccase and 22% of the tyrosinase activity goes undetected by pyrogallol.

Guaiacol and 1-naphthol substrates are commonly regarded as laccase specific (Table IX), but this categorization of guaiacol is questionable. While an immediate guaiacol reaction probably indicates laccase activity, tyrosinase appears to oxidize this substrate sufficiently to reduce drastically the value of this reagent, as formulated, to detect laccase. Guaiacol has been used by many investigators as a diagnostic substrate for laccase (Boidin 1951, Lyr 1958, Käärik 1965, Capellano and Demoulin 1969, Holubová-Jechová 1971, Ander and Eriksson 1976). Nevertheless, Higuchi (1958) showed that potato tyrosinase slightly oxidizes guaiacol, and Rösch (cf. Käärik 1965) indicated that guaiacol is oxidized by laccase at low pH values and by tyrosinase as well at higher pH values (pH 6.8-7.2). A freshly prepared guaiacol reagent, pH 5.9, is intermediate in value. The 1-naphthol test is significantly negative with "tyrosinase-only" species, a finding substantiated by other investigations (Yasanobu 1959). Higuchi and Kitamura (1953) were among the first to recognize the potential for using 1-naphthol to distinguish laccase from tyrosinase, and others have subsequently used this substrate diagnostically (Lyr 1958, Käärik 1965, Ander and Eriksson 1976). However, 1-naphthol is not an ideal detector of total laccase because of the frequency with which laccase activity goes undetected (Fig. IV). The peculiar shape of the laccase oxidation curve for 1-naphthol may indicate a combination of two reactions which are chronologically out of phase, the first reaction achieving peak activity during the lag phase of the second oxidation, or peroxidation, reaction. Because of the strong association ($P < 0.01$) of a negative 1-naphthol test in the "tyrosinase-only" group, a positive 1-naphthol test can generally be interpreted as indicating active laccase.

Both p-cresol and phenol are tyrosinase-specific substrates. Particularly p-cresol is an excellent substrate, detecting a maximum of tyrosinase activity and a minimum of laccase activity. This study supports the extensive diagnostic use made of p-cresol (Boidin 1951, Lyr 1958, Käärik 1965, Capellano and Demoulin 1969, Holubová-Jechová 1971, Ander and Eriksson 1976). Phenol has not been so widely used as a tyrosinase substrate, and while it is not recommended over p-cresol and tyrosine, a phenol reaction occurring within 15 min and possibly up to 30 min can be interpreted as evidence of tyrosinase activity.

Using Warburg manometry, Matsubara and Iwasaki (1972) obtained quantitative measures of laccase and tyrosinase activity for selected agarics. Their results are consistent with the qualitative determination of these enzymes by the identifier spot tests, syringaldazine and tyrosine. They found species of *Agaricus*, *Lactarius* and *Russula* to possess strong laccase and tyrosinase activity. Tyrosinase predominated in species of *Amanita*, *Collybia*, *Hygrophorus*, *Laccaria*, *Marasmius* and *Pholiota*, while, species of *Coprinus* exhibited very slight laccase activity. It is now clear that some of the larger families, such as the Tricholomataceae and Polyporaceae, include several phenoloxidase combinations such as those represented by Groups I, II, III, and IV. Extensive surveys of laccase and tyrosinase in these families are likely to prove valuable in resolving problems of taxonomy and evolution.

DISCUSSION

A large number of aromatic amines, phenols, and other compounds are known to be oxidized by laccase and tyrosinase (Hoffmann and Esser 1977, Yasanobu 1959). Differences in substrate specificity of these two enzymes have been vigorously sought, and until recently it was thought that tyrosinase, but not laccase, oxidized monophenols (Küster and Little 1963, Christman and Oglesby

1971). This generalization is certainly with exceptions. 1-Naphthol is a monophenol oxidized by laccase and not appreciably by tyrosinase, and the literature is replete with references to laccase oxidation of p-cresol to white compounds (Benfield et al. 1964, Blaich and Esser 1975, Dubernet et al. 1977). There appears to be no simple explanation to account for the observed substrate specificity of these enzymes. Yasanobu (1959) points out that a combination of different forces may be operating between enzyme and substrate, and other investigators have noted that laccase and tyrosinase exist in multiple forms, each form (isoenzyme) exhibiting a characteristic substrate-specific pattern. Blaich and Esser (1975) have studied two isoenzyme-complexes of laccase, and other researchers have described several molecular forms (Schánĕl and Esser 1971, Hoffmann and Esser 1977). Similarly, tyrosinase exists in multiple forms (Nelson and Mason 1970). The inability of some reagents to detect 100% frequency of enzyme occurrence (e.g. laccase detection by 1-naphthol), may be due to some isoenzymes, but not others, oxidizing the substrate.

Although the influence of pH on substrate specificity has been recognized in the past (e.g. Boidin 1951), only recently has the full importance of this factor been revealed. Tyrosinase activity has an approximate pH range of 3.5 to 7.1 (Käärik 1965), and a pH optimum of 6 to 7 (Nelson and Mason 1970, Gutteridge and Robb 1975, Decker 1977). The pH range for laccase activity is broader, 2-3 to 7-9.5 (Käärik 1965, Hoffmann and Esser 1977, Dubernet et al. 1977), but the pH optimum depends on the isoenzyme and substrate involved. For example, pyrogallol is oxidized by both laccase I and II at pH 5.0, but by only laccase I at pH 7.5; whereas gentisic acid is oxidized by both laccase I and II at pH 7.5 but only by laccase II at pH 5 (Schánĕl and Esser 1971). Thus, it is probable that a major source of variation in spot test results may be due to the lack of pH standardization. Furthermore, the specificity of reagents may be improved by pH control. Rösch (cf. Käärik 1965) suggested that guaiacol was laccase specific at low, but not at high pH values.

The extent to which positive spot tests are due to peroxidase mediated reactions is unclear. Laccase and peroxidase oxidize similar phenolic substrates, but presumably differ in their cosubstrate specificity, oxygen and peroxide respectively (Higuchi 1958, Sarkanen 1971). It is generally assumed that unless hydrogen peroxide is added to a specimen being tested that a positive reaction denotes the presence of phenoloxidases. This assumption was challenged when tincture of guaiac was found to produce peroxides (Maehly and Chance 1954, Harkin & Obst 1973), and that appreciable amounts of hydrogen peroxide were produced by wood-rotting fungi (Koenigs 1972). Also, Young (1973) discovered that minute quantities of hydrogen peroxide produced quinone reaction products in excess to what was predicted from the amount of peroxide present. In order to minimize peroxide contamination in this study reagents were freshly prepared approximately every two weeks, put in brown dropper bottles, and stored in the refrigerator. Peroxidase interference appears to be completely absent from the tyrosine test for tyrosinase. None of the 44 specimens giving a negative tyrosine test in air turned positive following application of 0.03% hydrogen peroxide, and Smith and Swan (1976) have indicated that peroxidase does not oxidize tyrosine to dopa except in the presence of dihydroxyfumaric acid and oxygen. Peroxidase interference of the syringaldazine-laccase test is less certain because this substrate is oxidized by both enzymes. According to Harkin et al. (1974) the levels of hydrogen peroxide produced by fungal hyphae, even in the high peroxide-producers identified by Koenigs, do not appreciably interfere with the syringaldazine-laccase test. Some of the reactions of the correlator spot tests may be peroxidase mediated and additional study of this problem is needed. The distinction between phenoloxidases and peroxidase is complicated even further by the discovery of "pseudoperoxidases". The activity of some laccase and tyrosinase isoenzymes is dependent on or enhanced by the presence of hydrogen peroxide (Stafford 1974, Blaich and Esser 1975, Gutteridge and Robb 1975, Decker 1977).

Spot tests have been a valuable investigative tool and with further research toward refinement their value should increase. The simplicity and rapidity of the tests make it feasible to conduct extensive surveys upon which taxonomic conclusions can be based. While this use of spot tests has occurred since the turn of the century, a great deal of reevaluation will be necessary with improved tests. Ecological studies of microbial decomposition of wood and humus have been accomplished with phenolic substrates (Schubert 1965, Hintikka 1970), and a new use for these tests is their application in morphogenetic studies. Localization of laccase and tyrosinase varies among species and during ontogeny within some species (Harkin et al. 1974, Turner 1974). These variations are undoubtedly of morphogenetic importance associated with several processes, e.g. pigmentation (Wickerham and Kurtzman 1975), fruiting (Turner 1974), and other processes. For the taxonomist and morphologist the ideal spot test repertoire would include general tests (e.g. measuring total active phenoloxidases), enzyme specific tests (e.g. measuring total active laccase), and isoenzyme specific tests. It would be essential for a good test to detect nearly 100% frequency of the enzyme and for spurious reactions not to occur. Presently, syringaldazine may be the best test reagent for detecting total active laccase, and L-tyrosine or p-cresol the better reagents for detecting total active tyrosinase; while, other enzyme specific reagents of limited value are 1-naphthol and phenol. Further study of substrate specificity, including the search for new specific substrates and the means for controlling specificity through pH, timing of tests, etc., should greatly increase the usefulness of spot tests.

ACKNOWLEDGEMENTS

To the following people I am most grateful for their generous commitment of time and professional skills toward the fulfillment of this research: Drs. Orson K. Miller, Jr., and Roy Watling for review of the manuscript, Dr. Madho Singh for advice on statistical methods, Ms. Belle Ang for writing a program to compute Chi Square, personnel of the Graphic Arts Department (SUCO) for producing the graphs and chemical formulas, and Mrs. Hilda S. Mercun for typing the final copy. The SUCO Biology Department provided facilities at the Field Station in Cooperstown, N.Y. where this study was conducted.

Special thanks is due to Dr. Daniel E. Stuntz who introduced his students to the application of spot tests in agarics, and who has since continued to provide intellectual and moral support for investigating the potential of these tests.

TABLE III. ASSOCIATION OF CORRELATOR REACTIONS WITH LACCASE, TYROSINASE IDENTIFIERS FOR THE TOTAL SAMPLE AT 0, 5, 15 AND 30 MIN

Time Reaction Recorded	Interpretation of Numbers	CORRELATOR TESTS Py	G	Gl	N	p-C	P	Mean of Tests
0 min	Sample Size	13	24	19	10	7	7	13.33
	Reactions Assoc. with Identifiers	9	17	13	7	7	6	9.83
	Reactions Not Assoc. with Identifiers	4	7	6	3	0	1	3.50
	% of Association	69%	71%	68%	70%	100%	86%	74%
	X_c^2	1.23	4.17	1.89	0.90	5.14	2.29	2.13
	Correlation	0	+*	0	0	+*	0	0
5 min	Sample Size	38	42	30	25	33	37	34.17
	Reactions Assoc. with Identifiers	29	34	25	21	28	32	28.17
	Reactions Not Assoc. with Identifiers	9	8	5	4	5	5	6.00
	% of Association	76%	81%	83%	84%	85%	86%	82%
	X^2	10.53	16.09	13.33	11.56	16.03	19.70	14.38
	Correlation	+**	+**	+**	+**	+**	+**	+**
15 min	Sample Size	44	48	38	27	43	42	40.33
	Reactions Assoc. with Identifiers	36	39	33	22	35	38	33.83
	Reactions Not Assoc. with Identifiers	8	9	5	5	8	4	6.50
	% of Association	82%	81%	87%	81%	81%	90%	84%
	X^2	17.82	18.75	20.63	10.70	16.95	27.52	18.52
	Correlation	+**	+**	+**	+**	+**	+**	+**
30 min	Sample Size	50	58	45	34	48	48	47.17
	Reactions Assoc. with Identifiers	47	50	42	30	42	45	42.62
	Reactions Not Assoc. with Identifiers	3	8	3	4	6	3	4.50
	% of Association	94%	86%	93%	88%	88%	94%	90%
	X^2	38.72	30.41	33.80	19.88	27.00	36.75	30.81
	Correlation	+**	+**	+**	+**	+**	+**	+**

Abbreviations: syringaldazine (Sy), L-tyrosine (Ty), pyrogallol (Py), guaiac (G), guaiacol (Gl), 1-naphthol (N), p-cresol (p-C), phenol (P).
* = $0.05 > P > 0.01$, ** = $P \leq 0.01$

TABLE IV. CORRELATION OF SPOT TEST RESPONSES WITH FUNGI POSSESSING LACCASE AND TYROSINASE, GROUP I

Time Reaction Recorded	Sample Size	Interpretation of Numbers	ENZYME IDENTIFIERS Laccase Sy	Tyrosinase Ty	SPOT TEST CORRELATORS Py	G	Gl	N	p-C	P
0 min	5	Reactions	5	5	4	5	5	3	3	3
		% of Sample	100%	100%	80%	100%	100%	60%	60%	60%
		χ_c^2			0.80	3.20	3.20	0.00	0.00	0.00
		Correlation			0	0	0	0	0	0
5 min	12	Reactions	12	12	11	12	12	11	11	12
		% of Sample	100%	100%	92%	100%	100%	92%	92%	100%
		χ_c^2			6.75	10.08	10.08	6.75	6.75	10.08
		Correlation			+**	+**	+**	+**	+**	+**
15 min	12	Reactions	12	12	11	12	12	11	12	12
		% of Sample	100%	100%	92%	100%	100%	92%	100%	100%
		χ_c^2			6.75	10.08	10.08	6.75	10.08	10.08
		Correlation			+**	+**	+**	+**	+**	+**
30 min	15	Reactions	15	15	14	14	15	13	15	15
		% of Sample	100%	100%	93%	93%	100%	87%	100%	100%
		χ_c^2			9.60	9.60	13.07	6.67	13.07	13.07
		Correlation			+**	+**	+**	+**	+**	+**

* = $0.05 > P > 0.01$

** = $P \leq 0.01$

TABLE V. CORRELATION OF SPOT TEST RESPONSES WITH FUNGI POSSESSING ONLY LACCASE, GROUP II

Time Reaction Recorded	Sample Size	Interpretation of Numbers	ENZYME IDENTIFIERS Laccase Sy	Tyrosinase Ty	SPOT TEST CORRELATORS Py	G	Gl	N	p-C	P
0 min	12	Reactions	12	0	3	11	8	4	0	0
		% of Sample	100%	0%	25%	92%	67%	33%	0%	0%
		X_c^2			2.08	6.75	0.75	0.75	10.08	10.08
		Correlation			0	+**	0	0	-**	-**
5 min	13	Reactions	13	0	7	13	9	8	0	2
		% of Sample	100%	0%	54%	100%	69%	62%	0%	15%
		X_c^2			0.00	11.08	1.23	0.31	11.08	4.92
		Correlation			0	+**	0	0	-**	-*
15 min	15	Reactions	15	0	9	15	13	8	0	3
		% of Sample	100%	0%	60%	100%	87%	53%	0%	20%
		X_c^2			0.27	13.07	6.67	0.00	13.07	4.27
		Correlation			0	+**	+**	0	-**	-*
30 min	19	Reactions	19	0	12	18	16	12	2	5
		% of Sample	100%	0%	63%	95%	84%	63%	11%	26%
		X_c^2			0.84	13.47	7.58	0.84	10.32	3.37
		Correlation			0	+**	+**	0	-**	0

* = 0.05>P>0.01

** = P $\leq$ 0.01

TABLE VI. CORRELATION OF SPOT TEST RESPONSES WITH FUNGI POSSESSING ONLY TYROSINASE, GROUP III

Time Reac-tion Record-ed	Sam-ple Size	Interpretation of Numbers	ENZYME IDENTIFIERS Laccase Sy	Tyrosinase Ty	SPOT TEST CORRELATORS Py	G	Gl	N	p-C	P
0 min	5	Reactions	0	5	2	1	0	0	4	3
		% of Sample	0%	100%	40%	20%	0%	0%	80%	60%
		χ^2_c			0.00	0.80	3.20	3.20	0.80	0.00
		Correlation			0	0	0	0	0	0
5 min	20	Reactions	0	20	11	9	4	2	17	18
		% of Sample	0%	100%	55%	45%	20%	10%	85%	90%
		χ^2_c			0.05	0.05	6.05	11.25	8.45	11.25
		Correlation			0	0	-*	-**	+**	+**
15 min	24	Reactions	0	24	16	12	8	3	23	23
		% of Sample	0%	100%	67%	50%	33%	13%	96%	96%
		χ^2			2.67	0.00	2.67	13.50	20.17	20.17
		Correlation			0	0	0	-**	+**	+**
30 min	27	Reactions	0	27	21	18	11	5	25	25
		% of Sample	0%	100%	78%	67%	41%	19%	93%	93%
		χ^2			8.33	3.00	0.93	10.70	19.59	19.59
		Correlation			+**	0	0	-**	+**	+**

* = $0.05 > P > 0.01$

** = $P \leq 0.01$

TABLE VII. CORRELATION OF SPOT TEST RESPONSES WITH FUNGI LACKING PHENOLOXIDASES, GROUP IV

Time Reaction Recorded	Sample Size	Interpretation of Numbers	ENZYME IDENTIFIERS Laccase Sy	Tyrosinase Ty	SPOT TEST CORRELATORS Py	G	Gl	N	p-C	P
0 min	0	Reactions	0	0	0	0	0	0	0	0
5 min	5	Reactions	0	0	2	3	0	1	1	2
		% of Sample	0%	0%	40%	60%	0%	20%	20%	40%
		χ^2_c			0.00	0.20	3.20	0.80	0.80	0.00
		Correlation			0	0	0	0	0	0
15 min	7	Reactions	0	0	3	4	1	2	4	2
		% of Sample	0%	0%	43%	57%	14%	29%	57%	29%
		χ^2_c			0.00	0.00	3.57	2.29	0.00	2.29
		Correlation			0	0	0	0	0	0
30 min	11	Reactions	0	0	3	8	3	4	6	3
		% of Sample	0%	0%	27%	73%	27%	36%	55%	27%
		χ^2_c			1.45	1.45	1.45	0.36	0.00	1.45
		Correlation			0	0	0	0	0	0

* = $0.05>P>0.01$

** = $P \leq 0.01$

TABLE VIII. SPECIES OF GROUP IV CONTAINING PEROXIDASE

Time Reaction Recorded	Total Group IV Size	No. of Species Containing Peroxidase	% of Group IV Containing Peroxidase	SPOT TEST CORRELATORS Positive Reactions Occurring in Air Py	G	Gl	N	p-C	P
0 min	0	0	0%	0	0	0	0	0	0
5 min	5	4	80%	1	2	0	1	0	1
15 min	7	5	71%	2	2	1	2	3	1
30 min	11	7	64%	2	4	2	4	3	2

FIG. I. COMPARISON OF LACCASE AND TYROSINASE OXIDATION OF PYROGALLOL

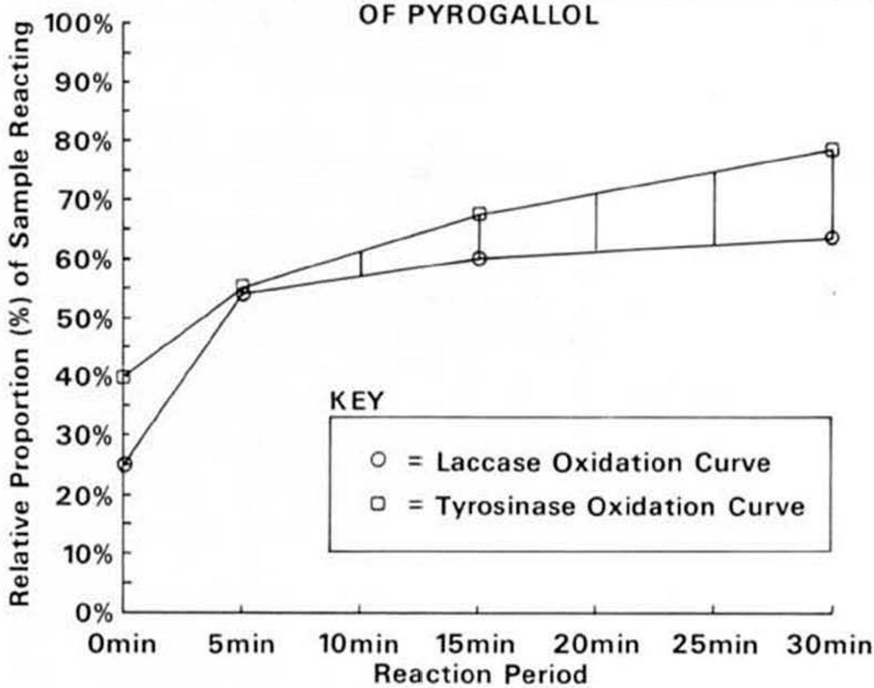


FIG. II. COMPARISON OF LACCASE AND TYROSINASE OXIDATION OF GUAIAC

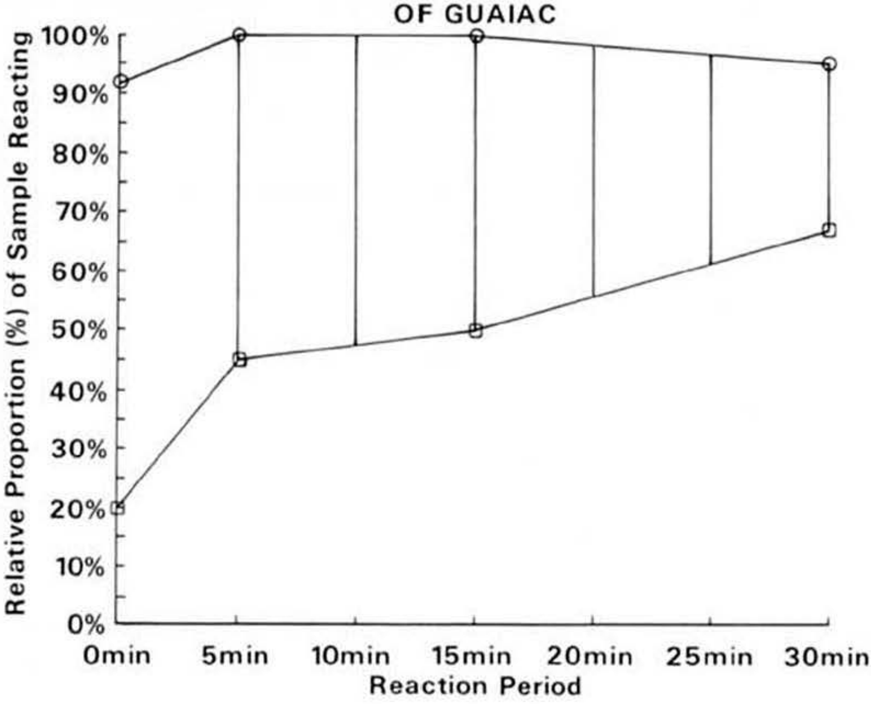


FIG. III. COMPARISON OF LACCASE AND TYROSINASE OXIDATION OF GUAIACOL

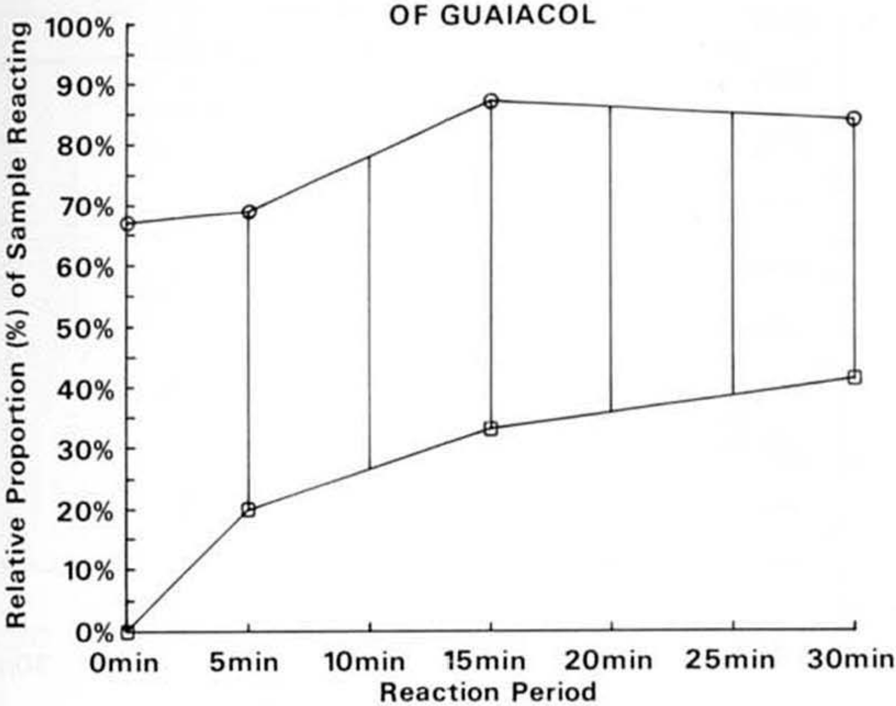


FIG. IV. COMPARISON OF LACCASE AND TYROSINASE OXIDATION OF 1-NAPHTHOL

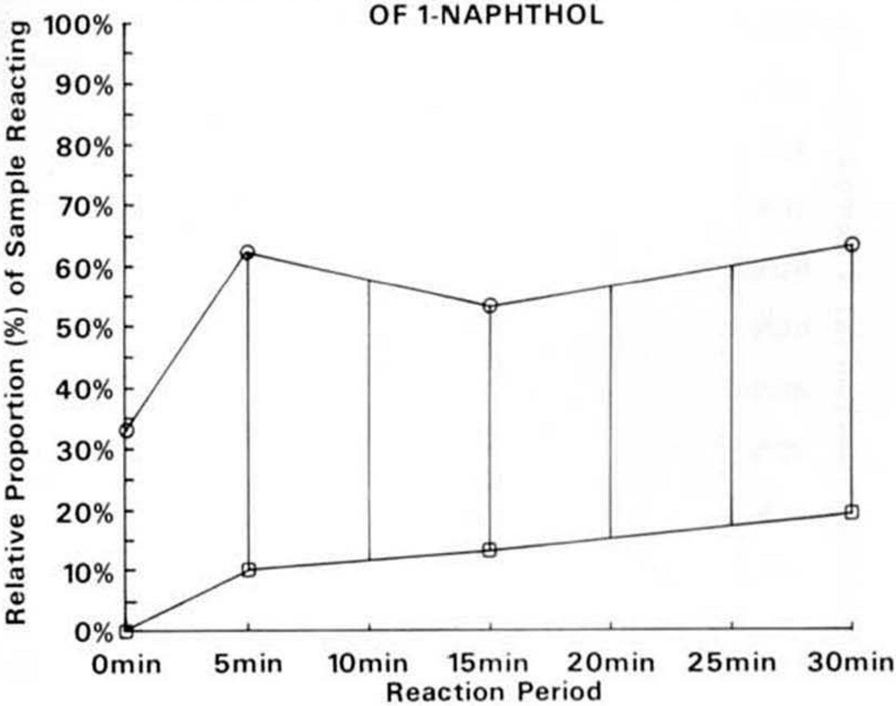


FIG. V. COMPARISON OF LACCASE AND TYROSINASE OXIDATION OF p-CRESOL

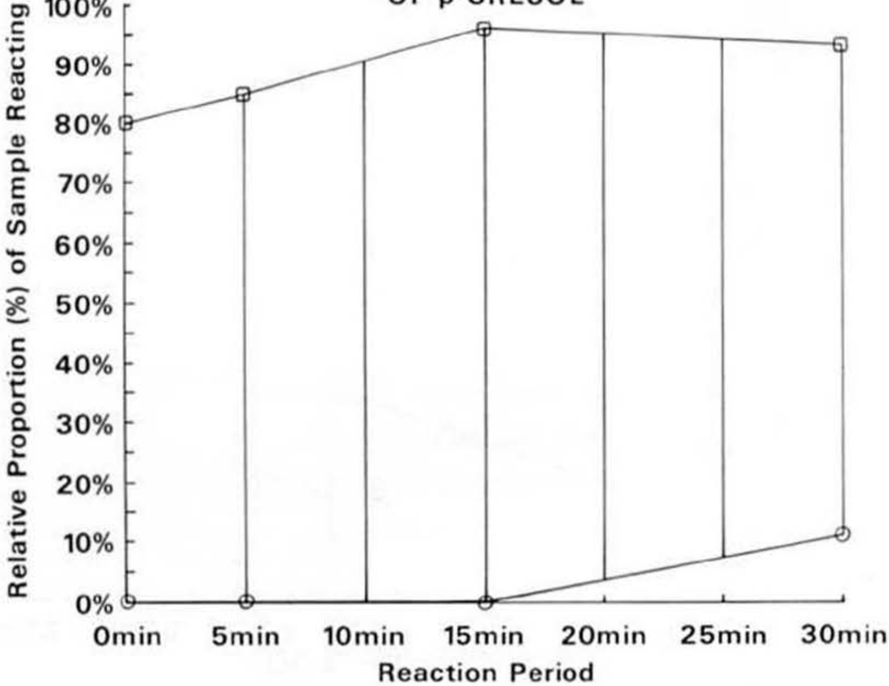


FIG. VI. COMPARISON OF LACCASE AND TYROSINASE OXIDATION OF PHENOL

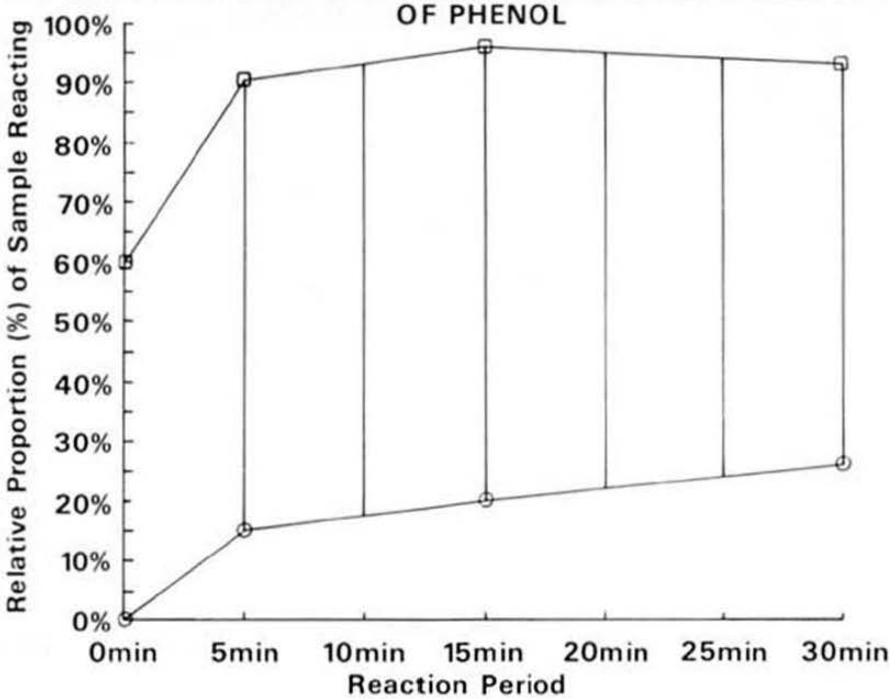


TABLE IX. LACCASE, TYROSINASE SUBSTRATE SPECIFICITY BASED ON LITERATURE

	LACCASE SUBSTRATE SPECIFICITY + = substrate oxidized - = substrate not oxidized	TYROSINASE SUBSTRATE SPECIFICITY + = substrate oxidized - = substrate not oxidized	SUBSTRATE SPECIFICITY EXCEPTIONS + = substrate oxidized - = substrate not oxidized
p-Cresol	- Ander & Eriksson 1976 Boidin 1951 Capellano & Demoulin 1969 Clutterbuck 1972 Higuchi & Kitamura 1953 Holubová-Jechová 1971 Käärik 1965 Kumari & Sirsi 1972 Matsubara & Iwasaki 1972 Schubert 1965	+ Ander & Eriksson 1976 Boidin 1951 Capellano & Demoulin 1969 Dawson & Magee 1955 Fåhraeus & Ljunggren 1961 Higuchi & Kitamura 1953 Higuchi 1958 Holubová-Jechová 1971 Käärik 1965 Lyr 1958 Matsubara & Iwasaki 1972 Nelson & Mason 1971 Sarkanen 1971 Schubert 1965 Yasunobu 1959	+ LACCASE (WHITE SOLID) Benfield et al. 1964 Blaich & Esser 1975 Dubernet et al. 1977 Fåhraeus 1961 Fåhraeus & Ljunggren 1961 Higuchi 1958 Küster & Little 1963 Lyr 1958 Sarkanen 1971 Schánĕl & Esser 1971
Guaiacol	+ Ander & Eriksson 1976 Blaich & Esser 1975 Boidin 1951 Capellano & Demoulin 1969 Demoulin 1967 Fåhraeus 1961 Fahraeus & Ljunggren 1961 Higuchi 1958 Hoffmann & Esser 1977 Holubová-Jechová 1971 Käärik 1965 Küster & Little 1963 Lyr 1958 Sarkanen 1971 Schánĕl 1967 Schánĕl & Esser 1971 Schubert 1965 Turner 1974	- Ander & Eriksson 1976 Boidin 1951 Capellano & Demoulin 1969 Demoulin 1967 Holubová-Jechová 1971 Käärik 1965 Lyr 1958 Sarkanen 1971	+ TYROSINASE Higuchi 1958 Rösch 1961

TABLE IX. Continued

1-Naphthol	+ Ander & Eriksson 1976 Clutterbuck 1972 Fåhraeus 1961 Fåhraeus & Ljunggren 1961 Higuchi & Kitamura 1953 Käärik 1965 Kumari & Sirsi 1972 Lyr 1958 Schubert 1965 Ulezlo et al. 1975	- Ander & Eriksson 1976 Higuchi & Kitamura 1953 Käärik 1965 Lyr 1958 Schubert 1965 Yasunobu 1959	
Phenol	- Kumari & Sirsi 1972 Fåhraeus & Ljunggren 1961	+ Ander & Eriksson 1976 Dawson & Magee 1955 Käärik 1965 Yasunobu 1959	+ LACCASE Ander & Eriksson 1976 Fåhraeus 1961 Käärik 1965
L-Tyrosine	- Ander & Eriksson 1976 Boidin 1951 Demoulin 1967 Dubernet et al. 1977 Higuchi 1958 Käärik 1965 Kumari & Sirsi 1972 Küster & Little 1963 Lyr 1958 Matsubara & Iwasaki 1972 (nearly -) Sarkanen 1971 Schubert 1965 Turner 1974	+ Ander & Eriksson 1976 Boidin 1951 Dawson & Magee 1955 Decker 1977 Demoulin 1967 Higuchi 1958 Käärik 1965 Lyr 1958 Sarkanen 1971 Schubert 1965 Turner 1974 Yasunobu 1959	+ LACCASE Fåhraeus 1961 Matsubara & Iwasaki 1972 (slight oxidation)
Guaiac	+ Harkin & Obst 1973 Harkin et al. 1974 Kratochvil et al. 1971 Nobles 1958	+ Harkin & Obst 1973 Harkin et al. 1974 Kratochvil et al. 1971 Nobles 1958	
Syringaldazine	+ Harkin & Obst 1973 Harkin et al. 1974	- Harkin & Obst 1973 Harkin et al. 1974	
Pyrogallol	+ Ander & Eriksson 1976 Benfield et al. 1964 Blaich & Esser 1975 Clutterbuck 1972 Fåhraeus 1961 Higuchi 1958 Käärik 1965 Kumari & Sirsi 1972 Küster & Little 1963 Maehly & Chance 1954 Matsubara & Iwasaki 1972 Schanel & Esser 1971 Schubert 1965 Ulezlo 1975	+ Ander & Eriksson 1976 Higuchi 1958 Käärik 1965 Yasunobu 1959	- LACCASE Koenigs 1970

LITERATURE CITED

Ander, P. and K. E. Eriksson. 1976. The importance of phenol oxidase activity in lignin degradation by the white-rot fungus *Sporotrichum pulverulentum*. Arch. Microbiol. 109: 1-8.

Benfield, G., Sheila M. Bocks, K. Bromley, and B. R. Brown. 1964. Studies of fungal and plant laccases. Phytochem. 3: 79-88.

Blaich, R. and K. Esser. 1975. Function of enzymes in wood destroying fungi: II. Multiple forms of laccase in white rot fungi. Arch. Microbiol. 103: 271-277.

Boidin, J. 1951. Recherche de la tyrosinase et de la laccase chez les Basidiomycètes en culture pure. Milieux différentiels. Intérêt systématique. Rev. d. Mycol. 16: 173-197.

Capellano, A. and V. Demoulin. 1969. Nouvelles recherches sur la distribution des phénoloxydases et des peroxydases chez les Gastéromycètes. Bull. Soc. Myc. Fr. 85: 251-254.

Christman, R. F. and R. T. Oglesby. 1971. Microbiological degradation and the formation of humus. In, Lignins. K. V. Sarkanen and C. H. Ludwig, eds. Wiley-Interscience, N.Y. pp. 769-795.

Clutterbuck, A. J. 1972. Absence of laccase from yellow-spored mutants of *Aspergillus nidulans*. J. Gen. Microbiol. 70: 423-435.

Davidson, R. W., W. A. Campbell, and Dorothy J. Blaisdell. 1938. Differentiation of wood-decaying fungi by their reactions on gallic or tannic acid medium. J. Agr. Res. 57: 683-695.

Dawson, C. R. and R. J. Magee. 1955. Plant tyrosinase. In, Methods in Enzymology. Vol. II. S. P. Colowick and N. O. Kaplan, eds. Academic Press, N.Y. pp. 817-827.

Decker, Lillian A. (ed.). 1977. Worthington Enzyme Manual. Worthington Biochemical Corp., Freehold, N.J. pp. 66-76.

Demirevska-Kepova, K. N. and N. T. Bakardjieva. 1976. Study on competition between guaiacol and ascorbic acid in peroxidase reaction and on ion effect by means of absorption spectra. Can. J. Bot. 54: 90-99.

Demoulin, V. 1967. Proposition d'un processus de détection des phénoloxydases et peroxydases chez les macromycètes. Application à quelques Gastéromycètes. Planta 76: 129-137.

Dubernet, M., P. Ribereau-Gayon, H. R. Lerner, E. Harel and A. M. Mayer. 1977. Purification and properties of laccases from *Botrytis cinerea*. Pytochem. 16: 191-193.

Fåhraeus, G. 1961. Monophenolase and polyphenolase activity of fungal laccase. Biochim. Biophys. Acta. 54: 192-194.

__________ and H. Ljunggren. 1961. Substrate specificity of a purified fungal laccase. Biochim. Biophys. Acta. 46: 22-32.

Guilford, J. P. 1965. Fundamental Statistics in Psychology and Education. 4th ed. McGraw-Hill, N.Y. pp. 237-238.

Gutteridge, S. and D. Robb. 1975. The catecholase activity of *Neurospora* tyrosinase. Eur. J. Biochem. 54: 107-116.

Harkin, J. M., M. J. Larsen and J. R. Obst. 1974. Use of syringaldazine for detection of laccase in sporophores of wood rotting fungi. Mycologia 66: 469-476.

__________ and J. R. Obst. 1973. Syringaldazine, an effective reagent for detecting laccase and peroxidase in fungi. Experientia 29: 381-387.

Hidaka, T. 1976. Reevaluation study of mushroom tyrosinase-tyrosine metabolites by means of gas chromatography and mass spectrometry. I. Identification of 2-carboxy-5, 6-dihydroxyindole. Kurume Med. J. 23: 49-56.

Higuchi. T. 1958. Further studies on phenol oxidase related to the lignin biosynthesis. J. Biochem. 45: 515-528.

__________ and K. Kitamura. 1953. Biochemical study of wood-rotting fungi. II. Relation between Bavendamm's reaction and tyrosinase. J. Japan Forestry Soc. 35: 350-354.

Hintikka, V. 1970. Studies on white-rot humus formed by higher fungi in forest soils. Comm. Instit. Forest. Fenn. 69: 1-68.

Hoffmann, P., and K. Esser. 1977. The phenol oxidases of the Ascomycete *Podospora anserina* XII. Affinity of laccases II and III to substrates with different substitution patterns. Arch. Microbiol. 112: 111-114.

Holubová-Jechová, Věra. 1971. Polyphenoloxidase enzymes from wood-inhabiting Hyphomycetes. Česká Mykol. 25: 23-32.

Käärik, Aino. 1965. The identification of the mycelia of wood-decay fungi by their oxidation reactions with phenolic compounds. Stud. Forest. Suecia 31: 1-81.

Koenigs, J. W. 1970. Peroxidase activity in brown-rot Basidiomycetes. Arch. Mikrobiol. 73: 121-124.

__________. 1972. Production of extracellular hydrogen peroxide and peroxidase by wood-rotting fungi. Phytopath. 62: 100-110.

Kratochvil, J. F., R. H. Burris, Margaret K. Siekel, and J. M. Harkin. 1971. Isolation and characterization of α-guaiaconic acid and the nature of guaiacum blue. Phytochem. 10: 2529-2531.

Kumari, H. Lalitha, and M. Sirsi. 1972. Purification and properties of laccase from *Ganoderma lucidum*. Arch. Mikrobiol. 84: 350-357.

Küster, E. and B. T. Little. 1963. Role of phenolases in the formation of quinonoid fungal metabolic products of *Aspergillus fumigatus* Fres. and *Penicillium spinulosum* Thom. Biochim. Biophys. Acta. 67: 288-294.

Lamaison, J. L. 1976. Intérêt chimiotaxinomique de l'équipement enzymatique des macromycètes. Bull. Soc. bot. Fr. 123: 119-136.

Lerner, A. B. and T. B. Fitzpatrick. 1950. Biochemistry of melanin formation. Physiol. Rev. 30: 91-126.

Lyr, H. 1958. Über den nachweis von oxydasen und peroxydasen bei höheren pilzen und die bedeutung dieser enzyme für die Bavendamm-reaktion. Planta 50: 359-370.

Maehly, A. C. and B. Chance. 1954. The assay of catalases and peroxidases. In, Methods of Biochemical Analysis. Vol. I. D. Glick, ed. Wiley-Interscience, N.Y. pp. 357-408.

Matsubara, T. and H. Iwasaki. 1972. Occurrence of laccase and tyrosinase in fungi of Agaricales and comparative study of laccase from *Russula delica* and *R. pseudodelica*. Bot. Mag. (Tokyo) 85: 71-83.

Nelson, Rita M. and H. S. Mason. 1970. Tyrosinase (Mushroom). In, Methods in Enzymology. Vol. XVIIA. H. Tabor and C. W. Tabor, eds. Academic Press, N.Y. pp. 626-632.

Nobles, Mildred K. 1958. A rapid test for extracellular oxidase in cultures of wood-inhabiting Hymenomycetes. Can. J. Bot. 36: 91-99.

__________. 1971. Cultural characters as a guide to the taxonomy of the Polyporaceae. In, Evolution of the Higher Basidiomycetes. Univ. of Tenn. Press, Knoxville. pp. 169-196.

Noller, C. R. 1957. Chemistry of Organic Compounds. Saunders, Philadelphia. p. 505.

Rösch, R. 1961. Untersuchungen über den lignin-abbau und über die oxydasen von braun- und weissfäulepilzen. Arch. Mikrobiol. 38: 73-106.

Sarkanen, K. V. 1971. Precursors and their polymerization. In, Lignins. K. V. Sarkanen and C. H. Ludwig, eds. Wiley-Interscience, N.Y. pp. 95-163.

Saunders, B. C. 1973. Peroxidases and catalases. In, Inorganic Biochemistry. Vol. 2. G. L. Eichhorn ed. Elsevier, N.Y. pp. 988-1021.

Schánĕl, L. 1967. A new polyphenoloxidase test for distinguishing between wood-rotting fungi. Biol. Plantarum 9: 41-48.

__________ and K. Esser. 1971. The phenoloxidases of the Ascomycete *Podospora anserina*. VIII. Substrate specificity of laccases with different molecular structures. Arch. Mikrobiol. 77: 111-117.

Schubert, W. J. 1965. Lignin Biochemistry. Academic Press, N.Y. pp. 77-119.

Singer, R. 1975. The Agaricales in Modern Taxonomy. 3rd ed. Cramer, Vaduz. 912 p.

Smith, P. I. and G. A. Swan. 1976. A study of the supposed hydroxylation of tyrosine catalyzed by peroxidase. Biochem. J. 153: 403-408.

Stafford, H. A. 1974. The metabolism of aromatic compounds. Ann. Rev. Plant Physiol. 25: 459-486.

Turner, Elizabeth M. 1974. Phenoloxidase activity in relation to substrate and development stage in the mushroom, *Agaricus bisporus*. Trans. Br. Mycol. Soc. 63: 541-547.

Ulezlo, I. V., T. M. Uporova and R. V. Feniksova. 1975. Study of oxidative enzymes of the lignin-degrading fungus *Pleurotus ostreatus*. Prikl. Biokhim. Mikrobiol. 11: 535-538.

Watling, R. 1971. Chemical tests in Agaricology. In, Methods in Microbiology. Vol. 4. C. Booth, ed. Academic Press, N.Y. pp. 567-597.

Westerfeld, W. W. and C. Lowe. 1942. The oxidation of p-cresol by peroxidase. J. Biol. Chem. 145: 463-470.

Wickerham, L. J. and C. P. Kurtzman. 1975. Synergistic color variants of *Aureobasidium pullulans*. Mycologia 67: 342-361.

Yasunobu, K. T. 1959. Mode of action of tyrosinase. In, Pigment Cell Biology. M. Gordon, ed. Academic Press, N.Y. pp. 583-608.

Young, Maria and C. Steelink. 1973. Peroxidase catalyzed oxidation of naturally-occurring phenols and hardwood lignins. Phytochem. 12: 2851-2861.

Zar, J. H. 1974. Biostatistical Analysis. Prentice-Hall. Englewood Cliffs, N.J. p. 49.

MYCOTAXON

Vol. IX, No. 1, pp. 277-284 June 12, 1979

TWO NEW SPECIES AND NEW RECORDS OF *TULOSTOMA* FROM THE PACIFIC NORTHWEST[1]

DENNIS M. OLIVER

Department of Biological Sciences
Central Washington University
Ellensburg, WA. 98926

DAVID R. HOSFORD

Department of Biological Sciences
Central Washington University
Ellensburg, WA. 98926

SUMMARY

Two new species of *Tulostoma*, *T. stuntzii* and *T. ferrugineum* are described. Eight additional species are recognized, six of which are new records for the Pacific Northwest.

INTRODUCTION

Work on *Tulostoma* has been limited in North America and is lacking for the Pacific Northwest. Basic publications available for North America are Morgan (1890), White (1901), Lloyd (1903, 1906), Coker and Couch (1928), Johnson (1929), Long (1944, 1946a, 1946b, 1947), Smith (1951), Herrera (1959), and Wright et al. (1972).

In *Tulostoma*, as in many genera of Gasteromycetes, species are difficult to separate because of the small number of reliable characteristics available. An excellent discussion and evaluation of specific characters used in the taxonomy of *Tulostoma* is provided by Wright (1955). The characters we stress basically follow his ideas. In descriptions, color terms followed by brackets refer to specific swatches in Kornerup and Wanscher (1962).

- - - - - - -

[1]Portion of a dissertation by the senior author to the Graduate School of Central Washington University for the degree of Master of Science.

Material examined, unless otherwise indicated, is stored in Central Washington University (CWU) herbarium. This paper is the first report from a survey begun in 1969 by Hosford and a subsequent taxonomic study by Oliver.

Tulostoma stuntzii Oliver and Hosford, Sp. Nov.

Fig. 1

GASTEROCARPIA nana, crassa, 1.7-1.8 cm alta. SPOROTHECA subglobosa, e globosa ad depresso-globosam varians, 9-12 mm alta, 13-14 mm lata. EXOPERIDIUM cinereum, granulosum, ex parte secedens praeter vaginam peridialem 1 mm crassam, 4-7 mm latam, compactam. ENDOPERIDIUM cinnamomeum aetate albidum, membranaceum, ex leve ad aliquantum foveatum varians. OSTIOLUM prominens, tubulosum 1-1.5 mm altum, orificium 1-3 mm diam. STIPES albus, brevis atque crassus, 5-9 mm altus, 4-8 mm latus, cupulam basalem praebens. SPORAE 5-6 (-7) µm *diam., e globosis ad subglobosam virians, subtiliter echinulatae interdum apiculate. HABITATIO in solo arenoso. Holotypus Hosford 1594 prope oppido Vantage lectus, in herbario CWU conservatus.*

Etymology: In honor of Professor Daniel E. Stuntz.

GASTEROCARP small, stout, 1-7 to 1.8 cm tall. *SPORE CASE* subglobose to depressed globose, 9-12 mm tall × 13-14 mm wide. *EXOPERIDIUM* gray in color, granular, deciduous except for a 1 mm thick, tightly compact peridial sheath, 4-7 mm wide, which flakes off in pieces. *ENDOPERIDIUM* light brown (6D6-6D7), becoming dull white in age; membranous, smooth to somewhat pitted; composed of two loosely defined layers: an outer layer composed of more or less gelatinized hyphae interspersed with thick walled hyphae, intergrading with an inner layer composed of tightly intertwined thick walled hyphae similar to the glebal capillitia. *MOUTH* prominent, tubular, 1-1.5 mm tall, the opening varying from 1-3 to 2-3 mm in diameter; concolorous with endoperidium.

STIPE short, stout, 5-9 mm tall × 4-8 mm wide with a slight taper toward the apex; white in color, striate to deeply furrowed; base broad, rounded, enclosed in a sand cup, no radiating base present. *COLLAR* indistinct, in most covered by peridial sheath; when visible, smooth.

SPORE range 4.5-6 (-7) µm in diam., averaging 5.7 µm, globose to subglobose, finely echinulate with spines extending into a thin hyaline layer surrounding the spore; some apiculate; yellow brown in 3% KOH or water, acyanophilous in cotton blue (Aniline Blue) and generally no reaction with Melzer's, except for an occasional spore which darkens. *CAPILLITIA* rare, when present, hyaline, 4-7 µm wide, smooth lacking crystalline incrustations and thick walled; septa rare, when present, joints slightly swollen to 5-10 µm wide (refer to type 1 of Wright, 1955).

HABIT, HABITAT, SEASON: growing solitary in sand, semi-stabilized dune areas, growing with *Chrysothamnus* spp. Fall species.

MATERIAL EXAMINED: WASHINGTON: *Kittitas Co.*, near town of Vantage, Hosford 1594 (type). *Grant Co.*, Powerline Rd., Oliver 14.

DISCUSSION: This species has been collected in the fall in Central Washington and is distinguished by its small stature, cinnamon brown endoperidium, and weakly echinulate spores. *T. stuntzii* is closely related to *T. simulans* and *T. jourdani*. It may be distinguished from *T. simulans* by its smaller stature and stipe, and its echinulate rather than verrucose spores; it differs from *T. jourdani* by its somewhat darker endoperidial color, smaller stature, and echinulate rather than smooth spores.

Tulostoma ferrugineum Oliver and Hosford, Sp. Nov.

Figs. 2, 3

GASTEROCARPIA 3-6.5 cm alta, SPOROTHECA subglobosa, e globosa ad depresso-globosam varians, 7.5-10 mm alta, 10-13 mm lata. EXOPERIDIUM granulosum, ex strato tenui arenae atque hyphae constatum, mox secedens, solum vagina peridialis 3-4 mm lata remanens. ENDOPERIDIUM tenax, membraneceum, brunneocinereum. OSTIOLUM tubulosum, brevis, 1 mm altum, zona distincta cinerea basim tubi cingenti. STIPES ferrugineus, manifeste squamulosus, 2.2-5.5 cm altus, 3.4 mm latus, cupula bulbosa basali. SPORAE 5-6 (-7) µm diam., e globosis ad subglobosam varians, valde verrucosae verrucis truncatis. CAPILLITIA hyalina, 4-9 µm lata, levitunicata. HABITATIO in solo arenoso.
HOLOTYPUS Oliver 145, in junipereto ad septentriones opidii Pasco lectus, in herbario CWU conservatus.

Etymology: Latin, *ferrugineum*, referring to the conspicuously rusty brown stipe.

GASTEROCARP medium, 3-6.5 cm tall, consisting of peridium, stipe, and a bulbous to diffuse base. *SPORE CASE* subglobose to depressed globose, 7.5-10 mm tall × 10-13 mm wide. *EXOPERIDIUM* granular, composed of a thin layer of sand and entangled, thick-walled hyphae, soon retreating leaving only a basal peridial sheath, 3-4 mm wide. *ENDOPERIDIUM* tough membranous, composed of intertwined thick walled, septate hyphae; brownish gray (5C3-5D3 to 6C2-6D2). *MOUTH* tubular, short, 1 mm tall, the opening 1 mm in diam.; a distinct gray (6C1) endoperidial zone, 1-1.5 mm wide, is present around the base of the tube, tending to fade in age.

STIPE 2.2-5.5 cm tall × 3-4 mm wide, even to slightly tapering at apex; reddish brown (7E4-8E4), distinctly squamulose; base bulbous, diffuse from large conglomeration of sand, hyphae and roots, and occasionally radiating. *COLLAR* indistinct.

SPORE range 5-6 (-7) µm in diam., averaging 5.5 µm, globose to subglobose; strongly verrucose, warts flat-topped (truncated), extending into an amorphous hyaline layer; a partial reticulum evident in optical section; yellow brown in 3% KOH or water, acyanophilous in cotton blue and no reaction with Melzer's. *CAPILLITIA* hyaline, 4-9 µm wide, smooth walled, lacking crystalline deposits and thick walled; frequently branched and septate, joints often swollen to 6-12 µm wide and yellowish (Type 1 - Wright, 1955).

HABIT, HABITAT, SEASON: growing solitary to gregarious in semi-stabilized dune areas, in protected hollows, associated with *Chrysothamnus* spp. and other shrubs. Late Winter and Spring.

MATERIAL EXAMINED: WASHINGTON: *Franklin Co.*, Juniper Forest north of Pasco, Oliver 145 (type), 146, 206.

DISCUSSION: *T. ferrugineum* is recognized by the presence of a distinct gray zone below a prominent tubular mouth, reddish brown, scaly stipe, spores with truncated verrucae and habitat. It appears to be closely related to the European *T. brumale* complex, but differs from these by its lack of crystalline deposits on capillitia (as reported by European workers), truncated verrucae rather than aculeate ornamentation, and sandy habitat. The most closely related species in the complex seems to be *T. melanocyclum*, a rare species sometimes associated with *T. brumale*.

DISTRIBUTION DATA ON PREVIOUSLY DESCRIBED SPECIES

1. *Tulostoma campestre* Morgan

Additional collections: OREGON: *Multnomah Co.*, along Columbia River, Hosford 2159 (Oswald Collection). WASHINGTON: *Asotin Co.*, near Clarkston, WSU-1265 (WSU). *Yakima Co.*, Sunnyside, Ebenal 1, 35, 59, 60, 80, 97, 98, 217, 218, 221, 222, 259, Hosford 1583, 1836, Oliver 216, 217, 218; Wapato, Oliver 214, 215.

A fairly common species in northern United States. Previously reported from Wisconsin, South Dakota, Nebraska, Colorado, the District of Columbia, and Ontario, Canada.

2. *Tulostoma fibrillosum* White

Additional collections: IDAHO: *Ada Co.*, Boise, Trueblood 5830. WASHINGTON: *Franklin Co.*, Juniper Forest north of Pasco, Oliver 113, 133, 138, 139, 142b, 144. *Grant Co.*, near Beverly, Scates 2836. *Whitman Co.*, Wanawai, WSU-56747 (WSU).

Previously known from Michigan and Ontario, Canada.

3. *Tulostoma jourdani* Pat. sensu Long (1947)

Additional collections: OREGON: *Harney Co.*, Rattle Snake Butte, Malheur National Wildlife Refuge, Oliver 187 (Trappe Collection). WASHINGTON: *Franklin Co.*, Juniper forest north of Pasco, Ebenal 47, 80B, Oliver 127, 130, 131, 132, 134, 135, 142A, 143, 147, 148, 151, 152, 200, 205, 210. *Grant Co.*, Crab Creek, Oliver 182; Priest Lake Dam, Hosford 1466; near Vantage, Hosford 1567, 1574, 1578, 1585, 1592, Oliver 26; Summer Falls, Hosford 1872.

The most common and widespread species of *Tulostoma* in the Pacific Northwest. This species shows great variability in size of sporocarps and degree of spore ornamentation, believed due to environmental conditions.

4. *Tulostoma poculatum* White

Additional collections: OREGON: *Wallowa Co.*, near Wallowa Lake, WSU-32482 (WSU). WASHINGTON: *Grant Co.*, Vantage, Hosford 1591, Scates 2833. *Benton Co.*, Prosser, WSU-32493 (WSU).

Previously reported from Arizona, Alabama, Colorado, Indiana, Nebraska, New Mexico, Texas, and Washington. A widely distributed species but seldom collected in numbers.

5. *Tulostoma simulans* Lloyd

Additional collections: IDAHO: *Latah Co.*, near Genesee, WSU-23344 (WSU). *Valley Co.*, McCall, WSU-52713 (WSU).

This species is distributed throughout the United States and is especially common in the Midwest. In Central Washington it is very difficult to distinguish *T. simulans* from *T. jourdani*. A considerable amount of additional work is needed to clarify this complex of species.

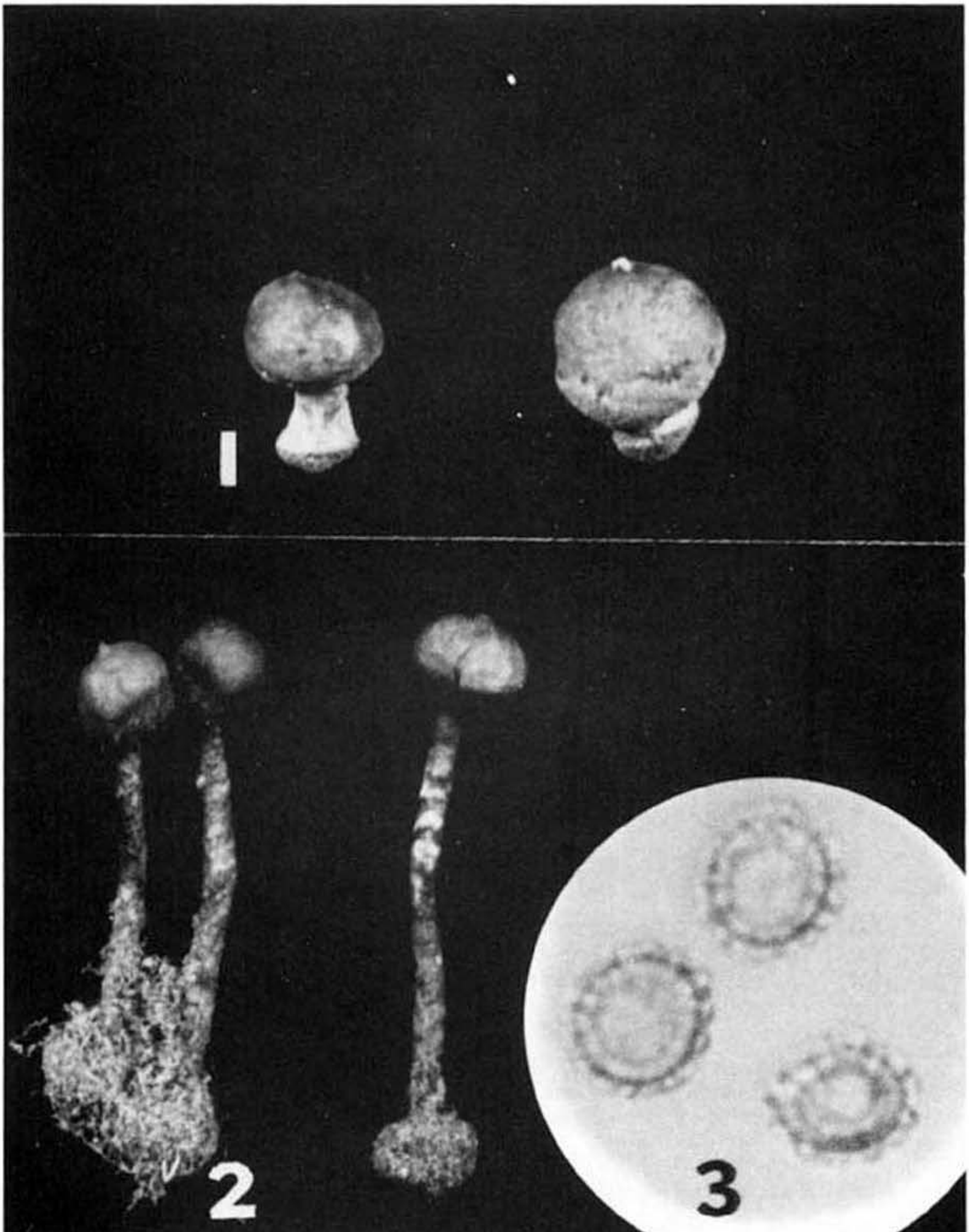


Fig. 1. *Tulostoma stuntzii*, × 1.3 (Hosford 1594, holotype).

Figs. 2-3. *Tulostoma ferrugineum* (Oliver 145, holotype).
2. Gasterocarps, × 1.
3. Basidiospores, 5-6 µm diam.

6. *Tulostoma striatum* Conn.

Additional collections: CALIFORNIA: *Marin Co.*, San Anselmo, Mills 1216 (identified as *T. berteroanum* Lev., WSU-52772). *Stanislaus Co.*, Turlock, Oliver 238 (D. Gottelli Collection). OREGON: *Lake Co.*, near Plush, Oliver 236. WASHINGTON: *Chelan Co.*, along Columbia River near Wenatchee, WSU-23721 (WSU).

This is one of the most easily recognized species due to its striate spores. Although considered uncommon, this species is widely distributed in the west.

7. *Tulostoma tuberculatum* White

Additional collections: IDAHO: *Butte Co.*, Craters of the Moon National Park, WSU-20417 (WSU). *Owyhee Co.*, Marsing, Trueblood 5757; Rabbit Creek, Trueblood 5821.

Previously reported from Washington, Texas, Illinois, and Ohio. This species might be more properly placed under *T. granulosum* as proposed by J. E. Wright.

8. *Tulostoma verrucosum* Morgan

Additional collections: OREGON: *Benton Co.*, Corvallis, Lloyd 28941 (Lloyd Collections).

This is the only known report of the species in the Pacific Northwest based on a collection sent to Lloyd by S. M. Zeller.

ACKNOWLEDGEMENTS

The authors wish to thank C. G. Shaw of Washington State University for loan of herbarium specimens. Also thanks is given to Kit Scates, John Ebenal, Ellen Trueblood, Dr. William Barker, and Lee Hoppis for field collections. Finally we express our appreciation to Dr. J. M. Trappe for his constructive criticisms of the manuscript and to Dr. D. E. Stuntz for his help with the Latin diagnoses.

LITERATURE CITED

Coker, W.C. and J.N. Couch. 1928. Gasteromycetes of Eastern United States and Canada. Univ. North Carolina Press. Chapel Hill. 201 pp.

Herrera, T. 1959. *Batterraea* Y *Tylostoma* en El Valle De Mexico. Sobretiro de los Anales del Instituto de Biologia. 30:21-33.

Johnson, Minnie May. 1929. The Gasteromycetae of Ohio: Puffballs, Bird's Nest Fungi and Stinkhorns. Ohio Biol. Surv. Bull., No. 22. 4(7):271-352.

Kornerup, A. and J.H. Wanscher. 1962. Reinhold Color Atlas. Reinhold Publ. Corp. New York. 224 pp.

Lloyd, C.G. 1903. The Tylostomeae. Mycological Notes. 1(14):133-136.

________. 1906. The Tylostomeae. Mycological Writings. 2:9-26.

________. 1923. *Tylostoma finkii* from Professor Bruce Fink, Ohio. Mycological Notes. 7(68):1169.

Long, W.H. 1944. Studies in the Gasteromycetes X. Seven New species of *Tylostoma*. Mycologia 36:318-339.

________. 1946a. Studies in the Gasteromycetes XII. Five species of *Tylostoma* with membranous exoperidia. Mycologia 38:77-90.

________. 1946b. Studies in the Gasteromycetes XIII. The types of Miss White's species of *Tylostoma*. Mycologia 38:171-179.

________. 1947. Studies in the Gasteromycetes XV. Notes on new or rare species of *Tylostoma*. Lloydia 10:115-135.

Smith, A.H. 1951. Puffballs and their allies in Michigan. Univ. of Mich. Press. Ann Arbor, Mich. 131 pp., 43 Pls.

White, V.S. 1901. The Tylostomaceae of North America. Bull. Torrey Bot. Club 28:421-444.

Wright, J.E. 1955. Evaluation of specific characters in the genus *Tulostoma* Pers. Papers of the Mich. Acad. Sci., Arts, Letters 40:79-87.

Wright, J.E., T. Herrera, and G. Guzmán. 1972. Estudios sobre el género *Tulostoma* in Mexico. Ciencia (Mex.) 27:109-122.

MYCOTAXON

Vol. IX, No. 1, pp. 285-296 June 12, 1979

THE GENUS SUILLUS IN THE WESTERN UNITED STATES

HARRY D. THIERS

Department Of Biology
San Francisco State University
San Francisco, CA 94132

SUMMARY

A taxonomic key is presented to the forty species of Suillus occurring in the western United States. Short descriptions of each species are also included.

Species belonging to the genus Suillus (Boletaceae) constitute a common and often dominant element of the bolete flora of the western United States, and may be expected to occur wherever certain members of the Pinaceae are growing. This genus of fleshy fungi is characterized by a yellow, tubulose hymenophore with concolorous (rarely gray brown or pinkish) pores that vary in diameter from very small (less than 1 mm) to radially elongate or lamellose and reach 3-5 mm. In addition clustered cystidia, which typically stain brown in dilute solutions of potassium hydroxide, are often present and may be found on the surface of the stipe as well as on the pores. There is usually a viscid pellicle on the pileus surface, and the spores are smooth and olive brown in mass. There are several species which vary from the above description by having a dry, often squamulose to fibrillose pileus or by the absence of the clustered cystidia. Such species are characteristically annulate and possess radiately elongate pores. Only a relatively few Suillus species show the blue discoloration of the context when exposed or bruised that is so often seen in other genera of boletes. None are known to be toxic to man, but, unfortunately, none are considered as truly desirable esculents.

The almost complete restriction of these boletes to mycorrhizal associations with pines and related conifers has led to considerable speculation concerning their origin and phylogenetic relationships with other groups of boletes. Species of pines (Pinus), larch (Larix), Douglas fir (Pseudotsuga) and spruce (Picea) are the most common mycorrhizal hosts and firs (Abies) and other genera are rarely, if ever, involved. No fruiting of these fungi has been observed under species belonging to the Cupressaceae and Taxodiaceae which are generally considered to be endomycorrhizal, and, similarly, no fruitings have been observed under any hardwoods except possibly Suillus anomalus which has been found in the vicinity of oaks and madrones, but ponderosa pines were also in the vicinity. There are numerous endemic species of this genus in the west, resulting, perhaps at least in part, from the unusually large number of endemic pines and other conifers also present. Many Suilli show such severe restriction of mycorrhizal hosts that only a single species of conifers is involved as evidenced by S. caerulescens, S. imitatus, S. ponderosus and S. lakei all of which are confined to Douglas fir, at least in this region. Some species, on the other hand, enjoy a much broader spectrum of associates.

The area included within this report includes all of the states bordering on or located west of the Rocky Mountains. In this region a total of 40 species has been recorded. No new species are presented in this paper, but it must not be assumed that the flora is thoroughly explored. Indeed, there are numerous areas in which little or no collecting has been done and in which the potential for the existence of undescribed taxa is quite high.

KEY TO SPECIES

1. Pileus dry to moist, or if viscid, then stipe annulate and glandular dots absent........................2

1. Pileus subviscid to viscid or glutinous. Stipe and/or pores with glandular dots..........................9

2. Pileus dry to moist, fibrillose to tomentose or squamulose..................................3

2. Pileus viscid or subviscid, glabrous to streaked or with scattered appressed fibrils or obscurely fibrillose scaly..................................4

3. Stipe hollow. Clamp connections present. ....*S. cavipes*

Pileus moist to dry, fibrillose to fibrillose squamulose, dull yellow to reddish brown, margin appendiculate. Tubes yellow, radiating. Stipe often with slight annulus. Spores 7-10 x 3.5-4 um. Cystidia solitary. Cuticle a trichodermium. Larch.

3. Stipe solid. Clamp connections absent. ....*S. lakei*

Pileus dry, fibrillose scaly, gelatinous layer beneath fibrils, pink to reddish, margin often appendiculate. Tubes yellow. Stipe annulate. Context sometimes bluing. Spores 8-11 x 3-4 um. Cystidia solitary or clustered. Cuticle a basal layer of gelatinous hyphae subtended by clusters of erect fascicles of hyphae. Douglas fir.

4. Context in base of stipe changing to blue when exposed..5

4. Context in base of stipe unchanging or not becoming blue when exposed..............................7

5. Annulus well developed, colored orange to yellow orange and viscid on outer (lower) surface ....*S. ponderosus*

Pileus glabrous, reddish brown, margin often appendiculate, sometimes with green stains when old. Tubes yellow. Stipe annulate. Spores 8-10 x 3.8-5 um. Cystidia solitary or clustered. Cuticle an ixotrichodermium. Douglas fir.

5. Annulus not as described above.......................6

6. Pileus cinnamon to reddish cinnamon, glabrous. ....S. imitatus

Pileus glutinous. Tubes yellow. Stipe annulate. Spores 7-9 x 4-4.5 um. Cystidia solitary or clustered. Cuticle an ixotrichodermium. Douglas fir.

6. Pileus paler in color, with scattered fibrils or streaked with gluten..........S. caerulescens

Pileus viscid, margin often appendiculate. Tubes boletinoid, yellow. Stipe annulate, annulus moist to subviscid, white to pallid. Spores 8-11 x 3-5 um. Cystidia solitary or clustered. Cuticle an ixotrichodermium. Douglas fir.

7. Context of pileus changing to blue then fuscous when exposed........................S. lithocarpi-sequoiae

Pileus glabrous, viscid, pallid to reddish brown (variegated). Tubes yellow. Stipe annulate. No glandulae. Spores 7.5-9.8 x 3.2-3.8 um. Cystidia solitary or clustered. Cuticle an ixotrichodermium. No fresh material examined. Tanbark oak (?) and Sequoia (?).

7. Context of pileus not changing as described above 8

8. Context of pileus bright yellow, changing to pink or flesh color when exposed. Associated with larch. ....S. grevillei

Pileus glutinous, glabrous, often brownish then yellow. Tubes yellow. Stipe annulate, pallid, viscid outer surface. Spores 8-10 x 2.8-3.5 um. Cystidia clustered. Cuticle an ixotrichodermium. Larch.

8. Context pale yellow to pallid, unchanging. Associated with firs (Abies)..............S. appendiculatus

Pileus glabrous, yellow, dry, margin appendiculate. Tubes yellow. Stipe non glandulose, yellow. Spores 7.5-9.5 x 3-3.5 um. Cystidia solitary or clustered. Cuticle an ixotrichodermium. Firs.

9. Basidiocarps gastroid, i.e., pileus expanding only slightly and irregularly. Stipe often poorly developed and pores frequently large and irregular 10

9. Basidiocarps not gastroid..............................12

10. Pileus covered with a white fibrillose veil that breaks into patches or squamules as pileus expands. ....*S. albivelatus*

Pileus viscid, buff to brown, margin appendiculate. Tubes yellow. Stipe white, glandulae absent or obscure. Slight annulus sometimes present. Spores 7-8.5 x 2.8-3 um. Cystidia clustered. Cuticle an ixotrichodermium. Western white pines.

10. Veil absent or not persisting as above...........11

11. Pileus bright yellow. Stipe short, often eccentric and/or poorly developed.........*S. megaporinus*

Pileus viscid, fibrillose to fibrillose scaly, buff to pale ochraceous, scales darker, margin appendiculate. Tubes yellow, pores up to 5 mm long and 3 mm broad, lamellose. Stipe often short and eccentric, glandulose, no annulus but fibrillose zone often present. Spores 8.5-10.5 x 4.5-6 um. Cystidia clustered. Cuticle an ixotrichodermium Lodgepole pines.

11. Pileus yellow brown. Stipe central, well developed. ....*S. riparius*

Pileus viscid, glabrous then rimose to areolate-scaly, brown then dark yellow, margin with conspicuous roll of cottony tissue. Tubes yellow, pores up to 3 mm in diam. Stipe glandulose, no annulus but fibrillose zone sometimes present. Spores 8-11 x 3.2-5 um. Cystidia clustered. Cuticle an ixotrichodermium. Pines.

12. Pores greater than 1 mm in diameter, sometimes radiately arranged..................................13

12. Pores not exceeding 1 mm in diameter.............18

13. Annulus present..................................14

13. Annulus absent...................................15

14. Pileus colored pinkish cinnamon to vinaceous brown. Context white.................*S. punctatipes*

Pileus viscid, glabrous and streaked, brown to dark brown, margin glabrous. Tubes yellow, pores radiately arranged. Stipe glandulose, no annulus. Spores 7.5-9 x 3-4 um. Cystidia clustered. Cuticle an ixotrichodermium. Pines.

14. Pileus colored deep olive buff, umbonate. Context yellow.......................S. umbonatus

Pileus viscid, streaked, pale tan to pale yellow, often darkening with age, margin appendiculate. Tubes yellow, pores 2-3 mm long. Stipe annulate, glandulose (more obvious when old). Spores 7-11 x 3.5-4.5 um. Cystidia clustered. Cuticle an ixotrichodermium Lodgepole pines.

15. Basidiocarps robust. Pileus up to 10 cm broad; stipe up to 10 cm long and 5 cm broad. Tubes strongly decurrent...........S. anomalus

Pileus viscid, yellow brown to dark brown, glabrous or streaked, margin with cottony roll. Tubes yellow, pores 1-1.5 mm wide. Stipe infrequently glandulose. No veils. Spores 6.5-10.5 x 3-4 um. Cystidia clustered. Cuticle an ixotrichodermium. Mixed woods: oaks, madrones and ponderosa pine.

15. Basidiocarps not possessing the combination of characters described above.......................16

16. Pileus margin with a cottony roll of white to whitish tissue.......................S. sibiricus

Pileus viscid, glabrous to streaked or with fibrillose patches, yellow to dark yellow with reddish brown plaques. Tubes yellow, pores up to 2 mm broad. Stipe glandulose, dry, obscure annulus stometimes present. Spores 8-12 x 3.8-4.5 um. Cystidia clustered. Cuticle an ixotrichodermium. Western white pine.

16. Margin of pileus glabrous...........................17

17. Pileus subconic to campanulate or umbonate, 1.5-4 cm broad.........................S. helenae

Pileus viscid, virgate, ochraceous. Tubes boletinoid, yellow, pores lamellose. Stipe glandulose. No veils. Spores 6.5-9.5 x 2.8-4 um. Cystidia clustered. Cuticle a trichodermium, not appearing gelatinous. Beach pines.

17. Pileus convex to plane, 6-9 cm broad ....S. flavogranulatus

Pileus glabrous, viscid, pallid to pale yellow ochraceous. Context white. Tubes yellow. Stipe white then yellow, glandulose. No veils. Spores 7.5-9 x 3-3.2 um. Cystidia clavate to cylindric to fusoid, clustered. Cuticle an ixotrichodermium. Pines

18. Annulus present, existing either as a fibrillose zone or as a flared, conspicuous collar..............19

18. Annulus absent....................................22

19. Annulus represented by a thin, more or less evanescent fibrillose ring..............S. pseudobrevipes

Pileus dark yellow brown to cinnamon brown, viscid, glabrous, margin often appendiculate. Tubes yellow, pores 2 per mm. Stipe dry, glandulose, often obscure when young. Spores 7-9 x 2.5-3.5 um. Cystidia scattered to clustered, clavate to subcylindric. Cuticle an ixotrichodermium. Lodgepole pines.

19. Annulus and/or veil well developed................20

20. Pileus colored dark reddish brown. Annulus conspicuous, with a purple to purplish zone or outer (lower) surface.......................S. luteus

Pileus glabrous, viscid. Tubes yellow, pores 3 per mm. Stipe glandulose above annulus. Spores 7-9 x 2.5-4 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Conifers.

20. Pileus and annulus not with the above combination of characters.....................................21

21. Pileus white when young, eventually becoming brown. Associated with sugar pines......S. brunnescens

Pileus viscid, glabrous or streaked. Tubes yellow, pores 2 per mm. Stipe glandulose. No veils. Spores 6.6-8.8 x 2.8-3.2 um. Cystidia clustered, subcylindric to fusoid ventricose. Cuticle an ixotrichodermium. Sugar pines.

21. Pileus dark brown to olive brown. Pores olive gray ....S. subolivaceus

Pileus viscid, fibrillose to often fibrillose scaly on margin, glabrous on disc, margin glabrous. Tubes yellow, pores 1-2 per mm. Stipe with conspicuous annulus, glandulose. Spores 9-11 x 3-4 um. Cystidia clustered. Cuticle an ixotrichodermium. Conifers.

22. Pileus surface tomentose, fibrillose, fibrillose scaly or squamulose....................................23

22. Pileus glabrous, streaked or with scattered fibrils. Tomentose roll (false veil) may be present on the margin of pileus.................................28

23. Context changing to blue when exposed...........24

23. Context not changing to blue when exposed but may change to some other color.........................26

24. Pileus colored bright red.........<u>S. ruber</u>

Pileus viscid, bright red, fibrillose. Tubes yellow, pores 2 per mm. Stipe glandulose, yellow. No veils. Spores 7.8-9.8 x 2.3-4 um. Cystidia solitary or clustered. Cuticle an ixotrichodermium. No fresh material examined. Conifers.

24. Pileus yellow with grayish fibrils...............25

25. Spores up to 14 um long. Stipe fibrillose ....<u>S. subvariegatus</u>

Pileus dry to subviscid, squamulose. Tubes pale yellow to pale orange. Stipe pallid to yellow. Spores 9-14 x 3.5-5 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Pines.

25. Spores up to 10 um long. Stipe glabrous, glandulose ....<u>S. tomentosus</u>

Pileus yellow, densely fibrillose, sometimes reddish with age, margin glabrous. Tubes yellow, pores up to 1 mm. Stipe glandulose. No veils. Spores 7-10 x 3.5-4.5 um. Cystidia clustered. Cuticle a tangled ixotrichodermium with erect fascicles of hyphae. Pines.

26. Pileus surface moist to subviscid.................27

26. Pileus surface viscid............*S. acerbus*

Pileus surface fibrillose, brown to reddish brown margin glabrous. Tubes yellow, pores up to 1mm. Stipe dry, glandulose. No veils. Spores 9.3-12 x 3-3.4 um. Cystidia clustered, often rare, clavate. Cuticle an ixotrichodermium. Pines.

27. Pileus fibrils black to dark brown
....................*S. fuscotomentosus*

Pileus fibrillose scaly, olive brown to fuscous, margin glabrous. Tubes yellow, up to 1 mm. Stipe glandulose, yellow, dry. No veils. Spores 9-12 x 3-4 um. Cystidia clustered, clavate. Cuticle a trichodermium with very slight gelatinization. Pines.

27. Pileus fibrils brown.............*S. californicus*

Known only by type collection. Poorly understood and description inadequate for positive determination.

28. Pileus margin appendiculate or with a distinct cottony roll at least when young.........................29

28. Pileus margin glabrous at all stages............33

29. Glandulae on stipe obscure, often apparent only at the apex. Associated with Jeffrey pines
..................*S. volcanalis*

As in *S. brevipes* except for differences noted in key. Pileus often yellow. Spores 6.6-10 x 3-4 um. Jeffrey pines.

29. Glandulae apparent on stipe during all stages
.....................................30

30. Taste harsh, unpleasant. Pileus white then gray and eventually brown.................*S. pungens*

Pileus viscid, glabrous. Tubes yellow, pores 1-1.5 mm broad. Stipe glandulose. No veils. Spores 9.5-10 x 2.8-3.5 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Monterey and knobcone pines.

30. Basidiocarps not with the above combination of characters..............................31

31. Pileus brown to dark reddish brown; margin usually appendiculate................S. borealis

Pileus viscid, glabrous. Tubes yellow, pores 1 mm broad. Stipe glandulose, no annulus. Spores 6-8.5 x 3-5 um. Cystidia solitary or clustered. Cuticle an ixotrichodermium Western white pines.

31. Pileus not with the above combination of characters 32

32. Pileus white or pallid when young becoming brown to tawny with age............S. albidipes

Pileus viscid, glabrous. Tubes yellow, pores 3 per mm. Stipe white, obscurely glandulose, slowly darkening. No veils. Spores 6.6-8.8 x x 2.5-3 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Pines.

32. Pileus pinkish buff to pinkish cinnamon. ....S. glandulosipes

Pileus viscid, glabrous. Tubes yellow, pores 1-2 per mm. Stipe dry, strongly glandulose. No veils. Spores 6-9 x 3-4 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Beach and Bishop pines.

33. Stipe reticulate. Context changing to blue when exposed......................S. reticulatus

Pileus subviscid to viscid, glabrous to obscurely appressed fibrillose, brown to reddish brown, margin glabrous. Tubes yellow, pores 1 per mm. Stipe dry. No veils, glands obscure. Spores 9-11 x 3-4 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Pines.

33. Stipe not reticulate. Context not changing to blue when exposed...................................34

34. Pileus colored buff, brown or ochraceus at maturity 35

34. Pileus yellow at maturity......S. wasatchicus

Pileus viscid, glabrous, occasionally with reddish flushes. Context pale yellow. Tubes dark yellow. Stipe yellow at apex, white below, dry, glandulae conspicuous. Spores 8-10.4 x 3-4 um. Cystidia clavate to cylindric, clustered. Cuticle an ixotrichodermium. Ponderosa pines.

35. Stipe with inconspicuous glandulae or glandulae absent....................................36

35. Glandulae present, apparent during all stages of development...............................38

36. Pileus white at first then darkening. Spores up to 11 um in length.............S. pallidiceps

Pileus glabrous, eventually colored yellow to buff, viscid, margin glabrous. Tubes yellow,pores 2-3 per mm. Stipe white. No veils. Spores 8-11 x 3.5-4.2 um. Cystidia solitary to clustered, clavate. Cuticle an ixotrichodermium. Lodgepole pines.

36. Pileus and spores not as described above.......37

37. Pileus buff to pinkish cinnamon ....S. occidentalis

Pileus viscid, glabrous, streaked. Context white then yellow. Tubes tan then yellow. Stipe dry, white to yellow, glandulae obscure or not apparent. Spores 8-9.6 x 3-4 um. Cystidia clavate, clustered. Cuticle an ixotrichodermium. Ponderosa pines.

37. Pileus dark to vinaceous or dark reddish brown. ....S. brevipes

Pileus viscid, glabrous or streaked, margin glabrous. Tubes yellow, pores 1-2 per mm. Stipe often very short, glandulae obscure or lacking. No veils. Spores 7-10 x 3-4 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Pines.

38. Pileus context white, surface fibrillose to scaly ....S. monticolus

Pileus viscid, light brown then brown, margin glabrous. Tubes yellow, sometimes radiately arranged, pores typically up to 1 mm in diam., sometimes up to 2 mm. Stipe dry, glandulose in apex. Spores 8.5-11 x 3-4 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Lodgepole pines.

38. Pileus not with the above combination of characters 39

39. Pileus buff to pinkish cinnamon. Pores pink to reddish (due to abundance of glandulae) ....S. kaibabensis

Pileus viscid, glabrous. Context white, yellow above tubes. Tubes buff then yellow. Stipe dry, white to pale yellow above, vinaceous below, glandulose. Spores 7.6-9.5 x 3.2-4.5 um. Cystidia clustered, clavate. Cuticle an ixotrichodermium. Ponderosa pines.

39. Pileus reddish brown to brown. Pores yellow ....S. granulatus

Pileus viscid, glabrous, white to pallid young then reddish brown to brown, margin glabrous. Tubes yellow, pores 1-2 per mm. Stipe strongly glandulose, whitish to yellow. No veils. Spores 7-9 x 2.5-3.5 um. Cystidia clustered, clavate to subcylindric. Cuticle an ixotrichodermium. Pines.

MYCOTAXON

Vol. IX, No. 1, pp. 297-340 June 12, 1979

THE ORDERS, FAMILIES, AND GENERA OF HYPOGEOUS ASCOMYCOTINA (TRUFFLES AND THEIR RELATIVES)

JAMES M. TRAPPE

Forest Service, U.S. Department of Agriculture
Pacific Northwest Forest and Range Experiment Station
Forestry Sciences Laboratory
Corvallis, Oregon 97331

SUMMARY

Of 31 genera of hypogeous Ascomycotina accepted, one is assigned to the monotypic order Elaphomycetales ord. nov. and the rest are placed in the Pezizales. The polyphyletic order Tuberales is abandoned. Nine families of the Pezizales include hypogeous species: Helvellaceae emend. nov., Pezizaceae emend. nov., Ascobolaceae, Pyronemataceae emend. nov., Balsamiaceae emend. nov., Geneaceae fam. nov., Terfeziaceae emend. nov., Tuberaceae emend. nov., and Carbomycetaceae. New genera and species are described: *Clelandia arenacea* gen. et sp. nov., *Dingleya verrucosa* gen. et sp. nov., *Choiromyces aboriginum* sp. nov., and *Peziza stuntzii* sp. nov. New combinations are proposed: *Barssia yezo-montana* (Kob.) Trappe, *Elaphomyces* subgen. *Ascoscleroderma* (Clém.) Trappe, *Genea kraspedostoma* (Gilk.) Trappe, *Labyrinthomyces varius* (Rodw.) Trappe, *Peziza ellipsospora* (Gilk.) Trappe, *Tuber hiromichii* (Imai) Trappe, *T. oligospermum* (Tul. & Tul.) Trappe, and *T. phlebodermum* (Gilk.) Trappe. A synoptic key to genera is provided.

Dr. Daniel Stuntz once emphasized to me that existing keys to the truffle genera were virtually unuseable by any but specialists and that improved, useable keys would be a real service to mycology. I can vouch that most past keys are troublesome to specialists as well. Part of the problem lies in the dearth of attention devoted to phylogenetic relationships of the hypogeous genera. Orders and families as traditionally conceived are broad, polyphyletic aggregations that include genera with similar morphologies developed by parallel or convergent evolution from disparate origins. Another source of trouble is the dichotomous key. The gross morphology of hypogeous fungi is relatively simple compared to epigeous fungi. The builder of a dichotomous key must use extraordinary care to avoid ambiguity and must often use characters that are well understood only by the specialist with considerable experience.

In this paper I propose reorganization of the genera of hypogeous Ascomycotina into groups based on phylogeny. The problems inherent in dichotomous keys are circumvented by use of a synoptic key. The paper is dedicated to Dr. Stuntz, who excited my original interest in mycology, and to Dr. Helen Gilkey, who tutored me in the hypogeous Ascomycotina for several years before her death.

PHYLOGENY

The hypogeous Ascomycotina traditionally have been treated as related to but taxonomically independent of the Pezizales. The two orders have been separated by forcible spore discharge of the former vs. no spore discharge of the latter (Burdsall 1968, Eckblad 1968, Kimbrough 1970, Korf 1973a). Trappe (1971) and Korf (1973a) suggest that evolution has proceeded from epigeous Pezizales to hypogeous Tuberales along parallel or convergent lines. Korf (1973a) presents a compelling case for the relationship and concludes: "I look with suspicion at any member of the Tuberales possessing paraphyses which do not greatly exceed in length cylindrical, 8-spored asci. How many of them are Pezizales in hiding?"

If we seek phylogenetic relationships as the foundation for taxonomy, we need not stop at relative lengths or shapes of paraphyses and asci. Burdsall (1968) began the transfer of genera of Tuberales to Pezizales with *Geopora*. An analogous process has begun with transfer of secotioid and related hypogeous Basidiomycotina from the Gasteromycetes to relevant families of Agaricales (Shaffer 1968, Smith 1973). In the taxonomic scheme presented in the following pages, I have discarded the artificial, anachronistic order Tuberales. All hypogeous genera that relate morphologically to families of Pezizales are assigned to those families. Some hypogeous families are retained with emendation but assigned to the Pezizales. The monotypic order Elaphomycetales is erected to accommodate the Elaphomycetaceae, which do not seem related to the Pezizales.

SYNOPTIC KEY

Korf's (1972) synoptic key to the Pezizales provided the means to discern relationships of genera of Tuberales to genera of Pezizales. In using it for that purpose, I became enamored with its ease and flexibility for identifying specimens in hand. With few exceptions, a hypogeous fungus can be identified by synoptic key as fast or faster than by dichotomous key. Without exception, the determination can be made with greater confidence, because all characters of the specimens can be brought into play. It is virtually impossible to identify immature specimens with a dichotomous key, but the chances are quite good with a synoptic key.

Users of the following key are advised to study Korf's (1972) lucid exposé on efficient use of synoptic keys. I merely summarize the procedure here. The key contains six major categories of characters: 1) Ascocarp morphology, 2) Peridium, 3) Asci, 4) Paraphyses, 5) Spores, and 6) Habitat. Each major category contains one or more couplets concerning individual characters. Numbers assigned to genera in the same sequence as in the ensuing generic descriptions are listed after the proper lead in each couplet. If the genus number occurs after only one lead of a couplet, it is in Roman type; if after more than one lead, in italic type.

To use the key, one can begin with any major category and couplet. To identify a specimen, the numbers recorded for the proper lead of the first couplet are jotted down on a piece of paper. Any second couplet is then selected, either from the same major category or from another. Numbers jotted on the paper from the first couplet but not listed in the proper lead of the second couplet are crossed out. The procedure is repeated with additional couplets until only one jotted number remains, representing the genus of the specimen being identified.

Korf (1972) suggests a number of refinements in the procedure to increase efficiency. Among these are clues to entering the synoptic key. To paraphrase him, a quick glance down the following list of "leading questions" should help speed identification of a hypogeous genus:

1. Does the ascocarp have an *orifice* or *distinct cavity*? If so, enter at Couplet 1-2.

2. Is the ascocarp *green, blue, violet, purple* or *black*? Enter at Couplet 1-5.

3. Does the ascocarp have a *distinct basal mycelial tuft* or *stem*? Enter at Couplet 1-6.

4. Is the interior of the ascocarp a *single chamber stuffed with spores* or is it *solid with the hymenium on the outer surface*? Enter at Couplet 1-9.

5. Do the asci become *blue in Melzer's reagent*? Enter at Couplet 3-4.

6. Are the ascus walls distinctly *brown in KOH*? Enter at Couplet 3-6.

7. Do the paraphysis *tips differentiate to form a peridium-like epithecium*? Enter at Couplet 4-2.

8. Are the *spores fusoid*? Enter at Couplet 5-1.

9. Are some *spores longer than 60 μm*? Enter at Couplet 5-2.

10. Are the *spores pitted* or *ornamented with hollow tubes*? Enter at Couplet 5-3.

11. Do the ascocarps occur in a *desert*? Enter at Couplet 6-1.

A note of caution is needed with hypogeous Ascomycotina. Maturation often takes several months, and it is quite common to find sizeable specimens that are immature. When immature, the spores of nearly all are hyaline and smooth and the full complement of spores may not be apparent in asci. Because glebal color often darkens with development of pigment in maturing spore walls, young specimens often have a much paler gleba than when mature. One of the better signals of immaturity is the absence of spores in many of the asci. If that is observed, many asci from different parts of a sporocarp or from different sporocarps in a collection should be examined to determine if some contain pigmented or ornamented spores. If one is still uncertain about mature spore color and ornamentation or number of spores per ascus, then the couplets involving these characters should be avoided in use of the synoptic key. The hazards of dealing with immature material are exemplified by *Choiromyces alveolatus* (Harkn.) Trappe, an immature collection of which served as the type species of a new genus, *Piersonia*, and other immature specimens as the respective types for four new species epithets (Trappe 1975a).

ASCOCARP MORPHOLOGY

1-1. *Shape*

a. subglobose to globose - all numbers except Roman type in b.

b. turbinate, irregular, lobed, cerebriform, etc. *2*, *3*, *5*, 6, *7*, 9, *10*, *12*, *14*, *15*, *16*, *19*, *20*, *21*, *22*, 23, *24*, *25*, *26*, *27*, *28*, *29*, *30*

1-2. *Orifice or cavity to interior*

a. absent - all numbers except Roman type in b.

b. present *2*, 5, 13, 17, *19*, *20*, 22, 23, *29*

1-3. *Largest dimension*

a. <1 cm *2*, 11, *13*, *16*, *17*, *18*, *20*, *22*, *23*, *25*, *26*, *29*, 30

b. 1-4 cm *1*, *2*, *3*, 4, *5*, *6*, 7, 8, 9, *10*, *12*, *13*, *14*, 15, *16*, *17*, *18*, 19, *20*, 21, *22*, *23*, *24*, *25*, *26*, *27*, 28, *29*, 31

c. >4 cm *1*, *2*, *5*, *6*, *10*, *12*, *14*, *21*, *24*, *25*, *27*, *29*

1-4. *Surface configuration*

a. smooth (even) *1*, 2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, *21*, 24, *25*, 26, 27, 28, *29*, 30, 31

b. with rounded warts *1*, *9*, *20*, *21*, *22*, 23, *25*, *29*

c. with angular warts *1*, 3, *9*, *20*, *21*, *22*, *25*, *29*

1-5. *Surface color*

a. absent (white) *5*, *6*, *8*, *15*, *17*, *26*, *28*, *29*, *31*

b. yellow (various tones) *2*, *8*, *10*, *18*, *23*, *24*, *25*, *26*, *27*, *28*, *29*, *30*, *31*

c. green or blue *1*, *25*

d. orange, pink, or red *2*, *9*, 16, *19*, *20*, *25*, *29*

e. brown (various tones) *1*, *2*, 3, 4, *5*, 7, *9*, *10*, *11*, 12, 13, 14, *15*, *17*, *18*, *19*, *20*, *21*, *22*, *23*, *24*, *25*, *26*, *27*, *29*, 30, *31*

f. violet or purple *6*, *11*

g. black *1*, *2*, *9*, *20*, *21*, *22*, *23*, *25*, *27*, *29*

1-6. *Basal mycelial tuft or stem*

a. absent - all numbers except Roman type in b.

b. present *1*, *4*, 5, *11*, 12, 17, 18, *20*, 22

1-7. *Surface texture*

a. glabrous *1*, *2*, *3*, *5*, *6*, 7, *8*, *10*, 11, *14*, *15*, 16, *17*, 18, *19*, 20, *21*, *22*, 23, *24*, 25, *26*, 27, 28, *29*, 30, 31

b. scabrous *1*, *2*, 4, *5*, *6*, *8*, *17*, *19*, *21*, *24*, *26*, *29*

c. pubescent or tomentose *1*, *3*, 9, 12, 13, *14*, *15*, *21*, *22*, 28, *29*

1-8. *Color of spore-bearing tissues at maturity (all are pale when immature)*

a. absent (white to pale gray) *5*, *6*, *7*, *10*, 12, 13, 14, 15, 17, 19, *20*, 22, *23*, *26*

b. yellow (various tones) *1*, *2*, *7*, 8, *10*, 16, *18*, *20*, 21, *23*, *24*, *25*, *26*, *27*

c. pink to red *9*, *28*

d. brown to olive (various tones) *1*, *2*, *3*, 4, *5*, *9*, *11*, *18*, *21*, *24*, *25*, *26*, *27*, *28*, *29*, 30, 31

e. violet to purple *2*, *5*, *6*, *11*

f. black *1*, *2*, *25*, *29*

1-9. *Glebal structure*

a. single, empty chamber *1*, *2*, 5, *6*, 13, *16*, 17, 22, *23*

b. single chamber stuffed with spores or hyphae *1*, *16*

c. multiple, empty chambers or open veins *2*, *6*, 7, 12, *14*, 15, 19, *20*, *23*

d. multiple chambers or veins loosely stuffed with hyphae *14*, *20*

e. solid with rounded to labyrinthiform pockets separated by walls of paler tissue 3, *8*, *9*, 10, 21, *24*, 27, 28, 31

f. solid with narrow, pale meandering veins 4, *6*, *8*, *9*, *24*, 25, 26, 29, 30

g. solid with hymenium on outer surface 11, 18

1-10. *Columella*

a. absent - all numbers except 4

b. present 4

PERIDIUM

2-1. *Presence*

a. absent 11, 18, *28*

b. present - all numbers except 11 and 18

2-2. *Epicutis*

a. interwoven to parallel hyphae *1*, *6*, 7, 10, *15*, *19*, *24*, *29*, 30, *31*

b. interwoven hyphae mixed with ± isodiametric cells 4, *6*, *8*, *15*, *19*, *24*, 27, *28*, *29*, *31*

c. ± isodiametric cells only *1*, 2, 3, 5, *6*, *8*, 9, 12, 13, 14, *15*, 16, 17, 20, 21, 22, 23, 25, 26, *28*, *29*

ASCI

3-1. *Shape*

a. cylindric to clavate *2*, 3, 5, 6, *7*, *8*, 11, 12, 13, 14, *15*, *16*, 17, 18, 19, *20*, 22, *23*, *24*, *25*, *28*

b. saccate to ellipsoid or obovoid *2*, 4, *7*, *8*, *9*, 10, *15*, *16*, *20*, *21*, *23*, *24*, *25*, *26*, *27*, *28*, *29*, *30*

c. subglobose to globose 1, *9*, *21*, *25*, *26*, *27*, *29*, *30*, 31

3-2. *Number of spores per ascus at maturity* (young specimens often show fewer spores per ascus than at maturity)

a. 1 only 30

b. 1-6 *4*, *14*, *15*, 16, *23*, 28, 29

c. 4-8 *4*, 9, *12*, *14*, *15*, *23*, *24*, *25*, *26*, 27

d. 8 only 1, 2, 3, 5, 6, 7, 8, 10, 11, *12*, 13, 17, 18, 19, 20, 21, 22, *24*, *25*, *26*, 31

3-3. *Spore arrangement in asci*

a. uniseriate only *2*, 3, 5, 6, 11, 12, 13, 14, 15, 16, 17, 18, *19*, 22, *23*, *24*, *25*, *28*

b. at least some biseriate *2*, *4*, 7, 8, *19*, *23*, *24*, *25*, *28*

c. irregularly clustered 1, *2*, *4*, 9, 10, 20, 21, *23*, *24*, *25*, 26, 27, 29, 31

3-4. *Iodine reaction in Melzer's reagent*

a. yellow to orange - all numbers except Roman type in b and c

b. blue only near ascus apex 5, 6, *7*

c. diffusely green or blue over most of ascus *7*, 8, 9, 10, 11, *25*

3-5. *Ascus arrangement*

a. mostly in a hymenial palisade 2, 3, 5, 6, 7, 8, 11, 12, 13, 14, 15, *16*, 17, 18, 19, 22, 23, 24, *25*

b. mostly randomly embedded in glebal tissue 4, 9, 10, 20, 21, *25*, 26, 27, 28, 29, 30, 31

c. borne among loose hyphae 1, *16*

3-6. *Color in KOH*

a. hyaline - all numbers except 31

b. brown *2*, *4*, 31

PARAPHYSES

4-1. *Presence*

a. paraphyses present - all numbers except Roman type in b.

b. paraphyses absent 1, 4, 9, 10, 16, 21, *25*, 26, 27, 28, *29*, 30, 31

4-2. *Tip differentiation*

a. tips free, rounded 2, 3, 5, 6, 7, *8*, 11, 12, *14*, 15, *16*, 19, *24*, *25*

b. at least some paraphyses growing beyond the palisade to stuff glebal veins or chambers *8*, *14*, *16*, *24*, *25*, 29

c. tips differentiated to form a peridium-like epithecium that encloses the hymenium 13, 17, 22, 23

SPORES

5-1. *Shape*

a. cylindric to ellipsoid *2*, 3, 4, 5, 6, 8, *10*, *12*, *14*, 17, *19*, 20, *21*, *22*, *23*, 24, *29*, *30*, *31*

b. fusoid *21*

c. subglobose *2*, *7*, *10*, *12*, *21*, *22*, *29*, *30*

d. globose 1, *2*, *7*, 9, *10*, 11, 13, *14*, 15, 16, 18, *19*, *21*, *22*, *23*, 25, 26, 27, 28, *29*, *30*, *31*

5-2. *Length (or diameter if globose) excluding ornamentation*

a. <20 µm *1*, *2*, *3*, 5, 6, 7, *8*, *9*, *10*, *15*, *16*, *18*, *20*, 25, *26*, *27*, 31

b. 20-40 µm *1*, *2*, *3*, *8*, *9*, *10*, 11, 12, 13, 14, *15*, *16*, 17, *18*, 19, *20*, *21*, *22*, *23*, 24, *26*, *27*, 28, *29*

c. 40-60 µm *1*, *2*, *4*, *15*, *20*, *21*, *22*, 23, *27*, *29*

d. >60 µm *4*, *21*, *29*, 30

5-3. *Ornamentation at maturity (spores of all species are smooth in youth)*

a. smooth 5, *6*, 7, *10*, 12, 13, 14, 16, 17, 19, *20*, 21, *31*

b. minute lines or roughening *10*, *20*

c. warts *1*, *2*, *3*, *4*, *6*, *8*, *9*, 15, 22, *24*, *25*, *27*

d. amorphous epispore *1*, *2*, *3*, *8*

e. pits *2*, *8*, *24*

f. spines or rods *1*, *2*, *4*, *9*, *11*, *18*, 23, *24*, *25*, *27*, *28*, *29*, *31*

g. hollow tubes *24*

h. reticulation *1*, *2*, *6*, *11*, *18*, 26, *27*, *28*, *29*, 30

5-4. *Color at maturity (spores of all species are hyaline in youth)*

a. hyaline 5, *6*, 7, *8*, *9*, 10, 11, 12, 13, 14, *15*, 16, 17, *18*, 19, 20, *21*, 22, *24*, *25*, *26*, *31*

b. yellow to pale brown *1*, *2*, *6*, *8*, *9*, *15*, *18*, *21*, *23*, *24*, *25*, 26, *27*, *29*, *31*

c. medium brown *1*, *2*, 3, *4*, *18*, *21*, *23*, *25*, *29*, *30*

d. dark brown to nearly opaque *1*, *4*, *29*, *30*

HABITAT

6-1. *Plant associations*

a. temperate to boreal - all except Roman type in b and d

b. tropical *1*, 17, *23*, *29*

c. subalpine to subarctic *1*, *2*, *12*, *29*

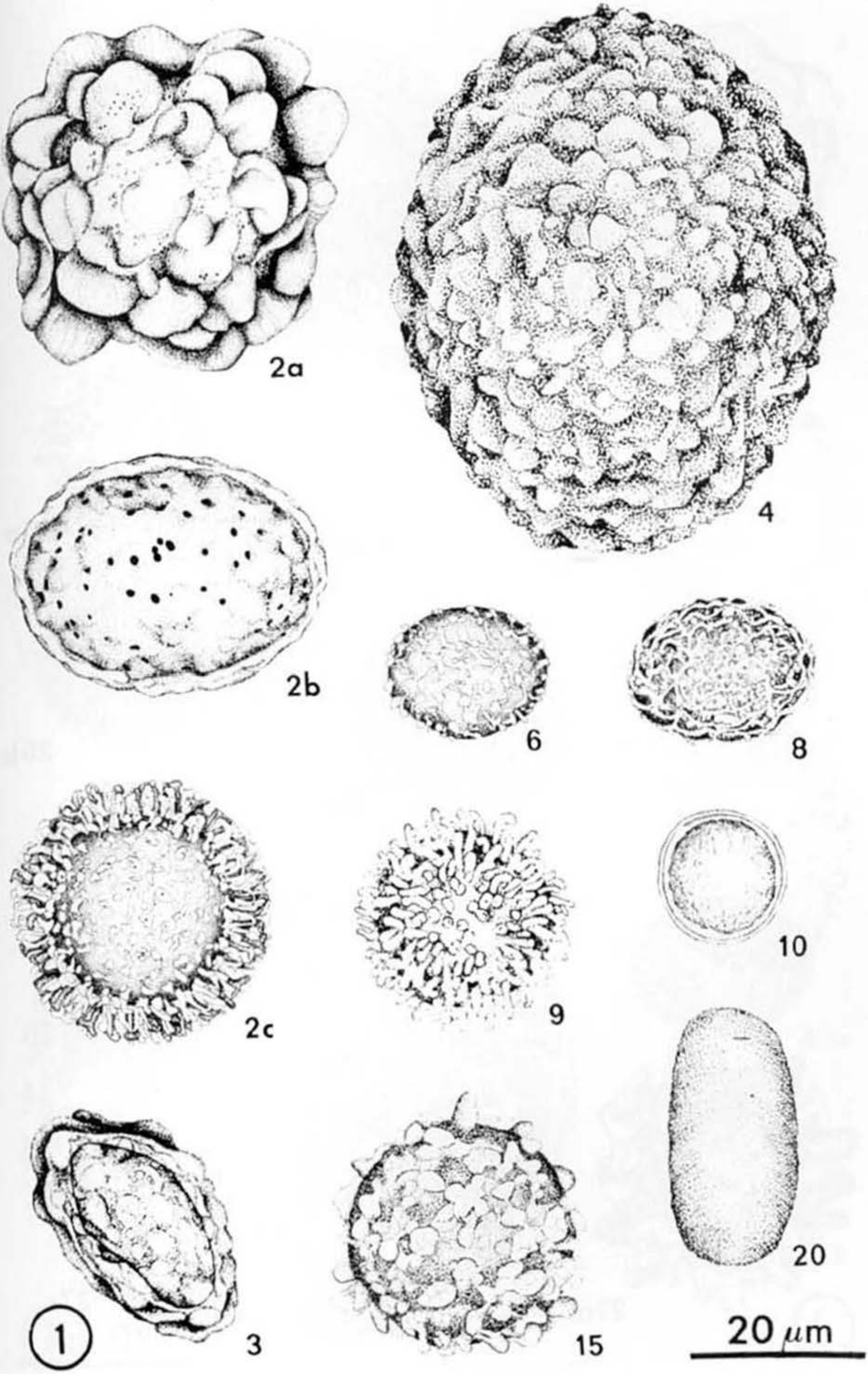
d. desert *5*, 7, 10, *14*, *21*, *24*, *27*, 31

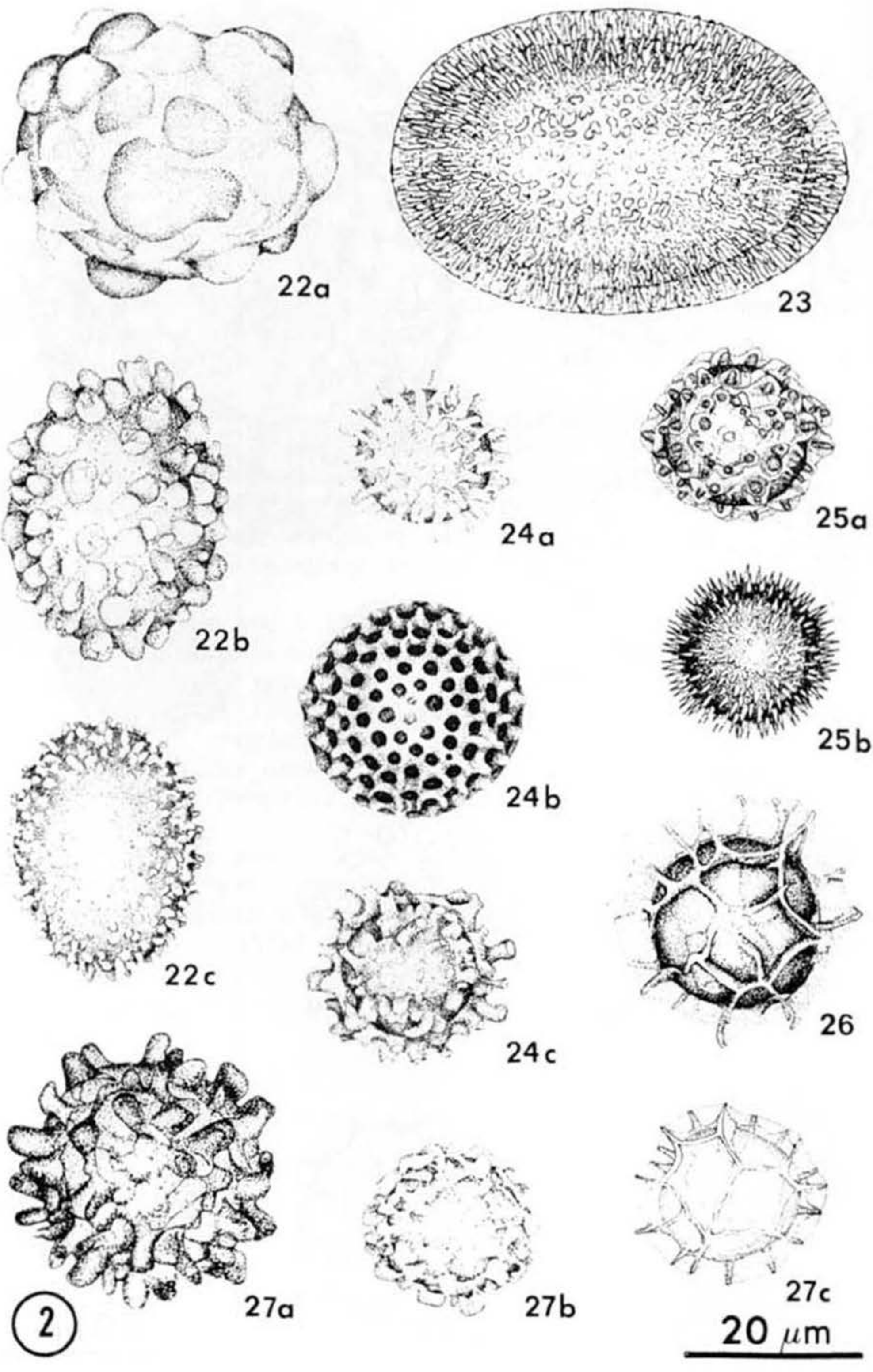
PLATES 1-3. Spores of representative species of genera of hypogeous Ascomycetes (numbered as in the text descriptions).

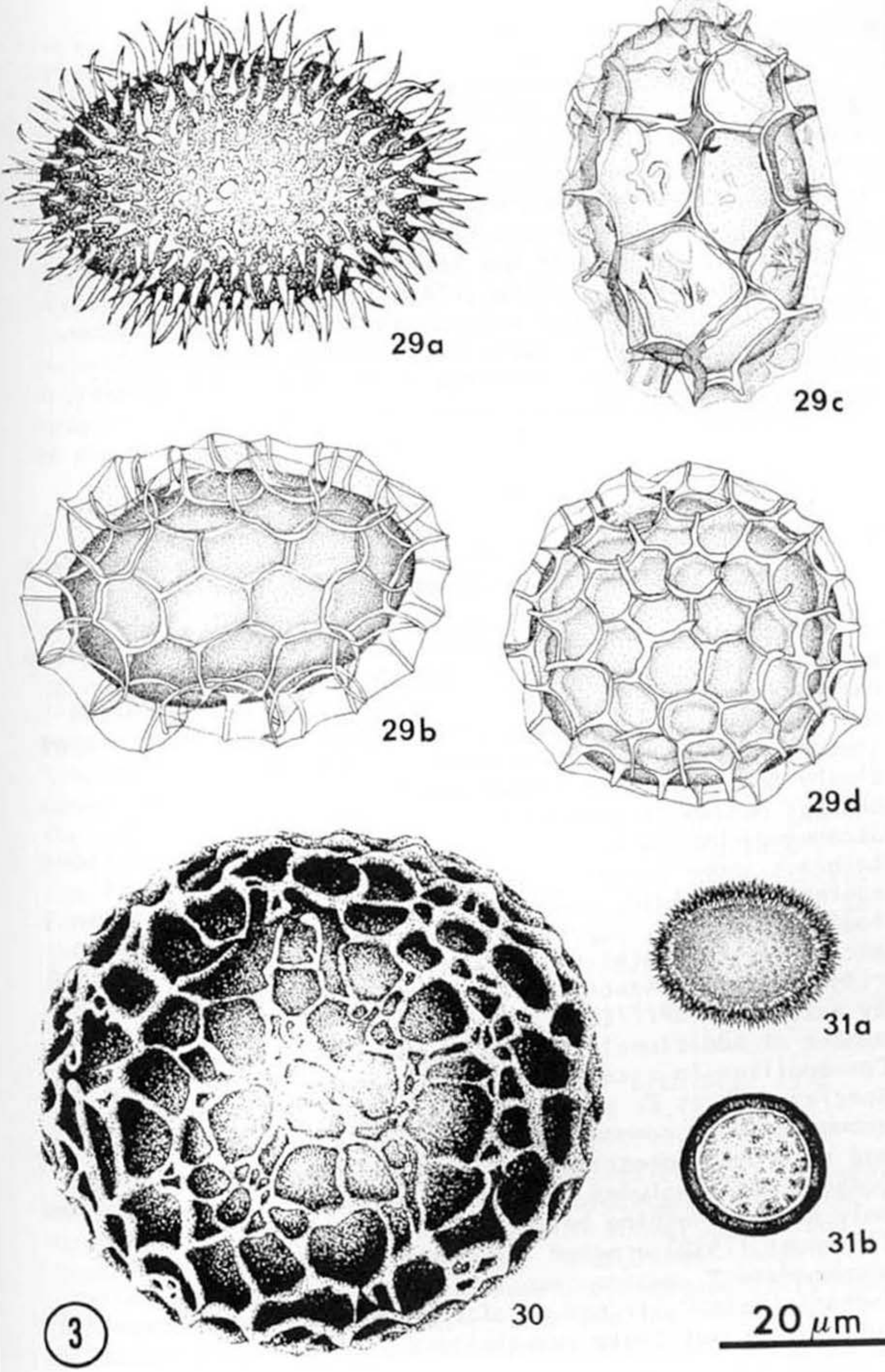
1--(2) *Hydnotrya* spp.: (2a) *H. tulasnei*, (2b) *H. variiformis*, (2c) *H. cerebriformis*. (3) *Dingleya verrucosa*. (4) *Fischerula macrospora*. (6) *Peziza ellipsospora*. (8) *Hydnotryopsis compacta*. (9) *Amylascus herbertianus*. (10) *Tirmania pinoyi*. (15) *Labyrinthomyces varius*. (20) *Balsamia alba*.

2--(22) *Genea* spp.: (22a) *G. gardneri*, (22b) *G. compacta*, (22c) *G. arenaria*. (23) *Genabea fragilis*. (24) *Choiromyces* spp.: (24a) *C. echinulatus*, (24b) *C. alveolatus*, (24c) *C. venosus*. (25) *Pachyphloeus* spp.: (25a) *P. conglomeratus*, (25b) *P. citrinus*. (26) *Hydnobolites cerebriformis*. (27) *Terfezia* spp.: (27a) *T. arenaria*, (27b) *T. claveryi*, (27c) *T. longii*.

3--(29) *Tuber* spp.: (29a) *T. brumale*, (29b) *T. besseyi*, (29c) *T. aestivum* var. *mesentericum*, (29d) *T. shearii*. (30) *Paradoxa monospora*. (31) *Carbomyces* spp.: (31a) *C. longii*, (31b) *C. emergens*.


2a
4
2b
6
8
2c
9
10
20
1
3
15
20 μm


22a
23
22b
24a
25a
25b
24b
22c
26
24c
27a
27b
27c
2
20 μm


29a
29c
29b
29d
30
31a
31b
3
20 μm

Order ELAPHOMYCETALES ord. nov.

Cleistothecia composed of a thick peridium enclosing a single chamber. Ascogenous hyphae emerge from the chamber lining to loosely stuff the chamber. *Asci* globose, mostly with 8 clustered spores, evanescent. *Spores* globose, ornamented, at maturity filling the ascocarp chamber as a powdery mass. DISCUSSION: The monotypic family Elaphomycetaceae has been the spurned stepchild of the hypogeous Ascomycotina, often placed in the Tuberales because it is hypogeous and not satisfyingly related to other orders (Fennell 1973, Korf 1973b). Because its relationships to the Tuberales or Pezizales are equally unsatisfying, it deserves erection of a new order.

Family ELAPHOMYCETACEAE Tulasne & Tulasne 1851

1. *Elaphomyces* Nees ex Fries 1829, lectotype *E. granulatus* Fries. SYNONYMS: See Dodge 1929.

Ascocarps subglobose, 1-3 (-4) cm in diam, the surface brown to dark blue or black, smooth or ornamented with hard, rounded warts, pyramids, or cones, often tomentose and enhusked by proliferated ectomycorrhizae of associated trees or shrubs. *Peridium* mostly 2-5 mm thick, crisp-fleshy to leathery or carbonaceous. *Gleba* a single chamber hollow in youth but soon loosely stuffed with ascogenous hyphae and finally packed with brownish yellow to black spore powder. *Asci* globose, with 8 clustered spores, nonamyloid, evanescent before spores are morphologically mature. *Spores* globose, 8-30 (-45) µm in diam excluding ornamentation of spines, reticulum, or spiralled ridges, in most species olive to brown or nearly opaque by maturity. SPECIES: ± 30 known, with a roughly equal number of additional species epithets as synonyms. Cosmopolitan in association with ectomycorrhizal hosts. Species such as *E. granulatus* Fr. and *E. muricatus* Fr. are among the more common hypogeous fungi in boreal, subalpine, and subarctic forests of the northern hemisphere. KEY: Dodge (1929) includes the common species but is recommended only because nothing better is available. DISCUSSION: Clémencet (1932) erected the genus *Ascoscleroderma* to accommodate *E. cyanosporus* Tul. & Tul., because it is "substipitate." It has an often ephemeral, basal mycelial tuft but is not truly substipitate. This feature hardly justifies a new genus and may, indeed, be subtly present in other *Elaphomyces* species. Because it may be a useful character for infrageneric separation, however, I reduce the rank of *Ascoscleroderma* to subgenus. Mature hypogeous specimens in the Basidiomycete genus *Scleroderma* can be mistaken for *Elaphomyces* spp. In both cases the powdery spore mass leaves little evidence of spore origins by maturity, and the spores are similar in appearance. Sporocarps of most *Scleroderma* spp., however, have a distinct basal attachment whereas this is obscure or lacking in *Elaphomyces*. Sterigmal attachments are generally evident on *Scleroderma* spores. *Scleroderma* spp. are never blue or black, never enhusked by proliferated mycorrhizae, and never have hard, rounded warts, pyramids, or cones on the sporocarp surface.

Order PEZIZALES sensu Korf 1973b emend. nov.

The order is emended to include hypogeous taxa with cylindric to globose asci sometimes embedded in tramal tissues rather than borne in a distinct hymenium and lacking forcible spore discharge. DISCUSSION: Korf (1973a) believes "the Tuberales to represent a biological unit rather than a phylogenetic one. Several distinct lines of the Pezizales have presumably given rise to members of the Tuberales, independently by loss of functional opercula." For phylogenetic integrity, the hypogeous taxa need to be transferred to appropriate families of Pezizales whenever the evidence so indicates. Families and genera of Tuberales that cannot be linked to those of epigeous Pezizales are retained as discreet entities within the Pezizales. The order Tuberales is abandoned.

Family HELVELLACEAE Dumortier 1829 sensu Korf 1972 emend. nov.

The family is emended to include astipitate, infolded and chambered to solid, hypogeous sporocarps with cylindric to globose asci sometimes embedded in tramal tissue and lacking forcible spore discharge. DISCUSSION: Korf (1973a) in effect emended the family to include astipitate, infolded and chambered ascocarps by the description of *Helvella astieri* Korf and Donadini. This species is essentially a *Hydnotrya* with operculate asci and hyaline spores. Transfer to the Helvellaceae of *Hydnotrya* and related genera evolved to spore dispersal by animal mycophagy is clearly in keeping with phylogenetic relationships.

2. *Hydnotrya* Berkeley & Broome 1846, monotype *H. tulasnei* (Berk.) Berk. & Broome. SYNONYMS: see Trappe 1975a. PLATE 1.

Ascocarps urnulate to cerebriform, 0.5-6 (-8) cm in diam, the surface pale yellow to yellowish pink, reddish brown, brown, or nearly black, smooth or minutely scurfy. *Peridium* composed of rounded to subangular, inflated cells often arranged in chains with clavate terminal cells. *Gleba* sometimes a single, empty, hymenium-lined chamber (small specimens) but usually with a few to many small to large chambers formed by complex infolding and fusing of sporocarp walls; trama concolorous with sporocarp surface; hymenia white in youth but reddish brown to brown at maturity. *Asci* cylindric to clavate or saccate, with 8 uniseriate to biseriate spores, nonamyloid, indehiscent, formed among paraphyses in a hymenial palisade (in a few species some asci also embedded in tramal tissue). *Spores* ellipsoid to globose, 16-34 x 16-35 µm excluding ornamentation, smooth in youth but soon with a yellow to brown, amorphous, cyanophilic epispore that is smooth, pitted, warty, or ridged. A few globose-spored species have echinulate spores. SPECIES: ± 12, with a roughly similar number of additional species epithets as synonyms. North America and Europe in ectomycorrhizal forests. The genus has not been reported yet from Asia but surely occurs there. KEY: Gilkey's (1954) key is the most complete available. In that key, *H. ellipsospora* Gilkey is a sparassoid *Peziza* and is thus recombined at the end of this paper, and *H. yukonensis* Gilkey is a synonym of *H. michaelis* (Fischer) Trappe. DISCUSSION: The echinulate, globose-spored species of *Hydnotrya* are structurally similar to the other species of the genus. Because of their spore characters, however, they do not conform completely to the Helvellaceae. If future studies reveal a different affinity, they may deserve generic separation.

3. *Dingleya* gen. nov., monotype *D. verrucosa* sp. nov. PLATES 1 and 4.

Ascocarps subglobose to irregular, 1-3.5 cm in diam, the surface verrucose with polyhedral warts, glabrous but with small, tomentose patches scattered among the warts. *Peridium* of inflated, ± isodiametric cells. *Gleba* solid, of pallid tramal tissue with narrow, labyrinthiform chambers lined with hymenial palisades and stuffed with asci and spores. *Asci* cylindric, with 8 uniseriate spores, nonamyloid, indehiscent, hyaline, formed among scattered paraphyses in a loose hymenium. *Spores* ellipsoid, 19-26 x 15-18 µm excluding ornamentation, smooth in youth but soon developing a brown, amorphous, cyanophilic, knobbed and ridged epispore. SPECIES: 1, New Zealand. DISCUSSION: *Dingleya* resembles *Hydnotrya* except for the solid gleba and verrucose surface. The former character seems likely to be an evolutionary advance towards spore dispersal by mycophagy. The latter may simply result from continued expansion of the gleba after the helvelloid epicutis of isodiametric cells has completed its development.

4. *Fischerula* Mattirolo 1928, monotype *F. macrospora* Matt. PLATE 1.

Ascocarps subglobose, astipitate to substipitate, 0.8-2.5 cm in diam, the surface yellowish pink to yellowish brown or dark brown, scabrous. *Peridium* of hyphae and inflated cells 5-30 (-40) µm in diam. *Gleba* solid, at maturity brown to dark brown, marbled with white to grayish yellow veins that emerge through the peridium; columella present or absent. *Asci* ellipsoid to obovoid, reniform, or clavate, with 1-6 (-8) uniseriate to clustered spores, nonamyloid, indehiscent, with 1-3 or more wall layers, randomly embedded in glebal tissue. *Spores* ellipsoid, 40-77 (-101) x 25-59 µm excluding ornamentation, smooth in youth, at maturity ornamented with conic warts, broad ridges, or agglutinated flexuous spines, dark brown. SPECIES: 2, Italy, Oregon and Washington. KEY: Trappe (1975b). DISCUSSION: *Fischerula* has distinct ties to *Hydnotrya* and thus to the Helvellaceae. It is analogous to the genus *Tuber* in having evolved to a morphology completely adapted to spore dispersal by mycophagy, with asci embedded in tissue. The strongly developed epispore may have particular functions related to the passage of spores through an animal digestive tract.

Family PEZIZACEAE Fries 1822 sensu Korf 1972 emend. nov.

The family is emended to include chambered or solid hypogeous taxa with cylindric to globose asci sometimes embedded in tramal tissue and lacking forcible spore discharge.

5. *Sarcosphaera* Auerswald 1869, monotype *S. macrocalyx* (Reiss) Auersw. [=*S. crassa* (Santi ex Stendel) Pouzar.] SYNONYMS: *Caulocarpa* Gilkey 1947.

Ascocarps when hypogeous subglobose, 2-6 cm in diam, sordid white to brown, glabrous to minutely scabrous, the upper surface furrowed and sometimes split open, short-stipitate. *Peridium* of inflated, irregular cells. *Gleba* a hollow chamber or occasionally 2-4 chambers formed by infolding of ascocarp walls, white to gray in youth becoming deep dingy violet by maturity. *Asci* cylindric, with 8 uniseriate spores, amyloid near the apex, operculate, formed among paraphyses in a hymenial palisade. *Spores* ellipsoid, 10-18 x 6-8 µm, smooth, hyaline. SPECIES: Apparently 1. Hypogeous fruiting of this normally epigeous Discomycete has been observed only under thick, felted humus in subalpine zones of western North America. DISCUSSION: Trappe (1975a) relates the taxonomic confusion resulting from the hypogeous fruiting of this fungus.

6. *Peziza* Linnaeus per St.-Amans 1821, lectotype *P. vesiculosa* Bull. per St.-Amans. SYNONYMS: see Korf (1973a) and Trappe (1975a) for hypogeous taxa.
PLATES 1 and 4.

Hypogeous *ascocarps* 2-6 (-12) cm in diam, urnulate to turbinate or cerebriform, white to pink or violet, glabrous to scabrous. *Gleba* nearly solid with veins or with chambers lined with hymenia. *Asci* cylindric, with 8 uniseriate spores, amyloid near the apex, operculate, formed among paraphyses in a hymenial palisade. *Spores* cylindric to ellipsoid or globose, 8-18 x 4-14 µm excluding ornamentation, smooth to verrucose or reticulate, hyaline to light brown. SPECIES: 6 hypogeous species, including *P. stuntzii* sp. nov. and *P. ellipsospora* (Gilkey) comb. nov. North America, Europe and Australia. KEY: Korf (1973a) includes species recognized to that time. In his key *P. jactata* Burds. & Korf in Burds. =*P. whitei* (Gilkey) Trappe (1975a). DISCUSSION: Korf (1973a) discusses the sparassoid species, some of which are hypogeous to subhypogeous, in relation to the genus as a whole.

7. *Clelandia* gen. nov., monotype *C. arenacea* sp. nov.

Ascocarps ± 2 cm in diam, deeply furrowed, glabrous. *Peridium* of interwoven hyphae. *Gleba* with empty, labyrinthiform chambers lined with hymenia. *Asci* cylindric to saccate, with 8 uniseriate to biseriate spores, diffusely amyloid with the reaction strongest near the apex, indehiscent, formed among somewhat shorter, scattered paraphyses in hymenial palisades. *Spores* broadly ellipsoid to subglobose, 10-12 x 8-10 μm, smooth, hyaline, mostly containing a deBary bubble. SPECIES: 1, Australia. DISCUSSION: *Clelandia* resembles *Peziza* sensu lato in several anatomical features, but its cleistothecial sporocarp and indehiscent asci justify its separation at the generic level.

8. *Hydnotryopsis* Gilkey 1916, monotype *H. setchellii* Gilk. PLATE 1.

Ascocarp subglobose to irregular, 1-3 cm in diam, white to sordid yellow, glabrous to minutely scabrous. *Peridium* of ± isodiametric cells, sometimes with intermingling hyphae. *Gleba* solid, with labyrinthiform chambers or meandering veins lined by hymenia and stuffed with asci, spores, and mycelium, grayish yellow to brownish yellow. *Asci* cylindric to clavate or saccate, with 8 uniseriate to biseriate or clustered spores, diffusely amyloid, indehiscent, formed among paraphyses in hymenial palisades. *Spores* ellipsoid, 11-22 x 10-18 μm excluding ornamentation, smooth in youth but soon developing an amorphous, papillose to foveolate epispore, brownish yellow. SPECIES: 2, California. KEY: Gilkey 1954 (as *Choiromyces*). DISCUSSION: In its evolution to a solid gleba, *Hydnotryopsis* is related to *Peziza* a step farther away than *Clelandia*. The species are discussed by Trappe (1975a). Fischer (1938) placed this genus in the Pezizaceae.

9. *Amylascus* Trappe 1971, holotype *A. herbertianus* (Cribb) Trappe. PLATE 1.

Ascocarps turbinate to plicate or lobed, 1-3 cm in diam, red to brown or blackish brown, verrucose, tomentose. *Peridium* with ± isodiametric cells. *Gleba* with meandering veins or labyrinthiform chambers lined with a peridium-like epithecium of ± isodiametric cells. *Asci* ellipsoid to obovoid or subglobose, with (3-) 5-8 clustered spores, diffusely amyloid, indehiscent, embedded in tramal tissue. *Spores* globose, 15-24 μm diam excluding ornamentation, smooth in youth but soon developing spines or mucilage-embedded rods and cones, hyaline to pale yellowish brown. SPECIES: 2, Australia. KEY: Trappe 1975c. DISCUSSION: *Amylascus* has considerable anatomical ties to *Peziza* sensu lato. It is a step farther removed from traditional Discomycetes than *Hydnotryopsis* in having lost the hymenial palisade.

10. *Tirmania* Chatin 1890, monotype *T. africana* Chatin [=*Tirmania nivea* (Desf. ex Fries) Trappe]. PLATE 1.

Ascocarps subglobose to turbinate or lobed, up to 14 cm in diam, glabrous, wrinkled or cracked, with a basal mycelial attachment, yellow to brown or reddish brown. *Peridium* with large hyphae and many inflated cells. *Gleba* solid, of white to light yellow or ochraceous fertile pockets separated by white, sterile but otherwise undifferentiated tramal veins. *Asci* ellipsoid to obovoid, with 8 clustered spores, diffusely amyloid (sometimes weakly), indehiscent, randomly embedded in tissue of fertile pockets. *Spores* broadly ellipsoid to globose, 16-23 x 13-19 μm, smooth or, if roughened, the ornamentation enclosed by a smooth epispore, hyaline. SPECIES: 2, West Asia and North Africa. KEY: Malençon (1973) describes both species. DISCUSSION: This genus has been assigned to the Terfeziaceae sensu lato (Trappe 1971). Macroscopically it seems far removed from the Discomycetes, but its anatomy relates much more closely to the Pezizaceae than to any genera of the Terfeziaceae *sensu stricto*.

Family ASCOBOLACEAE Boudier ex Saccardo emend. Korf 1972

11. *Sphaerosoma* Klotzsch in Dietrich 1839 sensu Korf 1972, monotype *S. fuscescens* Klotzsch in Dietr.

Ascocarps pulvinate to globose, 0.5-1.5 cm in diam, brown to purple, glabrous. *Peridium* lacking. *Asci* cylindric to clavate, with 8 uniseriate spores, diffusely amyloid, operculate, formed among paraphyses in a hymenial palisade covering the sporocarp surface. *Spores* globose, 20-30 μm in diam, echinulate or reticulate, hyaline. SPECIES: 3, North America and Europe. KEY: No satisfactory keys exist. DISCUSSION: The placement of this genus follows Korf (1972). I have not examined specimens.

Family PYRONEMATACEAE Corda 1842 sensu Korf 1972 emend. nov.

The family is emended to include chambered or solid hypogeous sporocarps with cylindric to globose asci sometimes embedded in tramal tissue and lacking forcible spore discharge.

12. *Geopora* Harkness 1885, monotype *G. cooperi* Harkn. SYNONYMS: see Burdsall 1968.

Ascocarps subglobose to globose, 1-7 (-10) cm in diam, cupulate to convoluted, brown, tomentose. *Peridium* of ± isodiametric cells. *Gleba* a hollow chamber or many-chambered from infolding of sporocarp walls, chambers lined with hymenia, white to gray. *Asci* cylindric, with (6-)-8 uniseriate spores, nonamyloid, operculate, formed among paraphyses in hymenial palisades. *Spores* ellipsoid to subglobose, 20-30 x 13-24 µm, smooth, hyaline. SPECIES: 12, Northern Hemisphere. KEY: Burdsall (1968). DISCUSSION: The disposition of *Geopora* is fully discussed by Burdsall (1968) and Korf (1972), who places it in subfamily Otideoideae, tribe Mycolachneae. Fischer (1938) had earlier assigned it to the Pezizaceae sensu lato.

13. *Hydnocystis* Tulasne & Tulasne 1845a, monotype *H. piligera* Tul. & Tul. SYNONYMS: see Trappe 1975a.

Ascocarps globose, 0.4-2 cm in diam, often substipitate, with a single opening from the interior, brown, tomentose. *Peridium* of subangular, ± isodiametric cells. *Gleba* a hollow chamber lined with an epithecium of interwoven hyphae. *Asci* cylindric to subclavate with 8 uniseriate spores, nonamyloid, indehiscent, formed in a hymenial palisade among paraphyses that extend to produce the epithecium (a few asci also embedded in the subhymenium). *Spores* globose, 24-35 µm in diam, smooth, hyaline. SPECIES: 2, Europe and Japan. KEY: Burdsall (1968) describes the type species and Kobayasi (1963) describes *H. japonica* (Kob.) Trappe. DISCUSSION: Fischer (1938) assigned *Hydnocystis* to the Pezizaceae sensu lato and Burdsall (1968) to the Geneaceae because of its epithecium-enclosed hymenium and indehiscent asci. In other respects, however, it little resembles Geneaceae sensu stricto. Its apparent relationship to the genus *Trichophaea* sensu Korf (1972) suggests placement in tribe Mycolachneae.

14. *Stephensia* Tulasne & Tulasne 1845b, monotype *S. bombycina* (Vittadini) Tul. & Tul. SYNONYMS: *Densocarpa* Gilkey 1954, *Elderia* McLennan 1961.

Ascocarps globose to irregular, 1-4(-7) cm in diam, light pinkish brown to brown, pubescent to tomentose (in one species the tomentum is evanescent on the upper ascocarp surface). *Peridium* of subangular to globose cells. *Gleba* pallid, infolded or with chambers lined with hymenia and loosely stuffed with cottony hyphae or asci and spores, by maturity the larger chambers often partly empty. *Asci* cylindric to narrowly clavate, with 1-8 uniseriate spores, nonamyloid, indehiscent, formed in a hymenial palisade among paraphyses that extend to stuff the chambers, a few asci often embedded in tramal tissue. *Spores* ellipsoid to subglobose or globose, 12-26 μm in diam if globose, 28-40 x 15-18 μm if ellipsoid, smooth, hyaline. SPECIES: 6, North America, Europe, West Asia, Indonesia, and Australia. KEY: Fischer (1938) is inadequate but the best available. DISCUSSION: *Stephensia* appears derived from genera in the tribe Mycolachneae emend. Korf (1972). McLennan's (1961) erection of the monotypic genus *Elderia* with *Stephensia arenivaga* Cooke & Massee as type species was based on a new collection presumed to be that species. It is actually a quite different taxon, described later in this paper as *Choiromyces aboriginum* sp. nov. The type collection of *S. arenivaga* satisfactorily conforms to the original concept of *Stephensia*.

15. *Labyrinthomyces* Boedijn 1939, monotype *L. steenisii* Boed. [=*L. varius* (Rodway) comb. nov.]. PLATE 1.

Ascocarps globose to subglobose or lobed, 1-4 cm in diam, the surface white to brown, glabrous to tomentose or areolate. *Peridium* of interwoven hyphae, ± isodiametric cells, or a mixture of the two. *Gleba* with labyrinthiform, open to appressed chambers lined with hymenia and often filled with asci and spores at maturity. *Asci* cylindric to clavate or ventricose, with 2-8 uniseriate spores, nonamyloid, indehiscent, formed among shorter to equal paraphyses in a hymenial palisade. *Spores* globose, 18-47 μm in diam excluding ornamentation, smooth in youth but soon developing scattered to crowded, hemispherical warts, hyaline to light brown. SPECIES: 4, Australia, Indonesia, and North Africa. KEY: Beaton and Weste (1977).

DISCUSSION: The type of *Labyrinthomyces* seems well related to tribe Mycolachneae. At least one species, *L. donkii* Malençon, diverges sufficiently from the type concept in peridial and spore characteristics that it may deserve assignment to another genus. An examination of the type collection of *Stephensia varia* Rodway revealed it to be synonymous with *L. steenisii*. The Rodway epithet having priority, it is recombined as *L. varius*.

16. *Paurocotylis* Berkeley in Hooker 1855, monotype *P. pila* Berk. in Hook.

Ascocarps subglobose to flattened or irregular, 0.5-3 cm in diam, glabrous, orange-red to scarlet. *Peridium* of ± isodiametric cells. *Gleba* of one or a few chambers divided by loosely formed, irregular walls, empty except for ingrowing mycelial tufts and protrusions, lined with tangled asci, pale yellow to pale brownish yellow. *Asci* of various shapes, with 2-6 uniseriate to irregularly arranged spores, nonamyloid, indehiscent and collapsing, loosely arranged in a quasi-hymenium that lacks paraphyses. *Spores* globose, 17-23 µm in diam, smooth, hyaline. SPECIES: 1, New Zealand and England. DISCUSSION: This colorful species is described in detail by Dennis (1974). It suggests an aleurioid fungus gone underground and fits nicely in tribe Aleurieae sensu Korf (1972).

17. *Petchiomyces* Fischer & Mattirolo in Fischer 1938, monotype *P. thwaitesii* (Berk. & Broome) Fisch. & Matt. in Fisch.

Ascocarps urnulate, 0.5-3 cm in diam, white to brown, glabrous to scabrous. *Peridium* of isodiametric cells that cover both the outer surface and hymenium. *Gleba* a hymenial palisade with the paraphysis tips differentiated to form a peridium-like epithecium. *Asci* cylindric to clavate, with 8 uniseriate spores, nonamyloid, indehiscent, formed among paraphyses in a hymenial palisade enclosed by the epithecium. *Spores* ellipsoid, 24-37 x 14-17 µm, smooth, hyaline. SPECIES: 2, Indonesia and Sri Lanka. KEY: Fischer 1938. DISCUSSION: *Petchiomyces* is apparently epigeous but is included here because of its traditional assignment to the Tuberales. Its relationship to genera of Pyronemataceae is unclear, but it seems akin to *Geopyxis* sensu Korf and thus is assigned to subfamily Ascophanoideae, tribe Geopyxideae (Korf 1972) for the present. *Petchiomyces kraspedostoma* Gilkey was originally described from a collection of mostly immature ascocarps. Extensive examination of the type collection has revealed that its mature spores are ornamented and that it conforms to the genus *Genea* in other respects as well, so it is recombined into that genus.

18. *Sphaerozone* Zobel 1854 sensu Korf 1972, monotype *S. tulasnei* Zob. [=*Sphaerozone ostiolatum* (Tul. & Tul.) Setchell].

Ascocarps pulvinate to globose, 0.5-1.5 cm in diam, yellow to brown or olive. *Peridium* lacking. *Asci* cylindric, with 8 uniseriate spores, nonamyloid, operculate, formed among paraphyses in a hymenial palisade covering the sporocarp surface. *Spores* globose, 8-25 µm in diam, echinulate or reticulate, hyaline to yellowish or brown. SPECIES: 4, North America, Europe, and Australia. KEY: No dependable key exists. DISCUSSION: The placement of this genus follows Korf (1972). I have not examined specimens.

Family BALSAMIACEAE Fischer 1897 emend. nov.

Ascocarps subglobose, smooth to verrucose. *Gleba* solid, with narrow, open or stuffed veins or with pockets of fertile tissue separated by veins of sterile but otherwise undifferentiated tissue. *Asci* cylindric to globose, nonamyloid, indehiscent, formed in a hymenial palisade or randomly embedded in tramal tissue or fertile pockets. *Spores* fusoid-apiculate to ellipsoid, smooth, hyaline to olivaceous. DISCUSSION: The family as emended includes three smooth-spored genera not readily assignable to other families of Pezizales with present evidence. *Barssia* and *Balsamia* have been placed in Tuberaceae and *Picoa* in Terfeziaceae by most authors (Fischer 1938, Gilkey 1954, Hawker 1954, Lange 1956). Both families sensu lato are polyphyletic.

19. *Barssia* Gilkey 1925, monotype *B. oregonensis* Gilkey. SYNONYMS: *Phymatomyces* Kobayasi 1937.

Ascocarps subglobose, some with an apical or lateral cavity, 1-4 cm in diam, smooth or erratically verrucose, glabrous to scabrous, yellowish pink to reddish brown. *Peridium* of large, interwoven hyphae or inflated cells.

Gleba solid, except for broad to narrow hymenium-lined veins. *Asci* cylindric to narrowly clavate, with 8 uniseriate to incompletely biseriate spores, nonamyloid, indehiscent, formed in a hymenial palisade among paraphyses. *Spores* oblong, 24-36 x 12-21 µm, or globose, 19-23 µm in diam, smooth, hyaline. SPECIES: 2, Pacific Northwestern United States and Japan. KEY: None exists. DISCUSSION: The type and only collection of *Phymatomyces yezo-montanus* Kobayasi was a casualty of World War II (Gilkey 1961). Its similarities to *Barssia* seem to exceed the differences, so the two monotypic genera are merged by the recombination *Barssia yezo-montana*.

20. *Balsamia* Vittadini 1831, lectotype *B. vulgaris* Vitt.
SYNONYMS: see Trappe (1975a). PLATE 1.

Ascocarps subglobose to irregular, 0.7-2(-4) cm in diam, sometimes with an apical or lateral cavity, verrucose, brownish orange to brown or black, often with a basal mycelial tuft but otherwise glabrous. *Peridium* of subangular to globose cells. *Gleba* with narrow, meandering, open or hypha-stuffed veins or labyrinthiform chambers lined with a palisade of paraphyses, white to pale yellow. *Asci* cylindric to broadly clavate or ellipsoid, with 8 clustered spores randomly embedded in the trama or occasional in the palisade of paraphyses lining glebal veins. *Spores* obtuse to ellipsoid, 13-42 x 10-18 µm, smooth or rarely with nearly submicroscopic radial lines, hyaline. SPECIES: 6, North America, Europe and North Africa. KEY: Hawker (1954) for European species, Gilkey (1954) for American species (including the genus *Pseudobalsamia*). No complete keys exist. DISCUSSION: *Balsamia* is a well defined genus that has suffered little confusion since it was described.

21. *Picoa* Vittadini 1831, lectotype *P. juniperi* Vitt.
SYNONYMS: see Trappe (1971).

Ascocarps subglobose to irregular, 1-7 cm in diam, roughened to verrucose, brown to black, glabrous or pubescent. *Peridium* of subangular to globose cells. *Gleba* solid, of fertile pockets separated by sterile but otherwise undifferentiated veins, the fertile pockets gray to olive or brown and the veins pallid. *Asci* ellipsoid to obovoid or globose, with 8 clustered spores, nonamyloid, indehiscent, embedded in glebal tissue. *Spores* apiculate-fusiform to subcitriform, ellipsoid, or globose, 25-105 x

19-43 μm, smooth, hyaline to olive or brown. SPECIES: 5, North America, Europe, West Asia, and North Africa. KEY: no inclusive keys exist. DISCUSSION: *Picoa* has traditionally been placed in the Terfeziaceae, but it appears to have no close phylogenetic relationship to the genus *Terfezia*.

Family GENEACEAE fam. nov.

Ascocarps hollow, the interior lined with peridium-like epithecia. *Asci* cylindric to clavate, 4-8 spored, nonamyloid, indehiscent, borne among paraphyses in continuous or interrupted hymenia. *Spores* ellipsoid or globose, papillate to echinulate, hyaline to pale brown. DISCUSSION: This family first appeared in the literature in the late 1930's but has never been validly described. Various authors have included various genera, but as described here it is restricted to *Genea* and *Genabea*.

22. *Genea* Vittadini 1831, lectotype *G. verrucosa* Vitt. SYNONYMS: see Trappe (1975a). PLATE 2.

Ascocarps globose to irregular, 0.3-2(-3) cm in diam, with an apical orifice to the hollow interior and mostly with a tuft of basal mycelium, light brown to black, verrucose, glabrous to tomentose. *Peridium* and epithecium of subangular to globose cells. *Gleba* a single, even to irregular chamber lined with an epithecium similar to the peridium and enclosing the white to gray trama and continuous or interrupted hymenial palisade. *Asci* cylindric to clavate, with 8 uniseriate spores, nonamyloid, indehiscent, borne in a hymenial palisade among paraphyses whose tips differentiate to form the epithecium. *Spores* ellipsoid to subglobose or rarely globose, 20-45 x 12-34 μm excluding ornamentation, smooth in youth but soon developing rounded to conic warts that dissolve in 5% KOH, hyaline. SPECIES: ± 24, North America and Europe. KEY: Gilkey (1954) for North American species, Fischer (1938) for European. Revised keys are badly needed for the entire genus. DISCUSSION: Relationships of *Genea* to genera of Pezizales have not yet been satisfactorily established.

23. *Genabea* Tulasne & Tulasne 1845a, monotype *G. fragilis* Tul. & Tul. SYNONYMS: see Trappe (1975a). PLATE 2.

Ascocarps subglobose to convoluted and knobby, 0.2-1.5(-2) cm in diam, often with an orifice to the convoluted, hollow interior, finely verrucose, lacking a basal mycelial tuft, yellowish gray to brown or black, glabrous. *Peridium* and epithecium of subangular to rounded, ± isodiametric cells. *Gleba* an irregular chamber lined with an epithecium similar to the peridium and enclosing the white to gray or yellowish gray trama and pockets of hymenia. *Asci* clavate to ellipsoid, with (1-)4-8 uniseriate to biseriate or clustered spores, nonamyloid, indehiscent, borne in a hymenial palisade among paraphyses whose tips differentiate to form the epithecium. *Spores* ellipsoid to globose, 26-53(-70) × 20-53(-70) µm excluding ornamentation, smooth in youth but soon developing prominent spines, grayish yellow to brown. SPECIES: 5, North America and Europe. KEY: Gilkey (1954) for North American species, Fischer (1938) for European. DISCUSSION: Relationships of *Genabea* to *Genea* are discussed by Trappe (1975a).

Family TERFEZIACEAE Fischer 1897 emend. nov.

Ascocarps solid, the gleba marbled with meandering veins of hymenia or isodiametric cells or tramal tissue that encloses fertile pockets. *Asci* cylindric to globose, with 4-8 uniseriate to clustered spores, nonamyloid, indehiscent, borne among paraphyses in a hymenial palisade or randomly embedded in tramal tissue. *Spores* globose, ornamented with rounded warts, cones, hollow rods, spines or an irregular reticulum, hyaline to pale brown. DISCUSSION: The past concept of the Terfeziaceae (Trappe 1971) has been based largely on gross morphology and thus has included disparate genera such as *Terfezia* with nonamyloid asci and globose, ornamented spores; *Picoa* with nonamyloid asci and variously shaped, smooth spores; *Amylascus*, with amyloid asci and globose, ornamented spores; and *Tirmania*, with amyloid asci and ellipsoid to globose, smooth spores. The latter three genera have been assigned to other families earlier in this paper. The family Terfeziaceae as emended here is based primarily on ascus and spore characteristics that provide a common thread through genera that have evolved progressively to spore dispersal by mycophagy. The Terfeziaceae appear to be related to the Pyronemataceae, but the connections are uncertain at present.

24. *Choiromyces* Vittadini 1831, monotype *C. meandriformis* Vitt. [=*C. venosus* (Fries) T. Fries]. SYNONYMS: see Trappe (1975a). PLATE 2.

Ascocarps subglobose to irregular, 1-10 cm in diam, smooth to verrucose, pale yellow to yellowish brown, glabrous to scabrous or pubescent. *Peridium* of broad interwoven hyphae, often with many cells inflated. *Gleba* solid, with white to pallid trama marbled with narrow, brownish yellow to brown veins filled by opposing hymenia and hyphae or occasionally open. *Asci* cylindric to clavate or saccate, mostly with 8 uniseriate to clustered spores, nonamyloid, indehiscent, formed among paraphyses in a hymenial palisade. *Spores* globose, 10-30 μm in diam excluding ornamentation, smooth in youth but soon developing a pitted epispore, minute projections, spines, or hollow-rods, hyaline to light brown. SPECIES: 5, North America, Europe, Africa, and Australia, including *C. aboriginum* sp. nov. KEY: no satisfactory keys exist. DISCUSSION: With its fertile hymenium, *Choiromyces* is the closest of the family to pezizaceous ancestors.

25. *Pachyphloeus* Tulasne & Tulasne 1845a, monotype *P. melanoxanthus* (Tul. in Berk.) Tul. & Tul. SYNONYMS: see Trappe (1975a). PLATE 2.

Ascocarps subglobose, 0.5-5 cm in diam, often with an apical depression or cluster of grooves, scabrous to verrucose, brownish yellow to yellowish green, red, or black, glabrous. *Peridium* of subangular to globose isodiametric cells. *Gleba* solid, grayish yellow to nearly black marbled with pallid veins that often tend to converge near the sporocarp apex. *Asci* cylindrical to clavate, ellipsoid, or subglobose, with 8 uniseriate to biseriate or clustered spores, nonamyloid, indehiscent, borne irregularly as a lining to veins or embedded randomly in glebal tissue. *Spores* globose, 14-21 μm in diam excluding ornamentation, smooth in youth but soon developing mucilage-embedded to free papillae or spines, hyaline to brown. SPECIES: 6, North America, Europe, and Japan. KEY: Gilkey (1954) for North America species, Hawker (1954) or Lange (1956) for European species. DISCUSSION: The verrucose peridium of isodiametric cells separates *Pachyphloeus* and *Hydnobolites* from other genera of the Terfeziaceae. Spores and ascus characters, however, suggest a relationship to *Choiromyces* on the one hand and *Terfezia* on the other.

26. *Hydnobolites* Tulasne & Tulasne 1843, monotype *H. cerebriformis* Tul. & Tul. PLATE 2.

Ascocarps irregular, 0.3-3 cm in diam, smooth, white to brown, glabrous to minutely scabrous. *Peridium* of ± isodiametric cells. *Gleba* solid, gray to yellowish brown marbled with veins lined with cells similar to those of the peridium. *Asci* saccate to ellipsoid or subglobose, with (4-)8 clustered spores, nonamyloid, indehiscent, borne randomly in tramal tissue. *Spores* globose, 12-24 µm in diam, smooth in youth but soon developing an alveolate reticulum, hyaline to pale brown. SPECIES: 2, North America and Europe. *H. californicus* Fischer is known only from North America. *H. cerebriformis* had been regarded as a strictly European species, but specimens collected in Iowa by Christopher Walker (personal communication) prove its presence in America as well. KEYS: Gilkey (1954) describes *H. californicus* and Hawker (1954) and Lange (1956) describe *H. cerebriformis*. DISCUSSION: This genus is close to *Pachyphloeus* on the one hand and to *Terfezia* on the other.

27. *Terfezia* (Tulasne & Tulasne) Tulasne & Tulasne, lectotype *T. leonis* Tul. & Tul. nom. illeg. [=*T. arenaria* (Moris) Trappe]. SYNONYMS: see Trappe (1975a). PLATE 2.

Ascocarps subglobose to turbinate or irregular, 2-10 cm in diam, smooth, brownish yellow to brown or brownish black, glabrous. *Peridium* of broad hyphae with inflated cells. *Gleba* solid, with yellowish to dark brown fertile pockets separated by paler but otherwise undifferentiated sterile tramal veins. *Asci* saccate to globose, with (3-)5-8 clustered spores, randomly embedded in tissue of fertile pockets. *Spores* globose, 14-55(-64) µm excluding ornamentation, smooth in youth but soon developing an ornamentation of mucilage-embedded or free spines, papillae, or a reticulum, light yellowish brown. SPECIES: 12, southern North America, South America, Central and Southern Europe, Africa, and Asia. KEY: Gilkey (1954) for American species, Fischer (1938) for European, African, and Asian species. The genus needs monographing and new keys. DISCUSSION: As the type genus for the family, *Terfezia* is closely related to other genera of the family in terms of anatomical characteristics, with the possible exception of *Delastria*.

28. *Delastria* Tulasne & Tulasne 1843, monotype *D. rosea* Tul. & Tul.

Ascocarps subglobose to turbinate or irregular, 1-3 cm in diam, even, white to nearly black, velvety to tomentose. *Peridium* absent or of interwoven hyphae with many inflated cells, sometimes entirely of isodiametric cells. *Gleba* of rosy to brown fertile pockets separated by pallid veins. *Asci* clavate to saccate, with 2-4 mostly uniseriate spores, nonamyloid, indehiscent, embedded randomly in tramal tissue. *Spores* globose, 23-35 μm excluding ornamentation, smooth in youth but soon developing an ornamentation that varies markedly from a broad reticulum to crowded spines, even between spores within an ascus. SPECIES: 1, southern Europe and north Africa. KEY: The single species of this genus is described by Fischer (1938). DISCUSSION: *Delastria* is an unusual genus in many respects. I place it in the Terfeziaceae because of its globose, ornamented spores, but its relationship to the family is more tenuous than that of the other genera.

Family TUBERACEAE Dumortier 1822 emend. nov.

Ascocarps solid, marbled with hypha-stuffed veins meandering through fertile tissue. *Asci* ellipsoid to globose, with 1-6 clustered spores, randomly embedded in tramal tissue. *Spores* ellipsoid to globose, spinose to geometrically reticulate, pale brown to dark brown, the spores in single-spored asci larger than those in multi-spored asci within a given sporocarp. DISCUSSION: The Tuberaceae sensu lato has been a catchall for genera that didn't fit other families as conceived by previous authors. As defined here, it includes only the genera *Tuber* (including *Lespiaultinia* and *Mukagomyces*) and *Paradoxa*. It differs most strikingly from the Terfeziaceae in spore characteristics.

29. *Tuber* Sibthorp ex Fries 1823, lectotype *T. cibarium* Sibth. ex Fries (=*T. brumale* Vittadini). SYNONYMS: see Trappe (1975a), also *Mukagomyces* Imai 1940 and *Lespiaultinia* Zobel 1854. PLATE 3.

Ascocarps subglobose to much lobed and irregular, 0.3-12 cm in diam, smooth to coarsely verrucose, with scattered or clustered, pubescent furrows, white to yellow, red, brown, or black, glabrous to pubescent or tomentose.

Peridium of interwoven hyphae or ± isodiametric cells or a mixture of both. *Gleba* solid, white to gray in youth but gradually becoming brown to black as spores mature, marbled with meandering, white to grayish yellow veins often lined in youth with an ephemeral, erratic to regular palisade of paraphyses that grow out to stuff the veins with interwoven hyphae, the veins occasionally opening to furrows on ascocarp surface. *Asci* ellipsoid to obovoid or globose, with 1-5(-6) clustered spores, nonamyloid, indehiscent, randomly embedded in glebal tissue. *Spores* ellipsoid to globose, 32-88 x 21-54 µm excluding ornamentation in single-spored asci, 21-52 x 15-38 µm in 4-spored asci (spore size within a given sporocarp varying inversely with number of spores/ascus), smooth in youth but soon developing an ornamentation of spines or an alveolate reticulum, brownish yellow to dark brown. SPECIES: ± 60 with a similar number of additional species epithets as synonyms. Cosmopolitan in association with ectomycorrhizal tree and shrub hosts. KEY: No existing keys can be recommended, because the genus badly needs monographing with special attention to sharpening of species concepts. DISCUSSION: The wide range of variations now known for this large genus easily encompass the small genera *Lespiaultinia* and *Mukagomyces*, the species of which are recombined as *Tuber* spp. here. *Mukagomyces*, indeed, appears to have been erected as a result of a misunderstanding of the terms "venae externae" and "venae internae" commonly used in describing the glebal structure of *Tuber* spp. Because such misunderstanding is widespread and because the terms have not been uniformly defined or applied, I avoid them altogether.

30. *Paradoxa* Mattirolo 1935, monotype *P. monospora* Matt. PLATE 3.

Ascocarps subglobose to irregular, 0.4-1 cm in diam, smooth but with prominent furrows, brownish yellow to reddish brown, glabrous. *Peridium* of interwoven hyphae. *Gleba* solid, pallid in youth, by maturity blackish brown with pallid to brown meandering veins. *Asci* ellipsoid to globose, 1-spored, nonamyloid, indehiscent, randomly embedded in tramal tissue. *Spores* broadly ellipsoid to globose or occasionally irregular, 57-80 x 55-80 µm excluding ornamentation, smooth in youth but soon developing an alveolate reticulum, very dark brown at maturity. SPECIES: 1, Italy. DISCUSSION: *Paradoxa* has been placed in the Terfeziaceae sensu lato, but in anatomy and spore characteristics it is clearly related to *Tuber*.

Family CARBOMYCETACEAE Trappe 1971

31. *Carbomyces* Gilkey 1954, holotype *C. emergens* Gilkey.
PLATE 3.

Ascocarps subglobose, 2-4 cm in diam, smooth, white to dull yellow or brown, glabrous. *Peridium* of interwoven, periclinal hyphae, with many cells inflated in the subcutis. *Gleba* solid, of brown fertile pockets separated by white to olive veins. *Asci* subglobose to globose, with 8 clustered spores, nonamyloid, indehiscent but disintegrating at maturity, brown, randomly embedded in tissue of fertile glebal pockets. *Spores* ellipsoid, 17-19 x 11-14 µm excluding ornamentation of spines, or globose, 10-19 µm and smooth, hyaline to pale brownish pink. SPECIES: 3, deserts of southwestern United States. KEY: Gilkey (1954) includes two of the three species. DISCUSSION: *Carbomyces* species apparently develop hypogeously but often emerge, dry out, and are blown about by wind. In the dry stage, the gleba is friable to powdery because the greatly inflated glebal cells collapse. Relationships of *Carbomyces* to other Ascomycotina are unknown.

NEW TAXA

ELAPHOMYCETALES *ordo nov. Cleistothecia 0.5-4 cm in diam, persaepe ectomycorrhizis involuta, cava vel pulvere sporarum repleta. Peridium crassum, carnosum, coriaceum vel carbonaceum, laeve vel manifeste verrucosum, cinnamomeum, indigoticum vel atrum, glabrum vel tomentosum. Asci globosi, octospori, inamyloidei, indehiscentes, evanescentes. Sporae globosae, spinosae vel reticulatae, fulvae, brunneae vel opacae. Monotypus: Elaphomycetaceae.*

GENEACEAE *fam. nov. Ascocarpia 0.5-2 cm in diam, globosa vel irregularia, cava, orificio; cavitas aequata vel irregularis, epithecio peridiaceo limitata. Peridium verrucosum, cerinum, brunneum, vinaceum vel atrum, glabrum vel tomentosum. Asci cylindrici vel late clavati, octospori, inamyloidei, indehiscentes, inter paraphyses in hymeniis inclusis continuis vel interruptis portati. Epithecium apicibus differentiatis paraphysium formatum. Sporae ellipsoideae vel globosae, verrucosae vel spinosae,* *hyalinae vel bruneolae. Genera duo: Genea (holotypus) et Genabea.*

CLELANDIA ARENACEA *gen. et sp. nov. Ascocarpia exsiccata ± 2 cm in diam, profunde sulcata. Peridium glabrum, pallide fulvum, arena adherenti velatum. Gleba loculis vacuis labyrinthinis, hymeniis limitatis. Asci cylindrici vel saccati, octospori, valde amyloidei. Sporae late ellipsoideae vel subglobosae, 10-12 x 8-10 µm in diam, dispersae, inferiores quam asci. Holotypus: ADW 15885.*

Etymology: In honor of the collector, Australian mycologist J. B. Cleland, Latin, *arenaceus* (sandy).

Ascocarps hypogeous or subhypogeous, as dried ± 2 cm in diam, deeply furrowed. *Peridium* glabrous, pale orange brown as dried but appearing dark reddish brown from adherent sand. *Gleba* pale brownish yellow, with empty, labyrinthine chambers lined with hymenia.

Spores broadly ellipsoid to subglobose, 10-12 x 8-10 µm, smooth, hyaline, with a single de Bary bubble; walls ± 1 µm thick. *Asci* cylindric to saccate, 90-120 x 12-25 µm, with 8 uniseriate to biseriate spores, hyaline, diffusely blue but reaction strongest at the tip in Melzer's reagent, thin-walled, tapered to a simple base, indehiscent, persistent, borne among paraphyses in the hymenia. *Paraphyses* 5-8 µm in diam, hyaline, thin-walled, septate, loosely scattered among and shorter than the asci.

Peridial and *gleba tissue* of hyaline, thin-walled inflated cells 20-100 µm in diam. *Subhymenium* rehydrating poorly, narrow, apparently of interwoven, hyaline, thin-walled hyphae ± 8-15 µm in diam. Known only from the arid central region of Australia.

Specimens examined: HOLOTYPE-AUSTRALIA, Northern Territory: Mt. Wedge Station, 25 Aug. 1957, col. J. B. Cleland (holotype ADW 15885, isotype OSC). PARATYPE-Haast's Bluff Reserve, 3 Sept. 1957, col. J. B. Cleland (ADW 8615).

DINGLEYA VERRUCOSA *gen. et sp. nov.* PLATES 1 and 4. *Ascocarpia exsiccata usque ad 3.5 cm in diam, subglobosa vel lobata. Peridium verrucosum, fragmentulis pubescentibus, brunneum. Gleba loculis labyrinthinis, hymeniis limitatis, sporis et ascis farctis. Asci* *cylindrici, pro parte maxima octospori, inamyloidei. Sporae ellipsoideae, 19-26 x 15-18 µm sine ornamentis; episporis 1-3 µm incrassatis, amorphis, brunneo-vinosis, nodosis et porcatis. Paraphyses ± 2 µm in diam, aequales vel inferiores quam asci. Holotypus: PDD 29712.*

Etymology: In honor of New Zealand mycologist Joan M. Dingley, who recognized the novelty of this species; Latin, *verrucosus* (warty).

Ascocarps hypogeous to subhypogeous, as dried up to 3.5 cm in diam, subglobose to lobed. *Peridium* verrucose with subangular warts 0.2-0.4 x 0.2-1.0 mm, small pubescent patches scattered among the warts, the thin epicutis brown and the thick subcutis yellowish white. *Gleba* yellowish white, with labyrinthine chambers 0.2-1 mm broad and completely stuffed with asci and spores from adpressed hymenia.

Spores ellipsoid, smooth in youth, 19-26 x 15-18 µm excluding ornamentation, 32-38 x 20-28 µm including ornamentation at maturity of a vinaceous brown, amorphous epispore 1-3 µm thick with rounded knobs and ridges 4-12 x 2-5 µm, the knobs on spore ends frequently larger than those on the sides. Spore walls strongly cyanophilic, at maturity the epispore cyanophilic but strongly so only on the outer sides of the knobs and ridges. *Asci* cylindric, mostly 230-280 x 25-30 µm, mostly with 8 uniseriate spores, hyaline, nonamyloid, thin-walled, tapered to a broadly croziered base, indehiscent, persistent, borne among paraphyses in the hymenia. *Paraphyses* ± 2 µm in diam, hyaline, thin-walled, frequently septate, straight, round-tipped, equaling or shorter than the asci.

Peridial tissue with an epicutis 50-150 µm thick, of ± isodiametric cells 10-25(-30) µm in diam, with yellowish brown walls 2-3 µm thick, grading to the subcutis of interwoven, hyaline hyphae 4-6 µm in diam. *Glebal tissue* similar to that of subcutis. *Subhymenium* of interwoven, hyaline, thin-walled hyphae 4-8 µm in diam with occasional cells inflated to 10-12 µm.

Known only from North and South Islands, New Zealand.

Specimens examined: HOLOTYPE-NEW ZEALAND, *North Island*, Auckland District: Waima, Hokianga, 21 Sept. 1966, col. R. A. Cumber (holotype PDD 29712, isotype OSC).

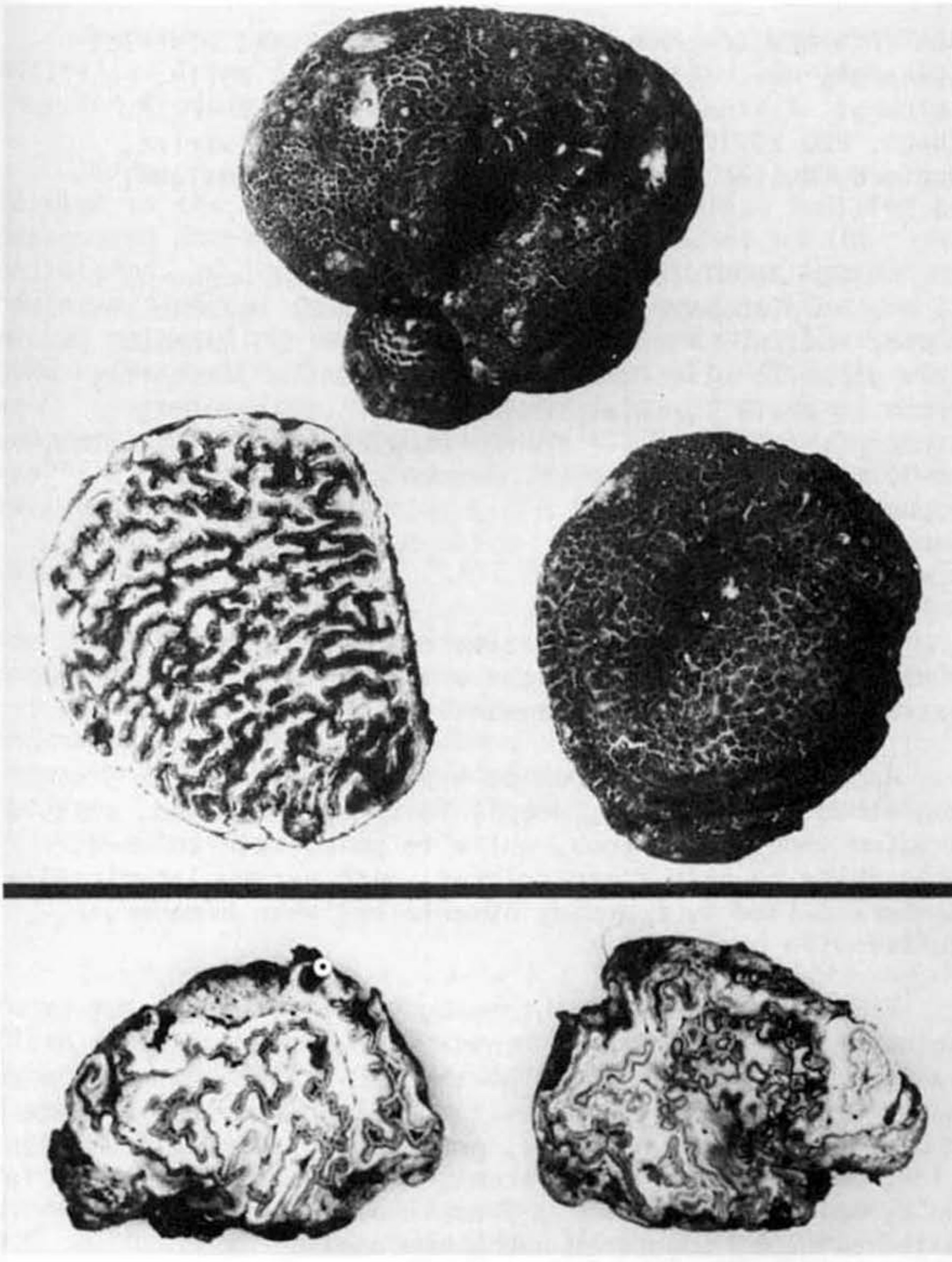


PLATE 4.--Fresh sporocarps of hypogeous Ascomycotina, about natural size. (ABOVE) *Dingleya verrucosa* sp. nov., cross section (left) and two surface views. Photo #14360 by A. Underhill, Plant Diseases Division, D.S.I.R., Auckland, N.Z. (BELOW) *Peziza stuntzii* sp. nov., two cross sections. U.S. Forest Service Photo by R. Molina.

PARATYPES-NEW ZEALAND, *North Island*, Auckland District: Titirangi, Nov. 1931, col. M. Hodgkins, PDD 29714; Titirangi, Atkinson Park, 3 July 1966, col. R. F. R. McNabb, PDD 29710. *South Island*, Westland District, Longford, Buller Gorge, March 1931, col. M. Bowland, PDD 29711.

CHOIROMYCES ABORIGINUM sp. nov. Ascocarpia usque ad 7x5 cm, subglobosa vel turbinata, profunde sulcata vel lobata, mollia. Peridium glabrum, album vel cremeum. Gleba alba, loculis labyrinthinis, hymeniis limitatis, sporis et ascis farctis. Asci claviti vel saccati, octospori, inamyloidei. Sporae subglobosae vel globosae, 9.5-13.5 x 8.5-12.5 µm sine ornamentatis, hyalinae, projecturis congestis 0.1 x 0.1 µm. Paraphyses 3-5 µm in diam, dispersae, sinuosae. Holotypus: MELU, leg. Donald Thompson, VIII 1958.

Etymology: Latin, genitive of Aborigines (original inhabitants), referring to the use of this truffle by the Australian aborigines (McLennan 1961).

Ascocarps subhypogeous to hypogeous, up to 7 x 5 cm, subglobose to turbinate, deeply furrowed and lobed, soft. *Peridium* smooth, glabrous, white to pale cream colored. *Gleba* white to pale cream colored, with narrow labyrinthine chambers filled by opposing hymenia or, when broader, stuffed with hyphae.

Spores subglobose to globose, 9.5-13.5 x 8.5-12.5 µm excluding ornamentation of minute, crowded projections, hyaline. Spore walls 1.5-2 µm thick. *Asci* clavate to saccate, 90-150 x 15-30 µm, with 8 uniseriate to biseriate or clustered spores, hyaline, nonamyloid, thin-walled, with a long tapered stem, indehiscent, borne among paraphyses in the hymenium. *Paraphyses* 3-5 µm in diam, hyaline, thin-walled sinuous, scattered among the asci.

Peridial tissue of interwoven hyaline, thin-walled hyphae 3-10 µm in diam with many cells inflated to 15-20 µm and scattered to abundant sphaerocysts 40-120 µm in diam. *Glebal tissue* and *subhymenium* similar to peridial tissue except with only few inflated cells and sphaerocysts; hyphal stuffing of chambers with abundant inflated cells and sphaerocysts.

Known only from the central Australian desert.

Specimens examined: HOLOTYPE-AUSTRALIA, Western Australia: near Lake Hazlett, Aug. 1958, col. Donald Thompson (holotype MELU, isotype OSC).

Discussion: McLennan (1961) described this collection as the basis for her new genus *Elderia*, but she designated *Stephensia arenivaga* Cooke & Massee as the type collection. *C. aboriginum* differs from *S. arenivaga* in having a glabrous rather than tomentose peridium, ornamented rather than smooth spores, and abundant sphaerocysts. Sphaerocysts do not occur in other species of *Choiromyces*, so *C. aboriginum* may eventually merit erection of a separate genus. Inflated cells are common in desert truffles, however, and thus may represent a special adaptation to that environment.

PEZIZA STUNTZII sp. nov. PLATE 4. *Ascocarpia usque ad 3 x 5 cm, irregularia, profunde sulcata. Peridium scabrum, carneum. Gleba carnea, solida, venis brunneis marmorata, venae saepe ad paginam apertae. Asci cylindrici, octospori, amyloidei (fortissime ad aspices), ad apices indentati. Sporae ellipsoideae, 12-15 x 10-12 µm sine ornamentis verrucarum et cristularum ± 0.5 x 0.5 µm, hyalinae. Paraphyses 3-8 µm in diam, apicibus clavatis. Holotypus: Trappe 4818 (OSC).*

Etymology: In honor of Dr. Daniel E. Stuntz.

Ascocarps hypogeous, up to 3 x 5 cm, irregular, deeply furrowed. *Peridium* scabrous, flesh pink. *Gleba* solid, flesh pink, marbled with brown veins mostly filled with hymenia and often opening to the surface. Odor of spicy sausage.

Spores ellipsoid, 12-15 x 10-12 µm excluding the ornamentation of cyanophilic warts and short ridges ± 0.5 x 0.5 µm, hyaline. *Asci* cylindric, 230-26 x 11-16 µm, with 8 uniseriate spores, hyaline, the apical half strongly blue in Melzer's reagent, apices indented or sometimes with a circumferential line, the bases croziered. *Paraphyses* 3-8 µm in diam, with clavate tips.

Peridial tissue a palisade of frequently septate hyphae 7-25 µm in diam, with obtuse to clavate tips. *Glebal tissue* of loosely interwoven hyphae 7-20 µm in diam with abundant rounded to subangular cells 10-45 µm in diam. *Subhymenium* of tightly interwoven hyphae 6-15 µm in diam.

Known only from the type collection in a mixed woods of *Pseudotsuga menziesii* and *Quercus garrayana*, elev. ca. 550 m.

Specimens examined: HOLOTYPE-U.S.A., Washington, Yakima Co., Tieton River Valley, Windy Point Forest Camp, 28 Oct. 1976; Trappe 4818 (OSC).

Discussion: P. stuntzii more closely approaches the typical truffles in form than do most sparassoid Pezizales as discussed by Korf (1973). I did not find indisputable opercula, but the ascus apices are structured for them. In any event, all other anatomical features clearly relate the species to the genus *Peziza*.

NEW COMBINATIONS AND RANKS

BARSSIA YEZO-MONTANA (Kobayasi) comb. nov.
Basionym: *Phymatomyces yezo-montanus* Kob., J. Jap. Bot. 13:913-914, 1937.

ELAPHOMYCES subgen. *ASCOSCLERODERMA* Clémencet status nov.
Basionym: *Ascoscleroderma* Clémencet, Le Bot. 24: 14-36, 1932.

GENEA KRASPEDOSTOMA (Gilkey) comb. nov.
Basionym: *Petchiomyces kraspedostoma* Gilkey, Oreg. State Monogr. Stud. Bot. 1:15, 1939.

LABYRINTHOMYCES VARIUS (Rodway) comb. nov.
Basionym: *Stephensia varia* Rodw., Roc. Soc. Tasmania Proc. 1897:129-130, 1897.

PEZIZA ELLIPSOSPORA (Gilkey) comb. nov.
Basionym: *Hydnotrya ellipsospora* Gilkey, Univ. Cal. Publ. Bot. 6:307, 344, 1916.

TUBER HIROMICHII (Imai) comb. nov.
Basionym: *Mukagomyces hiromichii* Imai, Proc. Imp. Acad. Tokyo 16:154, 1940.

TUBER OLIGOSPERMUM (Tulasne & Tulasne) comb. nov.
Basionym: *Terfezia oligosperma* Tul. & Tul., Fungi hypogaei, p. 176, 1851.

TUBER PHLEBODERMUM (Gilkey) comb. nov.
Basionym: *Delastriopsis phleboderma* Gilkey, Oreg. State Monogr. Stud. Bot. 1:49, 1939.

ACKNOWLEDGEMENTS

These studies were supported in part by National Science Foundation Grant GB-27378 and American Philosophical Society Penrose Grant 4439. As my teacher in mycology, Dr. Daniel E. Stuntz provided the original inspiration and enthusiasm that propelled me into this fascinating field of science. Spore drawings are by Jackie Atzet.

INDEX TO GENERA AS NUMBERED IN TEXT

REFERENCES

Auerswald, B. 1869. *Sarcosphaera* Awd., novum genus Discomycetum. Hedwigia 8:82-83.

Beaton, G. and G. Weste. The genus *Labyrinthomyces*. Trans. Brit. Mycol. Soc. 69:243-247.

Berkeley, M. J., and C. E. Broome. 1846. Notices of British hypogeous fungi. Ann. Mag. Nat. Hist. 18:73-82.

Boedijn, K. B. 1939. The Tuberales of the Netherlands Indies. Bull. Jard. Bot. Buitenzorg Ser. 3, 16:236-244.

Burdsall, H. H., Jr. 1968. A revision of the genus *Hydnocystis* (Tuberales) and of the hypogeous species of *Geopora* (Pezizales). Mycologia 60:496-525.

Chatin, A. 1890. Contribution à l'histoire naturelle de la truffe. Compt. Rend. Acad. Sci. Paris 111:947-953.

Clémencet, M. 1932. Contribution à l'étude du développement et de l'anatomie des Ascomycètes hypogés. Les Elaphomycétacées. Le Botaniste 24:3-105.

Corda, A. J. C. 1842. Anleitung zum Studien der Mycologie. Friedrich Ehrlich, Prague. 223 p.

Dennis, R. W. G. 1974. New or interesting British microfungi, III. Kew Bul. 30:345-365.

Dietrich, A. 1839. Flora regni borussici, Plates 433-504.

Dodge, C. W. 1929. The higher Plectascales. Ann. Mycol. 27:145-184.

Dumortier, B.-C. 1822. Commentations botanicae. Tournay.

__________. 1829. Analyses des familles des plantes. J. Casterman, Aine, Tournay. 104 p.

Eckblad, F.-E. 1968. The genera of operculate Discomycetes. Nytt Mag. Bot. 15:1-191.

Fennell, D. I. 1973. Plectomycetes: Eurotiales. *In* Ainsworth, G. C., F. K. Sparrow, and A. S. Sussman (eds.), The Fungi IV A. Academic Press, New York. pp. 45-68.

Fischer, E. 1897. Tuberaceen und Hemiasceen. Rabenhorst's Kryptog.-Flora Deutschlands, Österreich und der Schweiz, ed. 2 1, V(5):3-81.

__________. 1938. Tuberineae. Engler and Harms Nat. Pflanzenfam. ed. 2, 5b(8):1-42.

Fries, E. 1822. Systema mycologicum 2(1):1-274.

__________. 1823. Systema mycologicum 2(2):275-620.

__________. 1829. Systema Mycologicum 3(1):1-260.

Gilkey, H. M. 1916. A revision of the Tuberales of California. Univ. Cal. Publ. Bot. 6:275-356.

__________. 1925. Five new hypogaeous fungi. Mycologia 17:250-254.

__________. 1947. New or otherwise noteworthy species of Tuberales. Mycologia 39:441-452.

__________. 1954. Tuberales. North Amer. Flora 2, 1:1-36.

__________. 1961. New species and revisions in the order Tuberales. Mycologia 53:215-220.

Harkness, H. W. 1885. Fungi of the Pacific Coast. Bull. Cal. Acad. 1: 159-176.

Hawker, L. E. 1954. British hypogeous fungi. Phil. Trans. Roy. Soc. London 237:429-546.

Imai, S. 1940. Second note on the Tuberales of Japan. Proc. Imp. Acad. Tokyo 16:153-154.

Kimbrough, J. W. 1970. Current trends in the classification of Discomycetes. Bot. Rev. 36:91-161.

Kobayasi, Y. 1937. *Phymatomyces*, a new genus of the Tuberaceae. J. Jap. Bot. 13:912-914.

__________. 1963. On a new genus *Protogenea* of the Tuberales. Trans. Mycol. Soc. Japan 4:119-120.

Korf, R. P. 1972. Synoptic key to the genera of the Pezizales. Mycologia 64:937-994.

__________. 1973a. Sparassoid ascocarps in Pezizales and Tuberales. Rep. Tottori Mycol. Inst. 10:389-403.

__________. 1973b. Discomycetes and Tuberales. *In* Ainsworth, G. C., F. K. Sparrow, and A. S. Sussman (eds.), The Fungi IV A. Academic Press, New York. pp. 249-319.

Lange, M. 1956. Danish hypogeous fungi. Dansk Bot. Ark. 16:1-84.

Malençon, G. 1973. Champignons hypogés du nord de l'Afrique - I. Ascomycetes. Persoonia 7:261-288.

Mattirolo, O. 1928. Secondo elenco dei "Fungi Hypogaei" raccolti nelle Foreste de Vallombrosa (1900-1926). Nuovo Giorn. Bot. Ital. n.s. 34:1343-1358.

__________. 1935. Catalogo ragionato dei funghi ipogei raccolti nel Canton Ticino e nelle provincie italiane confinanti. Contr. Flora Crittogama Svizzera 8(2):1-53.

McLennan, E. I. 1961. Australian Tuberales. Proc. Roy. Soc. Victoria 74:111-117.

Rodway, L. 1897. Tasmanian fungi. Roy. Soc. Tasmania Proc. 1897: 129-144.

Shaffer, R. L. 1968. Keys to genera of higher fungi. Ed. 2, Univ. Mich. Biol. Sta., Ann Arbor. 131 p.

Smith, A. H. 1973. Agaricales and related secotioid Gasteromycetes. *In* Ainsworth, G. C., F. K. Sparrow, and A. S. Sussman (eds.), The Fungi IV B. Academic Press, New York. pp. 421-450.

Trappe, J. M. 1971. A synopsis of the Carbomycetaceae and Terfeziaceae (Tuberales). Trans. Brit. Mycol. Soc. 57:85-92.

__________. 1975a. Generic synonyms in the Tuberales. Mycotaxon 2: 109-122.

__________. 1975b. The genus *Fischerula* (Tuberales). Mycologia 67: 934-941.

__________. 1975c. The genus *Amylascus* (Tuberales). Trans. Brit. Mycol. Soc. 65:496-499.

Tulasne, L.-R. and C. Tulasne. 1843. Champignons hypogés de la famille des Lycoperdacees, observés dans les environs de Paris et les Départements de la Vienne et d'Indre-et-Loire. Ann. Sci. Nat. Ser. 2, 19:373-381.

__________. 1845a. Fungi nonnulli hypogaei, novi v. minus cogniti. Giorn. Bot. Ital. 2, Pt. 1(7/8):55-63.

__________. 1845b. Mémoire pour servir à l'histoire des champignons hypogés suivi de leur monographie et accompagné de planches. Comp. Rend. Acad. Sci. Paris 21:1432-1436.

__________. 1851. Fungi hypogaei. Friedrich Klincksieck, Paris. 222 p.

Vittadini, C. 1831. Monographia Tuberacearum. Felicis Rusconi, Milano. 88 p.

Zobel, J. B. 1854. A. C. J. Corda, Icones Fungorum hucusque cognitorum 6:1-91.

MYCOTAXON

Vol. IX, No. 1, pp. 341-347 June 12, 1979

THE STIRPS COHAERENS OF *MARASMIUS*

ALEXANDER H. SMITH

University Herbarium
University of Michigan
Ann Arbor, Michigan 48104

The agarics which revive when moistened, have ± white spore deposits, and tough often hairlike stipes, have presented great difficulty to taxonomists attempting to discern phylogenetic relationships among the various taxa. In the last twenty five years much has been done to clarify concepts in this group at the species level, but much still remains to be done. For instance, the fact that a few species of *Marasmius* have amyloid spores is now, following Singer (1975) or Gilliam (1976), considered sufficient for excluding them from the genus. This is done in spite of the fact that in other genera of the Tricholomataceae such as *Cystoderma* Fayod, we have species, one with and one without amyloid spores but otherwise remarkably similar in all their other basic features. One subject of a general nature which will command critical attention in the foreseeable future is the degree of variability in microscopic characters as this relates to the use of various features in proposing species and generic concepts.

It should be kept in mind that the hypha is the basic unit of structure of all agaric fruiting bodies and that the same environmental pressures are likely to produce the same changes in the various groups of agarics as these are based on spore and hyphal characters. Thus we find that narrow hyphae in the cuticle of the pileus are a feature of many unrelated (relatively) species. In some of these the hyphae will become gelatinized and in others not, or in some the hyphae will excrete slime but the walls will not gelatinize -- but in both types a viscid pileus will result; or one may find that both features, the breakdown of the hyphal wall and the excretion of slime, may take place in the caps of a single species. In the present states of our knowledge of agarics, situations like this complicate the problem of recognizing true relationship in the order Agaricales. We must not only learn to recognize a character exhibited by a fungus, but also know something of its origin before we claim to have correctly perceived its phylogenetic significance. Another illustration of changes in our viewpoint relative to the phylogenetic significance of a character, is in that involving spore ornamentation. Smooth spored as contrasted to species with ornamented spores have in some instances been regarded as relatively unrelated (in the Boletaceae for instance). This conclusion was arrived at with data obtained with the light microscope. Later, with the aid of SEM some "smooth spored" species were found to have distinctly ornamented spores. Thus the problems of phylogeny must be reexamined periodically as more data are gathered and new techniques are developed.

One approach to the problem of studying the marasmioid agarics as well as other groups is to recognize and define small groups of obviously closely related species as arrived at on the basis of all the characters known (overall similarities), and to gradually construct a system of classification with such groups as the foundation stones. The unofficial category of stirps is ideal for this since it can be adjusted to new information without extensive bookkeeping on the officially recognized genera, species, subspecies, varieties and forms. A stirps bears the specific epithet of its central species, as indicated in the title of this contribution. The following example of a stirps involves three Michigan species and one of southeastern distribution. The concept of the stirps and its name, have been widely but not frequently used in taxonomic botany for at least fifty years.

Stirps *Cohaerens*

The central and most widely known species, *Marasmius cohaerens* (Pers. ex Fr.) Cooke & Quélet, is a marasmioid species featuring, among other characters the thick-walled setalike pleurocystidia with ± rusty brown walls. In addition to the central feature of the pleurocystidia, it features a mat of basal mycelium, a more or less cartilaginous to horny ± polished stipe, and the occurrence of basidiocarps typically in clusters on a woody substrate. The cells of the pilear cuticle are smooth to branched as Gilliam (1976) has correctly pointed out.

A second species, *Marasmius cystidiosus* (Smith & Hesler) Gilliam, is southeastern in distribution, but rather similar to *M. cohaerens* in general features. It has both thin- and thick-walled pleurocystidia and their walls are hyaline to very slightly colored (as revived in KOH). It occurs on humus scattered to gregarious or in small groups, a basal mat of white mycelium is only weakly developed, the taste of the raw context is bitter, and the pileus cuticle is a palisade of clavate cells. It is distinct from *M. cohaerens* in having pleurocystidia with paler to hyaline walls, in being terrestrial, and in having a bitter taste. In describing the species Smith & Hesler (1940) stated of the pleurocystidia: "the walls usually thickened" (p. 306). Gilliam (l.c. p. 48) described them as: "with hyaline to pale yellow thin walls". The cystidia are extremely variable in size and shape, however, as described by Gilliam as well as the original authors. Because of the relatively fleshy nature of the basidiocarps, Smith & Hesler did not compare the species with those of *Marasmius* at the time they described it.

A third species, *Marasmius leighii* Smith occurs in dense clusters on wood, has thick-walled ± hyaline setalike pleurocystidia, a basal mat of mycelium around the cluster, and a mild to weakly nauseous (not bitter) taste. It is closer to *M. cystidiosus* in cystidial features than to *M. cohaerens*, as indicated by Gilliam who considered it synonymous with *M. cystidiosus*. Smith previously (in 1929) and under Kauffman's direction identified this species as *Marasmius fasciatus* Pennington. For a clarification of the nomenclature relative to *M. fasciatus* see Gilliam (1976).

The last species, *Marasmius delectans* Morgan, differs from all the above in its white pileus. It has thick-walled pleurocystidia and the basidiocarps are bound to each other to some extent by a mat of mycelium in the fallen leaves and humus. It also has the polished cartilaginous stipe. These four species appear to me to be closely related on the basis of all their characters, but at the same time have a central character to focus on them as a group. In Gilliam's treatment *M. cystidiosus*, and by implication *M. leighii*, are placed in Section *Globulares* and *M. cohaerens* and *M. delectans* are in section *Sicci*. To me these four species (all of which I have studied in the fresh condition) should be placed in the same section and in the same stirps. The concept of a stirps is marked by the degree of relationship of the species included in it rather than by any particular number included. There are genera that might well be regarded as a single stirps.

Key to Species of Stirps Cohaerens

1. Pileus white or whitish. . . . . *M. delectans* (pl.3): see Gilliam p. 54 for description.
1. Pileus brown to grayish brown. 2
2. Taste of raw context bitter. . . *M. cystidiosus* (see fig. 8, S. & H.)
2. Taste of raw context mild or slight. 3
3. Pleurocystidia setalike and ± rusty brown in KOH or H_2O. . . *M. cohaerens* (pl.2; see Gilliam p. 64 for description).
3. Pleurocystidia setalike but mostly hyaline . . . . *M. leighii* Smith pl.1

Marasmius cystidiosus (Smith & Hesler) Gilliam, Mycotaxon 4: 47. 1976 (*Collybia cystidiosa* Smith & Hesler, Journ. Elisha Mitchell Sci. Soc. 56:4050. 1940.)

Pileus 2-5 cm broad, convex or with an obtuse umbo, margin incurved at first, spreading in age, slightly hygrophanous, when moist watery avellaneous, spreading in age, slightly hygrophanous, when moist watery avellaneous to near "pinkish buff" (usually grayer than pinkish buff), often translucent-striatulate on the margin, becoming opaque in age, "Sayal brown" to "ochraceous tawny" on the disc, the margin remaining pinkish buff, surface rugulose after fading or finally rugose-pitted or reticulate; context thin, white, cartilaginous, odor pungent (sometimes faint), taste bitter.

Lamellae rounded and attached by a basal tooth or appearing free, sometimes deeply and narrowly adnexed, moderately close to subdistant, narrow (2.5 mm ±), whitish, edges pruinose from cystidia (under a lens), sometimes with reddish brown stains in age.

Stipe 3-8 cm long, 3-6 mm thick, equal, strict, tubular, fragile, polished and translucent, not striate (at least at first), whitish above, tinged brownish at base, base sometimes slightly enlarged and white mycelioid.

Spore deposit white; spores 7-10 x 3-4µm, narrowly ellipsoid to subcylindric, smooth, yellowish in Melzer's. Basidia 4-spored, 20-25 x 5-6µm. Pleurocystidia very abundant, 32-80 x 8-15µm, fusoid-ventricose to ± versiform, many lanceolate in age, the bases usually curved, originating in the subhymenium, walls hyaline and usually thickened. Cheilocystidia scattered, 28-35 x 7-9µm, smooth, walls somewhat thickened, clavate to subcylindric or tapered to the apex.

Gill trama of subparallel hyphae reddish brown in Melzer's. Pileus trama homogeneous beneath a cuticle formed by a palisade of clavate to inflated cells 10-25 x 8-15µm reddish brown in Melzer's. Clamp connections present.

Scattered on humus in a mixed forest, Indian Creek, N. C., Great Smoky Mts. National Park, Sept. 6, 1937 (Smith 7416 and 7437, Aug. 14, 1938, Smith 10167; Smith 12195 (coll. by Hesler), July 30, 1939.)

Observations. Since this species was found frequently and never exhibited the fasciate pattern of fruiting-body occurrence, the pattern of occurring scattered on humus cannot be dismissed as an accidental happening. The above description is from the type and other collections made in the Great Smoky Mountains area.

Marasmius leighii sp. nov. Pl. 1.

Pileus 2-4 (6) cm latus, demum plano umbonatus, lubricus demum siccus, pallide alutaceus demum subfulvus, sapor mitis; lamellae angustae confertae demum pallide alutaceae; stipes 6-12 cm longus, (2) 3-6 (8) mm crassus, cartilagineus, deorsum fulvus, sursum pallidus vel pallide alutaceus; sporae 7-9 (10.5) x (2.5) 3-3.5µm, non-amyloidiis; pleurocystidia 36-70 x 3-8 (12)µm, ± crasso-tunicata, subhyalina. Specimen typicum in Herb. Univ. Mich. conservatum est, legit prope Ann Arbor Smith n 15213.

Pileus 2-4 (6) cm broad, expanding to campanulate to ± convex, in age nearly plane or with a slight umbo, moist but soon dry, or lubricous at first at times; colors "clay color" to "tawny olive" when fresh or young (clay color to pale spadiceous), on margin "pinkish buff" or paler, disc (or umbo) clay color to dull fulvous in age, glabrous, in fading becoming radially rugulose and with small depressions (inconspicuously alveolate) over the broad marginal area; context white, ± watery when fresh, thin, odor fungoid to mild, taste mild or becoming subnauseous but not bitter.

Lamellae narrow to (finally) moderately broad, crowded, adnate-sededing, pale buff (± "pinkish buff") or finally darker, unchanging where injured, edges entire.

Stipe 6-12 cm long, (2) 3-6 (8) mm thick, bases often bound together by white mycelium, terete or compressed, strict, cartilaginous, at times twisted-striate, pallid above and gradually pale tan to dull fulvous downward.

Spores 7-9 (10.5) x (2.5) 3-3.5µm, narrowly lanceolate to base, smooth, non-amyloid, hyaline in KOH. Basidia 4-spored. Pleurocystidia 36-70 x 3-8 (12)µm, hyaline, mostly with thickened walls, refractive in KOH, subfusoid, apex often nipple-like, arising in the subhymenium and basal third often curved. Cheilocystidia similar to (but often smaller than) the pleurocystidia. Gill trama parallel, reddish in Melzer's, the cells tubular to somewhat inflated. Pileus cuticle a hymeniform palisade of clavate cells some with slightly thickened walls at least in the pedicle. Clamp connections present.

Habit, habitat and distribution. Typically in dense clusters on decaying hardwood, summer, southern Michigan.

Observations. As far as observed to date this species has a consistently different fruiting pattern than that of *M. cystidiosus*, has a mild (not bitter) taste, and few clavate cheilocystidia. It is named in honor of Prof. L. H. Pennington who first recognized it as a species.

Literature Cited

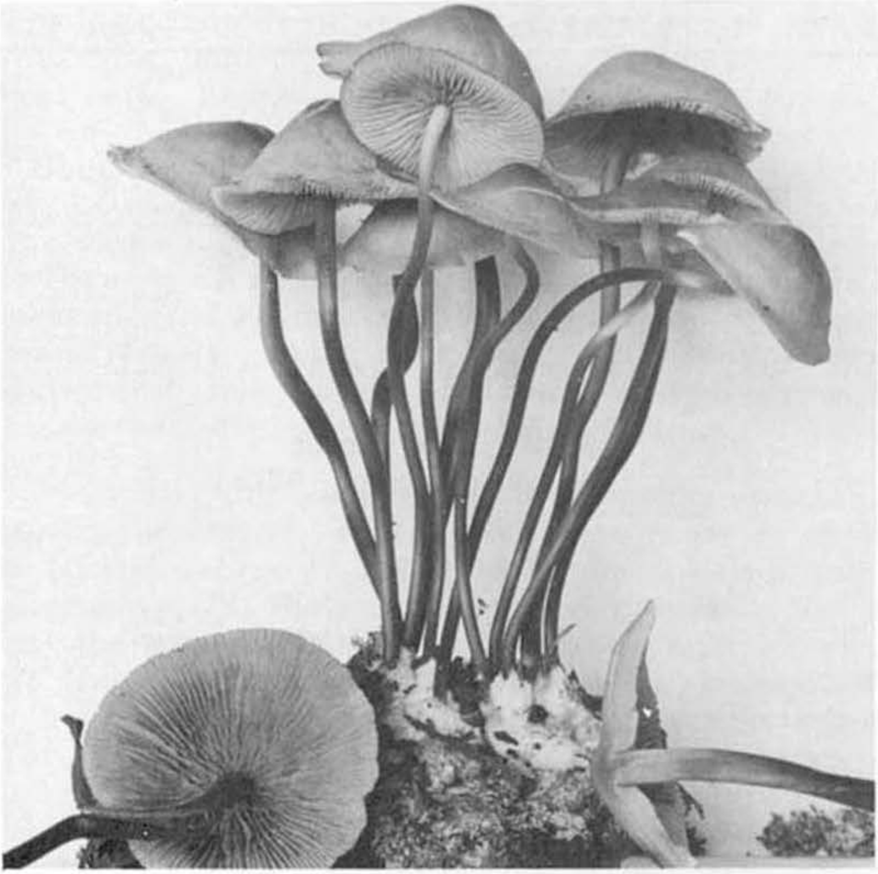
Gilliam, Martina S. (1976). The genus Marasmius in the northeastern United States and adjacent Canada. Mycotaxon 4: 1-144.

Pennington, L. H. (1915). Marasmius Fries. North Amer. Flora 9: 250-286.

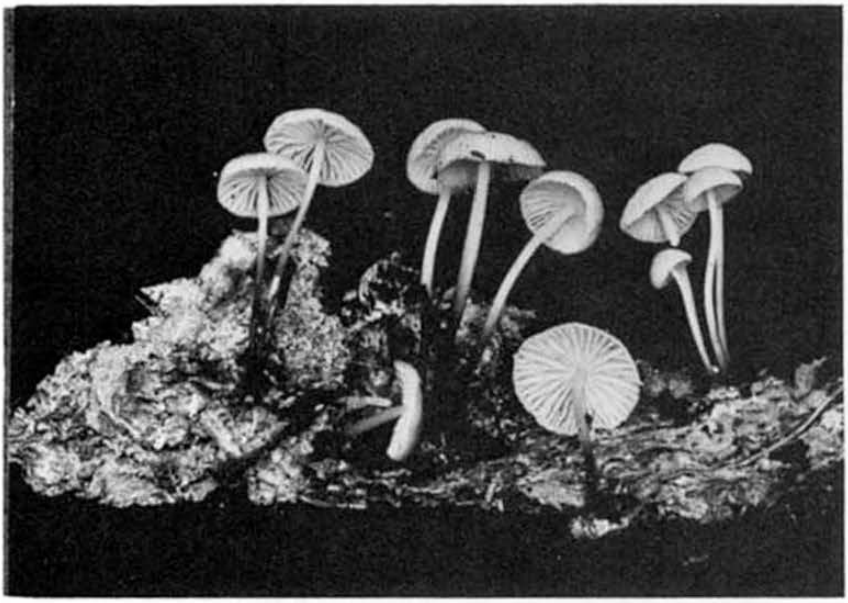
Smith, Alexander H. and L. R. Hesler. (1940). New and Unusual Agarics from the Great Smoky Mountains National Park. Journ. Elisha Mitchell Sci. Soc. 56: 302-324.

Singer, Rolf. (1975). The Agaricales in Modern Taxonomy. 912 p. Third Edition. J. Cramer, Vaduz.

Pl. 1. *Marasmius leighii* x 1 (type)



Pl. 2. *Marasmius cohaerens* x 1 (Smith 1514)



Pl. 3. *Marasmius delectans* x 1 (Smith 1709)

MYCOTAXON

Vol. IX, No. 1, pp. 348-357 June 12, 1979

THE SECTIONS OF *COPRINUS* PRESENT IN THE WESTERN UNITED STATES

FRED VAN DE BOGART

708 N. 117th Street
Seattle, Washington 98133

SUMMARY

The seven sections of the genus Coprinus occurring in the western United States are described and the principal criteria important in delimiting these sections are discussed. A key to the sections is provided.

Species of the genus Coprinus which have been examined from the western United States appear to fit well into the basic infrageneric taxa proposed by Kühner and Romagnesi (1953). The degree of agreement would seem to indicate that the criteria they used are in large measure applicable to species from widely separated areas, and their infrageneric taxa, with minor changes, probably will become the framework for future monographic treatments.

A primary division of Coprinus into two large groups of species is made on the basis of the pileal surface under any detersile velar layers. The pileal surface is composed of either radially oriented elongate elements or a cellular to hymeniform layer. The species in each of these two groups are further divided into sections on the

---

[1] This paper is based in part on a thesis submitted to the Graduate School of the University of Washington in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

kind of velar structures present, the presence or absence of pilocystidia, and on the kinds of cells present in the universal veil. Seven sections are thus recognized.

Sections Coprinus, Atramentarii, Lanatuli, Setulosi, Micacei, and Hemerobii are delimited in essentially the same manner as in Kühner and Romagnesi (1953). Section Picacei as presented in this paper, however, combines species Kühner and Romagnesi referred to Impexi and Vestiti, since no essential differences could be detected in type of pileal surface, veils, spores, and other characteristics of these latter two taxa.

In identifying collections of Coprinus species to the following sections, several features must be determined: (1) the nature of the pileal surface below any velar elements, (2) the morphological nature of the veil elements themselves, and (3) the presence or absence of pilocystidia and caulocystidia. Failure to determine the presence and the nature of these features makes identification of species difficult or impossible.

KEY TO SECTIONS OF COPRINUS PRESENT IN THE WESTERN UNITED STATES

A. Pileal surface below any detersile velar elements readily seen to be composed of radially oriented hyphae or veil adherent and masking the pileal surface, no pilocystidia or caulocystidia present .... B

A. Pileal surface below the detersile velar elements readily seen to be composed of a cellular to hymeniform layer of more or less isodiametric cells, veil never adherent and masking the pileal surface, pilocystidia and caulocystidia may be present .... E

B. Universal veil of mostly unbranched nondiverticulate cylindrical hyphae with no sphaerocysts present C

B. Universal veil often with few to many sphaerocysts present or if composed entirely of cylindrical hyphal elements these are either diverticulate and often branched or with nonswollen, thick-walled, clamped elements or with somewhat swollen, often thick-walled, nonclamped elements .... Section <u>Picacei</u> (p. 353)

C. Universal veil elements mostly abundant and either loose from the first or becoming loose as pileus matures, any veil remnants on stipe base white in color .... D

C. Universal veil elements scarce and adherent to pileal surface and difficult to remove, some brown veil remnants on stipe base below a flaring annular zone ..... Section <u>Atramentarii</u> (p. 352)

D. Species with a conspicuous annulus or volva, rarely with pleurocystidia ... . Section <u>Coprinus</u> (p. 351)

D. Species with no annulus or only an annular line or fringe marking the position of the unexpanded pileal margin on the stipe, pleurocystidia present .... Section <u>Lanatuli</u> (p. 351)

E. Pilocystidia present generally on entire pileal surface or occasionally restricted to a marginal fringe on the edge of the pileus .... Section <u>Setulosi</u> (p. 354)

E. Pilocystidia not present .... F

F. Universal veil present, species medium-small to large in size, pileus (1.5-) 2.5-48.0 mm in breadth .... Section <u>Micacei</u> (p. 355)

F. Universal veil not present, species small to medium in size, pileus 1.0-32.0 mm in breadth ...... Section <u>Hemerobii</u> (p. 356)

SECTION COPRINUS

Coprinus Pers. per S. F. Gray, Section Coprinus
= Comati Fr. (1838) em. Lange, Dansk. Bot. Ark. Bd. 2 No. 3, p. 36. 1915.
= Pelliculosi (Fr. 1838 ut tribus) em. Schröter, Pilze, p. 521. 1889.

Pileal surface outside of the apical disk composed of radially oriented hyphae, covered with and sometimes obscured by a universal veil of fibrils, often until late maturity. No sphaerocysts in the universal veil. No erect pilocystidia or caulocystidia, and usually no pleurocystidia. Definite annulus present, either free or attached to the base of the stipe like a volva and not reduced to a small bulge or flange. Stipe lumen generally with a yarn-like or weblike mass of loose hyphae. Sporocarp of medium to very large size and always undergoing autodigestion. Spores usually large, 10-25 µm in length, smooth walled. Species growing on dung or soil, rarely on wood, especially in disturbed areas.

TYPE SPECIES: Coprinus comatus O. F. Müller per S. F. Gray, Nat. Arrang. Brit. Pl. 1:632. 1821.

Observations: The distinguishing characters of section Coprinus are the pileal surface of radially oriented hyphae, the universal veil of mostly unbranched nondiverticulate hyphae with no sphaerocysts present, the abundance and loose nature of the veil when mature, the conspicuous annulus or volva and the lack of pleurocystidia in most species.

SECTION LANATULI

Coprinus Pers. per S. F. Gray, Section Lanatuli Fr., Epicrisis, p. 250. 1838.

Pileal surface except for the apical disk usually composed of radially oriented hyphae or radially elongated cells, at first covered very loosely with scales of universal veil composed mostly of parallelly oriented hyphae. Individual cells of scale hyphae often long and swollen, constricted at the septations, not branched, somewhat catenulate in appearance. Universal veil completely devoid of sphaerocysts. No erect pilocystidia or caulocystidia present. Large characteristic pleurocystidia present. Stipe without annulus, but sometimes with an annular line or small flange near the base where contacted by the margin of the unexpanded pileus. Sporocarps very variable in size, from minute to rather large. Spores less than 15 µm long, smooth walled or with an inflatable perisporium. Growing on dung, soil, decaying wood, or on charcoal.

TYPE SPECIES: Coprinus cinereus Schaeff. per S. F. Gray, Nat. Arr. Brit. Plants, p. 634. 1821.

Observations: The species of section Lanatuli found in western North America seem to fall into two general categories, one with globose to subglobose spores, and one with ellipsoidal spores.

SECTION ATRAMENTARII

Coprinus Pers. per S. F. Gray, Section Atramentarii Fr. Epicrisis, p. 243. 1838.

True pileal surface outside of the apical disk composed of radially oriented, slender, cylindrical hyphae, at least near the apex with small, appressed and usually colored, brown, red-brown or yellow-brown scales of fibrils, more or less parallelly aligned to themselves but not necessarily parallel to the radial pileal surface hyphae. These scales and fibrils often become confused with the epicutis in age so the pileus appears glabrous macroscopically. Universal veil devoid of sphaerocysts; both pilocystidia and caulocystidia absent. Many large and characteristic pleurocystidia present which act as mechanical braces to separate adjacent lamellae physically. No true annulus present; however, there is present an annular line or flange, composed of slender, anastomosed, interwoven, septate, occasionally clamped, hyaline to yellow hyphae, marking the early position of the pileal margin against the stipe. The filaments of the annular zone are the same as those forming the scales of the pileus and base of the stipe and often contain similar amorphous contents in some of the cells. Colored appressed scales like those at the pileal apex are often present on the stipe below the annular line or flange. Spores usually less than 12 µm in length and occasionally with distinct ornamentation. Species of medium to large size and growing near trees and on disturbed soils, never coprophilous.

TYPE SPECIES: Coprinus atramentarius (Bull. per Fr.) Fr. Epicrisis, p. 243. 1838.

Observations: The universal veil of the species of section Atramentarii seems to be unique. It is composed of mostly very slender, thin walled hyphae that usually contain a yellow to yellow-brown amorphous substance. With age or exposure, the walls of most of the veil hyphae seem to lyse, leaving this amorphous content behind as the only visual evidence of the veil. Sometimes the individual strands seem to merge into broad filaments and patches which form the colored scales of the stipe and pileus.

SECTION PICACEI

Coprinus Pers. per S. F. Gray, Section Picacei Fr., Epicrisis, p. 244. 1838. (as subtribe), emend. Van De Bogart.
Synonyms: Subtribe Picacei loc. cit.
Section Impexi Romagn. in Kühn. & Romagn., Fl. Anal., p. 386. 1953.
Section Vestiti (J. Lange) Kühn. & Romagn., Fl. Anal., p. 384. 1953, emend.

Pileal surface outside the apical disk composed either of radially oriented cylindrical hyphae or of cells distinctly elongate in a radial direction. Universal veil usually abundant, composed of some type of cylindrical hyphae, or sphaerocysts, or a combination of both. Universal veil elements mostly thin walled but in some taxa some or all elements thick walled, hyaline or pale, smooth or occasionally with acid-soluble or acid-insoluble incrustations and wall thickenings or with small to large diverticulations of the cell walls. Some species also with irregularly shaped cells present in the universal veil. The veil may have a woolly or mealy appearance in young specimens and may form a cortina. Other annulus types present only rarely. Spores variable in size and shape, a dislodgable perisporium often present. Spore wall somewhat thickened but seldom up to 2.0 μm thick. Clamp connections present or not. Cheilocystidia present and sometimes fused into a membranelike structure uniting adjacent lamellae when pileus is immature. Pleurocystidia present or not. Pilocystidia and caulocystidia absent. Sporocarps small to large. Species growing on dung, decaying plant debris, paper, wood, soil and charcoal.

TYPE SPECIES: Coprinus picaceus S. F. Gray, Nat. Arrang. Brit. Pl., 1:634. 1821.

Observations: The former sections Picacei (Romagnesi's Impexi) and Vestiti have been combined here for two reasons. The primary reason is that the presence of a pileal surface of radially oriented hyphae in Picacei and a hymeniform or cellular surface in Vestiti is in fact not valid. Species in Vestiti do not really have a cellular pileal surface. Careful examination of collections that were referable to section Vestiti showed that all except Coprinus poliomallus have a true pileal surface of radially oriented hyphae. This surface is sometimes overlain by a loose friable layer of sphaerocysts but not by a layer of isodiametric cells whose side walls are fused. The second reason is that certain features such as the spores and universal veil elements of species formerly assigned to one or the other section are very much alike. Often the general appearance of such species is also similar. With no real difference in pileal surfaces the only other difference becomes presence or absence of sphaerocysts in the universal veil. Even this criterion is not absolute. One collection of Coprinus filamentifer (FVDB 275) of Section Picacei shows the ends of some of its typical cylindrical veil hyphae as small diverticulated swellings that resemble the smallest sphaerocysts found in stirps Stercorarius (formerly comprising the bulk of Section Vestiti).

Coprinus poliomallus, which does have a good cellular pileal surface, has been placed in Section Micacei in view of its pileal surface and the nature of its spores and universal veil. The author of the species, Romagnesi, reports that the pileal surface cells are somewhat radially oriented in his material. The surface cells of my material are isodiametric and the taxon has been placed in Micacei. C. poliomallus seems to be transitional between Section Micacei and one group of species of Section Picacei.

SECTION SETULOSI

Coprinus Pers. per S. F. Gray, Section Setulosi (J.

Lange) Van De Bogart, stat. nov. et emend.
Basionym: Setulosi J. Lange ut subsectio Dansk. Bot. Ark. 2(3):32. 1915.

Pileal surface of the cellular-hymeniform type, always distinct. Universal veil, if present, composed of sphaerocysts and occasionally with elongated and branched hyphae. Pileal surface characteristically with numerous pilocystidia often of several distinct types, including sclerocystidia. Pilocystidia occasionally restricted to the pileal margin as a fringe. No partial veil. Spore size variable, 6.5-20.0 µm in length, depending on species. Inflatable perisporal sac present or not. Caulocystidia often present. Cheilocystidia often variable in shape. Pleurocystidia present or not. Clamp connections present or not. Species growing on dung, soil, charcoal, dead leaves and debris, or on wood.

TYPE SPECIES: Coprinus congregatus Bull. per Fr., Epicrisis, p. 249, ss M. Lange.

Observations: This section was first presented by J. Lange (1915) as subsection Setulosi of his Section Nudi. The subsection contained all species with pilocystidia and no universal veil. Since there are numerous species with a universal veil that have both the cellular pileal surface and pilocystidia of Lange's subsection, I have chosen to include such species with those lacking a universal veil and raise the group to the level of section.

SECTION MICACEI

Coprinus Pers. per S. F. Gray, Section Micacei Fr., Epicrisis, p. 247. 1838. emend. Kühn. & Romagn., Fl. Anal., p. 382. 1953.

Pileal surface of the cellular-hymeniform type and only obscured by velar elements while small primordia. Universal veil present as sphaerocysts, or as chains of ellipsoidal cells, or as cylindrical to mixed cylindrical and swollen or somewhat irregularly shaped hyphae, always distinct from the pileal surface. No pilocystidia present, even on the pileal margin. Caulocystidia and pleurocystidia present or not. Cheilocystidia present, although rare in one species. Clamp connections present or not. Certain species give a transitory rose-lilac color reaction to 10% aqua ammonia when fresh. Spore length variable between species, 6.2-16.5 µm. Sporocarps medium-small to large in size, growing on wood, soil, plant debris, and rarely on manured soil or dung.

TYPE SPECIES: Coprinus micaceus (Bull. per Fr.) Fr., Epicrisis, p. 247. 1838.

Observations: The species of this section are mostly very similar in stature, habitat, and universal veil characteristics. They differ chiefly in overall pileal color, spore shape, cystidia, and in the presence or absence of clamp connections.

SECTION HEMEROBII

Coprinus Pers. per S. F. Gray, Section Hemerobii Fr., Epicrisis, p. 253. 1838.

Pileal surface of cellular-hymeniform type. Universal veil absent. Partial veil absent. Sporocarp completely glabrous and devoid of pilocystidia. Caulocystidia rarely present. Small to medium sized species resembling a parasol as they expand, very membranous and pleated or furrowed like an umbrella. Some species tardily autolytic. Spores medium sized, cordate, triangular, ovate, or elliptical, flattened or nearly round in cross section, 7.0-15.0 µm long. Species growing on dung, soil, and rarely on bark.

TYPE SPECIES: Coprinus hemerobius Fr., Epicrisis, p. 253. 1838.

Observations: One group of species in this section has cordate or triangular flattened spores and seems to form a natural and close-knit series. The other group of species bear a strong resemblance to species of Sections Setulosi and Micacei and in reality resemble the species with cordate to triangular spores only in possessing the same kind of pileal surface and in the mutual lack of universal veil and pilocystidia. There is a very real possibility that collections which are depauperate or heavily rain washed might be placed in Section Hemerobii when they should be placed in one of the other two sections with a cellular-hymeniform pileal surface.

Literature Cited

1. Kühner, R. & H. Romagnesi. 1953. Flore Analytique des Champignons Superieurs, Masson et Cie, Paris. 556 p.

2. Van De Bogart, F. 1976. The Genus COPRINUS in Western North America, Part I: Section COPRINUS. MYCOTAXON 4(1):233-275

3. ______________. 1979. The Genus COPRINUS in Western North America, Part II: Section LANATULI. MYCOTAXON (in press).

INDEX TO FUNGUS AND LICHEN TAXA

This index includes all taxa. The pages where all taxa are described or discussed are underlined. New taxa are in CAPITALS. The page numbers of all illustrations and line drawings are in parentheses ( ).

MYCOTAXON

Volume IX June 12, 1979 No. 1

A FESTSCHRIFT IN HONOR OF DANIEL E. STUNTZ

CONTENTS

Guest Editor: DAVID L. LARGENT

Guest Co-Editor: DAVID R. HOSFORD

[MYCOTAXON for April-June 1979 (8: 321-572) was issued April 21, 1979]