Handbook to Additional Fungal Species of Special Concern in the Northwest Forest Plan

Michael A. Castellano, Efrén Cázares, Bryan Fondrick, and Tina Dreisbach
Authors

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Cover

The mushroom genus *Gomphus* is represented by four species in the Pacific Northwest. *Gomphus* is placed in the family Gomphaceae and is typified by often gregarious to ceaspitose habit, gross scales on the cap surface, and wrinkled hymenium. *Gomphus bonarii* (Morse) Singer, a strategy 3 fungus species from table C-3 in the record of decision, is presented on the cover. Locally abundant and widespread throughout northern California, Oregon, and Washington. Photo courtesy of D. Arora.
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Abstract


This handbook is a companion to the Handbook to Strategy 1 Fungal Species in the Northwest Forest Plan, Gen. Tech. Rep. PNW-GTR-476, published in October 1999. It includes 73 record-of-decision (ROD)-listed fungal species not contained in the first handbook, as well as updated site, field, and collecting forms; an expanded set of artificial keys to all fungal species from both handbooks; and an updated, partially illustrated glossary. The main purpose of this handbook is to help facilitate the survey, collection, and handling of potential ROD-listed fungal species by USDA Forest Service and USDI Bureau of Land Management employees. Each species is represented by a condensed description, a set of distinguishing features, and information on substrate, habitat, and seasonality. We also present a list of known sites within the range of the northern spotted owl, a distribution map, and additional references to introduce the available literature on a particular species.

Keywords: Mycology, mushrooms, sequestrate fungi, truffles, biodiversity, monitoring, rare fungi, forest ecology.

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Introduction

Purpose of This Handbook

This handbook is a companion to the *Handbook to Strategy 1 Fungal Species in the Northwest Forest Plan* PNW-GTR-476 published in October 1999. It includes 73 record-of-decision (ROD)-listed fungal species not contained in the first handbook, as well as updated site, field, and collecting forms; an expanded set of artificial keys to all fungal species from both handbooks; and an updated partially illustrated glossary. The main purpose of this handbook is to help facilitate the survey, collection, and handling of potential ROD-listed fungal species by USDA Forest Service and USDI Bureau of Land Management employees.

Important Revisions of the ROD That Pertain to Fungi

In January 2001, amendments to the “survey and manage,” protection buffer, and other mitigation measures, standards, and guidelines were published in which ROD species were placed in categories (A, B, C, D, E, and F) rather than in the original strategies. Table 1 lists the fungal species, their original ROD strategies, and their new categories. Following is a brief explanation of the categories, excerpted from the above-mentioned document:

**Category A. Rare, predisturbance surveys practical**
Species are included in category A when (1) there is a high concern for persistence, (2) the species occurs rarely or is sparsely distributed within the range of the Northwest Forest Plan, (3) all known sites or populations are likely to be necessary to provide reasonable assurance of persistence, and (4) predisturbance surveys are practical. Only one fungus species, *Bridgeoporus nobilissimus*, is placed in category A.

**Category B. Rare, predisturbance surveys not practical**
Species are included in category B when (1) there is a high concern for persistence, (2) the species occurs rarely or is sparsely distributed within the range of the Northwest Forest Plan, (3) all known sites or populations are likely to be necessary to provide reasonable assurance of persistence, and (4) predisturbance surveys are not practical. The majority of fungi are placed in category B.

**Category C. Uncommon, predisturbance surveys practical**
Species are included in category C when (1) there is not a high concern for persistence, (2) it is likely that not all known sites or populations throughout the species’ range in the Northwest Forest Plan area are necessary for reasonable assurance of persistence, (3) the species is uncommon, as opposed to rare, and (4) predisturbance surveys are practical. No fungal species are placed in category C.

**Category D. Uncommon, predisturbance surveys not practical or not necessary**
Species are included in category D when (1) there is not a high concern for persistence, (2) it is likely that not all known sites or populations throughout the species’ range in the Northwest Forest Plan area are necessary for reasonable assurance of persistence, (3) the species is uncommon, as opposed to rare, and (4) predisturbance surveys are not practical or necessary. Surveys of habitat across the landscape are likely to be more effective at finding sites needed for long-term persistence than focusing in areas proposed for projects. Ten species of fungi are placed in category D.
Category E. Rare, status undetermined
Species are included in category E when (1) the number of known sites indicates the species is rare, and (2) information is insufficient to determine whether survey and manage basic criteria are met, or to determine what management is needed for a reasonable assurance of the species’ persistence. Three fungal species are placed in category E.

Category F. Uncommon or concern for persistence unknown, status undetermined
Species are included in category F when (1) the total number of known sites indicates the species is uncommon rather than rare, and (2) information is insufficient to determine whether survey and manage basic criteria are met, or to determine what management is needed for a reasonable assurance of the species’ persistence. Six fungal species are placed in category F.

Keys and Glossary
A revised key to all ROD fungal species is included in this handbook. The numbers in parentheses after species’ names in the key designate the page number of each species’ description; underlined numbers indicate that the species’ description is included in the first handbook, and nonunderlined numbers refer to the page of our current handbook of the species’ description. An updated glossary, including terminology used in describing the taxonomic features of fungi, is included.

Collection Sheets
Updated collection sheets are included in appendix 2. Use the site and collection forms provided when submitting fungal collections to the survey and manage team.

Table 1—Fungal species included in survey and manage standards and guidelines (January 2001)

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### Table 1—Fungal species included in survey and manage standards and guidelines (January 2001) (continued)

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</tbody>
</table>

<sup>1</sup> Removed from list (January 2001)
<sup>2</sup> Does not occur in North America
<sup>3</sup> Removed from list in Oregon and Washington (January 2001)
<sup>4</sup> Removed from list in Oregon, except for Curry and Josephine Counties (January 2001)
Methodology

The methodology section from the first handbook is reproduced here to facilitate the collection and handling of fungal specimens. No new information is included.

Voucher Specimens

Collection of voucher specimens of fungi is requisite to document species’ occurrence. In general, specimens should be annotated with appropriate information on species’ identity, location, date, habitat, and collector, and sent to a recognized herbarium for long-term storage (see app. H2 for forms). All collections of suspected or confirmed ROD-listed fungal species should be sent for verification to the regional mycologist (3200 SW Jefferson Way, Corvallis, OR 97331). Except in the case of multiple collections of extremely common species from the same locality in a narrow timeframe, all collections should have a voucher. The one exception is Bridgeoporus nobilissimus, which should have only a small portion of the sporocarp cut from the specimen for vouchering. Large collections of common species do not provide additional useful information, particularly for a location where collection has occurred previously. One to five representative specimens (depending on size) of each of the common species per collecting period are adequate to document presence over time. Most, if not all, specimens of rare or uncommon species should be carefully harvested, dried, and sent to a herbarium, as these may yield additional morphological information or represent incompletely known taxa. Remember, sporocarps are like apples from a tree; if you are careful not to disturb the substrate, then minimal damage will be done to the actual organism itself.

Some fungi can be reliably identified with few or no notes; others require at least some notes for identification to species. For the novice collector and identifier, notes are critical. Some of the important characters to record include the surface texture, fresh colors and odors, subsequent color after exposure and handling (after 10-20 minutes and again after 2-3 hours or the next day after storage in a refrigerator), color after drying, whether the specimens exude latex from a cut surface, or the cut surface of a specimen changes color. Use the appropriate field form (app. H2) to record fresh characters. The date, specific location, and notes on the plant community, particularly the large woody plants, are important in reporting on the ecology of these fungi. Note whether the specimens were found on the soil surface (epigeous), were emergent, or were completely below the surface of the ground (hypogeous). Note whether they were found solitary, in groups of two or more, or in clusters. See the field forms (app. H2) for location and ecological data that should be recorded. Until processed, fungal specimens are best kept in cool conditions in waxed paper sandwich bags or loosely rolled up in waxed paper or aluminum foil. Never use plastic wrap or closed “air-tight” containers, because they lead to anaerobic conditions that stimulate resident bacteria and other microorganisms that can quickly degrade the condition of the sporocarp(s).

Specimens should be described and then dried as soon as possible, preferably within 1 day from collection. If specimens of some species are in prime condition when collected, and if they are handled properly and stored correctly, they can be kept for several days before drying. Once begun, deterioration proceeds rapidly, and much of a specimen’s value for later study is lost.

Rapid drying by using moving air at relatively low temperatures is the most successful process to preserve most fungi. A food dryer set at about 30 to 40 °C works well. Good air circulation is critical to rapidly dry specimens. Specimens can deteriorate quickly when heat alone is used. When electricity is not available, there are alternative methods to dry specimens. If specimens are not large (<2 cm wide), they should be thinly sliced, ±2 mm in thickness, and placed in a sealed, airtight container with predried silica gel (4 to 5 times as much gel as specimens by volume). Carefully pack the specimens closely in the silica gel. Specimens should not touch each other within the container.
Airspace within the container should be kept to a minimum to ensure the effectiveness of this method. No more than one collection should be put in a container because, when dried, species often can be difficult to identify by macroscopic characters. Specimens will dry sufficiently in 1 to 2 days if the volume of silica gel is adequate for the quantity of specimens. Use the indicator crystals to tell when the gel is wet. Specimens dried by silica gel should be transferred to a more conventional dryer at the first opportunity to ensure that they dry completely. You can redry the silica gel in the field in a frying pan over a low fire. Keep well-dried specimens in sealed plastic bags to prevent rehydrating until you get them to the herbarium.

In circumstances where silica gel is unavailable or impractical because of size or number of specimens, specimens can be strung together with waxed dental floss and a large needle and suspended over a campfire. Carefully space the thin slices to allow air movement between them and adjust to the right height above the heat to prevent cooking while encouraging drying. Alternatively, lightweight frames covered with a fine-mesh aluminum screen can be used. The screens can be suspended over the campfire or a fueled camp stove (set low) or exposed to a steady but not forceful breeze. Again, care is needed when using heat to prevent cooking while encouraging drying.

Special Considerations

Mushrooms—Notes on fresh characteristics, particularly colors, are critical to aid identification. A spore print from mushrooms is also important to aid identification. Cut off the stem of a fresh specimen and place the cap with the gills or pores facing down on a piece of black and white striped paper (see app. H2) for 8-12 hours to capture a spore print on both dark and light surfaces. Wrap in aluminum foil or place in a container to prevent drying. Do not place specimens in the refrigerator or expose them to heat before setting up a portion of the collection to capture a spore print. For purposes other than obtaining a spore print, well-dried specimens are much easier to work with later than those preserved in liquid.

Sequestrate specimens—Information on colors is useful but usually not necessary for all species. When in doubt, take some notes on fresh characters. Each sporocarp should be cut at least in half to hasten drying; cut large specimens (those over 2-3 cm in diameter) into several vertical slabs of ±5 mm thickness. Many sequestrate species have leathery, somewhat impermeable peridia (outer skins) that are slow drying. Other sequestrate species dry to the hardness of bone, and any attempt to break open the sporocarp to access spores results in disintegration of the sporocarp. A cut cross section can readily be rehydrated with water or potassium hydroxide (5 percent KOH) and sectioned with a razor blade. Many sequestrate species resemble one another on the surface but differ strikingly in the interior. Examining the interior reduces the chance of including more than one species in a single collection. Nearly all sequestrate fungi fruit below the litter, and some fruit well within the mineral soil layer.

Collecting Protocols

It is difficult to recommend a specific protocol to collect fungi. Each protocol has strengths and weaknesses, and the appropriateness of any one protocol is determined by the constraints of the project.

Most forests contain diverse microhabitats. Even in “uniform” plantations, the microtopography varies with localized wet and dry soil conditions. Distribution of woody debris is also variable, and the debris can be patchy, buried, or exposed. Some fungi are associated with or found in rotten wood, e.g., some Ramaria spp., Gymnopilus punctifolius, Radiigera spp., and Hydnotrya variiformis. The patchiness of ground cover and shrub and herb layers also can dramatically affect the microclimate in restricted areas. Sites with heavy ground cover will be more difficult to search for specimens because of obstruction of view and difficulty in laying out plots. Slope and aspect will have an important effect on water relations and temperature. In the Pacific Northwest, south-facing, steep slopes tend to be the driest, and north-facing, gentle slopes the wettest. All these variables must be accounted for when designing sampling procedures for each sampling objective.
Fungal sporocarp production is relatively clustered (Fogel 1981, States and Gaud 1997). Fungi also differ in their sporocarp abundance and size. A major difficulty with using sporocarps to determine presence is the lack of data on the correlation between the presence of the thallus and sporocarp production. Some species produce sporocarps irregularly or infrequently.

Use of a relatively small number (with respect to the selected stand area) of random quadrants may not effectively sample the selected area. A large number of randomly distributed plots is necessary but impractical to achieve a well-dispersed sample pattern. Alternatively, systematic placement of fewer plots will achieve the best coverage for unit area sampled.

**Sampling Protocols**

Methodology used in vegetation surveys is not completely adequate for use in fungal surveys because of the need for repeated sampling of often cryptic populations.

Protocol implementation should be supervised by personnel trained in its use and in fungal identification. Before sampling, personnel should familiarize themselves with the general biology, ecology, habitat associations, and specific morphological features of target species. This will aid identification in the field and use field search time most efficiently.

Fungi can fruit any time of the year depending on weather and substrate. Some species fruit in the middle of the drought season in or on buried rotten wood or near streams or standing water. For the most part, fungi should be sampled in the warm, rainy season, e.g., in lowland areas, mid-October through December and April through June. Some fungi are restricted in sporocarp formation to a particular season (see seasonality data in species descriptions). Freezing weather truncates or delays the maturation of sporocarps, and high temperatures may accelerate drying of substrate and specimen, thus curtailing fruiting. When sampling across an elevational gradient, one should visit low-elevation, south-facing slopes first in the spring but last in the autumn and high-elevation, north-facing slopes last in the spring and first in the autumn (Luoma 1988).

**Periodicity**

Each area surveyed should be visited every 2 to 3 weeks during the fruiting season(s). Surveys should be conducted for a minimum of 3, and preferably 5, years to increase the likelihood of detection (Arnolds 1981, Fogel 1981, Lange 1978, Luoma 1991, Luoma and others 1991, O’Dell and others 1992, Richardson 1970). Three to 4 days of lab work should be anticipated for each successful day of field work.

In general, fungi form sporocarps during a restricted portion of the year, some only in the spring, some in winter, still others in the autumn. The cryptic nature of sequestrate fungus sporocarps makes them more difficult to detect than epigeous sporocarps.

**Survey Methods**

The three survey methods of choice are line transects, randomized plots, or plotless transects. All can be implemented as permanent or temporary (moving) plots. Once a clear objective is identified and a full understanding of the resources available for sampling assessed, the best method can be selected to meet objectives with the available resources.

**Line transects**—This method has plots located along a line, which may or may not be straight. These plots should be widely dispersed in a stand and intercept a wider variety of microsites than a single circular plot of the same area (Luoma and others 1996). This method is particularly useful when the exact habitat requirements of the target species are unknown. One method uses twenty-five 4-m² plots that comprise the
sample. On slopes, the upper, mid, and lower slope strata contain transects of eight, nine, and eight plots, respectively. Plots may be placed every 6 m along the 50 m (Luoma and others 1996). A “collection” is defined as those sporocarps of the same species from a particular 4-m² plot. A total area of 100 m² per 5- to 15-ha stand in twenty-five 4-m² circular plots gives a reasonable sample for a particularly small stand. Plots are marked with a flag or stake to avoid resampling the same area in a future sampling period. Another approach is to space plots 25 m apart on transects in the horizontal direction (along contour) and space transects 75 to 150 m apart in the vertical direction (across contour). A statistician should be consulted before sampling. Of course, any time the target species is encountered outside the plots, it should be collected and recorded.

**Randomized plots**—Although statistically sound, this method is logistically difficult to implement owing to the inordinate amount of resources needed.

**Plotless transects (time-constrained search)**—Before conducting the search, plan the search route to give an extensive reconnaissance-level approach to the entire area of interest. The most likely habitats should be identified and located on the landscape. Likely habitat should be intensively searched, but other less likely habitat should not be ignored. Use moving rules to designate how much time will be spent in each designated area within the overall interest area.

Time of search applies only to time spent actively searching for sporocarps. When moving to a new site or collecting specimens that were found, the collector stops the timer. The time needed is unknown for any particular stand and will depend on size of the stand, accessibility, objectives, and available resources. Because of the uncertainty of fruiting, the site must be repeatedly sampled in any one year and over 3 to 5 years to be considered adequately assessed.

**Special Considerations for Sequestrate Species**

In season, a good indicator of sequestrate fungus fruiting is the presence of fresh, small animal digs, 5 to 8 cm in diameter. Small animals, such as squirrels, mice, and voles, commonly unearth sequestrate fungi one at a time as they mature, leaving a small pit 2 to 8 cm deep. These small animal digs can sometimes be hard to distinguish from other types of holes such as diggings for seeds or insects or from hoof prints. Sometimes only a portion of the specimen has been eaten and a portion remains at the bottom of the small pit. Many sequestrate fungi fruit in clusters, so further exploration within a radius of 30 to 60 cm around a suspected fruiting spot often reveals additional specimens. It is best to rake into the soil to the depth of the nearby small animal dig. Needles, leaf fragments, and other debris or spider webs in a small animal dig indicate that it is not fresh. Further exploration, however, may yet reveal specimens, particularly if there are fresh digs scattered about in the habitat.

Plotless transects also can be useful in habitat with compacted soil or where the humus layer is thin. Under such circumstances, even small specimens form small humps at the soil surface that look detectable to the trained observer. Larger specimens oftentimes are emergent from these small humps. Campgrounds, abandoned roads, road banks, and used or abandoned walking trails are sites where this method is sometimes successful.

Some caution is needed in repeated sampling for sequestrate fungal species. The nature of the sampling procedure for sequestrate fungi is disruptive. The disturbance of the microhabitat may adversely impact the microhabitat and render it uninhabitable by the rare fungus that once was resident. This is particularly evident in habitat such as coarse woody debris that is dismantled in sampling. Woody debris thus sampled does not rapidly, if ever, return to its former structure. It is our experience in low-elevation forests in western Oregon that soil substrate and concomitant herbs and forbs return to predisturbance levels 1 to 2 years after sampling.
Remarks About Using the Keys

The keys that follow contain all species currently listed in the 2001 ROD. The number following a species’ name refers to the page number where that species’ description is found within the handbooks. Species’ information for numbers that are underlined is contained in the first handbook, whereas species’ information for numbers without underlining is contained in this handbook. There are a few species of Ramaria keyed that are not included in either handbook. These are, for the most part, varieties of similar species, and it was thought that including them will help discriminate among varieties.

Arriving at a species’ determination should serve only to direct the reader to the species’ description within one of the handbooks. In particular, the reader’s attention should then be directed to the distinguishing-features section for that species. If the characters of the specimen fit exactly the characters listed in the description, the specimen has a high likelihood of being that species. For the most part, verification of specimens should be done by an accomplished mycologist, as there often are non-ROD-listed species that are quite similar and difficult to distinguish.

Additional pictures of the species contained in this handbook can be found on the World Wide Web at: http://www.fs.fed.us/pnw/mycology/survey.
Keys to taxa
(see Glossary for terms)

A.  Sporocarp with a cap and (usually) a stem, the underside of the cap with radially arranged bladelike gills
Gilled mushrooms

B.  Sporocarp with a cap and stem, the underside of the cap with a layer of tubes often easily separated from cap, tube layer over 0.5 cm thick at maturity
Boletes

C.  Sporocarp crustlike, sheetlike or cushionlike, smooth or lacking a cap and stem smooth or poroid
Resupinate polypores and fungal parasites

D.  Sporocarp with a cap and a stem, spore-bearing tissue made up of repeatedly forking, blunt ridges
Chanterelles

E.  Sporocarp erect, unbranched (clubs) or branched corallike from a common base, cap lacking
Corals and clubs

F.  Sporocarp erect, unbranched, yellow with a differentiated flattened, rounded head
Earth tongues and allies

G.  Sporocarp cup, disc, or bowl shaped, stem present or absent
Cups and allies

H.  Sporocarp with cap and stem, the cap saddle shaped or irregularly lobed (brainlike)
Elfin saddles and false morels

I.  Sporocarp with the appearance of a distorted agaric or bolete or resembling a potato, interior solid, with gills, or irregular chambers, if gills present they are covered by a persistent veil
Sequestrate fungi

J.  Sporocarp with a cap and stem, tough or leathery, the underside of the cap with a layer of tubes, tube layer less than 0.5 cm thick at maturity
Stalked polypores and toothed fungi

A.  Key to gilled mushrooms

1.  Gills contorted and fused see sequestrate fungi

1.  Gills more or less radial and bladelike ................................................................. 2

2.  Spores deposit white, yellow, or pink ................................................................. 3

2.  Spores deposit red-brown, brown, or black .................................................... 30

3.  Gills decurrent and waxy, may fruit in spring or near melting snow .................. 4

3.  Gills decurrent and nonwaxy ................................................................. 6

4.  Cap yellow-brown when young, becoming tinged with bright pale vinaceous colors in age, spores 11-15.5 x 5.5-7 µm see Hygrophorus vernalis (61)

4.  Cap blue, pink-tan to pale tan, cream colored, spores <11µm long ................................................. 5

5.  Cap cream to blue, spores 7-9 x 4-5 µm see Hygrophorus caerulescens (60)

5.  Cap pale pink-tan to pale tan, spores 7.0-10.4 x 5.2-5.9 µm see Hygrophorus saxatilis (78)

6.  Sporocarps large, cap >70 (up to 380) mm in diameter, stem 25-60 mm in diameter, membranous partial veil present see Catathelasma ventricosa (41)

6.  Sporocarps smaller, caps always <110 mm in diameter, stem < 25 mm in diameter, partial veil absent............ 7

7.  Cap and gills yellow to green-yellow, stem hollow see Chrysomphalina grossula (44)

7.  Cap and gills without green tones, stem not hollow ....................................................... 8
8. Gills serrate and spores inamyloid ................................................................. 9
8. Gills not serrate, if gills serrate then spores amyloid ................................................................. 10
9. Cap and stem with red-brown resinous coating ................................................. see Neolentinus adhaerens (75)
9. Cap dry, white to pale pink-yellow or vinaceous ........................................ see Neolentinus kauffmanii (76)
10. Stem with numerous side branches up to 5 mm long .................................................. see Collybia racemosa (51)
10. Stem without side branches ...................................................................................... 11
11. Cap and stem with red-brown resinous coating .................................................. see Neolentinus adhaerens (75)
11. Stem slender, fragile; cap conic to campanulate, margin striate ............................. 12
11. Stem not slender, or if slender then more tough and wiry; margin usually not striate .................. 21
12. Cap dark blue to blue black ........................................................................................................... 13
12. Cap not blue .................................................................................................................. 13
13. Spores 2.7-4.2 x 2.0-3.0 µm, cap with violet tones ............................................ see Baeospora myriadophylla (39)
13. Spores > 5µm long, cap with non-violet tones ............................................................... 14
14. Cap pink to red, gill edges and faces white; cheilocystidia with long projections (over 3 µm) that occasionally branch ................................................................. see Mycena monticola (72)
14. Cap some other color ............................................................................................................ 15
15. Cap gray, base of stem fuzzy, vernal fruiter, usually near melting snow .................... see Mycena overholtsii (73)
15. Cap not gray, or if gray fruiting in fall, base of stem not fuzzy ................................................................. 16
16. Gills brown, pruinose, spores 6.0-7.5 x 3.0-4.5 µm ............................................... see Hydropus marginellus (77)
16. Gills white, gray to pale lilac or yellow-brown, spores larger ................................................................. 17
17. Spores globose 8-9 µm in diameter ..................................................................... see Fayodia bisphaerigera (61)
17. Spores ellipsoid ............................................................................................................... 18
18. Cap pale yellow to yellow-brown or olive-tan, cystidia absent ....................... see Chromosera cyanophylla (43)
18. Cap without yellow, cystidia present. .......................................................................................... 19
19. Cap brown-black, cheilocystidia and pleurocystidia long pedicellate without spines .. see Mycena quinaultensis (74)
19. Cap gray to black, cheilocystidia and pleurocystidia long pedicellate with or without spines ................. 20
20. Cap gray to black, margin pale gray to white, cheilocystidia and pleurocystidia clavate with short spines see Mycena hudsoniana (71)
20. Cap fuscous to dark gray, cheilocystidia with long diverticula, pleurocystidia without spines .. see Mycena tenax (80)
21. Cap white, often with pink tints, on conifer logs, cheilocystidia of two types: cylindric to broadly clavate and obtuse and irregularly cylindric to nodulose to lobed ................................................................. see Collybia bakerensis (22)
21. Cap not white with pink, or cheilocystidia otherwise .................................................................................. 22
22. Cap 10-18 mm, brown to dark red-brown, and with garlic odor ............... see Marasmius applanatipes (67)
22. Cap with other characteristics and no garlic odor .................................................................................. 23
23. Cap tan to honey-brown, stem pale yellow to yellow-orange, fibrillose streaked, spores pink to pink-brown in deposit, angular, spores subglobose to obovoid, slightly angular ......................... see Rhodocybe speciosa (131)
23. Cap not tan and scaly or spores not pink in deposit and not angular ................................................................. 24
24. Cap white with gray to tan scales, gills sinuate, attached, white spore print .................................................................................................................................................................................................................................................. see Tricholoma venenatum (137)
24. Cap some other color, gill attachment otherwise ................................................................................................. 25
25. Cap orange-yellow to yellow-tan, with tawny fibrils near margin, gills adnate, spores broadly ellipsoid ........................................................................................................................................................................................................................................................................ see Tricholomopsis fulvescens (138)
25. Cap some other color or gill attachment otherwise ................................................................................................. 26
26. Spore print yellowish white, if spore print white, then gills decurrent .................................................................. 27
26. Spore print yellow, brown, purple-brown, black, gills not decurrent ........................................................................ 30
27. Gills adnate to adnexed ............................................................................................................................................ see Russula mustelina (98)
27. Gills decurrent ......................................................................................................................................................... 28
28. Cystidia absent ........................................................................................................................................................ 29
28. Cystidia present on cap, stem, and gills .................................................................................................................. see Rickenella swartzii (97)
29. Cap, stem, and gills gray, cap fibrillose matted, stem with white basal rhizomorphs ............................................................. see Clitocybe senilis (20)
29. Cap, stem, and gills gray-brown to gray-buff, cap glabrous, rhizomorphs lacking .......................................................... see Clitocybe subditopoda (21)
30. Spores black, up to 30 µm long, gill often contorted and fused, cap orange and fibrillose, partial veil present see ................................................................. Chroogomphus loculatus (19)
30. Spores brown, rusty brown to purple-brown ............................................................................................................ 31
31. Spore print purple-brown, spores 6-8.5 x 4-5.5 µm ........................................................................ see Mythicomyces corneipes (81)
31. Spore print brown ...................................................................................................................................................... 32
32. Stem not deeply rooting ......................................................................................................................................... 33
32. Stem deeply rooting .................................................................................................................................................. 51
33. Stem <25 mm thick ................................................................................................................................................ 34
33. Stem >25 mm thick ................................................................................................................................................ 38
34. Clamps absent ........................................................................................................................................................ 35
34. Clamps present ........................................................................................................................................................ 35
35. Pleurocystidia and pileocystidia present, spores 11-15 x 6-9 ................................................................. see Galerina atkinsoniana (62)
35. Either pleurocystidia or pileocystidia absent; caulocystidia present, spores smaller ............................................... 36
36. Stem 50-120 mm long, spores 9-11 x 6-8 µm ........................................................................................................ see Galerina sphagnicola (65)
36. Stem only up to 30 mm long ..................................................................................................................................... 37
37. Spores amygdaliform and noncalyptrate ................................................................................................................ see Galerina vittaeformis (66)
37. Spores calyptrate ..................................................................................................................................................... see Galerina cerina (63)
38. Cap viscid, violet to pale lilac, becoming white with a yellow disc, stem with marginate base, KOH on cap turns pink to red immediately ................................................................. see *Cortinarius olympianus* (25)
39. Spores 4.5-6 x 3-3.5 µm ................................................................. see *Stagnicola perplexa* (104)
39. Spores >6 µm long ........................................................................ 40
40. Veil red or pink ...................................................................................... 41
40. Veil lacking, but if present not red ........................................................... 42
41. Cap dull to violaceous brown, spores ellipsoid, 7-8 x 4-5.5 µm ....... see *Cortinarius boulderensis* (23)
41. Cap gray brown, spores subglobose to broadly ellipsoid, 7.4-8.9 x 5.6-7.0 µm ................................................................. see *Cortinarius depauperatus* (56)
42. Cap a variable blend of green, blue, and yellow, basal mycelium lavender, on well-rotted wood ................................................................. see *Gymnopilus punctifolius* (52)
42. Cap with other colors, basal mycelium lacking ........................................ 43
43. Cap dull cinnamon, viscid, veil faintly fibrillose .................................. see *Hebeloma olympianum* (53)
43. Cap not dull cinnamon, or dry or lacking persistent veil ............................................. 44
44. Cap orange, with yellow veil remnants on stem and dark scales on cap .......................................................................................................................... see *Cortinarius rainierensis* (26)
44. Cap and veil different .............................................................................. 45
45. Cap with enrolled margin and gray gills ................................................. see *Cortinarius variipes* (28)
45. Cap with margin not enrolled or gills not gray ........................................ 46
46. Young gills olive-yellow, cap surface and flesh olive-yellow to dingy brown, cap surface turning purple-brown with application of KOH ................................................................. see *Dermocybe humboldtensis* (31)
46. Young gills or cap some other color .......................................................... 47
47. Spores 4-5.5 µm in diameter with an apical pore, cap vinaceous brown, stem with membranous annulus, on litter ................................................................. see *Stropharia (as Pholiota) albivelata* (93)
47. Spores 5.5-7.0 (-7.8) µm in diameter lacking apical pore ............................................. 48
48. Sporocarp with violet to blue tones and strong red coloration of stem context ...... see *Cortinarius cyanites* (55)
48. Sporocarp without blue tones or no red reaction of stem context .................. 49
49. Gills violet to blue-violet ......................................................................... see *Cortinarius barlowensis* (54)
49. Gills non-violet to blue-violet .................................................................... 50
50. Cap gray-brown with violaceous margin, spores ellipsoid 8-10 x 5.5-6 µm ...... see *Cortinarius umidicola* (27)
50. Cap yellow-brown to brown with olive tones, spores ellipsoid to subglobose 7.4-8.9 x 5.6-6.7 µm ................................................................. see *Cortinarius valgus* (57)
51. Spores < 8 µm long ................................................................................... 52
51. Spores > 8 µm long .................................................................................. 54
52. Clamp connections present ................................................................. see *Phaeocollybia dissiliens* (86)
52. Clamp connections absent (or infrequent) ................................................................. 53

53. Stem stuffed, cheilocystidia cylindric, 24-34 x 3-6 µm .............................. see Phaeocollybia oregonensis (89)
53. Stem hollow, cheilocystidia clavate, 30-40 x 7-9 µm .............................. see Phaeocollybia sipei (92)

54. Caps with some green coloration ............................................................................... 55
54. Caps without green coloration ............................................................................... 57

55. Cheilocystidia clavate ............................................................................................... 56
55. Cheilocystidia capitulate, lageniform to tibiiform ................................. see Phaeocollybia pseudofestiva (85)

56. Stem hollow, cap up to 65 mm in diameter .................................................... see Phaeocollybia fallax (83)
56. Stem stuffed, cap 40-110 mm in diameter ..................................................... see Phaeocollybia olivacea (84)

57. Cheilocystidia cylindrical to clavate ...................................................................... 58
57. Cheilocystidia lageniform to tibiiform .................................................................. 61

58. Cap typically greater than 80 mm in diameter ........................................ see Phaeocollybia kauffmanii (88)
58. Cap less than 70 mm in diameter ......................................................................... 59

59. Spores 7-8.5 x 5-5.5 µm ................................................................................ see Phaeocollybia attenuata (82)
59. Spores larger ........................................................................................................ 60

60. Cap bright orange to red-orange ........................................................................ see Phaeocollybia piceae (90)
60. Cap gray-brown ..................................................................................................... see Phaeocollybia gregaria (87)

61. Stem stuffed .......................................................................................................... 62
61. Stem hollow ........................................................................................................... 62

62. Sporocarps in loose bundles, cap yellow-brown to orange-brown ........................................ see Phaeocollybia californica (85)
62. Sporocarps densely fasciculate, cap yellow-brown to brown-black ................................................ see Phaeocollybia scatesiae (91)

B. Key to boletes

1. Sporocarps small, cap <70 mm in diameter, bright yellow mycelium at base, taste peppery to acrid .............................................. see Chalciporus piperatus (42)
1. Sporocarps large, cap >70 mm in diameter, yellow mycelium absent from base, taste not peppery or acrid ...... 2

2. Tubes yellow in youth, becoming green-yellow to olive .................................... see Boletus haematinus (10)
2. Tubes red to dark brown to black ........................................................................... 3

3. Tubes dark brown to black, tubes bruising blue ............................................ see Tylopilus porphyrosporus (141)
3. Tubes dark red to red-brown ............................................................................... see Boletus pulcherrimus (11)

C. Key to resupinate polypores and fungal parasites

1. On rotting mushrooms ............................................................................................. 2
1. Not on rotting mushrooms, instead on dead wood or twigs ..................................... 4
K - 18

2. Sporocarps a crustlike covering on Russulaceae mushrooms, yellow to yellow-green to green-black ..................................................................................................... see Hypomyces luteovirens (79)

2. Sporocarps fruiting from rooting Russulaceae mushrooms, with a stem and cap .......................................................... 3

3. Chlamydospores smooth, fusoid, 12-17 x 9-11 µm .................................................. see Asterophora parasitica (38)

3. Chlamydospores ornamented, globose, subglobose to ovoid, 11-20 x 10-18 µm
...................................................................................................................... see Asterophora lycoperdoides (37)

4. Sporocarps small (<5 mm) cushion to disc shaped, pale yellow-brown hymenial surface on twigs, spores smooth .......................................................................................................................... see Acanthophysium farlowii (1)

4. Sporocarps resupinate with irregularly warty hymenial surface, ochraceous-buff hymenial surface, spores ornamented, on dead conifer wood .............................................................. see Dichostereum boreale (34)

D. Key to chanterelles

1. Cap dark blue to black, hymenium concolorous, odor mildly pungent
.......................................................................................................................... see Polyozellus multiplex (96)

1. Cap white, yellow, orange-yellow, yellow-brown, brown or yellow-olive .......................................................... 2

2. Cap white to off-white, handling yellow, spores 7-9 x 5-5.5 µm ...................... see Cantharellus subalbidus (40)

2. Cap yellow, orange-yellow, yellow-brown, brown or yellow-olive, spores longer ...............................................

3. Cap distinct, stem hollow and flabby, compressed or furrowed ....................... see Craterellus tubaeformis (58)

3. Cap indistinct mostly an extension of the stem, stem solid, thick ...................... 4

4. Cap brown to yellow-olive, hymenium violaceous ............................................ see Gomphus clavatus (69)

4. Cap orange to orange-yellow to orange-brown, hymenium white to brown .................. 5

5. Sporocarps in often caespitose clusters, spores 10-12 (-14) x 5-6 µm ............... see Gomphus bonarii (68)

5. Sporocarps not in caespitose clusters, spores 11.9-17.5 x 5.7-7.8 µm ............... see Gomphus kauffmanii (70)

E. Key to corals and clubs

1. Sporocarps clublike, sparsely branched or with ribbonlike or leafy lobes ....................... 2

1. Sporocarps usually with numerous branches .......................................................... see genus Ramaria key below

2. Sporocarps with some branches or ribbonlike or leafy lobes ...................................... 3

2. Sporocarps clublike ........................................................................................................ 4

3. Sporocarps with ribbonlike or leafy lobes ................................................................. 4

3. Sporocarps with a distinct stem clothed with fascicles, spore-bearing tissue palmate with a few branches .......................................................................................................................... see Clavulina castaneopes var. lignicola (50)

4. Spores 8-10 x 5-6 µm, sporocarps tinged with red ................................................. see Clavariadelphus subfastigiatus

4. Spores larger, sporocarps without red ................................................................. 5

5. Spores ≤17 µm long ......................................................................................... 6

5. Spores 18-24 µm long .................................................................................. see Clavariadelphus sachalinensis (47)

6. Spores 3.5-4.5 µm in diam ............................................................................... see Clavariadelphus ligula (45)
6. Spores >5.0 µm in diam .................................................................................................................... 7
7. Sporocarp with flattened apex, staining red with KOH, spore print white
                                                                                           see Clavariadelphus truncatus (49) 7
7. Sporocarp clavate shaped, not with flattened apex, KOH negative, spore print white to pale yellow
                                                                                           see Clavariadelphus occidentalis (46)

Owing to the difficulty in working with Ramaria species, we present both a traditional dichotomous key and a synoptic key. We suggest that the novice try both to build skills in working with this troublesome genus. These keys contain all the Ramaria species from the ROD including the strategy 3 species. We hope this helps in identifying the closely related species that are slightly more common than the strategy 1 species.

Key to subgenera of Ramaria
(after Marr and Stuntz 1973)

1. Spores striate ornamented, flesh usually amyloid ................................................................. Subgenus Ramaria
1. Spores smooth, warted or spiny, not striate, flesh in most species inamyloid (except species of the R. subbotrytis complex) ................................................................. 2

2. Sporocarps terricolous, spores smooth or warted, flesh and rhizomorphs monomitic
                                                                                           Subgenus Laeticolora
2. Sporocarps with one or more of the following characters: (1) lignicolous or duff habit, (2) spiny spores, (3) skeletal hyphae ................................................................. 3

3. Spores echinulate or echinulate-verrucose, with duff habit; rhizomorphs extensively developed, monomitic
                                                                                           Subgenus Echinoramaria
3. Spores smooth or warted, not spiny, lignicolous or duff habit, rhizomorphs extensively developed, dimitic in most species (except R. apiculata) ....................................... Subgenus Lentoramaria

General descriptions of the subgenera in Ramaria

Subgenus Ramaria
Sporocarps generally large, profusely branched, entirely white, pale yellow, alutaceous, or upper branches orange, red to violet; spores ornamented with cyanophilic striae sometimes subreticulate or subverruculose, flesh usually amyloid.

Subgenus Laeticolora
Sporocarps generally large, profusely branched, terrestrial, often brightly colored in yellow, orange, and red shades, a few species cream, violaceous, or brown; spores of most species warted, ornamentation consisting of fine to coarse, irregularly shaped, cyanophilic raised areas, in a few spores smooth, flesh and rhizomorphs monomitic, hyphae with or without clamp connections.

Subgenus Echinoramaria
Sporocarps generally small, in a few species of medium to large size, growing on twig litter, cones, needle duff, or leaf mold, rhizomorphic strands commonly conspicuous, and a well-developed felty basal tomentum or mycelial mat usually present; sporocarps cream, yellow, olive, green, or with brown shades, sometimes changing color where bruised; hyphae thin walled, monomitic, clamp connections frequently of the loop type or clamp cell vesiculate; spores echinulate or subechinulate, spines 0.2-3 µm tall.

Subgenus Lentoramaria
Sporocarps generally small to medium sized, habitat lignicolous or sublignicolous (growing from twig and leaf litter), rhizomorphic strands commonly conspicuous, and a well-developed felty basal tomentum or mycelial mat sometimes present; sporocarps cream, yellow, green, or with brown shades, sometimes quickly changing color where bruised; hyphae thin or thick walled, monomitic or dimitic, clamp connections present; spores smooth or finely warted.
Key to species of the subgenus Ramaria

1. Upper branches pale orange to brown, stem opaque white, bruising pale yellow to gray-orange, spores 12-16 x 4-6 µm .................................................................................... see R. botrytis var. aurantiiramosa (101)
1. Upper branches with red tones .................................................................................................................. 2
2. Red color of terminal branches evanescent at maturity, upper branches’ axils U-shaped, somewhat divergent, forked to multiforked near apices, stem milk-white discoloring yellow, bruising brown-violet, spores 11-13 x 4.5-5 µm, striae closely spaced .............................................................. see R. rubrievanescens (116)
2. Red color of terminal branches persists at maturity, upper branches with axils mostly acute to subacute, forked to multiforked near apices, stem milk-white to yellow-white and do not bruise red to violet brown, spores 8-13 x 3.5-4.5 µm, striae oblique to longitudinal ....................... see R. rubripermanens (117)

Key to species of the subgenus Laeticolora

1. Basidia with clamp connections at base or clamp connections frequent in the subhymenium and flesh of the branches or both ........................................................................................................................................ 2
1. Basidia without clamp connections at base, true clamp connections rare in the subhymenium and flesh of the branches .................................................................................................................................................. 2
2. Stem flesh amyloid when fresh .................................................................................................................. 3
2. Stem flesh inamyloid when fresh ............................................................................................................... 4
3. Lower branches distinctively staining red, interior flesh does not react with 10 percent Fe₂(SO₄)₃, spores 9-11 x 4-5 µm with warts in subspirals ........................................................................... see R. maculatipes (112)
3. Lower branches occasionally bruised violet-gray, interior flesh reacts instantly blue-green with 10-percent Fe₂(SO₄)₃, spores 7-10 x 3-4 µm with fine warts in lines .................................................. see R. amyloidea (98)
4. Stem white bruising strongly red brown, branches white to pale yellow with pale green-yellow apices, spores 11.6-15.8 x 4-5 µm with discrete low warts; spring fruiting ................................................... see R. thiersii (120)
4. Stem white to pale yellow not bruising red-brown, branches pale orange with intense orange apices, spores 11-15 x 3.5-5 µm with distinctive, irregularly shaped warts in subspirals; autumn fruiting ............................................................................................................................... see R. largentii (110)
5. Spores finely warted or smooth ............................................................................................................... 6
5. Spores distinctively warted ....................................................................................................................... 6
6. Stem medium sized, single and slender, white to orange-white, stem and lower branches staining dark red, flesh fleshy-fibrous without a brown fan-shaped area when cut longitudinally, fall fruiting, spores 10-14 x 3.5-5 µm, smooth to finely ornamented .................................................. see R. rubribrunnescens (115)
6. Stem large to massive, single white to off-white, slowly stains pale purple-gray where handled, flesh watery off-white, usually with brown band, spring fruiting, spores 8-13 x 3-4 µm, smooth to a few ill-defined, small, low warts ............................................................................................................................................... 9
7. Flesh amyloid .............................................................................................................................................. 8
7. Flesh inamyloid ......................................................................................................................................... 8
8. Branches scarlet in youth, fading to pale orange-red when mature and with apices intensely colored, stem white to pale orange, interior flesh without a brown band and no reaction with 10-percent Fe₂(SO₄)₃, spores 7-10 x 3-5 µm with small warts ........................................... see R. stuntzii (119)
8. Branches pale to pale orange with sunflower yellow apices, stem yellow-white covered with subareolate patches of brown to red-brown superficial hyphae, interior flesh with a brown band and reacts blue-green with 10-percent Fe₂(SO₄)₃, spores 8-11 x 4-6 µm with coarse warts and prominent apiculus ........... see R. celerivirescens (102)

9. Sporocarps typically fasciculate or caespitose ................................................................. 10

9. Sporocarps not fasciculate or caespitose ........................................................................ 13

10. Flesh gelatinous when fresh ............................................................................................. 11

10. Flesh rubbery, fibrous, or cartilaginous ........................................................................... 12

11. Apices deep orange and not bruising dull violet, gleoplerous hyphae absent, spores
    8-11 x 3.5-5 µm ..................................................................................... see R. gelatiniaurantia var. gelatiniaurantia (107)

11. Apices apricot-yellow, bruising dull violet, gleoplerous hyphae distinctive in stem, spores
    8-11 x 3.5-5 µm ................................................................. R. gelatiniaurantia var. violeitingens (not in handbooks)

12. Sporocarps white, branches salmon to peach with pale to maize-yellow branch tips, sometimes bruising pale
    violet in some areas, spores 6-10 x 4-6.5 µm ........................................ see R. fasciculata var. sparsiramosa (106)

12. Sporocarps white with small surface spots of red present, branches pale yellow to yellow, not bruising violet,
    spores 7.9-9.4 x 4.7-5.8 µm ............................................................ see R. lorithamnus (111)

13. Flesh gelatinous when fresh ............................................................................................ 14

13. Flesh fibrous .................................................................................................................. 15

14. Sporocarps stout, cauliflower-like, broadly obovate to broadly pyriform in outline with abortive branchlets,
    branches pale yellow to pale orange, spores 9-11.2 x 4.5-6 µm .................................. see R. verlotensis (121)

14. Sporocarps broadly fusiform to broadly obconic in outline without abortive branchlets, branches bright yellow to
    pallid salmon, spores 9.4-11.2 x 4-5 µm ....................................................... see R. hilaris var. olympiana (109)

15. Sporocarps dark orange-brown to brown overall, branches brown to violaceous brown, apices violaceous brown
    when young, concolorus with branches at maturity, spores 7.2-10.1 x 4.7-6.1 µm ............. see R. spinulosa var. diminutiva (118)

15. Sporocarps yellowish, brown-white, red to salmon, branches not showing violaceous tints .................. 16

16. Basidia with masses of cyanophilic granules ................................................................... 17

16. Basidia without masses of cyanophilic granules .............................................................. 19

17. Apices pale yellow to yellow .......................................................................................... 18

17. Apices pale red, never yellow, spores 8-10 x 4-5 µm .................................................... R. cyaneigranosa var. elongata (not in handbooks)

18. Branches intensely red; yellow apices, spores 8-15 x 4-6 µm ........................................ see R. cyaneigranosa var. cyaneigranosa (105)

18. Branches peach or salmon with minutely yellow apices, spores 7-11 x 3.5-6 µm ......................... R. cyaneigranosa var. persicina (not in handbooks)

19. Branches and apices intensely yellow orange, spores 8.5-14 x 3-5 µm ............ see R. aurantiisiccescens (100)

19. Branches magenta, red, yellow-orange, brown-salmon .................................................. 20
20. Branches red in youth fading to pale red at maturity, apices maize-yellow or pale to deep orange when mature, spores 8-13 x 3-4.5 µm ................................................................. see *R. araiospora var. araiospora* (99)

20. Branches intensely magenta red with blue tones, fading to pale red, apices magenta in mature specimens, spores 8-14 x 3-5 µm ...................................................... *R. araiospora var. rubella* (not in handbooks)

**Key to species of the subgenus Lentoramaria and Echinoramaria**

1. Spores distinctly spiny ........................................................................................................ see *R. abietina* (90)

2. Spores small, 5-6.5 x 3.5-4 µm, skeletal hyphae strongly cyanophilic, resembles *Ramariopsis kunzei* ................................................................. see *R. gracilis* (108)

3. Generative hyphae without ornamentation ................................................................. 4

4. Sporocarps with pink-cinnamon coloration ............................................................... 5

5. Rhizomorphs white, changing to bright pink in 10 percent KOH .................................................. *R. rubella f. rubella* (not in handbooks)

6. Sporocarps up to 14 cm tall, stem distinct, branches dull brown to orange-brown, axils concolorous or green ................................................................. 7

7. Branches open and lax, curved ascending, axils without green coloration .................................................. see *R. concolor f. marrii* (104)

8. Synoptic key to *Ramaria* species contained in the ROD

1. *R. abietina*  17. *R. hilaris var. olympiana*
2. *R. amyloidea*  18. *R. largentii*
3. *R. araiospora var. araiospora*  19. *R. lorithamnus*
5. *R. botrytis var. aurantiiramosa*  21. *R. ochraceovirens*
9. *R. fasciculata var. sparsiramosa*  25. *R. rubrievanescens*
11. *R. cyanegransiosa var. cyanegransiosa*  27. *R. spinulosa var. diminutiva*
13. *R. cyanegransiosa var. persicina*  29. *R. suecica*
15. *R. gelatiniaurantia var. violeitingens*  31. *R. verlotensis*
16. *R. gracilis*
Macroscopic characteristics
(Underlined numbers from species list above indicate that species occurs within more than one character.)

Stem color
Yellow: 2, 3, 5, 13, 14, 16, 17, 21, 22, 24, 25, 30
Orange: 1, 15, 16, 19, 21, 22, 23, 27, 30
Pink tones: 22
Red to magenta: 20, 31
Olive tones: 31
White to cream: 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 29, 30
Brown: 1, 2, 5, 6, 20, 22, 26
Red-brown: 28
Tan to gray-orange (this could be just tan): 7, 15, 21

Branch color
Green: 18, 20, 31
Yellow: 3, 7, 8, 12, 14, 15, 16, 18, 21, 22, 24, 29, 30, 31
Orange: 1, 3, 5, 8, 11, 12, 13, 14, 15, 16, 17, 19, 21, 22, 23, 24, 25, 27, 29, 30
Pink tones: 1, 2, 8, 9, 10, 11, 15, 18, 19, 22, 23, 24, 25, 28, 30
Red to magenta: 2, 27
Red-brown: 9, 28
White to cream: 4, 9, 15, 21, 24, 29
Gray to violet: 1, 7, 26
Brown: 6, 7, 11, 22, 23, 26
Tan-gray: 6, 15, 21

Branch tip color
Green: 20, 29
Yellow: 1, 2, 3, 5, 6, 8, 10, 12, 14, 15, 16, 18, 19, 21, 23, 29, 30, 31
Orange: 1, 2, 3, 4, 7, 11, 12, 13, 16, 17, 21, 23, 27, 30
Pink tones: 1, 2, 9, 10, 11, 24, 25, 28, 30
Red to magenta: 2, 19, 24, 25, 27
White to cream: 6, 7, 15, 21, 22, 24, 25, 28
Violet to gray: 1, 26
Brown: 1, 9, 26
Tan to gray-orange: 6, 15, 21

Stem flesh
White to cream: 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 18, 19, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31
Yellow: 2, 3, 16, 22
Orange: 21, 22, 23, 27
Brown: 26
Green tones: 20
Tan to gray-orange: 5
**Stem flesh with brown band**

Present: 1, 5, 9  
Absent: 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31

**Branch flesh**

Yellow: 1, 2, 3, 5, 8, 10, 12, 13, 14, 16, 19, 23, 29, 30, 31  
Orange: 1, 2, 3, 5, 8, 11, 12, 17, 19, 21, 23, 24, 27, 29, 30  
Red to magenta: 2, 27  
White to cream: 4, 6, 7, 9, 13, 15, 17, 18, 21, 22, 24, 25, 26, 27, 28, 29  
Green tones: 20  
Tan to gray-orange: 5

**Base of stem a rusty color**

Present: 1, 5, 9, 27  
Absent: 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 28, 29, 30, 31

**Yellow band on branch exterior**

Present: 3, 12, 13, 15, 30  
Absent: 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 14, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31

**Color of surface bruising**

Vinaceous: 7, 8, 9, 18  
Red: 18, 19, 22, 23, 24  
Violet: 1, 8, 9, 14, 24  
Brown: 6, 7, 9, 18, 24, 26, 29  
Yellow or orange or tan: 3, 4  
Blue-green or green: 20, 31  
Not bruising: 2, 5, 10, 11, 12, 13, 15, 16, 17, 21, 25, 27, 28, 30

**Context of stem**

Fleshy: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31  
Base gelatinous: 13, 14, 16, 30

**Context of branch**

Fleshy or non-gelatinous: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 31  
Gelatinous: 13, 14, 16, 30

**Rhizomorphs**

Present: 6, 7, 15, 20, 21, 22, 28, 31  
Absent: 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 23, 24, 25, 26, 27, 28, 29, 30

**Habitat**

Terrestrial: 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13, 14, 16, 17, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30  
Decayed wood: 6, 7, 15, 22, 31
Season
Spring: 9, 25, 29, 31
Autumn: 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 27, 28, 30, 31

Microscopic characteristics

Spore ornamentation
Spiny: 20, 31
Striate: 4, 24, 25
Warts: 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 21, 22, 23, 26, 27, 28, 29, 30
Smooth or nearly so: 8, 23

Spore length
Maximum spore length >7 µm, ≤10 µm: 1, 6, 7, 8, 9, 11, 15, 18, 20, 21, 22, 26, 27, 28, 30, 31
Maximum spore length >10 µm, ≤15: 2, 3, 4, 5, 11, 10, 12, 13, 14, 16, 17, 19, 23, 24, 25, 27, 30
Maximum spore length >15 µm: 4, 29

Spore width
Spore width (maximum) ≤4 µm: 1, 7, 9, 15, 28
Spore width (maximum) >4 µm, =5 µm: 2, 3, 6, 7, 11, 13, 14, 15, 16, 17, 19, 20, 23, 24, 25, 26, 27, 28, 29, 30, 31
Spore width (maximum) >5 µm, =6 µm: 4, 5, 10, 12, 18, 21, 22, 24, 26, 27, 28, 30
Spore width (maximum) >6 µm: 8, 30

Cyanophilic granules in basidia
Present: 1, 10, 11, 12, 21, 23, 24, 25, 27, 30
Absent: 2, 30, 31
Unknown: 3, 4, 5, 6, 7, 8, 9, 13, 14, 15, 16, 17, 18, 19, 20, 22, 26, 28, 29

Clamps in basidia or trama
Present: 1, 4, 6, 7, 15, 17, 19, 20, 21, 22, 24, 25, 28, 29, 31
Absent: 2, 3, 5, 8, 9, 10, 11, 12, 13, 14, 16, 18, 23, 26, 27, 30

Gleoplerous hyphae
Present: 1, 2, 3, 4, 5, 10, 11, 12, 13, 14, 17, 18, 19, 20, 22, 23, 24, 25, 27, 28, 29, 30
Absent: 2, 3, 5, 6, 7, 8, 9, 15, 16, 20, 21, 22, 23, 26, 31

Macrochemical test on sporocarp flesh

Melzer’s reagent
Reactive turning flesh dark purple or blue-black: 1, 4, 5, 19, 24, 25, 27
Non-reactive or some shade of brown but not dark brown or purple: 2, 3, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 26, 28, 29, 30, 31

Ferric sulfate
Reactive turning flesh blue-green to green: 1, 5, 9, 31
Non-reactive: 2, 3, 4, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30
F. Key to earth tongues and allies

1. Basidia present, sporocarps small, white, spatulate, with mosses ......................... see *Cyphellostereum laeve* (60)
2. Asci present ........................................................................................................... 2
3. Sporocarps attached to sequestrate (truffles) sporocarps with soil ................................................................. 3
4. Sporocarps not attached to sequestrate (truffles) sporocarps ........................................... 4
5. Sporocarp capitate, partospores cylindrical to subfusoid ........................................ see *Cordyceps capitata* (52)
6. Sporocarp clavate, partospores truncate ................................................................ see *Cordyceps ophioglossoides* (53)
7. Sporocarps cylindrical to clavate, spores obtusely fusoid, 2.5-4 x 4.5-5.5 µm ........................................................................................................ see *Podostroma alutaceum* (89)
8. Sporocarps capitate ................................................................................................. 5
9. Spore-bearing tissue pink-cinnamon, stem brown to gray-purple brown, spores globose 18-24 µm in diam .......................................................................................................................... 5
10. Spore-bearing tissue bright orange to pale orange, stem creamy white, spores fusiform to cylindric 9-13 x 2-3 µm ............................................................................................................ see *Bryoglossum gracile* (14)

G. Key to cups and allies

1. Cup yellow, red, or orange .......................................................................................... 2
2. Cup gray, dark brown to purple or black ........................................................................ 5
3. Cup with well-developed stem in youth, fruiting in fall ........................................ see *Sowerbyella rhenana* (135)
4. Cup without stem, or fruiting in spring ........................................................................ 3
5. Fruiting on twigs or foliage of *Chamaecyparis nootkatensis*, usually near melting snow ..................................................................................................................... 3
6. Fruiting on some other substrate, cup bright orange .................................................. 4
7. Cups 5 to 35 mm diam., on soil .................................................................................. 5
8. Cups 1-1.5 mm diam., on twigs or foliage of *Abies* sp., usually near melting snow ..................................................................................................................... 5
9. Interior of sporocarp gelatinized .................................................................................. 6
10. Interior of sporocarp not gelatinized .......................................................................... 7
11. Spores capsule shaped, sporocarp with olive tones, interior not highly gelatinized ..................................................................................................................... 7
12. Spores elliptical, interior highly gelatinized, sporocarp lacking olive tones ..................................................................................................................... 8
13. Sporocarps flat or cup shaped, lacking a stem ............................................................ 8
14. Sporocarp erect, ear shaped or stipitate and urnulate or enclosed when young .................. 10
15. Spores capsule shaped, spores 24-38 x 9-12 µm .................................................. see *Sarcosoma latahense* (132)
16. Spores ellipsoid, spores shorter .................................................................................. 9
17. Spores 21-24 x 8-10 µm; sporocarps with orange granules ........................................ see *Plectania melastoma* (88)
18. Spores (24.4-) 26.3-27.6 (-28.9) x 10.5-12.5 µm .................................................. see *Plectania milleri* (95)
H. Key to elfin saddles and false morels

1. Cap saddle shaped, lobed or cupshaped .............................................................................................................. 2
2. Cap in youth with margins uplifted, abhymenial surface distinctly pubescent .......................................................... 3
3. Stem round in cross section, hymenial surface dark gray-brown, even ........................................ see Helvella compressa (54)
4. Cap saddle shaped, stem round in cross section ..................................................................................................... see Helvella elastica (56)
5. Spores 12-14 µm long ............................................................................................................................................... see Gyromitra melaleucaoides (74)
6. Stem ribbed, flushed with pink tinges, spores 16.1-20.3 x 8.4-10.7 µm .................. see Gyromitra californica (71)
7. Spores large (21.4-) 24.3-35.8 (-37.5) x 10.7-15.8 µm .......................................................... see Gyromitra montana (75)
8. Spores (17-) 20-23 (-26) x 7-10 µm, cap forked ................................................ see Gyromitra infula (73)

I. Key to sequestrate fungi

1. Sporocarp surface more or less evenly covered with round to angular warts (use hand lens) ........ Ascomycetes
2. Sporocarp surface not warty ................................................................................................................................. 2
3. Sporocarp solid in cross section (use hand lens) ..................................................................................................... 3
4. Sporocarp with one to many empty or spore-filled canals or chambers .............................................................. 4
5. Sporocarp interior gelatinous or exuding a sticky fluid .................. Basidiomycetes and Zygomycetes
6. Sporocarp interior firm to crisp, not exuding a sticky fluid .................................. Ascomycetes
7. Chambers single to many, >3 mm broad ...................................................... Ascomycetes
4. Chambers or canals <3 mm broad ................................................................. 5
5. Sporocarp with a stem or stemlike tissue in vertical cross section ................................................ Basidiomycetes
6. Sporocarp with rhizomorphs at base or appressed on surface ................................................ Basidiomycetes
7. Sporocarp interior with long, meandering canals ............................................................... Ascomycetes
8. Sporocarp flesh soft, white to yellow or brown ................................................ Basidiomycetes and Zygomycetes
9. Sporocarp flesh firm to crisp, gray to brown or purple ................................................ Ascomycetes

II. Key to sequestrate Ascomycetes
(Spore measurements exclude ornamentation.)

1. Sporocarp with one to many empty or spore-filled chambers or canals ........................................ 2
2. Peridium >3 mm thick, chambers one or a few, often broader than 3 mm ........................................... 6
3. Peridium smooth, pale colored, spores 14-23 µm ........................................ see Elaphomyces subviscidus (36)
4. Peridium finely warty, nearly black, spores 21-25 µm ...................................... see Elaphomyces anthracinus (35)
5. Sporocarp surface coarsely and sharply verrucose ................................................ see Balsamia nigrens (9)
6. Spores with crowded, flexuous tapered spines 2-3 (-4) µm tall ...................... see Hydnotrya inordinata (58)
7. Spores with crowded mucilage-embedded spines ±1 µm tall ...................... see Hydnotrya subnix (59)
8. Gleba brown to black brown marbled with narrow, white veins ..................... see Tuber asa (139)
9. Gleba white to pale yellow marbled with narrow, yellow-brown to brown veins .......................... 8
10. Asci thin walled, mature gleba dark gray-brown marbled with off-white veins .............. see Tuber pacificum (140)
11. Asci thick walled, mature gleba brown to black-brown marbled with white veins............... see Tuber pacificum (140)
12. Spores minutely pitted like a golf ball ................................................... see Choiromyces alveolatus (17)
13. Spores with irregular, spines and rods, 3-6 µm tall ........................................ see Choiromyces venosus (18)

II. Key to sequestrate Basidiomycetes and Zygomycetes
(Spore measurements exclude ornamentation.)

1. Spores ornamented ........................................................................................................... 2
2. Spores smooth .................................................................................................................. 25
3. Spore ornamentation of ridges ............................................................................................. 3
4. Spore ornamentation of cones, rods, warts, or reticulation .......................................................... 4
5. Sporocarp staining blue, spores 13-22 x 10-16 µm ................................................ see Chamonixia caespitosa (16)
3. Sporocarps not staining blue, spores 17-24 x 8-12 µm, locules large .......... see *Gautieria magnicellaris* (46)
4. Spores inamyloid ............................................................................................................. 5
5. Sporocarp exuding latex from cut surface ........................................................................ 6
6. Peridium orange-red, odor distinctly sweet of maple sugar .................... see *Arcangeliella camphorata* (6)
7. Peridium with nests of large sphaerocysts with thickened walls ................... see *Arcangeliella crassa* (7)
8. Sporocarp somewhat agaric in form or shape ................................................................. 9
9. Spores globose 10-15 µm, gleba white to tan ................................................................. 10
10. Spores 8-9.5 x 6.5-7.5 µm, gleba orange-brown, odor of chlorine ........ see *Macowanites chlorinosmus* (64)
11. Spores globose, 7-9 µm .............................................................. see *Gymnomyces nondistincta* (51)
12. Peridial epicutis an epithelium ................................................................. see *Cystangium (as Martellia) maculata* (70)
13. Macrocystidia present ..................................................................................................... 13
14. Odor of vanilla, peridium with a turf of dermatocystidia ........ see *Gymnomyces (as Martellia) fragrans* (68)
15. Spores colorless in KOH ............................................................................................... 16
16. Sporocarps yellow, trama lacks inflated cells, spores 8-11 x 8-9 µm ........ see *Leucogaster citrinus* (62)
17. Spores globose ................................................................................................................ 18
18. Spores 13-18 µm, with cones up to 5 µm tall, peridium staining blue ........ see *Octavianina cyanescens* (79)
19. Spores 17-23 x 12-16 µm with spines up to 1.5 µm tall .......................... see *Octavianina macrospora* (80)
20. Spores smaller, ornamentation up to 1 µm tall .............................................................. 20
20. Sporocarps agariclike, with a persistent veil .................................................................................. 21
20. Sporocarps potatolike, veil absent ............................................................................................. 24
21. Spores large 14-18 x 9-10 µm .......................................................... see *Thaxterogaster pavelekii* (136)
21. Spores not longer than 13 µm ................................................................................................... 22
22. Sporocarp pale brown to yellow-brown, spores with coarse warts ........................................ see *Cortinarius verrucisporus* (29)
22. Sporocarp white to tan, spore ornamentation not coarse ............................................................ 23
23. Basidia small 17-22 x 5.5-7 µm .......................................................... see *Cortinarius wiebeae* (30)
23. Basidia large 27-40 x 7-10 µm .......................................................... see *Cortinarius magnivelatus* (24)
24. Sporocarps not staining pink, basidia four spored ............................................................... see *Destuntzia fusca* (32)
24. Sporocarps staining pink, basidia one spored ................................................................ see *Destuntzia rubra* (33)
25. Spores large >40 µm in diameter or basidia absent ................................................................ 26
25. Spores smaller <30 µm in length or diameter or basidia present ..................................................... 28
26. Spores 77-150 x 44-120 µm, walls 5-7 µm in diameter .................................................. see *Endogone oregonensis* (38)
26. Spores less than 100 µm in diameter or length ........................................................................ 27
27. Spores 60-110 x 48-75 µm, walls 4-8 µm thick ........................................................................ see *Glomus radiatum* (49)
27. Spores 15 x 30-80 x 59 µm, walls ≤5 µm thick ........................................................................ see *Endogone acrogena* (37)
28. Spores honey-colored, smokey black or dark brown in KOH .................................................. 29
28. Spores colorless in KOH ........................................................................................................ 31
29. Spores 7.5-9 x 5.5-6.3 µm, with a apical pore .......................................................... see *Nivatogastrium nubigenum* (78)
29. Spores ≥19 µm long, without a apical pore ............................................................................. 30
30. Gleba powdery, at maturity spores 23-26 x 13-16 µm ....................................................... see *Sedecula pulvinata* (134)
30. Gleba lamellate-loculate, not powdery, at maturity spores 19-30 x 6-9 µm ................................ see *Chroogomphus loculatus* (19)
31. Sporocarp boletelike with a distorted or reduced stem ............................................................. 32
31. Sporocarp potatolike without a reduced stem but sometimes with a sterile base ............................. 37
32. Peridium and stem pale buff to pale olive buff ......................................................................... see *Gastroboletus subalpinus* (42)
32. Peridium gray-yellow, rose to red-brown, bright yellow or dark sordid brown ............................... 33
33. Stem with glandular dots, spores 7-10 x 3.5-4 µm ........................................................ see *Gastrosuillus umbrinus* (45)
33. Stem without glandular dots .................................................................................................. 34
34. Sporocarps bright yellow and red, staining red, spores 13-18 x 6-7 µm .......................... see *Gastroboletus vividus* (43)
34. Sporocarps not bright yellow, if with red tones then staining blue ............................................. 35
35. Sporocarps gray-yellow with dark olive tints, spores 7-10 x ±2.5 µm ................................ see *Gastroboletus imbellus* (40)
35. Sporocarps with shades of rose to red-brown, spores wider ................................................... 36
36. Spores 9-15 x 4-6 µm .................................................................................................................. see Gastroboletus ruber (41)
36. Spores 13-18 x 6.5-9.5 µm .................................................................................................................. see Gastroboletus turbinatus (67)
37. Spores amyloid ................................................................................................................................. 38
37. Spores inamyloid but sometimes dextrinoid ........................................................................................... 39
38. Spores 6-9 x 3-5 µm, basidia 7-9 µm in diameter, tramal hyphae 4-7 µm in diameter .................................................................................................................................................................................. see Rhizopogon chamaleontinus (123)
38. Spores 7-9 x 3-4 µm, basidia 5-7 µm in diameter, tramal hyphae 2-3 µm in diameter .................................................................................................................................................................................. see Rhizopogon atrovilaceus (95)
39. Gleba pink .............................................................................................................................................. 40
39. Gleba olive to brown or yellow-brown ........................................................................................................ 42
40. Sporocarps yellow to vivid yellow, spores 7-9 x 3-5 µm ..................................................................... see Rhizopogon truncatus (96)
40. Sporocarps not vivid yellow, spores larger or smaller ........................................................................... 41
41. Spores 5-7 x 3-4 µm ............................................................................................................................... see Alpova alexsmithii (4)
41. Spores 10-13 x 4-5 µm .......................................................................................................................... see Fevansia aurantiaca (39)
42. Peridium staining red ............................................................................................................................. 43
42. Peridium not staining red .......................................................................................................................... 45
43. Peridium staining red then inky-fuscous, with amyloid globules in peridium, spores 3-3.5 µm in diameter .................................................................................................................................................................................. see Rhizopogon inquinatus (128)
43. Peridium without amyloid globules ........................................................................................................ 44
44. Peridium staining pink to vinaceous, spores 7.5-13 x 3-5 µm .............................................................. see Rhizopogon abietis (94)
44. Peridium staining ochraceous then red, spores 6.5-7.5 x 2 µm .................................................................................................................................................................................. see Rhizopogon evadens var. subalpinus (125)
45. Peridium with yellow when fresh; a shade of red in KOH; spores 5.5-6.5 x 2.5-2.8 µm .................................................................................................................................................................................. see Rhizopogon flavofibrillosus (127)
45. Peridium without yellow; not a shade of red in KOH; spores longer or broader ............................................................... 46
46. Spores ≥7 µm long .................................................................................................................................... 47
46. Spores ≤6.5 µm long .................................................................................................................................. 48
47. Spores 7-8 x 5-5.5 µm ............................................................................................................................ see Rhizopogon exigus (126)
47. Spores 8-10 x 3-4 µm .............................................................................................................................. see Alpova olivaceotinctus (5)
48. Spores 5-6.5 x 1.8-2.3 µm ...................................................................................................................... see Rhizopogon brunneiniger (122)
48. Spores 4.5-6 x 3-4 µm ............................................................................................................................ see Rhizopogon ellipsosporus (124)

J. Key to stalked polypores and toothed fungi

1. Sporocarps on wood ................................................................................................................................. 2
1. Sporocarps on soil .................................................................................................................................... 5
2. Sporocarps stipitate with spathulate spore-bearing tissue ....................................................................... see Spathularia flavida (103)
2. Sporocarps conklike or flabby or rubbery, with pink tinges ..................................................................................................................................................................................
3. Sporocarps flabby or rubbery, spore-bearing tissue smooth to slightly wrinkled, pink tinged  
   ........................................................................................................................... see *Tremiscus helvelloides* (105)

3. Sporocarp woody or tough fibrous, conklike ................................................................................. ...........
   ........................................................................................................................... see *Bondarzewia mesenterica* (12)

4. Cap yellow-orange, purple-brown in age or on drying, amyloid spores with warts or ridges
   ........................................................................................................................... see *Bridgeoporus nobilissimus* (13)

4. Cap often large (>50 cm), surface extremely shaggy, on or near dead *Abies* spp.
   ........................................................................................................................... see *Bridgeoporus nobilissimus* (13)

5. Sporocarps with pores .................................................................................................................. 6

5. Sporocarps with spines .................................................................................................................. 9

6. Spores 8-11 x 5-8 µm ........................................................................................................ see *Albatrellus ellisii* (35)

6. Spores <7 µm long .................................................................................................................. 7

7. Spores 3.5-4 x 2.5-3 µm ........................................................................................................ see *Albatrellus fletti* (36)

7. Spores larger and wider ........................................................................................................ 8

8. Cap purple-brown, becoming orange to tan with dark scales, spores 4.8-6 x 3.4-4.5 µm
   ........................................................................................................................... see *Albatrellus avellaneus* (2)

8. Cap surface and pores gray to blue, maturing to pale gray-brown, spores 4-6 x 3-5 µm
   ........................................................................................................................... see *Albatrellus caeruleoporus* (3)

9. Sporocarps blue-black to black, spores 3.8-4.2 x 3.3-3.8 µm ................................. see *Phelledon atratus* (87)

9. Sporocarps yellow, orange-yellow, tan, brown, red-brown or nearly black, if nearly black then spores >6 µm
   long and >5 µm wide ........................................................................................................ 10

10. Sporocarps pale yellow to orange, spores 9-10 µm long ........................................ see *Hydnum umbilicatum* (76)

10. Sporocarps tan to red-brown to nearly black, spores <8 µm long ................................................. 11

11. Sporocarps tan to red-brown ................................................................................ see *Sarcodon imbricatus* (100)

11. Sporocarps nearly black ........................................................................................ see *Sarcodon fuscoindicum* (99)
Species Information
Acknowledgments

We first and foremost thank the following contractors who provided expertise to compile much of the information and data used in this handbook: Dennis Desjardin, San Francisco State University, Lorelei Norvell, University of Washington, Ron Petersen, University of Tennessee, James Trappe, Oregon State University, and Nancy Weber, Oregon State University. Photographs are used with permission of Joseph Ammirati, Catherine Ardrey, David Arora, Tim Baroni, George L. Barron, Michael Beug, Howard Bigelow (deceased), Eugene Butler, Wes Colgan, III, Eric Danell, Robert Fogel, Gro Gulden, Janet Lindgren, Dan Luoma, Currie Marr, Steve Miller, Lorelei Norvell, Thom O’Dell, Eric Peterson, David Pilz, Daniel Powell, Scott Redhead, Maggie Rogers, Freeman Rowe, Herb Saylor (deceased), Michele Seidl, Harry Thiers (deceased), James Trappe, Steve Trudell, and James Weber (deceased). The following contributed helpful comments on various portions of the handbook: James Eblin, Sarah Jovan, Daniel Luoma, Randy Molina, Eduardo Nouhra, David Pilz, Dan Powell, Jane Smith, James Trappe, and Sarah Uebel. We received many helpful comments from field personnel who used the first handbook.
English Equivalents

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Literature Cited


Appendix 1

Helpful Hints to Working With the Synoptic Key to *Ramaria* Species

A synoptic key to the ROD-listed *Ramaria* species, in addition to a dichotomous key, is provided. Although learning to use a synoptic key requires patience and persistence, synoptic keys often are easier to use than dichotomous keys, particularly for the novice. Species identification with a synoptic key requires evaluating a sequence of characters to continually narrow the list of potential species, thereby allowing comparison of morphological similarities between species. Synoptic keys are easily expanded and less likely to lead the user astray than dichotomous keys (Castellano and others 1989).

Each species in a synoptic key is assigned a number and arranged in alphabetical order. In addition to ROD-listed *Ramaria* species, a few additional *Ramaria* species have been included in our key to facilitate accurate identification of those in the ROD. The key is divided into two sections: macroscopic and microscopic characters. Each section contains many categories of characters, such as stem, branch, and flesh colors. Each character is followed by a list of numbers corresponding to *Ramaria* species with that character. The number is underlined if the character is variable and thus is found under more than one character state. Multiple tallies per character indicate a range of characters, or a character and its modifier, or weak characters that may be present or absent.

*Ramaria* species identification requires precise microscopic examination. To observe the necessary features, it is necessary to mount a thin piece of sporocarp tissue in a drop of Melzer’s reagent or KOH on a microscope slide. A mount too thick will result in frustration and unnecessary time spent focusing up and down through the material. A sharp razor blade is essential for producing thin mounts, especially with fresh or dried gelatinized material. The ability to distinguish between similar characters microscopically, such as slightly rounded versus rod-shaped spore ornamentation, initially is difficult and requires practice. Success with microscopy requires familiarity with a properly adjusted and calibrated microscope. An improperly adjusted microscope can distort the image of spores or tissue measurements by as much as 10 percent. Such imprecision could lead to the selection of an incorrect set of characters and result in incorrect species identification.

Categorizing color variation is subjective and therefore difficult. Because *Ramaria* spp. often change color with age, specimens may be described differently at different phenological stages. A minimal list of color headings, common to *Ramaria* species, is provided.
Appendix 2

Collection, Preservation, and Mailing: Tips, Suggestions, and Data Forms

Collecting Tips

It is important to collect the entire specimen. Some ROD species like Phaeocollybia have an extremely long, radicate stem that can extend more than 0.3 m into the soil. Others like Cortinarius have bulbous bases. And still others, such as Ramaria, can have multiple bases, mycelial mats, and rhizomorphs that can be important in identification. Cordyceps grow from a buried larvae or truffle, and the ROD-listed Asterophora lycoperdoides and Collybia racemosa grow on other rotting mushrooms.

It is best to use some sort of digging tool when excavating specimens to preserve integrity and fragile characters such as veil remnants and cortina.

Collect individuals of all ages when possible, particularly Cortinarius and Ramaria whose colors fade rapidly with maturation.

It is important to know the substrate: wood, litter-duff, moss, soil, rotten fungi. Along with color notes, this is best noted at the time of collection. Use the field tag provided.

It is critical to describe the colors present on ALL fresh specimens! Detailed notes are needed for Ramaria and all agarics, particularly Phaeocollybia and Cortinarius. Color guides can be helpful. Be as detailed as possible. Use other colors as modifiers; for example, red-brown, pale salmon with yellow tints, drab olive with violet tones, bright yellow, chalk white, slightly darker than ivory, dusty tan, etc.

Place specimens into heavyweight foil, wax bags, or plastic boxes. Some moisture must be preserved, but plastic bags will cause the fungus to rot quickly. We prefer using foil for larger fungi because when packaged loosely, it protects the specimen better than paper.

We have found that plastic tackle and craft boxes with movable dividers work well for collecting small fungi and also allow ready storage in the refrigerator.

Place individually wrapped specimens into a sturdy container such as a 5-gallon bucket or basket to avoid squashing them.

Do not mix collections when collecting and storing specimens. Regularly clean your collecting materials (stray spores can hinder identification).

Spores must be mature when measured for species determination. Sometimes spore maturation in ascomycetes can be induced by placing a damp paper towel in the container with the specimen in the refrigerator. Allow a few days or even a week or two, checking regularly for decay, for maturation to occur.

What to Send and How to Send It

The survey and manage interagency taxa expert should verify all collections made. We accept vouchers of any fungus species from table C-3 of the ROD. Because of the ephemeral nature of fungi and the unsettled nature of fungal taxonomy, we must have a physical specimen for it to be recorded as a known site.

Even professional mycologists make errors in determining fungi in the field. It is important to send us collections for verification.
If possible, take a photo (preferably a slide) of the fungus before drying it. A photographic record can be extremely useful in making species determinations as well as for educational use. The optimal setup is to use a macro lens and ring flash with 64 ISO film (or 200 if nothing else is available) with a neutral gray background and something for scale.

**Specimens must be sent completely dried, unless prior arrangements are made.**

Use a food dehydrator that has a fan, at low to medium temperature (32.2-51.7 °C). Cut at least one specimen in half, particularly truffles. It is preferable to cut large specimens such as *Ramaria, Gomphus, Phaeocollybia, Bondarzewia*, etc., to facilitate dehydration and storage.

Package dried specimens individually, then package securely by using some sort of packing material, and mail in cardboard boxes. **Do not send fungi in unpadded envelopes.** Include your determination, the site form, maps, and descriptive notes on a field tag or one of the seven fungi description forms.

Each specimen should be accompanied by complete location data, habitat information, notes describing the specimen when fresh (color, texture, taste, odor), collection date, unique collection number, and person to contact. **Without this information specimens will be extremely difficult to identify, and it will be hard to relocate sites.**

Please try to make a preliminary determination. **When you make your determination, note on the field tag accompanying each specimen what characters led you to this conclusion.** Was it spore length or shape? Colored granules on the abhymenium? Cap color? Hairs on the hymenium? These notes help us with the verification process. They also help us track mistakes so we can be better teachers. If you have doubts or have a particularly rare species, please use one of the seven fungi description forms to describe it in greater depth.

Collections will be accessioned into the herbarium at Oregon State University. On request, a portion can be returned to you if you maintain an herbarium. An optimal collection would consist of multiple specimens both young and mature, properly dried with at least one specimen cut in half. Even if you have only one specimen, send it anyway.

**Completing the Site Form**

This form provides locality and habitat data for each collection site as well as documentation for ROD species found during your survey. Use this form similarly to a threatened and endangered species plant sighting form and any time specimens of potential interest are collected. **You need to fill out only one form per site; list all the fungi collected from that site.**

Fill out the form completely. Our team cannot personally visit every site, and we lack the expert knowledge that you have of the areas where you work.

Instructions are found on the back of the form. A “site” is (1) at least 100 m away or (2) from a different habitat/ecotype within a forested area (for example, a sale unit). Likewise, if you are confident with your field recognition, it is not absolutely necessary to collect a specimen every time it is encountered at a site; once or twice per site is adequate. Differences in habitat or substrate per species should be noted on the field tag.

**Completing the Field Tag**

Field tags are useful while foraying or surveying. They are designed to fit into our collection boxes. Complete one per collection.

The main function of the tag is to ensure that critical data such as location, substrate, and color notes are not lost in the bustle of a field day.
The field tag is used in addition to the site form; it is not a substitute.

The following are the fields on the field tag with an explanation of the information asked for.

- **Taxon**: Tentative identification of fungus
- **Date**: Collection date
- **Collector**: Collector of the specimen
- **Collection number**: Collection identification number (please be brief, like a license plate): Eblin 4756 or M.M2-12-98-a, etc.
- **County and state where collection was made**:
- **Land owner**: Name of federal agency and subunit: Siuslaw NF, Alsea RD, etc.
- **Location and T.R.S.**: A geographical place name, road number, as specific as possible
- **Substrate**: Circle appropriate category. If necessary, gently excavate the base of the specimen to determine the substrate.
- **Habitat**: Dominant trees, herbs, and shrubs and related notes
- **Notes**: Fresh specimen notes: color, taste, odor, shape, detail of habitat or substrate, or other site and specimen information. Use the back as necessary.
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Completing the Fungal Lot Form

This form is used by the Corvallis survey and manage team to track specimens in a database. Some field users have found it useful for their own records as well.

Separate collections into taxa groups as follows. Use separate forms for each taxa group (electronic forms are available from the survey and manage team). Circle the appropriate taxa group at the top of the page. Please leave the “final determination” field blank; we will fill that in and return the form to you when identifications are complete. You can use one set of site forms per taxa group.

**Collection date:** Use the DAY-MONTH-YEAR format with month spelled out. Examples: 05APRIL2001; 10SEPT2000.

**Collector’s name:** Your name.

**Collection number:** Your tracking number for each specimen. Often formatted as a number and letter system using the collector’s name, initials, collection number, or date. Examples: Fondrick-232; JS04May98-1. HINT: Long collection numbers may lead to confusion and frustration. Be as brief as possible; “license-plate” format works well.

**Substrate:** Soil, wood, moss, or litter.

**Tentative determination:** Your determination of what the species is, or at least a general description of the specimen. Examples: *Ramaria* spp.; *Craterellus tubaeformis*; black cup with orange granules; or chunky orange-brown polypore with no stem.

**TAXA GROUPS:**

**Gilled Fungi**
- Mushrooms
  - Use separate form for *Cortinarius*

  **Cortinarius**
  - Rusty spored with veil

**Ascomycete Fungi**
- Elfin saddles (*Gyromitra, Helvella*)
- Cup fungi
- Earth tongues (*Spathularia, Cudonia*)

**Nongilled Fungi**
- Clublike (*Clavariadelphus*)
- Cantharellaceae (chanterelles)
- Toothed (*Hydnum, Sarcodon*)
- Jelly fungi (*Tremiscus*)
- Boletes
- Polypores (*Bondarzewia, Albatrellus*)

**Coral Fungi**
- *Ramaria*

**Sequestrate Fungi**
- Form underground fruiting body
<table>
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<tr>
<th>Circle one:</th>
<th>Cortinarius</th>
<th>Gilled</th>
<th>Coral</th>
<th>Nongilled Basidiomycete</th>
<th>Ascomycete</th>
<th>Sequestrate</th>
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Directions for Survey and Manage Fungi Site Form
Fill out one site form per site (at least 100 m apart or different habitat)

CVS plot number/site ID: For field crews to complete.

Collectors: List collector(s).

Date: Date collection(s) were made.

Land ownership: Select: Bureau of Land Management (BLM), USDA Forest Service (USFS), state, or private.

Land allocation: Specify if this location is in a late-successional reserve, managed late-successional area, matrix, adaptive management area, area of critical environmental concern, research natural area, botanical special interest area, riparian reserve, wilderness, or describe others.

Forest/district/resource area: Specify which national forest and district or BLM district and resource area.

State and county: Specify, please do not abbreviate county.

Quad name: Write quad name and circle appropriate map scale. Please do not abbreviate.

TRS: Township, range, section, sixteenth of the quarter section, quarter.

Meridian: Found on USGS and forest map. Willamette is western Washington and Oregon, Humboldt is northwest California, Mount Diablo is northeast California; circle the appropriate one.

Complete one of the following, either latitude and longitude or UTM:

Latitude and longitude: Please record in decimal form. Please record to 4 decimal places.

Universal Transverse Mercator (UTM): Please use datum NAD27. Record UTM E (Easting), then UTM N (Northing).

Location/directions to site: Provide a geographical place name such as Icicle River campground, Salmon Berry wayside, Hart Mountain, Johnny Creek trail. Also provide clear, detailed directions sufficient for someone unfamiliar with the area to relocate site. Include road numbers, mileage from road junctions and distance and azimuth from road. Map the location on the appropriate topographic map and label with quad name, township, range, section, sixteenth, and quarter. Give approximate distance in miles from nearest municipality or ranger station.

Elevation, slope, and aspect: Please be as accurate as possible, specify units where appropriate.

Topography: Circle the appropriate categories or briefly describe area.

Habitat: List dominant overstory trees, indicator shrub and herb species. Use full species name (*Pinus ponderosa*), not acronym (PIPO). Note and describe plant association and successional stage if possible. Note general amount, size, and decay class of coarse woody debris. Describe any interesting or unusual observations of habitat. Note substrate if appropriate.

List species collected: List names of species collected at site; tentative determinations are OK.
Survey and Manage Fungi Site Form
Complete one site form per site.

CVS plot #/site ID number _____________________________________________________________

Multiple specimens at the same site need only one site form.

Collector(s): ___________________________ Date: ___________________________

Land ownership: BLM  USFS  State  Private  Land allocation: ___________________________

Forest/district/resource area: __________________________________________________________

State: ____________ County: ____________ Quad name: ________________ 7.5 min/15 min
T: ___ R: ___ Sec. __ 1/16 ___ 1/4 ___ Meridian: Willamette Mount Diablo Humboldt

Latitude (4 decimal places): ________________  Longitude (4 decimal places): ___________

UTM E  UTM N

Location/directions to site:
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

Elevation: ____________ feet  meters  Slope: ____________  Aspect: ____________

Topography: ridge  upper slope  mid slope  lower slope  valley  swale  bench  trail  roadside

Describe: ________________________________________________________________

Habitat: dominant trees: _______________________________________________________

shrubs: ________________________________________________________________

herbs: _______________________________________________________________

stand structure: __________________________________________________________

coarse woody debris: _____________________________________________________

List species collected with collection number: ______________________________________
Completing the Fungus Description Forms

These forms (boletoid and polyporus fungi, coral fungi, *Cortinarius*, gilled fungi, nongilled fungi, and sequestrate fungi) are used to take notes on freshly collected specimens, particularly on rare species, or if you really have no idea where to begin. **It is extremely difficult to determine dried specimens without notes on fresh characters.**

Descriptive notes of fresh specimens are important for identifying fungi when they are dry. Notes on fresh color, texture, size, taste, and odor are crucial. **Detail is critical when describing the color variations of fungi.**

In general, those characters used in the keys for the group of fungi you are working with are the characters that you should give the most attention to describing or measuring.

If you have the capability, measure spore size and note spore shape, ornamentation under oil immersion at 1000x magnification. This is a microscopic character commonly used in specific descriptions.

If you have additional questions concerning these forms, please contact:

Tina Dreisbach: Survey and Manage Mycology Team, USDA Forest Service, PNW Forestry Sciences Lab, 3200 SW Jefferson Way, Corvallis, OR 97331. Telephone (541) 750-7404; FAX (541) 758-7760

Electronic communication: tdreisbach@fs.fed.us

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Sarah Uebel: suebel@fs.fed.us
Survey and Manage Boletoid and Polyporous Fungi Description Form

Provide notes and circle as many of the characters from grouped character sets as appropriate.

Genus/species: _____________________________  Mycology team collection number: __________

Other collector’s number: _____________________  Date: _____________________________

Collected by: _______________________________________________________________________

Ecology:

Dominant trees and shrubs: __________________________________________________________

Growth habit: single scattered caespitose grouped

Age of specimens: immature mature old mixed

Substrate (circle one):  On duff: pine cone leaves needles twig litter

On soil: mineral humus

On wood: conifer hardwood Species: ___________________

General characters (write range of dimensions in mm for multiple specimens)

Sporocarp type: bolete polypore

Height of entire specimen: ___________________________  Length of stem: ______________________

Width of cap: _______  Width of stem at apex: _______  Widest width of stem: _________

Taste (don’t swallow): mild strong pleasant unpleasant peppery

Other: _____________________________________________________________________________

Color (note color gradations, spots, streaks, bruising reactions, changes with age or drying)

Cap surface: _____________________________  Bruising color: ________________

Cap flesh: _____________________________  Bruising color: ________________

Pore layer: _____________________________  Bruising color: ________________

Stem surface: _____________________________  Bruising color: ________________

Stem flesh: _____________________________  Bruising color: ________________

(Page 2 on reverse)
**Cap characters:**

**Surface texture:** dry  greasy  sticky  slimy

**Surface ornamentation:** smooth pubescent fibrillose cracked wrinkled scaly granular velvety

**Cap shape:** convex  plane  uplifted  irregular  centrally depressed  Other ______________________

**Flesh consistency:** fleshy  brittle  spongy  Other ________________________________

**Stem characters:**

**Stem shape:** equal  ventricose  tapered at apex  tapered at base  clavate  bulbous

**Surface texture:** viscid  sticky  dry  polished  glabrous  fibrillose  punctate

**Surface ornamentation:** glandular dotted  pruinose (lightly powdered)  scabrous  scaly  fibrillose

finely reticulated (netted)  coarsely reticulate

**Location of reticulum:** apex only  top 1/2 of stem  entire stem  Other: ______________________

**Color of ornamentation:** ________________________________

**Annulus present:** N  Y  **Annulus color:** ________________________________

**Annulus structure:** membranous  fibrillose  cottony-cortina  slimy
Survey and Manage Cortinarius Description Form
Use this form for specimens with rusty-colored spores and a veil or cortina.
Provide notes and circle as many of the characters from grouped character sets as appropriate.

Genus/species: __________________________
Mycology team collection number: ____________

Other collector’s number: ____________ Date: __________________________

Collected by: __________________________
Photo number(s): ____________________________

Ecology:
Dominant trees and shrubs: ____________________________________________________________

Growth habit: single scattered caespitose gregarious grouped
Age of specimens: immature mature old mixed

Substrate (circle one): On duff: pine cone leaves needles twig litter
On soil: mineral humus
On wood: conifer hardwood Species: ________________

General characters (write range of dimensions in mm for multiple specimens)
Color of spore print: ________________________________________________________________

Height of entire specimen: ________________ Length of stem: _________________________

Width of cap: ________________ Height of cap at center: _________________________

Width of stem at apex: ________________ Widest width of stem: _________________________

Cap flesh thickness __________________________________________________________________

Odor: mild strong pleasant unpleasant Other: _________________________

Taste (don’t swallow): mild strong bitter pleasant unpleasant peppery Other: _______________

Color (note color gradations, spots, streaks, bruising reactions, changes with age or drying)

Cap surface (young): ________________________________________________________________

Cap surface (mature): _______________________________________________________________

Hygrophanous (watery appearance when wet; changes color when losing moisture): N Y
First becomes hygrophanous near: margin  disc

Cap flesh: ________________________________________________________________

Gills (young): ___________________________________________________________

Gills (mature): __________________________________________________________

Gill edge: concolorous  darker  lighter

Stem surface: ____________________________________________________________

Stem flesh: ______________________________________________________________

Partial veil/cortina: _______________________________________________________

Universal veil remnants (if present, can be hard to see): ______________________

Cap characters:

Surface texture: dry  viscid  sticky  glutinous  Other: _______________________

Surface ornamentation: smooth  silky  fibrillose  radially fibrillose  scaly  tomentose

glittering  veil remnants Describe: __________________________________________

Shape: convex  conic  plane  depressed  umbilicate  funnel  mammilate  umbonate

Other: _____________________________

Margin shape: straight  uplifted  recurved  inrolled  incurved  Other: ______________

Contours of margin: striate  even  wavy  irregular  appendiculate  Other: __________

Flesh consistency: fleshy  brittle  spongy  tough  chalky  Other: __________________

Stem characters:

Stem shape: equal  ventricose  tapered at apex  tapered at base  radicate (rooted)  clavate

bulbous  twisted  Other: ____________________________________________________

Surface texture: viscid  sticky  dry  polished  smooth  fibrillose  punctate

Surface ornamentation: smooth  pruinose (powdered at apex)  scaly  fibrillose  tomentose

Other: ________________________________

Stem consistency: cartilaginous  fibrous  chalky  Other: _________________________

Flesh texture: solid  stuffed  hollow  Other: ________________________________

(Page 2 of 3)
**Gill characters:**

- **Attachment to stem:** free adnexed adnate sinuate decurrent **Other:**
- **Edge shape:** entire scalloped wavy serrate eroded **Other:**
- **Spacing of gills:** crowded close subdistant distant
- **Number of short gills between complete gills:**

**Veil:**

- **Any veil or veil remnants present:** N Y If yes, complete the following:
- **Partial veil structure:** persistent sparse fibrillose slimy Describe: __________________________
- **General position of annulus:** apical central basal Describe: ____________________________
- **Universal veil:** N Y **Universal veil structure:** slimy thin cottony filmy

**Chemical characters:** (Important for the genus *Cortinarius*)

- **KOH on cap surface** Melzer’s reagent of cap surface _____________
- **KOH on cap flesh** Melzer’s reagent on cap flesh _____________
- **KOH on partial veil**_____________

**Notes/Sketch:**
Survey and Manage Gilled Fungi Description Form

Provide notes and circle as many of the characters from grouped character sets as appropriate.

Genus/species: ____________________________ Mycology team collection number: ______________

Other collector’s number: ______________________ Date: ________________________________

Collected by: ____________________________ Photo number(s): ____________________________

Ecology:

Dominant trees and shrubs: ________________________________

Growth habit: single scattered caespitose grouped

Age of specimens: immature mature old mixed

Substrate (circle one):

- On duff: pine cone leaves needles twig litter
- On soil: mineral humus
- On wood: conifer hardwood Species: ______________
- Other: fungus insect

General characters (write range of dimensions in mm for multiple specimens)

- Color of spore print: ________________________________
- Height of entire specimen: ________________________ Length of stem: ______________________
- Width of cap: _______________________ Height of cap at center: _______________________
- Width of stem at apex: _______________________ Widest width of stem: __________________
- Odor: mild strong pleasant unpleasant Other: ___________________________
- Taste (don’t swallow): mild strong pleasant unpleasant peppery Other: ______________

Color (note color gradations, spots, streaks, bruising reactions, changes with age or drying)

Cap surface: ________________________________

Hygrophanous (watery appearance when wet; changes color when losing moisture): N Y

Cap flesh: ________________________________
Gills: ____________________________ Gill edge: concolorous darker lighter
Stem surface: _______________________________________________________________________
Stem flesh: _________________________________________________________________________
___________________________________________________________________________________________

Cap characters:
Latex: N  Y  Latex color: ____________________________
Surface texture: dry greasy sticky slimy
Surface ornamentation: smooth pubescent fibrilllose cracked wrinkled scaly granular warty
Shape: convex conic bell-shaped plane depressed umbilicate funnel mammilatate umbonate
Other: _____________________________________________________________________________
Margin shape: straight uplifted recurved inrolled incurved
Contours of margin: striate even wavy irregular appendiculate Other: _________________
Flesh consistency: fleshy brittle spongy tough chalky Other: _________________

Stem characters:
Stem shape: equal ventricose tapered at apex tapered at base radicate (rooted) clavate bulbous twisted
Other: _____________________________________________________________________________
Surface texture: viscid sticky dry polished smooth fibrilllose punctate
Surface ornamentation: smooth pruinose (powdered at apex) scaly fibrilllose tomentose
Other: _____________________________________________________________________________
Stem consistency: cartilaginous fibrous chalky Other: _________________
Flesh texture: solid stuffed hollow Other: _________________

Gill characters:
Attachment to stem: free adnexed adnate sinuate decurrent Other: _________________
Edge shape: entire scalloped wavy serrate eroded Other: _________________

(Page 2 of 3)
Veil:
Any veil or veil remnants present: N Y If yes, complete the following:
Partial veil: N Y Veil color: ____________________________
Veil structure: membranous fibrillose cortina slimy
Annulus: N Y General position of annulus: apical central basal
Annulus type: single double Annulus color: ____________________________
Universal veil: N Y Volva shape: saccate collared sheathing concentric zones
Volva color: ____________________________
Remnants present on cap: N Y Color of remnant: ____________________________

Chemical characters: (Important for the genus Cortinarius)
KOH on cap surface ___________ Melzer’s reagent of cap surface ___________
KOH on cap flesh ___________ Melzer’s reagent on cap flesh ___________
KOH on partial veil ____________________________

Notes/Sketch:
Survey and Manage Ascomycete Fungi Description Form Elfin Saddles and Cups

Provide notes and circle as many of the characters from grouped character sets as appropriate.

Genus/species: ________________________ Mycology team collection number: ________________

Other collector’s number: __________________________ Date: ____________________________
Collected by: ___________________________ Photo number(s): _______________________

Ecology:

Dominant trees and shrubs: _____________________________________________________________

Growth habit: single scattered caespitose grouped
Age of specimens: immature mature old mixed
Substrate (circle one):
  On duff: pine cone leaves needles twig litter
  On soil: mineral humus
  On wood: conifer hardwood Species: _______________________

General characters (write range of dimensions in mm for multiple specimens)

Sporocarp type: morel types elfin saddles cups
Height of entire specimen: ________________ Length of stem: ________________
Width of cap: ___________________________ Cap flesh thickness: _______________________
Odor: mild strong fragrant farinaceous Other: ____________________________
Taste (do not swallow): mild strong sweet bitter hot Other: ____________________________
Sporocarp shape: cup disk cushion rabbit-ear truncate club spatulate saddle-stipitate
  brain-stipitate pitted-stipitate Other: ____________________________
Flesh consistency (in cross section): gelatinous fleshy brittle tough rubbery spongy
Flesh color and bruising: _____________________________________________________________

Hymenium color (spore-bearing surface): ______________________________________________

Abhymenium color (opposite spore-bearing surface): _________________________________

Abhymenium texture: smooth pubescent scaly granular warty fibrillose greasy sticky dry
  silky hygrophanous (changing color when losing moisture)

(Page 2 on reverse)
**Stem characters** (if present, use cross-section for measurement):

**Stem present:** N  Y  (if yes, then continue)

**Length (mm):** ______  **Width at widest point (mm):** ______  **Width at base (mm):** ______

**Shape:** equal  ventricose  tapered at apex  tapered at base  compressed

**Other:** ____________________________________________

**Stem flesh texture:** gelatinous  firm  solid  stuffed  hollow

**Flesh color:** _____________________________  **Surface color:** _____________________________

**Surface character:** dry  moist  viscid  smooth  tomentose  ribbed  scaly  folded  grooved  wrinkled  fibrillose  **Other:** ____________________________________________
Survey and Manage Nongilled Fungi Description Form
Clublike, Cantharellaceae, Tooth, Jelly Fungi, and Allies

Provide notes and circle as many of the characters from grouped character sets as appropriate.

Genus/species: ____________________
Mycology team collection number: ____________________
Other collector’s number: ____________________
Date: ________________
Collected by: ____________________
Photo number(s): ____________________

Ecology:

Dominant trees and shrubs: ___________________________________________________________
Growth habit: single scattered caespitose grouped
Age of specimens: immature mature old mixed
Substrate (circle one):
On duff: pine cone leaves needles twig litter
On soil: mineral humus
On wood: conifer hardwood Species: ________________

General characters (write range of dimensions in mm for multiple specimens)

Sporocarp type: clublike chanterelle tooth jelly fungi
Height of entire specimen: ________________ Length of stem: ________________
Width of cap: ________________ Cap flesh thickness: ________________
Odor: mild strong fragrant farinaceous Other: ________________
Taste (do not swallow): mild strong sweet bitter hot Other: ________________
Sporocarp shape: club “mushroom”-like funnel cantherelloid Other: ________________
Flesh consistency (in cross section): gelatinous fleshy brittle tough rubbery spongy
Flesh color and bruising: ________________
Cap color (top of chanterelle or tooth fungus): ________________
Hymenium color (spore-bearing surface): ________________
Cap texture: smooth pubescent scaly granular warty fibrillose greasy sticky dry silky
    hygrophanous (changing color when losing moisture)

Stem characters (if present, use cross-section for measurement):

(Page 2 on reverse)
Stem present: N Y (if yes, then continue)

Length (mm): _____ Width at widest point (mm): _____ Width at base (mm): _____

Shape: equal ventricose tapered at apex tapered at base compressed

Other: _____________________________________________________________________________

Stem flesh texture: gelatinous firm solid stuffed hollow

Flesh color: ____________________________ Surface color: _______________________________

Surface character: dry moist viscid smooth tomentose ribbed scaly folded grooved wrinkled fibrillose Other: ________________________________
Survey and Manage Coral Fungi Description Form
Provide notes and circle as many of the characters from grouped character sets as appropriate.

Genus/species: ______________________ Mycology team collection number: ______________________

Other collector’s number: ________________________ Date: ________________________
Collected by: _________________________________ Photo number(s): ______________________

Ecology:
Dominant trees and shrubs: ____________________________________________________________

Age of specimens: immature mature old mixed

Substrate (circle one): On duff: pine cone leaves needles twig litter
                       On soil: mineral humus
                       On wood: conifer hardwood Species: ______________________

General characters (write range of dimensions in mm for multiple specimens)
Height of entire specimen (mm): Crown diameter (mm):

Width of stem: ___________ Width of stem at base: ___________

Odor: not distinct weak strong sweet anise beany pungent unpleasant musty earthy citrus

Taste (don’t swallow): not distinct mild strong bitter acrid Other: ________________________

Surface color (Write range for multiple specimens; note color gradations, spots, streaks, and bruising)
Tips: ______________________________________________________________________________

Branches: __________________________________________________________________________

___________________________________________________________________________________

Stem: ______________________________________________________________________________

___________________________________________________________________________________

Bruising (note color and location): _____________________________________________________________________

Yellow band at jct. of stem and branches (fades after picking and in older specimens): N Y

(Page 2 on reverse)
Color of flesh in cross section:
Tips: ____________________________________________________________
Branches: ______________________________________________________
Stem: __________________________________________________________
Rusty root present (pale brown band in lower stem when cross-sectioned): N Y

Branch and stem characters:
Stem form: massive chunky slender single fused fascicled
Stem flesh consistency (one or more): solid hollow fleshy-fibrous brittle rubbery-cartilaginous
firm-cartilaginous slimy-cartilaginous marbled-gelatinous Other: ______________________
Branch consistency: fragile firm fleshy-fibrous cartilaginous brittle rubbery firmly-gelatinous
slimy-gelatinous) Notes: __________________________________________________________
Rhizomorphs present (white threads at base): N Y
Reaction of Melzer’s reagent on interior stem flesh (optional): amyloid dextrinoid none
Reaction of Fe₂(SO₄)₃ on interior stem flesh (optional): green none
Survey and Manage Sequestrate Fungi Description Form

Provide notes and circle as many of the characters from grouped character sets as needed.

Genus/species: ______________________  Mycology team collection number: ________________

Other collector’s number: _________________________  Date: ______________________________

Collected by: _________________________________  Photo number(s): ______________________

Ecology:

Dominant trees and shrubs: ___________________________________________________________

Growth habit: single scattered grouped

Age of specimens: immature mature old mixed

Substrate (circle one):

- In duff: pine cone leaves needles twig litter
- In soil: mineral humus
- On wood: conifer hardwood Species: ___________________

General characters (write range of dimensions in mm for multiple specimens)

- Height (mm) ____________________________  Width (mm): ______________________________
- Shape: globose subglobose irregular top-shaped
- Overall consistency: tough crisp rubbery friable hard powdery inside
- Odor: mild strong pleasant unpleasant Describe: ________________________________

Peridium (outer surface):

- Color immediately upon collection: _________________________________________________
- Color changes or bruising: ________________________________________________________
- Texture: warty smooth tomentose wrinkled folded crusty
- Color change with KOH 5% (when available): _________________________________________
- Separable from gleba (inner portion): N  Y  Thickness (mm): ____________________________
- Rhizomorphs present: N  Y  If yes, attachment: at base along sides overall
- Rhizomorph color and changes: ____________________________________________________

(Page 2 on reverse)
**Gleba** (inner portion: describe when cut in half):

**Arrangement:** solid  veined  gilled  convoluted  chambered  

**Texture:** powdery  cottony  marbled  gelatinous  waxy  

**Color:** _____________________________________________________________________________  

**Color changes and bruising after 5 minutes:** _____________________________________________________________________________  

**Latex present:** N  Y  **Latex color:** _____________________________________________________________________________  

**Columella present** (sterile tissue): N  Y  If yes: single  robust  joins apex of peridium  dendroid  

**Columella color:** translucent  opaque  **Other:** _____________________________________________________________________________  

**Stem present:** N  Y  If yes, as: basal pad  distinct stem
Glossary

abhyemenial surface—opposite the spore-bearing surface
acanthophyses—clavate or cylindrical hyphae with pinlike outgrowths near the apex
acrid—sharp
acrogenous—borne at the apex
aculate—having narrow spines
acute—less than a right angle
acyanophilic—not staining blue when mounted in cotton blue
adnate—gills attached to the stem
adnexed—gills attached narrowly to the stipe
agaricoid—having the overall features of a gilled mushroom
agglutinated—stuck together as if with glue
allantoid—slightly curved with rounded ends
allutaceous—the color of buff leather
alveolae—honeycomblike hollows
alveolate—marked with honeycomblike hollows
amorphous—having no definite form
ampulliform—flasklike in form
amygdaliform—almond shaped
amyloid—staining blue or black with application of Melzer’s reagent
anastomose—fusion between hyphae
anise—smell of licorice
annulus—a ringlike partial veil, around the stipe after expansion of the cap
ANO—aniline oil (1:1 aqueous mixture)
ANW—alpha naphthol (5-percent aqueous solution)
apiculate—having an apiculus
apiculus—a short projection at one end, also called a hilar appendage
apobasidium—a basidium with nonapiculate spores, borne symmetrically on the sterigmata and not forcibly discharged
apothecium—a cup or saucerlike sporocarp in which the hymenium is exposed at maturity
appendiculate—the edge of the expanded cap fringed with toothlike remains of the veil
applanate—flattened
arcuate—arclike
areoles—cracks or divisions
Ascomycet(e)s—phylum level of classification for ascus-containing fungi
ascus(i)—saclike structure that contains ascospores
aseptate—lacking septa
astringent—bitter
asymmetrical—not symmetrical
attenuation—narrowing
autolysis—self-digestion of a cell
avellaneous—pale yellow brown
bacilliform—rodlike in form
basal collar—collar located at the base of the spore
basal pad—sterile tissue located at point of attachment
basal scar—scar located at point of attachment of spore to basidium
basidium(a)—cell that produces spores externally on sterigmata
basidiole—a sterile basidiumlike hymenial cell
Basidiomycete(s)—phylum level of classification for basidia containing fungi
bifid—forked
biguttulate—having two oillike drops within the spore
boletoid—resembling bolete in structure
brachybasidiole(s)—short basidioles
brunnescent—becoming brown
bryophilous—fungi growing on mosses or liverworts
bulbous—bulblike; a stem with a swelling at the base
caespitose—in groups or tufts, gregarious
calyptrotate—hooded
campanulate—bell shaped
cap cuticle—the outer layer of cells on a cap
cap cuticle—the outer layer of the pileus
capillitium—sterile, threadlike elements in among the spores
capitate—having a well-formed head
cartilaginous—firm and tough but readily bent
caulocystidia—cystidia found on the stipe
centipetally—toward the center
cheilocystidia—cystidia found on the edge of the lamella
chlamydospore—an asexual 1-celled spore
chrysocystidia—smooth, thin walled cystidia with highly staining contents
circumferentially aligned—aligned along the perimeter of a circle
clamp connections—a hyphal outgrowth that at cell division makes a connection between the resulting two cells by fusion
clavate—clublike; narrowing in the direction of the base
claviform—clublike; see clavate
cleft—partially split or divided
coalesced—grewn together
columella—a sterile central axis within a mature sequestrate sporocarp
concave—hollowed inward; similar to a bowl
concolorous—of one color
confluent—coming together
conic—shaped like a cone
conidium(a)—asexual spores
connate—born together
context—trama tissue
convex—broadly obtuse
copious—abundant
coral—corallike fleshy fungi in the family Ramariaceae
coriaceous—leatherlike in texture
corneous—hornlike in texture
cortex—a more or less thick outer covering
cortical tissue—tissue from the cortex
cortina—a weblike partial veil covering the gills
crenate—having the edge toothed with rounded teeth
crenulate—edged with delicate rounded teeth
cristate—crested
crozier—a hook of an ascogenous hypha before ascus development
cruciate—in the form of a cross
crustose—a hard surface layer
crystalloid—resembling crystals
cup—a Discomycete, particularly in the Pezizales or Leotiales
cutis—outer layer, consisting of compressed hyphae
cyanophilic—readily absorbing cotton blue
cystidium(a)—a sterile, distinctively shaped cell
cystidloid—cystidialike
cytoplasm—the protoplasm of a cell
decurrent—running down the stipe
dendroid—treelike in form
denticulate—toothed
dermatopseudocystidia—cystidialike structures on the edge of the pileus
dextrinoid—staining red or red-brown in Melzer’s reagent
dichophyses—modified terminal hyphae in the hymenium
dichotomous—dividing into two parts
dimitic—having hyphae of two kinds
disc—the round, platelike or curved spore-producing part of an Ascomycete sporocarp
discoid—resembling a disk
distally—situated away from the center of the sporocarp
divaricate—divergent at right angles
diverticulum(a)—a pocketlike side branch
earth tongue—sporocarps of the genus Geoglossum
eccentric—not circular
echinate—having sharply pointed spines
ectal excipulum—the outer layer such as in the peridium
eguttulate—without guttules
ellipsoid—shaped like an ellipse
emergent—rising out of
encrusted—overlain with a crust
endophytic—living within another
enrolled margin—rolled within
ental excipulum—the inner layer such as in the peridium
ephemeral—lasting a short time
epicuticular—outer layer of tissue
epikutis—outer layer of tissue
epigeous—growing aboveground
epiphytic—living on the surface of another
epithelium—the outer layer of tissue
esculent—of use as food, edible
ETOH—ethanol
euhymenium—containing a palisade of basidia
evanescent—having a short existence
excrescence—an abnormal outgrowth
extracellular—outside the cell
fabaceous—resembling a bean
farinaceous—smells like cornmeal
farinose—like meal in form
fascicle—a little group or bundle
fasciculate—growing in fascicles
fawn—pale gray-brown
FCL—ferric chloride (10-percent aqueous solution)
ferruginous—resembling iron rust in color
Fe₂(SO₄)₃—ferric sulfate (10-percent aqueous solution)
fibrillose—with fine hairs or fibers
fibrils—small fibers
filamentose—threadlike
filiform—threadlike
fimbriate—delicately toothed, fringed
flabellate—shaped like a fan
flabelliform—shaped like a fan
flaccid—limp or not stiff
flexuous—elastic
floccose—cottony
flocculate—delicately cottony
friable—easily crumbled
FSW—ferric sulfate 10-percent aqueous
fulvous—pale brown-yellow
furcate—forked
furfuraceous—covered with flaky particles
fuscous—brown-gray
fusoid—tapering towards each end
gametangium(a)—cell containing gametes or gametic nuclei
gelatinized—jellylike
gelatinous—jellylike
generative hyphae—hyphae that are branched, septate, with or without clamp connections, thin or thick walled, and of unlimited growth
germ pore—a differentiated, frequently apical area in a spore wall
glabrescent—smooth
glabrous—smooth
glandular dot—a dot due to the presence of a gland
gleba—spore-bearing tissue in sequestrate fungi
gleocystidia—thin walled, usually irregular cystidia with yellow or highly refractive contents
gleoplerous hyphae—hyphae with long cells, with many oil drops
globose—sphaerical
gluten—a substance that is sticky when wet
glutinous—covered with gluten
granulated—covered with small particles
granule—a small particle
granulose—roughened with granules
gregarious—in groups but not joined together
GUA—tincture of guaiac (saturated solution of gum guaiac in 95-percent ethyl alcohol)
guttules—oillike drops
hemispheric—one of two half-spheres
heteromorous—having sphaerocyst nests among filamentose hyphae
hirsute—having long hairs
hyaline—colorless
hygrophanous—having a water-soaked appearance when wet
hymenium—the spore-bearing layer of tissue
hyphae—one of the filaments of a mycelium
hyphoid—like hyphae in form
hypogeous—growing belowground
IKI—Melzer’s reagent
imbricate—scales partly covering one another like roof tiles
inamyloid—not reacting to Melzer’s reagent
incurved—curved inward
inoperculate—opening by an irregular apical split to discharge spores
internodes—the interval between nodes
intervenose—condition where veins are found in the spaces between gills
isodiametric—having equal diameters
ixocutis—a slimy cuticle
ixotrichoderm(ium)—a trichodermium composed of gelatinized hyphae
KOH—as mounting medium: potassium hydroxide (2- to 5-percent aqueous solution)
KOH—as macrochemical reagent: potassium hydroxide (10-percent aqueous solution)
labyrinthine—structure of complex paths
lacerate—to tear roughly
lacticiferous hyphae—hyphae which secret a milky juice
lacunose—having a hole or hollow
lageniform—swollen at the base and narrow at the tip
lamella(ae)—hymenium-covered vertical plates on the underside of the cap
lamellar—of lamellae
lamellulae—a small lamella
laminate—composed of layers
latex—a milkylike juice
lattice—cross-barred; like a network
leptocystidia—a thin-walled smooth cystidia
lignicolous—occurring on wood
limoniform—lemonlike in form
loculate—divided into locules
locules—a cavity
lunate—like a new moon
macrocystidia—cystidia that arise from deep within the hymenium
macrofungi—fungi with sporocarps large enough to be seen without a hand lens
matrix—the substrate in or on which an organism is living
mediostratum—the middle layer
medullary excipulum—tissue below the generative layer in an apothecium
Melzer’s reagent—an iodine reagent
membranaceous—like a thin skin
metuloid—an encrusted cystidium thick walled at maturity
microfungi—fungi with small sporocarps that are seen only with a hand lens
moniliform—having swellings at regular intervals
monochromatic—consisting of one color or hue
monomitic—consisting of a single kind of hyphae
monosporus—one spored
mottled—having patches of different colors or shades
mottling—to be mottled
mucilage—a gelatinous substance
mucilaginous—sticky or viscid
mucronate—an abrupt sharp terminal point
multifid—divided into a number of parts or lobes
multiguttulate—having more than two guttules
mushroom—an enlarged, epigeous, fleshy sporocarp of a fungus
mycelium—a mass of hyphae
mycophilic—lover of fungi
mycorrhiza(e)—a mutually beneficial symbiotic association of plant roots and fungi
napiform—turniplike in form
naviculate—boatlike in form
nodulose—having broad-based, blunt, wartlike structures
NOH—ammonium hydroxide (10-percent aqueous solution)
obclavate—inversely clavate
obconic—inversely conic
oblique—not at a 45-degree angle
obovoid—ovoid with the broad end towards the apex
obpyramidal—the reverse of pyramid shaped
obpyriform—the reverse of pear shaped
obtuse—rounded or blunt
ochraceous—somewhat ocherlike in color
ochre—a red-yellow color
oleiferous—containing a refractive substance
olivaceous—somewhat olive colored
opaque—unable to be seen through
operculate—opening by an apical lid to discharge spores
orbicular—circular
ostioles—the pore from which spores emerge
palisade—a layer of columnar cells
pallid—pale
palmate—having lobes extending from a common center
papilla—a small rounded process
papillate—having papilla
paraphysis—a sterile upward growing, basely attached hyphal element in an Ascomycete hymenium
partial veil—a layer of tissue, developed from the stem, that joins the stem to the cap edge during hymenium development
part spores—one of the 1-celled spores resulting from the breakup of a 2- or more-celled ascospore
pedicellate—having a small stalk
pellucid-striate—having a somewhat transparent top so that the gills can be seen from above
pendant—hanging down
percurrent—extending throughout the entire length
periclinal—curved in the direction of the surface
peridium—the outer membrane of a sequestrate sporocarp
perisporal sac—a wall that forms a loose envelope around a spore
perithecium(a)—a subglobose or flasklike Ascomycete sporocarp
PHN—phenol (2-percent aqueous solution)
pileate—having a cap
pileipellis—the cellular cortical layers
pileocystidia—cystidia found on cap
pileus—the umbrella-shaped (cap) structure of a mushroom
pip-shaped—shaped like an apple seed
plage—a smooth, colorless spot on a surface
plano-convex—flat on one side and convex on the other
pleurocystidia—cystidia found on the side of the structure
pluridigitate—multidigitate; many fingerlike structures
plurinodulose—with multiple nodulose elements
polychotomous—having an apex dividing into more than two branches
polypore—a macrofungus with a pored hymenium
pore—a small opening
pruinose—having a frostlike or flourlike surface
pseudocystidia—cells that appear like cystidia but are not cystidia
pseudoparenchymatous—inflated cells in the peridium or trama of certain fungal groups
pseudorhiza—rootlike structure of the lower stem
pseudosclerotium—a compacted mass of intermixed substratum held together by mycelium
pubescent—having soft hairs
puffball(s)—species in the order Lycoperdales
pulvinate—cushionlike in form
punctate—marked with small spots
pungent—having a strong smell
PYR—pyrogallol (10-percent aqueous solution of pyrogallic acid)
pyriform—pearlike in form
radicate—spreading from a center
raphanoid—radishlike
recalcitrant—not easily changed
recurved—curved backward or inward
refractive—not translucent
refractive hyphae—hyphae with contents that are colored
refigringent—not translucent
reniform—kidney shaped
repand—having a waved edge which is turned back
repent—prostrate
resupinate—found with the hymenium upward and little sterile tissue
reticulum—like a net
rhizomorph(s)—a rootlike aggregation of hyphae having a well-defined apical meristem
rhizomorphic—rhizomorphlike
rimose—having small cracks
rimose-rugulose–having small cracks or delicately wrinkled
rostrate–beaked
rugose–wrinkled
rugalose–having small wrinkles
saccate–like a sack
salmon–yellow-pink
salmonaceous–somewhat yellow-pink
saprophyte–living on dead material
sarcodimitic–long, thick-walled, inflated hyphae
scabrous–rough
scurfy–flakes or scales that adhere to the surface
seceded–withdrawn
sepia–brown-gray to dark olive-brown
septum(a)–a dividing wall in fungal cells
sequestrate–sporocarps that normally retain their spores within until they decay in place or are eaten
sessile–without a stem
sheen–shiny or glossy appearance
silica gel–colloidal silica
sinuate–notched
skeletel hyphae–hyphae that are thick walled, aseptate, of limited length, with thin-walled apices, usually unbranched
sordid–a dull or muddy color
spathulate–like a spoon in form
sphaerocysts–globose cells
sphaeropedunculate–
spherical–having the form of a sphere
spinule–a small spine
sporiferous–bearing spores
sporocarp–a general term for a spore-bearing organ
squamule–a small scale
squamulose–having small scales
stalactiform–having the form of a stalactite
sterigmal attachment–the attachment point for the spore on the basidium
sterigma–the structure that attaches the spore to the basidium
stipitate–having a stem
stipitipellis–layer of tissue making up the stem
stipitipith–the tissue within the context of the stem
stratum–a layer of tissue
striate–marked by lines, grooves, or ridges
striatulate–marked by small lines, grooves, or ridges
strigose–rough with sharp-pointed hairs
sub–prefix for approximating
subglobose–not quite globose
sublacrimiform–like a tear drop
sulcate–grooved
suprahilar–the area above the sterigmal attachment
suprapellis–the topmost cortical layer
SYR—syringaldazine in ethanol
tawny—brown-orange to pale brown
terete—cylindrical but narrowing at one end
terrestrial—growing on soil
terricolous—growing on the ground
tibiiform—shaped like a tibia bone
tomentose—a covering of soft, matted hairs
tomentum—a covering of tangled or matted wooly hairs
tortuous—with repeated twists, bends, or turns
torulose—cylindrical but with swellings at intervals
trama—the layer directly beneath the subhymenium
trichodermium—the outer layer composed of hairlike elements projecting from the surface
truffle(s)—sequestrate Ascomycota, Basidiomycota, and Zygomycota
truncate—ending abruptly
tuberculate—wartlike processes
tubulose—having the form of a tube
turbinate—in the shape of a top
turf—a distinct layer
TYR—l-tyrisine
umbilicate—have a small hollow; cap of a pileus having a hollow on the top above the stripe
umbo—a rounded elevation
umbonate—having a rounded elevation
undulate—rising and falling as in waves
ungulate—a hoofed animal
unisepitate—with a single septa
uniseriate—in a single series
urnulate—shaped like an urn
veil—a ringlike tissue on the stipe after sporocarp expansion
velutinous—covered with a silky pubescence
venae externae—veins of pale colored tissue that reach the outer surface within sequestrate ascomycota
venae internae—dark-colored, spore-bearing tissues that do not reach the outer surface within sequestrate ascomycota
ventricose—swelling in the middle or on one side
verrucose—small rounded warts
versiform—changing form with age
vesicle—a bladderlike sac
vesicular—vesiclelike
vesiculose—full of vesicles
villose—covered with long soft hairs
vinaceous—the color of wine
violaceous—the color violet
viscid—slimy, sticky, or viscous
volva—the cup-like lower part of the universal veil, around the stipe base
Zygomycete(s)—the class of fungi having zygospores
zygospores—the formation of spores by the fusion of gametangia
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