D. M. Huffman
L. H. Tiffany
G. Knaphus
R. A. Healy

Mushrooms and Other Fungi of the Midcontinental United States

SECOND EDITION

Mushrooms and Other Fungi of the Midcontinental United States

Second Edition

A Bur Oak Guide

Mushrooms and Other Fungi of the Midcontinental United States

D. M. Huffman, L. H. Tiffany,
G. Knaphus, and R. A. Healy

SECOND EDITION

University of Iowa Press | Iowa City

University of Iowa Press, Iowa City 52242

www.uiowapress.org

Printed in China

Design by April Leidig-Higgins

The University of Iowa Press is a member of Green Press Initiative and is committed to preserving natural resources.

Art credits: Figures 1, 2, 3, 6, 8, 11, 16, 20 (top two), and 21 by Anna Gardner. Figures 4, 5, 7, 10, 12, 13, 15, 18, 19, and 20 (bottom five) by Elsie Froeschner. Plates 5, 11, 15, 29B, 62, 83, 104, 111, 114, and 195 by Don Huffman. Plates 6A, 6B, 9, 12, 13A, 14, 17, 28, 30, 31, 33, 34, 35A, 38A, 39, 41, 45, 48, 49, 55A, 58, 60, 68, 74A, 77, 78, 81, 82B, 86, 91, 92, 93, 94, 96, 100, 103, 106, 108, 120A, 120B, 121, 122, 130, 131, 136, 145, 147B, 150, 151, 165, 174B, 177, 182, 190, 201, 208, 211, 216A, 216B, 217, 218, 219A, 219B, 220, 221, 222, 223, 224, 225, 226, 227A, 227B, 228A, 228B, 229, 230, 232B, 237B, and 246A by Rosanne Healy. Plates 164 and 213 by Wendell Bragonier. Plate 72 by Mark Gabel. Plate 186 by Larry Hufford. All other plates by George Knaphus and Lois Tiffany.

Printed on acid-free paper

Library of Congress Cataloging-in-Publication Data
Mushrooms and other fungi of the midcontinental United States /
D. M. Huffman . . . [et al.].—2nd ed.
p. cm.—(A Bur Oak guide)
Rev. ed. of: Mushrooms & other fungi of the midcontinental United States / D. M. Huffman, L. H. Tiffany, and G. Knaphus. 1st ed. 1989.
Includes bibliographical references and index.
ISBN-13: 978-1-58729-627-7 (pbk.)
ISBN-10: 1-58729-627-6 (pbk.)
1. Mushrooms—Middle West—Identification. 2. Fungi—Middle West—Identification. I. Huffman, D. M. (Donald M.), 1929–
II. Huffman, D. M. (Donald M.), 1929– Mushrooms & other fungi of the midcontinental United States.
QK605.5.M53M87 2008 2007021244
579.60977—dc22

08 09 10 11 12 P 5 4 3 2 1

Contents

Preface and Acknowledgments

The first edition of *Mushrooms and Other Fungi of the Midcontinental United States* (Iowa State University Press, 1989) was developed specifically to provide a guide to the fungi of the deciduous woodlands and tallgrass prairies of Iowa. The number of similar guides contributing to our knowledge has increased since that time. Our additional experience with these fungi of our region has prompted us to revisit our treatment of them in the first edition. In this project, we miss the expertise, general knowledge, and sprightly companionship of George Knaphus. We gratefully acknowledge the contributions from members of the Prairie States Mushroom Club. Their interest and field information are of significant value.

We have not changed the general format of the first edition but have added some common fleshy fungi that were not included there. The most significant addition is the section on the truffles, a most interesting but elusive group of fungi not usually encountered unless specifically sought.

We still include some of the showy common slime molds, although technically they are not fungi. They do occur in habitats colonized by fungi, however, and are commonly encountered. They are a fascinating group of organisms traditionally studied by mycologists.

We gratefully acknowledge Anna Gardner for her original illustrations and for revised line drawings from the first edition and Elsie Froeschner for permission to reuse her line drawings from the first edition. We also deeply appreciate Walt Sundberg, Orson Miller, and Sybilla Brown for their very valuable suggestions and reviews of our manuscript, which greatly improved our updated edition. We thank Tom Harrington and Joseph Steimel for molecular analysis and valuable discussions on *Armillaria*. We also thank Mark Gabel and Larry Hufford for generously contributing their photographs. Finally, our thanks to all those who assisted in countless ways and encouraged us as we prepared this second edition.

Donald Huffman, Lois H. Tiffany, and Rosanne Healy

Preface to the First Edition

In recent years several factors have combined to renew interest in studies of natural history. Scientific, educational, and recreational groups have come to recognize that organisms have been neglected by our post-Sputnik, molecularly oriented sciences. Our natural habitats and their rich and irreplaceable natural resource of species are endangered by environmental disruptions and threatened with possible extinction. Each group of organisms has its unique appeal, but we think the fungi, especially mushrooms and fleshy fungi, are an unusually diverse and colorful group with distinctive appeal to those with artistic, scientific, photographic, and culinary interests. There has been rapid growth of regional and state mushroom groups, many of which are affiliated with the North American Mycological Association, an organization that synergistically combines the enthusiasm of dedicated amateurs and professional mycologists.

In many parts of the United States, flowering plants, birds, and even geological features have been treated in state or regional field guides, but the lower plants and fungi often are not so well studied or understood. It is our goal to make this guide useful for everyone, but with sufficient depth to meet some of the needs of the more serious scholar. We believe it will appeal to mycology enthusiasts within the larger area of the midwestern prairie states, where woodland and grassland habitats prevail. "Midcontinental United States" indicates that our studies cover a group of transitional habitats in a region formerly covered in large part by tall grass prairies and woodlands of the eastern deciduous forest and lakes states forest. This region has weather that geographers and meteorologists refer to as midcontinental; and even though these habitat-weather combinations have features in common with adjoining regions, there is a distinctive biological mix.

This is not a complete record of the fungal flora. The midcontinental habitats support a surprisingly abundant variety of mushrooms and other fungi. Our intent is to provide a usable field guide to the regional macroscopic fungi, and we have chosen to present about 250 of the more common species. We include a representative sampling of edible mushrooms, some important poisonous species, and other attractive and/or interesting fungi of the region. More information on other fungi is available in the general and technical references.

A note of caution: there are many mushrooms that are not found in this book. If you are confused when attempting to identify a specimen, try one of the other mushroom books. Do not eat any specimen that cannot be positively identified.

No book of this type is done in isolation, and this is a cooperative venture by many people. We cannot personally thank all who have aided and encouraged us; but several individuals played instrumental roles, and we wish to thank them specifically.

Each author was fortunate to have studied with Joseph C. Gilman, a mycologist-scholar who was a faculty member at Iowa State University from 1918 until his death in 1966. He was not only extremely knowledgeable in his professional area but had a broad background of interests and information. His national recognition as a mycologist was evident in his election to offices in the Mycological Society of America, for which he served as president in 1945–1946. He influenced many students of mycology who were fortunate to experience his quiet wisdom, sparkling wit, and gentle humanity.

We thank our administrators, colleagues, and students at both Central College of Iowa and Iowa State University who have assisted us, field tested our taxonomic keys, and encouraged us to persist in our publication efforts.

We are also deeply appreciative of the help of Clark Rogerson, Walter Sundberg, and Harry Knighton for reviewing the manuscript and providing suggestions for improvements; Wendell Bragonier for the use of some of his color slides; and Elsie Froeschner for her help with some of the line art.

Finally, we express our gratitude for the financial support of personal and professional friends. In particular, we are grateful to Joan Kuyper Farver and the Stuart Kuyper Memorial Fund, Pella, Iowa, for a gift in honor of the late H. Stuart Kuyper, former president of the Rolscreen Company of Pella and an enthusiastic supporter of educational and scientific projects. Stu's love for natural history and conservation was evident to those who knew him well, and his generous support of studies in these areas is a tribute to his family, his education, and his vision.

We count ourselves privileged to have known Joseph Gilman, Stuart Kuyper, Joan Kuyper Farver, and the many others who have aided us and encouraged us, and we dedicate this book to them.

How to Use This Guide

The introduction gives background information on the fungi, and the remainder of the book is devoted to fungi that occur in the midcontinental United States, particularly in Iowa. We recommend reading the introduction, of course, especially the sections that will be most helpful in keying out a particular mushroom or other fungus.

The first part of the introduction discusses the various ways in which people have interacted with fungi, including their effects on human health and economic impacts. The second deals more specifically with mushrooms, mushroomers, and mycophagy. The third part provides basic information about mushrooms and introduces special terms that are helpful in using the keys for identification (these terms are also defined in the glossary). Next come descriptions of the groups of larger, often fleshy, fungi that are not mushrooms, grouped by shared macroscopic features. The illustrations help in identifying these fungi. The following sections discuss the naming and classification of fungi and their edibility and toxicity. The next part describes the habitats of various fungi, which are dependent to a large extent on their sources of nutrition and the times of year when the most common species tend to occur in these various habitats. Habitat descriptions are followed by a brief description of the common native trees, many of which are involved as mycorrhizal associates with fungi.

Following the introduction, we present a dichotomous key to the families and other major groups of fungi described in the book, along with an explanation of how to use it. When you identify the family or group, you will find the page for the description. A key to the genera within that group is also included. Once you have determined the genus, you will see the page where it is described. In many cases a key to species is provided. The keys identify only species included in this guide, but the references at the end provide sources on species not discussed here as well as books on cultivating mushrooms and using them for cooking and dyeing.

The section for each species includes one or more photographs, a systematic description, and information about edibility, habitat, when it fruits, and a comparison with look-alike species.

We hope that you enjoy using this guide as much as we have enjoyed writing it.

Mushrooms and Other Fungi of the Midcontinental United States

Second Edition

Introduction

Fungi have been studied and used throughout recorded history. The biblical prophet Amos referred to the "blasting of wheat," which was his way of describing a wheat blight, probably a rust disease caused by *Puccinia graminis*. The word "berserk" comes from the name "Berserks": crazed Viking fighters who probably used the mushroom *Amanita muscaria* as a stimulant.

In the Middle Ages an ailment that caused gangrenous rotting of the flesh of the feet, hands, nose, and ears attacked many people in Europe, resulting in crippling and often death. St. Anthony's fire, as it was called, was later found to be caused by ergot, a fungus parasite of rye inflorescences threshed out with the normal grain and then ground into the flour. This fungus contains alkaloids that may have several effects when eaten, such as restricting circulation.

The compounds developed in the ergot bodies also cause other reactions. A chemist for a pharmaceutical company who was pipetting lysergic acid diethylamide (LSD) isolated from ergot bodies sucked some of the compound into his mouth. This was possibly the first LSD high.

Several species of the fungus *Psilocybe* produce hallucinogenic compounds such as psilocybin. It is illegal to use, sell, or possess these hallucinogenic mushrooms.

Fungi produce a much more widely used and abused drug: ethyl alcohol. This is one of the most toxic alcohols, but the human body can detoxify it if the quantity imbibed is small enough. One alcohol-producing fungus is the yeast *Saccharomyces cervesiae*. Yeasts are also used in baking bread. Letting the bread rise is simply a way of allowing the yeast to produce carbon dioxide and alcohol. Baking eliminates the carbon dioxide and alcohol, but the spaces left behind give the bread its lightness. Omar Khayyam spoke of "a loaf of bread, a jug of wine, and thou." Two out of three is not bad for a tiny fungus.

Fungi are also involved in cheese making. The fungus *Penicillium roquefortii* is involved in the production of Roquefort, a blue mold cheese. The blue-green material is fungus mycelium and spores, which impart the special flavor. Other cheeses and milk products also have fungi that contribute to their special flavors and characteristics.

The genus *Penicillium* is also known for the antibiotic penicillin. The original effects had been noted and used by doctors, but Sir Alexander Fleming is credited with documenting the effects of *Penicillium notatum* products. Many other antibiotics and medicinal compounds are produced from fungi. The ergot fungus (the source of the hallucinogens already mentioned) produces many compounds used in medicine, including treatment for migraine headaches.

While fungi produce compounds that can help people regain health, some fungi are detrimental to human health. Common ringworm and athlete's foot are among the pesky but not life-threatening fungi that attack humans. Histoplasmosis, a rather common midwestern disease, results from a fungal infection in the lungs. In most cases it causes flulike symptoms, the infection site is walled off, and the victim recovers. Sometimes, however, the fungus becomes systemic, causing very serious disease and possibly death. Birds are associated with this disease organism because it grows in high-nitrogen soil promoted by bird droppings. People who work with poultry or who are exposed to dust from soil enriched by droppings are most likely to inhale the dry powdery spores. Another fungus with dry, airborne powdery spores is associated with a disease commonly called valley fever. Like histoplasmosis, it may be encapsulated in the lungs, causing minor to moderate health problems. If it becomes systemic, it may involve other parts of the body, including the brain, and result in very serious disease and often death. This fungus is found in the desert regions of the southwestern United States and adjacent Mexico.

Fungal infections are very difficult to treat effectively, so we can be thankful that they are not our most common disease pathogens. Plants, however, are not as fortunate. Fungi are the most serious plant pathogens. Plant diseases such as the rusts can destroy entire crops. One of the best-known incidents of devastating plant disease was the potato famine in Ireland between 1846 and 1850. The disease and related economic factors resulted in 1.5 million deaths and massive emigration to the United States. The Irish population fell by over 50 percent.

One of the most interesting fungal disease situations occurred from 1916 to 1918. Farmers of the northern wheat-raising regions of the United States were growing wheat with a limited genetic diversity. In 1916 a very serious outbreak of wheat rust destroyed over half the crop. When the United States entered World War I in April 1917, the 1916 wheat crop was insufficient to meet the needs of America and its allies. The wheat crop was again reduced by rust in 1917, but not to the same extent as the year before. In Germany, however, an epidemic of potato blight (caused by *Phytophthora infestans*) destroyed a major part of the 1917 potato crop. The food problems there were even more pronounced than in the Allied countries, and Germany eventually succumbed to the military might and greater food supplies of the Allied forces.

Plant breeders are concerned with the major factors that foster resistance to plant diseases, especially those caused by fungi. Unfortunately, the fungi are able to mutate and produce different genetic strains with new potential for successful invasion and destruction; the plant breeder must constantly strive to maintain a diverse genetic base to stay ahead of the relentless fungi.

Sometimes a fungus can live in association with a green plant in a mutually supportive relationship; a mycorrhizal relationship is one such symbiotic association. Many green plants have one or more fungi present in the roots, enhancing the uptake of mineral nutrients into the plant. The green plant is the source of food for the fungus. The mycorrhizal fungi often are quite specific. Non-native seedlings planted in soil without the required fungus may produce very weak, poor-growing plants, although a seedling that develops in its native soil will grow very well. Continuing studies of the mycorrhizal phenomenon indicate that a majority of plants are probably involved in such relationships.

We have reserved the most important impact of fungi for last. Can you imagine a 10,000-year-old forest where nothing ever decayed? Obviously, it would be impossible, because the tangle of fallen trees would be a poor environment for further growth. Even more serious would be the problem of binding the mineral compounds in the trees: almost no nutrients would be available in the soil for new growth. Fungi are the major plant-recycling organisms and help replenish the soil nutrients for subsequent generations of plants.

We have not said much about mushrooms yet. While the eating of mushrooms is economically important in some countries, it is minor compared to the significance of the recycling aspects of fungal activity, the destruction by plant disease fungi, and possibly even the fermentation of beer. For many of us, however, a bright spring day that dissolves the memories of a harsh winter as we search for that elusive first morel also makes us forget the everyday importance of recycling and of plant diseases—for a short time we think only of edible fungi!

Mushrooms, Mushroomers, and Mycophagists

The fleshy fungi, particularly the mushrooms, are of great interest for a variety of reasons. The possibility of using them as food—is it edible or poisonous?—is the first concern of many people. The diversity of form and vivid colors are a satisfaction and a delight for others. It is a challenge to find some kinds of fleshy fungi during their brief season, when they suddenly appear and almost as suddenly disappear. Mushrooms may reappear each year or may skip a year or more before again producing fruiting bodies. The mysteries of poisons and hallucinogens have created a mushroom folklore containing truths, half-truths, and superstitions.

Groups of organisms have their followers and champions, such as birdwatchers, game-hunters, or fly fishers; mushrooms are no exception. In the Midwest (and around the world in northern temperate regions) numerous people flock to the woods in early spring, clutching a bag or basket, gazing intently at the ground, and scuffling in the leaf litter looking for the elusive morel. The fascination associated with this vernal ritual is far out of proportion to the culinary value of the fungus itself. Without dwelling on the allegedly eccentric behaviors of mushroom enthusiasts, it seems safe to say that they are a recognizable cultural variant. After all, people who take pleasure in foraging through mud and rain, thorns and bogs, and mosquitoes and poison ivy looking for mushrooms are at least as eccentric as ice fishers, surfers, or spelunkers. If you are a mushroom enthusiast, you are already aware of this unique behavior. If you are not, we invite you to participate. As one author said, "Mycologists have more fungi!"

Basic Mushroom Biology

Mushrooms are the fruiting bodies of fungi. A typical mushroom consists of a flattened to variously rounded cap, borne like an umbrella at the end of a stalk (fig. 1). On the underside of the cap, usually radiating from the stalk, are thin plates of tissue called gills or lamellae, which are lined on both sides with tiny specialized cells called basidia, on which the basidiospores (the reproductive units) are produced (fig. 2). The way the gills develop in relation to the stalk (fig. 3) is a significant macroscopic feature of a mature mushroom. The gills of a young mushroom may change color as the spores mature.

Mature spores are flung from the cell on which they developed and drift in the air until they fall to the ground. If moisture is available, the spores germinate into threadlike strands of cells called hyphae, which develop into a mycelium,

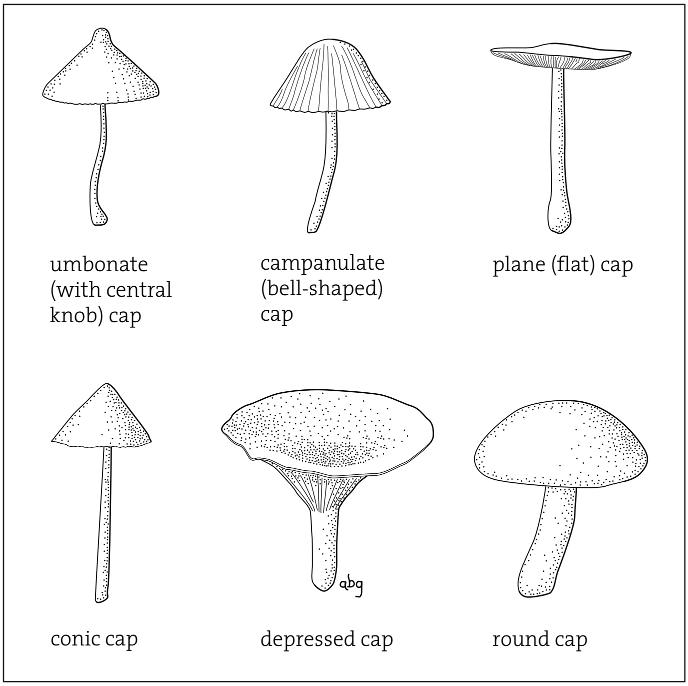


FIG. 1. Mushroom cap shapes

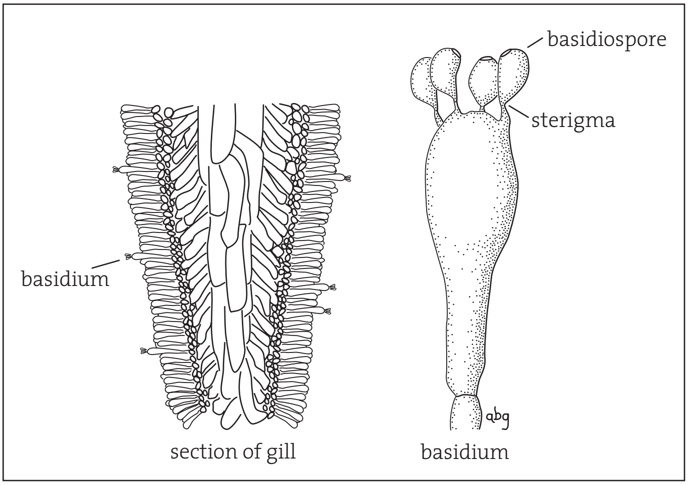


FIG. 2. Mushroom gill section and basidium

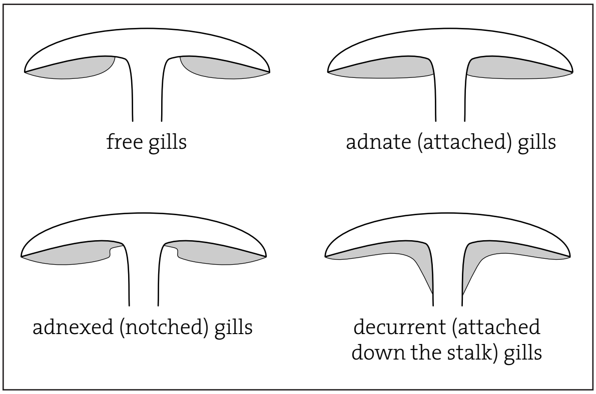


FIG. 3. Gill attachments

the vegetative body of the fungus (pl. 1A, B); they must be established where they can obtain food if they are to survive. The hyphae of many mushrooms can obtain food and grow in litter consisting of fallen leaves, twigs, and other dead plant parts. Some hyphae will grow only on wood and thus develop in downed logs, decaying tree stumps, or living standing trees.

Hyphae may grow for months or even years in a particular site (studies indicate that mycelium can continue growing for four hundred years or more). When environmental conditions (particularly temperature and moisture) are favorable, spore-producing fruiting bodies (such as mushrooms) eventually will be formed. Some mushrooms are most frequently found in rings or arcs (pl. 2). *Chlorophyllum molybdites*, *Agaricus campestris*, and *Marasmius oreades* are prob-

PLATE 1. Mycelium
A (Top): *Clavaria* sp. on plant debris, B (Bottom): *Lycoperdon* sp. on log

ably the commonest examples. The most plausible explanation is that the fungus grows at the center of the ring, then the mycelium grows outward in an ever-expanding circle, accumulating nutrients. When conditions are favorable, a ring of mushrooms is produced, a few inches behind the leading edge of the mycelium. The ring enlarges with each subsequent occurrence.

The hyphae of still other fungi (some basidiomycetes and some ascomycetes) inhabit the living roots of higher plants, forming a relationship called a mycor-

PLATE 2. Fairy ring of *Chlorophyllum molybdites*

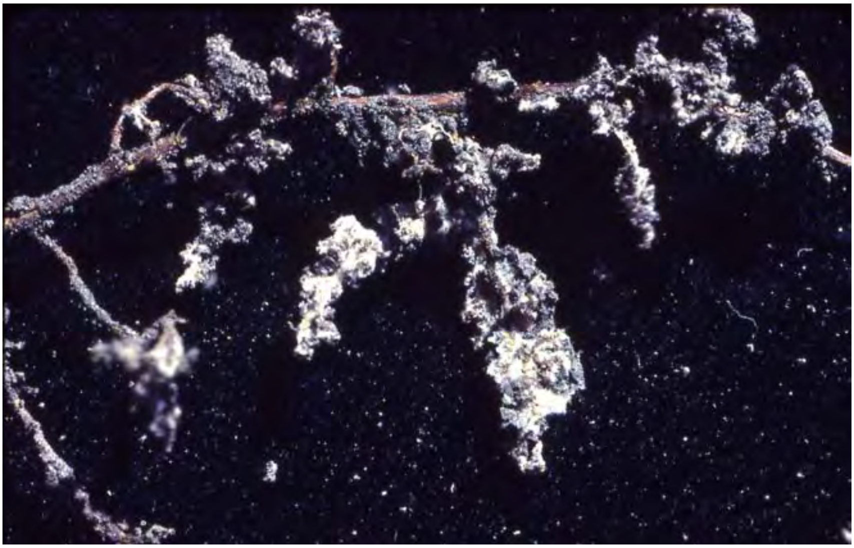


PLATE 3. Mycorrhizal white oak roots

rhiza (pl. 3). These mycorrhizae are very effective in transferring nutrients from the soil into the green plant and are often essential to the welfare and survival of both the fungus and the plant. The discussion of mushroom habitats below contains more information about hyphal growth and nutrients available to fungi.

A complete young mushroom, sometimes referred to as an egg or button, develops from an interwoven clump of hyphae (fig. 4). The cap (pileus) with gills

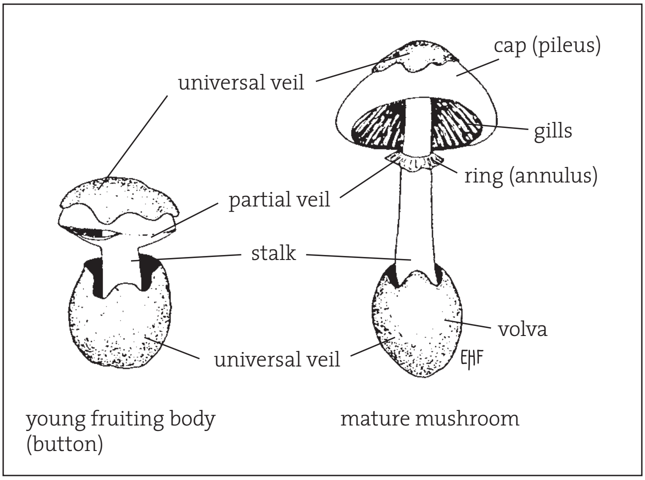


FIG. 4. Principal parts of a complete mushroom

and the stalk are identifiable even when the entire structure is very small. Some mushrooms develop with a cover of interwoven hyphae that entirely encloses the young mushroom. As the stalk grows and elongates, the outer cover (the universal veil) breaks, and pieces of it may stick to the cap (fig. 4). The lower portion typically encloses the base of the stalk as a cuplike structure (volva). Some mushrooms have another cover (partial veil) that extends from the edge of the cap to the stem and encloses the lower surface of the young cap. The manner in which the partial veil breaks when the cap expands is a characteristic feature used in identification. It may persist as a ring of tissue (annulus) on the stalk or, less commonly, hang as shreds of tissue from the edge of the cap.

As a mushroom matures, the spores (basidiospores) develop on the specialized cells (basidia) on the gills (fig. 2). The gills and spores may remain the same color throughout development (often white) or change color with age; thus the gills of completely mature mushrooms may appear to be white, pink, rusty brown, yellow-brown, purple-brown, or black.

Spore mass colors are used in identification. To be sure that the color observed is really the color of the spore mass and not the gill color, a print should be made. This can be done by cutting off the stalk as close to the cap as possible, then placing the cap with the spore-producing surface down on a sheet of paper for several hours. Cover the cap with a dish or bowl to prevent excessive drying and to avoid wind currents. If the specimen is mature it will release spores, which will accumulate in the gill pattern for gilled mushrooms (pl. 4A) and in the tube pattern for the boletes (pl. 4B). Both white and colored spore deposits (prints) will be visible on white paper, but some people prefer to place the cap partly

PLATE 4. Spore prints. A: Mushroom B: Bolete

on white paper and partly on colored paper. The dried prints may be preserved with a light coating of clear lacquer spray, or the paper on which the spores were deposited can be folded with the spores inside for future microscopic study. The basidiomycete fungi that do not forcibly discharge spores, such as puffballs and false truffles, do not make spore prints.

The following basic macroscopic and field information is needed to identify mushrooms: (1) the presence or absence of a volva and/or annulus; (2) the manner in which gills are attached to the stalk: along the entire width of the gill (adnate), only at the top of the gill (notched or adnexed), tapered to a position on the stalk below the gill edge (decurrent), or not attached to the stalk (free) (fig. 3); (3) the mass color of the dry spore print; (4) the texture, diameter, shape (fig. 1), and color of the cap; (5) the texture, length, diameter, shape, and color of the stalk; (6) the grouping of the mushrooms (for example, single, scattered, or clustered); and (7) the habitat, such as in lawns, on downed wood, or on the ground under coniferous or deciduous trees. In addition to these characteristics, taste and aroma are also useful in some species identifications.

As you collect fleshy fungi, you will soon notice that many of them do not have the typical mushroom form; they develop other kinds of fruiting bodies with their own macroscopic features. The majority of macroscopic fleshy fungi are basidiomycetes. Basidiomycetes produce spores on a basidium, the basic feature that separates them from other groups of fungi. Some of the basidiomycetes forcibly discharge their spores from the basidia, which remain after spore discharge. Other basidiomycete groups release their spores by collapse of the basidia, which are not present in the mature fruiting body. The most common basidiomycete groups can be summarized as follows:

A. Groups in the class Basidiomycetes that forcibly discharge basidiospores (can make spore prints, figs. 1–10)
   1. Mushrooms (Agaricales) (figs. 1–4) are fleshy and have a cap and platelike gills.
   2. Boletes (Boletales) (fig. 5) are fleshy and have a mushroomlike cap and stalk but have openings or pores on the underside of the cap instead of the typical thin, platelike gills of a mushroom. These pores are the open ends of tubes that form the lower surface of the bolete cap, with basidia lining the inside of each tube.
   3. Aphyllophorales
      a. Chanterelles (fig. 6) have a mushroomlike cap and stalk. The lower surface of the cap has decurrent ridges that are thicker than the gills of mushrooms, or the surface may be wrinkled or smooth. They grow exclusively on the ground.
      b. Tooth fungi (fig. 7) may have various fruiting body forms with conelike or spinelike structures on the underside of the cap. The basidia develop in layers over the surface of each tooth.
      c. Coral or clublike fungi (fig. 8) have the same kind of basidia, which are produced in layers on the surface of single clubs or cover the upright branches of the fruiting body.
      d. Bracket and other shelflike fungi (fig. 9) have distinctive, typically nonfleshy bracket or shelflike fruiting bodies. They are common on wood, branches, downed logs, stumps, and standing dead or living trees. These fruiting bodies may have an apparently smooth lower surface or a layer of holes similar to those on the lower surface of a bolete cap or on toothlike projections. The smooth lower surface or the inside of the tubes (whose open ends are the holes) or the outer surface of the teeth is covered with a layer of basidia. These fruiting bodies are usually leathery, corky, or woody, although a very few are fleshy enough to be edible.
   4. Jelly fungi (fig. 10) have firm to gelatinous fruiting bodies that are variously lobed or branched, with a cover layer of basidia. Although the basidia are not like those of the previous groups, the basidiospores are flung into the air in the same way.

B. Groups in the class Basidiomycetes in which basidiospores are not forcibly discharged (figs. 11–16)
   1. Stinkhorns (fig. 12) have a fleshy, hollow stalk with a dark, slimy spore mass that has a carrionlike odor at the upper end. They are truly distinctive, both in appearance and in aroma.
   2. Puffballs (fig. 13) have dry, powdery spore masses that are released by being puffed out. The common puffball has a hole at the top and a flexible wall, which releases the spores when depressed. The giant puffball has an outer layer that breaks away in large irregular pieces, exposing the

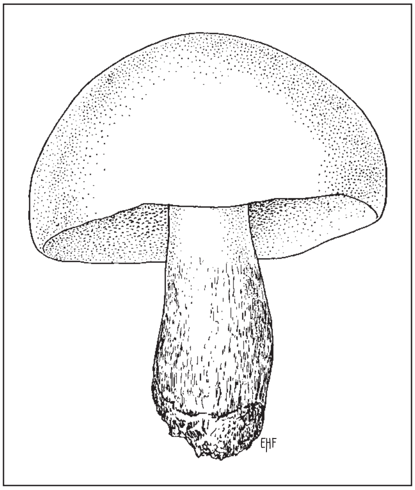


FIG. 5. Bolete

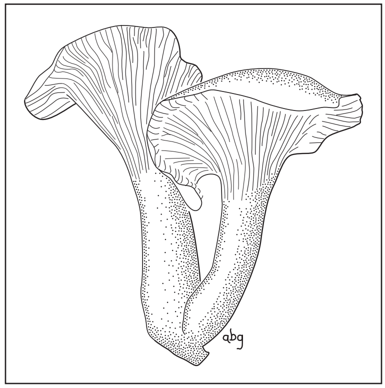


FIG. 6. Chanterelle

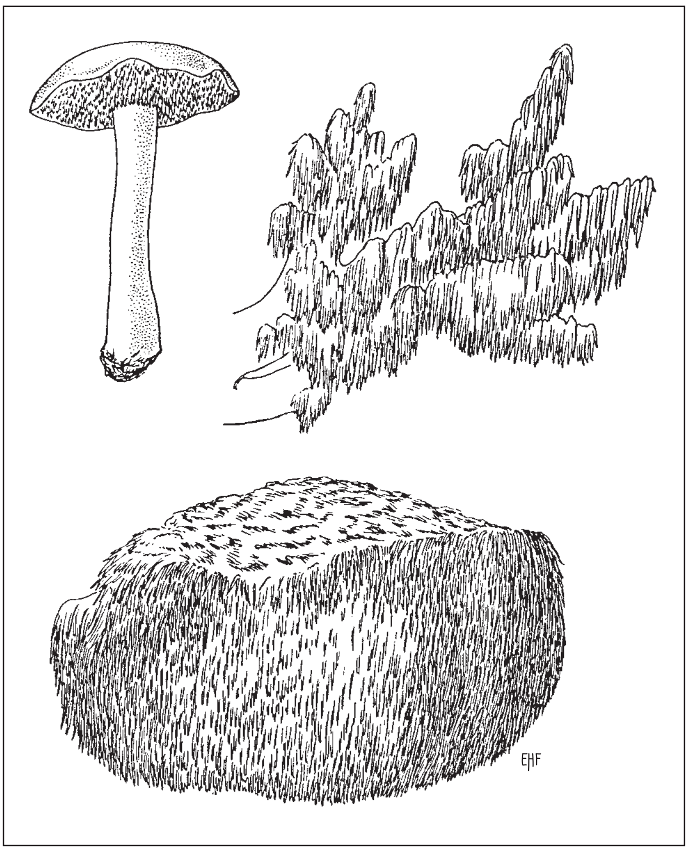


FIG. 7. Different fruiting body forms of tooth fungi

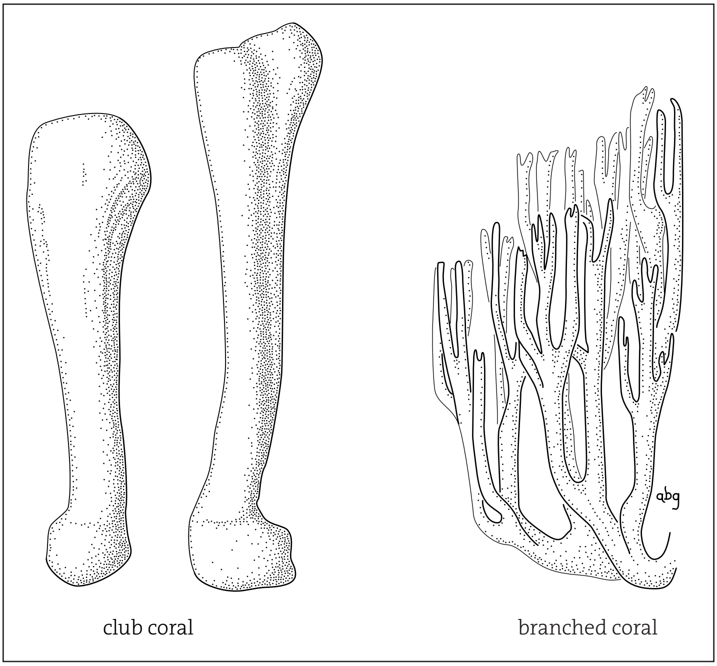
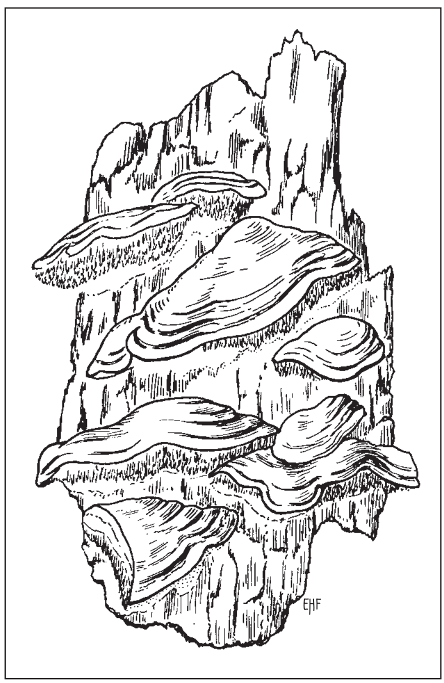


FIG. 8. Coral fungi

FIG. 9. Bracket fungus



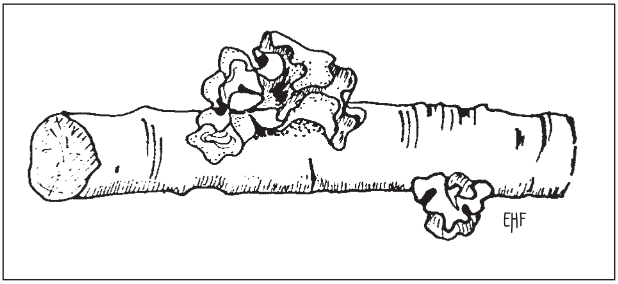


FIG. 10. Jelly fungus

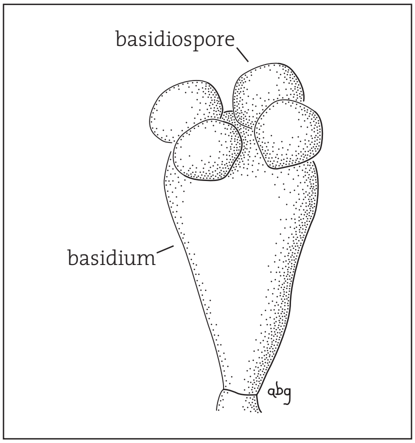
powdery spores. The stalked puffball has a hole at the top of a persistent, flexible cover mounted on a tough stalk. The hard puffball has a comparatively thick, hard cover that breaks irregularly to release the spores.

3. Earthstars (fig. 14) occur on the ground in the woods or on sandy soils. They look like a puffball with a hole at the top through which the dry spores puff out, but they also have an outer layer (peridium) that folds back in starlike segments.
4. Bird's nest fungi (fig. 15) have cup- or goblet-shaped fruiting bodies and usually occur in groups on wood, wood chips, or high-cellulose substrates. Each open bird's nest is 0.5–1 cm in height and contains several lens-shaped eggs, in which the spores are produced.
5. False truffles (fig. 16) have fruiting bodies that typically develop under the soil surface and have a covering that does not break open to release the spores. The basidia and spores of false truffles, as seen microscopically, are borne along veins or hollow to stuffed channels in the interior (gleba) and resemble those of mushrooms and boletes rather than those of the above groups. The basidiospores are attached to basidia by sterigmata (projections from the apex of the basidium) but lack the spore discharge mechanism present in mushrooms and boletes. Mammals and insects attracted by the odors of truffles and false truffles eat them (mycophagy). The spores are released in the dung of these animals or are released as the fruit body decays.

All these types of fungi produce basidiospores on special cells (basidia) that have undergone a particular sequence of events, including meiosis of their nuclei, during development.

Basic Ascomycete Biology

Another large group of fungi is characterized by developing spores (ascospores) inside a special cell (ascus) (fig. 17), with nuclei that have undergone a similar



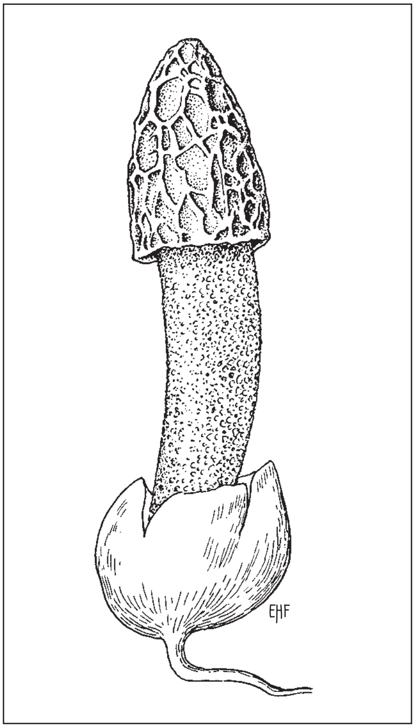


FIG. 11. (Above) Basidium with four sessile basidiospores

FIG. 12. (Right) Stinkhorn fungus

sequence of events during their development. The fruiting bodies of this group of fungi are often small and inconspicuous (less than 1 mm in diameter). Sometimes perithecia (flask-shaped structures that contain asci and ascospores) are grouped in or on a mass of fungal tissue (a stroma) that is macroscopic (fig. 20). The cup fungi, another macroscopic group, have cup- or saucer-shaped fruiting bodies that are somewhat fleshy and sometimes brightly colored (fig. 18). The inner surface is a layer of asci. The morels, false morels, and saddle fungi are stalked cup fungi, with the pitted or folded upper caplike area developing the typical asci (fig. 19). Some of the more common of these fruiting bodies are as follows:

A. Groups in the class Ascomycetes that forcibly discharge ascospores (figs. 18–20)
   1. Cup fungi (fig. 18) are cup- or saucer-shaped structures that are either stalkless or short-stalked; they may be tan, brown, bright red, orange, or yellow. The asci line the inner surface of the cup.
   2. Stalked ascomycete fungi (fig. 19) have fruiting bodies typical of the morels, false morels, saddle fungi, and earth tongues. They have a fleshy stalk

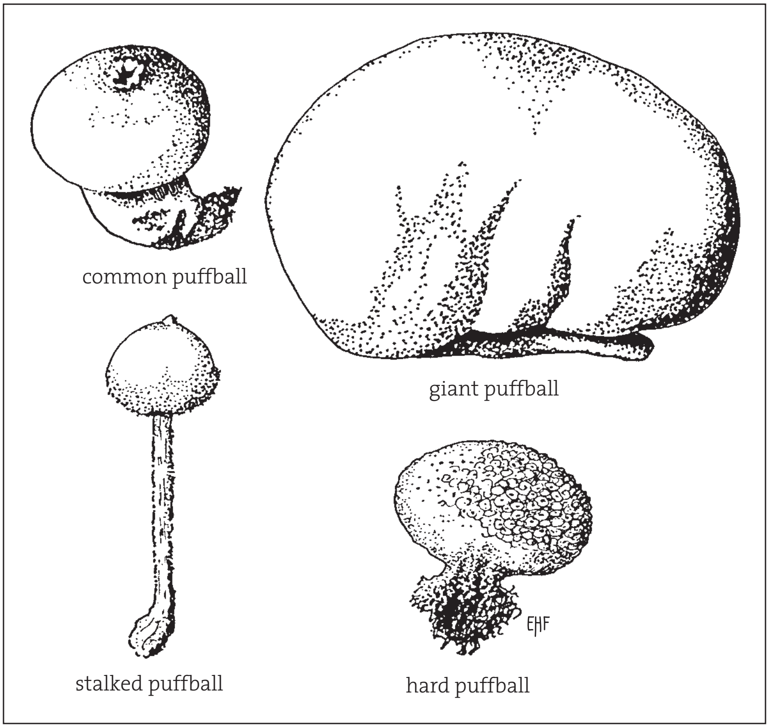


FIG. 13. Puffball fungi

and upper region, which may be spathulate (spoon-shaped or cuplike) or caplike. The enlarged cap may be smooth, pitted, or folded.

3. Perithecial fungi (fig. 20) form more or less flask-shaped fruiting bodies, which are normally very small (less than 1 mm in diameter) and barely visible without the magnification of a hand lens or a dissecting microscope. The ascospores may be forcibly ejected from the asci through an opening at the top of the perithecium. In many species perithecia form singly or are scattered on the substrate, but other types form within a larger fungal mass (the stroma). Stromata may be large and evident, as in dead man's fingers.
4. Pseudothecial fungi are macroscopically very like some perithecial fungi. Their stromata have a cavity or cavities containing asci. They have a different developmental history and different asci, which are evident only microscopically.

B. A group in the class Ascomycetes that does not forcibly discharge ascospores

1. Truffles (fig. 21) are globose to ellipsoidal, often lobed, fleshy fruiting bodies that form under the soil surface but sometimes are visible at the

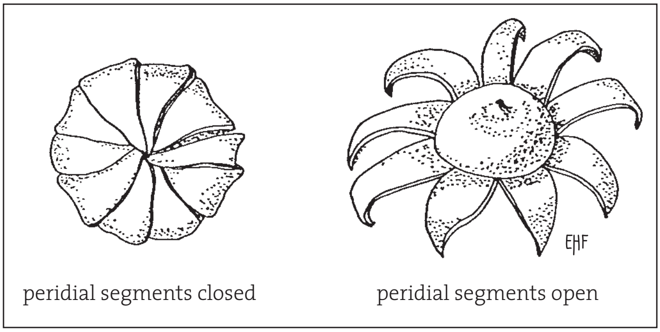


FIG. 14. Earthstar fungus

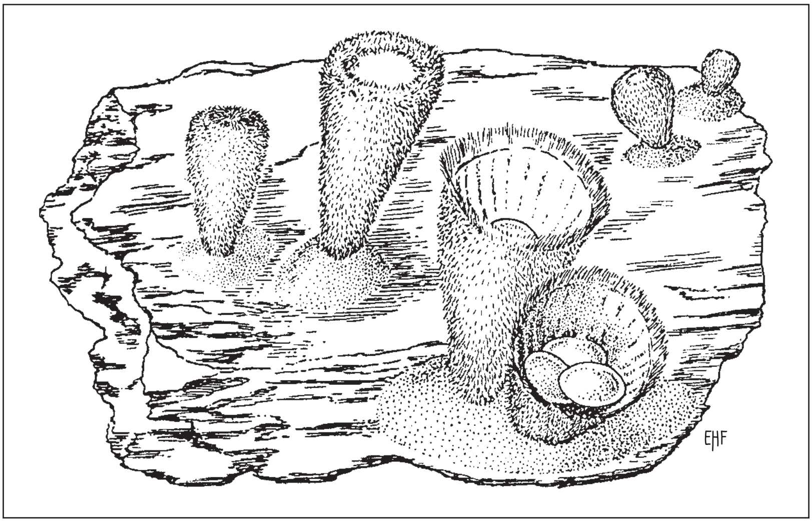


FIG. 15. Bird's nest fungus

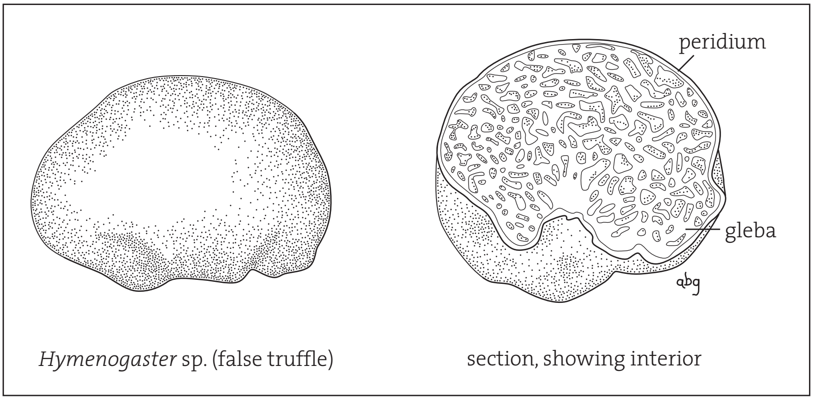


FIG. 16. False truffle

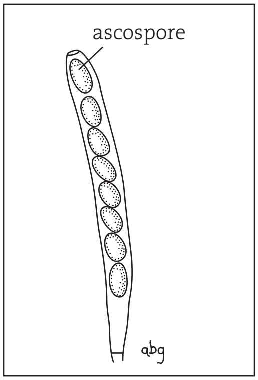
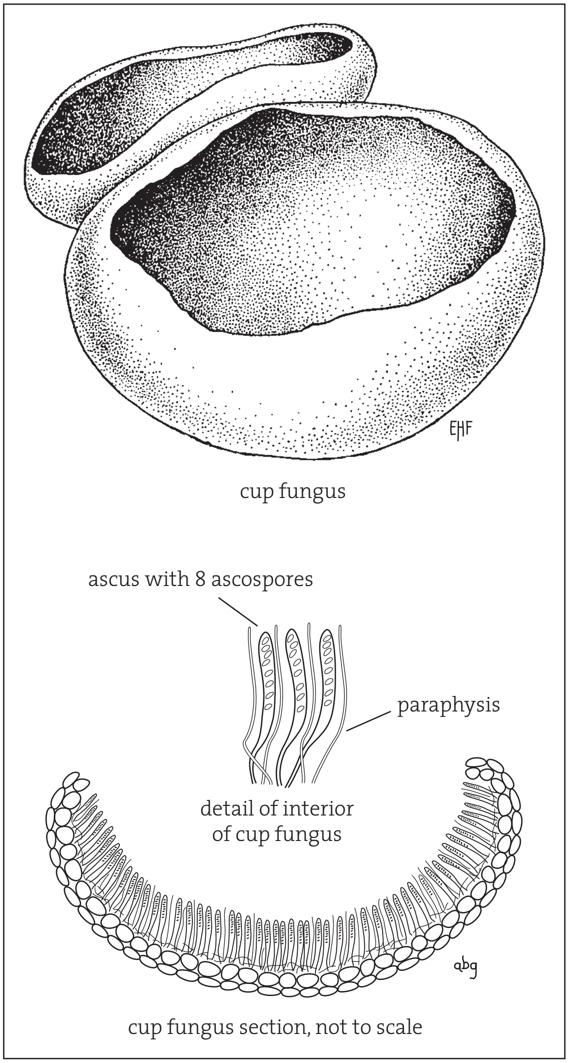


FIG. 17. (Above) Ascus with eight ascospores

FIG. 18. (Right) Cup fungus



surface when mature; they may be various shades of white, black, brown, red, pink, purple, orange, or yellow. The asci line channels within the fruiting body or are formed irregularly within the tissue of the interior. While most ascomycetes have eight spores per ascus, some truffle species have fewer. The spores are dispersed through mycophagy or passively in soil water when the fruiting body breaks down.

A number of these ascomycete fungi are included, because some are edible, some are economically important in wood decomposition or as plant parasites, some are mycorrhizal, and some are simply showy and appealing. Our key to the

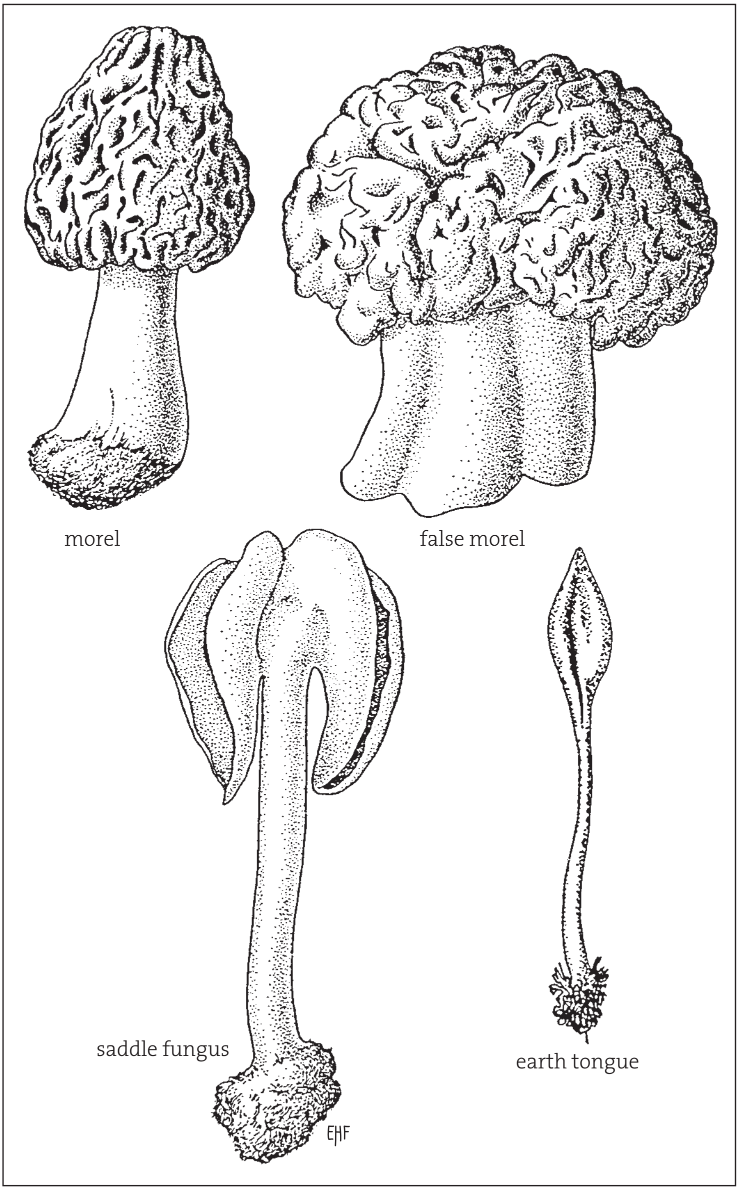


FIG. 19. Stalked ascomycetes

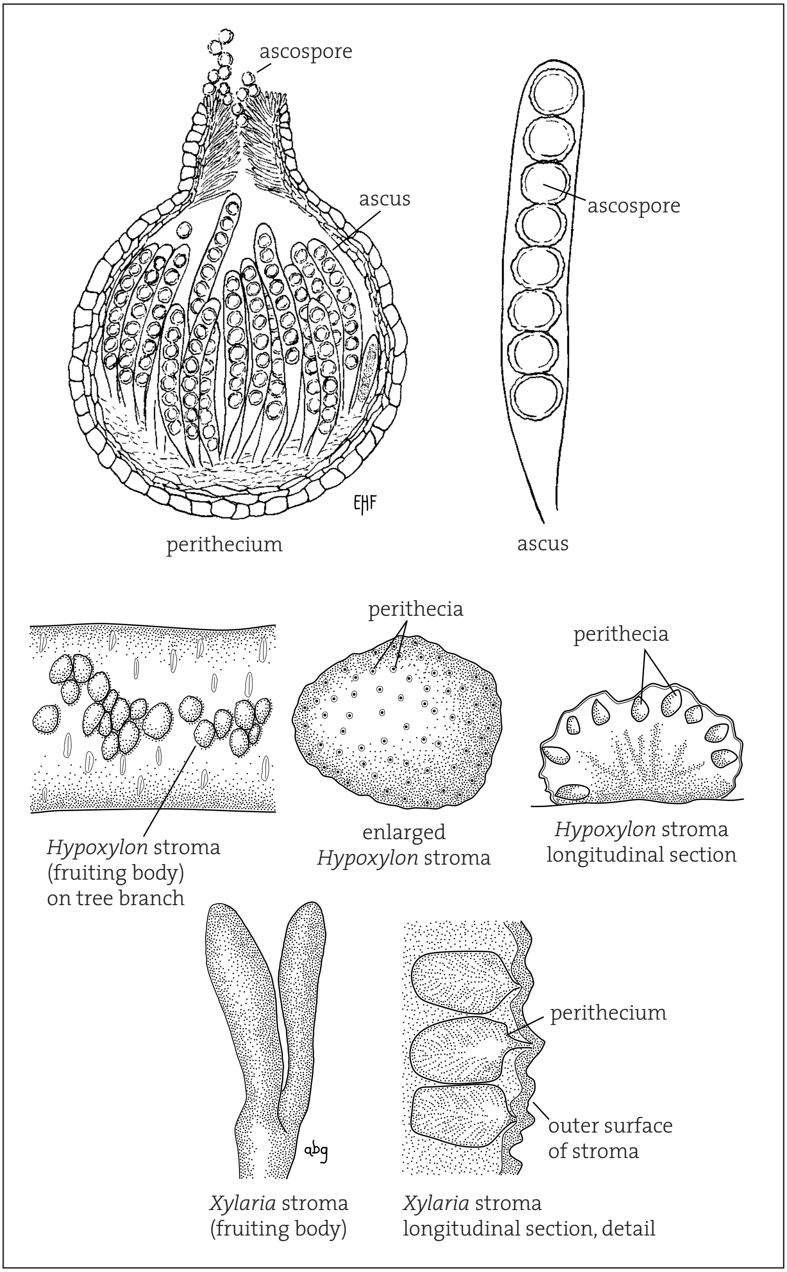


FIG. 20. Perithecial ascomycetes

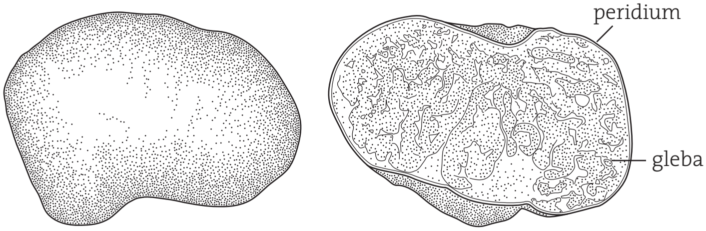


FIG. 21. Truffle

major classes of fungi, Basidiomycetes and Ascomycetes, and the slime molds introduces the groups discussed in this guide.

Naming and Classifying Fungi

Although microscopic examination may be necessary for full identification of some species, good field notes based on careful observation and keys such as those included in this book and other field guides are the tools generally needed for successful identification. Knowing the season during which a fungus usually develops fruiting bodies also may aid in identification and may serve as a guide to species expected at a given time.

Not all mushrooms have common names, and some may have several different common names in various countries or in various regions of one country. Obviously, the use of common names can lead to confusion. For this reason, a scientific or technical name is necessary. Since the time of Carl Linnaeus (an eighteenth-century botanist), each organism has been assigned a two-part name, the genus-species binomial. The binomial is written in Latin to be universally consistent. While genus-species names initially may seem unfamiliar, they are not difficult to learn. The species names often are descriptive of the fungus under consideration. For example, *Agaricus campestris* refers to "the *Agaricus* of the meadows"; the common name is the meadow mushroom, a clue to its habitat. *Russula virescens* means "the *Russula* that becomes green," a reference to the color of the mature cap. Species names are especially important, because most mycological books (including this one) use species epithets as an indexing base. This reinforces familiarity with the species names as the book is used, and the species name is usually retained even if the fungus is placed in a different genus.

The authority (the name of the person who first described the fungus, often abbreviated) usually follows the genus-species name. For example, *Agaricus* *campestris* L.: Fr., tells us that Linnaeus was the first to name this fungus, but Elias Magnus Fries used the same name (in his *Systema Mycologicum* in 1821) for the mushroom that he felt was identical to the one described by Linnaeus. The *Systema Mycologicum* serves as the definitive reference for taxonomic treatment of many fungi. As species are redescribed or transferred to other genera by later workers, several changes in authority may occur. All must be in accordance with the rules of naming set forth in the latest revision of the *International Code of Botanical Nomenclature*. These rules can become complex in application, but that need not concern us here.

Most mycologists currently accept a classification scheme that places fungi in the kingdom Fungi. In a classification scheme, the units are progressively less inclusive: usually several phyla and classes in a kingdom, several orders in a class, several to numerous families in an order, several to numerous genera in a family, and several to numerous species in a genus.

Kingdom: Fungi
Phylum: Basidiomycota, Ascomycota, etc. (names end in -*mycota*)
Class: Basidiomycetes, Ascomycetes, etc. (names end in -*mycetes*)
Order: Agaricales, Aphyllophorales, etc. (names end in -*ales*)
Family: Agaricaceae, Amanitaceae, etc. (names end in -*aceae*)
Genus: *Agaricus*, *Amanita,* etc. (names are capitalized and italicized)
Species: *campestris*, *placomyces,* etc. (names are lowercase and italicized)

Classification schemes are based on the premise that all species in one genus tend to have characteristics in common, in addition to the set of characteristics unique to any given species. Even a given species, however, includes considerable variation in field characteristics. Genetic changes occur in fungi as they do in other organisms. Food, moisture, temperature, and other environmental variables also can affect these characteristics.

A number of species in this edition have had name changes since the previous edition. These changes are a reflection of the dynamic state of fungal systematics. Molecular methods are being used to reanalyze relationships, leading to some surprising interpretations. For example, the inky caps are now hypothesized to be members of four genera, rather than all being species of *Coprinus*. For general ease of use, this field guide includes generally accepted name changes, comments on other name changes under species where appropriate, and otherwise retains the well-known names.

Of the many species of higher fungi in the Midwest, we discuss about 250. While we have tried to illustrate and describe the typical and widespread species, you will inevitably find some that are not included in this book. Several other guides may need to be consulted before a less common mushroom can be satisfactorily identified.

Edibility and Toxicity

When collecting wild mushrooms for food, remember that information about their edibility was most commonly based on trial and error; people got sick or died from eating poisonous specimens. Evaluations of fleshy fungi as edible, suspect, not recommended, and poisonous have accumulated with time. Identification of a particular species therefore becomes very important, though it is not always easy.

Some people believe that all mushrooms are edible and all toadstools are poisonous, although it is unclear how this distinction can be made. The problem of mushroom edibility or toxicity is not that simple. The only reliable method to ensure safe consumption of mushrooms is accurate identification, careful handling and preparation, and tasting a very small portion of the mushroom before ultimately eating that collection. Many fungi contain toxic compounds; the effects range from mild or severe digestive upsets to hallucinogenic reactions and even death. Probably only about 10 percent of the fleshy fungi are desirable edibles, less than 10 percent are toxic or poisonous, and the remainder are not normally eaten because of factors such as their bad taste, texture, or small size. Individual sensitivity and allergic responses to specific mushrooms make it impossible to recommend any mushroom as safe for everyone. Learn to identify mushroom species accurately and eat only identified edible specimens that are in good condition. Up to one-fifth of all mushroom-caused illness may result from eating spoiled specimens of otherwise edible species. Avoid mixing collections and exercise your creativity in cooking rather than in exploring unknown or doubtful species. If you are not completely certain of the identification or the freshness of the mushroom, do not eat it.

Mushrooms in the Midwest that contain toxins are often placed in seven groups by toxicologists.

Group I includes mushrooms containing cyclopeptides (that is, amanitins) that damage kidney and liver tissues; victims have a high mortality rate. The first symptoms occur from six to twenty-four hours after ingestion of the mushroom and include distorted vision, stomach cramps, diarrhea, and vomiting. When these symptoms begin to subside, far more serious events occur, including destruction of liver and then kidney tissue. Death commonly results. In the Midwest, *Amanita bisporigera*, *A. verna,* and *A. virosa* (all deadly), and *Galerina autumnalis*, are part of this group. Some authors now believe that the three *Amanita*s compose a single species. You must learn to recognize the genus *Amanita*. While some species are not toxic, the safest policy is not to eat any species of *Amanita*.

Group II includes mushrooms containing monomethylhydrazine (a component of gyromitrin), which damages liver tissue and has a significant mortality rate. Symptoms occur from one-half to three hours after ingestion of the mushroom and include nausea, vomiting, cramps, and diarrhea along with loss of muscular coordination. Mushrooms suspected of containing toxins in this group include species of *Gyromitra*.

Group III includes mushrooms containing coprine, a toxin that induces nausea, a flushed feeling of the skin, chest pains, and vomiting from one-half to three hours after ingestion but apparently only when alcohol is already in the body or is ingested with the mushroom. *Coprinus atramentarius* is the principal species involved in the Midwest, but *C. variegatus* and *C. micaceus* may also produce this reaction.

Group IV includes mushrooms containing muscarine, which (like the species in Group III) affect the autonomic nervous system. Perspiration, abdominal cramps, salivation, and lacrimation appear within one-half to three hours after ingestion, sometimes accompanied by a reduction of the pulse rate and lowering of blood pressure to critical levels. Death may occur, depending on the quantity eaten and the size of the victim; children are more vulnerable than adults. Species in this group include *Amanita muscaria, Boletus luridus,* and *Inocybe fastigiata*.

Group V includes mushrooms containing mucimol or ibotinic acid, two closely related toxins that may cause loss of coordination, confusion, dizziness, vomiting, and convulsions within one-half to three hours after ingestion. Symptoms are quite variable from person to person, and mortality rates are less than 1 percent. *Amanita muscaria* and *A. pantherina* are two of the species involved in this group.

Group VI includes mushrooms containing psilocybin or psilocin, two related toxins that may cause hallucinations, headaches, fever, twitching, convulsions, vomiting, and severe dysphoria occurring from one-half to three hours after ingestion; mortality rates are less than 1 percent (one person is reported to have died from eating *Psilocybe cubensis* in the 1980s). This group of mushrooms is used recreationally and used in rituals by some Mexican Indians.

Group VII includes mushrooms with a wide variety of gastrointestinal toxins that produce symptoms of nausea, vomiting, diarrhea, and headaches within a few hours of ingestion. We do not have mortality rates for this group, due to the diverse types of toxins and mushrooms involved. A sampling of midwestern species includes *Boletus luridus, Chlorophyllum molybdites*, *Gymnopus dryophilus, Lactarius piperatus* and *L. torminosus*, *Omphalotus illudens, Ramaria formosa,* and *Russula emetica*.

Mushrooms may have diverse effects. Sometimes individuals are seriously affected (possibly due to an allergic response), while others who eat the same species at the same meal show no effects. The subject of the edibility of mushrooms and the possibility of poisoning is very complex.

1. Individual mushrooms within a species may vary in toxin content.
2. Geographical location may be a variable; that is, a mushroom species may

be toxic in the eastern United States, while another variety of the same species collected in the Pacific Northwest apparently can be eaten safely.

3. Mushrooms reproduce sexually, and genetic differences between individual strains may result in varying amounts of toxins.
4. The effects produced by toxins vary from person to person.
5. Other foods or substances (such as alcohol) consumed with mushrooms may enhance toxicity.
6. Often a very poisonous mushroom such as *Amanita bisporigera* very closely resembles an edible mushroom. One such mistake may be fatal.
7. Cooking may reduce the toxin content. Raw toxic mushrooms are probably more dangerous than cooked ones.

No book or brief discussion can assure people that they will or will not be affected by any given mushroom. Each person must respect the potent diversity of mushrooms. The best advice is to follow these rules:

1. Identify mushrooms carefully by using good mushroom guides with accurate keys. Be absolutely certain of the identity of the mushrooms you eat.
2. Do not eat *Amanita* species.
3. Eat only a small amount of a mushroom species the first few times you eat it. Do not eat too much at any one time. Some mushrooms can be eaten in smaller quantities but may be toxic in larger quantities.
4. Consider possible allergic reactions; mushrooms may sensitize a person, so the next meal might result in serious problems.
5. Recent evidence has raised concern that mushrooms from lawns sprayed with pesticides may have been sprayed or may have taken up the pesticide from the underground mycelium. Edible mushrooms from the sides of well-traveled roads may also be a problem, because the soil there may contain heavy metals or other toxic residues rain-washed from the road into the soil. Fungi may possibly take up some of these compounds, which may be translocated to the fruiting bodies. It is worth considering the old axiom “Better safe than sorry.”

Preferences for edible mushrooms are a matter of personal judgment, but mushroom fanciers generally agree that some flavors and textures are more desirable than others. Choice edible mushrooms such as the chanterelles, morels, and king boletes head the list of favorites. Other terms (good edible, edible, inedible, edibility unknown, not recommended, and poisonous) are self-explanatory and are based on accumulated and published information.

Mushroom Habitats

The mushroom hunter should be aware of habitats, for fungi grow effectively only where the food that they can use is available. The particular plant species found in an area, the association of plants (a prairie, an upland deciduous forest, a floodplain, a grove of planted pines), the soil and other geological factors, rainfall patterns, and the season may influence not only the survival of a particular fungus species but also the production of fruiting bodies by that fungus in any given year.

Mushroom collectors use their knowledge of fruiting seasons and habitats when hunting fungi. Some fungi have a short, rather well defined fruiting time each year; other species have a longer, less definite fruiting time; and some can be sought and found anytime from spring through fall.

The method of obtaining food and nutrients for survival and reproduction delimits the various habitats of fungi. Some fungi, including many mushrooms, are saprobes: they obtain the energy that they need to grow only from the digestion of decaying organic matter. The enzymes that a particular fungus can produce determine the organic compounds that can be utilized. A given fungus may be able to utilize only a few, or perhaps only one, of the organic compounds available, while another fungus may utilize another compound or group of compounds. A particular substrate may thus support the growth of several fungi simultaneously or in sequence. As each fungus species accumulates enough food reserves under appropriate environmental conditions, it forms its characteristic spore-producing structures (mushroom, cup, branched coral, puffball, etc.).

Other fungi are parasites and get their food from living plant or animal hosts at the expense of the host. These parasitic fungi vary widely in their methods of establishing food relationships: they may produce toxic compounds that kill living cells, which are then used for food; they may establish special arrangements with living cells that enable the fungus to obtain food directly from the host cells without killing them; or they may live and develop only in particular kinds of cells in the plant, such as the water-conducting cells in the veins.

Other fungi establish a special relationship with the roots of living plants (a mycorrhiza) in which both the host plant and the fungus are mutually benefited. The fungus grows between or within the root cells and into the surrounding soil; the form of the root may or may not be changed. The fungus utilizes materials in the root cells, and the fungal filaments enhance absorption of mineral nutrients from the soil. These symbiotic mycorrhizal relationships can be so specific that in some instances a fungus can live only in association with one species of vascular plant, or a species of plant can thrive only in association with a specific fungus. In other instances, however, fungi may establish successful mycorrhizal relationships with several vascular plant species or even a broad range of them.

The following outline summarizes the general habitat and fruiting time of some very common fungi discussed in this book.

I. On the ground in woods

A. Spring

1. Morels: *Morchella* spp.
2. False morels: *Gyromitra* spp., *Verpa* spp.

B. Summer

1. Mushrooms: *Amanita* spp., *Clitocybe* spp., *Cortinarius* spp., *Entoloma* spp., *Laccaria laccata*, *Lactarius* spp., *Russula* spp., *Xerula megalospora*
2. Boletes: *Boletus edulis*, *Gyroporus purpurinus*, *Strobilomyces floccopus*, *Tylopilus felleus*
3. Saddle fungi: *Helvella crispa, H. elastica*
4. Cup fungi: *Peziza succosa*
5. Corals: *Clavaria* spp., *Ramaria* spp.
6. Other species: *Cantharellus cibarius, Craterellus fallax, Hydnum repandum, Tremellodendron* spp.

C. Fall

1. Mushrooms: many of above-mentioned summer genera as well as *Hygrophorus* spp., *Tricholoma* spp.
2. Boletes: *Boletus edulis, Strobilomyces floccopus*, *Suillus* spp., *Tylopilus felleus*
3. Puffballs: *Calvatia* spp., *Lycoperdon* spp.

II. On the ground in woods but attached to buried plant parts such as sticks

A. Spring: *Sarcoscypha dudleyi, Urnula craterium*

B. Summer: *Galiella rufa*, *Microstoma floccosum, Sarcoscypha occidentalis*

C. Late fall: *Sarcoscypha dudleyi*

III. On downed wood such as logs, twigs, and branches on the ground in woods

A. Spring

1. Mushrooms: *Flammulina velutipes, Pleurotus ostreatus*
2. Poroid fungi: *Polyporus alveolaris*, *P. arcularius*, *P. squamosus*

B. Summer

1. Mushrooms: *Coprinus variegatus, Crepidotus* spp., *Marasmius rotula*, *Mycena* spp., *Pholiota* spp., *Phyllotopsis nidulans*, *Pleurotus ostreatus*, *Pluteus cervinus*
2. Coral fungi: *Clavicorona pyxidata*, *Ramaria stricta*
3. Jelly fungi: *Auricularia auricula, Tremella* spp.
4. Bird's nest fungi: *Crucibulum laeve, Cyathus striatus*
5. Cup fungi: *Peziza repanda*, *Scutellinia scutellata*
6. Other species: *Laetiporus sulphureus*, *Schizophyllum commune*

7. Slime molds: *Fuligo* or *Mucilago* spp., *Lycogola epidendrum, Physarum* spp., *Stemonitis* spp.

C. Fall

1. Mushrooms: *Panellus serotinus, Pholiota* spp., *Pleurotus ostreatus*, *Pluteus cervinus*
2. Miscellaneous others: *Bisporella citrina, Hericium coralloides, H. erinaceus*, *Ischnoderma resinosum, Laetiporus sulphureus*, *Polyporus badius, Schizophyllum commune, Stereum* spp., *Trametes* spp.

IV. Around or on stumps or where roots of stumps are decomposing in the ground

A. Summer: *Coprinus atramentarius, C. micaceus*, *Geastrum triplex, Phallus hadriani, Pluteus cervinus*

B. Fall: *Armillaria mellea*, *Laetiporus sulphureus, Omphalotus illudens, Pluteus cervinus*

V. Standing dead trees

A. Spring and fall: *Flammulina velutipes, Fomes* spp., *Pleurotus ostreatus*, *Polyporus* spp.

VI. Living trees

A. Summer: *Fomes* spp., *Laetiporus sulphureus, Volvariella bombycina*

B. Fall: *Fomes* spp., *Grifola frondosa*, *Hypsizygus ulmarius*

VII. Pastures and lawns

A. Summer

1. Associated with various dead organic materials in soil: *Agaricus campestris, Chlorophyllum molybdites, Coprinus comatus, Leucoagaricus naucinus*, *Marasmius oreades*, *Psathyrella candolleana*
2. Associated with dead or dying tree roots in soil: *Coprinus atramentarius*, *C. micaceus*, *Phallus hadriani*

B. Fall: *Calvatia* spp., *Chlorophyllum molybdites, Coprinus comatus*, *Lycoperdon* spp., *Scleroderma polyrhizum*

VIII. Parasitic on other fungi

A. Summer and fall

1. On mushrooms: *Asterophora lycoperdoides, Hypomyces lactifluorum* on *Russula* and *Lactarius* spp.; *Hypomyces hyalinus* on *Amanita* spp.; *Hypomyces tremellicola* on *Crepidotus* spp.; *Spinellus fusiger* on *Mycena* spp.; *Syzygospora mycetophila* on *Gymnopus dryophilus*
2. On jelly fungi: *Hypomyces rosellus*
3. On boletes: *Hypomyces* spp., *Sepedonium* spp.
4. On old poroid Aphyllophorales brackets: *Hypomyces* spp.
5. On cup fungi and saddle fungi: *Mycogone* spp.

Eastern deciduous forest characterizes the woodland habitats of the Midcontinental United States. These woodlands are found mainly along rivers and their tributaries. The dry upland woodland canopy is dominated by white oaks, bur oaks, and hickories, with ironwood and young canopy trees dominating the understory. Gooseberry, prickly ash, viburnum, coralberry, and hazelnut predominate in the shrub layer. The cooler, wetter slopes are dominated by maples, basswood, and red oaks, with American hornbeam, alternate-leaved dogwood, and young canopy trees dominating the understory. Lowland floodplain forest canopies include cottonwood, ash, hackberry, silver maple, and boxelder perdominantly. While American elm was at one time a canopy species in all of these habitats, Dutch Elm disease has altered that. Still, elm species are part of the understory, and their downed wood provides a substantial amount of substrate for fungal saprobes. Spring ephemerals carpet the ground from April to May but die back in summer and are overgrown by ferns, Virginia creeper, and poison ivy. In moister habitats during summer there are thick stands of nettles. A forest type not associated with waterways in the Midwest is the savanna, which is dominated by white and bur oaks, with an herbaceous understory of prairie plants. Disturbance tree species such as red cedar (juniper) and honey locust colonize many of the grazed woodlands and unburned hill prairies. Eastern white pine, the only native pine in Iowa, occurs primarily in northeastern Iowa along the Mississippi River. However, a number of woodlands and state forests were planted with non-native conifers, which were used extensively in commercial and private landscaping where they support mycorrhizal fungi not found elsewhere.

We include field characteristics, habitat, spore measurement (normal range of length × width, with rare extensions in parentheses), pore size (number of pores per mm) in boletes and polypores, and spore print color as factors that determine species; ordinarily these features effectively identify the fungus. Additional microscopic observations of value for the professional mycologist but not included here are the morphology, size, and content of cystidia (distinctively shaped sterile cells); the morphology, size, and content of the cap cells; the presence of clamps; and various other microscopic details. Chemical tests such as those to identify oil deposits and color changes in response to specific chemical solutions may be useful. For example, Melzer's solution (see the glossary for the formulation) is a commonly used reagent that permits a distinction between amyloid (blue-staining compounds), nonamyloid, and dextrinoid (reddish brown–staining compounds) deposits in spores or hyphae. Other chemical tests may be found in several of the books listed in the general references. These additional tests are discussed in many of the more technical books and technical articles dealing with mushrooms.

Keys

While keys may look unfamiliar and formidable, it is quite easy to learn to use them. Each numbered couplet in the key (for example, 1a and 1b) is a set of alternative descriptions, usually an either/or choice based on a macroscopic or field characteristic. Each choice also includes a number that leads to another set of alternatives for consideration. You proceed through the key by choosing alternatives that describe the features found in the fungus in question until you reach a name, a page number, or both, directing you to the general description.

The following key will lead you to the major groups of fungi included in this guide. Where only one species is included, the key is for that species. The sections on mushrooms and boletes include supplemental keys to the genera in addition to the keys to the species within each family discussed. Each of the subsequent sections contains a key to the genera and species, except where so few species are discussed that a key is not necessary. Many mushrooms are not included in these keys or in this book; thus you may come to a dead end. A more serious problem could be the misidentification of a fungus that is not included here. This problem has no satisfactory solution if you use only this guide.

Key to Major Groups of Fungi Included in This Guide

A. Fruiting body producing asci or basidia that actively release spores into the air; a spore print can be made

- 1a. Fruiting body fleshy; cap with thin gills (plates of tissue) on lower surface; usually with stalk: Agaricales (mushrooms), 2
- 1b. Fruiting bodies of various textures; lacking thin gills: 14
- 2a. Spore print white to cream or green: 3
- 2b. Spore print other than white, cream, or green: 7
- 3a. Gills entirely free from stalk: 4
- 3b. Gills partly or entirely attached to stalk: 5
- 4a. Volva present at base of stalk: Amanitaceae, page 43
- 4b. Volva not present at base of stalk: Lepiotaceae, page 86
- 5a. Gills thick and fleshy, waxy when rubbed: Hygrophoraceae, page 79; see also Tricholomataceae (*Laccaria*), page 137
- 5b. Gills thin or thick but never waxy: 6
- 6a. Cap flesh brittle, with or without latex: Russulaceae, page 99
- 6b. Cap flesh firm, soft, tough (not brittle), without latex: Tricholomataceae, page 124

7a. Spore print salmon to pink: 8
7b. Spore print neither pink nor salmon: 9
8a. Gills free; volva present or not; growing on wood or on the ground from soil: Pluteaceae, page 94
8b. Gills attached; volva absent; growing on the ground from soil: Entolomataceae, page 74
9a. Spore print smoky gray to black: 10
9b. Spore print other than gray or black: 11
10a. Gills thick, somewhat fleshy, extending along stalk (decurrent); on the ground near or under conifers: Gomphidiaceae, page 78
10b. Gills thin, often breaking down into inky mass, not decurrent; on wood buried in the ground or on rotting wood: Coprinaceae, page 58
11a. Spore print purple-brown to chocolate brown: 12
11b. Spore print other than purple-brown or chocolate brown: 13
12a. Spores usually purple-brown; gills white to tan when young, attached to stalk: Strophariaceae, page 118
12b. Spores usually chocolate brown; gills gray, sometimes white or pink when young, free from stalk: Agaricaceae, page 37
13a. Spores bright yellow to clay-brown; gills usually free: Bolbitiaceae, page 55
13b. Spores rust-brown to cinnamon-brown; gills attached: Cortinariaceae, page 67
14a. Fruiting body caplike with stalk or bracketlike; lower surface with a layer of tubes opening as pores or with a smooth surface or a layer of spines: 15
14b. Fruiting body variously shaped; lower surface without tubes or spines: 17
15a. Fruiting body with conical or jagged spines on lower surface: spiny Aphyllophorales, page 223
15b. Fruiting body with tube layer on lower surface: 16
16a. Fruiting body a soft and fleshy cap; usually with central stalk; on the ground associated with live trees, usually mycorrhizal: Boletales (boletes), page 159
16b. Fruiting body seldom soft and fleshy, usually tough, corky, or woody, often bracketlike and broadly attached; occasionally with stalk; directly attached to living or dead trees: poroid Aphyllophorales, page 187
17a. Visible fungus structures developed on diseased living plants: plant parasitic fungi, page 327
17b. Fruiting bodies of various sizes and textures; not directly associated with living plants, usually on the ground or with dead plant parts: 18
18a. Fruiting bodies with a stalk and a differently shaped upper portion: 19
18b. Fruiting bodies lacking a definitely different stalk: 28
19a. Fruiting bodies fleshy: 20

19b. Fruiting bodies tough, fleshy to leathery to hard: 25

20a. Fruiting bodies many-branched, branches usually upright, single or in small clusters; on the ground in woods or on rotting logs: clavarioid Aphyllophorales (branched corals), page 180

20b. Fruiting bodies not branched, single, or in groups; on the ground or parasitic: 21

21a. Fruiting bodies with a cap and stalk (mushroomlike); lower surfaces with broad ridges extending along the stalk or smooth: 22

21b. Fruiting bodies with a differently shaped upper area: 23

22a. Fruiting bodies firm, often irregular in shape, bright orange, becoming water-soaked and reddish purple with age; covered with slightly raised, rounded areas with central water-soaked dots: mushrooms parasitized by *Hypomyces lactifluorum*, page 323

22b. Fruiting bodies that do not undergo such color change with age; lower surface smooth or with broad ridges extending along the stalk: cantharelloid Aphyllophorales (chanterelles and associates), page 176

23a. Fruiting bodies with a pitted spongelike upper portion or convoluted apical region or saddle-shaped area: Cup fungi, page 268

23b. Fruiting bodies with a clublike upper area: 24

24a. Fruiting body growing from a parasitized insect pupa or larva buried in soil or in a rotting log: *Cordyceps* spp., page 318

24b. Fruiting body not associated with a juvenile insect stage: clavarioid Aphyllophorales (single corals), page 180

25a. Fruiting bodies hard, club-shaped, single or with few branches; solid white central region covered by black rind; associated with wood: *Xylaria polymorpha* (dead man's fingers), page 325

25b. Fruiting bodies leathery to tough-fleshy; many-branched, on the ground: 26

26a. Fruiting body tough-fleshy (gelatinous when old); branches hollow, rounded: *Tremella reticulata,* page 265

26b. Fruiting bodies leathery; branches solid, flattened: 27

27a. Fruiting bodies light-colored, sometimes overgrown by green algae; in groups on the ground in woods: *Tremellodendron* spp., page 265

27b. Fruiting bodies purple-brown; tips of young branches whitish to gray; on the ground: *Thelephora* spp., page 265

28a. Fruiting bodies thin leathery brackets, broadly attached, often in overlapping clusters; lower surface smooth; on wood: smooth Aphyllophorales (*Stereum* spp.), page 217

28b. Fruiting bodies not as above: 29

29a. Fruiting bodies black, hard and carbonous, rounded to flattened; on downed wood or occasionally on standing trees: *Hypoxylon* spp., page 325, or *Daldinia concentrica*, page 321

29b. Fruiting bodies at least somewhat fleshy, not carbonous: 30

30a. Fruiting bodies flat, of indefinite size, light or bright yellow; attached firmly on downed wood: *Hypocrea sulphurea,* page 321

30b. Fruiting bodies upright, lobed, or cup- or saucer-shaped; on wood or on the ground: 31

31a. Fruiting bodies firm-gelatinous, sometimes becoming hard and brittle when dry and becoming firm-gelatinous when remoistened: jelly fungi, page 257

31b. Fruiting bodies dry to fleshy: 32

32a. Fruiting bodies fleshy to somewhat fleshy, cup- or saucer-shaped, with or without a stalk: cup fungi, page 268

32b. Fruiting bodies tough, with longitudinally split gill-like structures on the lower surface, drying then reviving when moistened: schizophylloid Aphyllophorales, *Schizophyllum commune*, page 216

B. Fruiting bodies producing spores which are not actively discharged, often dry and powdery in covered masses or in slimy exposed masses

1a. Fruiting bodies fleshy with slimy, stinking spore masses over apical portion: Gasteromycetes (stinkhorns), page 229

1b. Fruiting bodies fleshy or dry when mature, spore mass not slimy and stinking: 2

2a. Fruiting bodies small, tough, cylindrical to goblet-shaped, nestlike, containing a number of lens-shaped eggs; spores inside the eggs are released only when the outer covering decays or breaks: Gasteromycetes (bird's nest fungi), page 229

2b. Fruiting bodies with one or two covering layers, opening in various ways, or a cover layer that eventually disintegrates: 3

3a. Fruiting bodies either 1–6 cm in diameter, single or in small groups, or very small, 1–3 mm in diameter, with many in an area; cover usually soon breaking and releasing powdery spores: Myxomycetes (slime molds), page 335 (not fungi but resemble some fungi and fruit in similar areas, such as leaf litter and very rotten logs)

3b. Fruiting bodies larger, cover layer remaining unbroken or opening in various ways: 4

4a. Fruiting body covering with one or two layers, breaking randomly or by an apical pore or outer covering breaking and folding back in starlike lobes, typically above the ground at maturity: Gasteromycetes (puffballs, giant puffballs, earthstars, hard puffballs), page 229

4b. Fruiting bodies not breaking open, typically developing in the upper soil layer or at the interface of soil and litter layers: truffles (ascomycetous truffles, basidiomycetous truffles), page 297

Mushrooms

(Agaricales)

The mushrooms are a group of fleshy fungi that have gills on the lower surface of the cap. The gills are thin plates of tissue lined on both sides with basidia (fig. 4). Details of their basic structure and development are presented in the introduction. While common usage of the term "mushroom" may include other fleshy fungus fruiting bodies, such as those of morels, tooth fungi, and sometimes even puffballs, we are using the term in the more limited, technical interpretation.

Another confusing term used for fungus fruiting bodies is "toadstool." Originally intended to indicate mushrooms that are inedible, toxic, or poisonous, this term cannot be used with precision. We cannot describe such a group as distinct from mushrooms in general either technically or based on field information.

Key to the Genera of Mushrooms Included in This Guide

1a. Fruiting body attached directly to another mushroom species, parasitic; cap becoming a powdery mass of spores: *Asterophora*, page 129
1b. Fruiting body not attached directly to another mushroom species, not parasitic: 2
2a. Fruiting body shelflike, broadly laterally attached or attached by a short central or lateral stalk, often central in *Rhodotus palmatus* and *Hypsizygus ulmarius*; on wood: 3
2b. Fruiting body not shelflike, stalk attached centrally or off-center: 8
3a. Spore deposit white to pale yellowish or pale lilac: 4
3b. Spore deposit pink or brown: 6
4a. Gill edges serrate (sawtoothed): *Lentinellus*, page 139
4b. Gill edges smooth: 5
5a. Fruiting body tough, reviving when moistened after drying: *Lentinus*, page 141
5b. Fruiting body somewhat tough to soft, not reviving when moistened: *Pleurotus*, page 153, or *Resupinatus*, page 155
6a. Spore deposit yellow-brown to brown: *Crepidotus,* page 71
6b. Spore deposit pink: 7
7a. Fruiting body sessile, hairy; gills bright orange: *Phyllotopsis,* page 153
7b. Fruiting body usually with a short lateral stalk, sometimes sessile or stalk central; upper cap surface strongly wrinkled, pinkish: *Rhodotus*, page 157
8a. Gills dissolve as fruiting body matures; spores black: *Coprinus*, page 59
8b. Gills remain as definite structures as fruiting body matures; spores variously colored: 9
9a. Fruiting body with a universal veil that is retained as a volva at maturity and/or with a partial veil that becomes a ring or annulus at maturity: 10
9b. Fruiting body lacking these structures: 20
10a. Volva present, gills free: 11
10b. Volva lacking, gills free or attached: 12

11a. Spore deposit white; ring present: *Amanita,* page 44
11b. Spore deposit pink to dingy pink; ring lacking: *Volvariella*, page 97
12a. Annulus conspicuous, usually persistent at maturity, gills free: 13
12b. Annulus present or lacking, often not conspicuous at maturity, gills attached: 15
13a. Spore deposit green: *Chlorophyllum*, page 87
13b. Spore deposit not green: 14
14a. Spore deposit white: *Lepiota,* page 86, or *Leucoagaricus,* page 86
14b. Spore deposit purple-brown to blackish brown: *Agaricus,* page 37
15a. Spore deposit white: *Armillaria,* page 126
15b. Spore deposit colored: 16
16a. Spore deposit yellowish clay to rusty brown: 17
16b. Spore deposit blackish, violaceous (with a violet hue) brown to chocolate brown: 18
17a. Partial veil cobwebby on young fruiting bodies, with remnants visible for a while on stalk; typically on the ground in woods: *Cortinarius*, page 69
17b. Partial veil remains as annulus, usually well-developed and/or stalk scaly; cap scaly or smooth, typically on wood: *Pholiota*, page 121, or *Galerina*, page 71
18a. Gills decurrent; on the ground under or near conifers: *Gomphidius,* page 78
18b. Gills attached but not decurrent: 19
19a. Annulus persistent, often not conspicuous at maturity: *Stropharia,* page 123
19b. Annulus lacking or not conspicuous at maturity: *Psathyrella,* page 65
20a. Gills thick, waxy: 21
20b. Gills thin, not waxy: 22
21a. Gills flesh color to purple; spore deposit white or pale lilac; spores spiny: *Laccaria*, page 137
21b. Gills white, occasionally yellowish or orange; spore deposit white; spores smooth: *Hygrophorus,* page 79
22a. Cap and gills brittle, crumble easily; on the ground in woods or near trees: 23
22b. Cap and gills firm, do not crumble; on the ground, on wood, or in litter: 24
23a. Freshly cut fruiting body exudes a colored or colorless liquid (may be difficult to obtain from old fruiting bodies): *Lactarius,* page 99
23b. Freshly cut fruiting body does not exude a liquid: *Russula*, page 100
24a. Fruiting bodies on or associated with wood: 25
24b. Fruiting bodies on the ground on various kinds of organic debris: 31
25a. Spore deposit white: 26
25b. Spore deposit colored: 35
26a. Cap margin straight; cap usually bell-shaped: *Mycena*, page 147

26b. Cap margin incurved when young, expanding with age: 27
27a. Stalk velvety, dark brown at maturity; typically in clusters: *Flammulina*, page 133
27b. Stalks not velvety, single or in clusters: 28
28a. Gills adnexed, fruiting bodies single or scattered, on downed wood, cap streaked with darker gray or brown fibrils (fine hairlike strands of hyphae embedded in cap): *Megacollybia*, page 145
28b. Gills adnate or decurrent, fruiting bodies scattered or clustered; on wood, lacking darker fibrils: 29
29a. Gills adnate, fruiting bodies in knot or wound areas on living standing or downed trees: *Hypsizygus*, page 135
29b. Gills decurrent: 30
30a. Fruiting bodies clustered, orange, on or near wood on the ground: *Omphalotus*, page 151
30b. Fruiting bodies single or scattered, cap grayish brown to buff, gills widely spaced: *Omphalina*, page 149
31a. Stalk with a rooting base (dig out carefully): *Xerula*, page 158
31b. Stalk lacking such a base: 32
32a. Stalk black and wiry or yellow-brown and tough; fruiting bodies reviving when moistened: *Marasmius*, page 143
32b. Stalks not wiry; fruiting bodies decaying with age, not reviving: 33
33a. Gills decurrent: *Clitocybe*, page 131
33b. Gills attached broadly or narrowly to stalk: 34
34a. Cap margin inrolled when young; cap flesh very thin; stalk tough: *Gymnopus,* page 135
34b. Cap margin straight; stalk thick and fleshy: *Tricholoma*, page 157
35a. Spore deposit pinkish: 36
35b. Spore deposit brown: 38
36a. Gills free: *Pluteus*, page 94
36b. Gills attached: 37
37a. Gills decurrent: *Clitopilus,* page 75
37b. Gills adnate or adnexed, not decurrent: *Entoloma*, page 77
38a. Fruiting bodies clustered, on wood: *Hypholoma*, page 119
38b. Fruiting bodies solitary to scattered, on wood or on the ground: 39
39a. Spore deposit bright yellow-brown to clay-brown; gills free or nearly so: *Conocybe*, page 57
39b. Spore deposit rusty brown, purple-brown, or black; gills attached: 40
40a. Spore deposit purple-brown to black: 41
40b. Spore deposit rusty brown to cinnamon-brown: 42
41a. Cap narrowly conic; stalk thin: *Panaeolus foenisecii*, page 65
41b. Cap campanulate (bell-shaped) to convex: *Psathyrella*, page 65, or *Psilocybe*, page 123

42a. Cap conic to bell-shaped, silky fibrillose (surface covered with silklike fibers), usually small (3 cm diameter or less): *Inocybe*, page 73
42b. Cap usually convex with a cobwebby veil when young, many species large (3 cm diameter or more): *Cortinarius*, page 69

Agaricaceae

Mushrooms in this family are usually fleshy, with rounded to flattened caps ranging from white to brown or gray-brown. Cap surface is smooth to scaly, with flesh normally white to pink, sometimes changing color when cut or bruised.

Gills are free, white to gray, or pink to dull chocolate brown to purple-brown.

Stalks are relatively thick, always with a prominent annulus, either single or double. Stalk is usually smooth above the annulus, often hairy to scaly below.

Spores are purplish brown to dark brown, elliptical, smooth, with an apical pore; spore print is dark chocolate brown to purplish brown.

These species occur in a number of habitats, including lawns and pastures, humus and litter in hardwood and conifer forests, and manured areas. They often resemble the white *Amanita*s in early development, so it is important to examine the mature mushroom.

Many of the species of this group are prized edible mushrooms, but gastrointestinal upsets have been reported, particularly for the woodland species of *Agaricus*. These may be individual reactions and not a general toxicity, but it is wise to eat any species sparingly until you know your individual reaction.

Key to the Species of *Agaricus* in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Caps gray, with blackish brown scales scattered at the edge, concentrated centrally: *A. placomyces*, page 41
1b. Caps white, at least in young specimens: 2
2a. Partial veil single, flesh color unchanged or slowly turning brownish when cut or bruised: *A. campestris*, page 41
2b. Partial veil double: 3
3a. Flesh color unchanged when cut or bruised: *A. bitorquis*, page 39
3b. Flesh turning yellowish when cut or bruised: 4
4a. Caps white to cream with yellowish brown center, cap and stalk bruising yellow when cut or bruised: *A. arvensis*, page 39
4b. Caps white to creamy white, cap and stalk becoming yellow when cut or bruised: *A. silvicola*, page 43

PLATE 5. *Agaricus arvensis*

PLATE 6A and B. *Agaricus bitorquis*

Agaricus arvensis Schaeff. (plate 5) CHOICE EDIBLE

Horse Mushroom

Cap 7–15 cm broad, convex, flattening at maturity; white to cream, with yellowish brown center; dry and smooth, except center with small scales. Flesh thick; white, slowly yellowing when cut.

Gills free, crowded; initially white to gray-pink to deep chocolate brown at maturity.

Stalk 6–12 cm long, 1–2 cm thick, sometimes with bulb at base; white, bruising yellow; smooth, dry above annulus, cottony scales below annulus.

Partial veil two-layered, membranous; white; outer layer breaking into toothlike pattern; annulus skirtlike.

Spores 7–9 × 4–6 μm, smooth, elliptical; spore print dark purplish brown.

Scattered in pastures and fields or lawns after heavy rains; summer, fall.

This is a common species in some areas. Sometimes confused with *A. campestris*, *A. arvensis* typically stains yellow upon bruising or cutting the cap or stalk. The spores are larger, more nearly elliptical, rather than ovoid as in *A. campestris*. *A. silvicola,* a similar species found in woodland habitats, has similar general morphology but smaller spores (5–6.5 × 3–4 μm).

Agaricus bitorquis (Quél.) Sacc. (plate 6A, B) CHOICE EDIBLE

Cap 5–10 cm broad, convex to flattened; white to ivory; inrolled margin; dry without hairs. Flesh thick, white, not changing color when bruised or cut.

Gills free, close; pale pink, maturing to pinkish brown then blackish brown.

Stalk 2–5 × 1.5–2 cm, equal or tapered at base; white, smooth above and below annulus.

Annulus double, with extended upper edge and free lower edge, hairy, white, near middle of stalk.

Spores 4–6.5 × 4–5 μm, ovoid, smooth; spore print deep chocolate brown.

Single to numerous in grass or bare soil along packed paths, sidewalks, or lawns; early or late summer or fall.

This species is also known as *A. rodmani* and resembles *A. campestris* except for having a hairy double annulus instead of a single one.

PLATE 7. *Agaricus campestris*

PLATE 8. *Agaricus placomyces*

Agaricus campestris L.: Fr. (plate 7) CHOICE EDIBLE

Meadow Mushroom, Pink Bottom

Cap 3–10 cm broad, convex to nearly flat at maturity; white, becoming light brown or darker; smooth to fibrillose. Flesh firm; white or brownish, unchanging or slowly turning brownish when cut.

Gills free, crowded, narrow; pink, maturing to purple brown.

Stalk 3–6 cm long, 1–2.5 cm thick, equal; white and smooth above annulus, white and hairy below; same color as cap at maturity.

Annulus one single layer, thin, sometimes disappearing.

Spores 6–7.5 × 4–5 μm, ovoid to elliptical; spore print dark chocolate brown.

Scattered to abundant in lawns, meadows, and pastures following rains and cool weather; spring, summer, fall.

This delicious common mushroom is closely related to the cultivar *A. hortensis,* which is grown commercially. The characteristic bright pink, free gills and the brown spore print clearly distinguish this mushroom from the white-spored *Amanita*s.

Agaricus placomyces Pk. (plate 8) NOT RECOMMENDED

Cap 4–10 cm broad, oval to round, maturing to almost flat; white with gray to brown hairy scales; margin incurved when young, becoming straight at maturity. Flesh white to pale pink to dull pink, bruising yellow and finally reddish brown.

Gills free, crowded; gray pink, maturing to chocolate brown.

Stalk 3–9 cm long, 0.5–2 cm thick, slightly enlarged toward base; white, becoming dingy brown with age.

Annulus membranous; cottony white with yellow to brown; soft, flat patches beneath, persistent.

Spores 5–6 × 3.5–5 μm, ovoid to elliptical, smooth; spore print chocolate brown.

Scattered to loosely clustered under hardwoods and in leaf piles; late summer or fall.

This species seems to be edible for some people but poisonous for others. It probably should be avoided. Another woodland species, *A. silvaticus*, has reddish brown rather than gray to brown cap scales.

PLATE 9. *Agaricus silvicola*

Cap 6–15 cm broad; convex, becoming flat at maturity; white to creamy white; somewhat silky fibrillose. Flesh firm, moderately thick, brittle; white, staining yellow when bruised; odor mild.

Gills free, crowded, narrow to moderately broad; white at first, then pink and finally chocolate brown.

Stalk 7–15 cm long, 1–2 cm thick, sometimes tapering slightly upward; white, staining yellow when bruised; base flattened or with bulb.

Annulus large, double, smooth above, with lower surface breaking into yellowish patches that may disappear.

Spores 5–6.5 × 3–4.5 μm, elliptical, smooth; spore print purplish brown to chocolate brown.

Scattered or in clusters, under hardwoods; summer, fall.

A. silvicola is quite variable both in size and in stalk base. The annulus is large and conspicuous. Reports on edibility also vary; therefore we do not recommend it. *A. silvicola* and *A. silvaticus* occur under hardwoods in similar habitats. *A. silvaticus* has scales on the cap, however, and the cap flesh bruises reddish brown rather than yellow, as in *A. silvicola*. Gastrointestinal upset has been reported for *A. silvaticus*.

Amanitaceae

All mushrooms in this group develop from an oval to round structure covered by a universal veil, which breaks when the mushroom stalk elongates. Caps are rounded to conic or flattened at maturity and may be smooth, viscid, or warty from universal veil remnants. Cap margins are often inrolled at first and entire or striate (with lines or grooves). Flesh is white to cream, either unchanging or bruising to brown or red in some instances.

Gills are free, white or nearly so, and close to crowded.

Stalk is even, smooth to roughened toward the base by universal veil remnants and may be enlarged to a bulbous base enclosed by the volva. Annulus is absent or usually membranous if present. Volva may be cottony or membranous in *Amanita* or gelatinous in *Limacella*. *Limacella* is not common in the Midwest and is not included in this guide.

Spores are oval to round, smooth and thin-walled, and amyloid or nonamyloid in Melzer's reagent. Spore prints are white to cream.

A mushroom can be recognized in the field as a species of *Amanita* if it has white spores, free gills, and a volva.

This family includes some of the most poisonous mushrooms and accounts for most deaths from mushroom poisonings in the United States. They are attractive, however, and interesting because of their mycorrhizal associations. They are also of interest to both amateur and professional mycologists due to the necessity of avoiding them when collecting edible mushrooms. People are fascinated with the deadly elements of our environment, such as a cobra, a white shark, or the destroying angel mushroom.

Certain species of *Amanita* are sometimes labeled edible in mushroom books. In spite of this, we urge you not to eat any *Amanita* species or any mushroom similar in appearance.

Key to the Species of *Amanita* in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Annulus absent; cap white to gray to gray-brown or light orange, cap margin striate: *A. vaginata* group, page 55
1b. Annulus present; cap white or colored: 2
2a. Fruiting body entirely white; volva a loose saclike sheath: *A. bisporigera* group, page 45
2b. Cap with some color; volva variously developed: 3
3a. Cap whitish yellow to tan at margin, darker tan at center: *A. pantherina* var. *multisquamosa*, page 51
3b. Cap orange or red, brown, dark brown, or gray-brown: 4
4a. Cap flesh and stalk staining reddish or brownish: 5
4b. Cap flesh and stalk not staining when bruised or cut: 6
5a. Cap flesh and stalk staining brownish, stalk with abruptly expanded and often split basal bulb: *A. brunnescens*, page 47
5b. Cap flesh and stalk staining reddish, stalk base ovoid to clavate (clublike), not split: *A. rubescens*, page 53
6a. Cap orange or red, at least in center: 7
6b. Cap yellow, yellow-green, or tan: 8
7a. Volva breaking in pieces as a basal bulb; cap margin even or faintly striate: *A. flavoconia*, page 49
7b. Volva persistent; cap margin faintly to distinctly striate: *A. muscaria*, page 51
8a. Cap yellowish to greenish yellow, margin not strongly striate: *A. citrina*, page 47
8b. Cap pale yellow to yellowish buff; margin distinctly striate: *A. gemmata*, page 49

Destroying Angel

Cap 4–12 cm broad, rounded or conic to flat at maturity, smooth; pure white; viscid or sticky when wet; margin at first inrolled, lacking striations. Flesh firm; white, outer cap layer yellow when potassium hydroxide (KOH) is applied.

Gills free; white.

Stalk 10–20 cm long, 1–2.5 cm thick, tapering from enlarged base to apex; white, barely fibrous above annulus, distinctly hairy below.

Annulus membranous, smooth; white; irregular, with delicate skirtlike ring that may easily detach from stalk.

Volva membranous; white; with distinct, persistent cup surrounding but separate from inflated base.

Spores only 2 per basidium, 7–10 μm, globose, amyloid in Melzer's reagent, thin-walled; spore print white.

Scattered, on the ground under hardwoods; summer or fall.

The description of *A. virosa* is the same except that it has four spores per basidium; the spores are 8.5–11 μm or 9–11 × 7–9 μm, globose to subglobose. The cap flesh turns yellow when KOH is applied. The description of *A. verna* is also the same as for *A. bisporigera* except that the spores are 9–12 × 6.5–8 μm and the cap flesh is not yellow when KOH is applied. *Amanita bisporigera, A. virosa*, and *A. verna* can be distinguished from one another only by spore characteristics. All three species are equally poisonous and should be avoided by anyone seeking edible fungi. *A. virosa* has been reported to be responsible for most of the mushroom deaths in the United States. *A. bisporigera* is the most common of the three species in Iowa.

PLATE 10.
Amanita bisporigera

PLATE 11. *Amanita brunnescens*

PLATE 12. *Amanita citrina*

Amanita brunnescens Atk. (plate 11) **POISONOUS**

Cap 2.5–12 cm broad, rounded to flat at maturity; gray-brown to dark brown with white patches when young; viscid; margin faintly striate. Flesh thin; white, bruising reddish brown.

Gills free, crowded; white.

Stalk 5–13 cm long, 1–2 cm thick, expanded to large, bulbous base with longitudinal splits or crevices; white, staining reddish brown when bruised; smooth above ring, hairy below.

Annulus membranous; white to pallid; may collapse around stalk.

Volva remains as patches on cap and on basal bulb, sometimes forming inconspicuous collar around top of basal bulb.

Spores 7–10 μm round, thin-walled, amyloid; spore print white.

Scattered, on the ground under hardwoods and mixed woods; summer, fall.

The lengthwise splits in the basal bulb and the viscid brown cap are good field characteristics for this species.

Amanita citrina (Schaeff.) Pers. (plate 12) **POISONOUS**

Cap 5–12 cm broad, rounded to broadly knobbed; greenish yellow to light olive buff, with irregular, flattened, white to creamy patches of universal veil; viscid; margin light. Flesh soft; white.

Gills free but reaching stalk, crowded to close; white.

Stalk 8–10 cm long, 1–1.5 cm thick, enlarging to nearly round basal bulb, often with one to several longitudinal splits in bulb; white; smooth above and cottony below annulus.

Annulus membranous, fragile; cream to buff; persistent, often collapsing around stalk.

Volva flattened against basal bulb, evident at rim of bulb as distinct collar.

Spores 7–9 μm, nearly round, amyloid; spore print white.

Single to scattered, on the ground under conifers, mixed woods, or hardwoods; summer, fall.

The patches of universal veil on the cap often wash off in rainy weather, so this feature is not a reliable characteristic for identification.


PLATE 13A and B. *Amanita flavoconia*

PLATE 14. *Amanita gemmata*

Amanita flavoconia Atk. (plate 13A, B) **PROBABLY POISONOUS**

Cap 3–9 cm broad, rounded to nearly flat; red-orange to yellow-orange; large, cottony, yellow warts; viscid; margin even. Flesh thin, firm, white to cream to nearly buff near cap surface.

Gills free, close; white with finely hairy edges.

Stalk 5–10 cm long, 0.5–1.5 cm thick, enlarging to almost oval basal bulb; yellow, powdery above annulus, white.

Annulus membranous; white to cream; persistent.

Volva breaking up around bulb and lower part of stalk, usually fragmenting in soil when mature; bright yellow-gold.

Spores 7–9 × 4.5–6 μm, elliptical, amyloid; spore print white.

Single to scattered, on the ground under hardwoods and mixed forests; summer, fall.

A. flavorubescens is similar to *A. flavoconia*, with a yellow to yellow-brown viscid cap with yellow warts; however, the lower stem and bulb slowly become reddish. *A. flavoconia* is also easily confused with *A. frostiana*. The globose to subglobose, 7–10 μm, nonamyloid spores of *A. frostiana* are a differential characteristic.

Amanita gemmata (Fr.) Gillet (plate 14) **POISONOUS**

Cap 2–7 cm broad, rounded to flattened at maturity; pale yellow with darker center and patches of whitish, irregularly shaped, membranous universal veil remnants; margin distinctly striate. Flesh soft, thin; white to cream.

Gills free, close; creamy white.

Stalk 6–14 cm long, 0.5–2 cm thick, enlarged near basal bulb; white; nearly smooth above to somewhat floccose (cottony) toward base.

Annulus membranous, fragile; white; sometimes remaining attached to margin of cap.

Volva attached to basal bulb; white to cream; margin free at first as collar at top of bulb but later breaking down, leaving torn margin.

Spores 8.5–11 × 6.5–9 μm, broadly elliptical, nonamyloid; spore print white.

Single or grouped, on the ground in hardwoods or mixed woods; summer, fall.

PLATE 15. *Amanita muscaria*

PLATE 16. *Amanita pantherina* var. *multisquamosa*

Amanita muscaria (L.) Lam. (plate 15) **POISONOUS**

Fly Agaric

Cap 7–20 cm broad, round, aging to flat with lightly to strongly striate edges; ranging from dark red to red-orange to yellow, covered with white scaly patches of universal veil remnants; surface viscid when fresh. Flesh white, bruising brownish.

Gills free, crowded; white.

Stalk 5–12 cm long, 1.5–3 cm thick, enlarging toward bulbous base; white; bare above annulus, hairy or scaly below annulus.

Annulus pendant, membranous, often detaching from stalk.

Volva remnants appear as irregular concentric rings above base of stalk.

Spores 8–12 × 6.5–8 μm, elliptical, thin-walled, nonamyloid; spore print white.

Scattered to abundant, on the ground under conifers and hardwoods; summer, fall.

This species shows great variation in color as well as in the amounts of toxins present. Hallucinogenic effects as well as poisonings have been reported from many areas. This mushroom should not be eaten under any circumstances.

Amanita pantherina var. ***multisquamosa*** (Pk.) Jenkins (plate 16) **POISONOUS**

Cap 4–10 cm broad, rounded to flattened; white to tan or olive at center; viscid to dry with white, woolly, moderately persistent warts or patches from veil remnants; margins faintly to conspicuously striate. Flesh white.

Stalk 4–12 cm long, 1–2 cm thick, nearly equal to slightly tapered upward; white; smooth above to floccose to nearly scaly below annulus, usually hollow; base bulbous, ovoid.

Annulus floccose, membranous; white; usually attached above middle of stalk, often flaring or partially collapsed around stalk.

Volva floccose, forming narrow collar or roll; often free at margin.

Spores 8–10 × 6–8 μm, broadly elliptical to almost round, thin-walled, nonamyloid; spore print white.

Single to scattered, on the ground in hardwoods; summer, fall.

This species has frequently been referred to as *A. cothurnata*.

PLATE 17. *Amanita rubescens*

Amanita rubescens (Pers.) (plate 17) NOT RECOMMENDED

Blusher

Cap 5–12 cm broad, rounded or slightly umbonate (with center of pielus raised above adjacent portion); reddish brown with shades of gray or tan with irregular, whitish, greenish gray to pinkish warts; viscid to slightly sticky; margin faintly to lightly striate. Flesh initially white, staining reddish to red-brown upon bruising or cutting.

Gills close to crowded, free to nearly free; whitish, staining quickly to pinkish or reddish brown when bruised or cut.

Stalk 6–20 cm long, 0.8–2 cm thick, widening to swollen basal bulb; lightly flushed with pink above annulus, commonly stained reddish to red-brown below annulus.

Annulus membranous; white to pinkish, staining reddish; fragile, often tearing irregularly.

Volva breaking into reddish pieces, some adhering to swollen base, others left in surrounding soil.

Spores 8–10 × 5–6 μm, elliptical, mostly smooth, strongly amyloid; spore print white.

Single or in groups, on the ground under hardwoods, particularly oaks; summer, fall.

The reddish stains that are the basis for the common name "blusher" and the irregular pinkish gray or greenish gray warts turning reddish on the rounded cap make this a distinctive mushroom. This is one of our most striking species when summer moisture is plentiful. Some daring individuals eat this mushroom; but because of the difficulty of distinguishing between this and some related species that are poisonous, we repeat our caution about not eating *Amanita*s.

PLATE 18. *Amanita vaginata*

Amanita vaginata (Bull.) Lam.

(plate 18) NONPOISONOUS BUT NOT RECOMMENDED

Grisette

Cap 3–8 cm broad, conical, becoming flat; dull orange, smoky gray to gray-brown, sometimes with large patches of universal veil; viscid when fresh; margin conspicuously striate. Flesh thin; white, unchanging when bruised.

Gills free, crowded when young; white.

Stalk 8–22 cm long, 1–2 cm thick, slender enlarging to bulbous base; white; smooth or with sparse, flattened hairs.

Annulus absent.

Volva membranous, saclike but not attached to stalk; white; often buried well below soil line.

Spores 8–12 μm, globose, thin-walled, nonamyloid; spore print white.

Single to numerous, on the ground under hardwoods; summer, fall.

Also known as *Amanitopsis vaginata,* this species is considered nonpoisonous. We do not recommend eating it, however, because it is easily mistaken for one of the poisonous *Amanita*s that have lost their universal veil remnants or annulus. The gray form is the commonest in Iowa hardwood forests. It is one of the commonest mushrooms, occurring even in years of limited moisture when many mushrooms do not fruit. Two other varieties of *A. vaginata* are often recognized: the orange-capped variant *A. vaginata* var. *fulva* and *A. vaginata* var. *alba*, with a white cap. These have also been recognized as separate species.

Bolbitiaceae

This family is characterized by bell-shaped to rounded fragile caps somewhat reminiscent of Coprinaceae. Caps range in color from white to pale yellow to tan to darker brown and are moist or viscid to dry. Some have prominent striations at the margin; cap surface layer (cuticle) is cellular. Flesh is thin and white to pallid.

Gills are free to attached and light colored, maturing to darker brown.

Stalks are typically long, thin, and slightly enlarged at the base; same color as cap or lighter; and with or without a partial veil.

Spores are yellow-brown to cinnamon or reddish brown, smooth or variously ornamented with an apical pore; spore prints are yellow-brown to darker reddish brown.

Most species are not of interest for eating because of their small size and thin flesh.

PLATE 19. *Conocybe lactea*

PLATE 20. *Conocybe tenera*

Conocybe lactea (Lge.) Métrod (plate 19) NOT EDIBLE

Cap 1–2.5 cm broad, 1–1.5 cm high, conic; creamy white throughout or slightly darker at top; smooth; margin flaring with age. Flesh thin.

Gills very narrow; whitish, becoming rusty brown.

Stalk 4–8 cm long, 1–2 mm thick, equal, very fragile; whitish.

Spores 12–16 × 7–9 µm, truncate; spore print rusty brown.

In groups or scattered in lawns or grassy areas, very common in rainy weather; summer, fall.

These delicate, fragile mushrooms may be present in large numbers in a lawn on a dewy summer morning and completely wilted and dried by noon. Some mycologists interpret this species as *C. albipes*.

Conocybe tenera (Schaeff.) Fayod (plate 20) EDIBILITY UNKNOWN

Cap 1–2 cm broad, 1–2 cm high, conic to bell-shaped; reddish to yellow-brown, becoming lighter with age; dry, striate nearly to center. Flesh thin, water-soaked; brown.

Gills nearly free, subdistant, narrow; clay-brown to cinnamon-brown.

Stalk 4–8.5 cm long, 1–2 mm thick, straight, equal; same color as cap; finely striate.

Spores 7–10 × 5–7 µm, elliptical, thick-walled, smooth with apical pore; spore print red-brown.

Scattered to abundant in lawns or open grassy areas; spring, summer.

This species is also known as *Galera tenera*, although this name and the mushroom it signifies are confusing. The small, somewhat fragile mushrooms of a group with conic to bell-shaped caps on long, thin stalks are common in lawns and grassy areas.

Another species, *Conocybe lactea*, differs in its white to light tan cap. Both species are common in lawns.

Another very fragile lawn mushroom, *Gastrocybe lateritia*, has narrow brown caps on long, fragile white stalks. As the brown spores mature, the gills gelatinize and cling to the stalk. They fruit in grassy areas in summer.

Coprinaceae

This family is characterized by thin, typically conical caps with nearly free to adnate or adnexed gills and a purple-brown to black spore print. In the genus *Coprinus* the gills are converted to an inky mass by autodigestion, a condition that has led to the name "inky caps" for many species. Recent molecular evidence supports placing *Coprinus* species in two families, eliminating the family Coprinaceae. The species now recognized as *Coprinus* would be in several different genera. Such name changes are noted in the comments on individual species. We have retained the traditional family name here.

Caps range from dry to viscid, some with scales; margins are striate to wrinkled or split. Flesh initially white or pallid.

Gills are crowded to distant, dissolve or remain firm, and are initially grayish, becoming darker. In *Coprinus* they deliquesce to form an inky black mass.

Stalks are relatively thin, smooth to hairy or scaly, and with or without an annulus.

Spores are usually dark purple-brown to black, elliptical, smooth, with an apical pore; spore prints are dark brown to black.

The Coprinaceae are saprobes on dung, wood debris, or humus in lawns. While several species of *Coprinus* are edible, some have been linked with gastrointestinal upsets. Some species induce other symptoms when eaten with alcoholic beverages. All species of *Panaeolus* should be avoided, because some contain poisonous or hallucinogenic compounds.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Gills breaking down into an inky black mass: 2
1b. Gills remaining firm, not inky or black, becoming darker as spores mature: 5
2a. Cap long, narrowly cylindrical to conical, white, covered with recurved brownish scales: *Coprinus comatus*, page 61
2b. Cap shorter, bell-shaped to conical, not white, with scales or particles mostly at or near center of cap: 3
3a. Cap tan to reddish brown, with glistening particles frequently covering center of cap: *Coprinus micaceus*, page 63
3b. Cap whitish gray to black, scaly or smooth: 4
4a. Cap smooth to scaly over the center only; usually on soil near stumps or from buried wood: *Coprinus atramentarius*, page 59

4b. Cap at first covered with flakes or scales; usually on rotting wood: *Coprinus variegatus*, page 63
5a. Cap small, less than 1.5 cm broad; occurring in large numbers on well-decayed wood: *Coprinus disseminatus*, page 61
5b. Cap larger; single or in small groups: 6
6a. Fruiting body without a partial veil: *Panaeolus foenisecii*, page 65
6b. Fruiting body with a partial veil when young: 7
7a. Cap buff fading to whitish; margin irregular: *Psathyrella candolleana*, page 65
7b. Cap tawny brown to yellowish brown; margin regular: *Psathyrella velutina*, page 66

Coprinus atramentarius (Bull.: Fr.) Fr.

(plate 21A, B) EDIBLE, CONDITIONALLY

Inky Cap

Cap 4–6 cm broad to 6 cm high, conic, becoming bell-shaped at maturity; white to gray to black to inky with age; smooth to scaly over center; margin striate, wrinkled when young, with thin fibrillose partial veil. Flesh thin, pallid.

Gills free to adnexed, crowded; whitish, dissolving into inky black fluid with age.

Stalk 8–15 cm long, 1–1.5 cm thick; white above annulus zone, brown fibrils scattered below; hollow.

Annulus membranous, fibrous.

PLATE 21. *Coprinus atramentarius.* A (Left): Young, B (Right): Old

PLATE 22. *Coprinus comatus*. A (Left): Young, B (Right): Old

PLATE 23A and B. *Coprinus disseminatus*

Spores 7–12 × 4.5–5.8 μm, elliptical, smooth; apical pore; spore print black.

Several in group to dense clusters in grass, on wood debris, or from buried wood; spring, summer, fall.

This species is reported to be toxic when ingested within several days of consumption of alcohol. The toxic reaction involves nausea, a flushed appearance and a hot feeling, and gastrointestinal disturbance. Under other conditions, it is a good edible species. This species has recently been interpreted as *Coprinopsis atramentaria*.

Coprinus comatus (Müll.: Fr.) Pers. (plate 22A, B) CHOICE EDIBLE

Shaggy Mane, Lawyer's Wig

Cap 5–12 cm tall, 2–6 cm across base just before spore maturation; egg-shaped, expanding to bell-shaped; white with shaggy recurved scales tinged with brown; margin ribbed to wrinkled. Flesh soft; white, darkening and dissolving with age.

Gills nearly free to notched and very crowded; white to pink, dissolving to black inky mass.

Stalk 5–20 cm long, 1–1.5 cm thick, equal, slightly bulbous at base; creamy white; dry.

Annulus fibrous, movable ring that may slip to base of stalk or may disintegrate.

Spores 13–17 × 7–8 μm, elliptical, smooth; apical pore; spore print black.

Scattered or in small groups on hard ground or in grass, along paths, roadsides; late summer, fall, sometimes spring; more common in fall.

Coprinus disseminatus (Pers.: Fr.) S. F. Gray (plate 23A, B) NONPOISONOUS

Cap 6–15 mm broad, conic to bell-shaped; grayish to gray-brown with pale buff to honey-brown center; striate with folds to margin. Flesh soft, thin; pallid.

Gills attached, subdistant; white to gray, then black but not inky at maturity.

Stalk 2–4 cm long, 1–2 mm thick, equal, curved; white; smooth, hollow.

Spores 7–10 × 4–5 μm, elliptical, smooth; apical pore; spore print black.

In large numbers (hundreds) on well-decayed wood debris or buried wood, common on or around old stumps; spring, summer, fall.

This mushroom has also been interpreted as a species of *Pseudocoprinus* because the gills do not deliquesce. This species has recently been interpreted as *Coprinellus disseminatus*.

PLATE 24A and B. *Coprinus micaceus*

PLATE 25. *Coprinus variegatus*

Coprinus micaceus (Bull.: Fr.) Fr. (plate 24A, B) EDIBLE

Mica Cap

Cap 1.5–5 cm broad, 2.5–4 cm high, conic to bell-shaped at maturity; tan to reddish brown, covered with glistening white to light tan particles that often disappear with age; strongly striate on edge and smooth at top. Flesh soft, watery; pallid.

Gills notched, crowded; white, turning first gray then black as it matures, dissolving into inky fluid.

Stalk 1.5–7 cm long, 3–6 mm thick, equal; white; hollow.

Spores 7–10 × 3.5–5 µm elliptical, smooth; apical pore; spore print black.

In dense clusters on rotten wood, near stumps or buried wood, after rains; spring, summer, fall.

This species is very common in large fruitings after rains in spring and fall, less abundant in summer. The mushrooms are delicate and soon deliquesce, resulting in dark inky masses in a lawn. This species has recently been interpreted as *Coprinellus micaceus*. A somewhat similar species, *Coprinus radians*, develops singly or in clumps from a tufted mat of coarse orange mycelium on wood. The mycelial mat is not uncommon, but fruiting is rare.

Coprinus variegatus Pk. (plate 25) EDIBLE

Cap 2–5 cm broad at base, 2–4 cm high, conic to bell-shaped; cream to pale gray to grayish brown, covered with whitish to dingy flakes or scales that may disappear with age; margin wavy and uneven. Flesh thin.

Gills reaching to stalk but free, crowded, broad; whitish, becoming purplish then black and inky.

Stalk 4–12 cm long, 5–8 mm thick, equal or tapering upward; whitish, sometimes with white cords of mycelium at base.

Annulus floccose, attached irregularly toward basal portion of stalk, often disappearing with age.

Spores 7.5–10 × 4–5 µm, elliptical, smooth; spore print black.

Common in large clusters on rotten logs or piles of woody debris; early summer, fall.

C. atramentarius is similar in appearance but lacks the floccose patches on the cap. *C. variegatus* occurs on rotten wood with well-developed rootlike cords of mycelia (rhizomorphs). This species has recently been interpreted as *Coprinopsis variegata* and is also known as *Coprinus quadrifidus*.

PLATE 26. *Panaeolus foenisecii*

PLATE 27. *Psathyrella candolleana*

Panaeolus foenisecii (Pers.) Schröt. (plate 26) **poisonous,** COMMON

Cap 1–3 cm broad, convex to conic; brown to grayish brown to reddish brown to violaceous brown, drying to lighter tan center and darker margin; margin smooth to faintly striate. Flesh thin, watery; tan to brown.

Gills attached, adnate, close; often mottled then chocolate brown to purplish black, with white edges.

Stalk 5–8 cm long, 2–4 mm thick, sometimes enlarging at base; pale tan at top, dingy brown below.

Spores 12–20 × 8–10 µm, broadly elliptical, roughened with low, irregular warts; apical pore; spore print dark purple-brown.

Scattered to numerous in lawns and pastures; spring, summer, fall.

This mushroom may contain hallucinogenic compounds (psilocybin and psilocin) and has been reported to cause poisoning. It has also been called *Panaeolina foenisecii* and *Psathyrella foenisecii*. It is widely distributed and common in lawns, particularly in the spring and summer. The cap usually does not expand much with age. Many species of *Panaeolus* occur on dung, and other species in grassy areas. They share these habitats with *Psilocybe* species, many of which contain the same hallucinogenic compounds.

Psathyrella candolleana (Fr.) Maire (plate 27) EDIBLE, COMMON

Cap 3–8 cm broad, rounded to finally upturned at maturity; buff to honey colored, fading to whitish, with scattered small white scales when young; veil remnants may be found hanging from margin; margin irregular. Flesh thin, fragile; white.

Gills attached, crowded; white to grayish, maturing purplish brown.

Stalk 3–10 cm long, 2–5 mm thick, rigid; shiny white; smooth, hollow.

Partial veil membranous; white; annulus rarely forming; veil tissue remains attached in separate pieces to young cap margin, disappearing with age.

Spores 6.5–8 × 4–5 µm, elliptical, smooth; apical pore; spore print purple-brown.

Single to scattered in grassy lawns or forest openings; spring, summer, fall.

This mushroom is also known as *Hypholoma incertum*. The irregular, radially asymmetrical margin of the cap is a distinctive field characteristic. The partial veil remnants tend to dry and are lost quickly, particularly in drying situations.

Psathyrella velutina (Fr.) Sing. (plate 28) EDIBLE

Cap 3–8 cm broad; convex, becoming plane with slightly raised central area; tawny brown to yellowish brown with darker center; appressed (flattened into cap) fibrils, becoming fibrillose scales; margin often fringed with remnants of partial veil, splitting. Flesh thick; brownish.

Gills attached to nearly free, close to crowded; edges white with beads of moisture in wet weather, becoming dark purple-brown.

Stalk 3–7 cm long, 4–10 mm thick, equal; whitish above ring, brownish below; hairy to scaly, especially below ring; hollow with age.

Partial veil fibrous, breaking loose from stalk with remnants hanging on edge of cap; annulus an obscure ring on stalk.

Spores 9–12 × 6–8 μm, elliptical to ovoid, warted; spore print dark purple-brown.

Single or in scattered groups of two or three, in grassy areas in lawns or in woods; summer, fall.

This species has also been interpreted as *Lacrymaria velutina* or *L. lacrymabunda*.

PLATE 28. *Psathyrella velutina*

Cortinariaceae

This large family includes mushrooms that are sessile (attached directly to the substrate, with no stalk) or eccentrically stalked (only the genus *Crepidotus*) or centrally stalked. Caps are rounded to nearly flattened at maturity, yellow to brown or purple, dry to viscid, with entire to slightly striate margins. Flesh colors are white to shades of brown and purple.

Gills are adnate to adnexed or sometimes decurrent and range from tan or buff to purple or red to brown, darkening or changing as spores mature.

Stalks may be very thick, some bulbous at base; smooth to hairy. Partial veils when present are cobwebby to floccose, often obscure and easily overlooked or soon disappearing.

Spores are yellow-brown to rusty brown, round to elliptical, smooth to variously ornamented with knobs, spines, ridges, or wrinkles; spore prints are yellow-brown to rusty brown.

We have included only a few examples from this family, although many occur in this region. The largest genus, *Cortinarius,* is very complex taxonomically. A few species are distinctive, but many are not easily recognized or identified without careful microscopic study.

Key to the Selected Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. On wood; stalk central, lateral or lacking: 2
1b. On the ground; stalk present, usually central: 3
2a. Typically laterally attached, bracketlike, often overlapping: *Crepidotus mollis*, page 71
2b. Stem present, usually central; annulus not always persistent: *Galerina autumnalis*, page 71
3a. Cap usually convex, not radially fibrillose, with a cobwebby veil when young: *Cortinarius* spp., page 69
3b. Cap conic to bell-shaped, typically fibrillose: 4
4a. Cap sharply conic, yellowish brown: *Inocybe fastigiata*, page 73
4b. Cap becoming almost flat with central, white knob: *Inocybe geophylla*, page 73

PLATE 29A, B, and C. *Cortinarius* spp.

Cortinarius spp. (plate 29A–C)

SOME **POISONOUS** SPECIES, NOT RECOMMENDED

Cortinarius is a large genus of mycorrhizal mushrooms with several hundred species and has been divided into several subgenera. Identification is very difficult, often requiring observation of a series of developmental stages and microscopic information. This genus is dangerous to the collector looking for edible fungi and should be avoided.

These mushrooms are usually quite fleshy, with convex caps, a cobwebby partial veil of silky hyphae when young (pl. 29A), somewhat fleshy stalks, and rusty brown to cinnamon-brown, usually spiny spores. Some have viscid caps or stalks while some do not, along with other varying characters. Many species are mycorrhizal, so these mushrooms are generally found on the ground associated with trees. Some species are beautiful shades of purple when young, with the colors fading or remaining in different groups of species. They usually fruit in late summer and fall.

We have not attempted to identify the common species because of the difficulties of identification at the species level. The figures illustrate some aspects of the genus.

Even though some species are reported to be edible, we emphasize the danger of eating species of the genus *Cortinarius*. Some species are deadly poisonous. Not only is *C. orellanus* deadly, but the symptoms may not appear for days or even weeks; medical treatment may be very difficult. This species has not been reported from North America, but other species believed to contain the same or similar toxic compounds do occur. **Do not eat mushrooms from the genus *Cortinarius*.**

PLATE 30. *Crepidotus mollis*

PLATE 31. *Galerina autumnalis*

Crepidotus mollis (Schaeff.) Staude (plate 30) EDIBILITY UNKNOWN

Cap 1–5 (to 8) cm broad, 2–2.5 cm wide, convex; buff with copious small, dark brown scales to nearly glabrous (smooth, hairless); hygrophanous (with a water-soaked appearance when wet); sessile or with rudimentary stalk. Flesh thin, soft; white.

Gills attached, close to subdistant (uncrowded gills with almost enough space between them to be called distant), narrow, becoming cinnamon.

Stalk lateral and rudimentary if present.

Spores 7–10 × 4.5–6 µm, short elliptical, smooth; spore print yellow-brown.

In overlapping groups on dead hardwoods, sometimes on conifers, widely distributed; spring, summer, fall.

Crepidotus includes a number of species, all with small, convex to fan-shaped sessile caps and found on wood. They are too thin to be considered edible. *C. applanatus* has caps 1–4 cm broad; is smooth to slightly downy, dull white to cinnamon; and is widely distributed on hardwood logs and stumps. Another fungus, *Hypomyces tremellicola*, parasitizes species of *Crepidotus*, deforming the cap.

Galerina autumnalis (Pk.) Sm. & Sing. (plate 31) **DEADLY POISONOUS**

Deadly Galerina

Cap 2–6 cm broad, convex to flattened, sometimes with small central knob when mature; viscid or sticky when wet, smooth; margin sometimes lightly striate, hygrophanous, medium brown, fading to tan when dry, with disc remaining brown.

Gills attached, close, yellowish when young, maturing to rusty brown; cystidia abundant on sides and edges of gills.

Stalk 1.5–6 cm long, 3–7 mm thick, brown to dark brown with white fibrils below, whitish above; equal to slightly enlarged at base.

Annulus fragile and sometimes missing, near top of stalk; white at first, later rust-colored from spores.

Spores 8–10 × 5–6.5 µm, elliptical, rough; spore print rusty brown.

Scattered to clustered on decayed hardwood or conifer stumps and logs; most common in fall.

This mushroom belongs in a complex with several other species of *Galerina*, including *G. marginata* and *G. unicolor*, recently interpreted as a single species. **This complex is deadly poisonous,** due to amatoxins similar to those found in the deadliest *Amanita*s.

PLATE 32. *Inocybe fastigiata*

PLATE 33. *Inocybe geophylla*

Inocybe fastigiata (Schaeff.) Quél. (plate 32) **POISONOUS**

Cap 2–6 cm broad, conic to campanulate with central knob, becoming expanded; tawny to yellowish brown, darker in center; dry, splitting readily on margin, streaked with fibers. Flesh thin except at center; white.

Gills attached, notched at the stem, crowded; white, becoming brownish.

Stalk 4–10 cm long, 2–8 mm thick, twisted striate, equal to slightly enlarged at base; whitish to light brown.

Spores 9–13 × 5–7 µm, elliptical, smooth; spore print dull brown.

Scattered or in groups on the ground under hardwoods or conifers and in grassy areas or lawns under trees; summer into fall.

All *Inocybe* species that have been studied have been found to contain toxins. **All species are potentially poisonous and should never be eaten.** *I. fastigiata*, one of the most common *Inocybe* species, is quite variable in size and color. This species has recently been interpreted as *I. rimosa*.

Inocybe geophylla (Pers.) Kumm. (plate 33) **POISONOUS**

Cap 2–4 cm broad, rounded to bell-shaped with prominent pointed apex; white, silky fibrillose, dry; margin upturned with age. Flesh thin except at center; white.

Gills attached or notched at stalk, crowded; white to grayish clay.

Stalk 2–7 cm long, 2–5 mm thick, solid; white to grayish white; silky fibrillose.

Partial veil cobwebby; white; annulus a faint hairy ring on stalk.

Spores 7–10 × 4.5–6 µm elliptical, smooth; spore print clay-brown.

Scattered on the ground under hardwoods and mixed woods, occasionally in lawns; summer, fall.

Entolomataceae

Caps of this family are conic to pointed or rounded to broadly rounded or even flat at maturity, ranging from white to dull grays and browns or pink- to orange-salmon. Cap flesh is soft and white to pallid off-white. Cap surfaces range from dry to tacky when wet, often drying to silky smooth, with margins frequently inrolled and splitting at maturity to entire to wavy.

Gills are attached and either notched or slightly decurrent.

Stalks are thin to moderately thick, nearly equal to somewhat enlarged at the base, often striate, brittle, and somewhat twisted in appearance.

Spores are pink to brownish pink and either have long ridges or are angular.

This is typically a cool, rainy weather group in the Midwest, including numerous species. Characteristics of spore morphology are generally used to delimit genera and species, so the group is not easily interpreted without a microscope. We do not recommend this group for eating because of the difficulties of identification and because the toxins in the poisonous species are apparently varied, with diverse effects.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Gills decurrent; spores longitudinally striate: *Clitopilus prunulus*, page 75

1b. Gills short decurrent, spores angular; often normal mushrooms accompanied by oval, white modified fruiting bodies: *Entoloma abortivum*, page 77

Clitopilus prunulus (Scop.) Kumm. (plate 34) NOT RECOMMENDED

Cap 3–10 cm broad, convex to flat to shallowly depressed in center; white to grayish to yellowish; tacky when moist; margin inrolled to even to wavy. Flesh firm; white.

Gills decurrent, close to subdistant, narrow; white, becoming pinkish.

Stalk 3–8 cm long, 4–15 mm thick; dull white; solid; usually central but occasionally slightly eccentric.

Spores 9–12 × 5–6.5 μm, tapering at ends, with longitudinal ridges, pinkish; spore print salmon-pink.

Scattered to loosely grouped on the ground in open woods, both hardwood and coniferous; summer, fall.

Sometimes two species, *C. prunulus* and *C. orcellus*, are recognized. These species are edible but are not recommended because they are easily confused with several similar poisonous white mushrooms, such as *Clitocybe dealbata*, which has white spores. Note the pink spore print deposited by an overlapping fruiting body on the cap surface of the fruiting body on the left (pl. 34).

PLATE 34. *Clitopilus prunulus*

PLATE 35. *Entoloma abortivum*
A (Top): Normal and parasitized, B (Bottom): Parasitized

Entoloma abortivum (Berk. & Curt.) Donk

(plate 35A, B) EDIBLE WITH CAUTION

Aborted Entoloma

Cap 5–10 cm broad, rounded to nearly flat at maturity, somewhat knobbed at center; gray-brown; obscurely zoned with fibrous hairs to scales, becoming smooth at maturity; margin inrolled. Flesh soft; white. Abortive, parasitized fruiting bodies: whitish, bumpy, soft, irregular masses occurring alone or near normal mushrooms.

Gills varying from merely attached to somewhat decurrent, somewhat crowded; gray, aging to dusty rose or salmon-pink.

Stalk 4–10 cm tall, 0.8–2 cm thick, white to gray with scruffy hairy surface and white mycelium at base.

Spores 8–10 × 4–6 μm, angular-elliptical; spore print tan-cinnamon to salmon-pink.

Scattered to frequent in hardwood or mixed woods, frequently clustered at base of trees in moist habitats, around stumps and rotted wood; late summer, fall.

Parasitized mushrooms are typically highly modified (pl. 35B), even looking like irregular lumps of soggy, off-white tissue. No evidence of either gill or stalk development may be present. The mushrooms involved in the parasitism are *Armillaria* spp. and *Entoloma abortivum*.

While this species is edible and valued by some who recognize it, we urge caution, because it is relatively easy to confuse the nonparasitized forms with poisonous *Entoloma* species and the parasitized form with other parasitized entities involving unidentifiable species. This mushroom has been known under several names; it may also be called *Clitopilus abortivus* or *Rhodophyllus abortivus*.

Gomphidiaceae

This family is characterized by a smoky gray to blackish spore print and thick decurrent gills. No clear distinction exists between the cap and stalk because of the decurrent gill development. Probably all species are mycorrhizal with conifers; thus the mushrooms develop under or near conifers.

Caps may be viscid to tacky to dry, with or without a partial veil. This is a small family. While these mushrooms are not reported to contain toxins, they are not particularly palatable, because the flesh changes color upon cooking and the texture becomes somewhat slimy.

Gomphidius glutinosus (Schaeff.: Fr.) Fr.

(plate 36) EDIBLE, NOT RECOMMENDED

Cap 2–10 cm broad, broadly convex to flat; gray-brown to purple-gray or reddish brown, often spotted or stained blackish; glutinous, smooth; margin upturned with age. Flesh thick, soft; white, sometimes pinkish.

Gills decurrent, close to subdistant; whitish then smoky gray to blackish.

Stalk 4–10 cm long, 1–2 cm thick, tapering toward base; white above slimy ring, yellow below ring.

Partial veil with thin, glutinous outer layer, with white hairy inner layer; annulus a glutinous ring, darkening with accumulated spores with age.

Spores 15–21 × 4–7.5 µm, cylindrical, tapered at both ends, smooth; spore print smoky gray.

Single to scattered, on the ground under conifers; late summer, fall.

Fruiting is usually abundant under conifers. It occurs throughout North America but is most common in the western states.

PLATE 36. *Gomphidius glutinosus*

Hygrophoraceae

This is an unusually colorful and conspicuous group. Cap colors range from reds, oranges, and yellows to white, gray, brown, and even green. Cap shape varies from conic to nearly flat, with the surface often viscid or slimy.

Gills are the distinctive feature of this group. They look and feel waxy when rubbed between the fingers and are thick (broadly triangular in cross section), well separated, and adnate to decurrent.

Stalks tend to be even, sometimes with a bulbous base; frequently the same color as the cap or slightly lighter, often bruising to a darker color; and usually hollow, with a tendency to split.

Spores are uniformly smooth, white, and elliptical; spore prints are white.

In a more technical interpretation of the genus *Hygrophorus,* groups of species are characterized by the structure of the gill tissue. This microscopic character is valuable in identification, but the species discussed here can be interpreted without involving gill tissue structure.

Species of *Hygrophorus* grow in litter or are mycorrhizal. Several species in our area have been reported from tall grass prairies. The unusual waxy gills make this a relatively easy group to recognize. *Laccaria* species also have waxy gills, and the common mushroom *L. laccata* may be mistaken for a *Hygrophorus* when first collected.

We include only a few distinctive species of *Hygrophorus*. Many more occur in this area.

Key to the Species of *Hygrophorus* in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Cap grass green to bluish green when fresh: *H. psittacinus*, page 83
1b. Cap whitish or some shade of red-orange or yellow-orange: 2
2a. Cap red to scarlet-orange: 3
2b. Cap white, pale yellow, pinkish, reddish yellow, to orange-brown: 4
3a. Cap scarlet to orange; gills and stalk bruising black: *H. conicus*, page 81
3b. Cap deep blood-red, aging to orange; gills and stalk not bruising to black: *H. puniceus*, page 83
4a. Cap usually pinkish or pinkish brown; cap, gills, and stalk bruising yellow when young: *H. russula*, page 85
4b. Cap white, whitish yellow, or reddish yellow, aging to orange-buff, not changing color when bruised: 5
5a. Cap cream to tan with central area light orange-brown to apricot-buff, slimy to sticky; stalk slimy at base: *H. subsalmonius*, page 85

PLATE 37. *Hygrophorus conicus*

PLATE 38A and B. *Hygrophorus occidentalis*

5b. Cap pure white when young, becoming smoky gray in the center; surface slimy to sticky; stalk slimy: *H. occidentalis*, page 81

Hygrophorus conicus (Scop.) Fr. (plate 37) NOT RECOMMENDED

Witch's Hat

Cap 2–7 cm broad, conic with acute peak; red to scarlet-orange, paler to olive near margin; viscid when wet; margin uneven, somewhat upturned at maturity. Flesh thin, same color as cap, bruising or aging to olive-gray to black.

Gills nearly free, crowded, edges uneven; whitish yellow to olive, bruising black; waxy.

Stalk 4–12 cm long, 3–10 mm thick, equal, striate-twisted; yellow to scarlet but white at lower part, black when bruised or when mature; moist, hollow.

Spores 9–12 × 5–7 µm, elliptical, smooth; spore print white.

Scattered to somewhat gregarious, on the ground; summer, fall.

This species is common in the loess hills of western Iowa and is not uncommon in woods. It is easily recognized because of the conic, brightly colored cap and stalk, which quickly become black when bruised or broken. This species is sometimes designated *Hygrocybe conica*.

Hygrophorus occidentalis Sm. & Hesler (plate 38A, B) EDIBLE

Cap 2–8 cm broad, nearly rounded convex, becoming knobbed or flat to sunken; pure white at first, becoming smoky gray on disc, color spreading out toward cap margin, but margin remaining pale; slimy to sticky when wet, often smooth. Flesh thin; white to off-white.

Gills decurrent, nearly distant to distant, fairly broad, thicker near stalk; white; waxy.

Stalk 2–7 cm long, 2–10 mm thick, with equal tapering toward base; white or colored like cap; slimy.

Spores 6–9 × 3.5–5 µm, elliptical, smooth; spore print white.

Single to scattered, on the ground under hardwoods or conifers and into adjacent grassy areas; summer, fall.

This species is widely distributed but occurs in limited numbers. Distinguished by the very glutinous covering on both pileus and stalk, it is shiny when dry. *H. eburneus* is very similar, but all parts remain white.

PLATE 39. *Hygrophorus psittacinus*

PLATE 40. *Hygrophorus puniceus*

Hygrophorus psittacinus (Fr.) Fr. (plate 39) EDIBILITY UNKNOWN

Cap 1–3.5 cm broad, conic or bell-shaped to rounded; grass green to bluish green, maturing to pinkish buff; viscid; margin striate. Flesh thin; same color as cap.

Gills adnate, moderately separated; light green, becoming orange-yellow or buff, sometimes more evidently green near cap; waxy.

Stalk 3–7 cm long (about twice as long as cap width), 1–5 mm thick, equal; green, becoming yellow-orange to cream; hollow, slimy.

Spores 6.5–9 × 4–5 μm, elliptical, smooth; spore print white.

Scattered, on the ground under hardwoods and conifers; summer, but mostly fall.

This species is most common after heavy rains. It is widely distributed but seldom occurs in large numbers. It is sometimes known as *Hygrocybe psittacina*. The unique green color is distinctive, although it disappears with age.

Hygrophorus puniceus (Fr.) Fr. (plate 40) EDIBILITY UNKNOWN

Cap 2–5 cm broad, rounded to bluntly conic; deep blood-red, aging to orange; viscid; margin incurved when young, somewhat striate. Flesh thin, watery; red-orange to yellow.

Gills attached, broad, fairly well separated; red-orange to yellow; waxy.

Stalk 3–7 cm long, 0.5–1.5 cm thick, equal or narrowing slightly at base; reddish fading to orange-yellow, base white-yellow; fibrillose-striate; center hollow to filled.

Spores 8–11 × 3.5–6 μm, elliptical to oblong, smooth; spore print white.

Scattered or in groups on soil under hardwoods and conifers; summer, fall.

H. coccineus is similar and occurs in the same kind of habitat. It differs in having a moist to tacky but not truly viscid cap and is reported to be less common. Other small, red to orange species of *Hygrophorus* also exist. This species is also known as *Hygrocybe punicea*.

PLATE 41. *Hygrophorus russula*

PLATE 42. *Hygrophorus subsalmonius*

Hygrophorus russula (Fr.) Quél. (plate 41) EDIBLE

Cap 5–12 cm broad, rounded, convex, maturing to nearly flat; pink to pinkish brown or whitish, streaked with purplish fibrils or flecked with wine-colored spots, sometimes bruising yellow when young; smooth at first, breaking into patches of fibrils. Flesh firm; white to pinkish.

Gills attached or extending slightly down stalk, crowded, firm; white but soon pale pink, staining spotted purplish red at maturity; waxy.

Stalk 3–7 cm long, 1.5–3.5 cm thick, equal; white when young, staining pink to reddish brown at maturity; dry, solid.

Spores 6–8 × 3–5 μm, elliptical, smooth; spore print white.

Scattered or clustered on the ground under hardwoods, common under oak; late summer, fall.

This species is the most common fall mushroom in some years, particularly in rainy falls. It has the appearance of a *Russula* species. Sometimes fruiting occurs in arcs or in fairy rings. The firm, waxy gills are a good field characteristic.

Hygrophorus subsalmonius Sm. & Hesler (plate 42) EDIBILITY UNKNOWN

Cap 4–12 cm broad, rounded to convex, becoming plane to slightly depressed with age; cream to tan with central area light orange-brown to apricot-buff, uniformly colored at maturity; slimy to sticky (glutinous to viscid) all over, smooth except for cottony margin. Flesh thick, firm; white.

Gills attached, usually somewhat decurrent, extending slightly along stalk, close to subdistant, moderately broad, alternately long and shorter; light buff to pinkish buff; waxy.

Stalk 3–10 cm long, 0.5–2.0 cm thick, same width throughout or tapering slightly at base; whitish to tan, darkening with age; lower portion slimy to sticky, solid.

Spores 6.5–8 × 3–4.5 μm, elliptical, smooth; spore print white.

Scattered or clustered on the ground under oaks or hickory in woods; early to late fall.

This is a relatively common late-fall mushroom but is often not seen, because it is under the cover of recently fallen leaves.

Lepiotaceae

This family is characterized by rounded to nearly flat caps at maturity, scaly to smooth; scales are part of the cap tissue, not remnants of a universal veil. Cap margins are entire, fringed, or striate. Flesh is white, thick, and soft to firm, unchanging or bruising yellow or reddish brown. Partial veil is present when young, persisting as an annulus when mature.

Gills are free, close to crowded, and white to light tan or greenish.

Stalks are somewhat enlarged toward the base, smooth to hairy scaly, with a prominent annulus, which becomes loose on the stalk in the larger species. The lack of a volva in the Lepiotaceae clearly distinguishes this group from the Amanitaceae.

Spores vary from elliptical to ovoid; spore prints are white in all except *Chlorophyllum molybdites,* which has green spores and a green spore print.

This family presents problems for mushroom collectors. It resembles *Amanita* species. In addition, some small species of the Lepiotaceae are reported to contain alpha-amanitin and thus have the potential to cause severe illness or death.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Spore print green; gills green at maturity: *Chlorophyllum molybdites*, page 87
1b. Spore print white: 2
2a. Cap surface smooth or fibrillose but lacking distinct scales: 3
2b. Cap surface with scales which do not rub off easily: 4
3a. Cap smooth, white: *Leucoagaricus naucinus*, page 91
3b. Cap fibrillose, some shade of red: *Lepiota rubrotincta*, page 89
4a. Cap large (6–24 cm); stalk long (12–30 cm): *Macrolepiota rhacodes*, page 93
4b. Cap smaller (2–5 cm); stalk shorter (2.5–7 cm): 5
5a. Cap dull reddish brown; reddish brown scales exposing whitish flesh: *Lepiota cristata*, page 89
5b. Cap lemon-yellow to cream-yellow; surface powdery or scaly yellow: *Leucocoprinus birnbaumii*, page 91

Chlorophyllum molybdites (Meyer) Massee (plate 43) **POISONOUS**

Cap 10–30 cm broad; hemispheric, maturing to nearly flat, often with broad central raised area; white to tan to cinnamon-brown, cracking to form patchy scales above white flesh; dry. Flesh firm; white.

Gills free, crowded; white maturing to green, bruising yellow-brown.

Stalk 5–25 cm long, 1–2.5 cm thick, smooth; white, staining brownish, especially toward enlarged base.

Annulus thick, firm; white, discoloring brown beneath; may become movable.

Spores 9–12 × 6.5–8 μm, elliptical, thick-walled; apical pore; spore print pale dull green, distinguishing it from the edible *Macrolepiota* species.

Scattered or forming fairy rings in lawns or pastures, especially following heavy rains; summer, early fall.

A fairy ring (pl. 2) is a striking phenomenon in itself, but closer inspection reveals another interesting characteristic. A band of lighter green grass is found outside the mushroom ring and a ring of lush, dark green grass inside it. The mycelium of the fungus is growing vigorously in advance of the ring of fruiting bodies, using soil nitrogen and other nutrients in its assimilation of cellulose. Behind the ring, the mycelium is dying. The nitrogen and other nutrients are released and quickly used by the grass.

This mushroom may be mistaken for edible species, so spore prints should be made before eating it. The green spore print will distinguish *C. molybdites*. This mushroom is not poisonous to all people but causes severe illness in some. This species has been known as *Lepiota morgani* or *L. molybdites* and is very common in moist years, producing spectacular fruitings.

PLATE 43. *Chlorophyllum molybdites*

PLATE 44. *Lepiota cristata*

PLATE 45. *Lepiota rubrotincta*

Lepiota cristata (Bolt.) Kumm. (plate 44) POISONOUS

Cap 1–5 cm broad, rounded oval, maturing nearly flat with central knob; dull reddish to reddish brown when young, breaking into small reddish brown scales that expose the whitish surface underneath; central knob remaining reddish brown and smooth; scales often in concentric circles and finer at edge; margin striate. Flesh thin; white.

Gills free, crowded; white; edges slightly wavy.

Stalk 3–5 cm long, 2–5 mm thick, equal; whitish or dingy pinkish to brownish at base; smooth or slightly downy.

Annulus fragile, often quickly breaking and disappearing; white.

Spores 6–8 × 3–4 μm, tapered on one end (wedge-shaped); spore print white.

Several to scattered on the ground in woods or grassy areas; summer, fall.

These mushrooms are most common during the summer in years of plentiful rainfall. They are small enough to escape notice. Some small species of *Lepiota* are potentially deadly poisonous and should be avoided.

Lepiota rubrotincta Pk. (plate 45) NOT RECOMMENDED

Cap 2–8 cm broad, rounded at first (convex), becoming flattened; surface at first smooth and pinkish to reddish brown and fibrillose, becoming rimose (cap cuticle separates longitudinally from near center to margin, producing radiating pattern of fissures like spokes in wheel) when expanded; color separated by white cracks; sometimes appearing scaly, but scaly areas never raised; center of cap remaining darker than margins.

Gills free, white, narrow, close; cystidia on edge.

Stalk 4–16 cm long, 3–10 mm thick, white, smooth.

Annulus white, persistent; edge sometimes reddish in color.

Spores 6–10 × 4–6 μm, elliptical, smooth; spore print white.

Single to scattered on soil and leaf litter; summer, fall.

This mushroom has recently been interpreted as *Leucoagaricus rubrotinctus*.

PLATE 46. *Leucoagaricus naucinus*

PLATE 47. *Leucocoprinus birnbaumii*

Leucoagaricus naucinus (Fr.) Sing. (plate 46) NOT RECOMMENDED

Cap 4–8 cm broad; ovoid, maturing to rounded and finally flattened; dull white or rarely gray, finally tannish; dry, smooth to sometimes minutely scaly. Flesh thick, soft; white.

Gills free, crowded; white, maturing pinkish gray; rounded near stalk.

Stalk 5–12 cm long, 1–2 cm thick, nearly equal, enlarged to a bulbous base; same color as cap; smooth above annulus, silky below.

Annulus membranous, thick; white; stiff and collarlike.

Spores 7–9 × 5–6 μm, ovoid or nearly so, thick-walled; small apical pore; spore print usually white, sometimes pinkish.

Scattered in lawns, in pastures, and occasionally under hardwoods, especially after heavy rains; summer, fall.

We do not recommend eating this species, because it can easily be confused with the poisonous white *Amanita*s. In addition, some forms of this species have been reported to cause gastric disturbances. It is also known as *Lepiota naucina*.

Leucocoprinus birnbaumii (Corda) Sing. (plate 47) POISONOUS

Cap 3–6 cm broad, bell-shaped, becoming conical to nearly flat with central knob; lemon-yellow, fading to cream-yellow; surface scaly or powdery; margin deeply striate. Flesh very thin; light yellow.

Gills free, crowded, thin; yellowish cream.

Stalk 3–8 cm long, 1.5–5 mm thick, often enlarged toward base; usually with evident powdery yellow scales.

Annulus lemon-yellow, readily breaking down.

Spores 8–13 × 5–8 μm, elliptical, smooth; spore print white.

Several to numerous on the ground in leaf litter or compost outdoors in southern United States; on soil of potted greenhouse plants; summer, fall outdoors or any season in greenhouse and house plant soils.

We know this species as a mushroom occurring with potted plants in greenhouse beds, but it is a widely distributed field species in the southern United States in summer. This mushroom has been known as *Lepiota lutea* and *Leucocoprinus luteus*. *Leucocoprinus birnbaumii* and many small species of *Lepiota* are reported to be poisonous.

PLATE 48. *Macrolepiota rhacodes*

Macrolepiota rhacodes (Vittadini) Sing.

(plate 48) EDIBLE WITH CAUTION

Cap 6–20 cm broad, dry, conic to rounded to nearly flat at maturity; gray-brown to reddish brown, fracturing to form concentric rings of upturned scales, exposing lighter flesh beneath; low central knob smooth, brownish. Flesh whitish (or pinkish at cuticle surface), bruising orange-red but soon becoming red-brown.

Gills free, close; whitish buff, bruising to yellowish brown or darker brown.

Stalk 10–15 cm long, 1.5–3 cm thick, club-shaped, enlarging to bulbous base; white above annulus, grayish white below, with gray-brown hairs above bulb; surface bruising red-brown; flesh bruising like cap flesh.

Annulus soft, thick, two-layered; white; becoming movable.

Spores 8–10 × 6–7 µm, broadly elliptical; spore print white.

Single to clustered in lawns, in leaf and compost piles, in open areas or under trees, often forming fairy rings; late summer, fall.

Another large species, *M. procera*, is also a late summer into fall species. It does not stain orange-red becoming red-brown, as do the stalk and cap tissue of *M. rhacodes*. Both species have been reported to be edible, even choice, but are recommended with caution because of the possibility of misidentification and confusion with *Amanita* and *Chlorophyllum* species. This mushroom has recently been interpreted as *Chlorophyllum rhacodes* and is also known as *Lepiota rhacodes*.

Pluteaceae

This family is represented by relatively few species in the Midwest, but some are spectacular and well known.

Caps are rounded to bell-shaped, ranging from white to gray through light brown to red, yellow, olive, and dark brown. The flesh is generally thin, white to off-white, soft in texture, with a smooth to somewhat fibrillar (silky-hairy) surface. The margins are hairy-fringed or sometimes striate. Gills are free from the stalk, whitish when young, maturing to pinkish or even brownish pink.

Stalks are thick, varying in color but often lighter shades of the cap color, and the surface texture resembles that of the caps. *Volvariella* species typically have a prominent volva enclosing the base of the stalk.

The salmon to pink spores are elliptical and smooth. These features along with the free gills are the most distinctive characteristics of mature specimens. Spore prints likewise vary from light pink to salmon to pinkish brown in heavy deposits.

We are not aware of any poisonous species in this family, but the species that fruit locally have not been favorites for eating.

Pluteus admirabilis (Pk.) Pk. (plate 49) EDIBLE, NOT RECOMMENDED

Cap 1–3 cm broad, rounded to campanulate, knobbed when mature; moist, smooth to wrinkled and darker yellow in center; margin striate when young. Flesh whitish, thin.

Gills free, crowded, smooth, pale off-white, becoming pink.

Stalk 2–6 cm long, 1–3 mm thick, equal and thin, smooth, moist, light yellow.

Spores 5–7 × 4.5–6 μm, elliptical, smooth; spore print salmon to pink.

Single to several on decaying downed hardwood; spring, summer, fall.

The delicate yellow cap with pink gills and thin yellow stalk which splits easily make this species distinct from related species. This mushroom fruits in low numbers and is too small to be of interest for eating. *P. lutescens*, another small, common species with a light yellow stalk, has a brownish cap. *P. aurantiorugosus* is a small to medium, less common species, with an orange to reddish cap. All of these mushrooms fruit on wood.

PLATE 49. *Pluteus admirabilis*

PLATE 50. *Pluteus cervinus*. A: Young with white gills, B: Mature with pink gills

PLATE 51. *Volvariella bombycina*. A: Immature, B: Mature

Pluteus cervinus (Schaeff.: Fr.) Kumm. (plate 50A, B)

EDIBLE, NOT RECOMMENDED

Deer Mushroom

Cap 3–12 cm broad, conic to bell-shaped or rounded to flattened at maturity; whitish, tan, or grayish brown, often with darker fibrils in streaks over raised center; frequently slightly wrinkled, dull when dry. Flesh thin at margins to thick at center; white.

Gills free, crowded; white, becoming pink.

Stalk 5–15 cm long, 0.5–1.5 cm thick, enlarged at base; white tinted brown or dull brown with appressed hairs.

Spores 5.5–7 × 4–6 μm, elliptical, smooth; spore print salmon to pink.

Single to several on decaying hardwoods and conifers, sawdust, and buried wood; spring, summer, fall.

Large distinctive sterile cells called pleurocystidia occur scattered among the basidia on sides of gills, 54–90 × 12–20 μm; somewhat spindle-shaped and inflated in middle, with two to five tapered hornlike projections around apex.

This common variable mushroom may be a complex of varieties or species. The gills are white at first (pl. 50A) and turn pink with maturity (pl. 50B). It is not considered a good edible and might be confused with similarly colored poisonous *Entoloma* species (which occur on soil). A number of other species of *Pluteus* occur on wood.

Volvariella bombycina (Schaeff.: Fr.) Sing. (plate 51A, B)

EDIBLE

Cap 5–20 cm broad, rounded to bell-shaped; white to yellowish; silky fibrillose to shiny, margin fringed with fine hairs. Flesh thick over cap center and thin at edges; soft; white.

Gills free; white, becoming pink to rose at maturity; edges finely toothed.

Stalk 5–18 cm long, 1–2 cm thick, enlarged at base; white; silky, dry.

Volva deep enclosing base as loose, cuplike bag; dull whitish, discoloring yellowish.

Spores 6.5–10.5 × 4.5–6.5 μm, broadly elliptical, smooth; spore print salmon to pink.

Single to several on hardwood logs, in knotholes, or in crotches of living trees; late summer, fall.

The fruiting body in plate 51 was photographed three days apart in the crotch of a living elm tree.

Volvariella speciosa (Fr.) Sing. (plate 52) NOT RECOMMENDED

Cap 5–15 cm broad, ovoid to globose, expanding to convex or plane, more or less raised in center; whitish to light tan, often darker in center; viscid, smooth, sometimes with pieces of universal veil adhering. Flesh soft, thinner toward margin, breaking radially under rapid-drying field situations; white.

Gills free, crowded; white, becoming deep flesh pink; edges somewhat uneven.

Stalk 9–20 cm long, 0.8–2 cm thick, sometimes enlarging toward base; white to cream; solid, smooth to slightly hairy.

Volva shallow; margin free from stalk; white to light gray.

Spores 11–20 × 7–12 µm, oval to ovoid, smooth; spore print deep flesh pink.

Single to small clusters in heavily manured or fertilized soils; especially in woodlands or cornfields in spring, when very wet.

Spectacular numbers of mushrooms may develop in a cornfield one spring, with no further indication of the fungus for years. The cap on the left mushroom in plate 52 has split, following heavy rains. This species may not actually be poisonous, but it is so similar to other species of *Volvariella* that have been reported to be poisonous that they could easily be confused. This species also has been interpreted as *V. gloiocephala*.

PLATE 52. *Volvariella speciosa*

Russulaceae

The two genera in this family, *Russula* and *Lactarius*, are characterized by rounded to depressed caps and gills composed of tissue with groups of large, round cells intermixed with regular cellular hyphae. Cap margins vary from inrolled, entire, or striate to split. Flesh is usually brittle and dry. *Lactarius* contains latex-producing cells; the latex is apparent when the gills or other tissues of young mushrooms are cut. Color changes in the latex are important in identifying species of *Lactarius*. *Russula* lacks latex cells, but the gill and cap flesh may change color following cutting or bruising.

Gills of *Russula* and *Lactarius* are adnate or decurrent, range from close to distant, and are white to cream to yellow. Gills of *Russula* species break and crumble easily.

Stalks tend to be rather thick, equal, short, and often smooth and chalky or brittle in texture.

Spores are white to yellow, elliptical to nearly round, and roughened with warts and ridges developed in the spore wall. These wall ornamentations exhibit an amyloid (blue) reaction in Melzer's solution; spore prints are white to cream or yellow.

This group contains poisonous as well as edible mushrooms, so it is not suitable for experimentation. Species such as *Lactarius deliciosus* often fruit in large numbers and are favorites of mushroom hunters who know them. Many of the species are associated with specific hardwood or conifer trees, and most are probably mycorrhizal associates. Both genera are large, and identification of collections can be a frustrating challenge.

Characteristic field aspects of these mushrooms are their short stalks; broad, often brightly colored caps; and gills (particularly those of *Russula* species) which break and crumble easily.

Key to the Genera in This Guide

1a. Cap exuding latex when cut or broken: 2, *Lactarius*
1b. Cap not exuding latex when cut or broken: 9, *Russula*

Key to the Species of *Lactarius* in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

2a. Latex initially white: 3
2b. Latex initially colored: 8
3a. Cap obviously hairy or cottony, especially on margin: *L. torminosus*, page 107

3b. Cap smooth or only slightly cottony on margin: 4

4a. Cap smooth, white, latex unchanging to slowly drying yellow or green or staining gills yellowish or green, gills frequently forked: *L. piperatus*, page 105

4b. Cap tomentose (densely covered with matted hairs) and white or differently colored, latex changing, staining gills a color other than yellowish, gills not forked: 5

5a. Latex changing, slowly staining gills dingy gray-green: *L. argillaceifolius* var. *argillaceifolius*, page 101

5b. Latex changing, slowly staining gills brown or pink to rose: 6

6a. Latex changing, white to cream-gray, staining gills lilac-tan; cap lilac to violet: *L. uvidus*, page 107

6b. Latex slowly changing brown: 7

7a. Cap minutely velvety woolly, dull white to creamy tan: *L. subvellereus* var. *subdistans*, page 105

7b. Cap dry, smooth, buff to orange-brown: *L. volemus*, page 109

8a. Latex bright blue; cap zoned blue: *L. indigo*, page 103

8b. Latex carrot-orange, staining flesh green; cap zoned carrot-orange: *L. deliciosus*, page 103

Key to the Species of *Russula* in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

9a. Cap bright red or red-orange: *R. emetica* group, page 113

9b. Cap not as above, another color or white: 10

10a. Cap yellow or yellowish brown: 11

10b. Cap other than yellowish: 12

11a. Cap yellowish brown, sticky to viscid, very striate: *R. foetens* group, page 115

11b. Cap yellow to pale yellow, dry, not striate: *R. ochroleucoides*, page 115

12a. Cap reddish purple, often mixed with green or olive, gills forking two or three times: *R. variata*, page 117

12b. Cap never tinted reddish purple, gills not regularly forked: 13

13a. Cap green to grayish green: *R. aeruginea*, page 109, *R. virescens*, page 117

13b. Cap whitish, not green: 14

14a. Cap white, staining dull yellow to brownish; flesh brittle, white: *R. brevipes*, page 111

14b. Cap white, aging brownish black; flesh white, slowly bruising reddish then black, gills alternating long and short: *R. dissimulans*, page 111

Lactarius argillaceifolius Hesl. & Sm. var. ***argillaceifolius***

(plate 53) NOT RECOMMENDED

Cap 5–18 cm broad, rounded, maturing to flattened and finally depressed; pink to lavender-gray or yellowish brown to cinnamon; surface slimy, viscid, and glabrous; margin incurved, downy to smooth or obscurely zonate. Flesh thick, firm; white; latex cream-colored, slowly staining gills dingy gray-brown or gray-green.

Gills adnate to subdecurrent (appearing to extend down the stalk somewhat), close to subdistant; pallid or pale tan.

Stalk 5–10 cm long, 1.5–3 cm thick, equal; tan to pale cinnamon; often hollow, slimy, becoming dry.

Spores 7–10 × 6–8 μm, subglobose to broadly elliptical; ornamented by interrupted network to warty; spore print pinkish buff.

Solitary to gregarious on the ground in hardwood forests; late summer.

This mushroom is usually present and is common in some years. It has been known as *L. trivialis* in North America and is a variable species.

PLATE 53. *Lactarius argillaceifolius*

PLATE 54. *Lactarius deliciosus*

PLATE 55A and B. *Lactarius indigo*

Lactarius deliciosus (L.: Fr.) S. F. Gray (plate 54) EDIBLE

Cap 5–15 cm, rounded, maturing to flat or funnel-shaped; carrot-orange with concentric rings of darker orange and varied amounts of dull green, zoned with 3 to 6 distinctly orange-rust zones 1–3 mm wide; viscid to sticky in wet weather; margin incurved. Flesh pale yellow-orange, staining green; latex carrot-orange, leaving green stains on flesh.

Gills crowded, decurrent; bright orange, slowly becoming green when bruised.

Stalk 3–8 cm long, 1.5–3 cm thick, narrowed at base; paler than cap, bruising green when handled or at maturity; dry.

Spores 7–9 × 6–7 μm, elliptical to nearly round, with warts and thickened bands on spore walls; spore print cream to buff.

Single to scattered on the ground in coniferous woods, especially common under pines; late summer, fall.

This species has several recognized varieties.

Lactarius indigo (Schw.) Fr. (plate 55A, B) EDIBLE

Cap 5–15 cm broad, rounded to depressed in center; dark blue, usually zoned, fading to pale blue-gray; surface sticky to smooth; margin inrolled at first. Flesh white, bruising blue or becoming blue when cut then turning blue-green to dark green with exposure; latex scant, dark blue, changing to blue-green or dark green.

Gills adnate to subdecurrent, close; dark blue, aging to pale blue-gray.

Stalk 2–8 cm long, 1–2.5 cm thick, often tapered; dark blue to silver-blue; hollow when mature, dry.

Spores 7–9 × 5.5–7.5 μm, broad elliptical to round, amyloid; spore print cream.

Scattered on the ground in hardwood or coniferous woods; summer, fall.

This bright indigo *Lactarius* is usually a fall species in the Midwest.

PLATE 56. *Lactarius piperatus* var. *piperatus*

PLATE 57. *Lactarius subvellereus* var. *subdistans*

Lactarius piperatus var. ***piperatus*** (Fr.) S. F. Gray
(plate 56) **POISONOUS?**

Cap 5–15 cm broad, convex, becoming flat to finally depressed, funnel-shaped; white, staining creamy white to dingy tan with age; surface dry, smooth to slightly uneven; margin even. Flesh white, unchanging to sometimes yellowish; latex white, unchanging to slowly drying yellow or staining gills yellowish; very peppery taste.

Gills attached, crowded, narrow; white, becoming pale cream; many forked one or more times.

Stalk 2–8 cm long, 1–2.5 cm thick, not tapering; white; dry, solid.

Spores 5–7 × 5–6 µm, broadly elliptical; warts and ridges amyloid; spore print white.

Scattered to clustered on the ground under hardwoods; summer, fall.

The very crowded, frequently forked gills are a very important characteristic in identifying this species. *L. piperatus* var. *glaucescens* is similar, but the latex dries greenish in color; this variety is known to be poisonous.

Lactarius subvellereus (Pk.) var. ***subdistans*** Hesl. & Sm.
(plate 57) NOT RECOMMENDED

Cap 5–15 cm broad, rounded to flattened to depressed; dull white to creamy tan; dry, minutely velvety woolly; margin inrolled at first but soon flattened. Flesh firm, thick; white; latex cream-white, turning slowly brownish.

Gills short, decurrent, crowded; white to creamy tan, slowly staining brown when cut.

Stalk 2–5 cm long, 1.5–3.5 cm thick, equal; dull white to cream; dry with minute velvety surface.

Spores 7.5–9 × 5–6.5 µm, elliptical; surface warty, amyloid; spore print white.

Single to scattered on the ground in hardwood or mixed forests, particularly under oaks; summer, fall.

This species has been known as *L. vellereus* in the past, but it is now evident that the smaller-spored *L. subvellereus* is separate. Some people eat this mushroom, but it is definitely toxic to others and thus cannot be recommended. Similar species have inrolled caps with a cottony roll at the margin.

PLATE 58. *Lactarius torminosus* var. *nordmanensis*

PLATE 59. *Lactarius uvidus*

Lactarius torminosus (Schaeff.) S. F. Gray var. ***nordmanensis*** (A. H. Sm.) Hesl. & A. H. Sm. (plate 58) **POISONOUS**

Woolly Milk Cap

Cap 4–10 cm across; depressed in center, margins curled under at first, becoming plane (flat); hairy, especially on margins; pale pink to cinnamon, fading to whitish.

Gills whitish or pale pinkish, becoming tan; latex white, slowly changing to cream-colored; acrid taste.

Stalk 3–7 cm long, 1–2.5 cm thick, straight, same color as cap, smooth.

Spores 8–11 × 6–8 µm, elliptical, with warts and ridges; spore print white.

Several scattered or in groups on the ground under hardwoods and conifers, particularly under birch, not uncommon; late summer, fall.

This mushroom is recognized by its hairy cap, smooth stem, and association with birch. Another variety has a slightly zonate cap, cream-colored spore print, and latex that does not change color. The very similar *L. pubescens* can be differentiated by its smaller spore size.

Lactarius uvidus (Fr.) Fr. (plate 59) **POISONOUS**

Cap 3–10 cm broad, rounded to flat, finally depressed; pale lilac, darkening, unzoned; margin inrolled initially, smooth, sticky to dry. Flesh whitish gray; latex white turning cream-gray, staining flesh dull lilac.

Gills attached, close; cream, becoming dull lilac to tan when bruised.

Stalk 3–7 cm long, 1–1.5 cm thick; whitish, often stained ocher-yellow at base; sticky to shiny dry.

Spores 7.5–9.5 × 6.5–7.5 µm, rounded to broadly elliptical, amyloid, with widely spaced bands and ridges; spore print pale yellow.

Single to scattered on the ground under pine, mixed hardwood-conifer woods; summer, fall.

PLATE 60. *Lactarius volemus*

PLATE 61. *Russula aeruginea*

Lactarius volemus (Fr.: Fr.) Fr. (plate 60) EDIBLE

Cap 5–10 cm broad, rounded, becoming depressed; rusty tawny to rusty orange-buff to orange-brown; dry, smooth. Flesh white to dull white, slowly bruising dark brown; latex white, slowly changing to brownish.

Gills adnate to decurrent, crowded; same color as cap or lighter, bruising brownish.

Stalk 5–8 cm long, 1–2 cm thick; same color as cap or lighter, staining darker than cap.

Spores 7–10 × 7.5–8.5 µm, nearly round, with ridges; spore print white.

Scattered on the ground under hardwoods, not uncommon during hot, wet weather; summer, early fall.

A similar species, *L. corrugis,* differs in having a more distinctly velvety dark brown cap with a corrugated surface and somewhat larger spores. Both species occur primarily in deciduous woods.

Russula aeruginea Fr. (plate 61) EDIBLE

Cap 3–8 cm broad, broadly rounded, becoming depressed in center; dull green to darker green or smoky green with darker center and sometimes paler brownish margin; viscid when wet, slightly velvety when dry; margin slightly striate with age. Flesh thick in center, thinner at margin; white or greenish under surface.

Gills narrowly attached to nearly free, close to subdistant, equal or with a few shorter ones; white, becoming cream.

Stalk 4–6 cm long, 1–2 cm thick, nearly equal; white; smooth.

Spores 7–9 × 5.5–7 µm, subglobose; white, ornamented with small separate warts and a few small ridges; spore print white to cream.

Solitary or grouped on the ground in coniferous or mixed woods; summer, fall.

This species is distinguished from the other green-capped species *R. virescens* and *R. crustosa* by its smooth cap surface that does not break up into patches.

PLATE 62. *Russula brevipes*

PLATE 63. *Russula dissimulans*

Russula brevipes Pk. (plate 62) NOT EDIBLE

Cap 10–20 cm broad, rounded with depressed center, becoming deeply depressed; white, staining dull yellow to brownish; surface dry, minutely woolly; entire margin inrolled. Flesh brittle; white.

Gills attached to slightly decurrent, close to crowded, alternately long and short; white, staining brownish.

Stalk 2.5–5 cm long, 2.5–4 cm thick; dull white, staining brownish; dry, smooth.

Spores 8–11 × 6.5–10 μm, broadly elliptical, amyloid, with partial to complete reticulation; spore print white to cream.

Scattered on the ground under hardwoods or conifers; summer, fall.

This species may have been reported as *R. delica,* which has more widely spaced gills, however, and apparently does not occur in the Midwest. The mushrooms are often partially covered by the soil and leaf litter through which they emerge. Some may remain concealed, and collectors can easily miss rather large groups.

Russula dissimulans Shaffer (plate 63) NOT RECOMMENDED

Cap 7–15 cm broad, rounded to flattened or depressed; whitish, becoming smoky to brownish black; viscid when moist; margin incurved. Flesh white, slowly turning reddish upon bruising or cutting then becoming black.

Gills adnexed, unequal, alternating long and short, broad, close to subdistant; white, becoming reddish then black when bruised.

Stalk 3–6 cm long, 1.5–2.5 cm thick, equal; whitish, becoming smoky brown with age, changing to reddish then to black when bruised.

Spores 7.5–11 × 6.5–9 μm, nearly round; wall with low warts joined by network of fine ridges; spore print white.

Single to scattered on the ground in woods or openings; late summer.

Some people consider this an edible mushroom, despite its unattractive appearance as it matures. Others, however, report gastric upset after ingestion. Therefore this species and others of the group are not recommended.

R. dissimulans is one of a small group of *Russula* species with alternate long and short gills and flesh that becomes blackish with age or with bruising. Old fruiting bodies of *R. dissimulans* may be completely blackened. *R. dissimulans* is distinguished from the very similar *R. nigricans* by more closely spaced gills and slightly larger spores and from *R. densifolia* by more well-separated gills. These species may easily be misinterpreted, with some confusion about their frequency of occurrence and their habitats. *R. dissimulans* is often parasitized

PLATE 64A and B. *Russula emetica* group by *Asterophora lycoperdoides*. The parasite produces a number of small mushrooms from the cap or occasionally from the stalk of the parasitized specimen.

Russula emetica group (Schaeff.: Fr.) Pers. (plate 64A, B) **POISONOUS?**

Cap 5–10 cm broad, rounded, becoming depressed; red to red-orange, fading with age or damp weather; cuticle leaves pink stain when peeled; margin striate, upturned in maturity. Flesh soft, fragile; white, pink just under cap surface; very hot peppery taste.

Gills attached, crowded; white; sometimes forked.

Stalk 5–10 cm long, 2.5–3 cm thick, usually longer than cap width; dull white; equal, often ridged, fragile, hollow at maturity.

Spores 8–10 × 6–8 μm, round or nearly so, with warty ridges; spore print yellow.

Single or in groups on the ground in deep moss or near rotting conifers; summer, fall.

The description here probably includes a number of bright red-capped species with white gills, white spores, a white stalk, and a peppery taste constituting the *Russula emetica* group. Other species of red *Russula*s are not included in the *emetica* group. They should all be avoided for eating but are often colorful and impressive in the woods.

PLATE 65. *Russula foetens*

PLATE 66. *Russula ochroleucoides*

Russula foetens (Pers.) Pers. group (plate 65) NOT RECOMMENDED

Cap 5–14 cm broad, broadly convex to slightly depressed; yellowish to brownish yellow; sticky to viscid in wet weather, smooth; margin tuberculate-striate; odor becoming stronger and fetid with age. Flesh thin, rather fragile; dingy white.

Gills adnexed, rather close, broad; white, becoming yellowish with age and bruising slightly darker, exuding drops of water when young; sometimes forked.

Stalk 3–6 cm long, 1–2.5 cm thick, equal; dull white, becoming brownish with age; smooth.

Spores 8.5–10 × 8–9 µm, almost round, with coarse projections; spore print white.

Scattered or in clusters on the ground under hardwoods or in mixed woods; summer.

R. foetens is part of a complex of similar species. All have yellowish to yellow-brown strongly striate caps, with a disagreeable taste and odor. They should all be avoided but are not likely to be eaten because of the unpleasant odor.

Russula ochroleucoides Kauff. (plate 66) NOT RECOMMENDED

Cap 4–12 cm in diameter, convex to hemispherical, becoming flattened or slightly depressed in center; yellow to pale yellow, sometimes brownish; dry, dull. Flesh white, hard, brittle.

Gills close, attached; white-cream to pale yellow with age.

Stalk 4–7 cm long, 1.5–2 cm thick, equal or tapered at base; white; smooth to minutely frosted.

Smooth globose to ovoid, 7–8.5 × 5.5–7 µm, hyaline (colorless), with warts and ridges making partial reticulum (net); spore print pale yellow.

Single or scattered on the ground in deciduous or mixed woods, especially with oak; mycorrhizal; summer, fall.

This species is not unusual in some years.

PLATE 67. *Russula variata*
A (Above): Fruiting bodies
B (Right): Close-up of forked gills

PLATE 68. *Russula virescens*

Russula variata Banning (plate 67A, B) EDIBLE

Cap 5–15 cm, rounded to depressed in center; reddish purple to brownish purple, often mixed with olive or green, sometimes quite greenish; viscid and shiny, becoming dry; margin cracking with age. Flesh firm; white to grayish just under surface.

Gills adnate to slightly decurrent, close to crowded, narrow; white; forking two or three times, usually some distance from stalk.

Stalk 3–9 × 1–3 cm, dull; whitish or stained brownish at base.

Spores 7.5–10 × 6–8.5 µm, subglobose; ornamented with low warts; spore print white.

Often common, scattered to loosely clustered on the ground under hardwoods; early summer, early fall.

The confusing mix of cap colors and the narrow forked gills (pl. 67B) are distinguishing field characteristics.

Russula virescens (Schaeff.) Fr. (plate 68) EDIBLE

Fruiting bodies 5–12 cm, cap plane when mature, depressed on disc, firm; upper surface dry; green to grayish green, broken into crustlike patches, with cracks exposing white flesh.

Gills attached; white; close, with few to no cystidia.

Stalk 3–7 cm long, 1–2 cm thick; white, firm, equal, browning slightly with age or when handled.

Spores subglobose, 6–9 × 6–7 µm, ornamentation variable, from warts to reticulations (warts with connections to form net); spore print white.

Single to several scattered on the ground in woods; summer.

Three other green species of *Russula* occur in Iowa, all of which have a cream rather than white spore print. *R. crustosa,* another edible species, is very similar in appearance to *R. virescens* but has numerous cystidia (sterile cells) on the gills and varies in color from cream-white to blue-green to brown. *R. aeruginea* is olive to yellowish green and has a smooth cap. Greenish forms of *R. variata* differ in having smooth caps and gills that are dichotomously forked.

Strophariaceae

This family includes mushrooms with spore prints ranging from purple-brown to yellow-brown. The fruiting bodies somewhat resemble those of the Coprinaceae but are more pliant and tend to be brighter. *Pholiota* has often been placed with the Cortinariaceae but is included here because of the microscopic apical pore, which is a spore characteristic of all other genera in the Strophariaceae.

Caps range from bright yellow to green or brown tints and are usually viscid or scaly, rounded to flattened at maturity, with margins that are often scaly or hairy. Gills are adnate, close to well separated, and yellowish to darker with spores at maturity.

Stalks vary from thin to thick, smooth to hairy or scaly, with or without an annulus; some have a slightly enlarged base.

Spores are smooth, usually more or less elliptical with an apical pore; spore prints are yellow-brown or rust-brown to purple-brown.

Several species of *Stropharia, Hypholoma,* and *Pholiota* are poisonous. Some *Psilocybe* species are reported to be hallucinogenic when consumed in moderate amounts but definitely toxic in larger amounts. Exercise caution when eating any members of this family.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Annulus well developed and persistent: *Stropharia coronilla*, page 123
1b. Annulus absent or disappearing with age, thin: 2
2a. Cap margin buff to cinnamon, center brick-red, densely clustered, spore print purple-gray: *Hypholoma sublateritium*, page 119
2b. Cap not so pigmented, spore print rusty brown to purple-brown: 3
3a. Gills dark brown with white edges; cap viscid, brown: *Psilocybe* spp., page 123
3b. Gills rusty brown, uniform in color: 4
4a. Partial veil cottony, fruiting bodies single or in small clusters, on logs of cottonwood, aspen, or poplar: *Pholiota destruens*, page 121
4b. Partial veil thin, fruiting bodies densely clustered, on various wood species: *Pholiota squarrosa*, page 121

Hypholoma sublateritium (Schaeff.) Quél. (plate 69) EDIBLE

Brick Cap

Cap 2–10 cm broad, rounded to almost flat; brick-red center, buff to cinnamon at margin; moist; margin inrolled at first. Flesh whitish brown, bruising or maturing yellowish.

Gills attached, crowded; white to yellowish, changing to gray to smoky purplish brown at maturity.

Stalk 5–10 cm long, 0.5–1.5 cm thick, equal; whitish above annulus, darkening to brown below, with flattened hairs.

Annulus thin, yellowish buff; partial veil fragments may also be attached to cap margin but dry quickly and disappear.

Spores 6–7.5 × 3.5–4 µm, elliptical; spore print purple-gray.

Dense clusters on hardwood stumps and logs; late summer, fall.

This species is also known as *Naematoloma sublateritium*.

PLATE 69. *Hypholoma sublateritium*

PLATE 70. *Pholiota destruens*

PLATE 71. *Pholiota squarrosa*

Pholiota destruens (Brond.) Gill. (plate 70) NOT RECOMMENDED

Cap 8–16 cm broad, rounded, often with central knob; creamy, maturing to light brown with scattered, large, soft, whitish to buff scales; surface slimy when wet, often cracking across top; partial veil remnants hanging from margin. Flesh firm; white.

Gills attached to notched, crowded; white to cinnamon at maturity.

Stalk 5–18 cm long, 1–3 cm thick, commonly enlarged at base; white above ring, densely scaly below, maturing darker tan to brown.

Annulus attached high on stalk near gills, loose; sometimes disappearing with age.

Spores 7–9.5 × 4–5.5 µm, elliptical, smooth; apical pore; spore print brown.

Single to densely clustered on ends of logs or on standing wood of cottonwood, aspen, and poplar; fall.

This mushroom is also known as *P. populnea*.

Pholiota squarrosa (Weigel) Kumm. (plate 71) NOT RECOMMENDED

Cap 3–12 cm broad, bell-shaped to rounded, broadening with maturity; yellowish to brownish yellow, covered with tan to brown upturned scales in concentric rings; surface dry; margin wavy with partial veil remnants. Flesh firm; pale yellow.

Gills attached and sometimes notched, narrow, crowded; yellowish or tinged greenish brown, finally dull rusty brown at maturity.

Stalk 4–12 cm long, 0.5–1.5 cm thick, equal; covered with tan to yellow-brown curved scales below annulus, smooth above.

Annulus whitish; partial veil membranous; remnants hanging from edge of cap, disappearing with age.

Spores 5–8 × 3.5–4.5 µm, elliptical, smooth; apical pore; spore print brown.

In dense clusters on hardwoods or conifers; fall.

This species often has a faint onionlike odor and is eaten by some people when it is young; others have suffered gastrointestinal upsets. *P. squarrosoides,* a similar species, also occurs in clusters on wood. It has a scaly cap that is viscid between the scales and has slightly smaller spores.

PLATE 72. *Psilocybe* sp.

PLATE 73. *Stropharia coronilla*

Psilocybe spp. (plate 72) NOT RECOMMENDED

Fruiting bodies small to medium with smooth caps, conic to rounded, on slender stalks; gills attached, purple-brown to darker brown.

Spores smooth with an apical germ pore; spore print purple-brown to chocolate brown.

Cap and stalk of some species stain greenish-blue with age or when bruised.

Saprobes on a variety of substrates including wood debris and dung, on soil, and among mosses.

This large genus contains hallucinogenic species containing psilocybin and psilocin. The macroscopic aspect of *Psilocybe* species is similar to those of several other purple-brown to chocolate brown spored genera. Species are often interpreted on an arbitrary basis.

Stropharia coronilla (Bull.) Fr. (plate 73) NOT RECOMMENDED

Cap 2–5 cm broad, rounded to nearly flat at maturity; pale yellowish to yellowish brown; moist to viscid. Flesh thick, soft; white.

Gills attached, close; lilac, becoming purple-black with white edges.

Stalk 2.5–4 cm long, 3–7 mm thick; white; minutely hairy above annulus, with shiny longer hairs below.

Annulus white, soon purple-brown from spores.

Spores 7–9 × 4–5 μm, elliptical, smooth; apical pore; spore print purple-brown.

Several to abundant on lawns and in openings in woods; late summer, fall.

This species is suspected of being poisonous, and is thus not recommended.

Tricholomataceae

This is a large and diverse mushroom family. All genera have attached gills. Many of the Tricholomataceae occur on wood, and mycologists often use this as a nontechnical characteristic of this very diverse group.

Caps vary from laterally attached and fan-shaped to rounded or flattened to depressed with a central stalk. Cap margins vary from even to inrolled, striate, wavy, or lobed. Flesh varies from white to shades of brown or gray.

Gills may be adnate, adnexed, or decurrent, close or crowded to distant, and white to brown or orange.

Stalks may be central to lateral or lacking. Texture and ornamentation also vary. *Armillaria*, *Cystoderma,* and *Pleurotus dryinus* have an annulus, but other genera lack this structure.

Spore prints are white or have light tints of lilac, buff, or yellow; spore shape varies from nearly round through elliptical, cylindrical, or tapered at one end, with smooth to roughened surfaces.

Edible mushrooms in this group include *Pleurotus ostreatus* and *P. sapidus*. People have long considered *Armillaria mellea* edible, but recent reports suggest that it may produce gastrointestinal disorders. The current recommendation is to consider it edible only if well cooked. *Clitocybe dealbata, Omphalotus illudens,* and a number of species of *Gymnopus* are toxic.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Fruiting bodies develop on parasitized mushrooms, usually species of *Russula* and *Lactarius: Asterophora lycoperdoides*, page 129
1b. Fruiting bodies on wood, litter on ground, or on the ground: 2
2a. Fruiting bodies directly attached to wood, single or in clusters: 3
2b. Fruiting bodies on litter on the ground or on the ground: 19
3a. Fruiting bodies usually single but sometimes in loose groups: 4
3b. Fruiting bodies in clusters: 7
4a. Fruiting bodies developing from branch scar sites, usually on living elm or box elder trees: *Hypsizygus ulmarius*, page 135
4b. Fruiting bodies developing on dead wood: 5
5a. Gills decurrent: *Omphalina epichysium*, page 149
5b. Gills adnate: 6
6a. Stalk short, sometimes eccentric, sometimes sessile, with raised network on cap: *Rhodotus palmatus*, page 157

6b. Stalk central, well-developed, cap with dark fibrils: *Megacollybia platyphylla*, page 145
7a. Fruiting bodies sessile, laterally attached: 8
7b. Fruiting bodies stalked: 11
8a. Gill edges coarsely toothed: *Lentinellus ursinus*, page 139
8b. Gill edges smooth: 9
9a. Cap smooth, viscid, green to yellow-green: *Panellus serotinus*, page 151
9b. Cap densely hairy over upper surface, dry, with no green tones: 10
10a. Upper and gill surfaces orange to orange tan: *Phyllotopsis nidulans*, page 153
10b. Upper surface violaceous to reddish brown, gill surface violaceous, becoming white: *Lentinus strigosus*, page 141
11a. Gills decurrent: 12
11b. Gills adnate or adnexed, not decurrent: 14
12a. Partial veil present when young, remnants persistent: *Pleurotus dryinus*, page 153
12b. Partial veil not present: 13
13a. Fruiting body white to tan or gray: *Pleurotus ostreatus*, page 155
13b. Fruiting body orange: *Omphalotus illudens*, page 151
14a. Cap bell-shaped even at maturity: 15
14b. Cap flat at maturity: 16
15a. Cap yellow to orange: *Mycena leaiana*, page 147
15b. Cap reddish gray to reddish brown; blood-red latex from stalk when broken: *Mycena haematopus*, page 147
16a. Partial veil cottony, becoming an annulus but not always well developed at maturity: *Armillaria* spp., page 126
16b. Lacking partial veil: 17
17a. Stalk velvety, brownish black: *Flammulina velutipes*, page 133
17b. Stalk smooth, not brownish black: 18
18a. Cap white, mushrooms developing from knotholes or wounds on trees, especially elm and box elder: *Hypsizygus ulmarius*, page 135
18b. Cap with gray fibrils, on downed logs or at base of stumps: *Megacollybia platyphylla*, page 145
19a. Fruiting bodies attached to litter on the ground or on basal bark of trees; caps thin, stalks slender, tough: 20
19b. Fruiting bodies developing through litter, caps fleshy: 22
20a. Cap orange, stalk brown and wiry: *Marasmius siccus*, page 145
20b. Cap white, stalk black: 21
21a. Gills attached to separate ring surrounding stalk; stalk black and wiry: *Marasmius rotula*, page 143
21b. Gills attached to stalk; stalk black under minute white hairs: *Marasmiellus nigripes*, page 141

22a. Fruiting bodies in clusters or close groups: 23
22b. Fruiting bodies single or loosely scattered: 26
23a. Fruiting bodies developing in a loose cluster from old walnut or hickory nut shells or husks buried in the litter or soil: *Mycena luteopallens*, page 149
23b. Not associated with old walnut or hickory nut husks: 24
24a. Caps and stalks bright orange, usually near wood or developing from wood in soil: *Omphalotus illudens*, page 151
24b. Caps and stalks not bright orange: 25
25a. Stalks rounded; cobwebby veil present, usually with some evidence of it remaining: *Armillaria* spp., page 126
25b. Stalks flattened; annulus lacking: *Gymnopus dryophilus*, page 135
26a. Fruiting bodies developing near wood, such as downed logs or stumps: *Megacollybia platyphylla*, page 145
26b. Fruiting bodies widely scattered on the ground: 27
27a. Gills somewhat thick, waxy, either some shade of purple or cinnamon to reddish tan: 28
27b. Gills narrow, not waxy; cap various colors: 29
28a. Cap whitish to light gray; gills some shade of purple: *Laccaria ochropurpurea*, page 139
28b. Cap cinnamon-brown to reddish tan; gills colored like cap: *Laccaria laccata*, page 137
29a. Cap deeply depressed, pinkish cinnamon to pinkish tan: *Clitocybe gibba*, page 131
29b. Cap rounded, flattened, or slightly depressed: 30
30a. Cap with blue, pink, or greenish tones: 31
30b. Cap white or with brown or yellow tones: 32
31a. Cap bluish green, with aniselike odor, rounded or flattened: *Clitocybe odora*, page 133
31b. Cap violet-gray, gills lilac; no distinctive odor: *Clitocybe nuda*, page 131
32a. Stalk with rooting base; cap viscid; single in woods: *Xerula megalospora*, page 158
32b. Stalk not rooting, cap dry: 33
33a. Fruiting in grassy areas, often in arcs or rings: *Marasmius oreades*, page 143
33b. Fruiting in woods: *Tricholoma flavovirens*, page 157

Armillaria species complex (plate 74A, B) EDIBLE WITH CAUTION

Cap convex to plane, sometimes knobbed; creamy tan or yellowish to brown, smooth or with squamules (small scales), fleshy at center, thin at margins; flesh white, discoloring to brown with age; partial veil present.

PLATE 74. *Armillaria* spp. A (Top): *A. gallica,* B (Bottom): *A. mellea*

Gills adnate to slightly decurrent; white or dull cream, staining to rusty brown with age; close to subdistant.

Stalk central, with or without annulus; fibrillose and fleshy, often with rhizomorphs.

Annulus (if present) cottony, thick and well formed to ephemeral or wispy; white or buff to yellow.

Spores ovoid to elliptical, smooth; spore print white.

Single, in small groups or in large clusters, on soil, living and dead hardwood, or conifer wood or from wood buried in the soil; fall.

A. mellea was considered a complex of variable forms but is now interpreted as a complex of species that are difficult to distinguish by using field characteristics. Molecular and genetic studies have helped uncover a number of species that differ in their substrate, habitat, geographic localities, cap scaliness or smoothness, character of the annulus, and stalk shape, particularly at the base. *A. gallica* is the common species in Iowa woodlands. It bears squamules on its cap and grows singly or in loose groups, in soil and sometimes on downed wood, usually as a saprobe but opportunistically as a root rot or butt rot parasite. It is attached to black, rootlike strands (rhizomorphs) which develop from the mycelia. These rhizomorphs are noticeable in humus and between the bark and wood of downed logs and are collectively known as the shoestring fungus. The unexpanded cap has a cobwebby partial veil that leaves an ill-defined cottony annulus on the stalk when the cap expands, and the stalk is swollen at the base (pl. 74A, left mushroom). *A. mellea*, known as the honey mushroom, produces large clusters of mushrooms from buried wood, downed wood, or living trees. It has smooth, slightly sticky, honey-yellow to ocher-yellow caps on stalks that taper at their bases; each has a thick annulus (pl. 74B). This species can be a destructive parasite on many woody species. *A. tabescens* differs from the others in its lack of an annulus. Other species may occur in Iowa, but they are difficult to distinguish from either *A. mellea* or *A. gallica*. Species of *Armillaria* are involved with *Entoloma abortivum* in a parasitized situation (see *E. abortivum*).

The mycelia of all forms of *Armillaria* are luminescent and are brightest in decaying wood while growth continues. The bright white glow (which may also appear light blue or greenish and may be seen from a considerable distance) is called fox fire and has been reported for several hundred years by people in the woods. A quiet walk on a damp, dark September or October evening can be brightened by kicking the litter on the forest floor to reveal glowing patches of active mycelium. *Armillaria* species generally have been considered edible, but gastrointestinal upsets have been reported when the mushroom is eaten raw or incompletely cooked. We urge caution in eating this mushroom. *Armillariella* is a former name for this complex.

Asterophora lycoperdoides (Bull.) Ditmar
(plate 75A, B) EDIBILITY UNKNOWN

Cap 1–2 cm broad, subglobose to hemispherical; white, becoming brownish; cottony, becoming powdery. Flesh rather thick, moist; pale.

Gills often not developed, attached when present; whitish; sometimes forked.

Stalk 2–3 cm long, 3–8 mm thick, stout; whitish to brownish; stuffed, becoming hollow, often curved.

Spores not developed when gills do not form; 6 × 4 μm when present, elliptical, smooth; white; chlamydospores (a completely different kind of spore), 12–18 μm in diameter, develop from cells of cap; long spines create star shape; brownish; accumulate in dry, powdery mass on upper surface of cap (pl. 75A).

Parasitic on *Russula* and *Lactarius* spp., common on *Russula dissimulans*; late summer, fall.

A. lycoperdoides was formerly referred to as *Nyctalis asterophora*. This parasitic mushroom may possibly be found on mushrooms of other genera, but often the host mushroom is so disintegrated that it cannot be recognized. *A. parasitica* is a similar parasite, characterized by the production of large, smooth-walled chlamydospores.

PLATE 75. *Asterophora lycoperdoides* on *Russula* sp.
A (Left): Immature on *Russula* host, close-up
B (Above): Mature on *Russula* host

PLATE 76. *Clitocybe gibba*

PLATE 77. *Clitocybe nuda*

Clitocybe gibba (Pers.) Kumm. (plate 76) NOT RECOMMENDED

Cap 3–9 cm broad, flat, maturing to slightly depressed or depressed to funnel-shaped; pinkish cinnamon to pinkish tan, fading to whitish; moist, silky; margin inrolled at first, often irregular or lobed. Flesh thin; white.

Gills extending down stalk, crowded; white to cream to pale pinkish buff; sometimes forked.

Stalk 3–8 cm long, 0.5–1.5 cm thick, central; same color as cap or paler; dry, stuffed becoming hollow; smooth except densely hairy over enlarged base.

Spores 5–10 × 3.5–5.5 μm, elliptical, smooth; spore print white.

Solitary to scattered on the ground under hardwoods and mixed woods; summer, fall.

We hesitate to recommend eating this common, widespread mushroom because of the danger of confusing it with similar species that are poisonous. *C. dealbata* has been reported to cause gastric distress, while other reports claim that it is edible. This suggests that different strains from different geographic locations may vary in toxin production. The interpretation of the species also may differ. In addition, *C. dealbata* may fruit in or near fairy rings of *Marasmius oreades* in grass areas and could be included in collections. Thus all similar *Clitocybe* species should be avoided, and collections of *M. oreades* fairy ring fruitings should be carefully identified.

Clitocybe nuda (Bull.: Fr.) Bigelow & A. H. Sm. (plate 77) CHOICE EDIBLE

Blewit

Cap 5–12 cm broad, rounded with inrolled edge flattening at maturity, sometimes with small knob; violet-gray to lilac, fading to pinkish brown at maturity; moist, smooth; margin uplifted, wavy. Flesh violaceous, fading with age; faintly fragrant.

Gills notched at stalk, crowded; same color as cap, fading to flesh color at maturity.

Stalk 2–8 cm long, 0.5–1.5 cm thick, often enlarged and bulblike at base; same color as cap but darker at top; scattered white hairs on lower part.

Spores 5.5–8 × 3.5–5 μm, elliptical, roughened; spore print pinkish buff.

Single to several in deep leaf litter under hardwoods or conifers or in lawns or in leaf piles or compost piles; late summer, fall.

Another name for this mushroom is *Lepista nuda*. It can be readily distinguished from similarly colored poisonous species of *Cortinarius*, which have rusty brown spores. *C. nuda* may vary in color from pallid to violaceous, however, so it is important to be careful to avoid misidentifying poisonous *Clitocybe* spp.

PLATE 78. *Clitocybe odora*

PLATE 79. *Flammulina velutipes*

Clitocybe odora (Bull.: Fr.) Kumm. (plate 78) EDIBLE

Anise-scented Clitocybe

Cap 3–8 cm broad, rounded to nearly flat at maturity; bluish green to greenish gray to dull green to whitish. Flesh thin, soft; white to greenish white, with odor and taste of anise.

Gills attached, decurrent, crowded; white to pale buff.

Stalk 2.5–7.5 cm long, 0.5–2 cm thick, often with enlarged base; whitish to buff to greenish; moist, downy above.

Spores 6–7.5 × 3–4 μm, elliptical, smooth; spore print pink to pinkish cream.

Scattered under hardwoods; summer, fall.

Fresh specimens of this species have a distinctive odor of anise.

Flammulina velutipes (Wm. Curtis: Fr.) Sing. (plate 79) EDIBLE

Winter Mushroom, Velvet Stem

Cap 2–6 cm broad, rounded, maturing nearly flat; yellow-orange to yellow-red to reddish brown, paler at edge; surface viscid, shining; margin upturned or wavy, ribbed. Flesh thick, thinning at edge; white to yellowish.

Gills notched, fairly well separated; white to yellowish.

Stalk 2.5–8 cm long, 3–8 mm thick, often fused at base into clusters; yellowish tan at top, dense velvety brown to blackish brown below; tough.

Spores 7–9 × 3–4 μm, narrowly elliptical, smooth; spore print white.

Single or in clusters, often under edge of bark on downed and live hardwoods, especially elm; spring, summer, fall, winter.

This species can occur nearly anytime during the year, even during a winter thaw. It is also called *Collybia velutipes*. It is cultivated as enotake or enokitake and looks quite different in the cultivated form.

PLATE 80. *Gymnopus dryophilus*

PLATE 81. *Hypsizygus ulmarius*

Gymnopus dryophilus (Bull.) Murrill (plate 80) NOT RECOMMENDED

Cap 1–5 cm broad, rounded, flattening with age; rusty to tawny brown to reddish brown, usually with lighter band at margin; moist, drying silky, smooth; margin often incurved at first, becoming upturned, wavy. Flesh thin, white.

Gills attached to notched, narrow, crowded; white, aging to buff.

Stalk 1–8 cm long, 2–5 mm thick, often swollen at base and surrounded by mat of white mycelium; same color as cap or paler; slightly flattened.

Spores 5–6.5 × 3–3.5 μm, elliptical, smooth; spore print white.

Clustered to numerous in leaf litter under hardwoods, on wood or sawdust piles; spring, summer, fall.

The toxin content and morphology of this species are quite varied. It is not recommended. This mushroom is also known as *Collybia dryophila*. Occasionally fruiting bodies diseased by *Syzygospora mycetophila* are found with varying amounts of distortion. Some diseased mushrooms have irregular, rounded, or lobed growth on the upper cap surface or gills; some are completely distorted.

Hypsizygus ulmarius (Bull.) Redhead (plate 81) EDIBLE

Elm Pleurotus

Cap 8–12 cm broad, rounded to flattened to somewhat depressed; white to buff; small scales on surface; margin inrolled at first. Flesh firm; white.

Gills adnexed, moderately separated, broad; white to cream.

Stalk 5–10 cm long, 1.5–2.5 cm thick, nearly equal but sometimes expanded at base; white to sometimes yellowish at maturity; dry whitish hairs at top to nearly smooth in lower area.

Spores 5–8 × 4.5–7 μm, nearly round, smooth; spore print white to buff.

Single to clusters of two or three on hardwoods, particularly from branch scar sites on living or dead elms and box elders; fall.

This edible species has a very tough stalk. The flavor is somewhat like that of *Pleurotus ostreatus*, which we consider a good edible mushroom. This late fall mushroom dries well and can be seen on trees into the winter. It was formerly called *Pleurotus ulmarius*.

PLATE 82A and B. *Laccaria laccata*

Laccaria laccata (Scop.) Fr. (plate 82A, B) NONPOISONOUS

Cap 1.5–8 cm broad, rounded, maturing flattened or upturned, often with depressed center; reddish tan to cinnamon-brown to pinkish; margin uneven, wavy. Flesh same color as cap.

Gills distant, irregular, extending slightly down the stalk; same color as cap or paler pink; waxy.

Stalk 5–10 cm long, 5–10 mm thick; same color as cap or dull flesh color, often with whitish to purplish base; covered with scattered loose scales in age, fibrous.

Spores 7.5–10 × 7–8.5 µm, broadly elliptical to nearly round; spines scattered; spore print white.

Single to scattered on the ground in moist woods; summer, fall.

One of the commonest mushrooms in the woods in summer and one of the most confusing. It is variable (see color variations in plate 82A and B) and must be collected many times before it is recognized with certainty in the field. The widely spaced, pinkish, waxy gills are useful field characteristics; the spiny, nearly round, nonamyloid spores are a definitive microscopic characteristic. Some treatments divide this species into numerous varieties. *L. amethystina* is about the same size, but the entire mushroom is a beautiful deep violet. *L. trullisata* is a somewhat similar species with a light brown cap and thick pink to purple gills. It develops in sand or very sandy soils.

PLATE 83. *Laccaria ochropurpurea*

PLATE 84. *Lentinellus ursinus*

Laccaria ochropurpurea (Berk.) Pk. (plate 83) NONPOISONOUS

Cap 4–12 cm broad, rounded, maturing to flat; whitish to light gray or buff; dry. Flesh tough; dull white; taste unpleasant.

Gills attached to slightly decurrent, distant, thick, waxy; light to dark purple.

Stalk 5–12 cm long, 1–3 cm thick, more or less equal to enlarged at base; same color as cap; often curved and twisted, dry.

Spores 8–10 μm, round, spiny; spore print light lilac.

Single to several on the ground under hardwoods, common under oak; late summer, fall.

This species tends to be larger than other *Laccaria* species and can usually be distinguished by the size of the cap and the purple gills. It is edible but reported to be tasteless.

Lentinellus ursinus (Fr.) Kühn. (plate 84) NOT EDIBLE

Cap 3–11 cm wide, 2–5 cm from front to back, convex to flat, semicircular to kidney-shaped; laterally attached, margin lobed, incurved when young; reddish brown, paler toward margin, with dark brown hairs dense at attachment area, becoming sparse toward cap margin.

Gills radiating from area of attachment, close, white to pinkish brown; edges coarsely serrated.

Stalk absent.

Spores 3–4.5 × 2–3.5 μm, subglobose, minutely spiny, hyaline, amyloid; spore print white.

In overlapping clusters, rarely single, on rotten logs of deciduous trees on the ground; summer, fall.

This mushroom is not uncommon on downed logs or stumps but not conspicuous.

PLATE 85. *Lentinus strigosus*

PLATE 86. *Marasmiellus nigripes*

Lentinus strigosus (Schw.) Fr. (plate 85) NOT RECOMMENDED

Cap 1.5–7 cm broad, rounded to flattened, spathulate to fan-shaped; violaceous to pinkish tan to reddish brown; dry, dense; stiff hairs covering surface; margin inrolled and often irregularly lobed. Flesh thin, tough white.

Gills extending down stalk, crowded; violaceous but soon appearing white to light yellow.

Stalk absent to short, when present, lateral to eccentric; same color as cap; hairy.

Spores 4.5–7 × 2.5–3 μm, short elliptical, smooth; spore print white.

Common, single, or clustered on hardwood stumps or fallen logs; summer, fall.

Panus rudis is another name for this mushroom. The fruiting bodies typically appear dried in the field (pl. 85).

Marasmiellus nigripes (Schwein.) Sing. (plate 86) EDIBILITY UNKNOWN

Cap 0.5–2 cm broad, bell-shaped to flat; snow white.

Gills attached, sometimes slightly decurrent, distant; same color as cap.

Stalk 2–7 cm long, 1–2 mm thick, equal; white at first, becoming dark blue-gray to blackish by maturity, covered by minute white hairs, creating glaucous appearance; attached to substrate with no mycelia at base.

Spores 8–9 μm; triangular, smooth; spore print white.

Single to scattered on leaves and twigs on the ground; summer.

This species is inconspicuous but not uncommon. The blackish stem and snow-white cap are distinctive. This mushroom may also be found under the genus *Tetrapyrgos*, because it has star-shaped spores, which distinguish it from other genera.

PLATE 87. *Marasmius oreades*

PLATE 88. *Marasmius rotula*

Marasmius oreades (Bolt.: Fr.) Fr. (plate 87) CHOICE EDIBLE

Fairy Ring Mushroom

Cap 1–5 cm broad, rounded, maturing to bell-shaped to flat, often with prominent blunt knob; cream to reddish tan, fading when dry; dry, smooth; margin sometimes striate at maturity. Flesh thin; white or tan.

Gills adnexed to nearly free, well separated; paler than cap, creamy white to buff.

Stalk 2–7 cm long, 2–4.5 mm thick, equal; buff at top, darker brown at bottom, with dense white hairs at base; tough.

Spores 7–10 × 3.5–6 µm, elliptical, tapered at one end, smooth; spore print white.

Common, in groups or in fairy rings on lawns, pastures, and grasslands; spring, summer, fall.

This is one of three species that commonly grow in fairy rings in grasslands such as lawns, golf greens, and pastures. The other two, *Chlorophyllum molybdites* and *Agaricus campestris*, are quite different and not likely to be confused with *M. oreades*. While *A. campestris* and *M. oreades* are highly recommended edible species, however, *C. molybdites* is poisonous. The pesticide history of the area should be known and considered, because *M. oreades* may take up some lawn pesticides. *Clitocybe dealbata,* a poisonous species, may be found in the same area with *M. oreades*. Thus *M. oreades* should be collected and identified carefully.

Marasmius rotula (Scop.: Fr.) Fr. (plate 88) EDIBILITY UNKNOWN

Cap 1.5–17 mm broad, rounded, with central depression, distinctly folded; white; margin wavy, striate. Flesh very thin; white.

Gills not attached to stalk but to collar encircling stalk, distant; white.

Stalk 1.5–8.5 cm long, 0.3–1 mm thick, equal; shiny black; tough, smooth, hollow.

Spores 6–10 × 3–4.5 µm, narrowly elliptical, tapered at one end, smooth; spore print white.

Several to numerous on twigs and leaves on the ground in woods or on bark on lower trunk of trees; spring, summer, fall.

Several other species of *Marasmius* with black wiry stalks and small white caps are not uncommon on leaf litter in the woods. Some have gills directly attached to the stalk. One common distinctive species, *Marasmiellus nigripes*, has white hemispherical caps 5–10 mm across, widely spaced gills with occasional cross gills, and a dark stalk with a white powdery surface.

PLATE 89. *Marasmius siccus*

PLATE 90. *Megacollybia platyphylla*

Marasmius siccus (Schw.) Fr. (plate 89) EDIBILITY UNKNOWN

Cap 0.3–2.5 cm broad, rounded to bell-shaped, often with depressed center; rusty orange-red to buffy brownish red, darker in center; striate. Flesh very thin; white.

Gills notched to free, distant; white.

Stalk 2–7 cm long, 0.2–1 mm thick, equal; dark brown to brownish black at base, paler at apex, often with white cottony mycelium at base; tough, smooth, dry.

Spores 16–21 × 3–4.5 µm, narrowly elliptical, tapered at one end, smooth; spore print white.

Several to numerous on leaves, stems, or forest debris; summer, early fall.

This species is common, especially visible during humid weather. Another common species, *Mycena luteopallens*, has a light to dark yellow cap and stalk and occurs on walnut husks, especially in late summer and fall.

Megacollybia platyphylla (Pers.) Kotl. & Pouzar (plate 90) NOT RECOMMENDED

Cap 5–20 cm broad, flat to somewhat depressed at maturity; whitish gray or brown to blackish brown, streaked with darker fibrils; margin at first inrolled, wavy with age. Flesh thin; white to gray; pliant.

Gills of various lengths, adnate to adnexed, distant, broad; off-white to white.

Stalk 6–12 cm long, 1–3 cm thick, equal or enlarging toward rounded base; white to grayish white; smooth, hollow, or pithy with age.

Spores 7–9 × 4–6 µm, elliptical, smooth; spore print white.

Single to scattered on decaying logs of hardwoods or near decaying hardwood logs; spring, summer, fall.

This species has also been called *Tricholomopsis platyphylla* and *Collybia platyphylla*. While some people have eaten this species with no ill effects, it has been reported to cause gastrointestinal problems.

PLATE 91. *Mycena haematopus*

PLATE 92. *Mycena leaiana*

Mycena haematopus (Pers.: Fr.) Kumm. (plate 91) EDIBILITY UNKNOWN

Bleeding Mycena

Cap 1–4 cm broad, conic to bell-shaped; reddish brown to pinkish brown, appearing frosted when young; margin striate, often ragged. Flesh thin; gray-red.

Gills attached, close; whitish to grayish red, staining dark reddish brown.

Stalk 3–9 cm long, 1–2 mm thick, equal; pale cinnamon-brown; minutely hairy, dry, brittle, hollow; dull red latex exuding when cut or broken near the base.

Spores 8–11 × 5–7 µm, broadly elliptical, smooth, amyloid; spore print white.

Common, usually in clusters on well-decayed wood; spring, summer, fall.

The red latex that exudes from a freshly broken stalk gives this mushroom its name and makes it one of the easiest *Mycena* species to identify. It is sometimes found parasitized by another fungus, *Spinellus fusiger*, which makes it look hairy.

Mycena leaiana (Berk.) Sacc. (plate 92) NONPOISONOUS

Cap 1–4 cm broad, broadly rounded to bell-shaped, becoming expanded and convex, with slight depression in center; bright yellow-orange, fading with age; viscid, smooth; margin striate or slightly so. Flesh soft, watery; white.

Gills attached, crowded; yellowish to salmon, bright orange-red at edges.

Stalk 3–7 cm long, 2–4 mm thick, equal or slightly enlarged at base; orange with fine hairs above, densely hairy at base; viscid.

Spores 7–10 × 5–6 µm, elliptical, smooth, amyloid; spore print white.

Common, in dense clusters on hardwood logs and branches; summer, fall.

PLATE 93. *Mycena luteopallens*

PLATE 94. *Omphalina epichysium*

Mycena luteopallens Pk. (plate 93) UNKNOWN

Walnut Mycena

Cap 8–15 mm broad, conical at first, becoming campanulate and finally plane with slight umbo; smooth, deep orange to yellow, fading with age.

Gills broad, adnexed, subdistant; yellow to pale pinkish.

Stalk 5–9 cm, 1–2 mm thick, flexuous, base coarsely hairy; pale at base, same color as cap toward apex.

Spores 7–9 × 4–5.5 μm, elliptical, smooth; white spore print.

Single or in groups, coming up through soil and litter from buried walnut or hickory nut shells and husks; common in late summer, fall.

Although its walnut or hickory husk host easily identifies this pretty yellow *Mycena*, the husk or shell may be buried quite deep.

Omphalina epichysium (Pers.) Quél. (plate 94) EDIBILITY UNKNOWN

Cap 1–3 cm, depressed in center and recurved along margins; smoky brown to dark gray when young or moist, fading to light gray to tan when old and dry; smooth, silky and weakly striate.

Gills decurrent, narrow, close, thin; grayish white.

Stalk 1–3 cm long, 1–3 mm thick, smooth, smoky tan; slightly enlarged to equal downward, white mycelia at base.

Spores 6–7.5 × 4 μm, elliptical, smooth; white spore print.

Single to numerous on moist decaying logs and stumps, in deciduous or coniferous woods; common but easily overlooked; summer, fall.

This species is also known as *Arrhenia epichysium*. The change in cap color from young and moist (when it is very dark gray) to old and dry (when it is light gray to tan) is striking.

PLATE 95. *Omphalotus illudens*

PLATE 96. *Panellus serotinus*

Omphalotus illudens (Schw.) Bigelow (plate 95) **POISONOUS**

Jack-o'-lantern

Cap 8–15 cm broad; rounded, aging to flat, often with depressed center with shallow knob; bright orange to orange-yellow; margin inrolled at first, even at maturity, streaked with appressed hairs. Flesh thin, firm; white to whitish orange.

Gills extending down stalk, crowded; yellow-orange to orange; luminescent in dark when fresh.

Stalk 8–12 cm long, 0.5–2 cm thick, tapering to narrow base; light orange; dry, longitudinally fibrous at maturity.

Spores 3–5 μm, round, smooth; spore print creamy white.

Usually in large dense clusters at base of hardwood stumps or on buried wood or roots, especially oaks; late summer, fall.

This species contains a violent gastrointestinal toxin, so great care must be used to avoid confusion with other similarly colored mushrooms or other fungi. *O. illudens* has been confused with *Cantharellus cibarius* even though *C. cibarius* fruits singly or scattered on the ground in the woods in midsummer. *O. illudens* has also been confused with *Laetiporus sulphureus* (sulfur shelf). Both *L. sulphureus* and *O. illudens* occur in clusters on or very close to wood. They are easily distinguished, however, by the finely poroid to smooth lower surface of *L. sulphureus*, in contrast to the narrow gills on the lower surface of *O. illudens*.

All three of these species produce fruiting bodies that are yellow to yellow-orange to red-orange and strikingly obvious. The crowded decurrent gills, the densely clustered habit of growth, and the luminescence of *O. illudens*, however, make this species distinct.

Panellus serotinus (Schrad.) Kühn. (plate 96) EDIBLE, NOT RECOMMENDED

Fruiting bodies 3–8 cm broad, fan- to kidney-shaped; slimy when moist; yellowish green to dark greenish brown, with shades of purple and yellow; surface velvety when dry and mature, smooth. Flesh white.

Gills adnate to subdecurrent, thin, broad, close; white to ochraceous (pale brownish yellow).

Stalk absent or short if present, up to 2 cm long, 8–10 mm thick; laterally attached; yellowish; tomentose or surface broken into blackish scales.

Spores 4–6 × 1–1.5 μm, sausage-shaped, smooth, colorless, amyloid; spore print yellowish.

Solitary or in overlapping clusters on downed wood; late fall.

This mushroom is edible but tough. It has also been known as *Pleurotus serotinus*.

PLATE 97. *Phyllotopsis nidulans*

PLATE 98. *Pleurotus dryinus*

Phyllotopsis nidulans (Pers.: Fr.) Sing. (plate 97) NOT EDIBLE

Cap 2–8 cm broad, fan-shaped, rounded to flattened; light orange to orange-tan; surface densely hairy; margin inrolled to expanded at maturity. Flesh orange-buff to paler orange.

Gills adnate, crowded, narrow; orange-yellow or paler.

Stalk absent, sessile.

Spores 5–8 × 2–3 μm, elliptical, smooth; spore print light pinkish cinnamon.

Clustered on stumps and logs of hardwoods and conifers; summer, early fall.

This mushroom frequently has a strong, unpleasant odor, which makes it an unlikely candidate for eating. It is also known as *Claudopus nidulans*.

Pleurotus dryinus (Pers.) P. Kumm. (plate 98) EDIBLE

Veiled Oyster

Cap 4–10 cm in width, convex, becoming somewhat flattened; inrolled margin often ragged, with remnants of partial veil; white to cream; surface cottony, often scaly in center with age. Flesh thick, becoming tough.

Gills decurrent, somewhat close; white to cream with age.

Stalk central to eccentric, sometimes almost lateral; white, with thin cottony to membranous ring on upper stalk from remnants of partial veil, ring often disappearing with age.

Spores white, 9–12 × 3.5–5.5 μm, elliptical, smooth, nonamyloid; spore print white.

Single or in small clusters on logs and stumps of deciduous trees, occasionally on trunks of living trees; summer, fall.

This species is not common and is easily confused with *P. ostreatus*.

PLATE 99. *Pleurotus ostreatus*. A (Top): On a standing tree trunk, B (Bottom): On a log

Pleurotus ostreatus (Jacq.: Fr.) Kumm. (plate 99A, B) CHOICE EDIBLE

Oyster Mushroom

Cap 2–20 cm broad, 1–10 cm wide; shell-shaped to fan-shaped, broadly rounded; white or pale tan to yellowish brown; smooth.

Gills attached and extending down base, distant, broad, thick; white.

Stalk absent or much reduced if present, up to 15 mm long, 5–10 mm thick, eccentric or lateral; white; often drier than cap.

Spores 8–12 × 3–5 μm, elliptical, smooth; spore print white.

Several to clustered on branches, logs, or standing trunks of senescent or dead trees, usually hardwoods, especially elm; spring, summer, late fall.

This delicious edible mushroom is easily recognized by the beginner. *P. sapidus* differs from *P. ostreatus* only by its lilac spore print and is considered a variety of *P. ostreatus* by some. Late fall fruitings of *P. ostreatus* are often darker, gray to gray-brown. Several smaller to very small species are found on decaying logs, with bracketlike, laterally attached caps or sessile caps attached with the gill surface up. These white-spored mushrooms once were all interpreted as species of *Pleurotus,* but many are now considered members of other genera. They are all somewhat fleshy, usually occurring in large numbers if very small or in overlapping clusters if larger.

Cheimonophyllum candidissimum produces single or overlapping clusters of shell-shaped to semicircular, sessile or laterally attached, soft white mushrooms, 0.5–2 cm in diameter, with widely spaced gills on decaying wood. It is not uncommon but easily overlooked.

Resupinatus applicatus (Fr.) S. F. Gray, a common but very small sessile species, has 2–6 mm broad, grayish blue to grayish black caps, attached with the gill surface up (gills distant). This species occurs on the underside of logs or larger pieces of decaying wood in large numbers and can dry and curl up, only to expand when rewet. Even large fruitings are easily overlooked.

PLATE 100. *Rhodotus palmatus*

PLATE 101. *Tricholoma flavovirens*

Rhodotus palmatus (Bull.: Fr.) Maire (plate 100) EDIBILITY UNKNOWN

Cap 2–6 cm wide; convex, becoming flatter with age; reddish or pinkish to orange, with conspicuous network; flat gelatinous.

Gills attached, close; some cross veins raised, becoming pink.

Stalk 2.5–4 cm long, 3–6 mm wide, tough, eccentric to almost lateral; same color as cap.

Spores 6–8 μm, globose, warted; spore print pink.

Scattered or in small groups on dead hardwood logs or stumps, occasional but not uncommon; summer, fall.

This mushroom is distinctive, with a raised network on the cap and unusual cap color.

Tricholoma flavovirens (Pers.) Lundell (plate 101) NOT RECOMMENDED

Cap 5–10 cm broad, convex, becoming plane; pale to bright yellow; viscid, smooth to slightly scaly. Flesh firm; white or yellowish.

Gills adnexed, close to crowded; yellow.

Stalk 3–7 cm long, 1–2 cm thick, equal or slightly thickened at base; pale yellow to white; solid, smooth or slightly scaly.

Spores 6–7 × 4–4.5 μm, smooth, elliptical; spore print white.

Single to scattered on the ground under mixed conifers and hardwoods; late summer, fall.

Tricholoma is a large genus, and definite identification of the species is often difficult. The mushrooms typically develop on the ground in late summer or fall and are usually rather large. Although some species are edible, some have an unpleasant flavor, and some are poisonous.

T. flavovirens is also known as *T. equestre*. This bright yellow species is distinctive, but other species of *Tricholoma* are also yellow.

PLATE 102. *Xerula megalospora*

Xerula megalospora (Clem.) Redhead, Ginns and Shoemaker (plate 102) EDIBLE

Cap 3–10 cm broad, nearly flat; often wrinkled and darker at center; nearly white to gray-brown to dark brown; viscid or moist, smooth. Flesh thin; white.

Gills notched at stalk, broad, shiny, somewhat distant; of various lengths; white.

Stalk 5–25 cm long, 0.5–1.5 cm thick (above ground), slightly enlarged at soil line, with long, underground rootlike base; whitish at apex, shading brownish to grayish at base; twisted-striate.

Spores 18–23 × 10–14 µm, ovoid, smooth; spore print white.

Single or scattered on the ground under hardwoods, occurring even in quite dry seasons; spring, summer, fall.

This is one of the commonest woods mushrooms throughout the growing season and is easily recognized by the following combination of characters: tapered underground base, small flat cap, long slender stalk, and widely spaced gills of different lengths. *X. radicata* appears macroscopically identical to this species but has smaller spores. Both species are known as *Collybia radicata* or *Oudemansiella radicata* in many books. *Xerula furfuracea*, another common species, is distinguished by hairs present on the stalk.

Boletes

(Boletales)

The fungi of this group superficially resemble the gilled mushrooms and are fleshy and readily decaying. On the lower surface of the cap, the boletes have tubes, which are lined with a layer (hymenium) of basidia, instead of gills. Traditionally boletes were considered members of a single family, the Boletaceae, but modern interpretations divide them into several families. The arrangement of the open ends of the tubes, the pores (tube mouths), and the ornamentation of the stalk are useful field characteristics in determining the genera. Many species are mycorrhizal with various tree species, both softwoods and hardwoods.

Caps vary in shape from the typical rounded (convex) cap of *Boletus* to the sometimes fan-shaped, flattened cap of *Gyrodon*. Cap surfaces may be dry or viscid, hairy or floccose, with even to overhanging margins. Flesh colors vary from white or pale yellow to pinkish; dramatic color changes from white to shades of red or blue upon cutting or bruising can occur in some species. Pore surfaces vary in color with maturity, often changing color as mature spores develop. The mature pore surface color is characteristic for a species and sometimes changes upon bruising or cutting.

Stalks tend to be fleshy like the caps and may be quite bulbous at the base. Ornamentation varies from none to reticulate networks to large scales (scabers). In several of the genera, the partial veil becomes an annulus, which may be dry or viscid. Spore print colors are characteristic of the genus. Some boletes are poisonous, mostly *Boletus* species, which have red pore mouths when young and/or bruise blue. Many boletes are edible, and some are choice. Some mushroomers recommend removing the tubes of edible boletes (particularly if they are old), because they may become slimy after cooking. Others recommend peeling the cuticle (outer layer of the cap) because of its consistency and texture. *Tylopilus felleus,* a striking fleshy bolete, is so bitter that it is truly inedible.

Key to the Genera of Boletes in This Guide

1a. Cap covered with large, coarse gray to blackish scales; spores globose to subglobose; spore print blackish brown to black: *Strobilomyces*, page 169
1b. Cap lacking large dark scales; spores elongate (except for *Paragyrodon sphaerosporus*); spore deposit another color: 2
2a. Spores small, oblong to short elliptical: 3
2b. Spores long, elliptical to subfusiform (nearly spindle-shaped) or globose: 4
3a. Pores roundish; walls of even thickness; spore deposit pale yellow to yellowish ochraceous: *Gyroporus*, page 167
3b. Pores radially elongate; walls of varying thickness; spore deposit olive-brown: *Gyrodon* (*Boletinellus*), page 165
4a. Spore deposit pinkish, vinaceous (wine red) brown or chocolate or purple-brown; stalk not ornamented with dark points or squamules: *Tylopilus*, page 173

4b. Spore deposit another color; stalk ornamented or not: 5
5a. Stalk roughened with points, dots, or squamules that darken at maturity, usually to very dark brown or black: *Leccinum*, page 167
5b. Stalk ornamented or smooth, ornamentation not as above: 6
6a. Pileus viscid; spores elliptical or globose: 7
6b. Pileus not viscid; spores elongate, nonequilateral in most species: *Boletus*, page 163
7a. Spores elliptical: *Suillus*, page 171
7b. Spores globose: *Paragyrodon*, page 169

Key to the Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Cap viscid at least when young, occasionally moist: 2
1b. Cap not viscid: 5
2a. Partial veil a thick tough membrane, spores globose: *Paragyrodon sphaerosporus*, page 169
2b. Partial veil cottony when present, spores elongate: 3
3a. Cap smooth, slimy, dark vinaceous to vinaceous brown, fading with age: *Suillus brevipes*, page 171
3b. Cap with fibrils: 4
4a. Cap, stalk, and tube layer bright yellow to ocher-yellow: *Suillus americanus*, page 171
4b. Cap rose-red to brick-red, breaking into fibrils: *Suillus pictus*, page 173
5a. Stalk whitish to ivory to brown, with network of ridges (reticulations): *Boletus edulis*, page 165
5b. Stalks another color, ornamentation different or lacking: 6
6a. Stalk and cap covered by heavy gray to blackish, scaly hairs: *Strobilomyces floccopus*, page 169
6b. Stalk and cap ornamented otherwise or ornamentation lacking: 7
7a. Tube mouths elongate and uneven; tubes short: *Gyrodon merulioides*, page 165
7b. Tube mouths small, nearly round and even; tubes longer: 8
8a. Stalk and cap red: 9
8b. Stalk and cap not red: 10
9a. Tubes yellow, bruising slowly blue or greenish blue: *Boletus campestris*, page 163
9b. Tubes whitish, aging pale yellow, not bruising: *Gyroporus purpurinus,* page 167

10a. Stalk with buff to light brown reticulations; tubes pink: *Tylopilus felleus*, page 173
10b. Stalk with dark tufted hairs (scabers); tubes not pink: *Leccinum insigne*, page 167

PLATE 103. *Boletus campestris*

Boletus campestris A. H. Sm. & Thiers (plate 103) NOT RECOMMENDED

Cap 3–4 cm broad, rounded, maturing to flat; rose-red, becoming pinkish red and rimose with yellow showing through cracks with age; dry. Flesh thick; pale yellow, slowly bruising blue or greenish blue.

Tubes 6–8 mm long, often depressed near stalk; tube surface yellow, aging to greenish yellow, becoming olive as spores mature, slowly bruising blue or greenish blue; pores small (0.5–1 mm in diameter at maturity), angular.

Stalk 4–5 cm long, 0.5–1 cm thick, even to tapered; yellow at apex, rusty rose lower portion; with yellow mycelia at base, dry, smooth. Flesh yellow, slowly bruising blue.

Spores 11–14 × 4.5–6 μm, smooth, elliptical; spore print olive-brown.

Single to several or many on the ground under hardwoods (especially oaks) or in mixed forests on soil; late summer, fall.

The edibility of this species is questioned by some, because certain individuals cannot tolerate it. It may be difficult to separate from other undesirable species on the basis of field characteristics. The similar but larger species *B. bicolor* is common. *B. campestris* is one of several red-capped boletes with red blushed yellow stalks. The similar *B. fraternus* lacks bright yellow basal mycelia, *B. rubellus* has reddish orange dots on the stalk, and *B. subfraternus* has large pores (0.5–1 per mm).

PLATE 104. *Boletus edulis*. A: Fruiting body aspect, B: Pore surface, partially parasitized

PLATE 105.
Gyrodon merulioides
A (Above): Upper
and lower surface
of fruiting body
B (Right): Lower
cap pore surface

Boletus edulis Bull.: Fr. var. ***edulis*** (plate 104A, B) CHOICE EDIBLE

Steinpilz, King Bolete

Cap 7–15 cm broad, convex; cream-brown to clay to cinnamon-buff to reddish brown; tacky, becoming subviscid (slightly slimy and sticky) when wet. Flesh 2–4 cm thick, firm; white to reddish near cap surface, unchanging when bruised.

Tubes to 3 cm long, depressed near stalk; greenish yellow at maturity; stuffed when young; pores small (2–3 per mm), rounded.

Stalk 10–20 cm long, 3–4 cm thick at apex, 4–6 cm thick at base, clavate to more or less bulbous at base, massive; white to ivory to brown with network of fine lines (reticulations), especially at top.

Spores 13–17 × 4–6.5 μm, elongate-asymmetrical, smooth; spore print olive-brown.

Solitary to scattered on the ground under hardwoods; summer.

A. H. Smith considered *B. edulis* to be typically associated with conifers, but we find it commonly with no conifer association in oak-hickory forests. *B. edulis* is commonly parasitized by *Sepedonium chrysospermum*; the entire bolete or portions of it may become a golden yellow from the masses of *Sepedonium* asexual spores. The beginning of an infection is whitish (pl. 104B, right side of the cap pore surface).

Gyrodon merulioides (Schw.) Sing. (plate 105A, B) EDIBLE, NOT RECOMMENDED

Cap 5–12 cm broad, nearly flat to slightly depressed; dull yellow-brown to dark reddish brown; dry, becoming tacky when wet; margin incurved, becoming uplifted and wavy. Flesh up to 1 cm thick; pale yellow, sometimes slowly bruising bluish green.

Tubes 3–5 mm deep, 2–3 mm wide, extending down stalk, strongly radiating; yellowish, becoming dingy yellow, bruising dark olive to reddish brown; pores elongate and uneven.

Stalk 2–5 cm long, 1–3 cm thick, eccentric to lateral; yellow-brown, staining reddish on lower part at maturity or when injured.

Spores 7–11 × 5–7.5 μm, broadly elliptical to subglobose, smooth; spore print yellowish to brownish ochraceous.

Single to scattered on the ground, typically under ash trees; summer, fall.

The flavor is mild and not distinctive, and the appearance is not attractive. Often the stalks are so short that the boletes are hidden in the grass under ash trees. This bolete is also known as *Boletinellus merulioides* or *Boletinus merulioides*.

PLATE 106. *Gyroporus purpurinus*

PLATE 107. *Leccinum insigne*

Gyroporus purpurinus (Snell.) Sing. (plate 106) EDIBLE

Cap 1–5 cm broad, rounded, maturing to nearly flat; vinaceous; velvety, dry. Flesh up to 1 cm thick; white.

Tubes 5–8 mm deep, depressed around stalk; white, aging pale yellowish, not bruising; pores small (1–3 per mm).

Stalk 3–6 cm long, 3–8 mm thick, tapering upward to nearly equal; same color as cap but white below tubes; dry, velvety, hollow.

Spores 8–11 × 5–6.5 μm, elliptical, smooth; spore print yellow.

Single to several on the ground, under hardwoods; summer, fall.

G. castaneus differs in having a more brownish cap. *G. cyanescens* is larger, with a cap 4.5–12 cm broad, pale yellowish to tan, and coarsely scaly to tomentose. All parts of the fruiting body, the cap, the stalk, and the tubes turn instantly blue when bruised. This mushroom occurs under hardwoods or in mixed woods.

Leccinum insigne A. H. Sm., Thiers & Watling (plate 107) EDIBLE

Cap 4–15 cm broad, rounded, becoming broadly convex; rusty red-orange or orange-tan to dingy orange-brown; surface dry to subviscid, fibrillose to smooth; margin clearly exceeding tube area (appendiculate). Flesh thick, firm, becoming soft; white, staining vinaceous gray when cut.

Tubes 1.5–2 cm long, depressed at stalk; pale yellowish green, turning wood brown with yellowish tan tint; pores small (2–4 per mm), whitish, staining dingy yellow or olive.

Stalk 8–12 cm long, 1–3 cm thick at apex to 4 cm thick at base; surface whitish, ornamented with brown scales (scabers), darkening to black at maturity, staining smoky gray when cut; underlying surface cottony, uneven.

Spores 13–16 × 4–5.5 μm, more or less fusiform, smooth; spore print dark yellow-brown.

Single to scattered on the ground under aspen in mixed woods; summer.

The species commonly found under oaks in the Midwest is a variant of *L. insigne*. It has a cap that is generally less orange and a narrower stalk than the typical *L. insigne* of northern woods.

PLATE 108. *Paragyrodon sphaerosporus*

PLATE 109. *Strobilomyces floccopus*

Paragyrodon sphaerosporus (Pk.) Sing. (plate 108) NOT RECOMMENDED

Cap 5–15 cm broad, rounded to nearly flat at maturity; dull yellowish brown; smooth, slimy, viscid; margin often retaining pieces of the partial veil. Flesh thick; white to yellowish, staining brown.

Tubes 4–10 mm long; yellow, staining brown; pores large (1 per mm); angular, becoming decurrent near stalk.

Stalk 4–10 cm long, 1–3 cm thick; yellow, staining brown; annulus gelatinous.

Partial veil large, often much torn, thick, tough; same color as cap or darker; outer layer gelatinizing.

Spores 6–9 × 6–8 µm, globose to subglobose; spore print olive-mustard when fresh, darkening with age.

On the ground under hardwoods, particularly associated with oaks; summer, fall.

This bolete has an unusual combination of characteristics: a thick, almost fleshy double partial veil that disintegrates from attachment to the stalk, globose to subglobose spores, and angular pores extending down the stalk. It was first described as a *Boletus* but later transferred to *Suillus* and more recently considered the only species in *Paragyrodon*. It is common in single or scattered groups, particularly under oaks in suburban areas.

Strobilomyces floccopus (Vahl: Fr.) Karst. (plate 109) EDIBLE?

Old Man of the Woods

Cap 4–15 cm broad, rounded, finally flat; whitish gray, covered by grayish black; soft, coarse scales, dry; veil remnants hanging from margin. Flesh white, bruising pink or red, turning black.

Tubes 1.2–1.5 cm deep; white, becoming gray to blackish, staining like cap flesh; pores large (1–2 mm), angular.

Stalk 5–12 cm long, 0.5–2 cm thick; same color as cap, bruising black; shaggy, scaly annular zone.

Partial veil soft, cottony; white to gray.

Spores 9–16 × 8–12 µm, nearly round, with distinct reticulum; spore print black.

Single to several on the ground under hardwoods, especially oaks or mixed woods, common in average seasons, present even in dry years; summer, fall.

Two similar species, *S. confusus* and *S. dryophilus*, differ in spore ornamentation. If you eat this bolete, the cap should be peeled and the tubes cut away. It is not attractive, and few people seem to try it. This species is also known as *S. strobilaceus*.

PLATE 110. *Suillus americanus*

PLATE 111. *Suillus brevipes*

Suillus americanus (Pk.) Snell (plate 110) NOT RECOMMENDED

American Slippery Jack

Cap 3–10 cm broad, rounded to broadly convex, often with small knob; bright yellow, with buff to cinnamon patches of fibrils, sometimes streaked with reddish fibrils; margin with white to buff fibril remnants, which disappear at full maturity. Flesh thin; yellow to orange-yellow, bruising brown.

Tubes 4–6 mm deep; golden yellow to yellow-brown at maturity; pores large (1–2 mm wide), angular, extending down stalk.

Stalk 3–9 cm long, 5–10 mm thick, equal, often curved; bright yellow, with glandular dots especially on upper half, darkening with age or upon handling; dry.

Partial veil cottony, thick, usually not forming ring but hanging from cap margin.

Spores 8–11 × 3–4 µm, narrow, fusiform, smooth; spore print dull cinnamon-brown.

Several to many on the ground under eastern white pine; late summer, fall.

The veil is not a true partial veil. It does not attach to the stalk but consists of fibrils that extend over the edge of the cap. These fribrils may disappear with age. The large angular pores are distinctive.

Suillus brevipes (Pk.) Kuntze (plate 111) EDIBLE

Cap convex to flat, 4–9 cm in diameter; brownish to cinnamon-brown; glutinous, smooth, shiny when dry; cuticle peels easily. Flesh white to yellow.

Tubes pale yellow, becoming olivaceous (olive-green), to 10 mm deep.

Stalk 2–5 cm × 1–2 cm; white, becoming yellowish; short, dry.

Spores 7–9 × 2.5–3.5 µm, elliptical, smooth, cinnamon; spore print cinnamon-brown.

Single to scattered on the ground under pines; late summer, fall.

Removing the cap cuticle before cooking enhances the edibility.

PLATE 112. *Suillus pictus*

PLATE 113. *Tylopilus felleus*

Suillus pictus (Pk.) A. H. Sm. & Thiers (plate 112) EDIBLE

Cap 3–12 cm broad, conic, rounded to flattened at maturity; red, becoming buff with age, with abundant reddish hairs; dry, becoming tacky when wet. Flesh firm; yellow, bruising slowly reddish.

Tubes about 5 mm long; yellow to brownish at maturity; pores large (0.5–2 × 5 mm), angular, radially arranged and extending down stalk.

Stalk 4–10 cm long, 0.8–2.5 cm thick, enlarged downward, with dull red fibrils fading to gray with age; annulus floccose.

Partial veil dry, hairy; whitish.

Spores 8–10 × 3.5–5 μm, narrowly nonequilateral, smooth; spore print olive-brown, becoming clay to tawny olive on drying.

Single to scattered on the ground under white pine (*Pinus strobus*); summer, fall.

This bolete is found in the Midwest where white pines have been used in windbreaks, yards, and other plantings and in some native white pine stands. It is also known as *Suillus spraguei*.

Tylopilus felleus (Bull.: Fr.) Karst. (plate 113) NOT EDIBLE

Bitter Bolete

Cap 5–15 cm broad, broadly rounded; dingy cinnamon when young, buff to light brown with age; dry but somewhat slimy after rain, smooth. Flesh to 3 cm thick, soft; white, unchanging to bruising brownish.

Tubes 1–2 cm long; pores about 1 mm in diameter at maturity, often depressed at stalk; whitish, becoming deep pink.

Stalk 4–12 cm long, 1.5–3 cm thick, enlarged to bulbous below; pallid to pale brown, darker below; covered with network of ridges at least in upper portion.

Spores 9–15 × 3–5 μm, narrowly elliptical, smooth; spore print rose to pink.

Single to scattered on the ground in woods, sometimes near conifer stumps and under hardwoods; summer, fall.

This bolete is not poisonous but is so bitter that it is inedible, although some people apparently do not taste this bitterness.

Aphyllophorales

A number of common fungi with tough, fleshy to leathery to woody fruiting bodies are members of the order Aphyllophorales. At one time the fungi included here were grouped into families based on readily visible features: the form of the fruiting body and of the areas on which the spore-producing cells were developed. Modern classification of this large and very diverse group has been based largely on microscopic characters and is difficult to apply in the field. We have attempted to present these fungi in their modern groupings, without indicating the technical reasons for doing so. We have used the traditional common names for the groups as much as possible (chanterelles, smooth fungi, pore fungi, coral fungi, etc.). See the key to major groups (p. 29) for the initial identification of these groups.

The largest group is the poroid Aphyllophorales, traditionally called the pore fungi. These fungi are associated with wood decay of hardwoods and conifers, both living standing trees and dead logs on the ground. Some have considerable economic significance in addition to their recycling contribution.

Cantharelloid Aphyllophorales

This distinctive group varies in form from deeply depressed funnel-form fruiting bodies to normal mushroom shapes. The fleshy cap may be deeply depressed, with a layer of spore-producing cells on the lower surface, which can vary from a smooth to a blunt-ridged surface.

Cap colors vary from cream or buff through oranges and yellows to gray or purple or brown. Cap surfaces are dry to moist and smooth to scaly, with margins entire to lobed, wavy, or incurved. Flesh colors vary from white or yellow to brown or nearly black. Ridges are broad, with single to branched veinlike structures on the lower surface of the cap, and tend to be clearly decurrent.

Stalks are usually equal, sometimes flattened or furrowed, and occasionally fused in small clusters.

Spore prints vary from white to pink or salmon-buff.

This group is known worldwide as one of the very best groups of edible fungi; most of them have excellent flavor. *Cantharellus cibarius* (the golden chanterelle of France, kantarell in the Scandinavian countries, and pfifferling in Germany) is found in many of the city markets in Europe when in season. It is highly prized throughout North America and is one of the best edible wild mushrooms in the Midwest. The cinnabar or red chanterelle, *Cantharellus cinnabarinus*, that occurs in some numbers in northeastern Iowa and adjacent states also has excellent flavor.

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Fruiting body purplish or gray or darker: *Craterellus fallax*, page 179
1b. Fruiting body yellow to orange: 2
2a. Cap whitish-yellow to orange-yellow: *Cantharellus cibarius*, page 177
2b. Cap red-orange to cinnabar-red: *Cantharellus cinnabarinus*, page 179

Cantharellus cibarius Fr.: Fr. (plate 114) CHOICE EDIBLE

Golden Chanterelle

Cap 3–10 cm broad; depressed with inrolled margin when young, deeply depressed center with flat or upturned edges with age; light yellow to golden to orange-yellow; minutely hairy, aging to smooth. Flesh thick; cream-yellow.

Ridges narrow, extending down stalk, blunt; often somewhat lighter than cap color; well separated, forked.

Stalk 3–8 cm long, 0.5–2 cm thick, tapered at base; nearly same color as cap; solid, smooth.

Spores 7.5–10.5 × 4–6 μm, elliptical, thin-walled, smooth; spore print pale yellow to ochraceous.

PLATE 114. *Cantharellus cibarius*

PLATE 115. *Cantharellus cinnabarinus*

PLATE 116. *Craterellus fallax*

Scattered to clustered on the ground under hardwoods or in mixed woods, especially in low areas and on midslopes; summer.

This species occurs fairly commonly during its season, is widely distributed, and is quite distinctive in appearance, so it is not easily confused with other species. Beginning collectors soon learn to recognize it with confidence. The poisonous mushroom *Omphalotus illudens* is similar in shape, but its sharp-edged, knifelike gills distinguish it. In addition, O. *illudens* typically occurs in clusters very near or on downed wood or stumps or at the base of trees.

Cantharellus cinnabarinus Schw. (Schw.) (plate 115) EDIBLE

Red Chanterelle

Cap 1–4 cm broad, funnel-shaped; cinnabar-red to red-orange; dry, smooth; margin wavy, irregular. Flesh very thin; white.

Ridges narrow, decurrent on lower surface of cap, blunt; pinkish to nearly same color as cap; well separated, frequently forked.

Stalk 2–5 cm long, 5–10 mm thick, equal to slightly tapered at base; same color as cap.

Spores 7–11 × 4–5.5 μm, thin-walled, elliptical; spore print pinkish.

Single to several on the ground under hardwoods; summer, early fall.

This species is smaller and usually less common than *C. cibarius* but is similar in taste. Young fruiting bodies are quite red, fading with age.

Craterellus fallax A. H. Sm. (plate 116) EDIBLE

Black Trumpet

Cap 2–6 cm broad, deeply depressed funnel- or trumpet-shaped; purplish to ashy gray or brown to blackish outside, pale gray with dry stiff hairs on interior; margin widely flaring, wavy, and split. Flesh thin, brittle; dingy brown.

Lower cap surface slightly wrinkled to smooth; ashy gray to blackish.

Stalk very short, sometimes absent; dingy brown; hollow when present.

Spores 8–11 × 5–6 μm, elliptical, smooth; spores ochraceous to pale salmon.

In clusters on the ground under hardwoods, especially oak and hickory; summer, fall.

Dark and rather unattractive, this fungus has several common names, such as horn of plenty, trumpet of death, black chanterelle, and fairy's loving cup. It is edible despite its appearance and is unlikely to be confused with other fungi. A similar-appearing species, *C. cornucopoides*, has a white spore print and an almost smooth lower surface.

Clavarioid Aphyllophorales

The fungi in this group develop fleshy to tough fruiting bodies that are branched, clublike, or fingerlike and are often known as coral fungi. The basal portion is sterile, but the upper clublike or branched portion is covered with a smooth layer of basidia.

Fruiting bodies are diverse in form and color, varying from pure white to tan, yellow, purple, and red. Most are smooth to wrinkled; branching may be diverse, with tips varying from daintily pointed to broadly rounded or slightly flattened. Flesh of the fruiting bodies is mostly white but may vary in color.

Fruiting bodies develop principally among the leaves and litter on the forest floor, with a few common species inhabiting downed logs.

Species of *Thelephora* and *Tremellodendron* also occur on the forest floor but have flattened branches in contrast to the round branches of the corals.

Some coral fungi, including some species of *Ramaria*, are edible. Several species may cause gastrointestinal upsets, however; *Ramaria formosa* is considered very poisonous. This large, diverse group may be confusing for the beginner. Only a few very common species are discussed.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Fruiting body club-shaped, unbranched: 5
1b. Fruiting body branched: 2
2a. Fruiting body with short, irregular gray to purplish gray branches: *Clavulina cinerea*, page 185
2b. Fruiting body with longer, more slender branches: 3
3a. Thin, slender branches with distinctive tips that flare out to form a crown, on decaying logs: *Clavicorona pyxidata*, page 185
3b. Branches less slender, lacking distinctive tips, on decaying logs: 4
4a. Fruiting bodies on decaying logs, compactly branched with a number of similarly sized branches: *Ramaria stricta*, page 187
4b. Fruiting bodies developing through litter on the ground, branches of quite different diameters: *Ramaria aurea*, page 187
5a. Clubs thin; white to golden yellow: 6
5b. Clubs thicker than 1 cm in diameter, yellowish to ochraceous to light brown, often single: *Clavariadelphus pistillaris*, page 183
6a. Fruiting bodies white, browning at tip with age, in clusters or single: *Clavaria vermicularis*, page 183
6b. Fruiting bodies golden yellow, in clusters or single: *Clavaria pulchra*, page 181

Clavaria pulchra Pk. (plate 117) EDIBILITY UNKNOWN

Fruiting bodies 1.5–7.5 cm high, 0.1–0.6 cm thick near top; club-shaped to nearly cylindrical, apex bluntly rounded; golden to eggyolk yellow; sometimes smooth, sometimes grooved. Flesh tough, elastic.

Stalk not clearly distinct from apical spore-bearing area except for lighter color.

Spores 4.5–7 μm, oblong–ovoid; spore print white.

Gregarious; clusters closely scattered on soil or litter in hardwood or mixed woods; summer, fall.

Three other groups of fungi form club-shaped fruiting bodies that could be confused with these unbranched corals. Species of *Calocera,* one group of the jelly fungi, produce small, 2–12 mm tall, tough-gelatinous yellow fruiting bodies on wood. These dry to become hard and revive when remoistened. Some of the earth tongues, a group of ascomycetes (see *Spathularia*, p. 293), produce flattened to club-shaped, short-stalked fruiting bodies in damp or wet areas, often among mosses. Another ascomycete genus, *Cordyceps* (see *Cordyceps*, p. 318), parasitizes insect larvae and pupae in the ground and produces club-shaped structures above ground. Dig carefully to expose the base of any single or grouped club-shaped fungal structures developing from the soil to examine the basal portion for identification. This coral fungus is also known as *Clavulinopsis laeticolor*.

PLATE 117. *Clavaria pulchra*

PLATE 118. *Clavaria vermicularis*

PLATE 119. *Clavariadelphus pistillaris*

Clavaria vermicularis Scop. (plate 118) EDIBILITY UNKNOWN

Fruiting body 3–10 cm high, 0.1–0.4 cm thick, club-shaped or somewhat flattened, thickest at middle or above, tapering downward; white, browning at tip with age. Flesh white.

Stalk short, more or less distinct; white.

Spores 4.5–7 × 2.5–3.6 µm, ovoid, smooth; spore print white.

Usually clustered in small groups, sometimes single, in mossy shaded lawns and in woods; summer, fall.

This species is generally inconspicuous unless it develops in large numbers. The genus contains several similar small, white, single to clustered species. This species is also known as *C. fragilis*.

Clavariadelphus pistillaris (L.: Fr.) Donk (plate 119) NOT RECOMMENDED

Fruiting body 4–20 cm high, club-shaped, tapering from broad apex to narrow base, often wrinkled or grooved with top rounded and often depressed; yellowish to ochraceous to brownish. Flesh firm; light ochraceous; bitter taste.

Stalk somewhat differentiated; lighter in color.

Spores 11–16 × 6–9 µm, elliptical, smooth, thin-walled; spore print yellowish white.

Single to gregarious on the ground under hardwoods; late summer, fall.

If these distinctive club-shaped fruiting bodies are laid on a piece of colored paper, covered, and left for a while, a spore print can be obtained. Spore prints from other coral fungus fruiting bodies can also be made in this way. A similar species, *C. ligula*, develops singly or in clusters in conifer duff (partly decomposed needle and twig litter) under a number of conifer species. The clubs are usually smaller, 2–6 cm high.

PLATE 120A and B.
Clavicorona pyxidata

PLATE 121.
Clavulina cinerea

Clavicorona pyxidata (Pers.) Doty

(plate 120A, B) EDIBLE, NOT RECOMMENDED

Fruiting body 5–12 cm high, 6–10 cm wide, highly branched; tan to pale pinkish tan; branches slender, equal, each tipped with spikes forming crown or shallow cup. Flesh firm; white, somewhat waxy appearance.

Stalk whitish to pinkish brown at base.

Spores 4–5 × 2–3 µm, elliptical, smooth; spore print white.

Crowded or in clusters on dead wood or rotting logs; summer, fall.

This is a very common fungus on downed logs, easily recognizable even when dried because of its distinctive crown of branches from the upper levels of branching. It is reported to be mildly flavored and edible when young, but it quickly becomes tough.

Clavulina cinerea (Bull.: Fr.) Schröt. (plate 121) NOT RECOMMENDED

Gray Coral

Fruiting body 3–10 cm high, 3–10 cm wide, highly branched; smoky gray to dark gray to bluish gray at maturity; branches irregular, with blunt or pointed tips, compact, often wrinkled. Flesh firm, somewhat brittle; gray to white.

Stalk short.

Spores 7–10 × 5.5–7 µm, broadly elliptical, smooth; spore print white.

Scattered to clustered on the ground, often in moss, in woods after rains; summer, fall.

PLATE 122. *Ramaria aurea*

PLATE 123. *Ramaria stricta*

Ramaria aurea (Schaeff.) Quél. (plate 122) NOT RECOMMENDED

Fruiting body 11–13 cm high, 4–8 cm thick or thicker, highly branched; pale orange to orange-buff with yellower tips. Flesh fairly brittle to brittle.

Stalk 3–5 cm long, up to 4 cm wide; lighter than fruiting body.

Spores 10–12 × 3.5–5.5 µm, roughened; spore print yellowish to pale tan.

Single or in clusters through leaf litter under hardwoods; late summer, fall.

Although *R. aurea* is common, it usually does not occur in large numbers. Several similar yellow species are difficult to distinguish.

Ramaria stricta (Pers.) Quél. (plate 123) NOT EDIBLE

Fruiting body 4–12 cm high, 4–8 cm thick, highly branched, with main branches arising from thick base; buff-pink to tan; branches erect, compact, tapering, with pale yellow to buff-pink to pinkish tan tips. Flesh tough; bitter taste.

Stalk thick, branched above, broadened below where attached to wood; whitish.

Spores 7–10 × 4–5 µm, elliptical, minutely roughened; spore print cinnamon to buff.

Single to clustered on decaying hardwood logs; summer, fall.

This species is common and easily distinguished from the other common coral on decaying logs, *Clavicorona pyxidata*.

Poroid Aphyllophorales

The pore fungi (polypores) are a large, diverse group characterized by shelflike conks (sometimes with a stalk) or flattened (resupinate) fruiting bodies on wood. The fruiting bodies are usually leathery to corky or woody (and therefore not edible), but a few are fleshy. All have a layer of open-ended tubes on the lower surface. The open tube ends are called pores.

Fruiting bodies are frequently fan-shaped and broadly attached, but many have lateral or central stalks. The upper surface may be smooth or varnished or densely hairy, ranging from white or gray to bright orange to brown or black. They may be either annual or perennial. Perennial species develop a new tube layer each year, thus increasing in size with age. The flesh color above the pore layer (referred to as the context with the poroid fungi) ranges from white or tan to brown.

Fruiting bodies of species of these fungi usually develop on downed wood, dead branches of living trees, and living trees. Some species develop in the heartwood of living trees, causing decay and leading to a hollow tree. Other species grow in the sapwood of trees.

Pore surfaces are characteristic for a species and may be variously colored; some may change upon bruising. Color changes of the pore surface and flesh upon treatment with various chemicals (such as KOH) are useful in identification. Pore size, traditionally indicated as the number of pores per millimeter, ranges from minute to large, and the pore shape varies from round to angular to elongate to lamellate or mazelike, as in *Daedalea*.

Stalks, when present, may be fibrous or woody and often are the same color as the main portion of the fruiting body.

Spores vary from white to tan to brown.

While most pore fungi are too tough to eat, some species are edible: *Fistulina hepatica* (beefsteak fungus), *Grifola frondosa* (hen of the woods), and *Laetiporus sulphureus* (sulfur shelf). They are excellent when young, but *L. sulphureus* becomes too tough to eat with age.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Tubes separate and pendant, on lower surface of fruiting body; interior fleshy to tough, red-marbled like fresh meat: *Fistulina hepatica*, page 193
1b. Tubes on lower surface fused; interior not as described above: 2
2a. Fruiting bodies a number of fleshy overlapping brackets, becoming tough with age: 3
2b. Fruiting bodies tougher, corky to leathery to woody; clustered or single: 4
3a. Fruiting bodies bright orange on upper surface, yellow or cream to white on lower, fading with age: *Laetiporus*, page 201
3b. Fruiting bodies gray to smoky brown, typically with many small laterally stalked caps; at the base of living oak trees or stumps: *Grifola frondosa*, page 197
4a. Fruiting body with a shiny, dark red-brown upper surface: *Ganoderma lucidum*, page 195
4b. Fruiting bodies dull, sometimes with a crusted or hairy upper surface: 5
5a. Fruiting bodies with a central or lateral stalk: 6
5b. Fruiting bodies sessile or nearly so, sometimes like overlapping shelves: 10
6a. Pores averaging 3 or less than 3 per mm; fruiting bodies developing in spring or early summer: 7
6b. Pores averaging more than 3 per mm; fruiting bodies usually developing in late summer or fall: 9

7a. Fruiting bodies large (6–30 cm broad); stalk usually lateral, black at base; upper surface with brown scales: *Polyporus squamosus*, page 211
7b. Fruiting bodies smaller; stalk central or lateral: 8
8a. Stalk central; cap golden brown or darker; margin hairy: *Polyporus arcularius*, page 209
8b. Stalk central or lateral; cap reddish yellow to brick-red; margin smooth: *Polyporus alveolaris*, page 207
9a. Fruiting body brownish black, at least in center; margin paler; stalk black; usually on downed logs or stumps: *Polyporus badius*, page 209
9b. Fruiting body tan; stalk black at base; usually on branches: *Polyporus elegans*, page 211
10a. Fruiting body with a single layer of tubes (annual): 11
10b. Fruiting body with an indefinite number of tube layers, one developing each year (perennial): 20
11a. Pores round to angular but small (2–6 per mm) or pore walls breaking into jagged toothlike structures: 12
11b. Pores elongate radially, straight or curved or almost gill-like: 18
12a. Fruiting body dark brown to blackish brown, large, thick; margin thick, exuding drops of fluid when young: *Ischnoderma resinosum*, page 199
12b. Fruiting body different colors; margin smaller and thinner: 13
13a. Fruiting body white, single; rounded margin projecting beyond pore surface; on living or dead birch trees: *Piptoporus betulinus*, page 207
13b. Fruiting body white, cream, or darker; margin ending at edge of pore layer: 14
14a. Fruiting body indefinite in size, flat on wood (resupinate), pore walls irregular becoming toothlike: *Irpex lacteus*, page 199
14b. Fruiting body definite in size, brackets single or in overlapping clusters: 15
15a. Fruiting body thin, tough; context white: 16
15b. Fruiting body thicker; context colored: 17
16a. Pore layer on young fruiting bodies white to lavender; pores becoming jagged and irregular with age, with lavender persisting at outer lower edge for some time: *Trichaptum biforme*, page 215
16b. Pore layer completely lacking lavender; upper surface of fruiting body with color zones: *Trametes versicolor*, page 213
17a. Fruiting body surface, context, and tube layer orange-red to orange: *Pycnoporus cinnabarinus*, page 213
17b. Fruiting body surface, context, and tube layer yellow-brown to rusty brown: *Phellinus gilvus*, page 205
18a. Pores varying from round to elongate, resulting in a mazelike lower surface: *Daedaleopsis confragosa*, page 191
18b. Pore surface with elongate tubes, becoming gill-like: 19

19a. Broadly attached linear thick brackets, upper surface deep brown to grayish: *Gloeophyllum*, page 197
19b. Broadly attached rosette-shaped brackets; thin upper surface white to yellowish, zonate: *Lenzites betulina*, page 203
20a. Fruiting body broadly semicircular; ridges on upper surface; lower surface white when young, bruising brown; pores very small: *Ganoderma applanatum*, page 195
20b. Fruiting bodies hoof-shaped, growing thicker with age but not much larger in diameter; young pore surface not white: 21
21a. Fruiting body concentrically furrowed; interior reddish brown; on various living hardwoods, common on *Quercus*: *Phellinus everhartii*, page 205
21b. Fruiting body not concentrically furrowed; interior creamy tan to yellow-brown; usually on living ash trees: *Perenniporia fraxinophila*, page 203

Daedaleopsis confragosa (Bolt.: Fr.) Schröt. (plate 124) INEDIBLE

Fruiting body annual, up to 12 cm broad, to 2 cm thick, sessile; leathery and pliable when young, becoming rigid and firm; upper surface grayish to brownish, finely hairy to smooth; lower surface whitish to pale brown, often staining pinkish when injured when young. Context firm; pale buff to brown.

Tubes circular to radially elongated; pores up to 1 mm in diameter; pore surface mazelike.

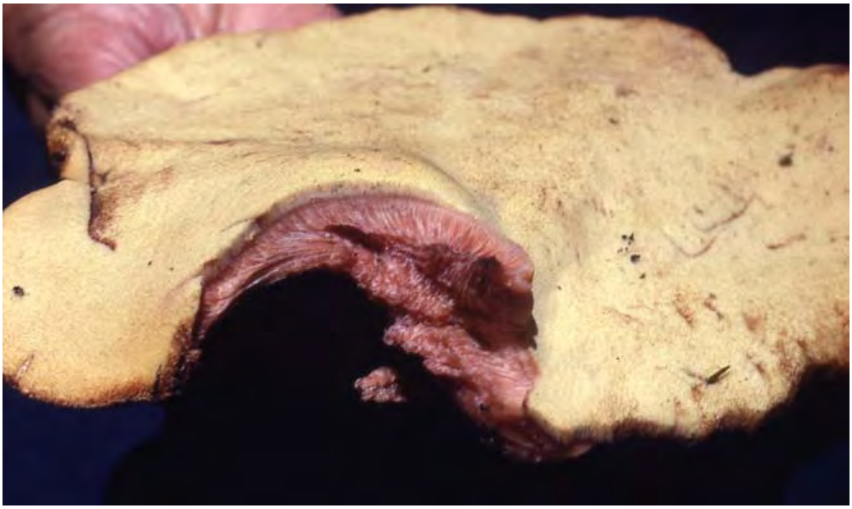
Stalk absent; fruiting body broadly attached.

Spores 7–9 × 2–2.5 μm.

Single to clustered, causing white rot of dead hardwoods, rarely on conifers, annual; summer, fall.

This species is also known as *Daedalea confragosa*. The fruiting bodies are quite variable in form and sometimes difficult to interpret. Another rather common species, formerly called *Daedalea unicolor* but now known as *Cerrena unicolor,* also has a mazelike pore surface. The fruiting bodies are thinner, with a black line in the context, and the tubes often break into irregular flattened teeth with age. It also occurs on dead hardwoods, causing a white rot. *Daedalea quercina*, especially common on oak, causes a brown heart rot and has a hard, more massive fruiting body, up to 20 cm broad and 1–8 cm thick.

PLATE 124. *Daedaleopsis confragosa*



Fistulina hepatica (Schaeff.) With. (plate 125A–C) CHOICE EDIBLE

Beefsteak Fungus

Fruiting body annual, up to 20 cm broad, fan-shaped; upper surface blood-red to liver color; moist, sticky. Context 3–7 cm thick, zoned white to reddish, oozing red juice; fleshy, becoming fibrous and duller with age.

Tubes separate (pl. 125C), closely packed; pores 4–6 per mm, white to pale yellowish, bruising dark reddish brown, with spongelike appearance.

Stalk short, usually lateral, sometimes with broad tapered area.

Spores 4–5.5 × 3–4 μm, ovoid, smooth, hyaline; spore print pinkish brown.

On stumps or at the base of living hardwoods, especially oaks, causing brown rot; fall.

This species is not common in the Midwest. The same common name is used for some false morels.

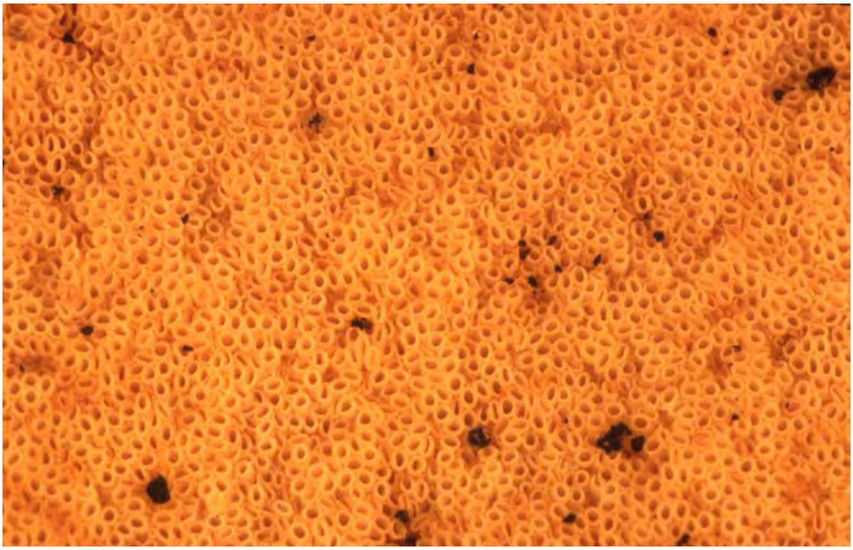


PLATE 125. *Fistulina hepatica*. A (Facing page, top): Upper surface, B (Facing page, bottom): Lower surface, C (Above): Tubes of lower surface

PLATE 126.
Ganoderma applanatum
A (Above): Upper surface
B (Right): Young lower surface

PLATE 127.
Ganoderma lucidum

Ganoderma applanatum (Pers.) Pat. (plate 126A, B) INEDIBLE

Artist's Conk

Fruiting body perennial, with shelflike conk up to 25–30 cm or more broad, broadly fan-shaped to semicircular, sessile; pale gray to gray-brown, dull; hard, smooth or concentrically ridged. Context dark rusty brown. Tubes in more than one layer after first year (perennial); tube layers separated by brown context-like layer. Pores small, 4–6 per mm; pore surface bright off-white in young brackets, bruising brown when scratched; pore layer may become yellowish when older.

Stalk absent; fruiting body broadly attached.

Spores 6–11 × 6–8 μm, ovoid, truncate at one end, with minute spines; spore print brown.

On living deciduous trees, often from wounds; also common on downed logs or hardwood stumps, seldom on conifers. Conks perennial, with new annual tube layer developing in summer.

This fungus produces a white rot in standing trees and is probably a factor in the death of senescent trees of numerous species. The young white pore surface has been used as a medium on which to etch pictures and designs: thus the name artist's fungus or artist's conk. This species is also known as *Fomes applanatus*.

Ganoderma lucidum (W. Curt.: Fr.) Karst. (plate 127) INEDIBLE

Fruiting body annual, to 15 cm or more broad to 3 cm thick at base, sessile to centrally or laterally stalked; upper surface dark red-brown, with thin varnished crust at maturity. Context zonate; creamy white, becoming dark purple-brown.

Tubes up to 1 cm deep; pores 4–5 per mm, circular to angular; pore surface creamy white when young, maturing to light buff, bruising dark purple-brown.

Stalk sometimes developed centrally or laterally, often absent.

Spores 9–12 × 5.5–8 μm, elliptical, truncate at apex, almost smooth; spore print white.

Single or clustered on living hardwoods near ground line or on dead stumps and tree trunks, common on oak; causes white rot and butt rot of living hardwoods; summer, fall.

PLATE 128.
Gloeophyllum sepiarium
A (Top): Upper surface
B (Bottom): Lower surface

PLATE 129.
Grifola frondosa

Gloeophyllum sepiarium (Wulfen) Karst. (plate 128A, B) INEDIBLE

Fruiting body annual to perennial, 2–10 cm long, 1–7 cm wide, 0.3–0.8 cm thick, kidney-shaped; upper surface rich rusty brown to red-brown or darker; hairy to somewhat smooth, with zonate ridges; margin often white, yellow, or orange. Context yellowish to rusty brown.

Tubes to 7 mm deep, round to elongate to modified lamellate (gill-like) with thick walls; lamellate areas mixed with poroid areas; pores about 1–2 per mm; pore surface golden brown to darker.

Stalk absent; fruiting body broadly attached.

Spores 6–10 × 2–4 µm, cylindrical, hyaline; spore print white.

Single to several, often in clusters, on dead wood, usually on conifers but occasionally on hardwoods, including birch, hawthorn, poplar, cherry, and willow; summer, fall.

This species causes a brown rot and often is the major fungus in the decay of dead conifers. It is also known as *Lenzites sepiaria.* Another species, *G. trabeum* (*Lenzites trabea*), has a gray to pale, dingy cinnamon upper surface with a somewhat poroid lower surface (2–4 per mm). It usually is associated with a brown rot of hardwoods and with decay of lumber used in building houses.

Grifola frondosa (Dicks.: Fr.) S. F. Gray (plate 129) CHOICE EDIBLE

Hen of the Woods

Individual fruiting bodies annual, entire structure up to 40 cm wide, stipitate (stalked); much branched from thick base, branches fan-shaped to petal-like, sometimes fused; pale gray to gray-brown; margin thin, often wavy or curled, finely hairy to smooth; formed in circular cluster as branches from thick, cream-colored base. Context about 2 mm thick in individual branches, fleshy, becoming brittle; ivory-white.

Tube surface extending down stalk; pores small, 1–3 per mm, rounded; pore surface white, aging yellowish.

Stalk white, lateral to eccentric; each single cap with smaller stalk.

Spores 5–7 × 3.5–4.5 µm, ovoid, smooth; spore print white.

Clusters on soil near stumps of hardwoods, usually at base of oaks; fall.

This species may require longer cooking than many mushrooms, but it is delicious. *G. frondosa* causes a white rot and butt rot of living trees. *G. gigantea*, also known as *Meripilus giganteus,* looks like a larger and tougher *G. frondosa.* Individual fruiting branches, 10–30 cm broad, overlap to form a compound fruiting body, 30–60 cm broad. The fruiting bodies are annual but often fruit with the same oak tree in subsequent years.

PLATE 130. *Irpex lacteus*

PLATE 131. *Ischnoderma resinosum*

Irpex lacteus (Fr.) Fr. (plate 130) INEDIBLE

Fruiting body annual, 1 × 7 × 0.5 cm; usually flat (resupinate), often turned up at edges (reflexed); separate bodies often fused at edges; pores on upper surface, white to cream or pale tan, pore walls 1–2 mm high, breaking irregularly with age. Context white to pale tan, 1–2 mm thick.

Spores 5–7 × 2–3 μm, oblong to cylindrical, straight to slightly curved.

Clustered on dead wood of hardwoods, common; present year-round.

This fungus is quite variable in appearance, often extensive in development on small to medium branches, usually on the ground.

Ischnoderma resinosum (Fr.) Karst. (plate 131) NOT RECOMMENDED

Fruiting body annual, 7–25 cm broad, 0.8–4 cm thick; dark brown or blackish brown; densely hairy when young, becoming smooth at maturity, sometimes shallowly furrowed, sessile; young margin thick and often exuding amber drops of fluid, thinner and dry with maturity. Context tough; straw-colored.

Tubes 1–10 mm deep; pores 4–6 per mm; pore surface white to pallid, maturing or bruising reddish brown.

Stalk absent; fruiting body broadly attached.

Spores 4–7 × 1.5–2 μm, cylindrical, smooth; spore print whitish.

Single to several, usually in overlapping clusters, on old logs and stumps of hardwoods and conifers, annual; late summer, very common in fall.

Drops of exudate are very conspicuous on the edge of young fruiting bodies along the rather thick margin. *I. resinosum* causes a white rot of dead conifers and hardwoods. It is also known as *Polyporus resinosus*. This species is not poisonous, but it is tough and not recommended for eating.

PLATE 132.
Laetiporus sulphureus
A (Right): Young, on living white oak
B (Below): Mature, on down log

Laetiporus sulphureus (Bull.: Fr.) Murr.
(plate 132A, B) EDIBLE, WITH CAUTION

Sulfur Shelf

Fruiting body annual, single brackets 5–25 cm broad, up to 2.5 cm thick; usually forming clusters 30–60 cm or more broad; upper surface bright orange to yellow when young, fading to tangerine or pale brownish with age; lower surface sulfur yellow, fading to pale tan; margin thinner with age, lobed, and wavy. Context up to 2 cm thick when young, tough to crumbly or chalky with age; white to yellow.

Tubes 1–4 mm long, shallow; pores 2–4 per mm, roundish to angular; pore surface bright sulfur-yellow to cream, becoming pale tan; pore surface appearing smooth when young.

Stalk lateral, very short or absent; whitish to yellow.

Spores 5–7 × 3.5–4.5 µm, broadly elliptical, smooth; spore print white.

In clusters on soil near stumps or on stumps, logs, or standing living hardwoods and conifers, very common on oak, annual; summer (occasionally early summer), fall.

This common fungus, which causes heart rot of living trees, has also been known as *Polyporus sulphureus*. The shallow tubes develop late, and young fruiting bodies appear smooth on the lower surface. The fruiting body fades to a pale whitish yellow with age. Less common is *Laetiporus cincinnatus*, similar but with an apricot-orange upper surface and whitish pore surface, which grows from roots, especially of oak. It is also edible when young. Although this species is edible for most people, gastrointestinal upsets have been reported. The young edges of the fruiting bodies are most desirable for eating; the older portions soon become quite tough.

PLATE 133.
Lenzites betulina
A (Above): On downed log
B (Right): Close-up of lower surface

PLATE 134. *Perenniporia fraxinophila*

Lenzites betulina (L.) Fr. (plate 133A, B) NOT EDIBLE

Fruiting bodies annual, 1–5 × 2–8 × 0.3–2 cm, single to clusters of a few; semicircular to broadly attached by partly resupinate effuse (spread out flat) area; tough, thin and flexible when young; upper surface hairy in concentric zones, white, becoming gray or cream; upper surface of old specimens greenish because of algae in the tomentum; lower surface with thin, undulating to flexuous radial lamellae.

Spores 5–6 × 2–3 µm, cylindrical, often slightly bent, hyaline.

Causes white rot of dead hardwoods, on various hardwoods but mainly on *Betula* sp.; occasionally on conifers; fall.

This species is easy to recognize because of the hairy zoned pileus and lamellate lower surface.

Perenniporia fraxinophila (Pk.) Ryv. (plate 134) NOT EDIBLE

Fruiting body perennial, 7 cm long, 9 cm broad, 7 cm thick; convex to somewhat hoof-shaped, sessile; white, turning grayish black to brown; margin thick, rounded, pale brown or white. Context woody; pale to wood-colored to yellow-brown.

Tubes 2–5 mm long; pores 2–3 per mm, circular; pore surface white to brownish.

Stalk absent; fruiting body broadly attached.

Spores 6–9 × 5–6 µm, elliptical to ovoid, hyaline; spore mass white.

Usually single on living or dead ash trees but also found on sycamore, oak, and elm; perennial, with new tube layer developed each year by fall.

This fungus is a major cause of trunk rot in living *Fraxinus* and may be a concern for property owners of diseased trees. On living standing trees, fruiting bodies often develop from areas where branches have pruned naturally. It is not uncommon to see several perennial brackets from such sites on a single tree.

PLATE 135. *Phellinus everhartii*

PLATE 136. *Phellinus gilvus*

Phellinus everhartii (Ell. & Gall.) A. Ames (plate 135) NOT EDIBLE

Fruiting body perennial, up to 6 × 13 × 8 cm, woody, sessile, convex to hooflike (ungulate); upper surface yellowish brown to black, smooth and incrusted with age, rough and furrowed; context rusty brown; lower pore surface with golden luster, dark yellowish brown to reddish brown, pores 5–6 per mm; new pore surface developing each year; tubes up to 6 mm long.

Spores 4–6 × 4–5 µm, subglobose to globose, smooth; setae (thick-walled, sharp-tipped sterile cells) in basidial layer frequent to abundant.

Causes white rot of heartwood of living hardwoods, usually on *Quercus*, occasionally on other hardwoods.

Another common perennial species, *P. igniarius*, occurs on many hardwood genera, continuing decay on dead trees. *P. pomaceus* is similar but produces smaller fruiting bodies on *Prunus*.

Phellinus gilvus (Schw.) Pat. (plate 136) NOT EDIBLE

Fruiting bodies annual or rarely perennial, up to 7 × 12 × 3 cm, leathery to corky, sessile, single or in overlapping groups; upper surface dark yellowish brown, hairy to smooth, pore surface grayish brown to reddish brown, pores 6–8 per mm, 1–5 mm long; context bright yellowish brown.

Setae abundant in basidial layer.

Spores 4–5 × 3–3.5 µm, elliptical to ovoid, hyaline, smooth.

On many genera of living and dead hardwoods, especially common on *Quercus*.

This species causes white rot of dead hardwoods and a heart rot of living trees.

PLATE 137. *Piptoporus betulinus*

PLATE 138. *Polyporus alveolaris*

Piptoporus betulinus (Bull.: Fr.) Karst. (plate 137) NOT EDIBLE

Fruiting body annual, up to 20 cm broad, 2–5 cm thick; white to pale brown; smooth to slightly rough; margin inrolled, remaining as rim around pore surface. Context tough when young, maturing to corky; white.

Tubes 2–8 mm deep; tube walls becoming jagged with age; pores 3–4 per mm; pore surface white to cream, becoming light brown with age.

Stalk lateral, short, or absent.

Spores 3.5–5 × 1–2 µm, straight or curved, smooth; spore print white.

Scattered on trunks of living or dead birch trees, common, annual; summer, fall.

This species causes a brown cubical rot of the sapwood of dead birch. It is restricted to birch. The short-stalked or sessile fruiting bodies are distinctive. *Fomes fomentarius* is also a common perennial polypore on birch, producing hoof-shaped fruiting bodies that become longer with age. These two common fungi on birch are easily identified.

Polyporus alveolaris (DC.: Fr.) Bond. & Sing. (plate 138) NOT EDIBLE

Fruiting body annual, 1–8 cm broad, rounded to kidney- or fan-shaped; stipitate to sessile; reddish buff or brick red, weathering to cream or white; fibrillose, dry. Context thin, tough; white.

Tubes radially elongate, walls breaking down with age; large pores 0.5–3 mm wide, angular to hexagonal; pore surface white to buff.

Stalk short, lateral or central; white to tan.

Spores 9–11 × 3–3.5 µm, narrowly elliptical, smooth; spore print white.

Single to several on branches and twigs of hardwoods, very common on shagbark hickory; spring and early summer.

P. alveolaris is one species in the group of pore fungi with large angular pores that form fruiting bodies in spring and early summer. It causes a white rot of dead hardwoods. It is also known as *Favolus alveolaris*.

PLATE 139. *Polyporus arcularius*

PLATE 140. *Polyporus badius*

Polyporus arcularius Batsch: Fr. (plate 139) NOT EDIBLE

Fruiting body annual, 1–2.5 cm broad, 1–4 mm thick, circular, depressed at center, stipitate; golden or yellowish brown to dark brown with hairs; upper surface dry; margin hairy. Context thin, tough; white.

Tube surface extending down stalk; large pores 0.5–1 mm wide, angular, radially elongate; pore surface white to yellowish.

Stalk 2–6 cm long, 2 mm thick, central; yellowish brown to dark brown; dry, smooth.

Spores 7–12 × 2–3 µm, cylindrical, smooth; spore print white.

Single or several in group on hardwood sticks, logs, or stumps; early summer.

This is one species in the group of attractive poroid fungi with large angular pores that fruit in early summer. It causes a white rot of dead hardwoods.

Polyporus badius (Pers.: S. F. Gray) Schw. (plate 140) NOT EDIBLE

Fruiting body annual, 4–20 cm broad, 1–8 mm thick, rounded to subcircular, convex, becoming depressed, centrally or laterally stipitate; chestnut-brown or reddish brown to nearly black at maturity; margin paler. Context thin, leathery; white or pallid.

Tubes to 3 mm deep; pores small 5–7 per mm, circular to somewhat angular; pore surface white to tan to brownish.

Stalk 1–6 cm long, 0.5–1.5 cm thick; black at least on lower half; smooth.

Spores 6–8 × 3–4 µm, elliptical, smooth, hyaline; spore print white.

Single to several, very common on stumps and logs of hardwoods; late summer, fall.

It is not uncommon in fall to see large downed logs completely covered with fruiting bodies of this attractive fungus. The pore surface of young fruiting bodies appears smooth, but tubes develop with age. It causes a white rot of dead hardwoods and conifers. This species has been commonly called *P. picipes*.

PLATE 141. *Polyporus elegans*

PLATE 142. *Polyporus squamosus*

Polyporus elegans Bull.: Fr. (plate 141) NOT EDIBLE

Fruiting body annual, 1.5–7 cm broad, 0.2–0.5 mm thick, circular to oblong, centrally to laterally stipitate; pale to dull tan, weathering to nearly white; nearly smooth, leathery, drying rigid. Context white or pallid.

Tube surface extending down stalk; pores small, 4–5 per mm, angular; pore surface gray to tan.

Stalk 0.5–6 cm long, 2–6 mm thick; black at base or lower half.

Spores 6–10 × 2.5–3.5 µm, cylindrical, hyaline; spore print white.

Common, often on branches of hardwoods; late summer, fall.

This species causes a white rot of dead hardwoods. The fruiting bodies usually are smaller than those of *P. badius*.

Polyporus squamosus Huds.: Fr. (plate 142) NOT EDIBLE

Fruiting body annual, 6–30 cm broad by 0.5–4 cm thick, roughly fan-shaped; stalk lateral to nearly central; whitish to yellowish to dingy tan to buff; dry with large brown scales. Context thick, tough; white.

Tubes up to 7 mm deep, some deeply split with age; pores large, 1–3 mm wide, angular; white to cream, becoming straw-colored with age.

Stalk 1–4 cm thick, short; white above, blackish below.

Spores 11–14–(20) × 4–5–(9) µm, elliptical; spore print white.

Single to several on hardwoods, from wounds on living trees, also on stumps and logs; spring, early summer.

Although *P. squamosus* is somewhat fleshy in appearance, it is tough even when young. This is the first species of the large angular pore group of pore fungi to produce fruiting bodies in the spring, often observed by morel collectors in May. It causes a white heartwood rot of living and dead hardwoods.

PLATE 143. *Pycnoporus cinnabarinus*

PLATE 144. *Trametes versicolor*

Pycnoporus cinnabarinus (Jacq.: Fr.) Karst. (plate 143) NOT EDIBLE

Fruiting body annual, 2–12 cm long, 2–7 cm wide, 0.5–2 cm thick; sessile or broadly attached laterally; orange to cinnabar-red, fading at maturity; slightly tomentose, weathering to glabrous. Context fibrous to soft-corky; red or orange-red.

Tubes less than 0.5 cm long; pores 2–4 per mm, circular or angular; pore surface cinnabar-red.

Stalk absent, fruiting body broadly attached.

Spores 4.5–6–(8) × 2–3 µm, cylindrical, often pointed at one end, smooth; spore print white.

Single to several on hardwoods, most common on oak and black cherry, occasionally on conifers; summer, fall.

This species is also known as *Polyporus cinnabarinus*. Its distinctive color makes it obvious and easy to recognize. It causes a white rot of dead hardwoods.

Trametes versicolor (L.: Fr.) Pilát (plate 144) NOT EDIBLE

Turkey Tail

Fruiting body annual, 2–6 cm broad, 0.5–3 mm thick, leathery, broadly attached in overlapping clusters; upper surface variably colored, with narrow concentric zones of white, cream, yellow, red, or bluish green to black, silky to velvety; lower surface white to yellowish or light brown with age. Context thin, up to 3 mm thick, white to tan.

Tubes up to 2 mm deep; pores averaging 3–5 per mm, angular; white to yellowish.

Stalk absent, fruiting body attached laterally.

Spores 4–6 × 1.5–2 µm, cylindrical, smooth, hyaline; spore print white.

Dense clusters on dead hardwoods or on wound sites of live trees involved in sapwood decay, very common; summer, fall.

This species is also known as *Polyporus versicolor* or *Coriolus versicolor.* It produces a white rot of dead hardwoods. Two similar common species are *Trametes hirsuta*, which is nearly unicolored grayish to yellowish to brownish, with darker marginal zones and a slightly thicker context, 1–6 mm thick; and *T. pubescens*, which is unicolor buff to off-white, with no contrasting zones.

PLATE 145. *Trichaptum biforme*.
A (Top): Upper surface and lower surface, B (Bottom): Lower surface

Trichaptum biforme (Fr.) Ryv. (plate 145A, B) NOT EDIBLE

Fruiting body annual, 1–7 cm long, 1–7 cm wide; sessile, often in overlapping groups; upper surface whitish to grayish to brownish; thin, tough, hairy, zonate at least at margin; lower surface white to violaceous, often fading with age but usually remaining violet at outer edge. Context thin, usually less than 1 mm thick; white.

Tubes 1–3 mm long; pores 2–5 per mm, round to angular when young, but soon breaking and becoming irregularly toothed; young pore surface violaceous, fading with age.

Stalk absent, fruiting body broadly attached.

Spores 5–6 × 2–2.5 μm, cylindrical to slightly curved; spore print white. On dead hardwoods, common; summer, fall.

This species belongs to a small number of thin, leathery, sessile pore fungi that develop in large groups of overlapping brackets on logs or stumps. They have color zones on the upper surface, weather slowly, and may persist for several years. Older, weathered fruitings are difficult to interpret. The delicate violet color of the young fruiting bodies of *T. biforme* is distinctive. This species has also been known as *Hirschioporus pargamaneus* and as *Polyporus pargamaneus*. It causes a white pocket rot of dead hardwoods.

Schizophylloid Aphyllophorales

The schizophylloid Aphyllophorales, a small group of wood-inhabiting fungi, produce small, cuplike fruiting bodies that are attached at the base. A layer of basidia develops inside each cup. In the only common genus, *Schizophyllum,* the walls of the fruiting body enlarge, flatten, and elongate, exposing longitudinally split gills. Typically tough and leathery, often with hairs on the outer surface, these fruiting bodies expand when moist and curl inward when dry.

Schizophyllum commune Fr. (plate 146) NOT EDIBLE

Fruiting body annual, 1–3 cm broad, fan-shaped, often attached broadly, sometimes in center of upper surface, densely hairy; whitish gray to gray; margin lobed and hairy. Flesh thin, tough.

Ridges on lower surface gill-like, split, distant; white to gray; hairy.

Stalk short, lateral to absent.

Spores 3–4 × 1–1.5 µm, cylindrical; spore print white.

Several to overlapping in clusters on sticks, stumps, and logs of hardwoods; very common, often seen on senescent limbs of living trees, common on dead sections of living trees; spring, summer, fall.

This fungus has been a favorite for experimental genetics research because it is readily cultured and produces fruiting bodies in the laboratory. The fruiting bodies curl on drying, becoming tough to almost brittle, then expand and flatten when moistened.

PLATE 146. *Schizophyllum commune*

Smooth Aphyllophorales

The very diverse fungi of this group typically inhabit or are associated with wood and wood products. They are significant decay fungi that may develop on dead branches of living trees but normally do not become established on healthy, functioning wood. Development does not seem to be seasonal; thus they colonize wood whenever it is available. The fruiting bodies range in structure from thin sessile brackets to stalked fruiting bodies with flattened branches to smooth, flat layers of a definite size or of various extent. Some of the flat fruiting bodies are a loosely interwoven, obscure hyphal tangle, and some have a more definite form.

Traditionally, these diverse fungi were grouped together, because a flat uninterrupted layer of basidia that produces basidiospores develops on the surface of the fruiting structure. In the flat forms, the basidial layer develops on the surface away from the wood; in the brackets, the smooth basidial layer forms on the lower surface of the bracket. On the stalked branched forms, the smooth basidial layer covers the flattened branches. Microscopic features of the tissues of the fruiting bodies, the cells of the basidial layer, and the spores are diagnostic in modern interpretations of these fungi.

Stereum is one of the more conspicuous genera, developing thin, bracketlike fruiting bodies in numbers on a downed log or stick. Often overlapping brackets develop from an area of the fruiting body flat on the woody substrate (pl. 147). The upper surface of the thin, leathery brackets is zoned and very similar in appearance to the zonate, thin, leathery brackets of the poroid Aphyllophorales. A look at the lower surface is sufficient to differentiate between the two groups, for the smooth lower surface of the *Stereum* brackets is very different from the poroid pattern of the others. *Stereum* species are very common on oaks.

Plates 148, 149, and 152 show some members of this group routinely encountered in deciduous woods and illustrate the diversity of the group. The tough fruiting bodies persist and are obvious all year but particularly evident in the fall, when new fruitings occur.

PLATE 147.
Effuse fruiting body of the smooth Aphyllophorales

PLATE 148. *Stereum* sp.

Aleurodiscus oakesii (Berk. & Curt.) Pat. (plate 149A, B) NOT EDIBLE

Fruiting bodies disc-shaped, up to 1 cm in diameter, single or clustered; in masses up to 2 cm; somewhat fleshy, drying tough; attached at center, with margin raised, incurved; whitish and hairy on lower side, upper side concave, drying cream-gray; curling when dry, expanding again when moistened.

Spores 18–21 × 12–13 µm, hyaline, smooth.

On trunk bark of living *Quercus* and *Ostrya*; present throughout the year.

The lower trunk bark of *Quercus alba* is often sufficiently modified in structure to be very obvious.

PLATE 149. *Aleurodiscus oakesii*. A (Left): On bark of white oak tree B (Right): Close-up

Peniophora rufa (Pers.) Boidin (plate 150) NOT EDIBLE

Fruiting bodies flat tough discs 5–10 mm across, surface wrinkled to nearly smooth, clustered; red to purple-brown with grayish bloom when dry; basidial layer covers upper flat surface.

Spores 6–9 × (1.5)–2–3 µm, hyaline, smooth, cylindrical, curved.

On dead branches of species of *Populus* and *Salix*; present throughout the year.

PLATE 150. *Peniophora rufa*

PLATE 151. *Phlebia incarnata*

PLATE 152. *Stereum ostrea*

Phlebia incarnata (Schw.) Nakasone & Burds. (plate 151) NOT EDIBLE

Fruiting bodies somewhat fleshy; flat, becoming shelflike in overlapping groups; upper surface coral pink, shading to whitish with age; lower surface cream to white, irregular with netlike folds, coarsely wrinkled.

Spores 4–4.5 × 2–2.5 μm, hyaline, smooth.

On hardwood logs, stumps, and branches, causing a white rot; late summer, fall.

This species is also known as *Merulius incarnatus*. A less colorful species, *Phlebia tremellosus*, is soft-gelatinous, flat to shelving, with a whitish hairy to woolly upper surface and a light pinkish to creamy lower surface with shallow netlike folds. It is also found on downed wood or stumps, causing a white rot.

Stereum ostrea (Blume & Nees: Fr.) Fr. (plate 152) NOT EDIBLE

False Turkey Tail

Fruiting bodies annual brackets, up to 8 cm wide, often semicircular and overlapping, thin, leathery; upper side with fine silky hairs, zonate, reddish brown to buff-yellow or wood brown; lower surface smooth, gray-yellow to reddish brown.

Spores 5–7.5 × 2–3 μm, cylindrical, smooth; spore print white.

Common, single or in overlapping clumps on downed wood, logs, and stumps of deciduous trees; present all year.

S. hirsutum, another species known as false turkey tail, is part of a species complex that cannot be distinguished from *S. ostrea* based on field characteristics, but *S. ostrea* can be distinguished by microscopic structures.

Xylobolus frustulatus (Pers.: Fr.) Boidin (plate 153) NOT EDIBLE

Ceramic Fungus

Fruiting bodies form flat crusts of aggregations of small (5 mm or less in diameter), hard, flat, chunklike pieces, whitish to yellow-brown to gray-brown with age; basidial layer covers upper surfaces.

Spores 3.5–6–(7) × 2.5–3–(3.5) µm, elliptical, smooth, hyaline.

On hardwood stumps and logs, common on debarked wood; present throughout the year.

PLATE 153. *Xylobolus frustulatus*

Spiny (or Toothed) Aphyllophorales

Fruiting bodies in this group are mostly annual, varying from branched, conklike, or shelflike structures to those that have caps with central or lateral stalks. The primary characteristic is toothlike spines that develop from the lower surface. The color varies from white through tan, brown, or orange. The flesh is soft to fibrous, tough, or brittle, ranging from white to brown.

Stalks may be single, branched, or absent.

Spore prints are often white but may be light tan to brown.

Species of this group are decay fungi of living trees or downed wood. Those on downed wood often form large, flat, thin fruiting bodies with conelike or irregularly jagged teeth.

The edible fungi in this group include *Hericium* spp. and *Hydnum repandum*.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Fruiting body caplike with stalk; spines from lower surface of cap: 4
1b. Fruiting body not a single cap: 2
2a. Fruiting body tough, bracketlike, overlapping in a cluster: *Climacodon septentrionalis*, page 225
2b. Fruiting body fleshy, single or branched: 3
3a. Fruiting body large, branched from a bulky base; spines clustered at tips of branches: *Hericium coralloides*, page 225
3b. Fruiting body unbranched, beardlike; spines from a lower surface of central fleshy mass: *Hericium erinaceus*, page 227
4a. Cap smooth, buff to cinnamon; fleshy teeth cream: *Hydnum repandum*, page 228
4b. Cap surface zoned reddish brown and lighter brown, tough, teeth brown: *Hydnellum scrobiculatum*, page 227

PLATE 154. *Climacodon septentrionalis*

PLATE 155. *Hericium coralloides*

Climacodon septentrionalis (Fr.) Karst. (plate 154) NOT EDIBLE

Fruiting bodies annual, sessile, tough fleshy brackets, fan-shaped in overlapping linear clusters from flat common base, up to 30 cm wide, 2.5–5 cm thick; upper surface roughened, whitish to creamy yellow, becoming darker with age; lower surface with crowded whitish spines 6–20 mm long, shorter near margin.

Spores 2.5–3 × 4.5–5 µm, elliptical, smooth, hyaline.

On wounds on standing hardwood tree trunks, especially on maple; developing midsummer into fall.

The fruiting bodies in plate 154 are young. This species is also known as *Steccherinum septentrionale*.

Hericium coralloides (Scop.) Pers. (plate 155) CHOICE EDIBLE

Fruiting body annual, 5–30 cm broad, with many compact branches from short rooting base; branches with delicate tapered spines hanging down; white, aging dark cream; spines 3–10 mm long. Flesh fibrous; white.

Stalk short, thick, branching.

Spores 3–5 × 3–4 µm, nearly round; spore print white.

Single to several on logs of hardwoods; late summer, fall.

Though the flavor may vary, this is usually considered an excellently edible fungus, either sautéed or cooked with meat and vegetables. *H. ramosum* closely resembles *H. coralloides* but differs in spine length and openness of the branching system. The differences and identity of *H. coralloides*, *H. ramosum*, and *H. americanus* have caused confusion. They occur on wood, develop in late summer or fall, and are edible. These fungi are truly spectacular, especially when young and pure white.

PLATE 156. *Hericium erinaceus*

PLATE 157. *Hydnellum scrobiculatum*

Hericium erinaceus (Bull.) Pers. (plate 156) EDIBLE

Fruiting body annual, large, 10–30 cm long, round fleshy mass with crowded slender spines hanging vertically from front edge and lower surface of fruiting body; white, aging grayish or yellowish brown. Flesh firm; white.

Stalk short to lacking.

Spores 4.5–6 × 4–5 μm, slightly roughened; spore print white.

From living hardwoods, especially oak; late summer, fall.

Hydnellum scrobiculatum (Fr.) Karst. (plate 157) NOT EDIBLE

Fruiting body annual, 3–7 cm broad, plane to funnel-shaped; reddish brown zoned with lighter brown; solid; margin paler, uneven, sometimes lobed.

Teeth up to 6 mm long, brownish with gray tips; tooth layer extending down stalk.

Stalk to 4 cm long, 1–3 cm thick; same color as cap, dull; sometimes fused with others to become irregular, mycelium at base interwoven with debris at soil surface.

Spores 4.5–6 × 4–4.5 μm, subglobose, warty, rough; spore print brown.

Single to clustered on the ground under hardwoods or mixed woods; summer, fall.

Several genera of fungi have centrally stipitate, tough, fibrous fruiting bodies with spines on the lower cap surface. *Auriscalpium vulgare* is widely distributed, typically fruiting on conifer litter or conifer cones. The fibrillar, small (1–4 cm broad) caps with brown spines on the lower surface and a central to laterally attached thin stalk are distinctive. Fruiting bodies of *Hydnellum* and *Phellodon* develop on the ground and are typically larger than *Auriscalpium*, with thicker stalks, often with spines developing down the stalk. Species of *Phellodon* have white spores; those of *Hydnellum* have brown spores.

PLATE 158. *Hydnum repandum*

Hydnum repandum L.: Fr. (plate 158) CHOICE EDIBLE

Fruiting body annual, 2–10 cm broad; rounded, maturing to flat; depressed, often irregularly shaped, with central stalk; buff to tan to dull cinnamon; surface dry, smooth. Flesh white to cream, slowly bruising yellow.

Teeth 0.5–1 cm long, with various lengths intermixed, extending slightly down stalk; white to cream, darkening with age.

Stalk 2–10 cm long, 0.6–2 cm thick, equal to slightly enlarged at base; same color as cap; solid.

Spores 6.5–10 × 6.5–8 μm, nearly round, smooth; spore print white.

Single to scattered on the ground under hardwoods; late summer, fall.

This species is also known as *Dentinum repandum*.

Gasteromycetes

These fungi develop basidia (spore-producing cells) within the fruiting bodies. The spores are not forcibly separated from the basidium, but the basidial cell collapses; the spores are dispersed in various ways that are characteristic of the different groups of gasteromycetes. The spore color described is spore color in mass, but it is observed directly in or on the spore-producing area of the fruiting body. Mycologists studying the relationships of specific species of mushrooms or boletes with certain species of gasteromycetes are questioning the traditional interpretations and grouping of these fungi. In this field manual we present the traditional organization of groups, intriguing as it is to think about changes based on current research information.

Fruiting bodies are diverse in this group but are similar in each order of the gasteromycetes. In the Lycoperdales (the puffballs and earthstars), the mature dry, powdery spore mass is covered by a thin flexible cover that may develop an apical opening or break irregularly into large pieces. If the cover breaks and falls away, the spores are blown about by the wind or splashed about by rain. If the puffball has an apical opening, spores puff out through the opening when something pushes against the cover, such as raindrops or a small animal scurrying through the woods.

In the Phallales (the stinkhorns), mature spores are in a foul-smelling slimy mass exposed on the fruiting structure. Insects that feed on the slimy mass carry the spores away on their bodies.

In the Nidulariales (the bird's nest fungi), the spores are produced inside peridioles (walled-off units of the gleba) in the small, cuplike fruiting bodies. The peridioles are flipped out of the cups by raindrops, but the spores are not released until the peridiole wall decays.

In the hard puffball members of the Sclerodermatales, the thick outer rind breaks irregularly, exposing the dark, powdery spore mass. The spores can be blown about by the wind or splashed about by rain.

In the basidiomycetous or false truffles, the fruiting bodies develop in the soil or litter. See the discussion of ascomycetous truffles for more information.

Some species in the Lycoperdales are considered excellent for cooking. Their flavors are generally somewhat bland by themselves, but in soups, omelets, and casseroles they seem to enhance other flavors. Especially recommended are *Calvatia gigantea, C. cyathiformis,* and *Lycoperdon pyriforme.* A word of caution about the hard puffballs (species of *Scleroderma*) should be added. Cases of illness in individuals who have eaten these fungi have been reported. The heavy, rindlike cover and the early development of the purplish to purple-black areas in the interior of the fruiting body of a young *Scleroderma* are quite different from the young true puffball's thin cover and white interior, shading into yellow to olive.

Some of the false truffles are superficially similar to puffballs or hard puffballs. The interior of false truffles has either channels or veins, which distinguish them from the homogeneous interior of puffballs and hard puffballs. Some species of *Elaphomyces*, an ascomycetous truffle genus, can be confused with *Scleroderma*: both have blackish powdery spore masses at maturity, and evidence of basidia or asci may be absent. The spores of gasteromycetes usually have a pedicel (small stalk), a remnant of their attachment to the basidium, while the spores of *Elaphomyces* have no appendages.

Young button specimens of some mushrooms (particularly *Amanita* spp.) may look like young puffballs. Cutting the fruiting body longitudinally is an easy and sure test for proper identification. If it is a young mushroom, the embryonic mushroom with cap, gills, and stalk will be obvious. If it is a puffball, it will have a thin outer covering and a white homogeneous interior.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Fruiting bodies with erect, spongy stalks covered with an olive-green to darker slimy spore mass at the apex (Phallales: stinkhorns): 2
1b. Fruiting body sessile or stalked; stalk not spongy when present; spore mass dry: 6
2a. Stalk pink to reddish: 3
2b. Stalk white with a distinctly limited olive-green to black slimy spore mass at apex: 5
3a. Stalk with an indefinite apical region of olive-green slimy spore mass: *Mutinus caninus*, page 249
3b. Head portion with 4–6 hollow arms or with a closed lattice structure with pits: 4
4a. Dark spore mass lining the interior of apical hollow arms: *Lysurus cruciatus*, page 247
4b. Dark spore mass exposed in open areas in the apical lattice: *Simblum sphaerocephalum*, page 255
5a. Stalk surrounded by an elongate, white netlike skirt: *Dictyophora duplicata*, page 241
5b. Stalk lacking such a skirt: *Phallus hadriani*, page 249
6a. Fruiting body resembling a tiny bird's nest with eggs (Nidulariales: bird's nest fungi): 7
6b. Fruiting body round, pear-shaped, or star-shaped, rarely stalked: 8
7a. Nest a short cylindrical cup with almost straight sides: *Crucibulum laeve*, page 239

7b. Nest goblet-shaped or vase-shaped, smaller in diameter at the base: *Cyathus striatus*, page 241

8a. Outer layer of fruiting body splitting and recurving in starlike lobes; inner layer firm but flexible, with a central opening (earthstars): 9

8b. Outer layer of fruiting body not breaking into raylike segments: may break away at maturity, or both layers may break in an indefinite manner at maturity: 11

9a. Outer layer thick, almost woody, hygroscopic (rays bend out and backward, exposing inner layer when wet, curve in over it when dry): *Astraeus hygrometricus*, page 235

9b. Outer layer fleshy, tough when young, drying to become leathery, not hygroscopic: 10

10a. Inner layer surrounded by a ring of tissue broken from inner surface of the fleshy outer starlike lobes: *Geastrum triplex*, page 243

10b. Inner surface of outer starlike lobes unbroken, smooth: *Geastrum saccatum*, page 243

11a. Fruiting body with a definite, round to irregular opening (pore) in the central upper part of the intact inner layer: 12

11b. Fruiting body not developing a pore; inner layer remaining or breaking irregularly at maturity: 16

12a. Fruiting body with a tough, almost woody stalk (stalked puffball): *Tulostoma brumale*, page 255

12b. Fruiting body sometimes with a sterile, chambered basal portion; lacking a definite woody stalk: 13

13a. Lacking a sterile basal portion or with only a very small unchambered area; dark, powdery spore mass completely filling fruiting body: *Bovista plumbea*, page 235

13b. Lower part of fruiting body a sterile, chambered base, upper part becoming a dry, powdery spore mass (puffballs): 14

14a. In clusters, often in large groups, on downed wood; outer cover smooth: *Lycoperdon pyriforme*, page 247

14b. Single or loosely grouped, usually on the ground, not on wood: 15

15a. Fruiting body with small pointed spines when young; mature spore mass olive to olive-brown: *Lycoperdon perlatum*, page 245

15b. Fruiting body with clusters of spines united at tips of spines; mature spore mass purple-brown: *Lycoperdon pulcherrimum*, page 245

16a. Cover of fruiting body thick, hard, persistent; capillitium (sterile threadlike hyphae in the gleba) lacking: 17

16b. Cover of fruiting body thin; capillitium present or absent: 19

17a. Outer cover very thick, eventually splitting irregularly and folding back; fruiting body partially buried in soil: *Scleroderma polyrhizum*, page 253

17b. Outer cover thinner, breaking but not folding back; fruiting body at soil surface: 18

18a. Outer cover thin, flexible; fruiting body opening by an irregular slit: *Scleroderma areolatum*, page 251

18b. Outer cover thick, distinctly scaly; fruiting body opening by irregular breaks: *Scleroderma citrinum*, page 253

19a. Thin cover breaking, exposing rounded discrete inner units, which break to release dry, cinnamon spore mass: *Pisolithus tinctorius*, page 251

19b. Thin cover breaking into irregular pieces at maturity, falling away from dry, powdery spore mass and capillitium (larger puffballs): 20

20a. Fruiting body large (10–50 cm), roundish; outer cover breaking irregularly to expose dry, powdery spore mass that completely fills fruiting body: *Calvatia gigantea*, page 239

20b. Fruiting body smaller, upper part larger in diameter; outer cover breaking from upper portion; sterile base: 21

21a. Mature spore mass purple: *Calvatia cyathiformis*, page 237

21b. Mature spore mass yellow-green to yellow-brown: *Calvatia craniiformis*, page 237

PLATE 159A and B. *Astraeus hygrometricus*

PLATE 160. *Bovista plumbea*

Astraeus hygrometricus (Pers.) Morgan (plate 159A, B) NOT EDIBLE

Fruiting body 1–4 cm broad when mature, with expanded rays; outer cover tough, splitting into 7–15 pointed rays bending and flattening outward when wet, curving inward over continuous inner layer when dry; inner layer light gray to tan and opening by slit or tear or irregular pore; interior white when young, becoming dry brown spore mass intermingled with dark threads (capillitium).

Spores 7–12 µm, nearly round, thick-walled, covered with warts and spines.

Scattered in sandy soils, cosmopolitan in distribution: in sandy areas along Mississippi River in Iowa; fall.

The tough fruiting bodies will be persistent for several years. Most of the earthstars are species of *Geastrum* and do not have hygroscopic rays that open and expand when moist and close when dry. One species, *G. mammosum,* does have somewhat hygroscopic thicker and brittle rays, however, and could be confused with *A. hygrometricus.* Fortunately, the spores are distinctive: the spores of *G. mammosum* are about 4 µm in diameter, round, and much smaller than those of *A. hygrometricus.*

Bovista plumbea Pers. (plate 160) NOT EDIBLE

Tumbling Puffball

Fruiting body 2–3 cm broad, nearly globose; smooth, thin, white outer layer soon peeling off or breaking at maturity to expose blue-gray to purplish brown inner cover with irregular apical opening.

Spores 6–8 × 4–5 µm, oval with long, narrow pedicel up to 13 µm long and loose capillitium branching several times, with pointed ends; spore mass dark purplish brown, filling fruiting body.

Solitary to scattered in pastures or other grassy areas; summer, fall.

Young fruiting bodies are loosely attached to the soil by the mycelium in the center of the lower surface. When the basal mycelium breaks down at maturity, they are free and may be tumbled about by the wind.

PLATE 161. *Calvatia cyathiformis*

Calvatia cyathiformis (Bosc) Morg.

(plate 161) CHOICE EDIBLE WHEN YOUNG AND WHITE INSIDE

Fruiting body 5–16 cm broad, 5–11 cm high, rounded; whitish to light tan; firm when young; upper portion maturing to purple dry, powdery spore mass and capillitium; lower portion smaller, solid, firm, persistent; cover over upper spore mass cracks irregularly, breaking with age and eventually falling away completely, exposing spore mass.

Sterile base, with lower third remaining long after top part (capillitium and powdery spore mass) has been scattered by fall rains and winter snows.

Spores 3.5–7.7 μm, nearly round with minute spines; spore mass purple.

Scattered to numerous in grassy pastures, at edge of woods; late summer, fall.

A similar puffball, *C. craniiformis* (pl. 162), also has an upper white edible portion when young and a bright yellow-green to yellow-brown spore mass at maturity. It is common on the ground in hardwood forests. The sterile bases of both species may persist for a year or longer.

PLATE 162. *Calvatia craniiformis*

PLATE 163. *Calvatia gigantea*
A (Top): Immature and mature, B (Bottom): Mature

PLATE 164. *Crucibulum laeve*

Calvatia gigantea (Batsch: Pers.) Lloyd
(plate 163A, B) CHOICE EDIBLE WHEN YOUNG AND WHITE INSIDE

Giant Puffball

Fruiting body 10–50 cm in diameter, round, with central basal cordlike rhizomorph often present; white or light gray to yellow then olive-tan at maturity; outer cover smooth, soft, leatherlike, splitting randomly and breaking away at maturity, completely exposing spore mass; interior white and firm when young, becoming yellow to olive-brown powdery spore mass and capillitium at maturity, filling fruiting body, without sterile basal area.

Spores 4–5.5 × 3–5 µm, globose with minute markings; spore mass olive-yellow to olive-brown, filling fruiting body.

Single to several in arcs or irregular groups on the ground in mixed hardwood forests and meadow edges; late summer, fall.

Because of its size and appearance this fungus is easy to recognize and is a choice edible when young. Some people do not like its texture.

Crucibulum laeve (Huds.: Rehl.) Kambly & Lee (plate 164) NOT EDIBLE

Bird's Nest Fungus

Fruiting body 3–7 mm broad, 3–8 mm high, cup-shaped, short cylindrical, with sides essentially parallel; yellowish white to tan; externally velvety, initially with tomentose membranous cover over top of cup that soon disappears; contains 8–10 light yellowish tan or whitish peridioles (eggs), each 1–2 mm broad, disc-shaped.

Spores 7–10 × 3–5 µm, elliptical, smooth.

On lignin-rich vegetable debris, stems, twigs, old nut shells or husks, and wood chips; summer, fall.

This species is also known as *C. vulgare*. Peridioles are removed from the fruiting body in a splash cup mechanism, with raindrops flipping them out. The sticky peridioles adhere to the surrounding substrate. The spores of this fungus and other bird's nest fungi are released only when the thick wall of the peridiole weathers away.

PLATE 165. *Cyathus striatus*

PLATE 166. *Dictyophora duplicata*

Cyathus striatus (Huds.) Willd. (plate 165) NOT EDIBLE

Bird's Nest Fungus

Fruiting body 7–15 mm tall, 6–8 mm wide; vase-shaped, with slender base flaring in upper third at maturity; pale cinnamon-brown to gray-brown; distinctly longitudinally ridged, hairy; white cover over top when young, breaking away, exposing striate interior wall and several drab to black peridioles (eggs), each attached to wall by cordlike structure; each fruiting body is attached by mycelial pad.

Spores 18–20 × 8–10 μm, elliptical, thick-walled, hyaline.

In clusters on bark and sticks or other woody debris, common on mulch under shrubs; spring, summer, fall.

Another species, *C. stercoreus*, is common on dung, wood chips, and manured soil. Fruiting bodies vary in size, 5–12 mm tall and 4–8 mm wide, with a shaggy outer cover when young; smooth inner walls are visible when mature. The interior of open mature fruiting bodies is lead-gray to bluish black; the peridioles are black and are distributed by the splash cup mechanism discussed under *Crucibulum laeve*.

Dictyophora duplicata (Bosc) E. Fisch. (plate 166) NOT EDIBLE

Netted Stinkhorn

Fruiting body 12–25 cm high, 2–6 cm broad at base, tapered slightly upward to reticulate head, chambered with pits and ridges and olive-brown with distinctive open depression at apex; indusium (veil) white, netlike, attached below slimy head, hanging 3–6 cm down stalk; young fruiting body (egg) 4–7 cm in diameter, globular to slightly flattened, white or flesh-colored, single or in groups.

Stalk cylindrical, honeycombed on surface; white; spongy, hollow.

Volva consisting of white to brownish remains of outer egg cover.

Spores 3.5–4 × 1.5–2 μm, elliptical, smooth, hyaline.

Single to sparse clusters in humus under hardwoods and among shrubs; summer, fall.

The disagreeable odor characteristic of this stinkhorn increases with maturation and makes this otherwise attractive fungus an unlikely candidate for eating, although it sometimes has been recommended as edible in the egg stage.

PLATE 167. *Geastrum saccatum*

PLATE 168. *Geastrum triplex*

Geastrum saccatum Fr. (plate 167) NOT EDIBLE

Earth Star

Fruiting body 0.6–2.5 cm broad, 8–15 mm high, ovate, pointed when young, with basal rhizomorph, two separate cover layers; outer layer golden tan to yellowish brown, splitting to form rays that recurve to base, 2–5 cm in diameter when rays expand; sessile inner layer 0.5–2 cm wide with central opening (pore) surrounded by paler area (mouth) bordered by line, dull brown, flexible, dry, smooth; interior white, solid when young, maturing to brown mass of powdery spores and thick-walled encrusted threads (capillitium).

Spores 3.5–4.5 µm, round, warty; spore mass brown.

Scattered to clustered in rich humus around stumps in woods; late summer, fall.

A very similar species, *G. fimbriatum*, lacks an apical disc and has slightly smaller spores.

Geastrum triplex Jungh. (plate 168) NOT EDIBLE

Earth Star

Fruiting body 1–5 cm broad, with two separate cover layers; outer layer gray-brown to wood brown, fleshy, splitting to form 4–8 recurving rays; fleshy inner part breaks, forming saucer- or bowl-like structure surrounding the globose spore-producing area, delimited by intact inner layer; inner layer with central opening (pore) surrounded by pale zone; interior initially solid, white, maturing to brown powdery mass of spores and thick-walled encrusted capillitium.

Spores 3.5–4.5 µm, round, minutely warted; spore mass brown.

Single to groups in rich humus in woods, often around well-rotted stumps; summer, fall.

This earthstar may be confused with *G. saccatum*, as the rays do not always break to form a bowl under the spore case. However, it is larger than *G. saccatum*.

PLATE 169. *Lycoperdon perlatum*

PLATE 170. *Lycoperdon pulcherrimum*

Lycoperdon perlatum Pers. (plate 169) GOOD EDIBLE

Puffball

Fruiting body 1.5–6 cm broad to 7 cm tall, obovoid to turbinate (upper portion larger in diameter); white, maturing to creamy tan; surface covered with small spines that detach later, leaving round temporary scars that are lost as fruiting body matures, opening by central pore with age; interior white upper portion, becoming olive to dark-brown dry, powdery mass of spores and modified hyphae (capillitium) at maturity; lower portion becoming sterile base, almost stemlike, chambered, and narrower than upper area.

Spores 3.5–4.5 µm, round, minute spines; spore mass olive-brown.

Single or in clusters on leaf litter and humus under hardwoods, common; late summer, fall.

All species of *Lycoperdon* are commonly called puffballs. When the flexible inner layer of a mature puffball is depressed by a large raindrop, a chipmunk, or a person's finger, a puff of dry spores comes out of the central opening. One of the pleasant temptations of a walk in the woods in fall is the opportunity to help spread puffball spores. All species of *Lycoperdon* are considered edible when young, when the interior is completely white.

Lycoperdon pulcherrimum Berk. & Curt. (plate 170) EDIBLE

Puffball

Fruiting body 2–5 cm broad, 3–4.5 cm tall, pear-shaped (pyriform), narrowing to base about 1–2 cm broad; outer layer covered with dense coat of white slender spines, which remain white even when dried and are often fused at tips; mature spines fall from purple-brown cover layer; upper two-thirds of young fruiting body white, spore-producing area maturing into purple-brown mass of spores intermingled with branched capillitium; lower one-third developing into base with distinct purple-brown chambers; apical pore with torn margins developing in center of top at maturity.

Spores 4–4.5 µm, globose, with stalk (pedicel) 10–13 µm in length; spore mass purple-brown.

Usually single to scattered on the ground under hardwoods; late summer, fall.

Several other species of *Lycoperdon* have white spines that fall away as the puffball matures.

PLATE 171. *Lycoperdon pyriforme*

PLATE 172. *Lysurus cruciatus*

Lycoperdon pyriforme Schaeff. (plate 171) GOOD EDIBLE

Puffball

Fruiting body 1.5–3 cm high, 2–4 cm wide, pear-shaped (pyriform) to subglobose, with conspicuous white rhizomorphs at base and in substrate; off-white when young, tan to brown at maturity; smooth, later covered with fine granules; round to slitlike apical pore formed when almost mature; upper two-thirds of interior maturing to olivaceous to olive-brown dry mass of spores intermingled with capillitium; lower one-third a chambered base.

Spores 3–4 μm, round, smooth; spore mass olive-brown.

Single to dense clusters on rotted wood of any kind; common in late summer, fall.

Old weathered fruiting bodies are recognizable into the following summer. This species, the only common species of *Lycoperdon* on wood, often develops in large numbers, completely covering rotting logs. White cords of mycelium (rhizomorphs) can be found throughout the wood.

Lysurus cruciatus (Lepr. & Mont.) Henn. (plate 172) NOT EDIBLE

Fruiting bodies developing from egglike structure up to 10 cm tall, with cluster of 4–6 hollow arms at apex.

Stalk white, porous; arms hollow, inner surface lined with gleba; arms erect but not fused, opening slightly at maturity.

Volva cuplike, remaining at base.

Spores 3–5 × 1.5–2 μm; spore mass brownish to olive-green.

Solitary or in small clusters in humus or woody debris; not common but widely distributed in southern United States; summer.

The fruiting body is quite distinctive in structure but shares the unpleasant stinkhorn aroma. This species is also known as *Anthurus borealis* or *Lysurus borealis*.

PLATE 173. *Mutinus caninus*

PLATE 174. *Phallus hadriani*
A (Above): Immature, B (Right): Mature

Mutinus caninus (Huds.) Fr. (plate 173) NOT EDIBLE

Stinkhorn

Fruiting body develops from egglike structure 6–10 cm long, 0.8–1.1 cm thick; narrowly tapered top 2–3 cm of stalk with olive-green, slimy spore mass; eggs 1–2 cm broad, 1–1.5 cm high, white subglobose to ovoid, from which young fruiting body emerges and elongates.

Stalk honeycombed; pinkish to red, spongy, hollow.

Volva cuplike, enclosing base.

Spores 3.5–5 × 1.5–2 μm, cylindrical, thin-walled; spore mass olive-green.

Single to several in soil and wood debris; late summer, fall.

Stinkhorn is a very appropriate name for this foul-smelling fungus.

Phallus hadriani Vent. (plate 174A, B) NONPOISONOUS

Stinkhorn

Fruiting body develops from egglike structure 3–6 cm in diameter (pl. 174A); pinkish to pink-purple, often with cord from center of bottom; young stinkhorn enclosed in tough covering and gelatinous layer that breaks down as stinkhorn emerges; mature fruiting body 10–20 cm tall, 1.5–3.0 cm thick; distinctly reticulate, ridged and pitted cap area covered by blackish olive, slimy spore mass with open depression at top (pl. 174B).

Stalk 10–20 cm long, 1.5–3 cm thick; white to cream; spongy, honeycombed, hollow.

Volva cuplike, consisting of remains of tough egg cover around base of mature fruiting body.

Spores 3–4 × 1–2 μm, cylindrical; spore mass blackish olive.

Single or in clusters in wood debris or under hardwoods; summer, fall.

The rank, nauseating odor makes it possible to detect this fungus with ease. Carrion-inhabiting insects are attracted by the odor, feed on the spore mass, and carry the spores away on their bodies. The netlike (reticulate) appearance of the head region is more obvious after the dark, slimy spore mass has been removed by the foraging insects or by rain. It is quite common in lawns, growing on dead tree roots or other woody debris buried under a covering sod. *P. impudicus* is very similar but has a white volva. *Phallus ravenelii* differs in having a smooth to granular outer cap surface visible when the olive-green spore mass is removed. The cap surface of *P. hadriani* is shallowly reticulate and reminiscent of the ridge-pit pattern of the morels when the olive-green spore mass has been washed away or removed by carrion-oriented insects.

PLATE 175. *Pisolithus tinctorius*

PLATE 176. *Scleroderma areolatum*

Pisolithus tinctorius (Pers.) Coker & Couch (plate 175) NOT EDIBLE

Fruiting body 5–20 cm high, 4–10 cm thick, pear-shaped to club-shaped, tapered to thick, fibrous rooting base; dingy mustard-yellow to golden brown to dingy brown; thin, shiny outer covering, splitting irregularly; interior with numerous circular to oval chambers in upper half of fruiting body, maturing to powdery mass from top downward.

Spores 8–12 μm, round, with minute spines; spore mass cinnamon.

Single to several on packed soil along paths or roads in mixed woods or conifer plantings; summer, fall.

This heavy, surprisingly dense puffball is one of the most unattractive fungi: it is foul smelling and stains hands and clothing an iodine color when rubbed. It is known to be mycorrhizal with some conifers and has been used commercially for this purpose. Workers using fungi as a dye source for brown or black shades also know it as the dye-maker's false puffball. This species has been used as a mycorrhizal partner for the revegetation of strip mines.

Scleroderma areolatum Ehrenb. (plate 176) **POISONOUS**

Fruiting body 1–5 cm broad, globose to irregular; firm outer cover (peridium) off-white or cream to light brown, darkening to yellowish brown at maturity, dotted with distinct darker brown scales; fractures irregularly at maturity; entire interior of young fruiting bodies cream, quickly developing purplish regions surrounded by irregular white lines; entire interior violaceous gray to darker grayish dusty spore mass at maturity.

Short stalklike enlargement at center of base of fruiting body obvious or lacking; if present, ending in group of short white to yellowish cords (rhizomorphs).

Spores 9–18 μm, round, variable, distinctly spiny; spore mass violaceous gray to more grayish.

Several to numerous on humus or wood debris under hardwoods, sometimes very common, typically irregularly scattered on the ground in woods; late summer, fall.

All species of *Scleroderma* should be avoided because of reports of illness after eating some species. They are often called hard puffballs because of the firm outer covering that persists as a hard layer, opening in various ways but often splitting irregularly at maturity, around the dry, powdery purple-brown to black spore mass. This Scleroderma is one of the softest hard puffballs and may be confused with a puffball, but the gray spore mass quickly distinguishes it. *S. areolatum* is also known as *S. lycoperdoides*.

PLATE 177. *Scleroderma citrinum*

PLATE 178. *Scleroderma polyrhizum*

Scleroderma citrinum Pers. (plate 177) **POISONOUS**

Common Scleroderma

Fruiting body 3–12 cm broad, round to somewhat flattened at maturity; thick outer cover (peridium) yellow-brown, covered with cracks, accentuating pattern of raised warts with somewhat darkened centers, sometimes breaking into irregular lobes when mature; entire interior becoming fleshy, spore-producing area, lilac-gray to violet-gray, with fine white lines throughout; dry purplish gray to black powdery spore mass at maturity.

Stalk merely broadened portion of outer cover in center of bottom, often with cords (rhizomorphs) attached.

Spores 8–13 µm, round, fine spines and ridges; spore mass brown to dark purplish gray to black.

Single to several or clustered on soil near base of trees, around logs or stumps, or under hardwoods or conifers; late summer, fall.

This species has been known as *S. aurantium* and is one of the common hard puffballs.

Scleroderma polyrhizum (Gmelin: Pers.) Pers. (plate 178) **POISONOUS**

Fruiting body 4–12 cm wide, round to somewhat depressed; outer cover (peridium) to 0.5 cm thick, rough, cream-yellow to yellowish tan to brownish to slate-gray, splitting at maturity into irregular sections, which eventually open and fold back; entire interior at first dark purple interspersed with sterile white to yellowish cream lines, becoming dark brown to black powdery spore mass at maturity.

Spores 6–12 µm, round, spiny, brown; spore mass dark brown to black.

Single or several on sandy soil, ditches, and under hardwoods, occasionally in lawns; fall.

This species is also known as *S. geaster*. It becomes an unpleasant lawn hazard when the mature fruiting bodies that have split open are buried, barely emerging from the soil.

PLATE 179. *Simblum sphaerocephalum*

PLATE 180. *Tulostoma brumale*

Simblum sphaerocephalum Schltdl. (plate 179) NOT EDIBLE

Fruiting body developing from egglike structure, with distinct stalk and head; head roundish, with reddish orange raised net surrounded by olive-brown spore mass.

Stalk 7–9 cm tall, hollow, bright red fading to whitish at tapered base; very fetid.

Volva at base, enclosing lower stalk.

Spores 3.2–4.5 × 1.5–2 μm, elliptical, smooth.

Not common but not unusual in mulch; summer, fall.

This is one of the foul-smelling fungi commonly called stinkhorns.

Tulostoma brumale Pers. (plate 180) EDIBILITY UNKNOWN

Stalked Puffball

Fruiting body 1–1.5 cm broad, 1–2 cm high, subglobose with thin outer cover that sloughs away, leaving tan, smooth, flexible inner wall with central opening (mouth); light reddish brown mass of spores and capillitium developing throughout interior.

Stalk 1–5 cm long, 0.2–0.4 cm thick with enlarged base; pale tan; finely scaly to nearly smooth.

Spores 3–5 μm in diameter, globose, minutely warty, some with short stalks; spore mass reddish brown.

Capillitium 4–7 μm in diameter, threadlike, hyaline.

In sandy soil; fall, persisting throughout year.

This species is locally common in sandy areas of central Iowa and in the loess hills region of western Iowa. The fruiting body of *T. simulans* is persistently covered with sand particles and the mouth has smooth edges, while that of *T. campestre* has persistent wartlike pieces of sand cover that remain for some time. The spores of these species are also different. *Tulostoma* is a large and cosmopolitan genus common in arid areas and in sandy habitats.

Jelly Fungi

This artificial group of fungi, which includes species in the orders Tremellales, Auriculariales, and Dacrymycetales, is characterized by fruiting bodies that are gelatinous or jellylike to tough and are found on rotting wood or on the forest floor. The characteristic firm but gelatinous fruiting bodies of the jelly fungi are a result of the formation and accumulation of gelatinous compounds around the threadlike mycelia that interweave, forming the fruiting bodies. Technically these fungi are placed in different orders because their spore-producing structures (basidia) differ in some morphological details, which are significant for the professional student of fungi but are of less concern for field recognition.

The jelly fungi produce fruiting bodies directly on the ground, on downed wood, around the bases of living plants in the woods, or directly on rotting logs and leaf litter; a few species grow on dead branches still attached in living trees. The fruiting bodies of some species have the ability to dry and become hard and brittle and then to absorb water and expand to normal size and texture when water is available; they can wet and dry an indefinite number of times, potentially producing a crop of spores each time. Species of *Tremellodendron* produce rosettes of tough flattened branches and thus are quite different in appearance from most of the jelly fungi. They do, however, produce the kind of basidia characteristic of the order Tremellales.

This group is not known for its edibility, but species of *Auricularia*, cloud ear, and *Tremella* are eaten.

Key to the Genera and Species in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Fruiting body upright from ground in woods: 2.
1b. Fruiting body developed on logs or woody branches, smooth or lobed, firm-gelatinous: 4
2a. Fruiting body surrounding vegetation, amorphous: *Tremella concrescens*, page 263
2b. Fruiting body standing on its own, branched: 3
3a. Fruiting body tough, with solid flattened branches, often fused in lower section: *Tremellodendron pallidum*, page 265
3b. Fruiting body gelatinous to tough, branches hollow, round in cross section: *Tremella reticulata*, page 265
4a. Fruiting body cuplike to ear-shaped, single to clustered, yellow-brown to darker brown, drying to become brittle: *Auricularia auricula*, page 259
4b. Fruiting body flattened to lobed, variously pigmented, drying brittle or disintegrating: 5

5a. Fruiting bodies undulate to flattened, brownish black to black, drying brittle: *Exidia glandulosa*, page 261
5b. Fruiting bodies pustulate or fused, variously pigmented: 6
6a. Fruiting body firm, waxy gelatinous, large, white to pale olivaceous, cerebriform (brainlike) to undulate: *Exidia alba*, page 261
6b. Fruiting bodies clustered, lobed, erect, variously pigmented: 7
7a. Fruiting bodies of thin lobes, variously clustered, yellow-brown to cinnamon-brown, drying brittle: *Exidia recisa*, page 263
7b. Fruiting bodies firm-gelatinous, bluntly lobed, clustered, orange to golden yellow: *Tremella mesenterica*, page 263

Auricularia auricula (Hook.) Underw. (plate 181) EDIBLE

Cloud Ear, Ear Fungus

Fruiting body 5–15 cm broad, cuplike to ear-shaped lobes; yellow-brown when young, becoming blackish brown and brittle when dry; centrally or laterally attached, tough-gelatinous; upper surface with erect brown hairs; lower surface covered with basidia.

Spores 12–14 × 4–6 µm, oblong, curved, cylindrical, smooth; spore print white.

Single or clustered on hardwoods, very common on shagbark hickory and elm, more common on hardwoods than on conifers; summer, fall.

This species has considerable variation. The older fruiting bodies tend to be lobed or ruffled, especially when clustered in tight groups on a downed log. The ability to dry and become hard and brittle and to wet and return to a flexible, spore-producing condition increases the possibility of variable appearance.

PLATE 181. *Auricularia auricula*

PLATE 182. *Exidia alba*

PLATE 183. *Exidia glandulosa*

Exidia alba (Lloyd) Burt (plate 182) EDIBILITY UNKNOWN

Fruiting body firm, waxy-gelatinous, small pustulate, lobed, fusing to form elongate clusters 2–10 cm wide, up to 12–15 cm long; white to pinkish white, drying to olive-brown.

Spores 8–11 × 4–5 µm, smooth, curved; spore mass white.

On downed wood or stumps of hardwoods; common in summer, fall.

This species often forms brainlike masses covering the length of a log. It is also known as *Ductifera pululahuana*.

Exidia glandulosa (Bull.) Fr. (plate 183) NONPOISONOUS

Fruiting bodies almost colorless initially, pustulate and separate, becoming darker to brownish black then growing together and becoming broadly effused to 20 cm or more long, drying black and brittle; spore-producing cells and wartlike papillae on outer surface.

Spores 10–16 × 4–5 µm, allantoid (curved); spore print white.

On decaying hardwoods, particularly oak and hickory; present all year.

This fungus is capable of repeated drying to a hard, horny fruiting body then reviving when moistened. Another species, *E. recisa*, is also common on hardwoods. The discoid to lobed, centrally attached, smoky brown to cinnamon-brown fruiting bodies are often clustered and fused. It becomes darker and brittle as it dries, as does *E. glandulosa*.

PLATE 184. *Exidia recisa*

PLATE 185. *Tremella concrescens*

PLATE 186. *Tremella mesenterica*

Exidia recisa (Ditmar) Fr. (plate 184) EDIBILITY UNKNOWN

Fruiting body firm-gelatinous, lobed but little fused at edges, usually in clusters; yellowish brown to darker brown, drying black; spores formed on lower surface; upper portion of lobes sterile, with minute scalelike patches.

Spores 10–14 × 3–5 µm, smooth, curved, spore print white.

On downed wood or dead branches of living trees, particularly on oak and hickory; present all year.

A very similar species, *E. repanda*, also occurs on hardwoods. The fruiting bodies of *E. recisa* become darker and brittle with age and rehydrate when moistened.

Tremella concrescens (Fr.) Burt (plate 185) EDIBILITY UNKNOWN

Fruiting body firm white to grayish, soft-gelatinous spreading mass, on ground but supported by and encrusting erect living herbaceous or woody stems or plant debris, drying hard.

Spores variable, 9–14 × 5–8 µm, cylindrical to broadly ovate, smooth; spore print white.

Arising from ground, supported by and encrusting living stems or plant debris; common in summer, fall.

This species is variable in size and shape but becomes quite conspicuous after summer rains.

Tremella mesenterica Retz (plate 186) EDIBILITY UNKNOWN

Witches' Butter

Fruiting body 3–12 cm broad, 3–4 cm thick, usually large, bluntly lobed to brainlike; orange to golden yellow; tough gelatinous to jellylike when fresh, drying to horny; entire surface of upright lobes fertile, producing spores.

Spores 10–12 × 6–10 µm, broadly ovate to elliptical, smooth.

Single to several on downed hardwood logs, above ground; spring, summer, fall.

This species often fruits during rainy periods, rehydrating from the dry, horny state. Two similar orange jelly species, *Dacrymyces palmatus* (which usually fruits on conifers) and *Dacrymyces ellisii* (typically found on hardwoods), differ in the kind of basidia produced. This species is also known as *Tremella lutescens*.

PLATE 187. *Tremella reticulata*

PLATE 188. *Tremellodendron pallidum*

Tremella reticulata (Berk.) Farl. (plate 187) EDIBILITY UNKNOWN

Fruiting body 3–8 cm tall, 3–8 cm wide, many-branched coral-like structures to broadly flattened rosettes of hollow branches from thickened, trunk-like center; branches sometimes fused together; whitish, becoming darker tan to yellowish tan with age; tough but gelatinous in appearance.

Spores 9–12 × 5–6 μm, elliptical to slightly curved, smooth; spore print white.

Single to several on the ground under hardwoods, in wet periods; summer, fall.

The fruiting bodies may persist for several weeks before decomposing into a gelatinous dark mass. A rose-colored dry layer of compact mycelium covers older fruiting bodies parasitized by *Hypomyces rosellus*.

Tremellodendron pallidum (Schwein.) Burt (plate 188) NOT RECOMMENDED

Fruiting body upright, coral-like rosettes of several to many flattened, partially fused branches 5–15 cm wide, 3–10 cm tall; white, tough flesh, especially at lower parts, drying to whitish-buff.

Spores 7–10 × 4–6 μm, curved, sausage-shaped to subglobose, smooth; spore print white.

Single to several on the ground under hardwoods or in mixed woods, very common; summer, fall.

This species is also known as *T. schweinitzii*. It is tough and slow to decay. Old fruiting bodies may have some green areas or appear completely green due to the growth of green algae. Species of *Thelephora* also produce rosette fruiting bodies of flattened tough branches from a thickened base, purple-brown with gray tips when young. Both *Thelephora* species and *Tremellodendron* species differ from the true coral fungi by their tough, flattened branches and can easily be recognized. All occur on the ground in woods.

Ascomycetes

Cup fungi, a subgroup in the class Ascomycetes, have macroscopic fruiting bodies in which the asci are in an open layer on the upper surface of the cup (apothecium). Other Ascomycetes, however, have tiny, round to flask-shaped fruiting bodies, smaller than 1 mm in diameter, with the asci inside. These tiny bodies may be produced on or in larger structures called stromata, which have distinctive shapes, colors, and textures and are easily visible for field identification (see pp. 318–325).

Key to Some Common Ascomycetes

1a. Fruiting bodies developed underground (hypogeous) in upper soil layer or at interface of litter layer and soil: truffles, page 297
1b. Fruiting bodies above soil surface at maturity: 2
2a. Fruiting bodies at least 1 mm in diameter, cup- or saucer-shaped, pitted spongy or convoluted, somewhat fleshy, with or without a stalk: cup fungi, page 268
2b. Fruiting bodies less than 1 mm in diameter, round to flask-shaped, sometimes buried in a stroma with only the opening of the fruiting bodies visible: other Ascomycetes, page 317

Cup Fungi

Key to the Genera and Species of Cup Fungi in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Fruiting body with a distinct upper area and stalk, on the ground: 2
1b. Fruiting body sessile or without a distinctly different stalk, on the ground or attached to wood: 7
2a. Upper area cup or saddle-shaped (saddle fungi): *Helvella*, page 277
2b. Upper area flattened, spathulate, or fleshy with ridges, delimited pits, or convolutions: 3
3a. Upper area flattened, spathulate: *Spathularia flavida*, page 293
3b. Upper area with pits with sharp-edged ridges (spongelike) or convoluted with rounded lobes to almost smooth: 4
4a. Upper area attached only at end of stalk, hanging bell-like around stalk: *Verpa*, page 295
4b. Upper area completely attached to stalk or at least terminal portion attached: 5
5a. Upper area with sharp-edged ridges delimiting pits; completely or partially attached to stalk (sponge mushrooms, morels): *Morchella*, page 283

5b. Upper area convoluted with smooth edges or smooth and completely attached to stalk: 6

6a. Upper area somewhat rounded to flattened, gelatinous, viscid when wet, yellowish; stalk flattened: *Leotia lubrica*, page 281

6b. Upper area convoluted with smooth edges, some shade of brown; stalk massive, often columnar (false morels): *Gyromitra*, page 275

7a. Apothecium (fruiting body) on the ground, sessile, free or attached to wood buried in soil or litter: 8

7b. Apothecium attached to logs or pieces of wood lying on surface of the ground: 15

8a. Apothecia sessile, on the ground, free: 9

8b. Apothecia developed at the surface of soil or litter, attached to branches, pieces of wood, or woody plant parts, on or in soil or litter: 11

9a. Apothecia about 1 cm in diameter, deeply cup-shaped; outer surface brownish, covered with stiff brown hairs; inner area whitish: *Humaria hemisphaerica*, page 279

9b. Apothecia large, more than 1 cm in diameter; outer surface lacking stiff brown hairs: 10

10a. Inner (upper) surface of apothecia orange: *Aleuria aurantia*, page 271

10b. Inner surface of apothecia typically tan to brown: *Peziza*, page 289

11a. Apothecia pigmented, attached to branches at least partially buried in leaf litter: 12

11b. Apothecia, white to cream to pale yellow, growing on old acorns or hickory nut husks: *Hymenoscyphus fructigenus*, page 281

12a. Apothecia brown: 13

12b. Apothecia with orange-red to red upper surface; lower surface whitish: 14

13a. Apothecia deeply urn-shaped, dark brown; edges torn; flesh thin and tough: *Urnula craterium*, page 295

13b. Apothecia cup-shaped with flat upper surface at maturity; edges smooth; flesh thick and gelatinous: *Galiella rufa*, page 273

14a. Apothecia large, cup-shaped and sometimes becoming flat: *Sarcoscypha*, page 291

14b. Apothecia small, goblet-shaped, with white hairs covering outer surface: *Microstoma floccosum*, page 283

15a. Apothecia not green; flattened, scattered, or in crowded group: 16

15b. Apothecia green to olive or blue-green, with short stalks: *Chlorociboria aeruginascens*, page 273

16a. Apothecia brightly colored, smaller than 1 cm in diameter: 17

16b. Apothecia tan to brown, large, more than 2 cm in diameter: *Peziza*, page 289

17a. Apothecia bright yellow, usually in groups on rotting logs: *Bisporella citrina*, page 271

PLATE 189. *Aleuria aurantia*

PLATE 190. *Bisporella citrina*

17b. Apothecia orange to orange-red, flat, with brown stiff hairs around edge and on lower surface; often on soggy, well-rotted logs among mosses: *Scutellinia scutellata*, page 293

Aleuria aurantia (Pers.) Fckl. (plate 189) NONPOISONOUS

Orange Peel Fungus

Apothecium 5–10 cm in diameter, often smaller, cup-shaped and regular, becoming broader, shallower, and contorted with age or from pressure; often split, sessile; exterior light orange to whitish; interior (hymenium) bright orange to reddish orange.

Asci 175–250 × 12–15 μm, cylindrical, operculate, 8-spored; ascospores 18–22 × 9–10 μm, uniseriate; ends often overlapping, usually containing 2 large oil drops; wall reticulations regular and shallow to more ridged toward ends, becoming pointed at each end, hyaline; paraphyses (sterile cells among the asci) abruptly enlarged at apex to 7–8 μm, filled with orange granules.

Single to closely clustered on damp soils in woods and open areas, occasionally in lawns but more common on exposed clay soils or on edges of gravel paths; late summer, fall.

Bisporella citrina (Batsch: Fr.) Korf & S. E. Carp. (plate 190) EDIBILITY UNKNOWN

Apothecia clustered, with shallow to flattened small cups, each 1–4 mm in diameter, centrally attached by small base; lemon-yellow.

Asci 100–135 × 10 μm, cylindrical to clavate, inoperculate (the ascus does not have a lid that opens at the ascus apex), 8-spored; ascospores 9–14 × 3–5 μm, elliptical or fusiform, 1–celled, occasionally 1–septate (with a cross wall), biseriate with oil drops at each end; paraphyses filiform, slightly enlarged at ends.

Clustered, often in large groups on decaying logs or pieces of wood, very common; late summer, fall.

This species is also known as *Helotium citrinum* and is an obvious fungus on downed logs in the fall, when the many small cups appear as bright yellow patches.

PLATE 191. *Chlorociboria aeruginascens*

PLATE 192. *Galiella rufa*

Chlorociboria aeruginascens (Nyl.) Kanouse: Ramamurthi, Korf & Batra (plate 191) EDIBILITY UNKNOWN

Apothecia up to 7 mm in diameter, cup-shaped, becoming flattened and expanded; blue-green.

Stalk short, 0.5–1.5 mm, central.

Asci to 70 × 5 µm, cylindrical, clavate, inoperculate, 8-spored; ascospores 6–10 × 1.2–2 µm, fusiform, 1–celled, hyaline, smooth; paraphyses slender.

Scattered or in small clusters on downed wood, mycelium staining wood blue-green, common on oak; summer, fall.

You may often see stained wood, particularly oak stumps, with no apothecia developed. *C. aeruginosa* differs mainly in larger ascospore size.

Galiella rufa (Schw.) Nannf. & Korf (plate 192) NOT EDIBLE

Apothecium 2–3 cm in diameter, shallow, cup-shaped, sessile or short-stalked; margin at first incurved; exterior blackish brown, covered with clusters of hairs, tough; interior gelatinous, giving fresh apothecia rubbery consistency; hymenium (layer with asci in the apothecium) slightly concave, becoming flattened, pale reddish brown; attached to sticks by dense mass of black mycelium.

Stalk when present to 1 cm long, 4–5 mm in diameter.

Asci 275–300 × 12–14 µm, cylindrical, suboperculate, 8-spored; ascospores 18–20 × 9–12 µm, elliptical, with ends strongly narrowed, uniseriate, hyaline, granular; paraphyses threadlike, scarcely enlarged above.

Scattered or clustered on buried or partially buried wood, commonly on oak; in woods, summer.

This species is also known as *Bulgaria rufa*.

PLATE 193. *Gyromitra brunnea*

PLATE 194. *Gyromitra caroliniana*

Gyromitra brunnea Underw. (plate 193) **POISONOUS**

Brown False Morel

Apothecium 5–12 cm broad and high, irregularly lobed to vaguely saddle-shaped; reddish to dark brown above, whitish on underside.

Stalk 6–9 cm long, 2–5 cm wide, slightly enlarged at base; white; ribbed or fluted, sometimes with anastomosing (connecting) ridges, interior stuffed with folded and furrowed tissue.

Asci operculate, cylindrical, 8-spored; ascospores 28–30 × 12–15 µm, elliptical, sculptured with fine warts or faint reticulations, hyaline, usually with 2–3 large oil drops at maturity; paraphyses numerous, slender, enlarged at apex.

Single or loosely grouped on the ground, often on or near well-rotted oak stumps or logs; spring.

This species is a common false morel in the Midwest. After the fruiting body has reached mature size, the outer surface of the apothecium changes to shades of brown with age over the week to two weeks when the asci are maturing. It has also been called *G. fastigiata* and *G. underwoodii*. Most *Gyromitra* species develop in the spring at the same time when morels are present. Only one species, *G. infula*, occurs in the fall. It is quite rare. We do not recommend eating any species of *Gyromitra* because of the possible presence of the toxin gyromitrin, which is converted to monomethylhydrazine.

Gyromitra caroliniana (Bosc: Fr.) Fr. (plate 194) NOT RECOMMENDED

False Morel

Apothecium 10–20 cm broad, 5–25 cm high, deeply wrinkled and convoluted; deep red-brown to brown.

Stalk 8–10 cm long, 3–5 cm wide, enlarged at base; white to cream; furrowed.

Asci operculate, cylindrical, 8-spored; ascospores 25–30 × 12–14 µm, elliptical, usually with at least 2 large oil drops, hyaline, finely warted with 1 to several short appendages; paraphyses numerous.

Single or loosely grouped on the ground, in rich humus under hardwoods; late spring.

These are impressively massive fruiting bodies but not common. This species is known as big red in Missouri and Arkansas. We do not recommend eating any species of *Gyromitra* because of the possible presence of the toxin gyromitrin.

PLATE 195. *Gyromitra infula*

PLATE 196. *Helvella crispa*

Gyromitra infula (Schaeff.) Quél. (plate 195) **POISONOUS**

Apothecium 3–10 cm broad, folded, saddle-shaped, smooth to wrinkled but not convoluted, attached to stalk at several points; yellow-brown to reddish brown.

Stalk 5–10 cm long, 0.5–1.5 cm wide; tan to yellowish pink to darker; hollow, smooth to grooved or folded.

Asci operculate, cylindrical, 8-spored; ascospores 20–23 × 7–10 μm, elliptical, with 2 large oil drops, hyaline, smooth; paraphyses numerous, slender, tips quite enlarged.

Single or scattered on the ground under hardwoods or mixed woods; late summer, fall.

This species contains the toxin gyromitrin, which when converted to monomethylhydrazine can cause serious poisoning as well as being carcinogenic. The species may well have a broad distribution but has been very rarely collected in September in eastern Iowa.

Helvella crispa (Scop.) Fr. (plate 196) PERHAPS **POISONOUS**, NOT RECOMMENDED

White Saddle

Apothecium about 5 cm wide, saddle-shaped to reflexed, irregularly lobed and folded, attached at apex of stalk; white to pale cream.

Stalk 4–10 cm long, 2–3 cm wide, tapered upward; white to cream; deeply folded or fluted.

Asci operculate, cylindrical, 8-spored; ascospores 18–20 × 9–13 μm, elliptical, containing 1 large oil drop, hyaline, smooth; paraphyses numerous, cylindrical, enlarged above.

Solitary to clustered on the ground under hardwoods or conifers, common; midsummer through early fall.

Though *H. crispa* is common, it is usually not found in large numbers at one time.

Another species, *H. acetabulum*, also has a fluted stalk; but the stalk is shorter and the apothecium is more cup-shaped and tan to light brown. It is common during spring in some years and is often parasitized, entirely covered with the parasite *Mycogone*, so that the fruiting bodies are a dusty rose-pink.

PLATE 197. *Helvella elastica*

PLATE 198. *Humaria hemisphaerica*

Helvella elastica Bull.
(plate 197) PERHAPS **POISONOUS**, NOT RECOMMENDED

Saddle Fungus

Apothecium 0.5–5 cm long, 3 mm wide, saddle-shaped to irregularly 2- to 3-lobed, centrally attached to stalk; whitish to medium gray to gray-tan, drying darker.

Stalk 5–10 cm long, 3–10 mm wide, cylindrical; white to yellowish; smooth.

Asci operculate, cylindrical, 8-spored; ascospores 18–20 × 10–13 μm, elliptical, containing 1 large oil drop, hyaline, smooth at maturity; paraphyses numerous, clavate to occasionally branched.

Single or clustered on the ground in wooded areas, common but usually not fruiting in large numbers at one time; summer, fall.

Several smaller species of *Helvella* with darker apothecia are less common. Another white species, *H. stevensii* (also known as *H. latispora*), differs in having a more cup-shaped rather than saddle-shaped apothecium with a downy undersurface. *Leptopodia* is another genus name for both species.

Humaria hemisphaerica (Wigg.) Fckl. (plate 198) EDIBILITY UNKNOWN

Apothecium reaching 2–3 cm in diameter, about 1–1.5 cm deep; at first globose, gradually expanding to become cuplike, hemispheric, sessile; inner surface (hymenium) whitish; outer surface brownish, with stiff hairs that also rim margin.

Hairs 400–500 × 15–20 μm, enlarged at base, tapering to sharp apex, septate, thick-walled; dark brown.

Asci 325–350 × 15–18 μm, cylindrical, operculate, ascospores 25–27 × 12–15 μm, elliptical, uniseriate, usually containing 2 large oil drops, hyaline to subhyaline; wall with minute roughenings; paraphyses slender, enlarged at apex.

Common on soil in woods, more rarely on rotten wood; summer, fall.

This fuzzy little cup fungus is easily identified. Two other hairy brown cup fungi on soil, *Jafnea semitosta* and *J. fusicarpa*, are much larger.

PLATE 199. *Hymenoscyphus fructigenus*

PLATE 200. *Leotia lubrica*

Hymenoscyphus fructigenus (Bull.) Fr. (plate 199) NOT EDIBLE

Acorn Cup Fungus

Apothecium 1–4 mm in diameter, deeply cup-shaped, becoming flattened; white to cream to pale yellow.

Stalk 2–10 mm long, cream, slender.

Asci 80–100 × 7–9 μm, cylindrical, clavate, inoperculate, 8-spored; ascospores 13–21 × 3–4 μm, oblong-fusiform or slightly nonequilateral, uniseriate to biseriate, often with 2 larger and numerous smaller oil drops; paraphyses filiform, slightly enlarged above.

In groups on old acorns and hickory nut husks on the ground in woods, common but conspicuous only as clump of small white apothecia covering old acorn or hickory nut husks; late summer, fall.

This fungus is also known as *Helotium fructigenum*.

Leotia lubrica (Scop.) Pers. (plate 200) NOT EDIBLE

Jelly Babies

Apothecium 10–12 mm broad, somewhat rounded to caplike; yellowish to ochraceous; somewhat viscid; margin lobed, overhanging.

Stalk to 6 cm long, 8–10 mm thick, flattened; yellowish to ochraceous.

Asci about 150 × 10–12 μm, inoperculate, 8-spored; ascospores 20–25 × 5–6 μm, slightly fusiform with rounded ends, often slightly curved, becoming 5- to 6-septate, hyaline; paraphyses slender, branching with clavate tips, hyaline.

Usually in clusters of stalked apothecia on soil among mosses in woods, often in moist shaded areas, not uncommon; summer.

Two other species of *Leotia* are very similar in form and habitat. *L. viscosa* has a dark olive-green to nearly black apothecium and a pale yellow stalk. *L. atrovirens* (recently interpreted as *Coryne atrovirens*) has a dark green to black apothecium and a pale green stalk. Further study may change the interpretation of these species.

PLATE 201. *Microstoma floccosum*

PLATE 202. *Morchella angusticeps*

Microstoma floccosum (Schw.) Raitv. (plate 201) NOT EDIBLE

Apothecium 5–8 mm in diameter, 1 cm deep, goblet-shaped; exterior whitish, covered with long, rigid, hyaline hairs up to 1 mm long, tapered to apex, giving cups shaggy appearance; interior (hymenium) scarlet; margin strongly incurved when young; thick-walled.

Stalk slender, gradually larger toward apothecium, length variable.

Asci 300–325 μm long, diameter 20 μm at apex, cylindrical, operculate, ascospores 20–35 × 15–17 μm, uniseriate, elliptical, with narrowed ends, smooth, hyaline or slightly yellowish; paraphyses slender, slightly thickened at tip, containing numerous red granules.

Scattered to clustered, attached to buried or partially buried wood, often on shagbark hickory, common; summer.

This species has been known as *Sarcoscypha floccosa*.

Morchella angusticeps Pk. (plate 202) EDIBLE, NOT RECOMMENDED

Black Morel

Apothecium 2–9 cm long, 1.5–5 cm wide, caplike, narrowly conic when young, becoming broader with age, spongy; pits elongate, brownish gray to grayish brown, with dark brown to black ridges.

Stalk 1.5–6 cm long, 0.5–3 cm wide; whitish to creamy to pinkish tan; surface rough and granular; hollow.

Asci 200–300 × 16–22 μm, operculate, 8-spored; ascospores 21–24 × 12–14 μm, elliptical, 1-celled; spore print cream.

Scattered to clustered on the ground under conifers or hardwoods; spring.

This species is one of the black morels. Another species, *M. elata*, occurs in the western United States. Both have been considered edible and choice, but mild poisonings from the black morels have been reported.

PLATE 203. *Morchella crassipes*

PLATE 204. *Morchella deliciosa*

Morchella crassipes (Vent.: Fr.) Pers. (plate 203) CHOICE EDIBLE

Thick-footed Morel

Apothecium 5–18 cm long, 4–8 cm wide, subconic, spongy; pits somewhat rounded to irregularly elongate; grayish, becoming tan; ridges pallid to cream to ochraceous with age.

Stalk 6–13 cm long, 3–6 cm wide, massive and often columnar to folded at base; pale to cream; hollow.

Asci 225–235 × 18–22 µm, cylindrical, operculate, 8-spored; ascospores 20–22 × 12–14 µm, elliptical, 1-celled; spore print cream.

Scattered to clustered on the ground under hardwoods at edge of woods, particularly in areas where elms have died recently; at end of spring morel season.

Many consider this species to be the best-flavored morel. Some interpret *M. crassipes* as part of an *M. esculenta* variable species complex.

Morchella deliciosa Fr.: Fr. (plate 204) CHOICE EDIBLE

White Morel

Apothecium 2–3 cm long, 1–2 cm wide, caplike, cylindrical, conic with blunt apex; pits elongate, grayish to blackish within; ridges about 1 mm thick, irregularly anastomosing, lighter than pit interior, pallid to whitish.

Stalk about as long as cap, occasionally enlarged at base; lighter than cap, whitish to cream; hollow.

Asci 200 × 12–15 µm operculate, cylindrical, 8-spored; ascospores 20–24 × 10–12 µm, elliptical, hyaline; paraphyses numerous, light-colored, slightly enlarged at apex; spore print light yellow.

Single or scattered on the ground in woods or in grassy areas at edge of woods; early spring.

This delicious morel tends to appear slightly before *M. esculenta* in the spring and is known by some collectors as the gray morel. Some consider it an early-season form of *M. esculenta*.

PLATE 205. *Morchella esculenta*

PLATE 206. *Morchella semilibera*

Morchella esculenta (L.) Pers. (plate 205) CHOICE EDIBLE

Sponge Mushroom, Yellow Morel

Apothecium 3–9 cm long, 2–5 cm wide, caplike, subglobose to elongate; pits irregularly arranged to radially elongate, grayish, becoming yellowish brown, surrounded by paler ridges.

Stalk 4–6 cm long, 1.5–3 cm wide, diameter usually not exceeding two-thirds diameter of cap, slightly larger at base; white to cream; hollow, longitudinally depressed in places, dry to granulose.

Asci 220–230 × 18–22 μm, cylindrical, operculate, 8-spored; ascospores 20–25 × 12–16 μm, elliptical, smooth, hyaline; paraphyses numerous, enlarged above, faintly colored; spore print light yellow.

Single to scattered on the ground under hardwoods in vicinity of standing dead elms, in old orchards, at edge of woods, in river and stream bottoms with cottonwoods and soft maple, and in a bewildering variety of habitats; spring.

This is a favorite edible fungus and probably is more hunted than any other. Efforts to grow it commercially have only partially succeeded.

Some have interpreted a later-fruiting *Morchella, M. crassipes,* as a large form of *M. esculenta*. *M. deliciosa* may also be considered part of this species complex.

Morchella semilibera DC.: Fr. (plate 206) EDIBLE

Half-free Morel

Apothecium 2–4 cm long, 1.5–3 cm wide, caplike, bell-shaped or conic; yellowish when young to brownish or olive-brown at maturity; free from stalk for about half its length; pits longer than broad, reaching diameter of 5–10 mm, with well-developed ridges.

Stalk 6–15 × 2–3 cm, somewhat enlarged at base (to 4 cm in diameter); whitish to yellow; often irregularly furrowed at base, granulose to mealy, hollow.

Asci 250–300 × 20–25 μm, cylindrical, operculate, 8-spored; ascospores 24–34 × 15–21 μm, elliptical, hyaline, smooth; paraphyses numerous, slightly clavate, hyaline to lightly colored; spore print light yellow.

Single to loosely scattered on the ground under hardwoods; early spring.

This is probably the least desirable of the morels, but many consider it an edible mushroom of good quality when young. Some people have an adverse reaction to this mushroom (as indeed they might have to any species). This species is sometimes placed in the genus *Mitrophora*.


PLATE 207. *Peziza repanda*


PLATE 208. *Peziza succosa*

Peziza repanda Pers. (plate 207) EDIBILITY UNKNOWN

Apothecium large, up to 10 cm in diameter, cup-shaped, shallow to expanded and flattened, sessile or very short stipitate; exterior whitish or pale fawn; interior (hymenium) pale brown, becoming darker; margin even or splitting with age, regular in outline to irregularly folded.

Asci 225–300 × 12–15 μm, cylindrical, operculate, 8-spored; ascospores 14–16 × 8–10 μm, elliptical, hyaline, smooth; paraphyses slender, slightly enlarged above, yellowish or brownish.

Single or clustered on rotten logs in woods, occasionally on wood chips or soil, not uncommon; summer, fall.

P. repanda appears quite variable in form at different ages.

Peziza succosa Berk. (plate 208) EDIBILITY UNKNOWN

Apothecium reaching diameter of 4–5 cm; hemispheric, expanding to become shallow cup-shaped, regular in outline or folded, sessile; exterior light to yellowish; interior (hymenium) browner than exterior. Flesh becoming yellow when broken.

Asci 200–225 × 12–15 μm, cylindrical, operculate, 8-spored; ascospores 16–20 × 8–12 μm; elliptical, uniseriate, usually containing 2 distinct oil drops, hyaline to faintly yellow, becoming sculptured with coarse warts and short ridges; paraphyses slender, enlarged at apex.

Single or in small groups on damp soil in woods, common in some years; summer.

One of the drab small to medium cups that develop directly on moist soil in open woods. The color change of broken flesh helps to identify it.

PLATE 209. *Sarcoscypha dudleyi*

PLATE 210.
Sarcoscypha occidentalis
A (Above): Fruiting bodies on buried stick
B (Right): Close-up showing stalks

Sarcoscypha dudleyi (Pk.) Baral (plate 209) NOT EDIBLE

Crimson Cup

Apothecium 2–6 cm in diameter, shallow to deeply cup-shaped; exterior white to almost white; more or less floccose, with matted hyaline hairs; interior (hymenium) scarlet to orange-red; margin initially incurved.

Stalk short to almost sessile, stout.

Asci 400–500 × 12–14 μm, cylindrical, operculate, ascospores 26–40 × 10–12 μm, elliptical to cylindrical with rounded ends, uniseriate, with 2 large oil drops, hyaline; paraphyses slender, slightly enlarged above, with numerous red granules.

Single or in very small groups, attached to buried or partially buried sticks or wood in woods, often on basswood, common; early spring, occasionally again in late fall.

This species is also known as scarlet cup. Traditionally recognized as *S. coccinea*, it has now been interpreted as part of a complex whose species differ principally in microscopic features of the ascospores. In this interpretation one species, *S. coccinea*, has been found only in the Pacific Northwest, while the other two, *S. austriaca* and *S. dudleyi*, occur in eastern North America.

Sarcoscypha occidentalis (Schw.) Cke. (plate 210A, B) NOT EDIBLE

Stalked Scarlet Cup

Apothecium reaching diameter of 1 cm (more rarely 2–3 cm), shallow to cuplike; exterior whitish; interior (hymenium) bright red-orange to almost scarlet.

Stalk variable in length, often reaching 2–3 cm, with diameter of 2 mm.

Asci cylindrical, operculate, ascospores 20–22 × 10–12 μm, elliptical, uniseriate, usually with 2 oil drops, hyaline to slightly yellowish; paraphyses slender, slightly thickened above reaching diameter of 3–4 μm at apex, with numerous red granules.

Scattered to clustered, attached to buried or partially buried wood, often on shagbark hickory, common; late spring, summer, fall.

Stalks vary in length depending upon how deeply the sticks colonized by the fungus are buried in litter.

PLATE 211. *Scutellinia scutellata*

PLATE 212.
Spathularia flavida
A (Above): In pine needle litter
B (Right): Close-up of two fruiting bodies

Scutellinia scutellata (L.: St. Amans) Lambotte (plate 211)

EDIBILITY UNKNOWN

Eyelash Cup

Apothecium up to 10 mm in diameter, almost globose when young, becoming flattened; exterior appearing dark brown because of brown, thick-walled hairs with forked bases tapering to apex and extending up to 1 mm beyond margin; interior (hymenium) bright red to orange-red.

Asci 200–225 × 12–15 µm, cylindrical, operculate; ascospores 20–24 × 12–15 µm, elliptical, uniseriate, hyaline, walls with minute warts; paraphyses enlarged above, containing numerous red granules, green with iodine solution.

Clustered to crowded on well-rotted wood, often among mosses, more rarely on wet soil, very common; spring, summer, fall.

A similar but smaller hairy cup species, *S. erinaceus,* has a dull orange hymenium and smooth spores.

Spathularia flavida Fr. (plate 212A, B)

EDIBILITY UNKNOWN

Fruiting bodies up to 5 cm long, apical portion (modified apothecium) flattened, fan-shaped to roundish; yellowish when mature, becoming darker with age; edge even or undulating, decurrent along stalk from one-third to one-half total length.

Stalk hollow, slender, paler than apical portion.

Asci 100–125 × 12–14 µm, clavate, inoperculate, 8-spored; ascospores 40–50 × 2–3 µm, clavate-filiform, becoming multiseptate, hyaline; paraphyses filiform, branched, hyaline, curled or coiled at apex.

Single to gregarious on soil or in humus in coniferous woods, usually under pines, not uncommon; summer.

This is one of the group of inoperculate ascomycetes known as earth tongues.

PLATE 213. *Urnula craterium*

PLATE 214. *Verpa bohemica*

Urnula craterium (Schw.: Fr.) Fr. (plate 213) NOT EDIBLE

Devil's Urn

Apothecium 3–4 cm in diameter, 4–6 cm deep, at first closed but opening soon, leaving ragged or smooth inrolled margin around star-shaped to round opening; tapers gradually to stalk; exterior brownish black to black, somewhat velvety; interior (hymenium) brownish black, slightly paler than outside; hairs of outer wall variable in length, thick-walled, flexuous, blunt.

Stalk to 3–4 cm long with mass of black mycelium at base.

Asci 600 × 15–17 µm, cylindrical, operculate; ascospores 25–35 × 12–14 µm, broad, elliptical, uniseriate, smooth, hyaline; paraphyses filiform, slightly enlarged above, pale brown.

Single or clustered, attached to buried sticks (oak) on ground in deciduous woods, common but not conspicuous; often deeply buried in litter with only upper third emergent; spring.

This is one of the few obvious springtime fungi, along with morels, *Gyromitra*, and crimson cups.

Verpa bohemica (Krombh.) Schröt. (plate 214) NOT RECOMMENDED

Apothecium 2–4 cm in diameter, 2–5 cm long, conic to bell-shaped, folded into longitudinal ridges that anastomose frequently; yellow–brown to brown to reddish brown; attached at top only.

Stalk 6–12 cm long, 1–2.5 cm wide, tapering upward; white to cream; loosely stuffed, becoming hollow, smooth.

Asci 250–350 × 25 µm, cylindrical, operculate, 2-spored; ascospores 60–80 × 15–18 µm, elliptical, smooth, hyaline to yellowish; paraphyses enlarged to 7–8 mm in diameter at apex, numerous; spore print yellow.

Single to scattered on the ground in woods (in Iowa collected only in northeastern area and uncommon there); very early spring.

This fungus has been eaten, but it may cause gastrointestinal upset and lack of muscular coordination. Illness usually seems to occur when larger quantities are eaten. It cannot be recommended. *Ptychoverpa bohemica* is another name for this species.

PLATE 215. *Verpa conica*

Apothecium 2 cm long, 1–3 cm wide, caplike, subconic to bell-shaped; brown with white underneath; smooth or with faint furrows near margin, attached only at top, flaring at lower edges with age.

Stalk 5–11 cm long, 1–1.5 cm wide tapering upward; white to cream; loosely stuffed, becoming hollow.

Asci to 350 × 23 μm, cylindrical, operculate, 8-spored; ascospores 20–26 × 12–16 μm, elliptical, smooth, hyaline; paraphyses numerous, gradually clavate; spore print light yellow.

On the ground in wooded areas; spring.

This species is not common in all years and is not of interest to morel hunters, although it does occur in the morel spring season.

Truffles and False Truffles

Truffles and false truffles develop underground, though some are visible at the soil surface when they are mature. The spore-bearing structures remain enclosed within the fruiting body; spores are released into the soil only when the outer covering is decayed or when dispersed by the animals that eat them. Those truffles and false truffles whose ecology have been investigated (e.g., *Elaphomyces, Hysterangium, Melanogaster, Rhizopogon*, and *Tuber*) are known to occur in symbiotic association (mycorrhizal) with a variety of trees, but the ecology of many others has yet to be determined. The fruiting bodies are in many cases formed within an inch or two of the soil surface and sometimes may be found emergent at the soil surface or between the woodland litter layer and the soil. Fruiting bodies are more easily found when the soil is neither soggy nor overly dry. The soil near rotting logs and on slopes bordering lakes tends to be a fruitful place to look.

Truffles are ascomycetes and false truffles are basidiomycetes. The two groups are distinguished by their spore-bearing structures, but a few macrocharacteristics can help to identify them. Many truffles have a solid interior (gleba) marbled with pallid veins enclosed by a continuous covering. The Iowa species tend to be no larger than 1.5 cm in diameter. Most genera are related to the cup fungi. *Elaphomyces*, an ascomycetous truffle not related to the cup fungi, has a fruiting body that in some species is superficially similar to that of *Scleroderma*. The outer covering is thick, and the fruiting body tends to be more globose than in most other truffles or false truffles. At maturity the asci break down and the interior becomes a dry, powdery spore mass.

False truffles are often larger than 1 cm in diameter. Some species have a sponge-like interior (fig. 16). In addition to their outer covering, some species have strands of aggregated mycelium (rhizomorphs) attached like roots to the base of the fruiting body, extending into the surrounding soil and sometimes partially or completely surrounding the fruiting body itself. Some have an internal pale columella, a basal or central sterile structure readily seen when the fruiting body is cut in half. False truffles are related to mushrooms and boletes.

Elaphomyces variegatus is sometimes collected by those not actively looking for truffles, when it is parasitized by *Cordyceps* sp. (pls. 216A, 231B), a fungus that sends a club-shaped fruiting structure above the ground. Most truffles and false truffles produce odors that become stronger as they mature and are detected by rodents who dig them to eat (mycophagists) and then disperse the spores in their scat.

Truffles and false truffles are produced when conditions are favorable in the soil near the trees whose roots they are associated with. Nobody knows what triggers fruiting, but certain species display seasonality. Most species in Iowa have been collected from midsummer to early autumn under oak, pine, basswood, ironwood, and hickory. Many truffle and false truffle species are found under at least two different tree genera. Species of *Tuber*, *Pachyphloeus*, and *Sclerogaster* have been collected in both deciduous and coniferous woods. Some species, particularly of *Rhizopogon,* are associated only with pines.

No truffles or false truffles are known to be poisonous, but the Iowa species are too small and difficult to find to be of interest as edible fungi. Species that fit decriptions from Europe are identified as such in this guide, but molecular analysis may eventually show that these taxa are not the same on the two continents.

Key to Selected Genera and Species in This Guide

Be aware of possible misidentifications. Do not eat any specimen not positively identified.

1a. Fruiting body folded, usually with hollow center, sometimes cup-shaped with small opening at apex, spore-producing area (interior) sandwiched between inner and outer coverings: 2
1b. Fruiting body knobby, folded, or roughly roundish to elliptical; with outer covering but no inner covering present: 3
2a. Fruiting body yellowish brown: *Genea* cf *thaxteri*, page 305
2b. Fruiting body dark reddish brown to black: *Genea* cf *gardneri*, page 303
3a. Interior of fruiting body with hollow canals or chambers: 4
3b. Interior of fruiting body solid or filled with powdery spores: 8
4a. Gleba some shade of green unless very old: *Hysterangium strobilus*, page 307
4b. Gleba not green: 5

5a. Fruiting body bruising reddish or reddish brown with reddish veins: *Rhizopogon*, page 313
5b. Fruiting body not bruising reddish but may discolor brown: 6
6a. Gleba with large chambers and no veins, appearing spongelike: *Hymenogaster niveus*, page 307
6b. Gleba with meandering canals and veins: 7
7a. Fruiting body gristly in texture: *Hydnobolites cerebriformis*, page 305
7b. Fruiting body not gristly in texture: *Stephensia shanorii*, page 315
8a. Fruiting body soft, pink to purple: *Elaphomyces appalachiensis*, page 301
8b. Fruiting body not pink or purple: 9
9a. Interior of fruiting body filled with powdery spores by maturity: 10
9b. Interior of fruiting body solid, not filled with powdery spores: 11
10a. Fruiting body often breaking open at maturity, usually with ample basal mycelial tuft, generally on soil surface: see *Scleroderma* in gasteromycetes, page 251
10b. Fruiting body not opening, usually hypogeous, no mycelial tuft but may be encased in soil mixed with roots: *Elaphomyces variegatus*, page 303
11a. Fruiting body mustard-brown to dark brown with moist, black interior: *Melanogaster broomeanus*, page 309
11b. Interior of fruiting body not black: 12
12a. Fruiting body white, turning dark brown to black with handling, gleba with white veins: *Octaviania asterosperma*, page 309
12b. Fruiting body not changing color with handling: 13
13a. Surface of fruiting body covered with raised or polygonal warts, differently textured apical pit and basal mycelial tuft usually present: 14
13b. Surface of fruiting body almost smooth to finely verrucose (with small wartlike projections), without differentiated apex or basal mycelial tuft: 15
14a. Fruiting body orange to brownish orange with polygonal warts, interior with white veins: *Pachyphloeus* cf *carneus*, page 311
14b. Fruiting body greenish yellow to yellowish brown with rounded warts, interior with cream to yellow veins: *Pachyphloeus virescens*, page 313
15a. Surface of fruiting body finely verrucose: *Tuber gardneri*, page 315
15b. Surface of fruiting body almost smooth: *Tuber* cf *lyonii*, page 316

PLATE 216. *Elaphomyces appalachiensis*
A (Top): Parasitized by *Cordyceps fracta*
B (Bottom): Longitudinal section to show peridium and gleba

Elaphomyces appalachiensis Linder

(plate 216A, B) EDIBILITY UNKNOWN

Ascocarps (fruiting bodies of ascomycetes) to 1.5 cm in diameter but usually less than 1 cm, sometimes with multiple roundish glebas encased within common irregular, soft, cottony pinkish purple peridium, pinkish to purplish within; inner peridium becoming dark brown closer to gleba, more compact than exterior hyphae; gleba white to slate-blue or gray; mycorrhizal roots encapsulated within outer peridium, with pinkish rhizomorphs extending into soil.

Asci 18 µm in diameter, globose to subglobose, inoperculate, with 4–8 irregularly arranged spores, evanescent, resulting in free spores in gleba that tend to remain grouped as though still in ascus.

Spores globose, 7–9 µm including spines 1 µm long, blue to bluish green.

Single to gregarious, hypogeous in deciduous woods, particularly under oak, uncommon; summer, fall.

This truffle is often parasitized by *Cordyceps fracta* (pl. 216A), which makes its detection above ground easier. It has no discernible odor.

PLATE 217. *Elaphomyces variegatus*

PLATE 218. *Genea* cf *gardneri*

Elaphomyces variegatus Vitt. (plate 217) EDIBILITY UNKNOWN

Fruiting body 5–22 mm, globose to laterally flattened and subglobose, often with mycorrhizal roots and dirt that encase the fruiting body, light brown to reddish brown, verrucose with light brown pyramidal warts, interspaces sometimes filled with yellow gel-like material; subdermal covering under warts 1–2 mm thick, whitish toward surface and darker chocolate brown toward gleba, marbled with dark brown veins; internal area white and cottony when young, sometimes with blue mycelia in center, maturing to powdery dark chocolate brown spore mass mixed with sterile white hyphae; rose to white sterile veins, when present.

Asci 29–40 × 17.7–36.3 µm, globose to subglobose, evanescent, (1) 3–5 (6) spored.

Spores (12) 15–21 (23.3) µm, including spines 2.5 to 3.8 µm high, globose, spiny, dark brown in mass.

Fruiting bodies single to numerous, hypogeous 2–6 cm below soil surface in mixed deciduous woods, especially under oak and ironwood; spring, summer, fall.

The parasitized sporocarps are lighter brown, include bright yellow rhizomorphs inside and outside the sporocarp, and may be withered, giving the sporocarp surface a wrinkled appearance. *E. variegatus* is very similar to *E. muricatus*, which differs in its larger spores and association with conifers. It has no discernible odor. *Elaphomyces* species are known as deer truffles.

Genea cf *gardneri* Gilkey (plate 218) EDIBILITY UNKNOWN

Fruiting body 4–12 mm × 2–10 mm, globose to subglobose, often laterally depressed, lobed, verrucose; almost glabrous over all but one area, usually at base, which has light brown mycelial tuft; outer covering continuous with and similar to inner covering, which defines central hollow space; entire covering dark reddish brown, appearing black; interior thin, white, slightly gelatinous sandwich of cylindrical asci and paraphyses lined up in palisade between outer and inner covering.

Asci 185–283 × 25–30.5 µm cylindrical, not amyloid, with 8 uniseriate spores.

Spores 27.5–35 (37) × 23–33 (37) µm, including ornamentation, subglobose with warts, hyaline.

Single to several, hypogeous close to soil surface or on the soil under litter, beneath canopy of oak, basswood, ironwood; summer, fall.

This species is probably not rare but is seldom collected because it is small and black, blending with Iowa soil. It differs from the very similar *G. anthracina* in its subglobose spores. These species have a slightly sweet odor.

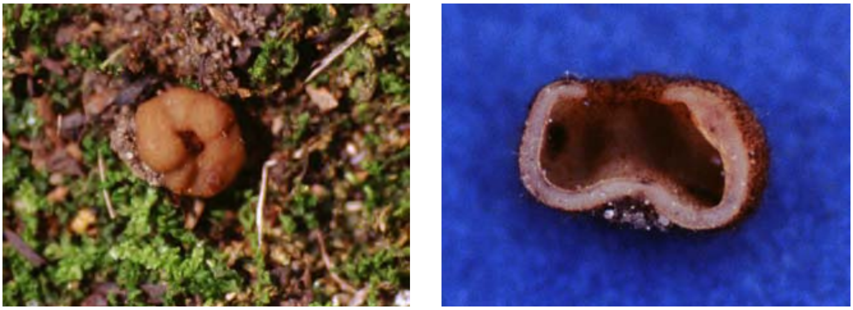


PLATE 219. *Genea* cf *thaxteri*. A: Fruiting body
B: Longitudinal section to show internal structures

PLATE 220. *Hydnobolites cerebriformis*

Genea cf *thaxteri* Gilkey (plate 219A, B) EDIBILITY UNKNOWN

Fruiting body up to 1 × 1.2 cm, globose to subglobose, often laterally depressed, lobed, verrucose, yellowish brown, glabrous except for basal tuft of mycelia that holds dirt; outer covering continuous with inner covering through aperture at apex of fruiting body; inner covering defining hollow space with sparse hairs and scattered setae, lighter brown than outer covering; interior thin, white, slightly gelatinous sandwich of cylindrical asci and paraphyses lined up in palisade between white subdermal layer under thick-walled darker outer covering on exterior of fruiting body; similar thick-walled outer covering on inner side of fruiting body, lining hollow portion.

Asci (209) 230–248 × 22–31 µm, cylindrical, not amyloid, with 8 uniseriate spores.

Spores 22.5–27.5 × 27.5–32.5 (35) µm, including ornamentation, elliptical, with rounded to acute-tipped uncrowded warts, hyaline.

Single to several, hypogeous, close to or on soil surface, not common, under basswood or oak; summer, fall.

The several species of *Genea* are all small and difficult to see but probably not rare. *G. hispidula* is similar in color to *G.* cf *thaxteri* but is hairy. They all have a mild, sweet odor and are found close to or on the soil surface.

Hydnobolites cerebriformis Tul. & C. Tul. (plate 220) EDIBILITY UNKNOWN

Fruiting body 6–18 mm in diameter, shrinking considerably with drying; much folded into knobby round to elliptical shape, with basal tuft of mycelia that holds soil; white, changing to orangish brown with handling or exposure; gristly consistency; smooth; interior composed of white veins interspersed with hollow to stuffed canals within folded fruiting body that forms convoluted mass; changing to orangish brown with drying.

Asci 58.4–65.7 × 80–92 µm, globose to subglobose, not amyloid, with (2) 3–6 (8) spores.

Spores (23) 25–32.5 µm including spines, globose, ornamented with spines connected by ridges, hyaline, irregularly arranged.

Single to gregarious, hypogeous, but close to soil surface under oak, basswood, or ironwood, probably not rare; summer, fall.

This species is named for the brainlike appearance of the convoluted fruiting body. The gristly consistency is unique among truffle species. Its odor is like that of mushrooms such as *Agaricus*. This species is described in Europe as having eight spores per ascus.

PLATE 221. *Hymenogaster niveus*

PLATE 222. *Hysterangium strobilus*

Hymenogaster niveus Vitt. (plate 221) EDIBILITY UNKNOWN

Fruiting bodies 0.25–1.6 × 0.3–2.2 cm, chalk-white to buffy brown, with silky smooth surface, becoming dingy with handling; indented at base, gleba with 1–3 chambers per mm, giving spongelike appearance, sometimes with small sterile base; interior white, turning cinnamon-brown as spores mature; white and brown mottled appearance with violaceous tones.

Spores oval to flask-shaped when apical beak is present; golden brown to reddish brown; sculptured with evenly spaced spines; spines and spore enveloped in colorless membrane, except for apical beak, (8) 9–12.5 (14) × 13–17.5 µm, basidia with 1–4 spores.

Hypogeous at interface of soil and forest duff, to shallowly buried under canopies of white pine, oaks, hickory, and basswood; single to numerous especially in summer but recorded throughout the year.

This is one of two relatively common species of *Hymenogaster* in Iowa. The other, *H. lycoperdineus*, differs in its dingy brown outer covering, darker brown gleba, and spore characters. These species have a sweet, humuslike odor.

Hysterangium strobilus Zeller & Dodge (plate 222) EDIBILITY UNKNOWN

Fruiting body 0.5–2 × 0.6–3 cm, subglobose to elliptical, with extensive white basal rhizomorphs that may extend up along sides; numerous white rhizomorphs in surrounding soil; white to vinaceous brown, staining pinkish brown, with easily detached cottony outer layer, smooth; interior slate-gray to greenish olive, sometimes becoming brownish olive; rubbery in texture, moist; central vein(s) translucent white to pinkish, with branches; numerous chambers, giving gleba spongelike appearance.

Spores 5–7.5 × 15–20 µm, with wrinkled perispore, hyaline individually, greenish to brown in mass.

Solitary to numerous, hypogeous to emergent under basswood, oak, and hickory; spring, summer.

The odor is mild to sickly sweet. Species of *Hysterangium* appear similar at the macrolevel. *H. strobilus* is distinguished from other species of *Hysterangium* by the spore characteristics and the structure of the outer covering. This species is not uncommon locally in the early summer and may fruit in large numbers.

PLATE 223. *Melanogaster broomeanus*

PLATE 224. *Octaviania asterosperma*

Melanogaster broomeanus Berk. ap. Tul. & C. Tul.

(plate 223) EDIBILITY UNKNOWN

Fruiting body 0.5–2 × 4–4.5 cm, nearly globose to elliptical and irregular; several thick basal rhizomorphs may extend along sides; yellow to yellowish brown when young, bruising liver brown and becoming deep mahogany-brown when mature; occasionally with holes that exude clear liquid; interior with dark brown to black gel-filled chambers and white or cream to yellowish veins, which may turn reddish; basidiocarp in young specimens is darkest in center, where spores mature first.

Spores 3.4–4.5 × 7.5–10 µm, cylindrical with truncate base, occasionally heart-shaped to peanut-shaped, smooth; dark brown individually, dark brown to black in mass.

Single to numerous, hypogeous, but close to soil surface when young, emerging through soil surface when mature, sometimes coming up through moss under basswood, hickory, oak, or ironwood, not uncommon locally; spring, summer, fall.

This is one of the largest false truffles. Unlike other species, it often forms at the soil surface and therefore is relatively easy to find. The black interior and dark brown spores are distinguishing features of *Melanogaster*. *M. broomeanus* is distinguished from other species mainly by spore shape and size. Fruiting bodies can have a fruity scent, but some have a strongly chemical odor. *M. broomeanus* is eaten in England, but we have no reports of the edibility of this false truffle in North America. It is sometimes parasitized by *Sepedonium chrysospermum* (*Hypomyces*).

Octaviania asterosperma (Vitt.) O. Kuntze

(plate 224) EDIBILITY UNKNOWN

Fruiting bodies 1–1.5 × 1.8–2.5 cm, knobby, especially at base, with few rhizomorphs originating from base; snow white, becoming dark brown to blackish after handling; smooth; interior white when young, becoming brown with white veins when mature, sometimes watery or moist; chambers more or less radiating from sterile base, varying from inconspicuous to several mm high and wide; veins and sterile base soon turning pinkish and sometimes forest green, finally becoming dark brown to black with exposure to air.

Spores 13.8–17.5 (18.8) µm including spines, globose, with coarse slightly to strongly curved spines 2.5–4.4 µm long; hyaline to light yellow individually, golden brown to light greenish brown in mass.

Hypogeous, near soil surface to emergent at soil surface under oaks, not uncommon in some years; summer.

PLATE 225. *Pachyphloeus* cf *carneus*

O. nigrescens also blackens with handling or exposure to air. It can be distinguished from *O. asterosperma* by its dingier white coloring, relatively small, subglobose spores with shorter spines, and lack of a sterile base. These species have the odor of mushrooms such as *Agaricus*.

Pachyphloeus* cf *carneus Harkness (plate 225) EDIBILITY UNKNOWN

Fruiting body up to 1.5 cm in diameter, globose to subglobose with basal tuft of white to cream soil-encrusted mycelium; orange to orangish brown with flattened polygonal warts; areole opposite mycelial tuft lighter orange to yellowish orange; interior when young with white veins in gray gleba, darkening to blackish gray when exposed to air, maturing to chocolate brown with white veins.

Asci 183–262 μm × 22.5–33 (37.5) μm, cylindrical to clavate-cylindrical, not amyloid, with 8 uniseriately arranged spores.

Spores 17.5–22.5 μm including spines, globose, ornamented with golf tee–shaped spines connected at tips by colorless membranelike structure that envelops spore; medium brown; uniseriate.

Single to gregarious, hypogeous under oak, basswood, hickory, ironwood, or pine, not uncommon; summer, fall.

This is one of the commonest truffle species in Iowa, found even in woodland gardens under oak and easily identified by its orange color and polygonal warts. It was thought to be the same as *P. citrinus*, which is found in Europe, but recently has been interpreted as a different species. It has an odor reminiscent of burned potatoes.

PLATE 226. *Pachyphloeus virescens*

PLATE 227. *Rhizopogon* sp.
A (Top): In pine needle humus, B (Bottom): Longitudinal sections of mature and immature fruiting bodies

Pachyphloeus virescens Gilkey (plate 226) EDIBILITY UNKNOWN

Fruiting body up to 1 cm in diameter, globose to subglobose with basal tuft of yellowish to soil-encrusted mycelium; greenish yellow to yellowish brown with rounded warts; yellowish areole opposite mycelial tuft, interior with cream to yellowish veins in yellowish gray to olive-brown gleba.

Asci 50–150 × 55 μm, globose to subglobose to almost clavate, not amyloid, with 8 irregularly arranged spores.

Spores 16–21 μm including spines, globose, ornamented with golf tee–shaped spines, hyaline to yellow.

Single to scattered, hypogeous under oak, basswood, hickory, ironwood, and pine, not common; summer, fall.

This species has an odor similar to that of *P.* cf *carneus*.

Rhizopogon sp. (plate 227A, B) EDIBILITY UNKNOWN

Fruiting body 15–20 × 10–15 mm, lobed, smooth; white when young, becoming yellow, bruising reddish and finally brown; firm when young, becoming soft and easily indented with age; one or two sparsely branched rhizomorphs attached to base; gleba white when young, becoming reddish brown; numerous small chambers, giving spongelike appearance to gleba.

Basidia 4- or 5-spored, spores 6.3–10 × 3.8 μm, cylindrical, hyaline to olive-green, reddish brown in mass.

Fruiting in large numbers between soil and duff layer under white pine; late summer, fall.

PLATE 228. *Stephensia shanorii*
A (Right): In soil
B (Below): Longitudinal sections showing inner and outer view

PLATE 229. *Tuber gardneri*

Stephensia shanorii (Gilkey) Gilkey (plate 228A, B) EDIBILITY UNKNOWN

Fruiting body up to 2.5 × 1.5 cm, globose to ovoid, regular to knobby, smooth to slightly granular, sparsely tomentose; pinkish ochraceous buff to brownish orange; peridium frequently cracked; interior white, with canals stuffed with hyphae or hollow.

Asci 150–188 × 17.5–22.5 µm, cylindrical tapering to narrower base, lining canals in palisade, not amyloid, with (3) 4–8 uniseriately arranged spores.

Spores 15–20 µm in diameter (often different sizes within same ascus); globose, smooth, hyaline, with 1 oil drop; wall thick, reddish brown.

Breaking through soil surface to shallowly hypogeous, single to gregarious in soil of deciduous woods; not common in spring, summer.

This truffle is distinguished by its reddish to orangish brown color; its strong, unpleasant rotten cabbage odor; and its gleba with hollow to hypha-stuffed canals. It commonly has fewer than eight spores of variable size in an ascus, presumably because some (often half or more) of the spores degenerate.

Tuber gardneri Gilkey (plate 229) EDIBLE

Fruiting body 0.5–1.5 × 0.5 × 2.5 cm, globose to subglobose, verrucose with fine warts; light yellowish brown to cinnamon-brown, with pale ochraceous buff to cinnamon-pink fissures; interior white when young, changing to light grayish brown and finally milk chocolate brown with white veins when mature.

Asci 77.5–83.8 µm × 35–62.5 µm, globose to subglobose, not amyloid, with 1–4 (5) spores.

Spores excluding sculpturing 20–50 µm × 20–35 (39) µm, with the size decreasing as number of spores per ascus increases; symmetrical to slightly narrower on one end; ornamented with ridges that form mesh, sculpturing (2.5) 3–5 (5.6) µm high; spores irregularly arranged, brown.

Single to clustered, hypogeous near the soil surface; not uncommon, especially under oak or hickory; summer.

T. gardneri is distinguished from other *Tuber* species by its light brown verrucose peridium and its spore characteristics. It is one of the most frequently collected truffles in oak woods in June and July and is often abundant. This species has been collected in woodland gardens under oak and hickory. It has the mild, sweet odor of fresh coconut.

Tuber* cf *lyonii Butters (plate 230) EDIBLE

Fruiting body 0.5–1.5 × 0.5–2.5 cm, globose to subglobose, smooth, white to cinnamon-brown to reddish brown with cinnamon-pink fissures; interior white when young, changing to mocha-brown with white to gray veins when mature.

Asci 75–90 µm × 52–57 µm, stipitate, globose to subglobose; not amyloid with 1–6 irregularly arranged spores.

Spores excluding sculpturing 30–45 × 20–25 µm, with size decreasing as number of spores per ascus increases; football-shaped, symmetrical to slightly narrower on one end; ornamented with spines 2.5–5 µm long, occasionally connected by low ridges; brown.

Single to scattered, hypogeous, usually less than 1 inch from soil surface, sometimes at surface when mature; under oak, basswood, and pine; summer, fall.

This species has a sweet, coconutlike odor when young, but it may become strong and unpleasant when old, particularly if infested with insect larvae. This species is very similar to *T. rufum*. Both have several color variations, from white to yellowish brown to reddish brown. The only apparent difference is that the spore spines are connected in *T.* cf *lyonii*.

PLATE 230. *Tuber* cf *lyonii*

Other Ascomycetes

The cup fungi make up a relatively small segment of the ascomycetes. The majority of ascomycetes produce small, roundish to flask-shaped fruiting bodies (perithecia, pseudothecia, cleistothecia). They are much less obvious and are often not noticed except by those who look carefully. Many of these fungi live on dead plant debris and produce scattered fruiting bodies on or in these materials. The fruiting bodies may be black dots on rotting downed wood, dead branches in trees, annual plant stems of the preceding year, or even the surface of living leaves. The fruiting bodies may also be red or yellowish clustered, roundish structures on tree bark or dead branches or on the larger fleshy fruiting bodies of other fungi.

Some of these ascomycetes are found on dead plant materials, decomposing them and recycling their components. Others are plant parasites of diverse kinds, some of which form fruiting bodies only on overwintered debris.

This field guide includes the common members of the class Ascomycetes that produce large macroscopic structures on or in which the much smaller fruiting bodies develop (usually many of them, grouped in various ways). These larger structures, called stromata if they remain attached to the material in which the vegetative mycelium developed and sclerotia if the macroscopic structure separates from the place where it was developed, have visible characteristic features. The following key is based upon these observable field details.

Key to the Genera and Species of Other Ascomycetes in This Guide

Be aware of misidentification. Do not eat any specimen not positively identified.

1a. Stromata somewhat fleshy, clublike; growing from insects in soil or rotting wood (often parasitic on the juvenile stages) or from truffles buried in the soil: *Cordyceps* species, page 318
1b. Stromata flat, rounded, or clublike; on downed wood, stumps, at the base of standing trees, or over larger fungus fruiting bodies such as mushrooms, boletes, and brackets: 2
2a. Stromata fingerlike, tough to hard, upright, gray to black; single or in clusters on rotting wood or at the base of trees: *Xylaria polymorpha*, page 325
2b. Stromata flat or hemispherical; on wood or on large fungus fruiting bodies: 3
3a. Stromata flat; on wood or on large fungus fruiting bodies: 4
3b. Stromata hemispherical; on wood: 6
4a. Stromata bright orange or reddish purple at maturity, parasitic on mush-

rooms; mushroom gills absent or poorly developed: *Hypomyces lactifluorum*, page 323

4b. Stromata on wood; variously colored: 5

5a. Stromata soft, bright yellow, not limited in size: *Hypocrea sulphurea*, page 321

5b. Stromata hard, black, often covered with a gray, green, or red-purple powdery layer when young: *Hypoxylon* spp., page 325

6a. Stromata with concentric zones (easily visible when stromata are cut or broken), with a single outer layer of flask-shaped fruiting bodies: *Daldinia concentrica*, page 321

6b. Stromata lacking zonation, similar texture throughout, with a single outer layer of flask-shaped fruiting bodies: *Hypoxylon* spp., page 325

Cordyceps militaris (L.: Fr.) Lk. (plate 231A, B) NOT RECOMMENDED

Fruiting structure (stroma) up to 5 cm long, 3–5 mm wide, club-shaped; orange to orange-red; surface of upper portion raised around each flask-shaped perithecium.

Stalk narrower in width than club-shaped upper portion, varying in length, depending on depth of parasitized insect host buried in soil or litter.

Perithecia buried in stroma in single layer over entire upper portion of stroma.

Asci cylindrical, in inner layer in perithecia, 8-spored; ascospores long and threadlike, often breaking into segments 3.5–6 × 1.5 µm when mature.

Usually solitary or a few arising from buried parasitized *Lepidoptera* larvae and pupae, common in woods; summer, fall.

The club-shaped stromata are easily confused with unbranched coral fungi. Attachment to a parasitized insect can be determined by carefully digging around the base of the fruiting body. Several other species of *Cordyceps* are not uncommon in the woods in summer and fall. *C. melolonthae* var. *melolonthae* parasitizes *Coleoptera* larvae and is most common on large larvae of June bugs. It produces yellow clavate heads up to 13 cm long, 5–15 mm wide. Two other common *Cordyceps* species parasitize buried fruiting bodies of *Elaphomyces,* one of the truffle fungi: *C. ophioglossoides* (pl. 231B) produces reddish to olive-brown clavate stromata up to 8 cm long in midsummer woods; *C. capitata,* a fall species, produces a stalk up to 11 cm long, capped by a rounded head in which the perithecia are buried. *C. fracta* (pl. 216A), which may be specific to *Elaphomyces appalachiensis*, is similar to *C. capitata* but smaller.

PLATE 231. Parasitic ascomycetes
A (Above): *Cordyceps militaris* on pupa
B (Left): *Cordyceps ophioglossoides* on *Elaphomyces*

PLATE 232. *Daldinia concentrica.* A: On stump, B: Internal zonation

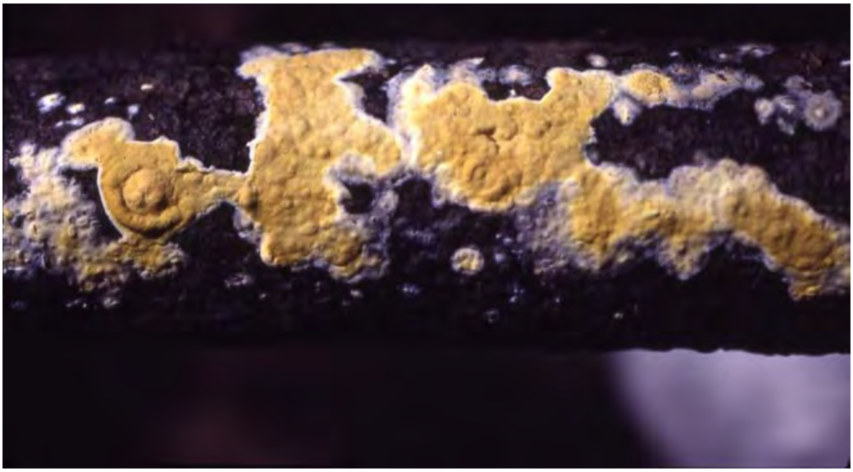


PLATE 233. *Hypocrea sulphurea*

Daldinia concentrica (Bolton: Fr.) Ces. & de Not. (plate 232A, B) NOT EDIBLE

Stroma hemispherical; black covered with purple-brown to reddish brown layer in young stages; hard, smooth; internal concentric zones of hard whitish and black carbonous tissue, even when young.

Perithecia buried in outer surface in single layer, flask-shaped with openings just breaking outer surface of stroma.

Asci 200 × 12 μm, cylindrical, 8-spored; apical plug staining blue with iodine solution or Melzer's reagent; ascospores elliptical with one flattened side, 1-celled, in single row; dark brown to black.

On wood or bark of dead trees, usually oaks or ironwood, very common; mid-summer, fall.

The stroma and surrounding wood are often covered by black spores as the mature ascospores are violently released from the asci. Field identification is very easy: the concentrically zoned, hard black stroma is unique.

Hypocrea sulphurea (Schw.) Sacc. (plate 233) NOT EDIBLE

Fruiting structure (stroma) broad, often at least several cm in diameter, flat; irregular in outline, effuse without definitive size, thin; white when young but quickly becoming bright yellow with irregular white edge; firm but fleshy.

Perithecia 150–250 μm in diameter, oval, completely buried in stroma and evident only as water-soaked dots on surface of stroma; flask-shaped with opening at surface of stroma, containing layer of asci.

Asci 75–150 × 5–6 μm, cylindrical with apical pore, 8-spored; ascospores, 3–4 × 9–11 μm, 2-celled in single row, hyaline, cells commonly separating when mature.

Common on downed wood in the woods; summer, fall.

The conspicuous bright yellow stroma is often associated with or developed over the old, partly disintegrated fruiting bodies of jelly fungi, particularly species of *Exidia*. Dried stromata may persist for some time, especially in the fall.

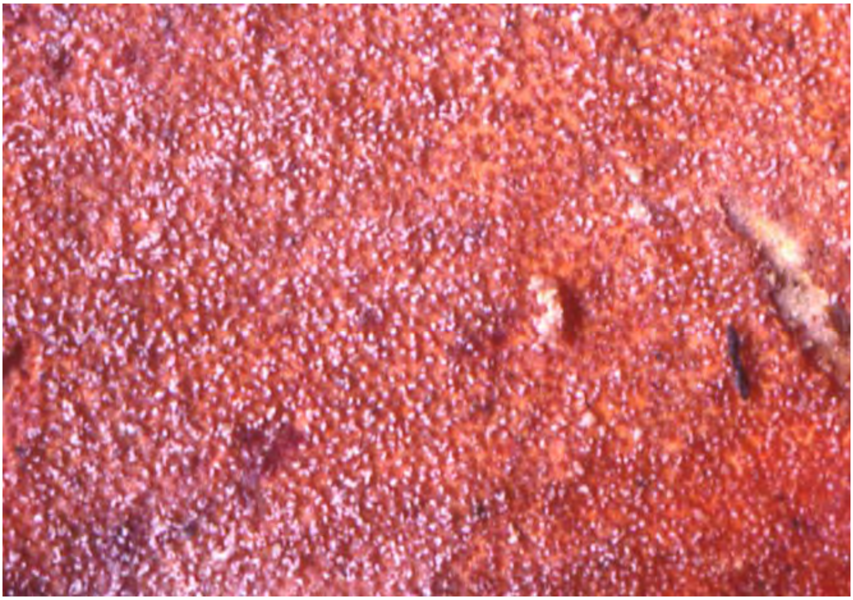


PLATE 234. *Hypomyces lactifluorum*
A (Top): Parasitized fruiting body, B (Bottom): Close-up of stroma with individual perithecia indicated by each bump

Hypomyces lactifluorum (Schw.: Fr.) Tul.

(plate 234A, B) RECOMMENDED WITH CAUTION

Lobster Mushroom

Fruiting structure (stroma) parasitic on mushrooms, probably on species of *Russula* and *Lactarius*, which are modified or completely changed in shape by it; bright orange to orange-red, becoming purple with age, entirely covering mushroom.

Perithecia buried in single layer over entire stromatized host, flask-shaped, with openings appearing as darker, slightly raised bumps from generally smooth surface of orange stroma.

Asci 150–175 × 7–8 μm, cylindrical, 8-spored; ascospores 35–40 × 7–8 μm, fusiform, sometimes slightly curved, 2-celled, hyaline, rough.

On the ground in woods, not uncommon; midsummer, early fall.

These bright orange parasitized mushrooms are distinctive. The stroma-covered mushroom may have the general mushroom cap and stalk shape with gills modified to blunt ridges or may be modified to an unrecognizable lump of mushroom tissue covered by the stroma. The stroma includes dark orange bumps, each individual being a perithecium (pl. 234B), and the stroma is often dusted with white, powdery spores extruded from the perithecia. The parasitized mushrooms will occur in the same area in the woods in successive years, failing to develop only in very dry seasons. We recommend eating this mushroom with caution. Many people consider it to be a safe edible, however, even though the host mushroom cannot be identified (possibly various species of *Lactarius* and *Russula*). Poisonings associated with this combination fungus have been reported, so caution is suggested.

Other species of *Hypomyces* occur as parasites on mushrooms, boletes, jelly fungi, saddle and cup fungi, bird's nest fungi, and old fruiting bodies of various bracket fungi. Some species have an orange stroma, while others are red, yellow, green, cream, or white.

PLATE 235. *Hypoxylon mediterraneum*

PLATE 236. *Xylaria polymorpha*

Hypoxylon mediterraneum (de Not.) Mill. (plate 235) NOT EDIBLE

Fruiting structure (stroma) 2–5 cm long, 1–1.5 mm thick, flat to slightly raised to somewhat rounded to elliptical; breaking through surface of bark; black and shining; evenly dotted with openings of perithecia buried in stroma.

Perithecia 0.5–1 mm long, 0.4–0.5 mm wide, elongated flask shape, compressed when crowded; buried in stroma with only openings (ostioles) emergent.

Asci 120–185 × 8–11 µm, cylindrical with short stalk, 8-spored; ascospores 16–23 × 6–10 µm, oblong, elliptical, ends rounded, 1-celled in single row, dark brown; paraphyses unbranched, numerous.

On living or dead oak branches, occasionally on other hardwoods, usually following injury; persists throughout year.

A number of common species of *Hypoxylon* appear as a flat crust 2–10 mm wide and 5–20 mm long or a hemispherical cushion 1–8 mm in diameter. The apical plug of the ascus stains blue with an iodine solution such as Melzer's.

Xylaria polymorpha (Pers.: Mérat) Grev. (plate 236) NOT EDIBLE

Dead Man's Fingers

Fruiting bodies (stroma) up to 8 cm long, 2.5 cm wide, more or less club-shaped, sometimes irregular or slightly lobed above; young stromata appear powdery, buff to white when covered with layer of asexual spores (which weather away and are not replaced as perithecia begin to develop); thin black crust on outside penetrated by flask-shaped perithecia; interior white and tough.

Stalk short, cylindrical.

Perithecia in single layer in stroma, flask-shaped, rather regularly spaced over upper portion.

Asci 200 × 10 µm, cylindrical, 8-spored; ascospores 20–32 × 5–9 µm, tapered at both ends but with one side flattened, 1-celled in a row, dark brown to black; paraphyses filiform.

Solitary or clustered on wood or stumps at soil level, common; summer, fall, persisting for months.

Several other species of *Xylaria* with smaller stromata are common on downed wood. This genus has also been called *Xylosphaeria*.

Plant Parasitic Fungi

Very few of the mushrooms cause diseases of other living organisms; they usually take their food from dead plant materials or are part of a mycorrhizal association. Many other fungi, however, obtain their food from living plants, resulting in serious plant diseases.

We have included four common and obvious plant parasitic fungi. These affect their hosts in ways that make their presence evident. Many plant parasitic fungi are less obvious in their interactions, but that is a fascinating world beyond the scope of this book.

Apiosporina morbosa (Fr.) von Arx (plate 237A, B) NOT EDIBLE

Black Knot

Swollen, convoluted, hard, black elongate structures 1–3 cm in diameter, up to 30 cm long, develop along a twig or branch of the host plant. They begin with an expanding swelling on a twig or branch, resulting in longitudinal breaks in the bark. Diseased tissues are straw-yellow to brown, becoming covered with a hard black rind in which the fruiting bodies develop. Young knots may have an olive-green velvety covering that is lost as the black outer region matures. Diseased twigs often are bent at odd angles; the portion of the twig or branch beyond the knot dies once the branch has been girdled.

Many tiny fruiting bodies develop in a single layer along and around the black diseased branch. Each fruiting body contains asci in which 2-celled, hyaline ascospores develop.

Several woody species in the rose family are hosts; choke cherry, *Prunus virginiana,* is particularly susceptible among the native hosts and is very noticeable when diseased.

PLATE 237. *Apiosporina morbosa*
A (Top): Stroma on choke cherry branch, B (Bottom): Growth habit on choke cherry tree

Claviceps purpurea (Fr.) Tul. (plate 238) **POISONOUS**

Ergot

Ergot sclerotia are common in the individual flowers of inflorescences of open-pollinated grasses such as brome grass or rye. The dark brown to purple-black sclerotia are up to 3 cm long, cylindrical, rounded at the base, and tapered at the apex. They are hard and separate readily from the flowering head; the interior is white and hard, surrounded by a narrow black rind.

Any mature planting of rye, such as those found on erodable banks along road construction sites, contains mature plants that have the long (two to three times as long as the rye grains), dark sclerotia.

Young developing sclerotia produce a secretion called honey dew that is attractive to some insects and sticky when touched. If mature sclerotia overwinter on the ground, one or several long-stalked stromata with rounded heads about 2 mm in diameter develop in the spring. Perithecia form in a single layer on the head.

Ergot sclerotia have probably been responsible for more poisoning deaths than any other fungus (see p. 1). All sclerotia must be removed from any grain to be used as human or animal food. Even wheat may occasionally contain sclerotia, but much less frequently than does rye.

PLATE 238. *Claviceps purpurea*

Gymnosporangium juniperi-virginianae Schw.

(plate 239A, B) NOT EDIBLE

Cedar-apple Rust

This parasitic fungus stimulates host cell growth, producing solid brown galls on the twigs or smaller branches of juniper (*Juniperus virginiana*). The galls may reach several centimeters in diameter and are most obvious in rainy weather in April and May, when each gall is covered by orange gelatinous spore masses (pl. 239A). As these gelatinous masses dry, millions of wind-borne spores are released. The spore masses may swell and dry a number of times during the spring. The spores cannot grow on juniper but can only germinate and grow successfully on apple leaves or young fruits that are just developing.

By July or August the fungus produces clusters of very small, cuplike fruiting bodies with masses of dry orange spores on the apple leaves or fruits (pl. 239B). These spores in turn cannot grow on apple but must be carried by the

PLATE 239. *Gymnosporangium juniperi-virginianae*
A (Top): On juniper, B (Bottom): On apple

wind back to a juniper, where they germinate and become established in a twig or small branch. The next growing season a gall develops as the fungus stimulates the juniper cells; by September the gall is mature. When rain falls the following spring, orange gelatinous masses of spores will be produced on the gall. A spore-producing gall functions for a single spring and then dies, as does the twig portion beyond the gall.

Another species, *Gymnosporangium globosum,* also produces galls on juniper, but hawthorn is the alternate host. After a wet July the hawthorn leaves may seem completely spotted with clusters of orange spore-producing cups of this rust.

While many rusts share the peculiar situation of alternate development on two very different host plant species, some pass through a similar cycle on a single host plant species. Variations on the basic scheme occur in confusing array. Most flowering plants are hosts to at least one rust species. Grasses particularly may have several rust species sharing a single host plant.

Ustilago maydis (DC.) Cda. (plate 240)

Corn Smut

Small to large galls are produced from young diseased tissue in various parts of the corn plant, most commonly in the flowers of the tassel or the ear. Young galls are firm and light green but soon become soggy and dark as the fungus cells in the gall develop dark, thick walls. At these young stages, corn smut galls are valued as food by some people. The outer gall tissues finally break, exposing a dry, powdery spore mass.

The dry spores blow about or remain on plant tissue in the field over the winter. When young corn tissues are exposed the following season, the surviving spores germinate to form thin-walled hyphae that enter the young corn plant cells; this can happen at any time during the growing season.

Many grasses and other plants develop similar dark smut spore masses in the flowers or leaves. Each smut fungus can develop in a specific group of plant hosts or sometimes in only a single species. The smuts that develop in flowers usually replace the fruits or seeds of the normal plant. In such plants, they are dangerously successful in competing with humans for the food produced by the green plant host.

PLATE 240. *Ustilago maydis* on corn

Myxomycetes

(Slime Molds)

The myxomycetes or slime molds are common organisms, but only a few produce large and relatively conspicuous fruiting structures. Their vegetative stage, called plasmodia, occurs as naked protoplasm dispersed in well-rotted logs, leaf mulch, or piles of straw or similar decaying plant material (pl. 241). Their fruiting structures occur on the outside of rotten logs, along living plant stems or leaves, or on the upper leaves in leaf litter on the woodland floor. Many of these fruiting bodies, called sporangia or aethalia, are quite small (less than 1 mm tall) and inconspicuous; some are larger and more obvious or are grouped in large associations and thus more conspicuous. All of them contain a dry, powdery spore mass, which readily blows around when the outer covering of the fruiting structure is broken. As the spore mass is dispersed, the threadlike capillitium may be seen. It is very conspicuous in some genera (pl. 242) and microscopic or lacking in others.

Some slime mold genera or species occur on particular substrates, such as overwintered fallen leaves on the forest floor or well-rotted (punky) logs. With a little field experience, you can learn to expect the common species on their usual substrates.

Slime mold fruiting bodies may develop at any time during the growing season but are more common in the summer and fall. They frequently develop within a week or so of dry weather following a rain or a rainy period, as the substrate in which the plasmodia have been feeding dries. Freshly developed fruiting bodies are the most striking and easiest to recognize. They are rather fragile, however, and the spores are washed away by rains, leaving the fruiting bodies drab and unrecognizable.

Only a few of the common slime molds with the most conspicuous fruiting bodies are discussed here. Some of the most useful books devoted to slime mold information and identification are listed in the technical references.

Key to Genera in This Guide

1a. Fruiting bodies usually larger than 0.5 cm in diameter; on a broad base: 2
1b. Fruiting bodies smaller than 0.5 cm in diameter; often with obvious stalks: 4
2a. Fruiting bodies a black powdery spore mass covered with a white to yellowish flaky layer: *Fuligo* and *Mucilago* (species of these genera look alike macroscopically but can easily be recognized using microscopic differences), pages 341, 343
2b. Fruiting bodies with a light-colored spore mass covered by a smooth, somewhat persistent thin layer; on wood: 3
3a. Fruiting bodies separate, globose to flattened, bright pink when young, becoming gray to gray-brown or olivaceous with age; powdery spore mass: *Lycogola*, page 341

PLATE 241. Slime mold plasmodium

3b. Fruiting bodies in small clusters, with a somewhat constricted base, bright red when young, becoming dark reddish brown in age; powdery spore mass reddish brown: *Tubifera*, page 347
4a. Spore mass brightly colored, often golden yellow; outer covering of fruiting bodies soon breaking, exposing a powdery spore mass and threadlike capillitium: *Arcyria*, *Hemitrichia*, *Metatrichia*, *and Trichia*, pages 339, 347
4b. Spore mass brown to purple-black: 5
5a. Fruiting bodies in a close cluster, each fruiting body with a wiry black central stalk, resembling a tiny cattail: *Stemonitis*, page 345
5b. Fruiting bodies in a common area but usually distinct and separate; round to somewhat elongate, with or without a short stalk: 6
6a. Fruiting body goblet-shaped, with a persistent wall and a definite lidlike area; white lumps in the exposed dark spore mass visible if the lid has broken away: *Craterium*, page 339
6b. Fruiting bodies spherical to slightly flattened; wall readily breaking into pieces and falling off or wall appearing as a dry, white powdery covering: 7
7a. Fruiting bodies with a dry, white powdery covering: *Didymium*, page 339
7b. Fruiting bodies with outer wall readily breaking into irregular pieces and falling away: *Physarum*, page 343

PLATE 242. *Arcyria nutans*

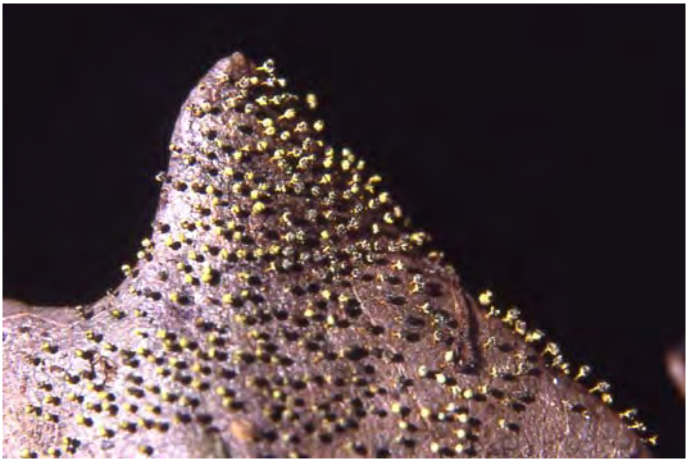


PLATE 243. *Craterium aureum*

PLATE 244. *Didymium* sp.

Arcyria nutans (Bull.) Grev. (plate 242)

Sporangia with short stalks crowded in clusters, yellow, cylindrical, 1.5–2 mm tall, 0.3–0.5 mm broad; when thin fragile peridium breaks, yellow capillitium expands to 4–12 mm and often droops; very elastic and barely attached to small, cuplike base at top of stalk.

Spore mass, including capillitium, yellow to yellow-tan; spores round, 7–8 μm, with scattered indistinct warts on surface.

On dead, well-rotted wood; summer, fall.

The genus is characterized by morphology of the capillitium that is only visible microscopically. This species is widely distributed and can be recognized by the pale yellow drooping capillitium and spore mass. Some fruitings may be yellow-tan.

Craterium aureum (Schum.) Rost. (plate 243)

Sporangia about 0.4–0.6 mm in diameter, 0.7–1.5 mm high, ellipsoidal to goblet-shaped; golden yellow to greenish yellow; apical portion of peridium breaks away, leaving opening that exposes spore mass.

Stalk short.

Spore mass dark; capillitium with scattered light-colored lime knots.

Occurs in large groups on old leaves of ground litter in woods; summer, fall.

C. leucocephalum has slightly larger sporangia and is the most common *Craterium* species.

Didymium spp. (plate 244)

Sporangia small, usually 1 mm or less in height and diameter; white; walls of commonest species with lime crystals, making tiny sporangia appear to be dusted with powdered sugar.

Stalk present or absent (sessile).

Spore mass uniformly dark; capillitium nonlimy.

Common in large numbers on old leaves of ground litter in woody areas; summer, fall.

Some species of *Didymium* are very similar macroscopically to those of *Physarum*, but they are quite different in microscopic features.

PLATE 245. *Fuligo septica*

PLATE 246. *Lycogola epidendrum*
A (Top): Immature and mature, B (Bottom): Mature

Fuligo septica (L.) Wigg. (plate 245)

Fruiting bodies (aethalia) large, 2–20 cm broad, 1–3 cm high, cushionlike; white, thick, flaky cover.

Spores 6–9 μm in diameter, round, 1-celled, black; spore mass dull black, powdery; capillitium very fine threads, uncolored; white deposit areas (lime knots) randomly scattered along threads throughout.

On rotten wood, plant litter, and leaves and/or stems of living plants, especially if surrounded by heavy mulch where plasmodium can grow; summer (most common), fall.

Fuligo and *Mucilago* produce similar fruiting bodies that are easily separated by microscopic features. Capillitium details separate the genera, and distinctive spores effectively separate the common species in this area.

Lycogola epidendrum (L.) Fr. (plate 246A, B)

Fruiting bodies (aethalia) 3–15 mm broad, hemispherical to slightly depressed; at first appearing bright pink, maturing in a few hours to gray, gray-brown, or olivaceous; cover tough, rough.

Spores 6–7.5 μm, globose, 1-celled, very lightly colored, with ridges (reticulations) on spore wall; spore mass, including spores and coarse threadlike capillitia, dull pinkish gray to yellow-tan, randomly exposed when cover breaks.

Always on wood; summer, fall.

The clusters of fruiting bodies look like very small puffballs and are often incorrectly identified as such. Another slime mold, *Reticularia lycoperdon,* also forms large (up to 8 cm in diameter), hemispherical to slightly flattened, puffball-like fruiting bodies on rotting logs in woods. When the tough outer covering breaks, the dry inner spore mass is dull reddish brown, resembling cocoa in color and texture.

PLATE 247. *Mucilago crustacea*

PLATE 248. *Physarum* sp.

Mucilago crustacea Wigg. (plate 247)

Fruiting bodies (aethalia) 1–7 cm long, 1–2 cm thick; white, creamy with flaky cover of white calcareous crystals; often surrounded by well-developed, thin, spongy to membranous white mat (hypothallus).

Spores 11–13 μm in diameter, round, 1-celled, densely warted, black; spore mass dark black mixed with very thin branched threads (capillitium).

On logs or bases of trees in woods, often on grasses in lawns or pastures, common on mulch; summer, fall.

Fuligo and *Mucilago* look quite similar and can be identified with certainty only when differences in the form of the lime deposits and the details of the capillitium are examined with a light microscope. They are the most conspicuous and thus the most frequently collected slime molds.

Physarum spp. (plate 248)

Fruiting bodies (sporangia) small, usually not more than 1 mm high, round to lobed; white or colored and may contain lime deposits; outer wall (peridium) quite thick and persistent or thin and fragile.

Stalks present or absent.

Spore mass dry, dark black to purple-brown when exposed; capillitium dotted at intervals with deposits of white lime knots, fine, threadlike, branched throughout, not easily seen.

Sporangial groups loosely scattered to closely clustered, with large numbers of individual sporangia (sometimes hundreds or thousands) developed concurrently over rotted logs or on dead leaves and ground litter; summer, fall.

Microscopic features must be considered in distinguishing *Physarum* from other dark-spored sporangiate genera and in identifying species. *P. viride* is stalked, with flattened sporangia; the wall is cracked to resemble a ginger-cookie pattern; it is common on well-rotted logs in wooded areas. *P. polycephalum* produces yellowish to gray, lobed and convoluted, stalked sporangia; it is not uncommon on rotted logs and adjacent litter. *P. polycephalum* is well known in biology laboratories in its vegetative stage, for the rapidly growing yellow plasmodium is easily cultured and maintained. Species of *Craterium*, *Didymium,* and *Badhamia* also are common in many of the habitats where *Physarum* species grow, all developing most frequently in the summer and fall.

PLATE 249. *Physarum cinereum*

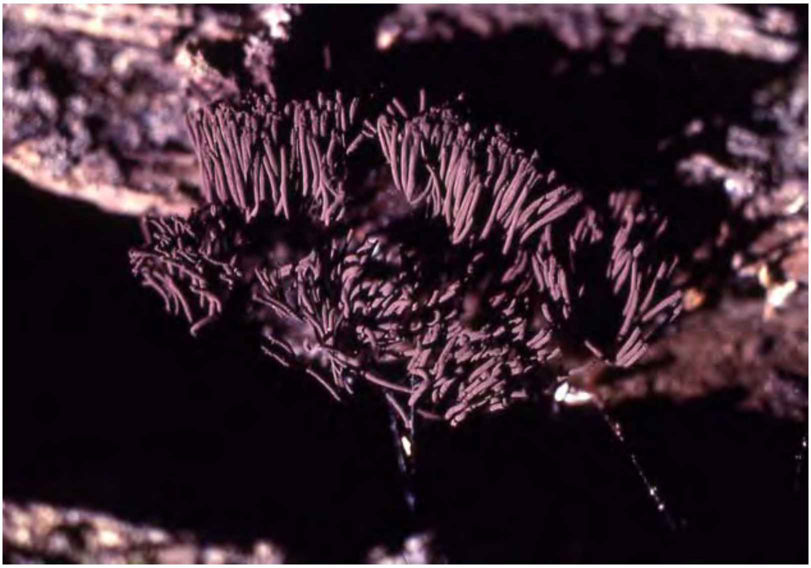


PLATE 250. *Stemonitis* sp.

Physarum cinereum (Batsch) Pers. (plate 249)

Sporangia sessile, lacking stalks, crowded, round or elongate, 0.3–0.5 mm broad, limy white or gray to drab; thin fragile outer covering breaks irregularly, exposing purplish brown powdery spore mass.

Spores violaceous, 7–12 μm diameter, with tiny warts on surface.

Extremely common, frequently on living plants and grass in lawns and also on dead leaves and litter on soil; summer, fall.

The vegetative stage (plasmodium) is scattered and inconspicuous in mulch, in grass litter in lawns, and on miscellaneous dead organic materials on the soil surface. It develops into sporangia after climbing into drier, lighted areas, such as living grass leaves in a lawn. The next lawnmowing or rain disperses the spores from the fragile sporangia.

Stemonitis spp. (plate 250)

Fruiting bodies long, cylindrical, closely clustered; groups often several cm across; purple-brown to black.

Sporangia slender, often curved; upper spore-filled portions dull purple-brown to black, above thin, shiny black stalks.

Stalks from a few mm to over 1 cm long, continuing into sporangium as central column with branched threadlike capillitium, surrounded by powdery dark spores; inner structure obvious as spores blow away or wash away in rain.

Common on downed logs in woods; summer, fall.

S. splendens is the most common species, with large clusters of long (2 cm or more), slender, dark purplish brown sporangia. *S. fusca* is shorter, with dark brown sporangia. Species cannot be identified with certainty without the use of microscopic information about the spores and capillitium.

PLATE 251. *Trichia* sp.

PLATE 252. *Tubifera* sp. (immature)

Trichia spp. (plate 251) and ***Hemitrichia*** spp.

Individual sporangia of species of *Trichia* and *Hemitrichia* usually 0.5–1 mm in diameter, roundish, often tightly grouped in clusters up to several centimeters across; golden yellow.

Stalk short or absent.

Somewhat shiny outer wall (peridium) breaking away irregularly, exposing bright yellow, powdery inner spore mass and capillitium, which are readily dispersed by wind and splashing rain.

Common on decayed logs; midsummer, fall.

Species of *Trichia* are more conspicuous because they are typically closely clustered and bright yellow. The common *Hemitrichia* species are equally yellow but are more often loosely scattered. The one common *Metatrichia* species forms clusters of sporangia. Identification to genus and species can be made only when microscopic details of the spores and capillitium are available.

Tubifera spp. (plate 252)

Sporangia often 0.5 mm in diameter, several mm in height, grouped in clusters up to 1 cm across; bright, clear red when young, maturing in a few hours to dull reddish brown.

Spores reddish brown, dry, quickly dispersed when thin outer cover (peridium) breaks.

Clusters of sporangia on well-rotted logs, a number of clusters often developing from the same plasmodium and occurring in same area; summer, fall.

This slime mold is much more conspicuous in the young sporangial stage (pl. 252) than at maturity, when the sporangia are dark brown.

Glossary

acrid: peppery or biting in taste.
adnate: broadly attached to the stalk (gills).
adnexed: reaching the stem, narrowly attached to it (gills).
aethalium (pl. aethalia): sessile fruiting body formed from plasmodium of myxomycetes.
allantoid: sausage-shaped, curved (spores).
amyloid: turning blue in the presence of iodine (as in Melzer's reagent).
anastomosing: joining crosswise to form angular areas.
annulus: ring of partial veil tissue left on the stalk of a mushroom.
apical: situated toward the upper part, such as the portion of stalk nearest the gills or cap.
apical pore: differentiated area in the spore wall through which the germ tube emerges.
apothecium (pl. apothecia): cup-shaped to saucer-shaped to saddle-shaped fruiting body of ascomycetes.
appendiculate: having fragments of veil hanging from the cap margin.
appressed: pressed close to or lying flat against.
ascus (pl. asci): saclike cell in ascomycetes in which ascospores are formed.

basidium (pl. basidia): hyphal cell in basidiomycetes on which the basidiospores are formed.
biseriate: arranged in two rows (as ascopores in an ascus).
bolete: stalked, fleshy fruiting body that has a cap with tubes on the lower surface.
boletinoid: having a cap undersurface with pore walls developed unevenly, appearing as radial rows from the stalk to the margin.
bracket: shelflike fruiting body produced by wood-rotting basidiomycetes.
brittle: rigid and breaking with a sharp snap; shattering (cap or stalk).
bulb: enlarged base of the mushroom stalk.

campanulate: bell-shaped (cap).
canal: tubular hollow space lined with asci and/or paraphyses in the gleba of truffles.
capillitium: mass of threadlike strands among the spores of some puffballs and slime molds.
cerebriform: brainlike.

chambers: enclosed spaces lined with basidia in basidiomycetous truffles.
chlamydospore: hyphal cell modified to be an asexual spore.
clavate: club-shaped.
complete mushroom: mushroom that develops with a universal veil and a partial veil.
conk: fruiting body of a wood-inhabiting fungus, especially a polypore.
context: mycelial tissue between the surface of the fruiting body and the spore-bearing area (gills or tubes) of basidiomycetes.
convex: rounded.
corrugated: wrinkled, usually with long, wavelike ridges.
cuticle: outer layer of a mushroom cap.
cystidium (pl. cystidia): sterile specialized cell occurring among the basidia in basidiomycetes.

decurrent: extending down the stalk (gills).
deliquescent: dissolving into a fluid, often inky, as in *Coprinus* (gills, etc.).
dextrinoid: staining yellow or reddish brown with Melzer's solution.
disc: central part of the mushroom cap.
discoid: flat and circular; disclike.
distant: well separated from one another (gills).
downed wood: nonliving wood on the ground.
duff: partly decayed organic matter on the forest floor.

eccentric: off-center (stalk attachment).
effuse: flat, of indeterminate size, and spread out over the substrate.
elliptical: rounded at both ends and with curved sides (spores).

family: group of genera related to one another, usually ending in -*aceae*.
fetid: stinking; smelling rotten.
fibril (adj. fibrillose): minute hair, usually scattered over the cap or stalk.
filiform: slender; threadlike.
fleshy: having soft, easily broken tissue (cap or stalk).
floccose: with cottony hairs.
fusiform: spindle-shaped (spores); tapered at both ends.

gall: outgrowth resulting from an attack by a fungus or other disease agent.
genus (pl. genera): group of related species or types of organisms; genus names are capitalized and generally italicized.
glabrous: smooth; lacking hairs or scales.
glandular dots: small, moist to viscid dots on stalks, especially of some boletes.

gleba: interior tissue of a young gasteromycete fruiting body from which the spores and capillitium develop; interior tissue of truffles and false truffles.
globose: spherical; nearly round.
glutinous: slimy; very sticky.
granulose: covered by granules.
gregarious: growing together in groups (fruiting bodies).
gristly: having a cartilaginous texture, tough and rubbery.

hyaline: colorless.
hygrophanous: having a watery appearance when wet and changing color when dry.
hygroscopic: capable of absorbing water readily, often swelling or changing shape.
hymenium: layer; in fungi refers to the layer in which the spore-producing cells (basidia or asci) are produced.
hypha (pl. hyphae): single thread or filament of the vegetative body of a fungus.

indusium: netlike structure hanging from the top of the stalk under the cap in some stinkhorns (*Dictyophora duplicata*).
infundibuliform: funnel-shaped.
inoperculate: opening in some way other than by an operculum (lid), as in the ascus of ascomycetes.

lamella (pl. lamellae): gill of a mushroom.
latex: milky juice found in some mushrooms.

margin: edge or outer portion of the cap.
mealy: having granular texture.
Melzer's reagent: solution widely used for amyloid test (blue reaction) of fungal cell walls or spores; 20 ml water, 1.5 gm potassium iodide, 0.5 gm iodine, and 20 gm chloral hydrate.
membranous: skinlike; thin and pliant.
micrometer (micron): one-thousandth of a millimeter; μm.
mushroom: fleshy fruiting body composed of the cap with gills.
mycelium (pl. mycelia; adj. mycelioid): collective network of hyphae (filaments) of the vegetative part of fungi.
mycology: study of fungi.
mycophagist: one who eats fungi.
mycophagy: eating of fungi; use of fungi for food by various animals.

mycorrhiza: symbiotic association of a fungus and the roots of a vascular plant.

obovoid: ovoid, with the broad end toward the apex.
ochraceous: pale brownish yellow.
olivaceous: olive-green.
operculate: with a lid (operculum) at the apex of the ascus.
order: group of related families, usually ending in –*ales*.
ovoid: egg-shaped.

paraphyses: sterile hyphae among spore-producing cells in a hymenium, usually among asci.
partial veil: tissue cover extending from the margin of a young, unexpanded mushroom cap to the stalk.
pedicel: small stalk.
peridiole: portion of the gleba surrounded by a separate wall in the bird's nest fungi.
peridium: outer wall of a fruiting body, particularly in truffles, gasteromycetes, and slime molds.
perithecium (pl. perithecia): flask-shaped fruiting body containing asci with ascospores.
pileus: cap or expanded portion at the apex of the stalk of fleshy fungi such as mushrooms.
plane: having a flattened mushroom cap, usually a mature cap.
plasmodium: multinucleate mass of membrane-bound protoplasm; growth phase in slime molds.
pliant: capable of bending without breaking (stalk).
polypore: group of the Asphyllophorales with tubes on the cap undersurface that end in pores.
poroid: having lamellae joined by cross-veins, to appear like pores.
pseudothecium (pl. pseudothecia): stroma with cavities containing asci with ascopores.
pustulate: covered with pustules or similar prominences.
pyriform: pear-shaped.

resupinate: flat on the substrate, lined with basidia facing outward (fruiting body).
reticulate: having a network of ridges.
reticulum: lines, veins, or ridges that intersect to form a network.
rhizomorph: cordlike or rootlike aggregation of fungal mycelium.
rimose: cracked by fissures.
ring: remains of the partial veil attached to the stalk (annulus).

saprobe: organism that gets its nutrition from dead organic matter.
scabers: dark tufts of hairs, especially on the stalk of *Leccinum* in the boletes.
scale: piece of tissue resembling a shingle on the cap or stalk.
sclerotium (pl. sclerotia): hard, dark mass of fungal tissue that separates from site of origin, usually a survival structure.
septum (adj. septate): cross-wall in a fungal hypha or spore.
serrate: toothed; notched like a saw.
sessile: with no stalk.
setae: pointed, thick-walled sterile cells.
sinuate: notched at the stalk (gills).
spathulate: spoon-shaped or tonguelike.
species: one sort of organism; second part of a binomial epithet; species names are lowercase and generally italicized.
sporangium (pl. sporangia): saclike cell within which spores are formed.
spore: single or multicelled reproductive structure of a fungus.
squamule: small scale of indefinite shape.
sterigma (pl. sterigmata): projection from the basidium on which a basidiospore is formed.
stipe (adj. stipitate): stalk supporting the cap of the mushroom; stemlike structure.
stipitate: with a stalk or stemlike structure.
striate: marked with minute lines or furrows.
stroma (pl. stromata): mass of hyphae on or within which fruiting structures are formed.
subdecurrent: extending a short way down the stalk (gills); between adnexed and decurrent.
subdistant: fairly well separated but less than distant (gills).
subfusiform: somewhat tapered but not spindle-shaped.
subglobose: nearly rounded.
superior: located near the top of the stalk (annulus).

tomentose: densely covered by hairy or woolly growth.
truncate: ending abruptly (spores with blunt ends).
tuberculate: covered with warty or knoblike projections.
turbinate: top-shaped.

umbonate: having a knob or raised swelling in the center of the cap.
uniseriate: arranged in a single row (as ascospores in an ascus).
universal veil: layer of tissue completely surrounding a young fruiting body, such as a young mushroom, or young stinkhorn.

verrucose: having small, wartlike projections; rough.
vinaceous: dark wine-red in color.
violaceous: violet in hue.
viscid: sticky to the touch; not deeply slimy.
volva: universal veil portion surrounding the base of the stalk or fragmenting to patches of remnant tissue around the bulb of a mushroom or a stinkhorn.

zonate: having concentric zones or bands of color.

General References

Alexopoulos, C. J., C. W. Mims, and M. Blackwell. 1996. *Introductory Mycology*. 4th ed. New York: John Wiley and Sons. Longtime standard textbook for mycology courses.

Ammirati, J. F., J. A. Traquair, and P. A. Horgan. 1985. *Poisonous Mushrooms of the Northern United States and Canada*. Minneapolis: University of Minnesota Press.

Arora, D. 1986. *Mushrooms Demystified.* 2nd ed. Berkeley: Ten Speed Press. Guide oriented to the western United States, with miscellaneous interesting information.

Barron, G. 1999. *Mushrooms of Northeast North America*: *Midwest to New England*. Renton: Lone Pine Publishing. Well-illustrated field guide.

Bessette, A., and W. J. Sundberg. 1987. *Mushrooms: A Quick Reference Guide to Mushrooms of North America*. New York: Macmillan Publishing Company. Well-illustrated source of general information.

Bessette, A. E., A. R. Bessette, and D. W. Fischer. 1997. *Mushrooms of Northeastern North America.* Syracuse: Syracuse University Press. Well-illustrated and comprehensive guide, including field keys.

Bessette, A. E., W. C. Roody, and A. R. Bessette. 2000. *North American Boletes*. Syracuse: Syracuse University Press.

Bessette, A. R., and A. E. Bessette. 2001. *The Rainbow beneath My Feet*. Syracuse: Syracuse University Press. Resource for using mushrooms in dyeing.

Bessette, A. E., O. K. Miller, A. R. Bessette, and H. H. Miller. 1995. *Mushrooms of North America in Color.* Syracuse: Syracuse University Press. Guide covering mushrooms not included in many regional books.

Czarnecki, J. 1997. *Joe's Book of Mushroom Cookery*. New York: Atheneum Press. Well-known mushroom cooking guide.

Farr, M. A. 1981. *How to Know the True Slime Molds*. Dubuque, Ia.: Wm. C. Brown Company. Very useful treatment of the myxomycetes.

Freedman, L., and W. Freedman. 1987. *Wild about Mushrooms: The Cookbook of the Mycological Society of San Francisco.* Berkeley: Aris Books. Well-established mycophagy book.

Horn, B., R. Kay, and D. Abel. 1993. *A Guide to Kansas Mushrooms*. Lawrence: University Press of Kansas. Good regional reference.

Kauffmann, C. H. 1971. *The Gilled Mushrooms (Agaricaceae) of Michigan and the Great Lakes Region*. (Reprint of 1918 ed.) New York: Dover Publications. Standard field guide for many years but now dated. Vol. 1 is text; vol. 2 is black-and-white illustrations, of limited usefulness.

Kendrick, Bryce. 2000. *The Fifth Kingdom*. 3rd ed. Newburyport, Mass.: Focus Publishing Company. Excellent treatment of the fungi (a CD-ROM with the same title is also available).

Kirk, P. M., P. F. Cannon, J. C. David, and J. A. Staplers. 2001. *Dictionary of the Fungi*. 9th ed. Wallingford, UK: CAB International. Professional reference, with fungal taxonomy updated to 2001.

Largent, D. I. 1977. *How to Identify Mushrooms to Genus: I. Macroscopic Features*. Eureka, Calif.: Mad River Press. Useful guide to field identification of mushrooms. The other Largent et al. references are also useful.

———, and T. J. Baroni. 1988. *How to Identify Mushrooms to Genus: VI. Modern Genera*. Eureka, Calif.: Mad River Press.

———, and H. D. Thiers. 1977. *How to Identify Mushrooms to Genus: II. Field Identification of Genera*. Eureka, Calif.: Mad River Press.

Miller, H. 1993. *Hope's Mushroom Cookbook*. Eureka, Calif.: Mad River Press. Well-organized mycophagy book, easy to use.

Miller, O. K., Jr., and H. H. Miller. 2006. *North American Mushrooms*. Falcon Guides. Guilford, Conn.: Globe Pequot Press. Updated edition of an old favorite: the first of the well-illustrated field-oriented mushroom books.

Phillips, R. 1991. *Mushrooms of North America*. Boston: Little, Brown and Company. Guide with studio photographs but no keys (out of print, but the website www.rogersmushrooms.com has keys, images, and descriptions).

Ramsbottom, J. 1989 *Mushrooms and Toadstools: A Study of the Activities of Fungi*. (Reprint of 1953 ed.) Collins New Naturalist Series. London: Bloomsbury Books. Interesting book on the fungi.

Roody, W. C. 2003. *Mushrooms of West Virginia and the Central Appalachians*. Lexington: University Press of Kentucky. Guide to fungi grouped by macrocharacters and substrate, with excellent illustrations.

Smith, A. H., H. V. Smith, and N. S. Weber. 1979. *How to Know the Gilled Mushrooms*. Dubuque, Ia.: Wm. C. Brown Company. Guide with useful keys and line drawings.

———. 1983. *How to Know the Non-gilled Mushrooms*. 2nd ed. Dubuque, Ia.: Wm. C. Brown Company. Guide with useful keys and line drawings.

Stuntz, D. E. 1977. *How to Identify Mushrooms to Genus: IV. Keys to Families and Genera*. Eureka: Mad River Press. Useful addition to the Largent et al. references, with keys.

Technical References

Agaricales

Antonin, V., R. E. Halling, and M. E. Noordeloos. 1997. Generic concepts within the groups of *Marasmius* and *Collybia sensu lato*. *Mycotaxon* 63: 359–368.

Banerjee, P., and W. J. Sundberg. 1995. The genus *Pluteus* (Pluteaceae, Agaricales) in the Midwestern United States. *Mycotaxon* 53: 189–246.

Bigelow, H. E. 1982. North American species of *Clitocybe*: Part I. *Nova Hedw. Beih.* 72: 1–280.

———. 1985. North American species of *Clitocybe*: Part II. *Nova Hedw. Beih.* 81: 281–471.

Coker, W. C., and A. H. Beers. 1974. *The Boleti of North Carolina*. (Reprint of 1943 ed.) New York: Dover Publications.

Gilliam, M. S. 1976. The genus *Marasmius* in the northeastern United States and adjacent Canada. *Mycotaxon* 4: 1–144.

Halling, R. E. 1983. The genus *Collybia* (Agaricales) in the northeastern United States and adjacent Canada. *Mycol. Mem.* 8: 1–148.

Hesler, L. R., and A. H. Smith. 1963. *North American Species of Hygrophorus*. Knoxville: University of Tennessee Press.

———. 1965. *North American Species of Crepidotus*. Darien, Conn.: Hafner.

———. 1979. *The North American Species of Lactarius*. Ann Arbor: University of Michigan Press.

Jenkins, D. T. 1986. *Amanita of North America*. Eureka, Calif.: Mad River Press.

Redhead, S. A., R. Vilgalys, J. M. Moncalvo, J. Johnson, and J. S. Hopple, Jr. 2001. *Coprinus* Pers. and the disposition of *Coprinus* species *sensu lato*. *Taxon* 50: 203–241.

Shaffer, R. L. 1957. *Volvariella* in North America. *Mycologia* 49: 545–579.

Smith, A. H. 1947. *North America Species of "Mycena."* Ann Arbor: University of Michigan Press.

———. 1972. *The North American Species of "Psathyrella."* Memoirs 24. New York: New York Botanical Garden.

Smith, A. H., and L. R. Hesler. 1968. *The North American Species of "Pholiota."* Monticello, N.Y.: Hafner.

Smith, A. H., and R. Singer. 1964. *A Monograph on the Genus "Galerina Earle."* New York: Hafner Publishing Company.

Smith, A. H., and Harry D. Thiers. 1971. *The Boletes of Michigan*. Ann Arbor: University of Michigan Press.

Snell, W. H., and E. A. Dick. 1970. *The Boleti of Northeastern North America*. Lehre, Germany: J. Cramer. Outdated but useful guide.

Volk, T. J., and H. H. Burdsall, Jr. 1993. The state of taxonomy of the genus *Armillaria*. *McIlvainea* 11: 4–11.

Aphyllophorales

Bigelow, H. E. 1978. The cantharelloid fungi of New England and adjacent areas. *Mycologia* 70: 707–756.

Coker, W. C., and A. H. Beers. 1970. *The Stipitate Hydnums of the Eastern United States*. (Reprint of 1951 ed.) Bibliotheca Mycologica 27. New York: J. Cramer.

Coker, W. C., and J. N. Couch. 1974. *The Club and Coral Mushrooms ("Clavarias") of the United States and Canada*. (Reprint of 1923 ed.) New York: Dover Publications.

Cooke, W. B. 1961. The genus *Schizophyllum*. *Mycologia* 53: 575–599.

Dodd, J. L. 1972. The genus *Clavicorona*. *Mycologia* 64: 737–773.

Gilbertson, R. L., and L. Ryvarden. 1986. *North American Polypores. Vol. 1: "Abortiporus"–"Lindtneria*." Oslo, Norway: Fungiflora. The most recent comprehensive treatment of the polypores, including U.S. dot maps for each species.

———. 1987. *North American Polypores. Vol. 2: "Megasporoporia"–"Wrightoporia*." Oslo, Norway: Fungiflora. See comment for Gilbertson and Ryvarden 1986.

Harrison, K. A. 1961. *The Stipitate Hydnums of Nova Scotia*. Publication 1099. Ottawa, Canada: Department of Agriculture.

———. 1973. The genus *Hericium* in North America. *Mich. Bot*. 12: 177–194.

Overholts, L. O. 1953. *The Polyporaceae of the United States, Alaska, and Canada*. Ann Arbor: University of Michigan Press. Out-of-print but still very useful guide.

Peterson, R. H. 1974. Contribution toward a monograph of *Ramaria* I: Some classic species redescribed. *Am. J. Bot*. 61(7): 739–748.

Gasteromycetes

Brodie, H. J. 1975. *The Bird's Nest Fungi*. Toronto, Ontario: University of Toronto Press. Guide with both technical information and trivia.

Coker, W. C., and J. N. Couch. 1974. *The Gasteromycetes of the Eastern United States and Canada*. (Reprint of 1928 ed.) New York: Dover Publications.

Guzmán, G. 1970. Monografía del género *Scleroderma* Pers. emend Fr. *Darwiniana* 16: 233–407.

Kambly, P. E., and R. E. Lee. 1936. The gasteromycetes of Iowa. *University of Iowa Studies* 17: 121–185.

Miller, O. K., Jr., and H. H. Miller. 1988. *Gasteromycetes: Morphological and Developmental Features with Keys to the Orders, Families and Genera*. Eureka, Calif.: Mad River Press. Guide with generic descriptions and line drawings.

Jelly Fungi

Lowy, B. 1971. *Tremellales*. Flora Neotropica Monograph 6. New York: Hafner Publishing Company.

Martin, G. W. 1952. Revision of the North Central Tremellales. *State University of Iowa Studies in Natural History* 19(3): 1–122. Outdated guide, difficult to use.

Ascomycetes

Dennis, R. W. G. 1981. *British Ascomycetes*. Revised ed. Vaduz, Germany: J. Cramer. Comprehensive treatment of Ascomycetes; out of print.

Seaver, F. J. 1942. *The North American Cup-fungi (Operculates)*. New York: author. Useful guide, but out of date.

———. 1951. *The North American Cup-fungi (Inoperculates)*. New York: author. Useful guide, but out of date.

Truffles

Castellano, M. A. 1988. The Taxonomy of the Genus *Hysterangium* (Basidiomycotina, Hysterangiaceae) with Notes on Its Ecology. Dissertation. Corvallis: Oregon State University.

Castellano, M. A., J. M. Trappe, Z. Maser, and C. Maser. 1989. *Key to Spores of the Genera of Hypogeous Fungi of North Temperate Forests with Special Reference to Animal Mycophagy*. Eureka, Calif.: Mad River Press.

Gilkey, H. M. 1939. *Tuberales of North America*. Oregon State Monographs No. 1. Corvallis: Oregon State University.

Montecchi, A. and M. Sarasini. 2000. *Fungi Ipogei d'Europa*. Vicenza, Italy: Fundazione Centro Studi Micologici dell Associazione Micologica Bresadola. Well-illustrated guide (text in Italian and English).

Pegler, D. N., B. M. Spooner, and T. W. K. Young. 1993. *British Truffles: A Revision of British Hypogeous Fungi*. Kew, UK: Royal Botanic Gardens.

Smith, A. H., and S. M. Zeller. A preliminary account of the North American species of *Rhizopogon*. *Memoirs of the New York Botanic Garden* 14: 1–178.

Trappe, J. M. 1979. The orders, families, and genera of hypogeous Ascomycotina (truffles and their relatives). *Mycotaxon* 9: 297–340.

Trappe, J. M., A. M. Jumponen, and E. Cazares. 1996. NATS truffle and truffle-like fungi 5: *Tuber lyonii* (= *T. texense*), with a key to the spiny-spored *Tuber* species groups. *Mycotaxon* 60: 365–372.

Zeller, S. M., and C. W. Dodge. 1936. *Melanogaster. Annals of the Missouri Botanical Garden* 23: 639–655.

Myxomycetes

Farr, M. A. 1981. *How to Know the True Slime Molds*. Dubuque, Ia.: Wm. C. Brown Company. Guide with line drawings.

Martin, G. W., and C. J. Alexopoulos. 1969. *The Myxomycetes*. Iowa City: University of Iowa Press. Comprehensive guide with keys and watercolor illustrations.

Stephenson, L., and H. Stempeh. 1994. *Myxomycetes: A Handbook of Slime Molds*. Portland, Ore.: Timber Press. Good general reference on slime molds.

Index

Numbers in bold indicate an illustration.