A FALCON GUIDE®

BASIC ILLUSTRATED

Edible and Medicinal Mushrooms

JIM MEUNINCK

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FALCON GUIDES

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FALCONGUIDES®

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Contents

Introduction

Here is a valuable field guide for foragers, homemakers, health practitioners, nutritionists, and chefs. The author is a plant guy, biologist, and counselor, who for many years suffered from "Anglomycoparanoia"—a profound fear of fungi. Then, in 2006, he discovered the cure, took up the challenge, and hit the books, searched the web, tramped fields and forests, and one by one added edible and medicinal mushrooms to his diet. This satisfying intellectual odyssey tugged him across the continent, deep into forests and high into mountains, searching for what appeared to be an endless supply of foodstuffs with health-protecting chemistry. Consider the numbers: A million plus species of fungi inhabit the earth with only one-quarter identified—of that staggering number, 30 species are widely accepted as food. With so few found and so few used, the good news overwhelms. Mushrooms are therapeutic and nutritious. They are rich in minerals, low in fat, high in protein, and low in calories. They help prevent disease and are anti-inflammatory. Many mushrooms have antibiotic chemistry and stimulate the immune system. As food, they facilitate wound healing and may provide protection from cancer. One Japanese epidemiological survey over a period of 14 years revealed that cancer rates among workers at research mushroom farms in Japan were 1 in 1,000 compared to 1 in 600 for the general population. A preponderance of evidence documented in this field guide suggests that adding mushrooms to a broad-based, holistic diet provides nutritional benefits with a health-protecting boost. Given all this, let's open our minds and present to our palates these creatures that make life possible. Read and discover what I, a converted mycophile, have learned from the journey—a mushroom odyssey with no end in sight.

The Third Kingdom

Ten minutes into my first mycology class, the instructor said, "Mushrooms are primarily toilets for the larger creature residing below." He also said, "They are *all* edible, but many are poisonous." Funny guy! Perhaps all mycologists tilt their humor precariously. I prefer calling mushrooms "fruiting bodies"—the integral reproductive organs of a fungus. They produce and disperse spores, thereby guaranteeing the success of the species. Mushroom mycelium and incorporated hyphae perform the essential task of decomposing organic matter into its elemental forms, enriching the earth and clearing away insufferable debris.

Fungi play other roles, too. They are parasites attacking and killing target plants and animals. Numerous mushrooms are mycorrhizal, living in a symbiotic and mutually beneficial relationship with an organism, specifically plant roots. They provide nitrogen, phosphorus, and increased moisture to the plant or tree, and the roots provide life-supporting carbon to the fungus. Knowing these associations and relationships will help you find mushrooms.

Two groups of saprophytic (plant-decaying) mushrooms, called brown rot and white rot fungi, have the ability to digest lignin (brown rot) or cellulose (white rot), the two primary components of wood. Brown rot fungi (70 percent of which are polypores such as agarikon and the artist's conk) release enzymes that digest whitish cellulose and leave behind brownish lignin. The more numerous white rot fungi—the oyster mushroom, for example—digest lignin and leave behind cellulose. With their ability to digest and concentrate complex compounds, mushrooms are used to clean toxic-waste sites, restoring them to uncontaminated, safe areas. For more on mycoremediation and mycorestoration see Paul Stamets's seminal book *Mycelium Running: How Mushrooms Can Help Save the World*.

So mushrooms are fruiting bodies; a few are edible, and others are poisonous. They are integral to a healthy ecosystem and essential to life. They provide health-protecting chemistry. And hundreds of thousands are undiscovered, their miracles unknown.

How To Use This Guide

It is the goal of *Basic Illustrated Edible and Medicinal Mushrooms* to help you add new fungal food choices to your diet with a slant toward "food is your medicine." Layout and organization make this field guide an effective tool. Both the common names and the preferred binomial genus and species names are used. This guide breaks down each entry by **Common name(s), Family** name, **Binomial** name, and **Origin** etymology, **Identification, Habitat** (including months available), **Edibility, Traditional uses, Research** uses (with scientific support), and **Storage** tips—all this and the author's **Notes**. In addition, there are preparation tips designed to capture both the flavor and benefits from the mushroom and a photo index of poisonous and poisonous look-alikes. Plus in the appendices, there is **Health Prep**, including directions and resources for extracting the benefits from the mushrooms you find. A **Grow Your Own** section combines the basics with excellent resources for mushroom farming.

Seven Strategies for Mushroom Identification

To identify a mushroom follow this advice: (1) Use several **field guides** (the more the better) to cross-reference each find, (2) discover and understand basic **mushroom structure**, the parts and elements that make a fungus a mushroom, (3) develop **field experience**, or the ability to recognize mushrooms and their habitats, (4) discover their **prey and partners**, the biomes, trees, plants, and animals that mushrooms companion with, parasitize, or decompose, (5) make a **spore print** and know how to read it, which may require a microscope, and (6) use **chemical tests** when necessary to help identify the mushroom. And (7) **forage familiar ground**.

- **Field guides.** I have 12 field guides and typically cross-reference a new mushroom in as many of them as time and endurance allows—four is a minimum.
- **Mushroom structure.** A mushroom may have a cap (pileus), a stem (stipe), ring (annulus), and a veil, or they may not. Knowing the structure of a specific mushroom is useful in identification. Spores are reproductive bodies and come in various sizes, colors, and shapes. Spore producing and disseminating organs are the gills (lamella), teeth, pores, and, in puffballs, the entire inner area of the mushroom. The mushroom may have scales, hair, warts, and striations—or it may

be smooth. Many mushrooms have a volva (an egg-like sack) from which they emerge. They may have rings and remnants of a veil that covered the gills. In addition, mushroom structures come in numerous colors. A few mushrooms present juices or may bruise into different colors when handled. They are dry and smooth, or moist and slippery, and a few have spots. Different species may be hard, fragile, flexible, or brittle. They have distinctive odors and distinctive flavors.

- **Field experience.** Travel by foot and observe the characteristics of the many different mushroom environments. Do this often. Discover where the remaining old-growth forests are in your area and visit them. Understand that both hardwoods and conifers in newly planted forests (say, after a forest fire) provide super resources for newly developing saprophytic mushrooms. Frequent visits to a variety of forest and field biomes will, over the four seasons, reward you with the right places to go.
- **Prey and partners.** As you will discover, mushrooms, animals, and plants live in close relationship with each. Find oyster mushrooms on beech and ash and less commonly on maple. Locate morels in association with old apple orchards or fallen elms but not beech. Seek them in recently burned-out pine forests. Honey mushrooms parasitize beech, maple, and oak. If you find aborted entalomas, honey mushrooms are not far away. Knowing these relationships and others will often reward you.
- **Spore prints.** Use spores as an identification tool: Separate the cap of a mushroom from its stem, place it over the intersection of two pieces of paper (or another two-dimensional surface), one piece white and the other black. Clear glass is a particularly effective material, with the glass over the intersection of white and black paper. A spore print on glass allows you to scrape spores onto a microscope slide without contamination. It also allows you to scrape large numbers of spores for inoculation when growing your own mushrooms (see Appendix C). After a few minutes or several hours, spores

Bolete spore print

Print of poisonous False Parasol

Spore print from an Elm Cap

drop from the mushrooms gills, pores, or teeth, leaving a spore print. The color of this print helps identify the mushroom.

- **Chemical tests and microscopy.** These provide the most definitive identification of spores, but they require a basic knowledge of chemistry, safe handling, and access. Chemicals used include ammonia (NH_4OH, ammonia hydroxide), potassium hydroxide (KOH), iron salts ($FeSO_4$), and concentrated hydrochloric acid (HCl) and Melzer's reagent (iodine, methyl chloride, and potassium iodide). For the mushrooms identified in this book, these tests are not absolutely necessary; however, should you go beyond the basics, familiarize yourself with chemical testing.
- Here is a primer on using **Melzer's reagent**: Carefully scrape spores from a spore print with a razor blade, preferably from a spore print on glass. Tap spore dust from the razor blade onto a microscope slide and examine spore color, size, shape, and special features under magnification (plus or minus 400X). When identifying a bolete or gilled mushroom, express a drop of Melzer's reagent onto the spores, slip over a slide cover slip, and examine whether the spores change color (the reagent's reaction to starch). This change is visible under the microscope, and may be to the naked eye. If spores turn bluish black, they are amyloid; if change is reddish brown, they are dextrinoid; and if no noticeable change then they are inamyloid. Match these color changes to what is expressed in the field guide you are using. These color changes help identify the mushroom. Potassium hydroxide (KOH) is used to identify spores from morels, cup fungi, and boletes. For a more complete description of microscopic spore study and where to purchase reagents visit the following websites:

Using potassium hydroxide: mushroomexpert.com/microscope_ascos.html.
Using Melger's reagent: mushroomexpert.com/microscope_spores.html
Microscope and reagent use: first-nature.com/fungi/facts/microscopy.php; centralpamushroomclub.org/sites/default/files/melzer.pdf; en.wikipedia.org/wiki/Melzer's reagent
The **Mushroom Farm** sells a basic mushroom chemical testing kit: mushroomfarm.com/mushroom-hunting/hunting-accessories/identification-reaction-kit.html.

- **Forage familiar ground.** As you expand your knowledge, you will discover forests and fields that provide what you are looking for, when you are looking for it, and often reward you with a new find. Note these places in your mushroom notebook. Cherish and visit them often. These secret sanctuaries provide all the clues and context needed to be successful. Old-growth forests are most productive. After a few trips, you will have a mental map and cognitive timetable that will lead you to a specific site at the right time of year to find exactly what you want.

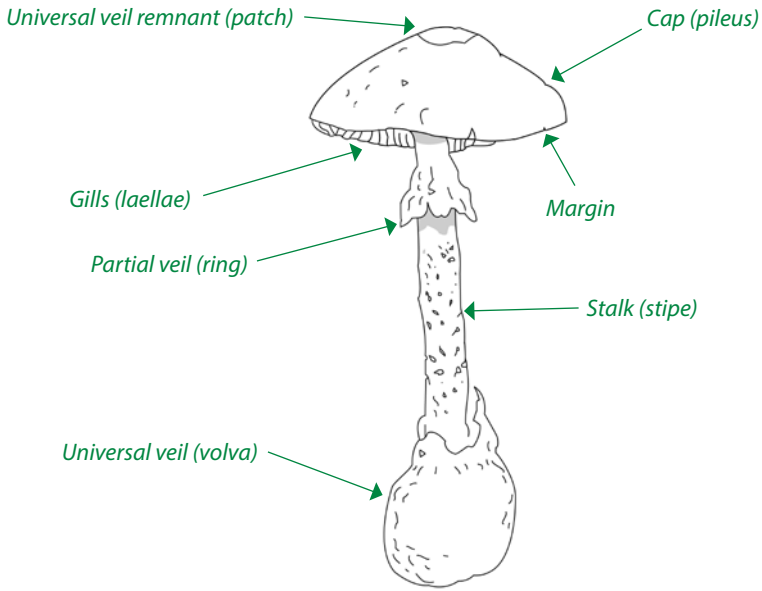
Identity Crisis

The binomial genus-species name of a mushroom may have one or more synonyms. For example, a mushroom described in this book, agarikon, has at least five synonyms for genus-species: *Fomitopsis officinalis, Polyporus officinalis, Boletus officinalis, Laricifomes officinalis,* and *Agaricum officinalis*. Add to that a confusion of common names—agarikon, quinine conk, white agaric—and it is likely that two foragers holding the same mushroom may name it differently. Further exacerbating the problem, mycologist and molecular biologists have new tools to accurately classify fungi. Therefore, more synonyms are popping up. The preferred binomial names used in this book, the genus-species names, are the most accurate I could find at the time of this writing. See Appendix D for the 12 field guides I use for checking and cross-checking a mushroom's identification.

Organizing the Fungisphere

This field guide organizes mushrooms from simple and familiar to more difficult and exotic. Most foragers are familiar with morels and puffballs, either from their own foraging or as food gifts from friends, so they are listed first. There are a few pitfalls when searching for these mushrooms, and I will help you over them. Next up are the pored and toothed mushrooms that produce and disperse spores from pores, spines, or teeth; many are relatively easy to identify and rewarding culinary finds. Pores and teeth give way to an intermediate group—the chanterelles, mushrooms possessing the precursor of gills in the form of folded flesh, gill-like, but not gills. Here are some of the best-tasting fungi available on the planet. Not to be upstaged are the gilled mushrooms. This vast group with so many look-alikes requires rigorous identification and cautious respect. They are potentially the most dangerous mushrooms and some of the most beneficial. The final two chapters cover commercially available medicinal mushrooms and poisonous mushrooms. Along the way, I will share information for growing your own mushrooms, including informative websites and recipe resources that will delight your family and friends. So let's get started.

Parts of the Mushroom



Chapter One

Morels and Inedible False Morels

Most who forage away from the supermarket know something about morel mushrooms. They are found throughout the United States, Mexico, Canada, and as far north as the Arctic Circle. Find them in March in southern Missouri, April in Michigan, and May in Minnesota. They also reside at high elevation; I found them at 7,200 feet on July 7 in the Absaroka-Beartooth Wilderness, Montana. Morels, ascomycetes, are spore shooters rather than the spore dropping basidiomycetes. They are mycorrhizal partners with trees that include conifers, poplars, old apple trees, honeysuckle, elm, and ash. Look for them along trails and in campgrounds or try the edges of old limestone quarries. Foragers in eastern states start their search when apple trees bloom and lilacs flush. In the mountainous West, the season starts later; measure your start by latitude and altitude.

Rule of thumb: Black morels have dark ridges and lighter pits; yellow morels have lighter ridges and darker pits.

Morels, 2

MORELS

Morchellaceae (*Morchella esculenta* (L.); Pers. & *Morchella elata* Fr.)

Yellow morels with lighter edges and darker pits

Origin: Medieval French for "dark colored" or "brown"; Latin derivative meaning "dark colored" or "brown."

Identification: *Black morels* have a brain-like outer appearance—ridged and pitted—with pits arranged in columns. They are hollow in the middle and take the form of a jester-shaped cap that tapers. Mushroom ranges from 2"–6" in height.

Yellow morels typically start out gray and mature to yellow. Larger than black morels and with a full body of pits and ridges of different shapes and sizes, yellows appear a week or two later than blacks. They can exceed 10" in height, but are typically in the 3"–6" size.

Habitat: Gray (yellow when mature) and black morels often are found about halfway down a slope in the woods, where spores have been washed and collected, usually in a tangle of brush. Dead ash, elm, apple, poplar, pines, and tulip poplars are good places to look. West of the prairie, find morels in burnouts, along the side of trails, and along the edges of campgrounds. In general, morels love rich soils with a lot of humus and rotting fallen trees and stumps. These are mushrooms of the spring, the timing of which varies by latitude and altitude.

Half-free morel cap, considered edible but has toxic look-alikes. Recent information also suggests this mushroom has made people ill.

Edibility: They are delicious in all dishes where mushrooms improve taste: omelets, frittatas, pizza, pasta, burgers, veggie burgers (sauté with wild stinging nettle, asparagus, and red bell pepper). Sauté the first bunch of the season in a pinch of butter and olive oil and serve on sourdough toast points. Delicious with eggs, beef, venison, cheese, and duck. ***Caution:*** To denature gastrointestinal irritants, ***always cook morels***.

Traditional uses: In southern Poland this mushroom is linked with the devil or the devil's work. The "early morel," *Verpa bohemica*, a false morel found in Poland, can make you sick. Could it be

V. bohemica is the victim of the devil and not *Morchella esculenta*? German folklore espouses that the devil condemned a wrinkled old woman to the existence of the mushroom. To this day, it is an insidious insult to call a German woman a "morel." In China, morels are considered an immune-modulating food, toning the stomach and intestines and opening channels regulating energy throughout the body—good for reducing phlegm and indigestion.

Black and yellow morels in Pike Place Market, WA

Research: An aqueous-ethanol extract from mycelium of *Morchella esculenta* showed both antitumor and anti-inflammatory action in a mouse model. Morel extract produced a significant dose dependent inhibition of both acute and chronic inflammation. The extract also exhibited antitumor activity against solid tumors and tumor ascites fluids (Nitha, Meera, and Janardhanan 2007). At just 3 micrograms per milliliter, morel polysaccharides stimulate immune-system response initiated in the mucosal immune system interface (Duncan et al. 2002; Lull, Wichers, and Savelkoul 2005). Ethanol extract of morels inhibits chronic and acute inflammation and prevented the growth of solid cancer tumors (Nitha, Meera, and Janardhanan 2007). The polysaccharide fraction appears to stimulate the immune system, providing enhanced immune protection.

After morel consumption, 146 patients presented gastrointestinal syndrome and 129 presented neurologic syndrome. Gastrointestinal and other neurological symptoms were also present (ocular/vision disorders, paresthesia, drowsiness/confusion, and muscle disorders). These patients frequently ingested a large quantity of morels. Confusion with *Gyromitra esculenta* (false morels) was ruled out (Saviuc, 2010).

Storage: Brush morels clean, cook in dishes, and freeze, or dry and store in canning jars. Try pickling them. Freeze fresh and whole for up to month.

Notes: To derive the health benefits from morels, eat them. Morels prefer a little sunlight, such as along fence lines and trail sides on the west or north side, in areas without high winds. In a lowland marsh near me, the water and elevation keeps things cooler for longer into the, spring; there the morels come a week or so later. I have seen morels picked in burnouts at various elevations in the West; the higher you go, the later in the season you will find them—July 7 at 7,000 feet in the Montana Absaroka-Beartooth Wilderness above Pine Creek campground. In Germany, starting fires to stimulate morel growth is a crime with severe penalties.

False Morels—INEDIBLE

Discinaceae (*Gyromitra* species) and Morchellaceae (*Verpa* species)

CAUTION—NOT EDIBLE: False morels, *Gyromitra* species, and *Verpa* species are included here as a potentially toxic look-alike. Avoid this mushroom. False morels look similar to edible morels but with grotesque folds, as if nuked with radiation. Certain *Verpa* species can be confused with the edible free cap morel (see photo page 2). Like *Gyromitra*, *Verpas* do not present the open hollow body of edible morels.

Origin: Gyrus, Latin means a convoluted fold of the brain

Habitat: Found in the same places as edible morels at the same time and even earlier.

Notes: *Gyromitra* are sometimes confused with morels. These odd-shaped mushrooms are toxic to various degrees even though a few foragers scoff, "I eat them. Ya just gotta cook the hell out of them." But then my ol' professor said, "You don't have to be smart to forage for mushrooms." So avoid *Gyromitra* and *Verpa* species (*Verpa* caps, unlike half-free caps, are totally free). Enjoy and celebrate their exotic appearance, but taste not. *Gyromitra* caps are weird—wavy, lobed, pitted, ridged, saddle shaped, and convoluted. Cap color varies from reddish and reddish brown to very dark brown and occasionally yellowish brown. Whereas morels are completely hollow, *Gyromitra* are not—they have pockets but are not completely hollow. Found across North America in the spring (account for altitude and latitude) growing singly, scattered under hardwoods and conifers. If only I had a morel for every *Gyromitra* I have found.

Gyromitra—*toxic*

Chapter Two

Puffballs

Puffballs are saprobes that begin to appear in the summer and continue showing through the fall of the year. They are round, oval, or pear shaped, and found across the continent in hardwood and coniferous forests, lawns, gardens, and parks. The large ones are easy to spot, but I find the smaller ones tastier. Instead of producing spores from gills, pores, or teeth, the entire inside matrix of the puffball manufactures spores—in the larger species, billions of spores. And with all that, their success continues. CAUTION: Be certain to read the sidebar on puffball look-alikes, page 8.

Puffballs, 6

PUFFBALLS

Lycoperdaceae (*Calvatia gigantea* (Batsch ex Pers.) Lloyd) (*Morganella pyriformis* (Schaeff.) Kreisel & D. Kruger)

Origin: *Calvatia*, Latin meaning "bald."

Identification: Puffballs range from small to large (1"–12" in diameter), whitish to brown (but not green, red, orange, or pink), oval to round or pear shaped, and are edible when fresh. Larger ones are easy to identify. Many grow on top of the ground without a distinctive stem. Puffballs produce spores in a stomach-like spherical fruiting body called a gasterothecium. In time, the puffball either develops a vent, or it dries and splits, releasing the spores.

Habitat: Find puffballs of various species from coast to coast and on open ground under trees and shrubs—often in lawns and parks. In southeastern Michigan, we start seeing *Calvatia gigantea* (up to 5' in diameter and weighing 40 pounds) in late September. Our favorite little brown puffball, *M. pyriformis*, found on dead maple and beech, appears at the same time. It is a choice edible when young and the inner flesh is white. Find the large western variety, *C. booniana*, on open ground under trees and shrubs, and often in lawns. Find *Lycoperdon perlatum* along forest roadsides and driveways under pines from summer through fall. Puffballs reside in the same area year after year and on the same tree until it is decomposed. *M. pyriformis* dines on beech trees among others.

Edibility: If you are not certain of the species of puffball you are eating, consult an expert. Prepare only white and densely fruited puffballs. Use fresh or slice thin and dry immediately. Dried puffballs have all the mass of helium-filled balloons. Grind the dried mushroom into powder and stir the powder into dishes to impart a mushroom flavor. Fresh puffballs are sliced, breaded,

Spore cloud from edible Morganella pyriformis

and sautéed or deep-fried. The flavor is good, enhanced by the addition of fresh ginger and tamari or soy sauce; the texture is mushy. ***Tip:*** Smash smaller puffballs flat with a knife or wooden paddle, dust with flour or panko, and fry crisp.

Widely dispersed and edible Lycoperdon marginatum

Traditional uses: *Calvatia gigantea* has been used traditionally by the Cree as a styptic wound dressing. A dried slice of the mushroom placed over a wound contracts tissue and reduces bleeding. After initial sopping of blood, place a new slice over wound as a dressing. Native Americans used the soft, white inner flesh to remove objects from the eye. Blackfoot drank the spores to stem internal bleeding. The Haisla Nation thought the spores of *Calvatia* poisonous. Anthropologists found puffballs in grave sites over 2,000 years old. Traditionally, *C. gigantea* spores were used to treat ear infections—spores are blown into the ear using a paper cone. The Masai mix spores of *Calvatia* into milk and drink it to relieve stomachaches. Nepalese villagers used a water-wetted spore paste from dried puffballs to treat wounds and abrasions on pack animals. In Mexico, puffballs are used to treat insect bites and stings. In Traditional Chinese Medicine, puffballs are considered anticancer.

Research: The anticancer agent calvacin has been isolated from young fruit bodies and cultures of *C. gigantea*, as well as from a few other puffball species. In vitro it has inhibited tumor cells. *M. pyriformis*, the pear-shaped puffball, may aid or induce sleep. All puffball spores are styptic wound sealants.

CAUTION: Doses of calvacin (in vivo tests) with cultures of 24 lines of mouse, rat, and hamster demonstrated antitumor activity in 14 of the tumor types. However, clinical/animal testing reveals numerous side effects, including anorexia, acute liver failure, muscle inflammation, and bleeding from the lungs. Some rats receiving the highest dosages died within two days of the experiment (Wong et al. 2014).

Storage: Cook into dishes and freeze, or slice large puffballs thinly and dry in a food dryer; powder the end product and add to soups, stews, and dishes requiring a mushroom flavor. Give powder to friends and have them experiment.

Notes: Use dried puffballs as tinder for starting fires. Smoldering this mushroom may be effective for shooing bees when hand-extracting wild honey; the smoke appears to sedate the bees. The largest puffball I ever found was in the park across from the Buffalo Bill Museum in Cody, Wyoming. The total number of spores produced by a single, average-size giant puffball *C. gigantea* is estimated at around 7 trillion; large specimens produce many more.

Toxic Puffball Look-alikes—INEDIBLE

CAUTION—NOT EDIBLE: Always slice the puffball mushroom in half to check for gills (or what may be the development of a gilled mushroom). Evidence of gills means it is not a puffball and is possibly a poisonous amanita in the egg stage. Even the ephemeral hint of gills indicates an amanita. Do not eat!

The pigskin poison puffball (*Scleroderma citrinum* Pers) and other sclerodermas look like edible puffballs. *Scleroderma citrinum* is yellow-brown with a tough, thick, and warty skin. At maturity, it is purplish and hard inside. It grows 1"–4" in diameter and has a topside vent emitting blackish-brown spores. Avoid these mushrooms.

Toxic amanita puffball look-alike

Scleroderma citrinum, *a toxic puffball look-alike*

Chapter Three

Polypores

Origin: Greek/Latin meaning is "many pores."

Mushrooms with spore-producing pores encompass a large group of fungi, many of which are easy to identify. Many are edible—medicinal, too. Parasitic and/or saprophytic, they are typically shelf- or hoof-shaped mushrooms (but not always) found clinging to trees across the continent. Here are some of the most important medicinal mushrooms produced in nature, especially rare old-growth forests. Because these mushrooms may be inedible due to their hardness, I have included a Health Prep section describing a few ways to prepare them and release their health-protecting chemistry (see Appendix A).

ARTIST'S CONK—INEDIBLE

Ganodermataceae (*Ganoderma applanatum* (Pers.) Pat.)

Artist conk

Origin: *Gano* is Latin for "shiny"; *derma* is Greek for "skin," thus "shiny skin."

Identification: The artist's conk, a wood decay (saprobe) fungus and a live sapwood pathogen (parasitic), gets its name from the white art-board-like underside. It is a woody shelf mushroom, more or less flattened, with a gray to dark gray top expanding in concentric bands and a white undersurface. Old specimens can grow to 35" in circumference and 1"–8" thick. Spore print is brown to reddish.

Habitat: The artist's conk is an abundant brown rot mushroom growing in beech-maple climax forests and other coniferous and deciduous forests on standing and fallen dead trees and stumps—often very large with an elf sitting precariously on the edges, knitting socks. The mushroom thrives on old live or decaying beech, cottonwood, poplar, birch, hemlock, and aspen. In the Lake Michigan dune forests, it attacks and decays eastern hemlock and white pine, forming large shelves. The mushroom is broadly distributed and easily found year-round in the upper Midwest and eastern states. In the West, find it on western hemlock, Douglas fir, and spruce. It grows in every temperate and many subtropical forest ecosystems from North America to Africa and Asia.

Edibility: Not edible, possibly medicinal; more research needed.

Traditional uses: Native Americans used the mushroom in spiritual cleansing rituals. In Traditional Chinese Medicine, conks are used to treat lung and respiratory problems and taken as an immune-system modulator and diuretic.

Research: Artist conk extracts are antimicrobial against *E. coli* and *Staphylococcus aureus*. It is antitumor in vitro. Decoctions still used in several countries to treat lung and respiratory problems. The polysaccharide portion is cholesterol lowering and immune-system modulating. Mushroom is antibacterial to several gram-negative and gram-positive bacteria. Polysaccharides have shown antitumor properties in rats and mice. Also have liver antitumor properties (Jeong 2008).

Storage: Keep dry in sealed container.

Notes: When scratched the white belly turns brown as if etched. Artists, skilled and otherwise, can use these shelf mushrooms as an expressive canvas. Folk art tables and shelving are made from large specimens. When burned at a campsite, it repels several varieties of insects, but I find blood root juice better for mosquitoes (Meuninck 2013). A large artist conk may release 30 billion brown spores per day, coloring the top side of the mushroom tan.

CHICKEN OF THE WOODS, SULPHUR SHELF

Polyporaceae (*Laetiporus sulphureus* Bull. ex Fr.)

Laetiporus conifericola *found growing on a larch stump in Montana*

Origin: From Latin *laeti* (happy, joyful), "joyful pores."

Identification: A lemon-to-orange-yellow (darkening with age) parasitic bracket fungus often grouped in overlapping stemless caps. This brown rot saprobe grows up to 20" wide on trees. Shape is typically semicircular, thick, and fanlike. Margins are softly rounded and undulating (reminiscent of chicken feathers). Mushroom is lemon-yellow to orange and fades with age. Surface is radially furrowed and smooth or feltlike to the touch. Tubes (pored tubes shelter and hold spores in polypores, hence the name polypore) are yellow, and when fresh a slight squeeze will exude yellow juice. Smell is pungent, mushroom found singly or in large overlapping clusters, emitting a typical fungal odor. Spores ovoid to elliptical. Spore print is white.

Habitat: Found in the Midwest to the East Coast and in the Pacific Northwest down to California growing on live or dying stumps, logs, trees; typically oaks and beech in southern Michigan, my foraging grounds. Photograph above taken in Montana is of *L. conifericola* on a larch tree. Also found on conifers and deciduous trees throughout its range. It is available from late spring through early fall; in Michigan, mushroom found from June to October, often in vacant woodlots, forests, and in rural and suburban populated areas.

Edibility: Edible and earthy, this meaty mushroom with a fleeting lemon flavor is best when young and tender; older mushrooms have a sour taste. It's a chewy, juicy mushroom that requires cleaning. If extremely dirty pull apart segments (layers), brush, and wash (I have used a hose). Blanching removes any bitter taste. Texture and flavor when cooked is like chicken. Sauté in olive oil and eat as an entree or add to stews, soups, pizzas, omelets. Ideal for vegetarians; goes well in risotto, curry, and various homemade salsas.

CAUTION—POISONOUS LOOK-ALIKE: *Laetiporus huroniensis* is almost identical to *Laetiporus sulphureus*; the two are distinguished by where they grow and what they grow on. The conifer-loving *Laetiporus huroniensis* of the Great Lakes may cause poisoning. In western North America, the true *Laetiporus sulphureus* does not occur, but at least two look-alikes do: *Laetiporus gilbertsonii* is found on eucalyptus and frequently is implicated in poisonings, and the western pine-loving variety *Laetiporus conifericola* tends to be a bit too sour tasting (Cornell 2006).

Research: *L. sulphureus* is antioxidant and antimicrobial, showing positive correlations between total phenolic content in ethanol extracts and their

antioxidant activities and has potential as a natural antioxidant. *L. sulphureus* has narrowly antibacterial activity against gram-negative bacteria and strongly inhibits the growth of the gram-positive bacteria. The crude extract exhibited high anti-candida activity against *Candida albicans*, opening the possibility as a suitable antimicrobial and antioxidant agent in the food industry (Turkoglu et al. 2007). *L. sulphureus* increased insulin secretion in a rat model (Hwang et. al. 2010). *L. sulphureus* showed activity against human T4 leukemic cancer cells and activity against *Plasmodium falciparum* (malaria microorganism), demonstrating possible antitumor and antimalarial (Lovy et al. 2000). Water extracts showed cancer-inhibiting activity in white mice. Mycelium is strongly antimicrobial. This mushroom's alkaloids appear similar to psychoactive chemicals and may induce hallucinations in a documented case. (Appleton, Jan, et. al. 1988).

Storage: Best eaten fresh. For storage, sauté to remove moisture, then freeze, and double-bag to prevent dehydration and freezer burn.

Notes: Find one of these large eastern mushrooms and you have food for days, if not weeks. No need to hike into the wilderness for this mushroom; it is common on trees in neighborhood fields and woodlots close to home, even in front and backyards. Eat this and other polysaccharide-rich mushrooms three times per week to prevent colds and flu. My wife, Jill, and I were once offered $400 from a New York City restaurant for a 35-pound chicken of the woods mushroom.

DRYAD'S SADDLE, PHEASANT TAIL

Polyporaceae (*Polyporus squamosus* (Huds.) Fr.)

Origin: Latin *squama* meaning scale or "being scaly."

Identification: This fan-shaped and profusely scaled mushroom forms shelves and often large clusters. Individuals grow up to 15" in diameter. Skin is pale tan to creamy yellow in color, with brown scales in a feather-like pattern. The underside has pores producing a white spore print. The stipe (stem) is short and tough, and the flesh is white and most tender near the margins. A fresh *P. squamosus* emits a watermelon-like fragrance when torn. Flesh toughens with age and becomes inedible.

Habitat: The mushroom is both a saprobe and parasite on trees, preferring wet woods of eastern North America, and is best picked after a substantial rain (most tender then). Found in marshes, along streams, and on long-dead timber of all kinds. Best in the spring and summer, but available year-round; sought and found during the morel season.

Edibility: Pick young specimens that are wet and soft to the touch. The mushroom gets tougher as you move toward the stem; use outer, tender edges. Place the mushroom upside down on a cutting board and cut from the outer edge. Let the knife glide through the flesh until it meets resistance as it nears the abrupt stem. Where the toughness begins to stall the knife, cut away all the soft tissue forward to the margin—eat this soft part only. A few soak the mushroom in the refrigerator in salt water. Slice the mushroom thin,

sauté, and add to soups, frittatas, pizzas, etc. It is not a stand-alone edible but works when incorporated in dishes.

Polyporus squamosus

Traditional uses: In Traditional Chinese Medicine (TCM), this mushroom is a warming remedy useful in remediating sore tendons and ligaments. Prepared formulations are available from TCM practitioners.

Research: *P. squamosus* is a low-calorie, high-fiber, low-fat food, relatively high in essential fatty acids, and a potentially valuable food in combating inflammation and heart disease (Ergönül et al. 2013). Dryad's saddle tested positively as a cancer-finding probe. Polyporus lectins that recognize sialic-acid-containing glycans have proven to be powerful tools for studying the biology of these structures. *Polyporus squamosus* Lectin's (PSL) unique carbohydrate-binding makes the recombinant PSL a potentially useful probe for discovering the metastasis and progression of tumors (Tateno, Winter, and Goldstein 2004).

Other research suggests anticancer activity by promoting cell differentiation. And water extracts appear to be chemoprotective to gastric cancer (Abreu, et. al. 2011). Also used as a cholagogue for cleansing the liver and gall bladder. Preliminary studies suggest the extract from the mushroom may have implications for treating urinary and prostatic diseases. Extracts show antimicrobial activity against *E. coli*, *Staphylococcus aureus*, *Bacillus subtilis*, and *Salmonella typhimurium*.

Storage: This mushroom is plentiful year-round in its habitat and usually not stored. Cook and freeze. Do not dry.

Notes: Turn to this mushroom when morels are unavailable. Dryad's saddle is abundant and easy to identify. The flavor is not great but good enough when sautéed and added to soups or stew. You are never "skunked" after you learn to identify this edible.

HEN OF THE WOODS, MAITAKE, KING OF MUSHROOMS, DANCING MUSHROOM, CLOUD MUSHROOM

Meripilaceae (*Grifola frondosa* (Dicks) Gray.)

Origin: Latin *frondosa* means "leafy."

Identification: *Grifola frondosa*, a polypore mushroom that grows in a layered cluster (see photo) at the base of trees, particularly oaks. It is a white rot saprobe fungus, typically in rotting roots and butts of oaks. It emerges from an underground tuber-like structure known as a sclerotium, about the size of a potato. The entire fruiting body (20"–40" wide) is a cluster of multiple

caps from gray to grayish brown to smoke-like brown, often curled or spoon shaped, with wavy margins (hen-feather-like, thus the name). Each cap is 1"–4" across. The undersurface of each cap bears approximately 1–3 pores per millimeter, with the tubes rarely deeper than 0.2". The milky-white branching stipes (stems) grow on the ground, and become tough as the mushroom matures. Spores are white, elliptical, and smooth. The mushroom has a few look-alikes: black-staining polypore (*Meripilus sumstinei*) blackens when bruised or handled; Berkeley's polypore (*Bondarzewia berkeleyi*) is thick fleshed and cream colored; and the edible eastern cauliflower mushroom (*Sparassis spatulata*) has ribbonlike folds.

Maitake, a 25-pounder

Habitat: Grows on trunks of dead and living trees, and occasionally on stumps. The fungus is native to moist hardwood forests, bottomlands, and woodlots in eastern North America, as well as in China and Europe. Typically on oaks but found on other deciduous trees. It is found from September to November in the eastern United States; earlier in the south, later in the north.

Edibility: A choice edible, gather when young. It may require diligent cleaning of the many cracks and crevices containing dirt and an occasional creature. I use a hose, then pat it dry. Cooking softens its tough texture, and it goes well in all mushroom dishes—especially stews. Simmer slowly in salted water until tender. Hen of the woods makes a hearty, meaty mushroom soup. I like to cut it into thin strips and fry until crisp. Harvest what you need and leave the rest to continue growing.

Traditional uses: Used for centuries in medicinal extracts, including teas, tablets, drinks, and powders as a diuretic in China. Called *maitake* in Japan, the name means "dancing mushroom," perhaps because people dance for joy when they find it—available in international groceries and cultivated in the United States. Used traditionally to treat diabetes and hypertension. For thousands of years, Asians have included maitake as tonics in soups, teas, prepared foods, and herbal formulas to promote health and long life.

Research: Maitake extract is combined with radiation and chemotherapy in the treatment of cancer. The mushroom provides support for the immune system and improves blood pressure, blood sugar, and cholesterol levels. Commercially available and marketed to "enhance immune function" and to treat HIV. Beta 1,6-glucan, a protein-bound polysaccharide, has been identified as the active constituent. Preliminary data also suggest that maitake may be useful in inducing ovulation in patients with polycystic ovary syndrome (PCOS).

A novel polysaccharide, MZF, in maitake was shown to enhance antitumor response in one study. Maitake also enhanced interferon activity against bladder cancer cells and alleviated inflammation associated with inflammatory bowel disease. In another study of postmenopausal breast-cancer patients, oral administration of maitake extract was shown to have immunomodulatory effects. Maitake exerts its effects through its ability to activate various effector cells, such as macrophages, natural killer cells, and T cells, as well as interleukin-1 and superoxide anions. Studies also suggest possible hypoglycemic activity; the antidiabetic effect of alpha-glucan may be due to its effects on insulin receptors by increasing insulin sensitivity and reducing insulin resistance of peripheral target tissues. Maitake-D fraction is marketed as a dietary supplement in the United States and Japan. In 2002, a group of Japanese patients with different types of cancer received maitake D-fraction and maitake powder in addition to standard cancer treatment. Although the researchers thought some patients showed improvement, the study did not include a control group. More scientifically designed studies needed to determine maitake's potential usefulness in preventing or treating cancer (Kodama 2002).

The National Cancer Institute is sponsoring a very early (Phase I) study at Memorial Sloan Kettering Cancer Center to learn whether beta-glucan can increase the effectiveness of rituximab (a drug used for treating some types of lymphoma and leukemia) by increasing cancer cells' sensitivity to it. This clinical trial studies the side effects and the best dose of beta-glucan when given with rituximab. It will look at young patients with relapsed or progressive lymphoma, leukemia, and similar disorders.

In another clinical trial, beta-glucan is being tested together with other drugs to learn whether they increase the effectiveness of a monoclonal antibody (3F8). Combining different types of biological therapy may kill more tumor cells. This is a small open-label trial (so-called because both patients and researchers know which treatment is administered). Test subjects are patients with neuroblastoma that has not responded to treatment.

Laboratory studies show maitake can reduce the growth of cancer in animals. Maitake does not kill cancer cells directly but works through the immune system (organizing the body's defense system against infection). Animal and human dose determining studies show that maitake can enhance immune function. The studies test whether maitake improves the neutrophil count and function in patients with bone marrow disease. The neutrophils are white blood cells that help to fight infection—a Phase II Trial (Yukiguni 2014).

Storage: Best fresh, store frozen for three months, or prepare the mushroom in cooked dishes, double-bagged, then freeze for longer periods. It may also be dried, double-bagged, and stored in a sealed container.

Notes: My spouse, Jill, has her own secret tree, whose location I hope she reveals while talking in her sleep. We find maitake biking and hiking the side streets and rural roads in early autumn.

TURKEY TAIL, YUN ZHI—INEDIBLE

Polyporaceae (*Trametes versicolor* (L.) Lloyd)

Origin: Latin *versicolor* means "changing colors" or "many colors."

Identification: *Trametes versicolor*, also known as *Coriolus versicolor* and *Polyporus versicolor*, is a polypore, brown rot saprobe, commonly called turkey tail. The mushroom forms colonies on wood often with the caps in tiled layers. Caps are variegated, fan shaped, leathery, often fused together, with smooth to wavy margins, and exhibit a variety of colors. The top of the cap often looks like a fanned turkey tail (hence the name) and displays concentric rows or zones of different hues; typical colors are brown, rust brown, black, blue gray, and, in older specimens, there may be green algae growth atop caps. Cap has zones of fuzzy hair. Flesh of cap is typically less than 0.13"–0.25" thick and 3.5"–2" wide. Pores are whitish to light brown, twisted, small, and numerous, 2–5 pores per millimeter.

Habitat: A common polypore mushroom found in forests throughout the world growing on stumps, dead branches, and dead trees—available year-round.

INEDIBLE: Not eaten as is, but sold over the counter as medicinal supplements.

Traditional uses: Turkey tail has been used as a medicinal tea in Asia for thousands and thousands of years; it clears dampness, reduces phlegm, heals pulmonary disorders, strengthens the stomach and spleen, increases energy, and treats chronic diseases. Used by Chinese medical doctors to treat infection and/or inflammation of the upper respiratory tract, urinary tract, digestive tracts. Also as therapy for chronic hepatitis and to treat general weakness of the immune system.

Research: Krestin, a proprietary anticancer drug approved in Japan, is extracted from the turkey tail mushroom. The US Food and Drug Administration (FDA) approved a clinical trial of turkey tail extract for patients with advanced prostate cancer to take it in combination with conventional chemotherapy. Another trial pending FDA approval will test the effects of taking the extract along with a vaccine treatment in women with breast cancer (Bastyr University 2012).

Preparations from the *Trametes versicolor* mushroom hypothesized to improve immune response in women recovering from breast cancer after standard chemotherapy and radiotherapy. Research continues to indicate that *Trametes versicolor* represents a novel immune therapy with significant applications in cancer treatment (Torkelson et al. 2012).

Polysaccharide peptide (PSP) is a protein-bound polysaccharide extracted from the edible mushroom *Trametes versicolor*. In the animal-testing phase as an antitumor drug it appears to work as an immune system modulator, enhancing the body's own use of macrophages and T lymphocytes, rather than directly attacking tumors (Ng, T. 1998). According to the American

Turkey tail

Cancer Society, "Available scientific evidence does not support claims that the raw mushroom itself is an effective anti-cancer agent in humans." However, Nakazato reported that 262 gastric cancer patients treated with PSK (Polysaccharide Krestin) as adjunct therapy with chemotherapy showed a decrease in cancer reoccurrence and a significant increase in disease-free survival rates (Nakazato et al. 1994). It also appears that the polysaccharide stimulates interleukin-1 and interferon production in human cells (Yamasaki et al. 2009).

Unlike many conventional anticancer drugs, PSK and PSP produce few, if any, side effects and show no immunosuppressive activity (Yang, Chen, and Kwok 1992). PSK has shown to be beneficial as an adjuvant in the treatment of gastric, esophageal, colorectal, breast, and lung cancers (Fisher and Yang 2002). Further in vitro studies have shown that a nutraceutical blend (MC-S) of PSK, lentinan, and other fungal extracts might also inhibit cancer-cell proliferation under laboratory conditions (Clark and Adams 2009).

The University of Texas MD Anderson Cancer Center reported that *T. versicolor* is a "promising candidate for chemoprevention due to the multiple effects on the malignant process, limited side effects and safety.

Storage: Dry and freeze or store in sealed jars.

Notes: One of the easiest mushrooms to identify and find; an attractive addition to landscaping as the fungus endures for months, even years, if protected from rain.

RESINOUS POLYPORE

Hapalopilaceae (*Ischnoderma resinosum* (Schrad.) P. Karst)

Origin: Latin *resinosum* meaning "resinous."

Identification: *Ischnoderma resinosum*'s pore surface is white, and the top is brownish orange to dark brown, becoming black with age. The caps are up to 10" wide and 1" thick. It often has dark, shiny, crusty, resinous zones. There is no stalk. The pore surface bruises brown. Young mushrooms are fleshy and soft, maturing to tough and leathery. When young and fresh this mushroom secretes brownish water droplets.

Habitat: Occurs on fallen and dead, sometimes long-dead, hardwood tree trunks and branches, dispersed on the dead tree singly or in overlapping clusters. It causes a white to yellow rot of the trees and may have an anise-like smell. Found in the fall, it is widespread in North America.

Edibility: Flesh of young specimens is soft and juicy, somewhat bland with fleeting bitterness. It is best to stew this mushroom in its own juices, reducing the juice, then make gravy with the chopped mushroom and its reduced juice for venison and other wild game, or cook by itself with root vegetables, reducing the stew to a thick consistency.

Traditional uses: *Ischnoderma resinosum* lectins are proteins that can be used as probes and are highly specific to sugar and are used in wound healing and reducing scars. They are carbohydrate-binding molecules used as markers or probes in agriculture and medical research and were isolated from *Ischnoderma* in 1995. Lectins are ubiquitous in nature, holding great potential in medicine.

Research: Antibacterial and inhibits sarcoma180, a transplantable, nonmetastasizing tumor that is often implanted in mice for cancer research. *Ischnoderma* mushroom shows moderate inhibition of *Staphylococcus aureus* and immune-modulating health benefits (Shodhganga 2011).

Notes: Abundant in old-growth beech-maple climax forests on decomposing dead trees felled by other fungi—a stellar recycler and passable survival food.

Resinous polypore, October, beech-maple climax forest

REISHI, LING CHI—INEDIBLE

Ganodermataceae (*Ganoderma lucidum* (Curtis) P. Karst.; *Ganoderma tsugae* Murrill)

Ganoderma tsugae *found in the Porcupine Mountains, Michigan*

Origin: Latin *lucida* means "bright, shiny."

Identification: Reishi and related species are saprophytic brown rot fungi that break down and feed on wood. Reishi is kidney- or fan-shaped with a shiny red-lacquer-like sheen on the upper skin. Typically associated with either hemlocks or hardwoods, Reishi frequently grows at the base and stumps of deciduous trees, especially maple. The photo here is of *Ganoderma tsugae*, a related species found in the Porcupine Mountains of Michigan and other northeastern states. In nature, it is rare with only about one on every 4,000 old-growth trees harboring the fungus.

Habitat: *G. tsugae* grows in eastern hemlock forests and is available year-round but best in the summer to fall when it releases spores. Both *G. tsugae* and *G. lucidum* have a worldwide reputation and distribution in both tropical and temperate zones. Distribution is widespread in old-growth forests. It is cultivated both outdoors on logs and on beds of wood chips

INEDIBLE: Reishi is added to soups with bitter consequences. It is available in standardized extracts and powders for health-supportive therapies.

Traditional uses: Reishi, listed in the *American Herbal Pharmacopoeia and Therapeutic Compendium*, has been used in Traditional Chinese Medicine (TCM) for 2,500 years. In China the mushroom is considered an immune-system modulator and used for treating viral infections such as the flu (influenza), swine flu, and avian flu. Other traditional uses include treating respiratory problems (asthma and bronchitis), as well as stomach ulcers and heart disease.

Research: Reishi is antibacterial, antiviral, anti-inflammatory, antitumor, anticancer, and is both an immune-system modulator and therapy for the immune system. Laboratory studies show reishi fungal extracts and isolated compounds may be effective against ovarian cancer. This chemistry may also slow metastasis. These extracts are now used for suppressing cancer proliferation and migration. It also inhibits platelet aggregation, lowers blood pressure, lowers cholesterol, and lowers blood sugar. Active chemistries are polysaccharides, terpenes, and other compounds contained in the mycelia and fruiting bodies.

See Oluba et al. (2014) for positive results obtained from crude aqueous extract of *G. lucidum* fruiting bodies possessing potent antioxidant activity that protects hemoglobin against plasmodium-induced oxidative damage.

Findings justify the use of the plant in traditional African and Chinese medicine as an anti-inflammatory and antimicrobial agent.

Storage: Dried whole or powdered, in sealed containers—keep dry.

Notes: I found *G. tsugae* in the Porcupine Mountains old-growth area in Michigan on eastern hemlock, (*Tsuga canadensis*). Purchase *Ganoderma lucidum*, whole mushroom and powders, at Asian markets and online.

AGARIKON, QUININE CONK, LARCH BRACKET MUSHROOM, BROWN TRUNK ROT, EBURIKO—INEDIBLE

Fomitopsidaceae (*Fomitopsis officinalis* (Villars: FR.) Bondartsev & Singer)

Origin: Latin *fomentum* means "tinder"; *officinale* means "medicinal uses."

Identification: *Fomitopsis officinalis* is a large bracket fungus found on the trunks of coniferous hosts, where it causes a brown rot. Fruiting bodies persist and become larger and larger, building layer upon layer over time—specimens may be 16" x 18" and a few up to 20" long. Sporophores (the mushroom's spore-producing body) are large. These distinctive conks are columnar or hoof shaped. They are soft, yellow-white when young, but soon becoming white and chalky. The decay produced by the fungus is brown, cubically cracked, with thick white felt like material in large cracks. Taste of the mushroom itself is very bitter. The spore color is white.

Habitat: Available year-round, found on conifers in the northwestern United States and is perhaps extinct in most of Asia and Europe. It is becoming rare within the old-growth forests of Washington, Oregon, Montana, Idaho, and British Columbia due to harvesting of old-growth trees.

Fomitopsis *on Douglas fir, Washington State old growth*

Edibility: INEDIBLE—not edible except as a tea or medicinal extract.

Traditional uses: Pliny the Elder named the mushroom *agaricum* after the town of Agarus (and a king of the same name) about 250 BC. Used medicinally by Dioscorides, a Roman physician, botanist, and pharmacist, who considered it an effective treatment (in combination with wine and honey) for consumption (tuberculosis). Early Europeans and Central Asians traditionally used this species for treating chronic coughs, asthma, rheumatoid arthritis, bleeding, and infected wounds. Native Americans referred to the fungi as "bread of ghosts" or "tree biscuits." Spiritual references to the special powers of the mushroom and its hanging fruiting bodies are documented. Shamans and spiritual leaders hung hand-carved fruiting bodies, representing spiritual figures, and spirit catchers with large open mouths and stomachs in dance lodges to capture spirits and protect the people. Upon the shaman's death, the people buried the mushroom with the shaman. The large sporophores were carved as jewelry, painted, and placed at the head of the shaman's grave—these grave guardians protected the shaman's burial site, an area occupied by spirits.

Research: Agaricin (or agaric acid), a chemical in *F. officinalis*, is a white, water-soluble powder that can be administered both orally and topically. Agaricin is an anhidrotic, anti-inflammatory, and a parasympatholytic nerve agent. Pharmaceutical companies produce agaricin synthetically. The mushroom has antibacterial, antiviral, and anticancer activity in vitro. In vitro tests also show anti-HIV and anti-pox viral activity. Speculation suggests functionality against prostate and breast cancer (Stamets, 2005). Alcohol tinctures of the powdered mushroom appear effective as a smooth muscle relaxant for stomach cramps. Homeopathic doses may be effective against night sweats, pancreatic inflammation, and liver inflammation cramps (Rogers 2011).

Storage: Dried and powdered in sealed containers or gelatin capsules.

Notes: I saw *F. officinalis* for the first time just off the Juan de Fuca Marine Trail on Vancouver Island, Canada. The species is rare due to old-growth cutting in the Pacific Northwest. Look for the species in the old growths of the Olympic Peninsula, Mount Rainier and the old growths along the Mount Baker Highway en route to the Mount Baker Ski Area in Washington State. Various homeopathic fractions of the mushroom are available online.

F. officinalis *from an old-growth larch*

Fresh birch polypores

BIRCH POLYPORE, BIRCH CONK, RAZOR STROP, ICEMAN FUNGUS

Fomitopsidaceae (*Piptoporus betulinus* Bull. ex Fr.)

Origin: Latin *piptoporus*, "to fall" or "easily detached"; *betulinus* relates to birch.

Identification: The birch polypore, a parasitic fungus found on dying or dead birch trees, has a distinctive cap that folds over at the edges to provide a smooth, rounded rim around the underlying pore surface. Caps vary from whitish to brownish, and the pore surface is whitish or grayish brown. The annual fruiting body lives for one season, but is visible year-round. Older caps blacken with age. Cap are 2"–10" wide, growing shelflike or hoof-like (kidney shaped in outline) and broadly convex to more or less flat. The mushroom dries with a somewhat roughened "skin" that often peels away. Pore surface is initially white and ages to grayish brown with 2–4 pores per millimeter; tubes grow to 0.4" in length. Stem is absent or rudimentary and stubby. Inner flesh is white, thick, and corky. Taste is slightly bitter. Odor is strong and pleasant. Spore print is smooth, cylindrical to long elliptical.

Habitat: Found in northern states and Canada on birch wood (parasitic) and seen year-round; best harvested in midsummer. Pictured specimens found in the national forest south of Manistee, Michigan.

Edibility: Edible when young, fresh, soft, bitter—with a short shelf life—available in supplemental and homeopathic preparations. CAUTION: *P. betulinus* when ingested can bring on diarrhea.

Traditional uses: Prehistoric man apparently used the mushroom as evidenced by the spheres of *P. betulinus* worn by the Iceman of Oetzi. It was and still is used as an anesthetic, anthelminthic ("against worms"), and anti-inflammatory. The mushroom is thinly sliced and dried as fire fuel. Slices are roasted black, dried, powdered, and used as a wound sealant (styptic). In Bohemia, the polypore is used to treat rectal cancer and stomach diseases. Thin slices of the mushroom positioned as corn pads may protect and relieve corns.

Research: Birch polypore contains betulinic acid, which is anticancer and antiviral. Betulinic acid suppresses tumor growth in cell cultures and animal models. The chemical is well absorbed and accumulates in the tumor of melanoma. It appears to be selective to tumor cells and less toxic to normal cells. The natural compound betulinic acid shows potent anticancer activity through activation of the mitochondrial pathway of apoptosis (natural programmed cell death). Betulinic acid is used in combination with chemotherapy and radiotherapy protocols to enhance antitumor activity. Betulinic acid is somewhat selective against malignant compared to normal cells, thus presenting its promise as a new experimental anticancer agent. Synthetic compounds based on betulinic acid derived from *Syzigium claviforum* are being tested as an anti-HIV agent. In vitro studies show the acid as antiviral against pox viruses and HIV. Polyporenic acid from the mushroom displayed anti-inflammatory activity in a rat model. Triterpene extract from the mushroom induced remission of vaginal tumors in female dogs. A few studies suggest that eating the fruiting body reduces fatigue and is mentally soothing. Several studies confirm that piptamine from the mushroom is antimicrobial (Cichewicz and Kouzi 2003)

Storage: Eat fresh when young and soft. For traditional uses store in a paper bag in a sheltered dry area outside the home to prevent spores from invading your house.

Notes: Used shredded or whole as fire starter or fire fuel. In Victorian England, birch conks sufficed as razor strops. Used as a substrate to pin insect collection in lieu of Styrofoam. Beekeepers use the smoldering dry mushroom to tranquilize bees. The hardened cap used for polishing metal. I have seen this parasitic fungus level entire stands of birch. That's good and bad news: The bad news is birch groves in Michigan are taking a beating; the good news is mushrooms are plentiful and foraging is easy.

TINDER CONK, AMADOU, HORSE HOOF FUNGUS, ICEMAN FUNGUS II—INEDIBLE

Polyporaceae (*Fomes fomentarius* (L.) Fr.)

Origin: Latin *fomentarius* means "material to feed a fire."

*Aged amadou, also called tinder polypore (*Fomes fomentarius*)*

Identification: The species produces a polypore fruiting body shaped like a horse's hoof and typically continues to live on trees long after they have died, changing from a parasite to a decomposer. Fruiting body is 2"–17" across, 1"–10" wide, and 0.8"–9" thick. While typically shaped like a horse's hoof, it can also be bracket-like with an umbonate (bump or protrusion on top of the cap). The species has broad, concentric ridges with

a blunt and rounded margin. Flesh is hard and fibrous, cinnamon-brown color. The upper surface is tough, uneven, hard, and woody, varying in drab color, usually a light brown or gray to silvery gray. The margin is whitish during periods of growth. The underside has round cream-colored pores when new, maturing to brown; pores darken when handled. Circular pores are 3-4 per millimeter. *F. fomentarius* can easily be confused with both *Phellinus igniarius* and *Fomitopsis pinicola*.

Habitat: *Fomes fomentarius* is a stem decay plant pathogen or parasite. The species' mycelium penetrates the wood of trees through damaged bark or broken branches, causing white rot in the host. It can grow on the bark wound, or even directly onto the bark of older or dead trees. Mushroom found in Canada, Alaska, Europe, Caucasus, northern United States, Russia. Available year-round in wet woods and fringes of wetlands and typically grows upon hardwoods. In northern forests, most common on birch; in the southern part of its range, beech—has also been known to grow upon maple, cherry, hickory, lime tree, poplar, willow, alder, hornbeam, sycamore, and rarely conifers. Fruit bodies are perennial, surviving for up to 30 years. Yearly growth always occurs on the bottom of the fungus, meaning that the lowest layer is the youngest. This occurs even if the host tree has fallen on the forest floor, as the white rot fungus weakens and kills the tree.

Edibility: INEDIBLE—too tough.

Traditional uses: Use of this fungus dates back to Mesolithic campsites 8,000 years ago. Oetzi the Iceman, the 5,300-year-old Neolithic man found frozen in the Austrian Alps, had *Fomes* species in his bag along with birch polypore strung on a leather thong. Perhaps the strung birch polypore was a charm or medicine to control intestinal parasites, whereas the shredded horse hoof was used as fire starting tinder. The species is still used as tinder and fire-starting material. In Siberia it is mixed with tobacco as snuff. In Japan, the fleshy part of the fungus smolders overnight in a ritual to clear evil spirits; it is also burned to cauterize wounds (Peintner 1998). In Europe, *F. fomentarius* is used internally to cure hemorrhoids and correct bladder disorders (unproven). Native Americans used *F. fomentarius* as a diuretic and a laxative. The fungus is claimed to calm nerves. The Chinese use *F. fomentarius* in the treatment of cancer of the throat, stomach, and uterus. Siberian Khanty tribe mixed the fungus with silver fir bark to make incense for ceremonies and rituals to protect the living from the dead (Saar 1991) and (PML Survivors 2007).

Research: *The International Journal of Medicinal Mushrooms* asserts that *Fomes fomentarius* raises immunity. The report credits the fungus with enhancing blood circulation, regulating blood sugar, and lowering blood pressure, and it may have an impact of prolonging life by reducing malignant cells that cause debilitating diseases (Seniuk 2012). Dentists used amadou (tinder conk) to dry teeth. It is styptic and useful for stemming bleeding wounds. The mushroom lignin displayed in vivo inhibition against herpes simplex. Extracts are antimicrobial to nefarious *Serratia marcescens* bacteria and may be a useful anti-HIV agent. Extracts are also anti-inflammatory.

In recent study, the petroleum ether fraction of *F. fomentarius* was effective in inhibiting the tumor growth induced by S180 cells and had lower immune organ toxicity. Researchers found that the *Pyropolyporus fomentarius* (Asian synonym for *F. fomentarius*) extraction has significant antitumor activity and great potential in screening antitumor drugs (Zhang et al. 2014).

Storage: Dry thoroughly and store in a sealed jar; keep dry.

Notes: Use *F. fomentarius* fruiting bodies as pincushions to keep pins and needles from rusting or to pin and mount insects. Fly fishermen use the shredded substance for drying tied flies: Cut it finely, powder, then pour the product in an old 35 mm film canister, drop in the fly, close the lid and shake—it works. Artists employing traditional art technique fabricate the mushroom into clothing, including caps, gloves, breeches, picture frames, and ornaments. To make fire starter from amadou, soak the fruit bodies in water then cut them into strips. Beat and stretch the strip into fibers called red amadou; add gunpowder to increase potency of the tinder. Survival Fire transport: Drill a 0.5" hole in the mushroom, stuff in a glowing ember, and use the smoldering conk to transport fire over moderate distances.

MESHIMA, MESHIMAKOBU, SONG GEN, BLACK HOOF MUSHROOM—INEDIBLE

Hymenochaetaceae (*Phellinus linteus* (Berkeley & M. A. Curtis) Teng (PL); *Phellinus everhartii* (Ellis & Galloway) Ames; *Phellinus pini* (Brot.) (Bondartsev & Singer)

Phellinus everhartii *on oak, Nordhouse Dunes Wilderness, MI*

Origin: Latin *phellinus* means "cork like."

AUTHOR'S NOTE: *P. linteus* is rare in nature. I add it to this field guide because of its reported benefits. After 322 days looking, I found its cousin *Phellinus everhartii* in Michigan's Nordhouse Dunes Wilderness.

Identification: This is a difficult genus to differentiate. DNA studies may soon make this easier, but they are beyond the means of the novice. *Phellinus linteus* is hoof shaped and bitter, found growing in the wild on mulberry trees; considered subtropical. Color ranges from dark brown to black; spores are light to dark brown. *Phellinus pini*, like *P. linteus*, is a parasitic pathogen of trees, typically conifers. Found on pines in the northern tier of states and especially the west. *Phellinus everhartii* is the species photographed here. It is widespread and typically found on oak. Spore print is reddish brown. All 3 species may present a dry, hard, cracked, and fissured appearance.

Habitat: *P. linteus* typically found on mulberry trees, though rare in nature; fruiting body is hard and visible year-round—not easily found but available

as a supplement in Asian markets. *P. pini* found on conifers in northern states. And *P. everhartii* found on deciduous trees in eastern and Midwestern states.

Edibility: INEDIBLE—use only as a supplement.

Traditional: Used as a medicinal for centuries in Japan, Korea ,and China to prevent ailments as diverse as gastroenteric dysfunction, diarrhea, hemorrhage, and cancers. Koreans consume this mushroom as traditional medicine in the form of hot tea.

Research: *P. linteus* is promising anticancer therapy that is chemoprotective in vitro and in animal studies. It has anti-angiogenic, antioxidant, and xanthine oxidase–inhibition properties. May prove effective against breast, colon, liver, lung, oral, prostate, and skin cancers. Harvard Medical School and the National Institutes of Health reported that although *P. linteus* is promising, more research is required to understand the mechanisms behind its anticancer activity (Li et al. 2004)

A water soluble extraction from *P. pini mycelium* showed immune modulating and anticancer potential. Also polysaccharides from *P. pini* are antiviral (Sliva 2010).

Extracts from fruit bodies or mycelium of *P. linteus* stimulate the hormonal and cell-mediated immune function, quench the inflammatory reactions caused by a variety of stimuli, and suppress tumor growth and metastasis (Li et al. 2004). May be useful in preventing damage from advancing age and chronic diseases such as cardiovascular diseases, Alzheimer's disease, cancer, peripheral neuropathy, and deafness.

A study reported that *P. linteus* regulates two responses in the lung cancer cells: cell-cycle arrest and apoptosis, both important cell regulating processes in fighting cancer (Jinjin Guo et al. 2007).

Storage: Store dried and powdered in sealed container. Available as supplement in health food stores.

Notes: This is one of the most studied families of mushrooms. Species identification in photo based on physical appearance, tree parasitizing (oak), and spore color. I reserve the right to change species when I return to Nordhouse Dunes for microscopic spore study and chemical analysis. Follow Jim Meuninck on Facebook. *P. everhartii*, I believe, will bear health-protecting chemistry when thoroughly researched.

CHAGA, CLINKER POLYPORE—INEDIBLE

Hymenochaetaceae (*Inonotus obliquus* Pers. FR.)

Origin: Latin *inonotus* meaning "fibrous ear."

Identification: Chaga, also called clinker polypore, is not your typical-looking fungus. It looks more like a large brown to black canker sore on the birch or beech host—a hard, dense, deeply cracked, pebbly, and corky texture, as if a dried burn scar. Dark outer brittle; pieces may flake off. The core of the mushroom is yellow to yellow brown with bits of white mixed in. It is

Chaga, the sclerotium and harvested core

moderately hard, requiring a saw or axe for harvesting. A potentially large mushroom up to 5 to 6 pounds.

Habitat: Chaga is found year-round persisting typically on older birch trees; it is available for many years—most often on yellow or white birch. It's possible to find it on gray birch, but a dying gray birch is more likely infected with *Piptoporus betulina*, the birch polypore. Seek the fungus in the winter, in lowlands of cedar and tamarack; often found high on the host tree and difficult to see when obscured by leaves. Trees scarred during lumber harvest often develop chaga on the wounds. Broken limb scars often fester with the fungus.

Edibility: INEDIBLE—used in alternative medicine as a health-protecting tea or tincture.

Traditional uses: Chaga used in folk medicine in Russia, Poland, and the Baltic countries as a cleansing and disinfecting supplement. It is prepared in decoction for stomach diseases, intestinal worms, liver and heart ailments, and cancer treatment. Russians have used the mushroom since the 16th century to treat various cancers; the preparation Befungin (available online), an alcohol extract, has been sold in Russia as a cancer treatment since the 1960s. In Siberia, chaga extract and tea have been used for hundreds of years to treat stomach diseases, liver problems, worms, and tuberculosis; it still enjoys popularity as a health-protecting tonic. Folk practitioners suggest chaga found on birch (versus other trees) has best qualities. Cree called the mushroom "*wiskakeeak omikih*"—the scab thrown against a tree to benefit mankind. The mushroom incense for smudging ceremonies kept tobacco burning in ritual pipe smoking. Also used instead of hops in beer making.

Research: Chaga has high antioxidant content and immune-stimulating properties. Compounds in chaga are betulinic acid, melanins, polysaccharides, and beta-glucans and the mushroom is considered one of the highest sources of antioxidants. Betulin found in birch bark is converted by chaga to a digestible form. It has anticancer, antimalarial, anti-retroviral and anti-inflammatory properties and currently is being studied for use as a chemotherapeutic agent. Melanin gives chaga its black color and is an antioxidant with restorative properties for the skin, hair, and eyes. Chaga's immune-stimulating polysaccharides reported to relieve chronic gastritis and treat ulcers. Polysaccharides from chaga exhibited many biological activities including antitumor, antioxidant, hypoglycemic, immune-stimulating effects, and so on. Ultrasonic technique was an effective method to extract bioactive polysaccharides from *I. obliquus* (Lingling et al. 2010). In a cell-culture study, chaga elicited anticancer effect on human lung carcinoma and colon adenocarcinoma—effects attributed to decreased tumor cell proliferation, motility and morphological changes. Of note, the preparation produced no or very low toxicity in tested normal cells. Animal studies showed treatment with *I. obliquus* led to a significant decrease in blood glucose levels in induced diabetic mice. Chaga significantly decreased the total cholesterol level in serum, increased glutathione peroxidase activity, and improved the growth physiological characteristics of the rodents. Terpenoid and sterol compounds appeared to be the major active constituent (Lu et al. 2010).

Seventy percent ethanol tincture of chaga reported effective as an anti-inflammatory and a Polish study with humans showed a reduction in tumor size in 10 of 48 patients (Stamets 2015).

CAUTION: Because of possible interaction with medications, use chaga extracts under your holistic health-care practitioner's supervision—good advice for using any mushroom in this book.

Storage: Dried as a powder and sealed, it will keep for 6 months in a freezer.

Notes: Use chaga for dyeing paper and cloth, yielding a yellow or sepia color, depending on mordant used; chaga will dye wool orange-brown without mordant. Dried chaga is fire-starting tinder and burned as incense. It requires little preparation as a fire starter: Use a hatchet, cleaver, hammer, or axe to remove the fungus from the tree; it is most easily removed when frozen. Then chop the mushroom into small pieces for drying and subsequent use. Dry twice in an electric dryer or an oven at 125°F: First dry for 24 hours, and then remove and cool for 24 hours; dry again for another 24 hours or until bone dry. For finer tea powder, grind it in a heavy-duty blender, or for a smaller measure, use a cheese grater. Contrary to documentation, I have witnessed chaga attacking young birch trees.

Chapter Four

Boletes

Boletes are mushrooms with spore-producing pores instead of gills that typically are found growing on the ground. Stems are centered and are either smooth, striated, dotted, or scabbed. Most are edible, and they include many delicious mushrooms. They comprise over 200 species; very few are toxic. With that revelation, follow this conservative advice:

1. Avoid boletes with reddish or orangish pore surfaces, and those that bruise blue when touched, pinched.
2. Avoid those that have yellow pore surface and bruise blue.
3. Avoid all orange-capped *Leccinum* species. *Leccinum* is identified by "scabers" on their stems (see photo). You'll miss a few edibles this way but play it safe.

Bolete colors range from brown to yellow or red and various shades of the same. Caps are dry or slippery, smooth or scaly. Stems vary from solid to hollow and may be smooth or show vein-like ridges, dots, and tufts. A partial veil and ring may be present or absent. Spores produced in tubes show either a round or triangular pore. With younger mushrooms, the tubes may have a cotton-like plug. Pore color varies from white, yellowish, red, or green and may bruise to blue, blue-green, blackish, or reddish. Spore-print color varies from olive to brown, black, pinkish, or yellowish.

Find boletes in the summer and fall all across the nation. Eat them when they are young, firm, and fresh. The photos are a sample of several boletes found during July and August in Michigan, Wyoming, Montana, and Washington.

King Bolete, Cep, Porcini, 31

Leccinum *species with scabers on stem*

A fine clutch of boletales north of Ludington, Michigan

Lunch! Edible boletales from West Ten Sleep Lake, Montana

King bolete found in the Upper Meadows Campground off SR 14 in Colorado.

KING BOLETE, CEP, PORCINI

Boletaceae (*Boletus edulis* Bull.)

Origin: Latin *boletus* means "mushroom"; *edulis* means "edible."

Identification: 3"–10" in diameter, a bun-shaped mushroom with a moist, smooth, and viscus surface (like a browned hamburger bun). Color variable from biscuit brown and paler; margins paler. Flesh is thick, often infested with worms, insects, and larvae. Tubes instead of gills, with the tube ends appearing to be stuffed with pith, first white in color and turning yellow, olive, or olive-yellow as it ages—solitary and scattered and occasionally in groups of two or three.

Habitat: I find king boletes in and around Yellowstone National Park in late July and August, typically in recovering burn areas, along trails, and in campsites with 3'–10' spruce and pine new growth. Often near streams with much dead timber on the ground. Farther west in Montana, I stumble across them in campgrounds and along the edges of streams, around the first and second week of August. The campgrounds and parks staggered along SR 14 in northern Colorado burst with ceps in middle August—look along stream banks and edges of trails.

Edibility: *B. edulis* is considered one of the safest wild mushrooms to pick for the table. They are watery, so slice thin and sauté. Cook them crisp with a strip or two of bacon. Eat or prepare as soon as possible; shelf life is short. Add to soups, pizza, and barbecue.

CAUTION: The mushroom chelates toxic heavy metals, such as selenium and cadmium. Avoid these mushrooms downstream of metal mines and in areas polluted by toxic tailings.

Traditional uses: One of the most important medicinals of the Nahua people in the Mexican state of Tlaxcala.

Research: *B. edulis* is an antioxidant and antimicrobial food. A novel lectin from *B. edulis*, purified from the fruiting bodies, has potent anti-proliferative effects on human cancer cells. *Boletus edulis* lectin (BEL) inhibits selectively the proliferation of several malignant cell lines and binds (inactivates) the neoplastic cell-specific T-antigen disaccharide (Bovi et al. 2011).

B. edulis fruit bodies contain approximately 500 mg of ergosterol per 100 g of dried mushroom. Ergosterol peroxide, a steroid derivative of egosterol, is antimicrobial and anti-inflammatory. Lectins in the mushroom stimulate cell division and are antiviral, inhibiting in vitro HIV. Antiviral activity extends to tobacco mosaic virus and *Vaccinia* species. Highest antioxidant activity appears to be in the edible cap. This anticancer activity is unsupported conclusively in recent research, however.

Storage: Cook into dishes and then freeze. Slice thin and dry. The flavor (like oyster mushrooms) intensifies with drying. Dry by stringing or in a food dryer or oven. Start oven temperature at 100°F with door open, dry between 120°F and 130°F until brittle or crisp; store in sealed jars. Reconstitute in hot water for 20 minutes, then prepare. Use the soaking water in soups or store for later use. The intense odor and flavor of the dried boletus makes this a useful addition to sauces, stews and soups.

Notes: Boletes are putrescent and break down into a slimy, mushy, odorous mass after sitting too long unrefrigerated. Insects love this mushroom and almost instantly climb aboard. Pick them in the morning, hopefully on the first day, to secure insect-free specimens. This is often a large and abundant mushroom; take only what you can use.

Chapter Five

Tooth Fungi

This group of mushrooms bears spores on teeth-like projections called spines or pendants. They are in the phylum Basidiomycota and produce spores in basidiocarps. Covered here are the almost unmistakable edible species *Hericium erinaceus* and *Hydnum repandum*—the hedgehog mushroom—as well as the inedible *Climacodon septentrionali*, the northern tooth fungus.

LION'S MANE TOOTH FUNGI, BEAR'S BEARD, OLD MAN'S BEARD

Hericiaceae (*Hericium erinaceus* (Bulliard: Fries) Persoon)

Lion's mane, Hericium erinaceus

Origin: Latin *hericium* means "hedgehog" or "shaggy"; *erinaceus* means "hedgehog".

Identification: Generally, a solitary white rot saprobe, 2"–20" across, a white, toothy mushroom that yellows with age. Sometimes called lion's mane, it presents as a cascade of dangling white spines (pendulous icicle-like teeth), which give this fungus its common name. Spines may up to 2" long, and give the fungus the appearance of a lion's mane or a frozen waterfall. Spore print is white. Mushroom attached to tree with a thick, tough, and solid central stalk.

Habitat: This mushroom, always a surprise, may be found singly and occasionally in pairs on a wound from a deciduous tree (hardwood), typically beech, maple, sycamore, oak, and rarely conifers. You may have to climb to harvest. Found most often in beech-maple climax forests in the Midwest and elsewhere. Various species found in the western, eastern, and southern states. Available in late summer and throughout the fall—available also in mushroom growth kits at farm markets or on line.

Toothy and delicious

Edibility: A delicious, sweet-tasting mushroom, lion's mane's succulent texture and mild flavor make it one of the best edible mushrooms. Sauté and eat by itself or serve hot in a vegetarian sandwich. Soften mushroom with cooking, which also rids some of the water from these hydrated specimens. It goes well with lemony marinades.

Traditional uses: In Traditional Chinese Medicine it is used to treat stomach and digestive problems including gastric ulcers and as a stimulating tonic in treating fatigue, neuralgia, headache, and other symptoms of neurasthenia. Native Americans used the dried powder of the mushroom to stem bleeding (styptic); powder was carried in a leather pouch as a first-aid kit.

Research: This mushroom is rich in physiologically active compounds, especially beta-glucan polysaccharides, which are responsible for anticancer,

immuno-modulating, hypolipidemic (antidiabetic), antioxidant, and neuroprotective activities. *H. erinaceus* also reported to have antimicrobial, antihypertensive, and wound-healing properties. One study investigated the antimetastatic (inhibits the spread of cancer from organ to organ) activity of four *H. erinaceus* edible mushroom extracts using CT-26 murine colon carcinoma cells as an indicator of inhibition of cell migration to the lung. Hot water and ethanol extractions of *H. erinaceus* elicited cancer-cell death through apoptosis (normal cell death) and inhibited metastasis of cancer cells. These results demonstrated the effectiveness of hot water extraction and microwaved 50% ethanol extraction as beneficial anti metastatic agents. Results suggest *H. erinaceus* as an edible mushroom has the potential as a health-promoting functional food (Khan et al. 2013).

H. erinaceus extracts show promise fighting pancreatitis and certain cancers, including intestinal, pancreatic, and esophageal cancers. When taken in the course of chemotherapy, extracts significantly reduced the side effects, such as fatigue, sickness, and nausea. In addition, *H. erinaceus* may counter osteoporosis (Yang, Newman, and Schulick 2011).

Palmitic acid, threitol, and D-arabinotol found in lion's mane and tested in an animal model showed the fungi's ability to reduce blood sugar and regulate lipid levels. Other studies showed the presence of antioxidants and nerve-cell stimulators, leading to enhanced cognitive function. Erinacines from lion's mane are potent stimulators for the production of nerve growth factor; nerve growth factor stimulators might play a role in treatment of many types of nervous system disorders including Alzheimer's disease and other forms of dementia. Of interest to multiple sclerosis researchers is that myelination was also enhanced. The anti-inflammatory chemistry of lion's mane may be useful to curb inflammation and cool gastric and esophageal ulcers (Yang, Newman, and Schulick 2011).

Erinacine and its derivative from lion's mane inhibit the kappa opioid receptor sites in the brain, providing protection from seizure and neural cell damage (Rogers 2011). Evidence suggests that this mushroom affects the response to allergies by lowering the allergy sensitivity. It also improves numerous conditions such as multiple sclerosis, neuronal degeneration, Alzheimer's disease, autism, and muscular dystrophy. It has a direct benefit slowing the aging process by prolonging brain plasticity and memory retention (Stamets 2010).

Storage: Store in prepared dishes in your freezer. Double-wrap to prolong storage longevity.

Notes: Hot-water extraction of the mushroom used as a performance-enhancing sports drink. I find one to a tree in October throughout the Midwest.

HEDGEHOG, WOOD
HEDGEHOG, SWEET TOOTH

Hydnaceae (*Hydnum repandum* L.)

Hydnum *species, hedgehog found in the Nordhouse Dunes Wilderness, MI*

Origin: Latin *hydnei*, "those with spines or tubercles"; *repandum* means "spreading."

Identification: *H. repandum* is micorrhizal and symbiotic with hardwoods and conifers; it prefers fir trees. It shows an orange, yellow, or tan cap up to 7" wide, typically smaller, studded underneath with teeth—a defining feature. It is an edible mushroom with no poisonous look-alikes, somewhat irregular in shape, concave or convex with a wavy margin that is inrolled when young. Shape of the cap becomes more irregular when crowded in clusters. Cap surface is generally dry and smooth, with mature specimens displaying cracks. Flesh is white, thick, firm, but brittle, and bruises yellow to orange-brown. Spines are slender, small, whitish measuring 0.1"–0.3" long. On close inspection spines may run down the stem on one side. Stem is 1.2"–3.9" long and 0.4"–1.2" thick, either white or the same color as the cap, and may be off-center. Spore print is pale cream. Spores are smooth, roughly spherical to broadly egg-shaped, and may contain a single oil droplet. There are two edible look-alikes: a pure white variety of this species, *H. repandum* var. *album*, and the giant hedgehog (*Hydnum albomagnum*). *H. albidum* has a white to pale yellowish-gray fruit body that bruises yellow to orange. *H. albomagnum* is large and paler than *H. repandum*.

Habitat: The fruiting bodies grow from the ground singly or in groups (and occasionally in fairy rings) on the ground or in leaf litter in both deciduous and coniferous forests. They are closely related to chanterelles and found with or near them. Available from summer to autumn, they are widely distributed in the northern temperate areas as well as Australia, Europe, and northern Asia.

Edibility: Good to very good with a sweet, nutty taste and crunchy texture. Brush the cap and stipe after harvest and avoid getting soil stuck between the mushroom's teeth. A versatile mushroom that tastes great alone; also may be pickled or simmered in stocks where it borrows the flavors of the ingredients. The fungus may be dried and ground into powder and used as a pepper substitute; use the powder to flavor roasts, steaks, soups, and chili. Freeze or dry for storage. Older caps respond to boiling or cooking in butter, which helps eliminate their bitterness. Specimens found under conifers may taste stronger. Hedgehog has a very high food value of 434 kilocalories per 100 g.

Traditional uses: Swiss consider the mushroom psychoactive.

Research: Shows blood-cholesterol-lowering ability in animals. Chemical diepoxide shows cytotoxic activity against several tumor cell lines in vitro, including sarcoma 180 cancer cell lines and Ehrlich carcinoma (Dembitsky et. al. 2013). Chloroform extracts of the fungus show mild antibiotic effect against *Enterobacter aerogenes*, various staphylococcus organisms, *S. epidermidis*, and *Bacillis subtilis* (Takahashi, Endo, and Nozoe 1992). At the molecular level, repandiol, an alkylating agent, inserts cross-links between strands of DNA, making it difficult for the genetic material to express or replicate (Millard et al. 2004). European studies conducted after the 1986 Chernobyl (Ukraine) meltdown have shown the fruit bodies have a high rate of accumulation of the radioactive isotope cesium (Stachowiak 2012).

Notes: In France, the mushroom's common name is *pied-de-mouton* (mutton's foot). Mexico, Spain, and Canada also market the mushroom. It is a favorite with wild ungulates and squirrels.

NORTHERN TOOTH FUNGUS—INEDIBLE

Hydnaceae (*Climacodon septentrionalis* (Fr.) Karston)

Origin: Latin *clima* meaning "climate"; *septentrionalis* meaning "of the north."

Identification: This is another tooth fungus that has a large shelflike fruiting body with overlapping fan-shaped caps growing in horizontal clusters 6"–13" high, arising from a solid base that forms an attachment about 1.5" wide where it enters the wood. Cap is 5"–6" across, 1"–2" thick near the base, the mushroom's cap color out toward the margin is whitish to yellowish or buff,

Oops! Not a chicken mushroom, it's a tooth fungus.

turning brownish-yellow when dry, densely hairy and roughened cap surface. Spines on undersurface ½ inch plus or minus long, narrow, with lacerated tips, crowded, pliable; dull white dries to yellowish. Flesh up to 2.5" thick, fibrous, tough, elastic; white; no odor or a mild one when fresh—it smells like ham when dried. Mild or no taste when fresh; bitter when old. Spore deposit white.

Habitat: Found high up or in the wounds of living deciduous trees (maple, beech, and birch). Found widely distributed in northeastern North America as far south as Tennessee and in Europe. Season is July through October.

Edibility: INEDIBLE—do not consume.

Research: Shows moderate in vitro inhibitory activity against *Staphylococcus aureus* and *Escherichia coli* (Robbins et al. 1945).

Notes: While driving back roads looking for mushrooms (a hazardous preoccupation I can't shake), I have mistakenly identified this tooth fungus for a white chicken mushroom (a polypore). A closer inspection reveals the truth. With its large spore-producing surface area, this parasitic fungus quite often targets old large sugar maples—disheartening for me: The sight of this fungus spells the end of a great tree.

Chapter Six

Cup Fungi

These fungi are cup shaped or disklike. Spore-producing asci (ascomycetes instead of basidiomycetes) line the inner surface of the cup or the upper inside surface of the disk or peel. This is a huge group of fungi with only a couple commonly found species covered here.

Scarlet Cup, Scarlet Elf Cap, 40

SCARLET CUP, SCARLET ELF CAP—INEDIBLE

Sarcoscyphaceae (*Sarcoscypha coccinea* (Scop.) Lambotte)

Scarlet cup fungi

Inedible devil's urn, distinctive, 1.5"–2.5" in diameter, found near scarlet cups

Origin: Latin *sarco* and *cypha* roughly means "fleshy drinking bowl"; *coccinea* means "scarlet color."

Identification: Saprobe, wood-decaying cup fungus with a round fruiting body at first and then cup shaped or saucer shaped. Size is about 1"–2" in diameter. Inside of cup is red, often deep red; may fade to orange with age or drying. Inner surface is smooth; outer surface is whitish with dense, matted fine small hairs. Stem, if present, is up to 1.6" long and 0.1"–0.3" thick. Spores are translucent with fat droplets at each end.

Habitat: The cup fungus grows on decaying wood in deciduous forests of rose, beech, hazel, willow, and elm. It is prevalent early in the season, often prior to morels, heralding the mushroom-foraging season. Found throughout the Northern Hemisphere from the Midwest to the Pacific Coast, north into Canada, and south into Mexico. Latitude will determine when available.

Edibility: INEDIBLE—various mycologists say it is edible, while others say it is not edible. Do not consume.

Traditional uses: The mushroom was used by various Native American nations. It was dried and ground into a styptic powder and applied to wounds, including the navels of newborns. Crushed or powdered the mushroom was used under wound dressing such as deerskin. No longer in wide use.

Research: A lectin (sugar-binding protein) purified from the mushroom is used to bind selectively to several specific carbohydrate molecules to include lactose.

Notes: Scarlet cups, as well as *Gyromitra* species, morels, wood ears, oyster mushrooms, and dryad's saddle, kick off the foraging season, and they are a most welcome sight. The devil's urn, a saprobe, is inedible and distinctive.

Chapter Seven

Jelly Fungi

Mushrooms that are amorphous, gelatinous mushrooms come in many sizes and all shapes and shades. They are saprobes and found on dead, decaying wood. Of the jelly fungi, wood ear is tastiest, but most are considered inedible (unless, of course, you are my mycology instructor), but they are always a delight to see and worthy members of an ever-expanding repertoire of your fungi knowledge.

Wood Ears, 42

Wood ear mushrooms, found May 5 in Indiana

WOOD EARS

Auriculariaceae (*Auricularia aricula-judae* (Bull.) J. Schröt.)

Origin: Latin, *auricula* meaning "external ear."

Identification: Rubbery fruiting body of this saprobe resembles an ear. It is 1"–3" across, with a jellylike texture that snaps in the mouth like a rubber band. It is tan-brown with grayish hairs on the velvety inner surface. Stretch the mushroom to make certain it is elastic and rubbery; this fungus is more rubbery than cap fungi. It emits a white spore. For safe identification, find this mushroom in Asian groceries where it is sold for its medicinal and culinary benefits.

Habitat: Woods, fringes of woods, edges of streams, ponds, and lakes; grows on wood (disintegrating, rotted wood) that can be shredded with your fingers—many sources mention elder trees as a preferred habitat. Although available for several months, we find it rarely, or rather accidently, stumbling over it. Begin your search in the spring while morel hunting.

Edibility: Wash thoroughly, then add to Asian stir-fry, or simply sauté in butter—an interesting chewy texture and surprisingly good taste—great in sauces cooked with wild leeks, thickened with sour cream, and served over toast. The fungus is a popular ingredient in hot-and-sour soup.

Traditional uses: Legend says this fungus emerged for the first time in the shape of an ear on the site where Judas died. *A. auricula-judae* was a folk

Other Jelly Fungi

Here are a couple jelly fungi you may discover:

Heterotextus alpinis

Heterotextus alpinis, the golden jelly or alpine jelly cone, is a western jelly fungus found in groups on dead conifers. Fruiting bodies are yellow to orange; small 0.16"–0.3 inch (4–8 mm); bell-, pendant-, cone-, or fan-shaped; often hanging from a single point of attachment like a gumdrop. Photograph shot at 7200 feet, near a melting snow field in Wyoming's Cloud Peak Wilderness. This mushroom is eaten by many (not me) and is said to be bland to tasteless. As folk medicine, it was (is) eaten to treat headaches.

Ductifera pululhuana—**INEDIBLE**—the white jelly fungus, is a saprobe found in eastern and southern North America on old, barkless, decaying hardwood. It often forms a gelatinous brain-like mass, made up of fleshy, thick and stemless blobs that, when linked together, form a mushroom up to 5" long. As it ages, color changes from white to yellowish, brownish, pinkish, or purplish. I have tasted the mushroom in Asian soups, and the texture is soft, spongy, and slimy, a bit like soft *omochi* (Japanese holiday rice candy without the sweetness). A few other sources say the mushroom is edible, but more documented experiences are needed, so **avoid**.

White jelly fungus, found September 28, Warren Dunes, MI

medicine treatment for sore throats, sore eyes, and jaundice. It is astringent and also used in Ghana as a blood tonic.

Research: Research into possible medical applications variously concluded that *A. auricula-judae* is antitumour, hypoglycemic, anticoagulant, and has cholesterol-lowering properties. Polyphenols and polysaccharides in *A. auricular-judae* have antioxidant activity and inhibit proliferation of vascular smooth muscle cells, providing a functional food to help prevent atherosclerosis (Luo et al. 2011).

As a functional food for the elderly, the mushroom is anti-inflammatory, antioxidant, anti-thrombotic (anticoagulant via inhibiting platelet aggregation), anticholesterol, and cardioprotective; simply grow or forage for the mushroom and then eat it (Powell 2014).

In another study, the extracts from *A. auricular-judae* showed significant anti-inflammatory action (Damte et al. 2011).

Recent investigations strongly suggest A. *auricular –judae* polysaccharides show an antidiabetic hypoglycemic effect, reducing plasma glucose, insulin, urinary glucose, and food intake (Yuan et al. 2005).

CAUTION: Dr. Dale Hammerschmidt, a hemotologist from Minnesota, linked eating wood ear mushrooms to bleeding and its antiplatelet aggregating activity. People on blood thinners should consult their physician. *A. auricular-judae* may possess a possible anti-fertility agent and should not be taken by pregnant or lactating women or those planning to conceive.

Storage: Holds up either dried and kept in sealed jars, or frozen in cooked dishes and double-wrapped.

Note: I found wood ears the first time while searching for morels; they were growing on small lengths of rotting wood (probably elder), and I found them throughout the spring and summer. The best time to hunt and taste them is after a soaking rain.

Chapter Eight

Chanterelles

Chanterelles are some of my favorite edible mushrooms. Here are three of the best—available from June through October in the north-central United States. They can be found from coast to coast with species and seasons varying by latitude and altitude.

Red chanterelles, C. cinnabarinus*, from knoll in a deciduous forest—delicious*

CHANTERELLES

Cantharellaceae (*Cantharellus cinnabarinus* Schwein; *C. lateritius* (Berk.) Singer)

Origin: Latin *cantharellus* means "vessel"; *cinnabarinus* refers to cinnabar red.

Identification: Numerous species of small to large mushrooms with primitive spore-producing folds instead of gills. At first convex then flattened with depressed center in broadly convex to vase-shaped. Margin is inrolled and wavy. Color varies from yellow to pale orange-yellow, cinnabar red, or peach. Surface is dry and smooth or tomentose (covered with minute densely matted filaments). No true gills, but false gills wrinkled, veined, and cross-veined descending the stem. The gills are wrinkles or folds in the mushroom's surface and not separate and distinct from the cap and stem. Stem is without ring and near the color of the cap. Underside of cap is orange to pale yellow. Odor hints of fruit—perhaps apricot. Ellipsoid spores leave a white to pale yellow spore print. Flesh is firm and solid, white to pale yellow, with no change in color when sliced. Taste is mild to peppery.

C. lateritius has faint folds or lacks folds under cap and is a bit larger than a yellow chanterelle. Found in association with oaks. Cinnabar red *C. cinnabarinus* is tiny in comparison to a large *C. cibarius*. Fruits from early summer into fall with a pink spore print. Found under hardwoods in eastern forests.

Habitat: Found growing throughout North America on the ground in coniferous and deciduous forests as micorrhizal partners with oaks and fir trees, from late June to August in the eastern United States, September through November in Pacific Northwest, and November through February in California. They grow singly, scattered, or in colonies.

Smooth chanterelles, Cantharellus lateritius

Edibility: Tastes floral, smells fruity, and is often abundant. Prepare without washing—brush clean—and toss, stir-fry, or sauté. Then dip into or drizzle with warm brie cheese. Chanterelles complement meat, poultry, fish, and shellfish; add white wine to the cooking juice and then gently finish cooking the mushrooms in the reduction. Try tossing them with a pinch of thyme and a minced garlic clove in ½ teaspoon of olive oil and a slice of bacon. When the bacon is crisp, the mushrooms are ready. Sauté in butter when in a hurry, then cover a piece of toast with the end result.

Chanterelles photo taken in August 2014; in 2008 they sold for $4.25/pound.

Traditional uses: In the early eighteenth century chanterelles entered the palace kitchens of Versailles. In Bhutan chanterelles are cooked with cheese and chili peppers.

Research: Chanterelles are relatively high in potassium, vitamin C, and rich in vitamin D_2. Their potassium content makes them a good addition to a blood-pressure-lowering diet. The alcoholic (methanol and ethanol) extracts of *Cantharellus cibarius* have antioxidant, antimicrobial, and other phytochemical potentials. Extracts contain phenols, terpenoids, flavonoids, alkaloids, anthraquinones, and saponins. Both methyl and ethanol extracts inhibited *Escherichia coli* and *Candida albicans* in vitro—and the methanol extract also inhibited the growth of *Salmonella typhi*, indicating a broader spectrum of activity from the methanol extract. The ethanol extract possessed greater antifungal activity, however. Chanterelles also possesses bioactive metabolites and phytochemical antioxidants capable of scavenging free radicals (Aina et al. 2012).

CAUTION

Never mistake chanterelles for *Omphalotus illudens*—the poisonous jack o'lantern mushroom and other *Omphalotus* species. The jack o' lantern grows on stumps and underground roots. False Chanterelle, *Hygrophoropis aurantia*, a chanterelle look-alike, is inedible with true gills and a hollow stem.

Poisonous jack o' lantern, Omphalotus illudens.

Storage: Best fresh but holds up to refrigeration and drying. An hour's exposure to sunlight may increase the vitamin D_2 content improving its nutritional value.

Notes: Research suggests that chanterelles have insecticidal properties but are harmless to humans. In an old-growth beech-maple forest nearby, where a few grand oaks hold off the climax species, I find *C. cibarius*.

BLACK TRUMPET, HORN OF PLENTY

Cantharellaceae (*Craterellus cornucopiodes* (L.) Pers.)

Origin: *Craterellus* is Greek for "cup, drinking vessel"; *cornucopiodes* refers to cornucopia or horn of plenty.

Identification: A thin-fleshed, fragrant, and funnel-shaped mushroom. Lower end of the stem is pinched. Cap and stem integrated and not separately defined. They grow singly but more often in tight clusters or groups of clusters (keep looking, there are more). From 0.75"–4" wide and 6"–7" tall, but typically smaller. First appears tubelike and then like a deep vase, upper edge rolled under. Flesh is smoky brown to black or dark gray. Surface is smooth or scaly with fibers or dark scales over a grayish to gray-brown base. Outer surface is smooth to slightly wrinkled as it ages. Funnel may open and become wavy at maturity. Spore print is salmon colored, yellowish, or cream colored.

Black trumpet found October 4, southwest Michigan

Habitat: A saprobe found growing from the ground typically on moss and perhaps having a symbiotic relationship with it. In southwest Michigan, it is found in association with beech trees and may have a symbiotic (mycorrhizal) relationship with trees (also found under conifers).

Edibility: Edible, excellent, easily cleaned, very good dried, and takes on the flavor of black truffles; powder some and use as a condiment on savory dishes. They are great sautéed or tempura-fried in a thin batter. Excellent crumbled on pizza. Crush fine, sauté in butter, and press into soft cheese. Allow to infuse for 24 hours in the refrigerator, then serve. For your first effort, sauté and get a taste of the flavor—new ideas will emerge.

Toxic Look-alikes

BEWARE, toxic devil's urn is a spring mushroom and grows on wood. Do *not* ingest.

Devil's urn near Messick, MI

Traditional uses: In French cuisine prepared in terrine (like meat loaf). Also used in marinades, dressings, and as integral ingredient in Moroccan tagine dishes, and fricassees.

Research: The mushroom's nutrient profile (per 100 g): 13.4 g carbohydrates includes mannitol and sugar, 4.9 g fat, 69.5 g protein, with 378 calories and 87 mg of vitamin C. Health-promoting nutrients include polyunsaturated fats and phenolic compounds, including numerous flavonoids. One undocumented source reported the mushroom stimulates the body to metabolize stored fat.

Notes: Although difficult to find, these mushrooms show up at the same sites every fall. Once you discover them, you have an annual source. They grow on moss and show up better than most field guides suggest. Look for moss forming a north-side mantle around beech or oak and start finding this mushroom.

Chapter Nine

Coral Fungi

These mushrooms have the shape, variety, and color of the marine corals, hence the name. A few are edible and others are toxic. Here is an edible one to start you on your journey. There are over 600 varieties of coral fungi.

Crown Coral, 52

Crown coral partially obscured by a competing polypore

CROWN CORAL

Auriscalpiaceae (*Artomyces pyxidata* (Fr.) Doty)

Origin: Latin *auriscalpium*, roughly meaning "ear pick."

Identification: Crown coral is a saprobe, found on rotting wood. The shape and points (typically four) on the tips of branches are distinctive—2"–5" tall. Color is pallid to dull ocher, tan to pinkish. Basidia and basidiospores are produced on the surface of the branches. Peppery when raw and nondescript when cooked.

Habitat: On decaying wood throughout North America; widely available in late summer through the fall.

Edibility: I like to sauté the mushroom in oil for a couple minutes, then add water, cover and let simmer until tender—a survival food.

CAUTION: A few people experience gastrointestinal upset when eating this fungus, especially when overeating it, although finding enough for a meal is somewhat challenging.

Research: The sesquiterpenes pyxidatols A-C, tsuicoline E, and omphadiol have been isolated and secured from the liquid culture of this fungus; sesquiterpenes are anti-inflammatory and antiseptic.

Notes: Upon close inspection, the tips on the branches of this coral have distinct points like the pearls or points above the arches of the crown (see photo). I have seen this coral in Ohio, Michigan, Indiana, and Washington State.

Chapter Ten

Gilled Mushrooms

I find more toxic gilled mushrooms than edibles—and many more I can't identify. It's challenging. But this chapter contains those that I have added to my own diet.

Shaggy manes found along a dirt road in a Montana campground

SHAGGY MANE, SHAGGY INK CAP, LAWYER'S WIG

Agaricaceae (*Coprinus comatus* (O.F. Müll.) Pers.)

Origin: *Coprinus* from Greek meaning "dung"; Latin *comatus* for "long haired."

Identification: *Coprinus comatus* is common and often seen growing on lawns, and along gravel roads and restored areas. The young fruit bodies first appear as emerging white cylinders pushing up from the ground. They continue to grow, forming into an elongated bell-shaped cap covering most of its stem. The stem continues to grow, the bell-shaped cap begins to open and disintegrate. Caps are white at first and covered with scales (scales are pale brown at apex), providing the origin of the name. Crowded free gills change rapidly (within hours) from white to pink, then to black, and it dissolves, depositing its spores. It is deliquescent; that is, it absorbs water and is best dry-brushed clean. The stem (stipe) has a loose ring and measures 3"–12" tall and 0.5"–1" in diameter. The flesh is white, and the taste mild. The spore print is black-brown.

Habitat: Shaggy manes grow in often unexpected places—yards, grassy roadsides, hidden under shrubs, aprons of grass along wood lots, edges of dirt roads, and meadows throughout North America—often fruiting in large numbers. Gather young fresh caps; available late summer through fall.

Edibility: The young mushrooms, before the gills start to turn black, are edible. Eat as soon as possible after collecting. For long-term storage, microwave, sauté, or simmer until limp, double-bag, and store in a refrigerator for several days or freeze. Use liquid left from cooked shaggy manes as a chicken-stock substitute in soups. This mushroom's robust flavor makes for tasty dishes, from tetrazzini to cream soups, but eat the mushroom before it begins to blacken and liquefy. Eating the dissolving mushroom is not harmful,

but the slimy mouthfeel and scant flavor are less than rewarding. Remember water hastens their deterioration. This fragile mushroom requires careful collecting and gentle handling.

CAUTION: Let these mushrooms emerge from the ground before harvesting to be certain they are not toxic amanitas. A few *Coprinus* species contain coprine, a mycotoxin. Do not consume these mushrooms before, after, or while drinking alcohol. Be certain you have *Coprinus comatus* before consuming, the safer mushroom to eat. A few individuals have allergic reactions after eating shaggy manes—unfortunately, you won't know until you try it—and in most cases, it is simply delicious. *Coprinus* species accumulate heavy metals including mercury, so avoid mushrooms growing in or around contaminated sites.

Traditional uses: The species is cultivated in China as food. Vietnamese purveyors place shaggy manes upside down inside egg cartons to prevent deterioration during transport, affording an extra day or two before the black deterioration.

Research: *Coprinus comatus* polysaccharides assist recovery in liver-damaged rats and may have human application as such, but as of yet there have been no human trials (Aina et al. 2014).

Another study analyzed the impact of vanadium absorbed by *Coprinus comatus* (VACC) on fracture healing in streptozotocin-diabetic rats. Compared with the diabetic control group, vanadium-treated rats significantly increased bone mineral content, biomechanical strength, and improved microstructural properties of the callus. In conclusion, the study suggests that systemic treatment with vanadium could promote fracture healing in streptozotocin-diabetic rats (Wang et al. 2012).

Storage: For eating and storage, process (sauté) immediately or within 4 hours after harvest to avoid undesirable changes to the mushroom.

Notes: Shaggy manes colonize in large numbers and may produce for 3 or 4 weeks. I find this mushroom while driving down a highway or biking backcountry roads, looking under hedges, and in farm yards. Use the dark juice of the spoiling mushroom as ink or as a hair coloring, or use as face and body paint, fly repellent, as a dye for fabric, paper, and wool.

OYSTER MUSHROOMS

Pleurotaceae (*Pleurotus ostreatus* (*Jacq. Ex FR.*) *P. Kumm*); *Pleurotus pulmonarius* (*Fr.*) *Quel*); *Pleurotus cornucopiae* (*Paulet*) Rolland)

Origin: Latin *pleurotus* means "sideways" or "side ear."

Identification: There are as many as 11 species of oysters, a saprophytic, white rot fungi, typically growing in colonies on wood, with attached gills running down the stem. Stem (stipe) is short and off to the side, supporting a funnel-like cap. *Pleurotus cornucopiae* is white to light gray in color, darkening to brown with age. *Pleurotus ostreatus* starts out white and ages to slate gray then light brown, with white to pale lilac-colored spores variable to lilac-gray.

P. pulmonarius is cream-colored to tan, lilac-hued spore print, and found on dead and living deciduous trees. Take your time and be thorough when identifying, cross-reference with several books and an expert or two.

Pleurotus pulmonarius *on dead beech*

Habitat: Find *P. ostreatus* and *P. pulmonarius* on beech, maple, elm, oak, and birch—predominant on beech in southwest Michigan. They grow in dense clusters and with as many as a half bushel on a downed beech tree. The same tree may support mushrooms for 3–4 years, until lignin decomposition is complete.

Pleurotus ostreatus *ready to steam*

Edibility: Excellent flavor! Panfry, battered in panko (Japanese bread crumbs). Taste great alone, or with your favorite red or white seafood cocktail sauce. Sauté and add to pizza, stuff in eggs, improve sauces, simmer reductions, and make unique and delicious Chinese and Mexican dishes.

Traditional uses: Largest recorded oyster mushroom found in Sicily (1988), weighing 42 pounds, 8' in circumference, 20" thick.

Research: Oyster mushrooms are antibiotic, antiviral, anticancer, anti-inflammatory, and hypocholesterolemic. And when you combine all that with their great flavor, what's not to like? A heat labile lectin exerted potent antitumor activity in mice bearing sarcoma S-180 and hepatoma H-22. Lectin treatment prolonged survival (Wang, Gao, and Ng 2000).

Pleuran, a polysaccharide isolated from *Pleurotus ostreatus*, increased superoxide ismutase and antioxidant activity in an animal model, significantly reducing growth of colon lesions as compared to a control (Bobek 2001).

A study relevant to the food and pharmaceutical industries showed that the ethanolic (alcohol I use is Everclear) extract of the mushroom *Pleurotus ostreatus* is rich in natural antioxidants, strongly suggesting this health-protecting food is a useful "mycopharmaceutical agent" (descriptor coined here) (Jayakumar et al. 2009).

Oysters may be the only food source of statins, like lovastatin, a cholesterol-reducing chemical (Tobert 2003; Memorial Sloan Kettering 2013). Highest content is in gills. Lovastatin also has been found effective in reducing and preventing inflammation in association with pancreatitis (Rogers 2011).

Storage: Oysters dry hard and crisp, intensifying their flavor and odor. I prefer them fresh or cooked in a dish or sauce, then canned or frozen.

Notes: Oysters were abundant and free for the picking May 23. I found them on dead beech, poplar, ash, and maple. They will be available through December. This is the second most abundant mushroom in southwestern Michigan. Identify this mushroom and enjoy a lifetime of good nutrition and good medicine.

ELM OYSTER

Lyophyllaceae (*Hypsizygus ulmarius* Bull. Fr.)

Elm oysters or elm caps on a box elder

Origin: Greek *hypsi zygus* means "carrying high" or "carrying yoke."

Identification: *Hypsizygus ulmarius* is a saprobe, sometimes called the elm oyster. It is white at first, turning with age to creamy buff to tan with a 2"–5" cap, convex with a slightly inrolled margin when young, then becoming flat, perhaps with a somewhat sunken center. At maturity cap may crack and form scales or patches. Gills attached, but do not run down stem; slightly close. Stem is 2"–5" long, stout and inedible, Stems are smooth to hairy and are located slightly off-center to nearly central; sometimes enlarged at base. Flesh is firm and white. Spore print is buff.

Habitat: This saprobe may grow in pairs or small groups but typically is alone in scars and injuries to living elm, box elder, and occasionally cottonwood. Found in the eastern United States and a few western states, including California—available in the upper Midwest about mid-October.

Edibility: The elm oyster is edible, but not so palatable as the *Pleurotus* group. Sauté in butter and a splash of soy with copious amounts of freshly ground pepper. Not likely to occur in large numbers in the field—taste and odor not distinctive, mouthfeel of cooked mushroom slimy.

Traditional uses: Folk food use, especially in Appalachia and by Native Americans.

Research: Immune-modulating polysaccharides providing protection from acute infections (colds and flu).

Storage: Chop, cook, and freeze; drying is not suitable, they get too hard.

Notes: I find elm oysters presiding on older stands of box elder, growing from knot holes and injuries.

Matsutake punching through pine needles

MATSUTAKE, PINE MUSHROOM

Tricholomataceae (*Tricholoma magnivelare* Peck)

Origin: *Trico loma* from the Greek meaning "hair" and "fringe"; Latin *magna vela* meaning "big veil."

Identification: Smooth, white, stocky gilled mushroom with thick stipe (stem) that tapers to a point at the base without an amanita-like bulge. Edge of cap curls under, and when young tissue-like veil presents. Texture of cap and lower stipe firm, and often adorned with brown fibers or scales. Cap matures to cinnamon-brown. Cottony ring present with gills attached to the stem typically with a notch. Gills white at first and then cinnamon-stained. Spore print is white. No color change when cut or sliced for use.

Habitat: Scattered and gregarious under conifers, preferably pines, Douglas fir, lodgepole pines, Ponderosa pine, sugar pine, Noble fir, and Shasta red fir, specifically in western North America, south through California and Mexico—also associated with rhododendron, salal, manzanita, madrone, and tan oak. Found in the autumn in the Pacific Northwest, Oregon coast, and into the Cascades. Northeastern foragers locate the mushroom in jack pine forests; available from September through November.

Edibility: Eat matsutakes raw or cooked; they are in the same league as caviar and truffles. They improve all dishes and are especially delicious raw with salads or sautéed with a sirloin steak. Find traditional Japanese dishes featuring this coveted mushroom online at mssf.org/cookbook/matsutake.html.

Traditional uses: Japanese use of matsutake goes back over 3,000 years. Japanese nobility hunted for them and celebrated their flavor, providing them as gifts and serving them at banquets. Clay statues, thousands of years old, of the fungus have been unearthed in Japan.

Thinly sliced, raw matsutake salad

Research: One study indicated that the purified polysaccharide of *Tricholoma matsutake* is a potential source of natural broad-spectrum antimicrobial activity. They are antitumor and immunomodulating (Hou 2013). Strong scientific evidence suggests eating matsutakes reduces or inhibits the growth of tumors and contain powerful free radical scrubbers, preventing oxidative damage that may lead to cancer. The anticancer health protecting substances are glycans, polysaccharides AB-P, and AB-FP, steroids, uronyde, and various nucleic acid elements (Steady Health 2010).

Notes: Matsutakes found in the Upper Peninsula of Michigan are associated with northern jack pine forests, often struggling up through mats of moss. This is a challenging find as there are several look-alikes; use multiple references and if possible show your find to an expert.

HONEY MUSHROOMS

Physalacriaceae (*Armillaria mellea* (Vahl.) P. Karst)

Origin: Latin *melle*(*a*) meaning "honey colored."

Identification: With as many as nine species, this parasitic mushroom's cap ranges from 0.75"–8" in size, and color varies from honey-like to dark brown with a clearly visible yellow, cottony ring. Stem varies from 2"–6" and is tough, but shreds to fibers (fibrous stem). Gills vary from off-white to dark brown. Flesh is white with strong, sweet odor. Cap almost always has a cluster of tiny scales at its center—shiny and sticky when wet—and often with tufts of tiny hairs. Found in large clumps, dispersing smooth, elliptical pale-cream spores. Because of toxic look-alikes, always, *always!* make a spore print. Once you are certain of the species, stay with that location and don't get creative—there are too many poisonous look-alikes. *You can live without this mushroom.*

Habitat: This forest-damaging parasite attacks both deciduous and coniferous forests; it is found on living or dead trees, stumps, and roots. It is widely distributed in the East and in California, but not the Pacific Northwest, where other varieties of the genus reside. Season from early summer to early winter; may reappear at the same location in the same year and in consecutive years, attacking beech and other hardwoods in the East. This is important: Once you have safely identified and tasted it, find it at the same spot next year.

Honey mushrooms, Ludington, MI

Edibility: One way to prepare the caps is by boiling them in slightly salted water for 2 minutes. Discard water then sauté in bacon or butter and season with garlic and fresh basil.

Traditional uses: Traditional plant food of Canada's indigenous people.

Research: *Armillaria mellea* is a popular ingredient in Traditional Chinese Medicine for treating geriatric patients. A recent study indicated that growing the mushroom on corn provides a good substrate to maximize the potency of the radical-scavenging (antioxidant) and antiedema activities of *A. mellea*. Phenolic compounds (flavonoids extracted with ethanol) are the antioxidant—and not the polysaccharide content (Lai and Ng 2013). Another study concluded that *A. mellea* extracts possess potent free-radical-scavenging and anti-lipid peroxidation activities. That means they are antioxidant and potentially cancer preventing, especially aqueous extractions (like in soup) (Ng et al. 2007).

Storage: Eat fresh or cook in recipes and store in freezer. Drying toughens the mushroom, and it does not reconstitute easily.

Notes: In August, September, and October, honey mushrooms appear in large numbers around the base of trees, stumps, and occasionally in the lawn, living off a submerged root. This parasitic fungus destroys its host.

ENTOLOMA, ABORTED ENTOLOMA

Entalomataceae (*Entoloma abortivum* (Berk.) Curtis and Donk)

Origin: Latin *abortivum* for "abortifacient."

Identification: The aborted entoloma parasitizes *Armillaria mellea*, the honey mushroom, and when doing so the mushrooms form a lumpy, bumpy, grayish mass of tissue, depressed and/or folded at the center, taking on a deformed puffball appearance—but flatter (see photo). Rub the white-colored skin off to reveal a tan tone. The aborted form intermingles with the capped version of the species, and *the capped form is inedible*. The aborted version is short to the substrate, without a stem usually somewhat brownish and striated or pithy inside; it looks rotten and infested when past its prime.

Aborted entoloma

Aborted entoloma parasitizing honey mushrooms

Flesh is whitish in the gilled version and fairly dense and meaty while the aborted version is somewhat pithy inside and can have pinkish tones or bruise slightly pink. Sometimes they are somewhat hollow. The brown rot spots inside older ones occur where cracks in the cap have allowed water, dirt, or bugs to enter. These do absorb water readily, and so they require careful brushing and cutting away of bad parts—avoid washing.

Habitat: Find *Entoloma abortivum* near decaying wood in eastern North America's hardwood forests (prevalent in beech-maple climax old-growths).

These fragile and quickly spoiling mushrooms typically appear in large numbers in September and October in Michigan.

Edibility: A chewy mushroom with a mild, slightly sweet, nutty taste. A few compare it to lobster meat without the lobster flavor but the same chewy texture. Apply ample amounts of butter and imagination and see what you think. They require cleaning where they interface with the ground. I cut this part away and remove any dirty, dark areas inside. Reclaim moisture from cooking for flavoring other dishes. Mushroom lends itself to delicate flavors. A strange-looking mushroom, it is best when it is relatively dense and not spongy—being pithy on the inside is actually normal. Waterlogged specimens are hard to cook. The mushroom is sometimes wormy, so check closely for small white maggots.

CAUTION: Be very careful and be certain before indulging in an aborted entoloma. A young amanita's egg, the capsules amanitas emerge from, has lines inside indicating a developing fruit and gills, and it is much denser inside and smoother on the outside than an aborted entoloma. Until you are expert, be careful foraging for the aborted form of the mushroom.

Traditional uses: Eaten as food by several eastern Native American tribes.

Research: Studies show the mushroom inhibits sarcoma 180 and Ehrlich carcinoma up to 90 percent in in vitro studies.

Storage: Eat fresh and cooked or cook into dishes, then freeze to store.

Notes: *Entoloma abortivum* parasitizes the mycelium of honey mushroom, *Armillaria mellea*. Aborted entolomas found in abundance parasitize honey mushrooms invading beech, oak, and maple trees. The strange appearance of this mushroom turns dinner guests off. Implore them to try a small bite. But for particular guests substitute lobster.

GIANT LEUCOPAX, GIANT TUNNEL

Tricholomataceae (*Leucopaxillus giganteus* (Sowerby) Singer)

Origin: Greek *leuco* means "white," thus "white paxillus"; Latin *giganteus* for "gigantic."

Identification: A large, broadly capped saprobe to 16" in diameter with a thickness of 0.4"–0.5". Caps are convex on younger specimens with the margin rolled downward. The cap flattens and then becomes funnel-shaped at maturity. Cap is smooth and creamy white in color, but it may crack and stain brown as it develops. Cream-colored gills, crowded and attached, run down the stem (decurrent). Gills darken to buff as mushroom ages. Stem is off-white with reddish-brown fibers and up to 1.8"–2.4" tall by 0.6"–1.2" thick. No ring! Mycelium mat evident at base of stem; flesh is firm, fibrous, and white. Mature mushroom is fragile. Spiny spores are white and stain bluish-black (amyloid) when moistened with Melzer's reagent. Small young specimens of *Leucopaxillus giganteus* resemble several clitocybes, *Lactarius*, and *Russula* species. Yep, it's tough identifying gilled mushrooms, *so be careful and circumspect*.

Giant tunnel embracing three chanterelles in Jill's capable hands

Habitat: Found in grassy areas, pastures, roadsides, and edges of woods; may form fairy ring. Available summer through autumn; widely distributed in Northern Hemisphere.

Edibility: Edible when young according to several sources; considered slightly toxic by other sources, causing stomach cramps and diarrhea. One friend says boil in water, then sauté, or cook longer in stews, soups, and casseroles. Be circumspect with identification.

Traditional uses: Used as food by various Native American tribes and eastern European ethnic groups.

Research: *Leucopaxillus giganteus* contains clitocine with antibiotic activity against pathogenic *Bacillus cereus*, *Bacillus subtilis*, *Mycobacterium tuberculosis*, *Salmonella typhi*, and *Brucea abortus*. Clitocine in vitro studies stimulated cell death in human cervical cancer cells. In liquid culture, *L. giganteus* mycelia produced phenols and flavonoids with antioxidant activity.

Storage: Can be dried; best cooked in a dish and frozen.

Notes: I find the mushroom often, a joy to behold, but not part of my diet. Find it, identify it, and forget it—too many toxic look-alikes for casual identification.

Wood blewits

WOOD BLEWIT

Tricholomataceae (*Clitocybe nuda* (Bull.) H. E. Bigelow & A. H. Sm.)

Origin: Latin *nuda* means "naked."

Identification: Research suggests the genus *Lepista* is nested within *Clitocybe*—*Clitocybe* is preferred. The convex cap (pileus) when young has a somewhat button shape with inrolled (rounded) edges. It matures to broadly convex with the edge typically turning wavy—cap size varies from 1"–6". The bluish-lavender color tends to fade toward tan with age; they maintain color better in shady locations. Aroma is fragrant. Gills are lavender fading to tan or brown with age and are crowded with a notched attachment to the stem. Stem (stipe) is thick with an enlarged base up to 1" thick. As the mushroom matures the stem may stretch out to several inches and fades toward tan. Attached mycelium has a slight bluish-lavender tint. Flesh is whitish-lavender. Spores are whitish-buff with possibly a slightly pinkish tint. This is a difficult mushroom to positively identify. Blewits are harder to identify when older because of the tannish-brown color and stretched-out profile they develop—unless you are a knowledgeable and gifted forager, take your time, be circumspect, and avoid the old tan mushrooms. As with many mushrooms, every once in a while a really confusing huge one appears. There are other mushrooms that are lavender or purple. *Cortinarius* species have a cobwebby veil. Avoid *Cortinarius* species! Entolomas (avoid) are likely to have thinner stems and a salmon/rouge-color spore print. Other species may have brown

spore prints and are more likely to occur earlier in the season. Be sure to make a spore print! When in doubt throw it out(side)!

Habitat: Cool nights before frost herald this early autumn mushroom found in piles of decomposing leaf debris. Search around oaks and other hardwoods in mature woods, in dumps of yard waste, and inside parks and cemeteries. Compost piles of grass and wood chips along edges of woods and lawns may be productive. Look in state park campgrounds and in shady, decaying leaf piles. In moderate climates, such as coastal regions, the season may continue into November and December.

Edibility: These porous mushrooms waterlog on wet days. Many mycologists consider blewits tasty mushrooms with a somewhat delicate flavor. Prepare blewits in a cream sauce or sauté in butter. They are a good addition to stew, veal, pork, fish, poultry, cheese, rice, pasta, and pizza. Try them battered and deep-fried, or as more delicate tempura.

CAUTION: Both wood blewits and field blewits (not covered here) are regarded as edible, but they may cause allergic reactions in sensitive individuals; this is more likely (but not exclusively) when the mushroom is eaten raw. Wood blewits contain the sugar trehalose, which is edible for most people but causes digestive disturbance in others. Who are you? Get precise and exact identification, then cook and taste a small amount, at your own risk.

Traditional uses: Wood blewits are used to dye fabric and paper green. One would think lilac or blue, but not so. Boil the chopped mushroom in water to release the color into paper or cloth.

Purplish Cortinarius *species, inedible*

Research: Blewit polysaccharides are hypoglycemic and may help regulate blood sugar. Various liquid extracts studied in vitro inhibited *Candida*, *E. coli*, *Staphylococcus aureus*, and *Streptococcus* species. Blewit extract (ethanol) showed antioxidant and antimicrobial properties and may be suitable in the food-processing industry (Mercan et al. 2006). Ethanolic and aqueous extracts of *C. nuda* inhibit cancer cell growth in vitro (Beattie et al. 2011).

Storage: Eat fresh or cook into dishes and refrigerate or freeze.

Notes: Fly larvae may infest field blewits. They do not store very well; therefore use ASAP after picking. The wood blewit mushrooms I find grow in woods and along the edges of fields and are found in leaf waste throughout the fringing dunes forest of Ludington State Park, Michigan. But as mentioned, a difficult mushroom to be certain of; collect with an expert before trying it.

SPLIT GILL, UMBRELLA POLYPORE, LUMPY BRACKET, ZHU LING—INEDIBLE

Schizophyllaceae (*Schizophyllum commune* Fries)

Origin: Latin *schizo* meaning "split"; Greek *phylon* meaning "tribe."

Identification: A small, white, hairy, fan-shaped white rot fungus. Caps have whitish or pinkish gill-like folds that split toward the edge of the cap—a small unusual looking mushroom. It grows in clusters on dead branches (typically birch) year-round, is tough and leathery, and dries, shrivels, and desiccates during dry periods. Cap is fan-shaped, whitish to grayish, with a dry, hairy, leathery texture. Underside is whitish to grayish to pinkish; also hairy, with spore producing gill-like folds that split lengthwise to the cap margin. Cap width is 0.25"–1.5". Stalk typically is not present, or if so, it is tiny. Spore print is white. Spores are cylindrical, smooth. The mushroom is easy to identify if you check for the split gills underneath the cap. As mentioned, it shrivels during dry times and revives when wet conditions return.

Habitat: *S. commune* grows in groups on dead branches of deciduous trees, and is found on every continent; very common. When on dead branches it is a saprobe, and on living branches a parasite, digesting and decomposing the wood. It can be found year-round but is quiescent in dry months. Found typically on hardwood sticks and stumps, including poplar, but also birch, pine, and spruce.

Edibility: INEDIBLE—not typically eaten as food (or with caution; see CAUTION and Storage below). They are tough and small and prepared by a few cultures (in Mexico and Madagascar) after thorough cooking. It is, however, prepared and taken more broadly as a supplement, available in standardized extracts.

Traditional uses: In Traditional Chinese Medicine, the mushroom is a tonic to strengthen the immune system and increase energy. In traditional Mexican medicine, according to Robert Rogers (*The Fungal Pharmacy*), it is used to reduce fever and inflammation, providing a cooling energy to the body.

Split gills on a stick

Research: Extract from *S. commune*, consists of schizophyllan, which is a polysaccharide-protein complex that may help to support liver and immune health. Also, the mushroom's mycelium's intracellular enzymes may degrade fibrin—supporting optimum blood pressure and cardiovascular health. Phenols in *Schizophyllum* show antioxidant free-radical scavenging activity in laboratory studies (Abdullah et al. 2012). Chitin and chitosan (antifungals and dietary supplements useful for transporting drugs across epithelial surfaces) have been isolated from the mushroom; this breakthrough presents potential medical opportunities (Smirnou, Krcmar, and Prochazkova 2011).

CAUTION: Inhalation of spores of *S. commune* may lead to infrequent medical emergencies. *S. commune* was the causative agent in human allergic bronchopulmonary mycosis (ABPM) and pulmonary fungal ball (the formation of hyphae, basidiocarps, and basidiospores in the infected area); over 70 cases reported globally, but it is believed that the condition is far more prevalent than diagnosed. See following for a case study of sinusitis caused by *S. commune* in a female with a diabetic-compromised immune system (Sigler et al. 1999).

Schizophyllum commune also reported as the causative agent of the mucosal lesion observed (ulcerated palate) in a 4-month-old child (Restrepo et al. 1973).

In another case, a pulmonary infection of *S. commune* disseminated to the brain and did not respond to antifungal and antibacterial therapy. The patient died (Rihs, Padhye, and Good 1996).

Storage: At this time, I do not recommend collection and storage of this mushroom because the possible inhalation of spores is dangerous to immune-compromised individuals. There are numerous and safer medicinal and edible mushrooms to choose from; choose carefully and with certainty.

Note: An attractive mushroom that I am drawn to, but won't touch and never kiss.

Chapter Eleven

From the Market

Medicinal mushrooms are commonly available in supermarkets and Asian groceries, and as such, they do not contain some of the identification information used in other chapters.

Portobello, Baby Ports, Cremini, Buttons, 70
Enokitake, 70
Shiitake, Yamabushitake, 72

Agaricus bisporus*, the button, cremini, and portobello*

PORTOBELLO, BABY PORTS, CREMINI, BUTTONS

Agaricaceae (*Agaricus bisporus* (Lange) Imbach)

Origin: Greek *agarikon*, named after Agaria, a town in Sarmatis.

Research: A controlled study of 2,018 women who ate *A. bisporus* had 64 percent fewer incidences of breast cancer than the control group. And by combining green tea with the mushrooms, the reduced risk skyrocketed to 90 percent—eat your portobellos, drink your tea.

A button mushroom chemical is similar to aromatase inhibitors—drugs used in the treatment of breast cancer that block the production of estrogen or block the action of estrogen on receptors. When cooked, these mushrooms may stimulate apoptosis, or programmed cell death in tumors; an in vitro study demonstrated enhanced dendritic cells in processing antigens and presenting them to immune system T cells (Ren et. al. 2011).

ENOKITAKE

Physalacriaceae (*Flammulina velutipes* (Curtis) Singer)

Origin: Latin *flammula* meaning "little flame"; French *velut* for "velvet."

Research: Enokitake mushrooms are antiviral and antibacterial and contain the water-soluble antioxidant ergothioneine. Animal testing implied possible applications of vaccines and cancer immunotherapy. A paper published at the National University of Singapore in 2005 stated that the stalk of the enokitake mushroom contains a large quantity of a protein that helps in the regulation of the immune system. The mushroom also contains flammutoxin, a cytolytic

and cardiotoxic protein that appears to be nontoxic when absorbed orally (Lin and Shi 1975). Other investigations suggest that the enokitake mushroom contains certain compounds that inhibit the formation of melanin due to the catalytic oxidation of polyphenol oxidase, as well as mushroom tyrosinase activity (Jang et al. 2003).

In 2014, researchers reported creating a transgenic (gene insertion) organism of *Flammulina velutipes* that expresses the gene used to synthesize baccatin III, a paclitaxel precursor, thereby finding another precursor mechanism for manufacturing paclitaxel, an anticancer, mitotic inhibitor (keeps cells from dividing).

Asparaginase from *Flammulina velutipes* is another inherent anticancer agent and, according to Christopher Hobbs (Hobbs 2014) it can prevent or even cure gastroenteric ulcers and liver disease when taken consistently. Research shows the chemical is also effective against *Staphylococcus aureus*.

Enokitake contains several types of amino acids, including valine, which inhibits the growth of Ehrlich ascities tumor (an abnormal buildup of fluid in abdominal cavity due to cancer of the abdomen). It was also effective against sarcoma 180 in mice. Other animal trials indicate possible application in the development of vaccines and cancer immunotherapy.

Notes: It is unlikely you will find this mushroom in the wild. It is grown from wheatgrass and sawdust kits and is widely available at supermarkets and Asian groceries. Enokitake is a regular part of the Meuninck mushroom diet that also includes shiitake, chicken mushroom, hen of the woods, bluets, chanterelles, oyster mushrooms, honey mushrooms, puffballs of all kinds, morels, wood ears, aborted entolomas, lion's mane, and an occasional dryad's saddle.

Enokitake

SHIITAKE, YAMABUSHITAKE

Ganodermataceae
(*Lentinus edodes* (*Berk.*) *Pegler*)

Origin: Latin *gano* means "shining," *derma* means "skin."

Shiitake—inexpensive health care

Research: Shiitake is one of the most studied mushrooms. Hot-water extracts said to lower serum cholesterol. This immune-system-potentiating and immune-modulating mushroom is antitumor. In Japan, a glucan isolated from shiitake is a popular complementary and alternative medicine used in cancer treatment (Hyodo et al. 2006).

Shiitake is used in Japanese Kampo medicine to alleviate arthritis, treat diabetes, lower cholesterol, and improve immunity. Prostate cancer research using shiitake extract, however, saw no improvement in the human participants, although there was an increased number of days of survival in stomach cancer—but no remission. Preliminary research suggests water extracts of the mushroom may be helpful in treating breast cancer. Lentinan from shiitake is moderately antibacterial and selectively antifungal. Sulfuric-flavored compounds extracted from shiitake (*Lentinus edodes*) showed inhibitory activity against platelet aggregation (clumping); the inhibitory activity is attributed to lenthionine, a sulfur compound, in shiitake essential oil (Shimada et al. 2004).

CAUTION: In perhaps less than 2 percent of the population, consumption of raw or slightly cooked shiitake mushrooms causes allergic reaction. Eliminate the effect, perhaps caused by the polysaccharide lentinan, with thorough cooking.

Notes: This is a popular mushroom to cultivate. Cultivation produces numerous fruiting bodies and the marvelous taste and potential health benefits. The dried, Asian supermarket variety is objectionable to the palate. However, it is my experience that the dried mushrooms from Japan are of higher quality than the Chinese varieties. Check their origin on the label. A few Chinese mushroom growers fire dry shiitakes and, objectionably, smoke taints the flavor. Modern influences are improving these imports. But take time to note any difference in color of dried shiitakes from Japan and China—it has been my experience that the Chinese shiitakes are darker in color.

Chapter Twelve

Inedible, Toxic, and Hallucinogenic Mushrooms

Here's an assortment of families with poisonous or inedible members, a few of which I covered earlier. The list is incomplete and always will be—mycologists and amateurs are discovering new mushrooms every season. What an adventure! The next mushroom you discover may be a new species.

AMANITA MUSCARIA AND OTHER AMANITAS—INEDIBLE

Amanitaceae (*Amanita* species)

Origin: *Amanita* is Greek for mushroom.

Amanita muscaria, *hallucinogenic mushroom*

Identification: To identify amanitas, dig out the base and underground part of the mushroom. The mature mushroom arises from a volva—a capsule, sack, or swollen bulb. The shape of this base is important in identification. I generalize here and suggest if there is a bulblike swelling (volva) or sack, then reject the mushroom. Prior to emerging, the entire mushroom is enclosed in this sack covered by a universal veil. This protects the developing mushroom and in its entirety looks somewhat egg-like. Slicing this egg in half vertically will reveal the immature mushroom and its gills (as you recall, this cross-section helps identify puffballs that are edible and do not have gills). The growing amanita ruptures the veil, and remnants of the veil remain on the cap (and may be remnants on the capsule (sack, volva) as fragments or warts. Rain may wash away remnants of the veil. There may or may not be a ring (annulus). Amanitas come in a variety of colors: white, yellow, red, orange, green, and tan. But the volva (sack, egg) is indicative, and for species specificity the spore shape, color, and size helps complete the picture. These specifics are, however, beyond the scope of this beginner's manual—to go further see Kuo's *100 Edible Mushrooms* book.

Habitat: Amanita species are found nationwide and have affinities toward specific trees but aren't picky. Often available for inspection from August through October in the upper Midwest, northeastern states, Badlands of North Dakota and mountain west.

Toxins: The most potent toxins are alpha-amanitin and beta-amanitin amatoxins. Psychoactive species contain psychoactive muscimol and the neurotoxin ibotenic acid that partially converts to muscimol after ingestion (Meuninck 2014).

Notes: The genus comprises over 600 species, many of which are toxic, a few psychoactive, and a few edible. Amanita poisonings account for about 95 percent of all mushroom consumption fatalities.

FALSE PARASOL, GREEN SPORED PARASOL—INEDIBLE

Agaricaceae (*Chlorophyllum molybdites* (G. Mey) Massee)

Origin: Latin *chlorophyllum* refers to "green tribe."

Identification: Medium to large saprobe mushroom found with a cap up to 15" in diameter. Cap is dry, whitish, soft (velvet to the touch) with white to brownish scales. Edge of cap has hanging white remnants of the partial veil, which covered the gills in the young mushroom. Cap is round at first, then convex to broadly convex or flat at maturity. Gills are free. Stem is long and slightly bulbous at the base. Stem bears a free double ring that moves up and down the stipe (stem) with little effort. The color of gills progresses from white to grayish with age. A defining feature is its green spores.

Habitat: Found across North America in fields, gardens, lawns, and waste ground, often in fairy rings, during the summer and autumn.

Toxin: Steroids causing gastrointestinal stress, vomiting, diarrhea, and colic—not fatal.

Notes: Said to cause more mushroom poisonings than any other mushroom, *Chlorophyllum molybdites* is similar to the parasol and shaggy parasol mushrooms, both edible. Don't eat parasols unless you have foraged with an expert. The likeness of these mushrooms to toxic amanitas is another concern—once again highlighting the difficulty of identifying gilled mushrooms.

False parasol from a fairy ring

Toxic clitocybe

CLITOCYBES—INEDIBLE

Tricholomataceae *(Clitocybe* species)

Origin: Latin *clitocybe* means "sloping head" (funnel-shaped).

Identification: A large genus (hundreds) of mushrooms, these medium-to large-size saprobes grow on the ground or on wood, and in open areas and forests. They have whitish to pale yellow or pale pink spore prints. Caps are flat, broadly convex, or depressed in center and generally smooth to the touch. Gills are fairly close to close, attached to and run down the stem or have a notched attachment (part of gill is attached, but as if notched below the attachment)—notched variety will have pink spores. Mushrooms are without veils, rings, or volvas. The smell may be sweet, but ingestion is toxic.

Habitat: Found nationwide in forests and open areas, summer through fall.

Toxin: Muscarine mimics the action of neural transmitter acetylcholine. Symptoms are blurred vision, sweating, salivation, abdominal cramping, diarrhea, tremors, convulsions and constrictions of the pharynx. Five percent of the victims die.

Edibility: INEDIBLE—may contain potentially deadly levels of toxic muscarine, most are difficult to identify.

RUSSULA—MANY INEDIBLE

Russula *(Russula* species)

Origin: Latin *russus*, meaning "red."

Identification: Large woodland group of widespread, somewhat brightly colored, brittle-textured gilled mushrooms that break easily and cleanly into many pieces. Medium to large size typically, with flattened caps of various colors: red, purple, yellow, green, and blue. Cap convex, flat, or centrally depressed, and diameter is about equal to length of the stem. Mushrooms lack veils, rings, and volvas. The crumbly brittle texture (like *Lactarius*) is due to spherical cells that move past each other rather than long entangled hyphae as in other mushrooms. Gills are brittle, attached, and run slightly down stem. Spores are shades of cream, to creamy white, yellowish, and ocher (orangish). Melzer's reagent stains spores bluish-black.

Habitat: Forest terrestrial and micorrhizal (symbiotic) partner with conifers and hardwoods. Found nationwide, summer and fall.

Toxin: Sesquiterpenoids cause vomiting, gastrointestinal distress, diarrhea. Vomiting usually ends the episode.

Edibility: INEDIBLE until one is expert at identification. The edible Russulas taste poor, many others are acrid or inedible; all, however, are colorful additions to the forest.

Russula *species, red with brittle broken texture*

LACTARIUS—MANY INEDIBLE

Lactarius *(Lactarius* species)

Origin: Latin *lact* for "milk."

Identification: Sometimes called milk caps, many members of this genus exude a milk-like substance from the gills, especially when the gills are handled or bruised—exudate may be white, red, orange, or a variation. Their flesh is brittle and breaks cleanly like *Russula* species, and the two genera are related. Flesh turns blue in Melzer's reagent. Cap usually is wider than stem length, and cap's edges typically incurved. Center depressed when mature. Most are medium-size or larger mushrooms.

Habitat: They are mycorrhizal to trees and a few host specific. Found in forests and fields from east to west, summer and fall.

Toxin: Several biting and bitter toxins in various species causing gastroenteritis.

Edibility: MANY INEDIBLE—a few are edible if cooked twice, boiled, and then sautéed, especially those that exude red or orange milk. Others are pungent and taste bad. Here is a genus that will keep you exploring and differentiating all summer and fall. Be careful, be circumspect, and forage with an expert.

Lactarius *species exuding "milk"*

Pholiota squarrosa *similar to* P. squarroi *indicated in mild to severe poisonings*

PHOLIOTAS—MANY INEDIBLE

Strophariaceae (*Pholiota* species)

Origin: Greek derived from *pholos* meaning "scale(s), scaly."

Identification: Medium-sized, fleshy mushrooms are white rot saprobes and a few, perhaps, parasites. Many species have a distinctive scaly appearance on caps and stems. Although these species are beyond the range covered in this guide, here are a couple photos to begin your challenge. Most species require microscopic identification of spores and characteristics. Spores and spore print light brown, brown, or yellowish brown.

Habitat: Nationwide, summer and fall, on stumps and trees, and, occasionally, forest litter, typically in groups.

Toxin: Amatoxins in *Galerina* species, often fatal, destroy function of the liver.

Edibility: INEDIBLE—this group of fungi has both edible and poisonous members. Always forage with an expert and be absolutely certain before consuming.

Pholiota aurivella*, golden pholiota on maple has a reddish-brown spore print and is inedible.*

Pinwheel saprobe in Michigan old growth

PINWHEEL MUSHROOM—INEDIBLE

Marasmeiaceae (*Marasmius rotula* (Scop.) Fr.)

Origin: Latin *rotula* for "small wheel."

Identification: The pinwheel mushroom or parachute mushroom, is a small (0.8" wide), bell-shaped, pleated, white, translucent, and delicate saprobe growing on dead branches and twigs. Gills yellow white, spore print white. Stalk is wiry and smooth, yellowish-white.

Habitat: Grows in clusters on dead wood; widespread in northern latitudes across the continent.

Toxin: Bitter inedible but not toxic.

Edibility: INEDIBLE—there are many inedible species in this large family of small mushrooms.

MYCENA SPECIES—INEDIBLE

Mycenaceae (*Mycena leaiana* (Berk.) Sacc.)

Origin: Named after a legend from Mycenae in Greece; *leaiana* is named for an eighteenth-century US mycologist, Thomas Gibson Lea.

Identification: A bright-orange saprobe numbering several to a group, with stems sharing a single point of origin on hardwood branches and logs. Cap is 0.4"–1.5" in diameter, bell-shaped at first, then convex as it ages. Orange color fades with age. Smooth cap sticky when wet. Gills narrowly attached (taper toward stem), crowded, yellowish, color deepening toward edges. Stem is 1.2"–3" long with fine hairs on upper portion of stem and denser hairs at base. Spore print white.

Habitat: Found throughout the eastern and central United States and Canada.

Toxin: Toxins and edibility of many species unknown. A few are edible but very difficult to identify.

Edibility: INEDIBLE

Research: It produces an orange pigment—leainafulvene—that has weak antibacterial activity against *Acinetobacter calcoaceticus* and has cytotoxic activity toward tumor cells. It also has mutagenic (cancer causing) activity, as measured by the Ames test (a test for carcinogenicity).

Mycena leaiana *group originating from a single point*

LITTLE BROWN MUSHROOMS—INEDIBLE

Several Families including *Inocybe*, *Conocybes*, and numerous other genera

Origin: *Ino*, a Greek name for the daughter of a god, and *cybe* meaning "head." Let's interpret it loosely to mean "little head" (hate me if you will). And Greek *cono* meaning "cone," *cybe* meaning "head"—thus, "cone head."

A little brown mushroom—LBM—perhaps an Inocybe

LBM donning a safari helmet

Identification: This catch phrase, "little brown mushrooms", clusters together numerous difficult to identify and potentially dangerous mushrooms. Most are saprobes and mycorrhizal mushrooms, many of which are brown with brown spore prints. *Inocybe* caps are often flat with a point or bulge in the middle, and in age they are cracked or lacerated. They are silky, hairy, or scaly when viewed through the hand lens and to the touch. Gills are typically a shade of brown. *Conocybes* have conical caps. They are small and fragile, with slender stems (stipes) with bright rusty-brown spores. These groups comprise many of the LBMs ("little brown mushrooms") but there are numerous other genera difficult to identify and a time-consuming endeavor for amateurs and pros alike. So grab your microscope, pour a brew, and get thumping.

Habitat: Broad distribution, fields, and forests, found nationwide in summer and fall.

Toxin: Numerous and varied, difficult species to identify with some edible and many toxic.

Edibility: MANY INEDIBLE, difficult to differentiate the edible from the toxic.

CAUTION: Many are toxic, a few seriously so.

Appendix A: Health Prep

General Principles of Preparing Medicinal Mushrooms
To capture their health-protecting chemistry, eat mushrooms as food or prepare them as supplemental health insurance (so to speak). When the desired result is a concentration of chemistry from inedible parts, specific techniques render optimum results. The following describes various ways to release the mushroom chemistry.

Decoction: This is an extraction made by simmering or boiling ground mushrooms in water. Decoctions pull water-soluble chemistry from the hard parts of the fungus; this is typically the immune-modulating polysaccharides. For example, steep ground and powdered chaga (the inner sclerotium) in hot water for a pleasant-tasting tea: Grind the mushroom in a food processor or blender, then simmer the grind by boiling 2 ounces fungi in 12 ounces water. Simmer for at least 30 minutes; up to 2 hours is best. In either case, the dark tea is surprising good with a tealike flavor, albeit slightly bitter; blend with other teas and spices. For a novel concentrated decoction make a 5:1 extraction; that is, pour five parts of boiling water over one part chopped and ground mushroom (e.g., 25 ounces of water over 5 ounces of mushroom). Let cool, then refrigerate for 48 hours. Strain off the liquid and store in the refrigerator. Now pulverize the remaining mash of mushroom; pour another 25 ounces of water just off the boil over the mash, let cool, store in frig for 48 hours, then strain and combine both liquids. Drink as tea or dilute in tea.

Percolation: Drip hot water or room-temperature 50 percent alcohol through a damp mass of powdered mushroom. Chop and grind the fungi, gather it in a coffee filter, then cover the ground fungi with water or alcohol or a combination of both. Allow this to drip through the filter to release the chemistry. Water releases the hydrophilic, or water-soluble fraction, whereas alcohol releases the lipophilic, or fat-soluble chemistry; for example, pour water off the boil and/or alcohol over powdered reishi in a coffee filter. Let drip into pot—50 ml of liquid through 10 g (5 to 1 ratio liquid to mushroom). Change filters and repeat the process over and over to increase the concentration.

Tincture: This requires chopping and blending a mushroom then adding it to alcohol. For example, blend 50% (100 proof) alcohol (Everclear cut in half with water) with dried mushroom powder: Cover powder with alcohol. Shake and put in a refrigerator for four days. Shake the blend two or three times daily. After four days pour off the liquid through panty hose and use in cooking or take a teaspoon at a time.

Double Extraction: For a double extraction, first fill a container, such as a bottle or jar, at least halfway with chaga powder, then cover the chaga with vodka or 50% Everclear. Allow the blend to sit for a few days (up to two weeks) in a darkened cupboard or refrigerator; shake twice a day. Strain off the liquid (a pair of panty hose is an effective strainer) and then run it through an unbleached coffee filter. Squeeze out the remains in the filter when it has stopped dripping. That is the "single extraction." Now take the chaga mash (marc), cover it with water, and simmer (decoct) for 30 minutes, adding water as necessary. Strain and then blend the extraction with a tincture of chaga, making a stronger "double extraction." Maintain an alcohol concentration of at least 25% (50 proof).

Appendix B: Foreign and Domestic Mycology Websites and Organizations

North American Mycological Association: namyco.org/clubs/
Funghi (international): facebook.com/pages/funghi/58761209888
Pugent Sound Mycology Society: psms.org/index.php
Vancouver Mycological Society: vanmyco.com/
Minnesota Mycological Society: minnesotamushrooms.org/
The Hoosier Mushroom Society (Indiana): hoosiermushrooms.org/
The Ohio Mycological Society: ohiomushroomsociety.wordpress.com/

Appendix C: Grow Your Own

I first grew mushrooms from logs, using dowels and short pegs impregnated with shiitake and oyster mushroom mycelia, ordered from Fungi Perfecti of Olympia, Washington (see in Online Resources, page 86). Logs were 3'–4' long and 5"–6" in diameter—ash and oak. I cleaned a 3/8" drill bit in alcohol and then drilled holes to the length of dowel and pounded the dowels into the holes with a rubber hammer. Typically, the plugged holes are sealed with beeswax to help prevent contamination (detailed instructions for this inoculating method come with your order of mycelium-laced plugs/dowels). After imbedding and sealing the dowels, I soaked the six logs in a barrel of water for 7 hours and then let them dry in the shade with the oyster-mushroom logs parallel to the ground and shiitake nearly vertical to the ground. When dry, I covered the logs with wet burlap and soaked the burlap once or twice a week, depending on humidity and rainfall (this is as much art as science). The burlap provides shade and protection from the wind and keeps the logs from drying. After 6–12 months, when ample evidence of mycelium growth shows at the ends of the inoculated logs, soak them again in a barrel or a plastic child's play pool for 24 hours. This forces the production of mushrooms; in few days reap the reward. From that start, the mushrooms and their mycelia provide an endless supply of spores and mycelia for future inoculations.

KITS

There are numerous alternatives for growing mushrooms. Many markets have mushroom-growing kits—a bag or other container filled with a substrate (wood chips or the like) inoculated with mycelia. This is a highly successful method to start with, and the mycelia can be reused.

For lucky risk takers, try making spore prints from oyster mushrooms (oyster mushrooms are one of the easiest to grow) by scraping the spores from the spore prints with a razor blade until you have a teaspoonful, then incubate the spores in a container of distilled nutrient water. Here is the procedure: Add a quarter teaspoon of noniodized salt and 1 tablespoon of sugar or light molasses to a gallon of water, boil for 10 minutes to sterilize, and pour hot into a very clean and rinsed container made of glass, plastic, or stainless steel. Never use a container that held harsh chemicals or milk. Next, cover and cool the broth to room temperature then add the teaspoon of oyster spores

(wear a mask and avoid contact with spores). Cover the pot and incubate the spores in a shaded area between 60°F and 70°F. Shake the broth two or three times a day. If your spores are fresh and young, you may see thin threads of mycelia growing.

Use this spore-broth inoculation to pour over or mix in to inoculate wood chips, cardboard, burlap, straw, and the like. And good luck.

ONLINE RESOURCES FOR GROWING MUSHROOMS

How to: "Gourmet and Medicinal Mushrooms," University of Kentucky, College of Agriculture Cooperative Extension Service, www.uky.edu/Ag/CCD/introsheets/gourmet.pdf

Growing mushrooms with coffee grounds: GrowVeg.com, www.growveg.com/growblogpost.aspx?id=261

Mushroom home-growing kits: Mushroom Adventures: www.mushroomadventures.com/; Fungi Perfecti: www.fungi.com

Appendix D: Recommended Books

These are the books the author uses in the field and at home to help identify mushrooms:

Arora, David. *Mushrooms Demystified*. Berkeley, CA: Ten Speed Press, 1986. A large book, too heavy for the field, but filled with useful and entertaining material.

Jordan, Peter. *The New Guide to Mushrooms: The Ultimate Guide to Identifying, Picking and Using Mushrooms*. Smithmark, 1996. Big beautiful photos, very helpful for in the home (after the field) identification.

Kuo, Michael. *100 Edible Mushrooms*. Ann Arbor: University of Michigan Press, 2010. Winter reading from cover to cover; a great back up reference after leaving the field.

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About the Author

Jim Meuninck is a biologist and counselor who has studied the use of wild plants and mushrooms as food and medicine in North America, Europe, Central America, Japan, and China for more than thirty years. He lives on the shores of Eagle Lake in Edwardsburg, Michigan.