Michigan Wild-foraged Mushroom Certification Program

MORELS

MAMI Wild-foraged Mushroom Certification Workshops

A Cooperative Effort

MAMI is proud to partner with the Michigan Farmers Market Association (MIFMA) and CROSSHATCH Center for Art and Ecology to provide training for certification in wild mushroom identification. The Michigan Department of Agriculture and Rural Development issues an "Expert Mushroom Identifier" card after a person attends a Workshop and passes a written exam with a score of 80% or greater. Certification, as an Expert Mushroom Identifier, remains valid for five years, after which recertification is necessary.

There are currently two Certification programs offered.

1.) The Wild-foraged Mushroom Certification allows certified participants to harvest and sell twenty species of mushrooms wild-foraged in Michigan.
2.) The Wild-foraged Morel Mushroom Certification allows certified participants to harvest and sell Morchella species which are wild-foraged in Michigan.

Additionally, previously Certified Mushroom Experts whose certification expire in 2020 and will expire in 2021 can recertify online.

Our programs are designed to ensure a participant will, upon successful completion, qualify to meet the requirements of Michigan to harvest, broker and sell wild-harvested mushrooms in Michigan. This includes selling directly to the public, restaurants, or retailers. Organizations and businesses such as restaurants, grocers and farmers markets, which either buy direct from mushroom sellers, or provide space for those people to sell mushrooms, are required by law to ensure all sellers of wild-foraged mushrooms do so in accordance with Federal and State law. We also realize there are professionals, such as chefs, farmers market managers and purchasing agents for grocers, who may have a legitimate interest in being educated in this curriculum, but who may not necessarily need to be certified.

Private citizens may also have an interest in being educated in foraging mushrooms in Michigan. To meet this need, we offer workshops, without certification, at a reduced rate.

What will be covered in the program?

The Certification programs include an overview by MDARD on state regulations for harvesting and selling of wild-foraged mushrooms in Michigan, as well as:

- lectures on fungal biology
- morphological characteristics of mushroom identification
- overview of species of wild-foraged mushroom approved for sale in Michigan and their possible look-alikes
- overview of toxic mushroom species found in Michigan
- interaction with Michigan mycologists

Individual participants will have the opportunity to review all of the material and ask questions. A written exam is administered to determine participants' eligibility for the Wild-foraged Mushroom Identifier Card from MDARD.

The Test

Participants are required by law to be an "expert" in the wild-foraged mushrooms they collect, identify and/or sell. Misidentification of poisonous mushrooms for safely edible mushrooms is a grave concern of public health and safety. To meet this standard, the test will be stringent and thorough. It should be made clear that an Expert Mushroom Identifier Card will not be issued unless an individual passes the test with a score of 80% or higher. It is, therefore, imperative for participants to study all of the material beforehand and come prepared to pass the test. The workshop should be considered a review session to confirm what has already been studied, and to resolve, with mycologists, any information that may not be clear after reviewing the study material. Those who are not prepared prior to attending the workshop should reconsider attending, as those who do not pass the test will neither be issued a card nor a refund. Attendees should prepare themselves appropriately before attending the workshop.

A sample test can be found online using the link https://midwestmycology.org/sample-test/

ACKNOWLEDGEMENTS

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Introduction

The Wild-foraged Mushroom Certification Program

Foraging for wild mushrooms requires thoughtful study, perception and caution. Those who harvest and sell mushrooms to restaurants, stores, and at farmers markets have a responsibility to ensure they are providing a wholesome and safe food in order to protect public health, safety and our food supply.

To help foragers qualify as expert mushroom identifiers so they may safely harvest, broker and sell wild-foraged mushrooms in accordance with Michigan and Federal law, Midwest American Mycological In- formation (MAMI) developed a curriculum which covers the information needed to accurately and responsibly identify, harvest and sell wild-foraged mushrooms. MAMI has partnered with the Michigan Farmers Market Association (MIFMA) and the CROSSHATCH Center for Art and Ecology. In cooperation with the Michigan Department of Agriculture and Rural Development (MDARD), MAMI has designed workshops and written exams that, if successfully completed, will qualify foragers as expert mushroom identifiers to meet Michigan standards.

Through the Wild-foraged Morel Mushroom Certification program, you will have the opportunity to familiarize yourself with the varieties of Morels which may be collected and sold in Michigan, meet and interact with renowned mycologists, review mushroom identification, learn MDARD regulations, and much more. At the end of the workshop you will be administered a test which, if successfully completed, will qualify you to receive an Expert Mushroom Identifier Card issued by MDARD. This Certification applies only to harvesting and selling Morchella species foraged in Michigan.

It takes a great amount of preparation and studying to reach the level of expertise necessary to become proficient in mushroom identification. If youplan to take any one of our mushroom identification programs in order to qualify for an Expert Mushroom Identifier Card from the State of Michigan, you will need to know all of the information contained in corresponding publications (also available on our website https://midwestmycology.org). We advise workshop participants to familiarize themselves with all of the material contained in this book (and information on our website) prior to attending the workshops.

Mushroom identification cannot be learned in just one day!

Consider the workshops to be a review session, during which you may resolve, with professional mycologists, any information you may not find clear.

Happy Foraging!

Please refer to these books for more information:

A Field Guide to Mushrooms: North America (Peterson Field Guides)Paperback –1998, by Kent H. McKnight (Author), Vera B. McKnight (Author, Illustrator), Roger Tory Peterson (Editor)

Edible Wild Mushrooms of Illinois and Surrounding States: A Field-to-Kitchen Guide (Field-To-Kitchen Guides) 2009, by Joe McFarland and Gregory M. Mueller

Medicinal Mushrooms: An Exploration of Tradition, Healing, & Culture (Herbs and Health Series), 2003, by Christopher Hobbs and Harriet Beinfield

Mushrooms of the Northeast, 2016, by Teresa Marrone and Walt Sturgeon

Mushrooms Demystified, 1986 by David Arora

Mushrooms of the Midwest, 2014, by Michael Kuo and Andrew S. Methven

National Audubon Society Field Guide to North American Mushrooms (National Audubon Society Field Guides), 1981, by NATIONAL AUDUBON SOCIETY, authored by Gary Lincoff

Mushrooms of Northeastern North America - 2000, by Alan E. Bessette, David W. Fischer (With), Arleen Raines Bessette (With)

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Are You Planning to Sell Wild Mushrooms in Michigan?

The U.S. Public Health Service, F.D.A., 2009 Food Code established rules for the commercial collecting and selling of wild mushrooms in all states, including Michigan. In order to legally collect and sell wild-foraged mushrooms anywhere in the United States, a person must be certified as an expert in the identification of wild mushrooms. Otherwise, there is a real danger that poisonous mushrooms may be collected and sold. The consumption of poisonous varieties of mushrooms can lead to illness or death. It is *imperative* that all people who collect and sell wild-foraged mushrooms be properly trained in the identification of mushrooms.

In some states, farmers markets require mushroom vendors to sign agreements releasing the municipality and Market Manager from damage claims in the event of an illness or death of a consumer. Insurance underwriters associated with municipal sponsors of farmers markets may require the municipality to carry additional liability insurance. Other restrictions may include limiting mushroom varieties to more common species like morels, oysters, sulfur shelfs, and chanterelles.

Michigan regulations regarding wild-foraged mushrooms

In Michigan, you are allowed to sell twenty specific species of mushrooms. This Workbook, Workshop and Certification will only allow a participant (upon successful completion of the Workshop and written exam) to sell one of those species, the Morel.

You are required to follow both State and Federal regulations.

Michigan law requires a person to be an approved mushroom identification expert in order to legally collect and sell wild-foraged mushrooms. This entails the successful completion of a mushroom identification program and written exam approved by the Michigan Department of Agriculture and Rural Development (MDARD). More information on MAMI programs designed to train individuals to be expert mushroom identifiers, can be found at the following link: https://midwestmycology.org

The Michigan Food Code

According to the 2009 Michigan Food Code, a mushroom seller must be recognized as an approved mushroom-identification expert. Alternatively, the seller may employ a certified mushroom identification expert but must keep a written record of all mushrooms purchased, the date, and name of the approving expert mushroom identifier.

Each individual mushroom must be inspected and identified by the certified expert. Only those mushrooms identified as safe maybe sold.

Every container used to store wild-foraged mushrooms must be labeled with the scientific and common name of the mushroom variety in the container. Packaged mushrooms may be identified by the common name only, and shall bear additional labeling in full accordance with current state and federal requirements.

Written records indicating the quantity, variety, expert identifier, and buyer of the mushrooms shall be retained by the seller for a period of *not less than two years*. These records shall be made available for MDARD examination upon request.

Wild mushrooms shall be handled and protected from contamination in accordance with all current state and federal regulations associated with the handling and processing of foods intended for human consumption.

Vendors are not presently required to hold a license from MDARD in order to sell wild-foraged mushrooms at a farmers market. An MDARD approved mushroom identification expert, however, must have identified (to species) each and every mushroom for sale by a vendor.

Slicing, drying or other processing of wild-foraged mushrooms must take place in an approved food kitchen licensed by MDARD or a local health department facility.

DISCLAIMER: PLEASE NOTE

If you harvest, eat or sell mushrooms you find, you are doing so at your own risk. While every effort has been made to ensure the information contained in this workbook is correct, the authors and the Midwest American Mycological Information Corp. (MAMI) caution against the use of the information in any particular application and accept no responsibility or liability for errors, omissions or representations, expressed or implied, contained herein. Neither the authors nor MAMI accepts responsibility or liability for errors the reader might make in identifying mushrooms, for harmful reactions to eating poisonous mushrooms, or for idiosyncratic reactions to eating any mushrooms.

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Fungal Biology

The Basics

Part I. Taxonomy

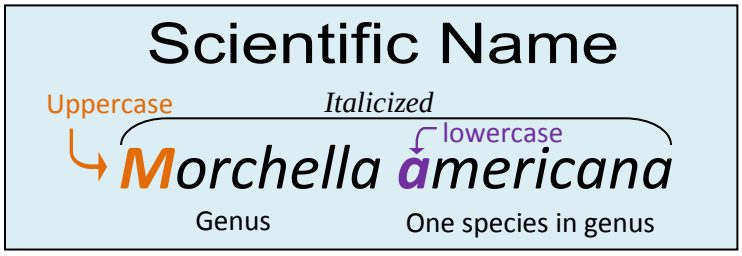
Taxonomy is the science of naming, describing and classifying organisms; in this case Morel mushrooms. Early mycologists based their classifications on the physical characteristics of the mushrooms they were discovering. Gilled mushrooms were grouped together while mushrooms with pores were placed in a separate taxonomic group and so on.

As science evolved and new techniques, like using microscopes to study the morphology of mushrooms, the simple taxonomic structure expanded into a much more complex structure. Today, DNA analysis is making way for a greater understanding of fungi morphology and, consequently, the classification of genus and species is constantly changing. One thing remains the same, all fungi are classified using the Latin binomial system created by Carl Linnaeus in the 1700s.

Why Latin? Because in using binomial nomenclature, people throughout the world are able to refer to a specific mushroom without ambiguity. For example, the *Gyromitra esculenta* is commonly referred to as "the Beefsteak". At the same time, *Fistulina hepatica* is also called "Beefsteak Mushroom". As you will learn later in this workbook, *Gyromitra esculenta* is listed as a Class C Toxic Mushroom in the Monomethylhydrazine Group of toxins. On the other hand, although considered acrid and bitter, *Fistulina hepatica* is considered to be a safe, edible mushroom (although it is not on the Wild-foraged Mushroom Certification list). Remember, the goal of all of the MAMI Workshops and MDARD Certification is to keep toxic mushrooms out of the food supply.

The binomial nomenclature is comprised of two parts and is always italicized: the genus name (generic epithet) and the species name (specific epithet). In the name *Morchella importuna*, *Morchella* is the genus to which the *importuna* species belongs to. See the illustration in the upper right corner.

All species observed to be related are placed together in a common genus. Keep in mind, though, as technology advances to enhance observations, genus and species are continuously being reorganized.



You will see this throughout the Morel descriptions; the currently recognized scientific name will be listed first. If there is a previously recognized name, it will be listed in parenthesis while synonymous names are preceded by an equal sign.

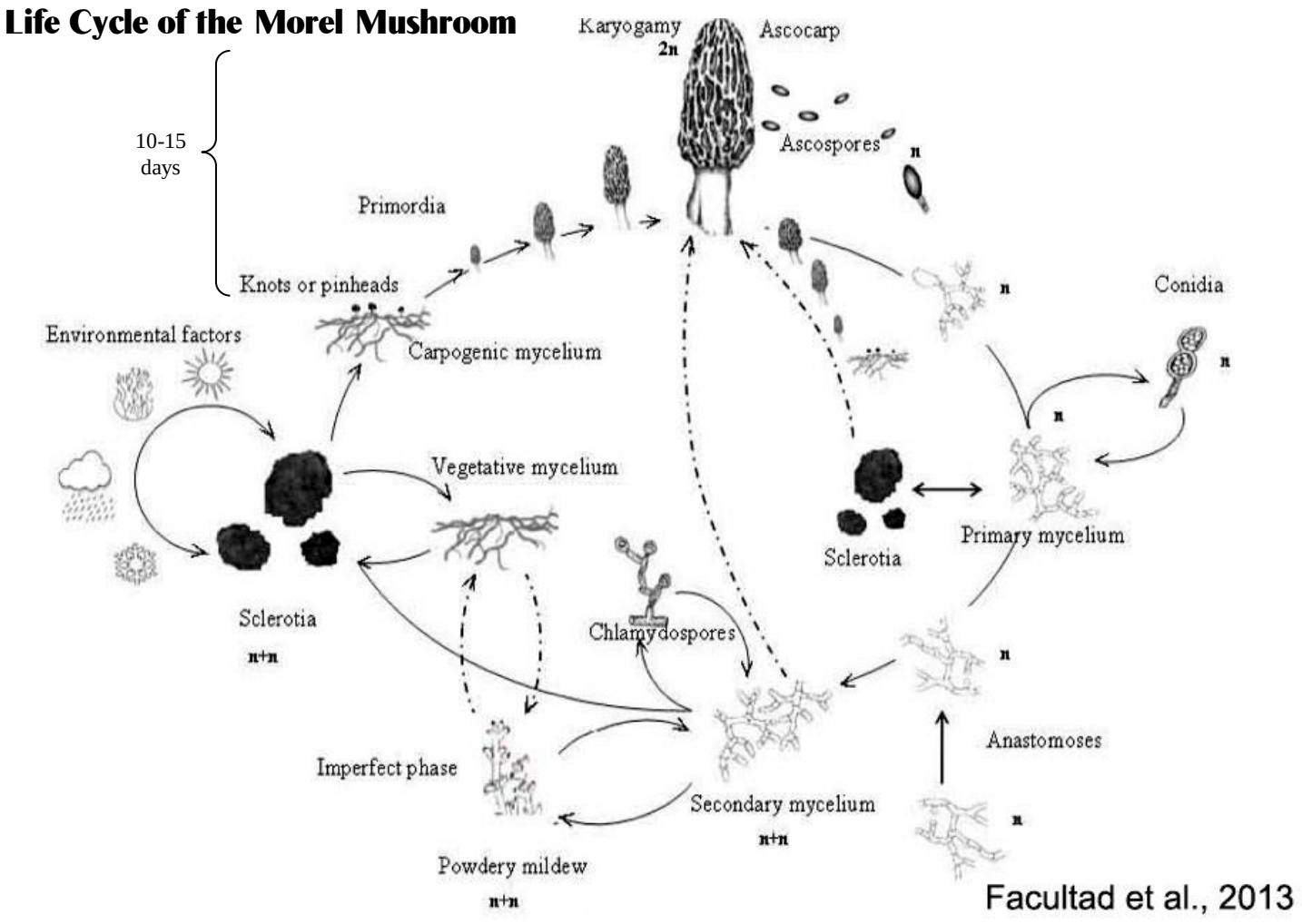
Part II. The whole fungus

The whole fungus is comprised of many parts, ofwhich the mushroom is but a fraction. Each mushroom derives its existence from a larger amount offungal tissue in the form of a network of threadlike cells, the hypha or mycelium (plural mycelia).

Through extracellular digestion, the mycelium grows inside its substrate (such as soil or wood) while gathering nutrition and resources to support its growth. These resources are in the form of organic nutrients from substrates such as decaying litter and wood, decaying fungi, or actively growing roots in the case of mycorrhizae.

In response to appropriate environmental cues, the mycelium produces a fruiting body or mushroom, analogous to when a plant sets fruit. Ingeneral, a mycelium will produce many mushrooms, and some mycelia are so large that they cover multiple acres underground, such as the humongous fungus, *Armillaria gallica*.

Mature mushrooms are supported by an extensive mycelium and are, themselves, comprised of mycelium.The common goal for all mushroom fruiting bodies is to produce billions of spores. Oftentimes, these spores can be "collected" to create a spore print. In early taxonomy, the color of the collective spore print was used to support the mushroom's placement in a particular group sharing like-colored spores. For example, all species in the genus Morchella have white spore prints.



The spore bearing surface (hymenium) of the morel lines the pits of the cap. An ascus (plural asci) is an elongated, sac-like cell located within this surface which releases ascospores. Each spore must disperse and then find a "proper" home in which to grow into new, primary mycelium. Each cell in this primary mycelium contains one nucleus, a condition termed haploid.

It is at this juncture which morels demonstrate unique reproductive strategies. Primary mycelium undergoes either an asexual phase by releasing conidia from specialized structures called conidiophores or will undergo a sexual reproductive phase called plasmogamy.

A pictorial view of the Morel life cycle is depicted in the illustration above.

There are two paths primary mycelium can take which produce a fruiting body:

1.) It can form sclerotium from which a button or primordia can develop or
2.) It can go through sexual reproduction called plasmogamy to form secondary mycelium.

Secondary mycelium forms sclerotium which can also take two paths:

1.) It can form the fruiting body or
2.) Lay protected in dormancy for up to several generations

In any event, it's significant to note the development of the morel fruiting body begins as a button or primordia from a sclerotium, unlike many other fungi. Sclerotium allows survival through over-wintering or desiccation and germinates to produce a genetically identical mycelium.

In order to complete the life cycle, the haploid mycelia must find another compatible haploid mycelia to fuse with.

Here, again, the Morel differs from many other fungi. Recent research shows Morels are heterokaryotic; the hyphal cell contains many *different* haploid nuclei per cell. Ongoing research even suggests these haploid nuclei are capable of a haploid meiosis which, in its simplest terms would be the equivalent of a mammal "haploid female growing from an unfertilized egg and then mating with herself to produce offspring." (Pilz et al., 2007, page 33)

Part II. The whole fungus, continued

The implications of heterokaryosis in morels are significant relative to adaptations to environmental changes, fluctuations, stressors and for cultivation.

It's important to understand the morel life cycle when harvesting morels. Harvesting only the fruiting body by cutting the stipe at the base near the ground minimizes injury to the sclerotium and/or mycelium for sustainable harvests.

Part II. What is the impact of harvesting on the mycelium?

As mushroom harvesters, we must be concerned about the fate of the whole fungal colony after we harvest mushrooms. To answer this question, we return to the analogy of trees bearing fruit.

Just as the timing (when) and the technique (how) for picking fruit effects future production, the same holds true for mushrooms. Mushrooms are short-lived and their fate is to produce spores and then be consumed or wither away after dispersal into the soil foodweb. However, the wild mushrooms we harvest are part of the ecology of the landscape. For this reason, harvesting wild mushrooms could affect the ability of a wild mushroom species to respore (i.e., reseed) a forest with its offspring.

Existing data that could address the effects of mushroom picking on future harvests are sparse. Overall, harvests of forest mushrooms are declining. For instance, the number of locations where chanterelles fruit in the Netherlands decreased by 60 percent in the late 20th century (Arnolds 1988). However, these data may reflect more the effects of pollution rather than overharvesting. A long-term study on the sustainability of chanterelle harvesting in the Pacific Northwest (Norvell 1995) showed no effects of harvesting of a repeated area over a ten-year period. A more recent study in Swiss forests over a 30-year time span also showed that mushroom harvesting had no effect on the diversity and abundance of mushrooms in small plots harvested throughout the growing season (Egli, 2006). However, the same study did find negative impacts of trampling a forest floor on the overall abundance of fruiting bodies in their plots.

Part III. Mushroom Ecology

Guilds

Mushrooms can be broadly classified into three ecological types or guilds: saprotrophs (sometimes called saprobes), ectomycorrhizae, and parasites.

Saprotrophs are species that are decomposers. They may be found in the litter, grass and/or soil, dung, or wood. These species are critical for the recycling of nutrients in nature, particularly of plant tissues rich in lignin (the compound that provides rigidity to wood and leaves) and cellulose. Most saprotrophs have specific preferences for the types of forests and substrates they utilize. For example, *Pleurotus populinus*, an oyster mushroom, is exclusive to wood of *Populus* trees (aspens and cottonwood). Most of the species that are saprotrophic can be cultivated, which means many of them are produced rather than harvested from the wild.

Ectomycorrhizal mushrooms are those forming an association with the roots of tree species. The fungus grows on the fine roots and in the neighboring soil, and provides the plant with minerals such as phosphorus, nitrogen, and water. In exchange, the fungus receives sugars from the plant. This form of mutualism means both partners are dependent upon each other. For this reason, most of the prized edible fungi that are mycorrhizal (e.g., truffles, chanterelles and boletes) cannot be grown to the mushroom stage without the tree host. Accordingly, in order to collect these fungi in nature, it becomes useful to be able to identify the tree species associated with each mushroom you wish to collect.

Parasitic species are those mushrooms that take nutrients from the host without giving anything back.

Some species can be weak parasites that invade wounds of trees and then participate in decay after the host dies. Because they are parasites, these fungi often have narrow host ranges, such as the hen of the woods, *Grifola frondosa*, which primarily attacks the roots of oak trees. Other species can actually parasitize other fungi. For example, lobster mushrooms are comprised of the fruiting bodies of a *Russulaceae* (normally not considered choice edibles) which are being parasitized by a microfungus (*Hypomyces lactiflourum*).

Morchella species are classified as either saprotrophs, mycorrhizal or both (at different stages of their life cycle). Research is ongoing to understand this.

Mushroom Economics

Part I. Laws on foraging

Mushroom foragers have excellent rights and ample hunting grounds across the State of Michigan for collecting mushrooms for personal use. As a forager, you are legally able to collect on these areas for personal use:

- State Parks (Forest, Game and Recreation areas managed by DNR)
- National Forests (check with each Region for updated rules and regulations)
- Private lands (with owner's permission)

However, you may not harvest mushrooms for personal consumption in:

- National Parks
- Metro and County Parks (rules may vary, check with the local municipality)

The following Michigan Department of Natural Resources State Land Use Rules applies to harvesting wild mushrooms for commercial use:

R 299.922 Unlawful acts generally.

Rule 22. On land owned or under the control of the department, it is unlawful to do any of the following:

> (h) Destroy, damage, or remove a tree, including a dead and downed tree and woody debris, shrub, wildflower, grass, or other vegetation. Except in a wildlife food plot, this subdivision does not apply to picking and removing mushrooms, berries, and edible fruits or nuts for personal use.
>
> (dd) Use state-owned land for a commercial operation unless the commercial operation is conducted pursuant to a permit issued by the department. The department may waive the requirement for a permit for a commercial operation if the department determines that the commercial operation will not require department oversight and the commercial operation is anticipated to have a minimal impact on the resource or facilities and the use of state-owned land by others.

The implications are: It is ILLEGAL to harvest mushrooms on state lands for commercial use since it is not for personal use. We recommend harvesting mushrooms from private lands with the owner's permission.

Part II. The mushroom market

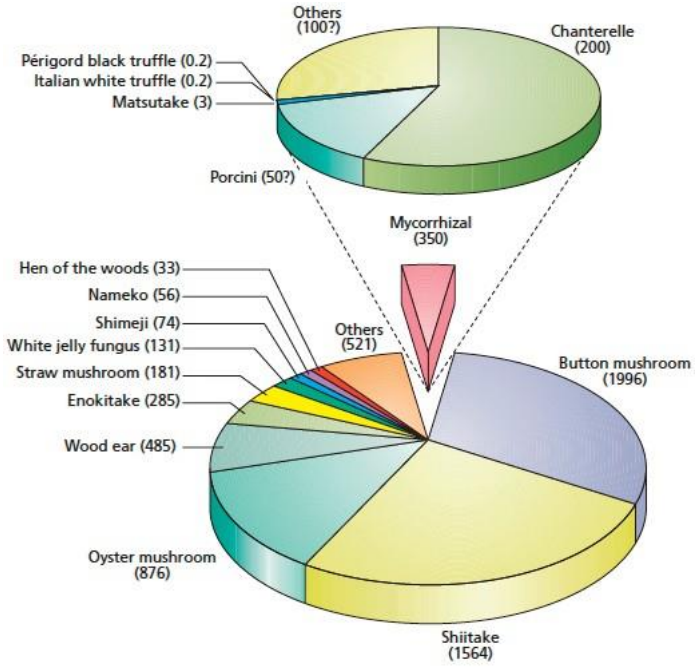
The overall mushroom market was about 6.6 millionmetric tons with 64% of the production coming from China. The types of mushrooms produced across China are shown below in Table 1.

TABLE 1. EDIBLE MUSHROOMS PRODUCED IN TWENTY-TWO CHINESE PROVINCES IN 1998 (Chinese Association of Edible Fungi 2000).

Scientific name	Common name	Amount produced (× 1000 tons)
Lentinula edodes	shiitake	1338
Pleurotus spp.	oyster mushroom	1020
Auricularia polytricha	wood ear	432
Agaricus bisporus and *A. bitorquis*	button mushroom	426
Flammulina velutipes	enokitake	189
Tremella fuciformis	white jelly fungus	100
Auricularia auricula	wood ear	59
Volvariella volvacea	straw mushroom	32
Pholiota nameko	nameko	31
Hypsizygus marmoreus	shimeji	22
Grifola frondosa	hen of the woods	10
Boletus spp.	boletes	8.1
Ganoderma spp.	conks	6.7
Lactarius deliciosus	saffron milk cap	6.0
Hericium erinaceus	lion's mane mushroom	2.8
Coprinus comatus	shaggy ink cap	1.8
Dictyophora indusiata	bamboo mushroom	1.1
Pleurotus cornucopiae var. *citrinopileatus*	golden oyster mushroom	0.5
Agaricus blazei	almond portobello	0.1
Others		293.9
TOTAL		4350

From: *Edible and Poisonous Mushrooms of the World* by Ian Hall et al.

Part II. The mushroom market, continued



Estimated world consumption of edible mushrooms in 1997 (× 1000 tons) (from Chang 1999).
From: *Edible and Poisonous Mushrooms of the World* by Ian Hall et al.

The figure above gives a breakdown of global consumption ofvarious mushroom types in 1,000 metric tons.
Despite the US market being dominated by *Agaricus bisporus* (the common button mushroom), this does not reflect the global market. It is interesting to note:

- Wild mushrooms make up a small fraction of the consumption (5%), the portion labelled "Mycorrhizal".
- Morels are suspiciously missing from this list. Are they in the "Others" or "Mycorrhizal" group?

Part III. Nutrient content

Mushrooms are a very healthy food that have low caloric value, are very low in fat, but are high in protein and vitamins and minerals. The nutritional content of 5 raw button mushrooms is shown to the right. The vitamins and minerals contained include copper, selenium, vitamin B2 (riboflavin), zinc, pantothenic acid, niacin, and riboflavin.

Wild harvested mushrooms andthose exposed to sunlight (UV light) can provide appreciable amounts of vitamin D2 to a diet. However, it is known that fungi accumulate heavy metals in their mycelium (and fruiting bodies). For this reason, take care of where you forage for wild mushrooms.

For example, it is not recommended to collect wild mushrooms near industrial sites, areas with heavy metal pollution (mercury, lead), golf courses or along busy roads bathed in car exhaust. Remember, the nutritional value of a mushroom is quite dependent upon where and how it was grown, handled and stored. When foraging for wild mushrooms, be mindful of where your food comes from and be thoughtful of the whole fungus.

Nutrition Facts

Serving Size 5 medium (84g/3.0 oz)

Amount Per Serving

Calories 20	Calories from Fat 0
	% Daily Value*
Total Fat 0g	0%
Saturated Fat 0g	0%
Trans Fat 0g	
Cholesterol 0mg	0%
Sodium 15mg	1%
Potassium 300mg	9%
Total Carbohydrate 3g	1%
Dietary Fiber 1g	4%
Sugars 0g	
Protein 3g	

Vitamin A 0%	•	Vitamin C 2%	
Calcium 0%	•	Iron 2%	
Vitamin D 4%	•	Thiamin 4%	
Riboflavin 20%	•	Niacin 15%	
Vitamin B6 4%	•	Folate 4%	
Pantothenic Acid 15%	•	Phosphorus 8%	
Magnesium 2%	•	Zinc 2%	
Selenium 10%	•	Copper 15%	
Manganese 2%			

*Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Saturated Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Potassium		3,500 mg	3,500 mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

REFERENCES

Arnolds, E. (1988). The changing macromycete flora in the Netherlands. Transactions of the British Mycological Society. 90, 391–406.

Egli S., Peter M., Buser C., Stahel W. & Ayer F. (2006). Mushroom picking does not impair future harvests - results of a long-term study in Switzerland. Biol. Conserv., 129, 271-276.

Iwasa M., Tanabe S. & Kamada T. (1998). The two nuclei in the dikaryon of the homobasidiomycete Coprinus cinereus change position after each conjugate division. Fungal Genet. Biol., 23, 110-116.

Norvell, L. (1995). Loving the chanterelle to death? The 10 year chanterelle project. McIlvanea 12, 6–25.

Pilz, Daved et al. (2007). Ecology and Management of Morels Harvested from the Forests of Western North America. USDA. General Technical Report pnw-gtr-710, 30-38.

Identifying Mushrooms

Most mushrooms and truffles can be identified using visual and aromatic cues as well as chemical tests. A 10x hand lens or magnifying glass is an important tool to help with this identification. The more serious mycophile will need a microscope to further observe spore and tissue characters.

Characteristics vital for identifying mushrooms include the substrate, form, cap shape, spore color and shape, type of veil, spacing of gills, stipe, texture, color change, odor and taste.

NOTE: To sell morels in Michigan, a Certified Mushroom Expert needs only to identify the morel to Genus, Morchella.

Substrate

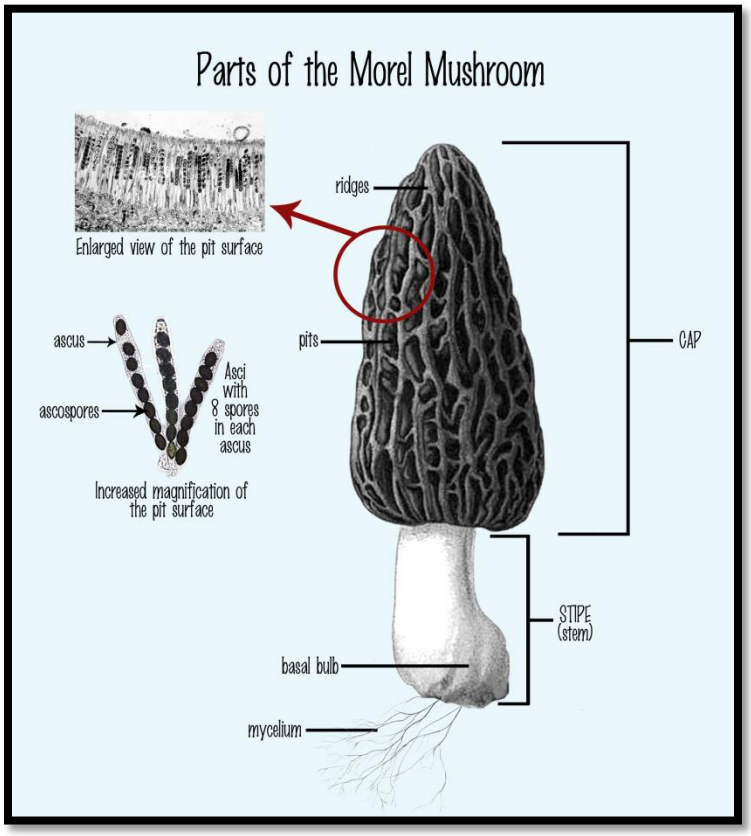
Identifying the substance (substrate) a mushroom or truffle is growing from can be important for diagnosing and discriminating species; different fungi are specialized in obtaining their nutrition in different ways. Pathogenic and various 'rot' species grow within, and from, living trees, and can be quite host specific. Accordingly, identifying the host plant for these species can be diagnostic. Saprotrophic fungi obtain their nutrition from non-living substrates such as dead wood, humus, compost, dung, or ashes. In contrast, ectomycorrhizal fungi obtain their carbon from living trees in an intricately evolved mutualism. These fungi fruit out of the forest floor and amongst the root systems of their hosts. Some ectomycorrhizal fungi show host preferences and even host-specificity. To help in their identification, be sure to look up and all around (not just down) and make note of the local plant community.

Form

There are many distinctive shapes or forms of mushrooms. Gilled mushrooms (agarics) differ from boletes and polypores by the shape of their fertile spore-producing layer, the hymenium. For example, morels, with their pitted hymenium are quite distinctive from coral fungi that have a smooth hymenium. For stipitate fungi (those having stems), the attachment of the cap and stem may be 'central', 'lateral' or 'reduced'. Some mushrooms, such as the giant puff- ball (*Calvatia gigantea*) have no stipe. Truffles produce their spores in a 'gleba' (the inside of their fruiting body) and often fruit below the soil or at the soil surface.

Spore color and shape

The color of a mushroom's spores, *en masse*, can be a key diagnostic feature. It is possible to obtain spore prints from a wide range of fungi including agarics, boletes, morels, coral fungi, and resupinate (crust) fungi.



Oftentimes mushrooms have 'spore-printed' themselves, and youwill see spores dusting the caps, along the stem or at the base of the mushroom. To obtain a spore print, place a section of spore producing tissue on a piece of paper, cover to keep the humidity high, and place in a cool dark environment. Note the spore color after a few hours. Spores can range in color from white, buff, pink, tan, chocolate brown, rusty brown to black. With a compound microscope you can observe other diagnostic features including the spore shape, size and ornamentations.

For more information on making a spore print see the following links:

http://www.mushroomexpert.com/spore_print.html
http://www.namyco.org/education/spore_prints.html

Right: Spore print of *Morchella americana*

Identifying Mushrooms, continued

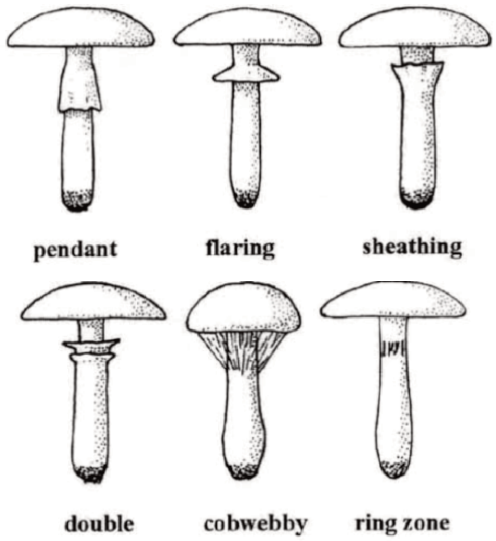
The presence or absence of veils

A veil is a thin tissue the covers the spore-producing hymenium before the mushroom reaches maturity. Veils are common in many groups of mushrooms and are most evident in young fruiting bodies. Many produce fragile or "cobwebby" veils that quickly disappear or weather away.

Superficial wisps of tissue around the apex of the stem or the margin of the cap may be all the remains of a partial veil.

Other times, veils form a collar around the mushroom stem and are strikingly evident. In other cases, such as in deadly toxic species of *Amanita*, fruiting bodies form in a sac-like structure, known as a volva, evident at the mushrooms' base.

Morchella species do not form a veil or volva.

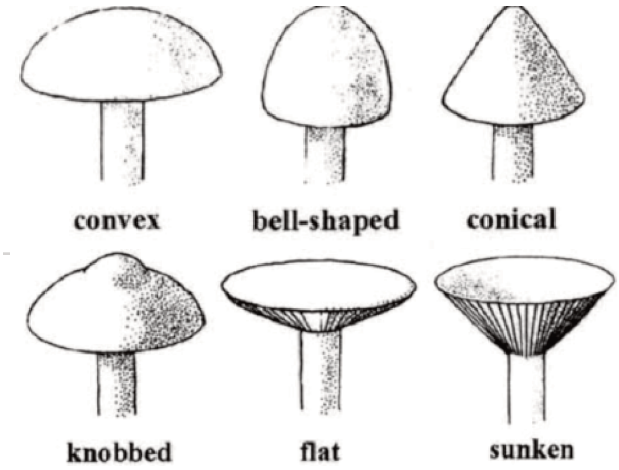


Veil Types

Mushroom caps

On the surface

Cap color, shape, size and texture are features which can be used to begin the identification process of mushrooms. In the case of Morels, the color and shape of the cap are the first observable indicators of the species of Morchella. It is important to observe the colors of the pits versus ridges while equally important to recognize the attachment of the cap to the stipe. The illustration to the right describes the shape of caps.



Mushroom cap shapes*

Hymenium (the fertile tissue)

The hymenium is the spore producing layer of a fungal fruiting body where cells develop into basidia or asci. Fungi are classified into phylum on the basis of how their spores are produced. For example, we previously discussed Morels producing their spores in asci. For this reason, they belong to the phylum Ascomycota. In contrast, some mushrooms produce their spores in structures called basidia and are, subsequently, in the phylum called Basidiomycota.

Alternatively, some mushrooms like puffballs and the previously mentioned truffles are versions of mushrooms with spore bearing surfaces enclosed in a called the gleba. However, puffballs belong to the phylum Basidiomycota because their spores are produced in basidia while truffles belong to the phylum Ascomycota because their spores are produced in sacs called asci.

The hymenium is found on gills, pores, spines, teeth and, in the case of morels, the lining of the pits.

For mushrooms with caps, the gills, gill attachment to the stem, gill edges and pores are evident on the underside of the mushroom's cap. A small mirror can be placed under a mushroom in the field to observe this character without disturbing the fungus. Gill attachment, gill spacing, forking and cross-venation can assist in its identification.

In fungi with pores, spines and teeth, the shape and size of these vary and can be diagnostic.

Identifying Mushrooms, continued

Stipe

The shape of the stem/stipe can also be a morphological characteristic used for identifying mushrooms. The illustration to the right demonstrates stipe morphologies used in mush room identification.

Texture and color change

Mushroom and truffle tissues vary in texture and can change color when handled. For instance, tissues of some boletes bruise blue when handled due to oxidation reactions. Such reactions can be a diagnostic feature. When the cap or stem of mushrooms is damaged, it may stain red, yellow, green, blue or purple, or may not stain at all. Tissues may 'peel', 'break', may feel 'slimy' or 'spongy' or may be 'woody' or 'fibrous'. For example, the outer surface of truffles, called the peridium, can vary in color, range in texture (from smooth to warty), thickness and cellular arrangement.

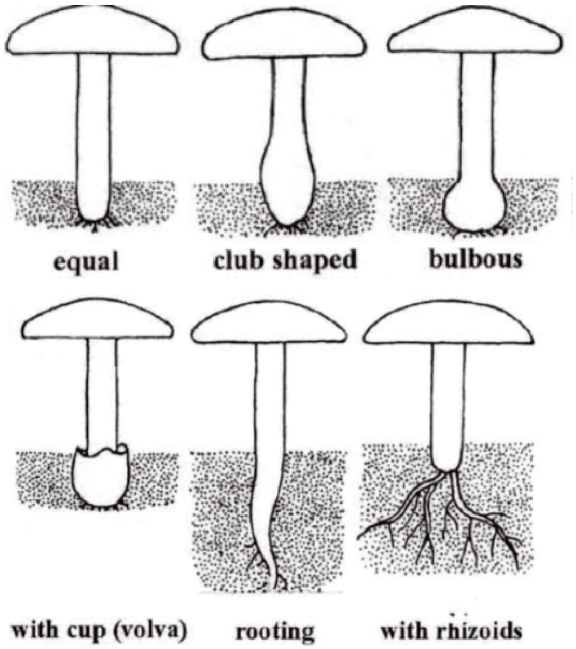
Odor

The odor of fungi can be an important character for identifying some types of mushrooms and truffles. While subjective and variable between individuals, some fungi have distinctive odors that may range from 'fruity', 'nutty', 'mushroomy' to 'phenolic' or 'putrid'.

Season, geography, weather

Many mushroom species are adapted to certain environments, especially morels. Making note of the location (GPS coordinates are standard), time of year, recent weather conditions, and day/night temperatures can be helpful in identifying fungi. Digital photographs of fresh specimens can be useful; pay special attention to the characters outlined above.

Reputable taxonomic keys and field guides of the region of collection should be referenced for identifying fungi.



Mushroom stipes*

*These diagrams are modified from Lincoff, G. H. 1981 National Audubon Society Field Guide to North American Mushrooms. Alfred A. Knopf, New York. ISBN 0-394-51992-2, as listed with the University of Saskatchewan.

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MORELS

The Morchellaceae family consists of the genus Morchella, genus Verpa and genus Disciotis. Although Gyromitra species belong to the same Order as Morchellaceae, they are in an entirely different Family (Discinaceae). Several species of Morels exist worldwide; many of these are being reclassified based on DNA analysis. Debate is ongoing about the actual number of morel species found in Michigan.

For that reason, Certified Mushroom Experts are able to sell morels which have been inspected and identified to the genus, Morchella.

Why is it important to know the species? Each unique species reflects the ecology between fungi and its respective environment; playing an essential role in sustainable harvests and healthy ecosystems.

KINGDOM: Fungi

PHYLUM: Ascomycota

CLASS: Pezizomycetes

ORDER: Pezizales

FAMILY: Morchellaceae

The following is a list of the six species of morels which are allowed to be harvested and sold in Michigan by a Certified Mushroom Expert.

- ***Morchella americana***
- ***Morchella angusticeps***
- ***Morchella diminutiva***
- ***Morchella exuberans***
- ***Morchella importuna***
- ***Morchella punctipes***

Common Description

"True Morels" are the members of the genus Morchella and "False Morels" are the members of the genus *Verpa* and genus *Gyromitra*.

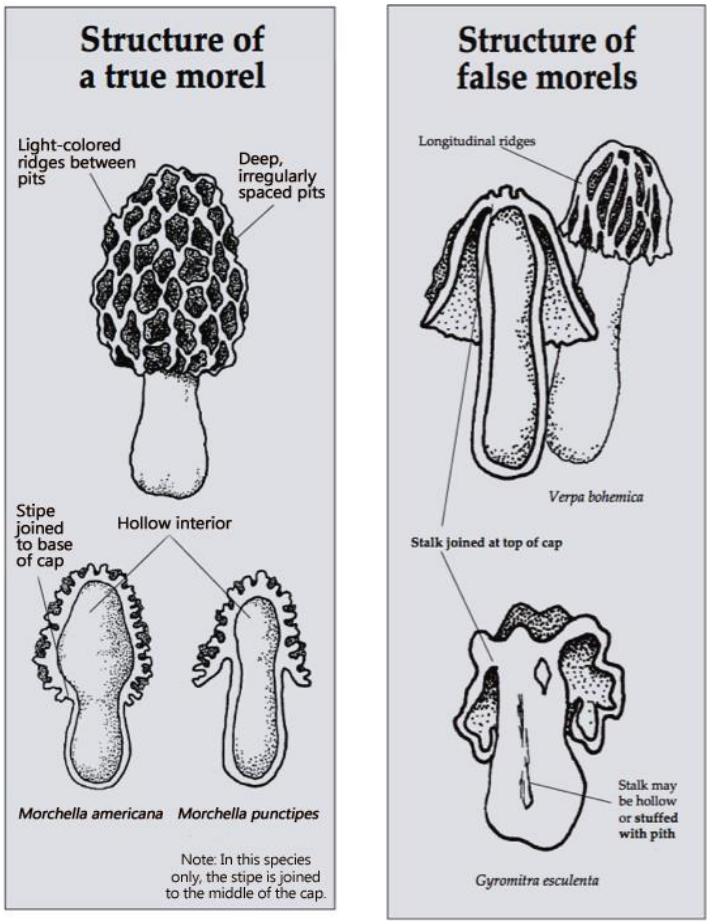
True Morels can generally by identified employing careful observation of the cap, stem, substrate, and time of appearance during the season. They are broken into two groups based on pitted and ridged caps:

1.) Black Morels – those having dark ridges and pale pits.

2.) Yellow Morels - those having pale ridges and dark pits.

The shapes of caps vary among species as conical, nearly rounded, egg-shaped, or oval. Caps are attached to the stipe with little or no rim or can overhang creating a noticeable groove. Cap color varies with species and maturity.

The stipe of every morel species is hollow; it may be enlarged or "fluted" at the base (see the specific description of *Morchella exuberans*). This is the main differentiating character between the Morchella and its poisonous look-alike, the Verpa spp.



(from The Fifth Kingdom - Chapter 4b http://www.my-colog.com/CHAP4b.htm)

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Ecology

Morchella spp. always fruit in the spring; some species appear in mid-March and others in mid-June. Environmental conditions as well as other stressors and conditions, play a direct role in the fruiting season of Morchella species. Each species has a specific guild-role and preferred habitat and is detailed in the following species' description.

Possible allergic reactions and symptoms

Although most people can safely consume cooked morels, a few people may experience an allergic reaction and/or experience gastrointestinal distress. **All morels must be cooked thoroughly and never served raw**, as cooking can destroy the gastro-irritant. The black morel, *M. angusticeps*, has been reported to cause stomach upsets when consumed with alcohol.

Various Morchella species myco-accumulate lead from 70-100 times; **attention must be given to selecting clean, contaminant-free picking sites**. It is best to avoid areas near roadways, golf courses, and industrial sites. An article by Elinor and Efrat Shavit in Fungi (2010) found lead arsenate used in old apple orchards in northeastern U.S. to be a contributor to morel toxicity. Always remember to eat only clean mushrooms, free of decay.

Tips for harvesting and storing

Morels should be cut with a knife near the soil surface and cleaned of detritus with a soft brush before placing in a basket. If the mushrooms are cleaned as they are harvested, it will help keep dirt out of the pits of those morels previously collected.

As with most fungi, morels should be stored in paper or waxed paper bags and refrigerated soon after harvest.

Do not store morels in airtight plastic bags or containers; they will last longer if kept from drying out, but allowed to breathe.

Morchella americana

Common names: Grays, White Morel, Yellow Morel

=*Morchella esculentoides*;
(previously *Morchella esculenta*, *Morchella crassipes* and *Morchella deliciosa*)

Description

Morchella americana is a commonly harvested Spring mushroom which ranges in color from gray to whitish to yellowish. The typical fruiting season is from March to June. The fruiting body is medium to large (up to 5-22 cm or more tall). The sponge–like head is egg-shaped, oval to conical, or pine cone-shaped with pits and ridges that are primarily vertically arranged. On all forms, the ridges are paler than the pits. The hollow, whitish stipe is nearly equal, or enlarged toward the base, attachedto the cap without a notable overhangor rim. When found with a stout and enlarged stipe base, yellow morels have been known as *M. crassipes*, but DNA evidence has shown these to be older yellow morels which have grown in optimal conditions of temperature and moisture. Interestingly, "DNA study of specimens in the Morel Data Collection Project by Carol Carter and Kerry O'Donnel showed that "gray morels" from the eastern North American collectors were not supported as separate species; there were merely immature forms of yellow morels like *Morchella esculentoides"*.

Ecology/Associated Habitat

Morchella americana is possibly saprotrophic and mycorrhizal at different times in its life cycle. This morel is often found under hardwoods, especially ashes and recently dead elms, as well as aspens, balsam poplars, sycamores, tulip trees, and apple trees in old abandoned orchards. Occasionally this morel will be found associated with conifers, especially white pine.

M. americana cut to show hollow stipe.

Morchella americana

Look-alikes

All true morels are edible but there are two edible species of true morels which can be mistaken for *M. americana*:

1.) *Morchella prava* differs visually by having pits and ridges that are randomly arranged and irregular; almost appearing as contorted. The pits are almost black in young fruiting bodies and may remain black or turn brown with age. Mycologist Michael Kuo says "My friends and I have collected *Morchella prava* for many years in northern Michigan, along the Straits of Mackinac, often within a few feet of water." *(http://www.mushroomexpert.com/morchella_prava.html)*

2.) *Morchella cryptica* is not discernible macroscopically to which Kuo et al, 2012 stated "we are stuck with not knowing, in the Great Lakes region, whether the most commonly collected, consumed and sought after morels are *M. cryptica* or *M. americana* without testing their DNA." According to the author, *M. americana* is the more common species.

Morchella angusticeps

Common name: Black morel

(previously *Morchella elata*)

Description

Morchella angusticeps is generally regarded as the first true morel to appear in Spring in Michigan. The fruiting body is up to 18 cm tall. The sponge-like head is variable in shape but usually elongated and pointed. The head has elongated and irregular pits with ridges that darken with age. The young black morel may appear almost white when covered by leaf litter, but the mature black morel will have brownish pits and dark ridges. The hollow, whitish stipe is attached to the head with a slight overhang or rim. The stipe will darken to reddish brown as it ages.

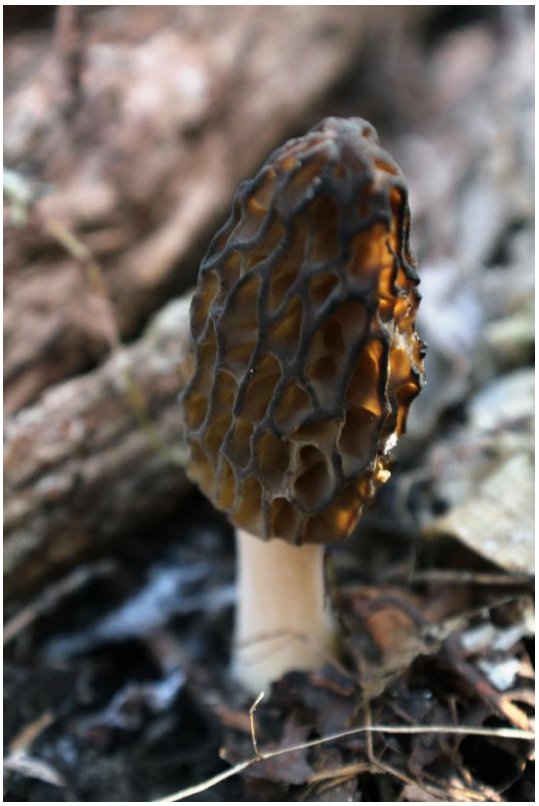


Photo courtesy Heather Johnson

Morchella angusticeps

Photo courtesy Heather Johnson

M. angusticeps cut to show hollow stipe.

Ecology/Associated Habitat

Morchella angusticeps is mycorrhizal and typically starts to appear in March, lasting through May. It can be found under hardwoods, especially white ash and tulip trees, as well as cherry, aspen and sometimes pines.

Look-alikes

Morchella septentrionales is a similar black morel which occurs north of the 45th parallel in Michigan. This black morel is slightly smaller, found under hardwoods and can be found fruiting from decaying wood of big-toothed aspen and white ash. Additionally, it is probably considered both saprotrophic and mycorrhizal. As with all true morels, it is edible as long as it is well cooked.

Morchella diminutiva

Common name: Yellow morel

Description

Morchella diminutiva is a yellow morel with a fruiting body up to 11 cm tall. The sponge-like head is conical and rarely egg-shaped or cylindrical. The pits are primarily arranged vertically. Young *M. diminutiva* are yellowish with bald, flat ridges and dark gray pits. As they mature, the ridges and pits equalize in color, becoming yellow to brownish yellow. The equal, hollow stipe can be up to 7 cm and is attached to the cap directly with little or no overhang. It may be slightly swollen at the base. The stipe is generally longer and skinnier than other *Morchella* species making this a feature to differentiate from other species.

Morchella diminutiva

Ecology/Associated Habitat

Morchella diminutiva is mycorrhizal and saprotrophic at different stages of its life cycle. It can be found growing alone, scattered and/or gregariously. *M. diminutiva* can be found under hardwoods, especially white and green ash, tulip trees and hickories. It usually fruits in April through May.

Look-alikes

This small morel can be mistaken for *Morchella americana* when its cap is less conical, stem is shorter and ridges and pits are more uniform. As with all true morels, it is edible as long as it is well cooked.

Photo courtesy Heather Johnson

Morchella diminutiva

Morchella exuberans

Common names: Burn-site Morel

=Morchella capitata

Description

The hollow caps of *Morchella exuberans* are from 4-8 cm tall, conical or nearly round. On mature caps, the ridges are dark brown to black. The pits are primarily vertically, elongated and brown to tan at maturity. The cap is attached to the stipe with a small groove.

The white stipe is layered or chambered, especially near the base; even when mature.

Ecology/Associated Habitat

Morchella exuberans is possibly saprotrophic and mycorrhizal at different times in its life cycle. It often appears in May through mid-June in conifer forests the first year after a fire but rarely two years after.

Fluted stipe of *M. exuberans*

Morchella exuberans

Look-alikes

There are no look-alikes for this morel; especially since this species is only found after a forest fire. This morel is edible but often the sand and fire residue on the mushrooms make them of less commercial value.

***Morchella exuberans* (=*captitata*) are adapted to post burn sites.**

Morchella importuna

Common names: Black Morel

Description

Morchella importuna is becoming an increasingly common morel appearing in the Midwest. It has a distinctive conical, or nearly so, cap which is 3-5 cm tall and 2-9 cm wide. The stipe is 3-10 cm high, usually swollen at the base, attributing to its overall height up to 19 cm. The yellow pits are vertically arranged but are uniquely arranged with ladder-like crossridges. The ridges are bluntly rounded; gray/brown when immature and becoming sharp, black/dark brown upon maturity. The cap is attached to the stipe with a small groove that can measure up to 5mm deep.

Ecology/Associated Habitat

M. importuna is saprotrophic and fruits from March to May. This morel is typically found in the northwestern United States but is now appearing in the Midwest in landscaped sites, gardens and planters; often associated with mulch.

Research is ongoing to evaluate its cultivation potential as it doesn't appear to be mycorrhizal with trees.

Photo courtesy Eric Johnson

Morchella importuna

Look-alikes

There are no look-alikes for this morel; especially since this species is only found in mulch, landscaped sites, gardens and planters.

This image was created by user Tim Sage (T. Sage) at Mushroom Observer, a source for mycological images. This is Image Number 216687 at Mushroom Observer, a source for mycological images., CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=25752660

Photo courtesy Heather Johnson

Morchella importuna, cut in half to reveal the hollow, fluted stipe.

Morchella punctipes

Common names: Half-free Morel

(previously *Morchella semilibera*)

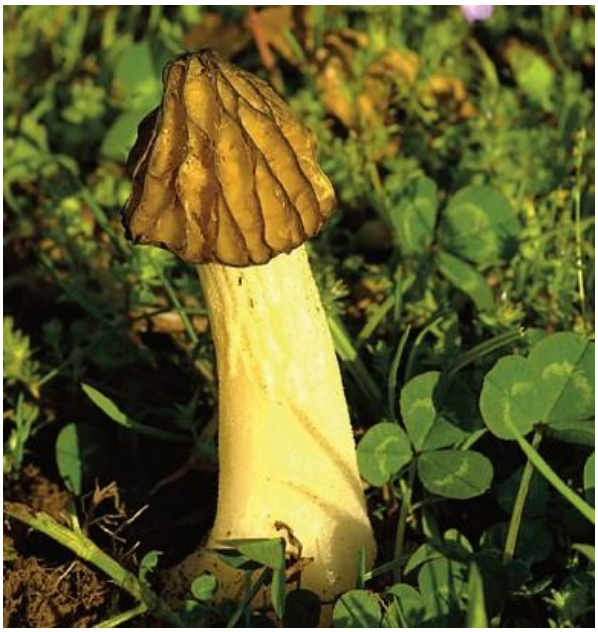
Description

Morchella punctipes has a cap, usually 1-4 cm high, which attaches about halfway down the stipe and flares away from the stipe in a skirt-like manner. The hollow cap is broadly conic with a round to blunt apex, divided into pits and vertical ridges with secondary shorter horizontal ridges. The whitish stipe is 3-15 cm high, nearly equal, enlarging downward and is hollow. The surface of the stipe is spotted with mealy granules that may darken with age.

Ecology/Associated Habitat

Morchella punctipes is mycorrhizal. It is found solitary or scattered in hardwood forests or old apple orchards generally appearing March through May and before the yellow morel. This species of half-free morel is found east of the Rockies; DNA analysis of western collections differs from *M. punctipes* as well as the European species, *Morchella semilibera*.

M. punctipes cut in half to show the skirt-like cap attached to the hollow stipe.



Morchella punctipes

Look-alikes

Verpa bohemica and *Verpa conica* can be confused with *M. punctipes*. *Verpa* spp. have a cap perched only atop of the stipe so the sides hang completely free (refer to picture on page). *Verpa* spp. have a stipe at least partially stuffed with a soft cottony tissue. *Verpa* causes gastrointestinal distress in some people and is best considered inedible.

REFERENCES

Bueg, M., Bessette, A, Bessette, Arlene. 2014. Ascomycete Fungi of North America: a mushroom reference guide. University of Texas Press. 488p.

Kuo M. 2005. Morels. Ann Arbor: Univ. Michigan Press. 205p.

Kuo, M., Dewsbury, D.R., O'Donnell, K., Carter, M.C.,Rehner,S.A., Moore, J.D., Monclavo, J.M., Canfield, S.A., Stephenson,S. L., Methven, A.S., Volk, T.J. 2012. Taxonomic revision of the true morels (Morchella) in Canada and the United States.

Marrone, Teresa and Sturgeon, Walt. 2016. Mushrooms of the Northeast.Adventure Publications. Cambridge, Minnesota.

Mycologia 104(5):1156-1177, doi:10.3852/11-375.

Kuo, M., Metheven, A. 2014.Mushrooms of the Midwest. University of Illinois Press. Urbana, Chicago, and Springfield.

Rodgers, R. The Fungal Pharmacy. 2011. North Atlantic Books, Berkeley, CA. pp. 287-291.

Shavit, Elinor and Efrat. 2010. Lead and arsenic in Morchella esculenta fruit bodies collected in lead arsenate contaminated apple orchards in northeastern UnitedStates: A preliminary study. Fungi3(2):11-18.

Internet Sources

Michael W. Beug. Poisonaous and hallucinogenic mushrooms. http://academic.evergreen.edu/mushrooms/phm/566.htm.

Kuo, M. (2012, November) The Morchellaceae: True morels and verpas. http://www.mushroomexpert.com/morchellaceae.html

Morchella Look-alikes

There are a few mushrooms that fruit at the same time as morels, and vaguely look like morels.

Verpa spp.

Verpa bohemica, the wrinkled thimble cap, and to some extent *Verpa conica*, the smooth thimble cap, bear some resemblance to the half-free morel. They are easily distinguished by:

- The folds on the cap instead of the ridges and pits seen in true morels
- The cap of the Verpa attaching ("perching") to the top of the stipe. Almost the entire cap hangs free, skirt-like. In contrast, the half-free morel cap attaches to the stipe, half way up the cap, leaving half of the cap hanging free like a skirt.
- The stipe of Verpa spp. containing a cotton-like tissue. All true morels have a hollow stipe.

Verpa bohemica can more likely be confused with *Morchella punctipes* than thesmooth capped *Verpa conica*.

Verpa spp. are slightly poisonous and are not authorized for collecting and selling in Michigan.

Verpa bohemica

Verpa conica

Verpa bohemica

Compare the cotton-like tissue filled stipe of the *Verpa bohemica* above to the hollow stipe of the *Morchella punctipes* to the right.

Verpa conica

Compare the cap attachment (perched) to the stipe of the *Verpa conica* above to the cap attachment (half-way down the hollow stipe) of the *Morchella punctipes* pictured left.

Gyromitra spp.

There are several species of Gyromitra found in Michigan which fruit at the same time as morels.

Chemical analysis has shown all Gyromitra species contain the chemical Gyromitrin as well as other toxins, including an unidentified carcinogen, which remain in the mushrooms and can build up over time (bioaccumulate) with repeated Gyromitra meals. Our digestive system converts Gyromitrin into Monomethylhydrazine; a volatile toxin and carcinogen. Commonly referred to as "rocket fuel", it is used as a propellant in rocket engines. The amount of Gyromitrin varies in species and individual but the effects can be so devastating, this mushroom should **never** be consumed. Research is ongoing to understand this toxic component of Gyromitra species.

Three of the more common Gyromitra species are discussed below.

Gyromitra esculenta, the false morel or the beef-steak morel, also fruits at the same time as morels. This mushroom has been responsible for many deathsin Europe and several poisonings in the U.S. *G. esculenta* is distinguished from Morchella species by its folded, brain-like cap and association with conifers. Morchella spp. are usually found in association with hardwoods.

Gyromitra brunnea, also known as the "Gabled False Morel", is found in or near hardwood forests and its lobe-like cap can appear pinched with seams.

Gyromitra korfii, regarded as the "Bull-Nose False Morel", is also found in or near hardwood forests, especially near stumps or dying trees. Its wavy cap folds over the stipe with little overhang; it can appear blocky and stemless.

All Gyromitra species have a thick, multi-chambered stipe (see below). *Morchella exuberans* has a multi-chambered hollow stipe but its cap has ridges and pits which distinguishes from the Gyromitra caps.

Gyromitra esculenta

Photo courtesy Dr. Timothy James

Gyromitra brunnea

Gyromitra korfii

Photo courtesy Dr. Timothy James

Compare the multi-chambered stipe of the *Gyromitra brunnea* (left) to the "fluted, chambered" stipe of the *Morchella exuberans* (right).

Don't Pick Poison!

When Gathering Mushrooms for Food in Michigan

Amanita bisporigera

Contents

Introduction

At least 50 of the larger species of wild mushrooms that grow in Michigan are known to be poisonous. There may be more.

The ultimate decision whether to eat a wild mushroom is yours. Michigan State University, the Michigan Department of Public Health, the authors of this publication and those contributing to the subject matter assume no responsibility for the safety or well-being of any mushroom collector.

What is a poisonous mushroom?

For the purposes of this bulletin, we define a poisonous mushroom as one that may be expected to have an adverse effect on a sizable percentage of the population the majority of the time. This definition excludes idiosyncratic reactions and allergies that may cause a person to have an adverse reaction to a usually edible mushroom. Just as some people are allergic to wheat or peanut butter, some people are allergic to certain mushrooms.

Approximately 2,500 species of large, fleshy wild mushrooms grow in Michigan. By "large and fleshy" we mean those fungi big enough to be seen and large enough to make a meal when collected in quantity.

The number would be increased by several thousand if microscopic fungi were included in the count. Within our approximately 2,500 large species, at least 50 species are known to be poisonous. Anywhere from 60 to 100 species are regarded as generally safe for eating.

How can you tell them apart? You cannot determine whether a mushroom is poisonous or safe by any easy, magic method. You must learn to positively identify each individual mushroom you pick for food.

Poisonous wild mushrooms grow in Michigan

From documented case histories and from the scientific literature, we have compiled a partial list of Michigan mushrooms known to be poisonous. Some are deadly; others, discomforting. Species that have caused rare deaths under special circumstances are marked with an asterisk; those that are frequently deadly are marked with two asterisks. Hallucinogenic species are marked with †.

Mushrooms that are predominantly poisonous

Agaricus praeclarosquamosus
*Amanita bisporigera***
Amanita cothurnata
Amanita muscaria†*
*Amanita pantherina**
*Amanita phalloides***
Amanita spreta
*Amanita tenuifolia***
Amanita velatipes
*Amanita verna***

(continued on next page)

*Amanita virosa***
Boletus luridus
Boletus satanus
Boletus subvelutipes
Chlorophyllum molybdites
Clitocybe clavipes (with alcohol)
Clitocybe dealbata
Clitocybe morbifera
Conocybe filaris
Conocybe lactea
Coprinus atramentarius (with alcohol)
Coprinus insignis
Genus ***Cortinarius***** *(Cortinarius* contains more than 1,000 species. Most have not been tested or are of unknown edibility; some, such as *C. orellanus*, are deadly poisonous.*)*
Genus ***Entoloma***
Genus ***Galerina*****
Gomphus floccosus
Gymnopilus spectabilis†
Genus ***Gyromitra***** *(Gyromitra esculenta, G. brunnea)*
Hebeloma crustuliniforme
Hebeloma sinapizans
Hypholoma (Naematoloma) fasciculare
Genus ***Inocybe***
Lactarius pallidus
Lactarius scrobiculatus
Lactarius torminosus
*Lepiota subincarnata***
Omphalotus illudens
Panaeolus subalteatus
*Paxillus involutus**
Pholiota squarrosoides
Psathyrella foetidissima†
Psilocybe caerulipes†
Psilocybe (Stropharia) cubensis†
Ramaria apiculata
Ramaria formosa
Russula emetica

(continued on next page)

Sarcosphaera crassa
Scleroderma citrinum
Tricholoma pardinum
Tricholoma saponaceum
Tricholoma subacutum
Tricholoma vaccinum
Tricholoma venenata

Edible mushrooms that occasionally cause gastric distress

Armillaria mellea
Laetiporus sulfureus
Lepiota naucina
Verpa bohemica

In addition, most edible mushrooms can cause gastrointestinal distress if eaten raw. *Armillaria mellea*, the stumper or honey mushroom; *Lepista nuda*, the blewit; and *Morchella* species, the morels, are particularly egregious in this regard.

Some mushroom myths

1. "If an animal eats it, I can eat it." This is not true. Squirrels and rabbits can safely eat the *Amanita* mushrooms, which are deadly poisonous to people.
2. "If I eat a little bit, wait for a while, and do not get sick, the mushroom is safe." The most dangerous mushroom toxins known have a delayed action. Amatoxins (deadly toxins in several mushrooms) cause painful symptoms only after 6 to 14 hours, but the onset of symptoms can be delayed for 36 hours or more. Symptoms of poisoning by *Cortinarius* toxins may take from 10 days to three weeks to occur.

3. "Cooking the mushroom will destroy the toxin." There is no way to destroy most of the dangerous mushroom toxins. Cooking is recommended for all mushrooms because it will break down some of the mushroom sugars that we cannot digest. A few fungal toxins are destroyed by cooking, but the majority of toxins are not.

4. "Tests" to distinguish poisonous mushrooms from wholesome ones are not to be trusted. Folk tradition has given rise to a number of tests: a poisonous mushroom is supposed to darken a silver coin; cooking mushrooms with silver is supposed to eliminate the poison; a mushroom is supposed to be safe if you can peel the cap; mushrooms growing on wood are supposed to be safe. These are invariably false. THE ONLY RELIABLE WAY TO DISTINGUISH A POISONOUS MUSHROOM FROM AN EDIBLE ONE IS TO LEARN TO IDENTIFY THE INDIVIDUAL SPECIES.

Why are mushrooms poisonous?

Sometimes the poison appears to serve a defensive role. Certain species of *Russula* and *Lactarius* are extremely peppery and will burn your mouth if you taste them. The burning, acrid taste effectively prevents people and animals from eating the mushroom, allowing it to mature and release its spores.

In other fungi, the purpose (if any) of the poison is not so clear-cut. The deadly *Amanita* species, unfortunately, are

reported to be good-tasting. This trait, in combination with the characteristic delay before any symptoms appear, would imply that the toxin is not a very good defensive compound – at least not against humans. The toxins may have evolved to discourage insect larvae.

Some toxins may serve some other, unidentified role in the fungus, and the physiological effect that the chemical has on us may be mere coincidence. And some toxins may have no role and may simply be waste products. The mushroom is the most disposable part of the fungal organism.

Why are people poisoned?

Many cases of poisoning occur in immigrants who are not familiar with the local mushroom flora. A person may have safely collected a familiar mushroom in his/her native land and then moved to a place where very similar-looking but poisonous mushrooms occur.

Children are particularly susceptible to mushroom poisoning, for a variety of reasons. Toddlers go through a "grazing" phase, in which anything the child can reach is put into its mouth. Slightly older children may not realize that there's a difference between the mushrooms they eat on their pizza and the mushrooms that grow in the yard. Because children are smaller than adults and are still developing, the dose required to make a child ill is often smaller than that required for an adult. Symptoms of poisoning may differ and are often more severe in children.

Mushroom poisoning often occurs in those attempting to get high on "magic mushrooms". This poisoning is usually due to mistaken identity, which results in highly toxic species being inadvertently collected. Most hallucinogenic species are little brown mushrooms and, as such, look a great deal like other little brown mushrooms, some of which can be deadly. Since the 1960s, there have been numerous severe poisonings of people who consumed *Galerina* species that they mistook for *Psilocybe* species.

Hunting and gathering wild mushrooms for food can be an immensely rewarding experience. You can enjoy pleasant excursions in the woods and experience the satisfaction of collecting wonderfully flavorful mushrooms for food. But you MUST take the time to learn about the mushrooms you collect before you risk your health or life for the sake of a meal.

What can you do to protect yourself?

Mushroom poisoning is eminently avoidable. The only way you can be poisoned by a mushroom is by eating a poisonous mushroom.

1. **Never eat any mushroom unless you know what** it is. You presumably would not pick wild raspberries unless you could tell a raspberry from deadly nightshade; by the same token, you should not collect mushrooms for food unless you can distinguish the food species from the poisonous species.

a) Use a reliable field guide that was written for your region of the country. Read the descriptions of the mushrooms carefully; do not just rely on the pictures. Colored pictures are aids to identification, nothing more. Many mushrooms are extremely variable. Most books can spare only one or two pictures per mushroom and cannot demonstrate the full range of appearances.

b) Participate in a class on mushroom identification. Both Michigan State University and the University of Michigan offer such classes in the fall; additionally, special workshops may be available. MSU Extension and Michigan Technical University have been offering a weekend-long workshop on edible and poisonous mushrooms of Michigan the past several years in September.

c) Go on mushroom hunts with knowledgeable persons. The classes and workshops mentioned above have a mushroom-hunting component. The Michigan Mushroom Hunters' Club is an amateur society that holds forays virtually every weekend throughout the mushroom season.

d) Dig up each mushroom you collect to get the entire base. Do not simply cut the stalk at the soil line. The sac at the base that enables you to identify a poisonous *Amanita* may be buried under the soil or duff.

e) Take a spore print of each species you collect (see page 13).

2. **Never eat raw mushrooms.** Even mushrooms that are commonly edible contain sugars and enzymes that we cannot properly digest and that will cause problems unless they are broken down by cooking.

3. **Never eat old or decaying mushrooms.** Many cases of "mushroom poisoning" are actually cases of food poisoning due to spoilage bacteria contaminating the mushroom. Always make sure your mushrooms are free of insect larvae. Slice through the mushroom from top to bottom to check for insect tunnels.

4. **Be careful the first time you eat a mushroom**. Just as some people are allergic to wheat flour, strawberries or peanuts, some people are allergic to certain mushrooms. Do not assume that because you can eat some mushrooms safely, you can eat them all.

5. **Any time you sample a new species, save a whole, uncooked specimen in your refrigerator to aid in identification in case you should get sick.** It is easier for a mycologist or physician to identify a whole specimen than to try to make an identification based on stomach contents.

6. **Try new species one at a time**; if you do become sick, it is easier to identify the culprit if you ate only one type of mushroom rather than several types.

7. **Do not overindulge.** Even the best, safest mushrooms may be difficult to digest if eaten in large quantities. The fungal cell wall is made of chitin, a sugar that we cannot digest.

8. **Respect others.** Many people are very frightened of any mushrooms that do not come from the store. They want nothing to do with wild mushrooms, no matter how safe or delicious the mushroom is. Respect this and do not force your mushrooms on anybody else.

Mushroom biology/ mushroom anatomy

To be sure of the identity of a mushroom, we must have an understanding of mushroom morphology and anatomy. To safely identify mushrooms, we must learn to recognize the component parts that make it possible to distinguish an edible mushroom from a poisonous one. The diagram of the development of a poisonous *Amanita* at right provides an introduction to fungal anatomy.

White *Amanita* mushrooms are poisonous at all stages

a) An *Amanita* spore lands on a supply of food in a suitable environment. It germinates and produces a vegetative growth called **mycelium** composed of many fine, hairlike threads called **hyphae**.

b) A nodule develops in the mycelium, which will become a button, then expand into the **fruiting body** (mushroom) of the fungus.

One very important feature in the identification of many mushrooms is the spore color. This can easily be determined by making a **spore print**. Cut off the cap of a mature mushroom and set it on a piece of paper, gill surface down. It is helpful to put a bowl or a glass over the mushroom to keep the mushroom from drying out and to reduce air currents. Leave the mushroom for a couple of hours, then lift it off the paper. An accumulation of spores should be present. Use white or black paper (colored paper can give a distorted impression). Ideally, you could use a piece of paper that is half black and half white. Some amateur mushroom clubs have such paper available, or it is easy to make some yourself at a copy center. *Amanita* species and many other mushrooms have white to cream-colored spores that will not show up clearly on white paper. Other mushrooms may have colored, dark brown or black spores.

Spore print

Mushroom toxins

The vast majority of mushroom poisonings are not serious. Gastrointestinal symptoms shortly after ingestion of the mushroom are the most common symptoms. These may be quite severe and may cause great discomfort for a day or two, but they will usually pass on their own. In extreme cases, hospitalization may be necessary to combat dehydration. If symptoms occur within two hours following ingestion of the mushroom, it is a good sign because the most dangerous mushroom toxins rarely cause symptoms before six hours after ingestion.

Each of the major mushroom toxins is discussed individually below. Poisindex® numbers are listed, followed by the usual symptoms and treatment, if known. Poisindex® refers to the Poisindex® system widely used by hospitals and poisoning centers. This classification may mean nothing to you but will be of help to a poisoning center or physician.

The usual symptoms are listed next, followed by treatment, if known. **It is not within the scope of this publication to prescribe treatment. When treatments are known, they will be listed, but in all cases a medical doctor should be consulted. Many treatments are not available outside of a hospital, and self-treatment can be more dangerous than no treatment at all.** Further details about the poisoning follow, as well as the identifying features of the mushrooms and other useful information. Finally, look-alikes are discussed. If you are collecting mushrooms for food, make certain that you have not collected a poisonous species that resembles the mushroom you want.

Amatoxins (Class A/ Poisindex® group 1)

Mushrooms: Certain fungi in the genera *Amanita, Galerina, Lepiota* and *Conocybe*.

Symptoms: Severe gastrointestinal distress (stomach cramps, vomiting, diarrhea) begins ***at least six hours following ingestion***. This phase lasts for a day or two, followed by a remission in which the patient feels better. In the third phase, the patient may fall into a coma or die as a result of liver and kidney failure.

Treatment: No known antidote. The stomach can be emptied (emesis or gastric lavage) shortly after ingestion; if more than two hours have passed, however, this will not be effective. Treatment is decided on a case-by-case basis and involves careful monitoring of the patient's liver

Amanita phalloides

Lepiota subincarnata

Galerina marginata

Conocybe filaris

(Photo courtesy Mike Wood.)

enzyme levels and general condition. Charcoal filtration of the blood may be performed. Liver transplant may be considered.

Description: Amatoxins are small chemicals technically known as bicyclic octapeptides. These are responsible for the vast majority of known mushroom fatalities. Amatoxins are found in fungi in four unrelated genera: *Amanita, Galerina, Lepiota* and *Conocybe*; all four occur in Michigan. Amatoxin poisoning is particularly dangerous because symptoms are delayed anywhere from 6 to 36 hours after the mushroom is eaten, with an average delay of 12 hours. By the time the patient feels sick, it is too late for emesis or gastric lavage to be of any use.

Amanita species cause the majority of poisonings because they are the only amatoxin-producing mushrooms that are large enough to be tempting to those seeking a meal. Amanita species are usually easy to recognize because of their possession of a **volva** (cuplike structure) at the base of the stalk, an **annulus** (ring) around the mid- to upper portion of the stalk, **white, free gills,** and a **white or light-colored spore print** (see diagram and photos). *Amanita* is the only genus to possess both an annulus and a volva. The volva may be buried in the duff. ANY mushroom being collected for food should be dug up out of the ground (not cut off at ground level) to determine whether it has a volva. In some species, the volva is fragile and may be lost or destroyed when the mushroom is removed. The annulus may also be fragile and may or may not be present in the mature mushroom. To be on the safe side, be wary of eating any mushroom possessing any of these characters.

Amanita species are usually associated with trees, though the association may not be immediately obvious – the tree may be several yards away from the mushroom. *Amanita* species are common in Michigan parks, woodlands and recreation areas from late June until the end of the mushroom season in November.

Amanita bisporigera, A. verna and *A. virosa* are known as the destroying angels. These are medium to large mushrooms that are often a pristine, satiny white. There is some debate about their classification, and they can be distinguished to species only with a microscope. **All white *Amanita* species should be considered deadly**.

Amatoxin-producing *Lepiota* species are small (the caps are usually less than 2 inches in diameter). They possess free gills, white spores and an annulus but lack a volva. The *Lepiota* annulus is loosely attached and can often be slid up and down the stalk. Young specimens may have reddish brown caps; older ones will have reddish brown scales on a white background. Small *Lepiotas* are difficult to identify, and none should be eaten. Despite their diminutive size, these species can contain up to 100 times the toxin of a much larger deadly *Amanita*.

Galerina and *Conocybe* species are little brown mushrooms and are not particularly appetizing. Both yield brown spore prints. *Galerina* grows on decaying wood, while *Conocybe* tends to inhabit lawns. *Conocybe filaris* is the only *Conocybe* species known to produce amatoxins, but other species may as well; they have not been widely tested. *Conocybe lactea,* common in Michigan, produces a related chemical and may produce amatoxins on occasion. Do not experiment! No Michigan

Galerina is safe. These fungi have caused fewer poisonings than *Amanita* because of their smaller stature and their drabber colors. *Galerina* is responsible for periodic poisonings of people wishing to get high on "magic mushrooms". Hallucinogenic species of *Psilocybe* are small to moderately large and brown with black spores, and some people have formed the mistaken opinion that all little brown mushrooms are hallucinogens.

Look-alikes: An edible puffball may be confused with an immature *Amanita* in the button stage. If you slice it open from top to bottom, the *Amanita* will show the beginnings of the stalk, gills and cap of the mushroom, while a puffball will simply be a uniform, slightly grainy white or contain a mass of yellowish to dark olive-green spores. Always slice open puffballs to be certain before eating them. Immature *Agaricus* species (meadow mushroom and horse mushroom) may resemble *Amanitas* because of the whitish free gills, annulus and general stature. The *Agaricus* will have pink and, eventually, chocolate-brown gills with deep brown spores on maturity, while the *Amanita* will retain whitish gills and spores throughout. *Lepiota (Leucoagaricus) naucina* can appear very similar to the destroying angels, but the *Lepiota* lacks a volva. Though some books list it as edible, *L. naucina* is not recommended because it has caused stomach upsets in some people. *Chlorophyllum molybdites* is a poisonous look-alike, with white, free gills, an annulus and a similar stature to the *Amanita* species. The gills turn pale green in maturity, and the spore print will be green. *Chlorophyllum* lacks a volva and possesses pale tan scales on the cap.

Cortinarius toxins (Class B/ Poisindex® group 1-A)

Mushrooms: Species in the genus *Cortinarius*.

A representative *Cortinarius*. Notice the cobwebby cortina covering the gills in these young specimens.

Symptoms: *Cortinarius* poisoning is characterized by an extremely long delay. A minimum of three days, or as long as 10 days to three weeks, may pass between eating the mushroom and the onset of symptoms. Symptoms include vomiting, diarrhea, loss of appetite, headache, a feeling of coldness and eventual kidney failure. Kidney failure may lead to death.

Treatment: Treat as kidney failure. Some patients spontaneously recover; others may require dialysis or kidney transplants.

Description: *Cortinarius* poisoning is particularly dangerous because of the very long delay before any symptoms occur. This delay has made it very difficult to identify precisely which species of *Cortinarius* may be responsible. The poisoning occurs so long after the ingestion of the mushroom that it is quite rare for the mushroom to be associated with the illness at all. The toxins responsible are unknown. Two toxins, both of which can produce disease in laboratory animals, are assumed to be responsible for human poisonings.

Cortinarius is the largest known genus of mushrooms, with well over a thousand species. None of them are particularly choice and, until we know considerably more about *Cortinarius* poisoning, none should be eaten. The distinguishing features of the genus are the presence of a cobwebby veil (the **cortina**; see photo, page 20) and the **rusty brown spores**. The cortina may wear away as the mushroom matures, but a few strands usually remain visible on the stalk, often highlighted by a rusty spore deposit. The gills become rusty brown in age, and a spore deposit may often be visible on the caps of adjacent mushrooms. Many (but not all!) *Cortinarius* species have a swollen, bulbous base. Most species are mycorrhizal and grow in wooded areas.

Look-alikes: The highly desirable blewit, *Lepista (Clitocybe) nuda*, is purple and resembles several purple *Cortinarius* species. The blewit, however, lacks a cortina and has a spore print that is creamy to pinkish to lilac, never rusty brown.

Monomethylhydrazine (Class C/ Poisindex® group 3)

Mushrooms: Members of the genus *Gyromitra* (false morels).

Gyromitra esculenta

Symptoms: A ***latent period of six to eight hours*** is followed by a feeling of fullness in the stomach, then vomiting and watery diarrhea, which may persist for up to two days. Headache, lassitude, cramps and intense pain in the regions of the liver and stomach may be followed by jaundice. Red

blood cells may be broken down. Poisoning may be fatal.

Treatment: Emesis may help if employed early (more than two hours after ingestion it will have no effect, so it will be ineffective by the time symptoms occur). Fluid replacement may be necessary if patient is dehydrated. Patient should be hospitalized so laboratory tests can be performed to detect signs of hemolysis or liver or kidney failure.

Description: Monomethylhydrazine poisoning is among the most confusing mushroom poisoning syndromes. The amount of toxin can vary greatly from mushroom to mushroom, and susceptibility can vary greatly from person to person. The method of preparing the mushrooms makes an immense difference. The toxin is volatile and is destroyed by heating. The "safest" way to prepare *Gyromitra* species is to parboil the mushrooms (being careful not to inhale any of the vapors, which will contain the toxin), discard the cooking water and fry the mushrooms in a separate, clean pan. This removes the majority of the monomethylhydrazine. Other toxins, including an unidentified carcinogen, remain in the mushroom and can build up over time with repeated *Gyromitra* meals. Despite the fact that many people persist in deliberately gathering and eating these mushrooms, **we do not recommend eating any *Gyromitra* species**.

Mushrooms in this genus are very distinctive. The cap is some shade of brown and is on a whitish to pale tan stalk. The cap may be **wavy, convoluted or lobed**, but it is not pitted. **There are no gills**. *Gyromitra* is an Ascomycete; it

belongs to a very different group of fungi than the other mushrooms in this pamphlet and is related to the morels. No spore print will be obtainable. If you slice open the mushroom from top to bottom, the attachment of the cap to the stalk is distinctive. Unlike most mushrooms, which fruit in the late summer or fall, *Gyromitra* fruits in the spring.

Look-alikes: Morels (*Morchella* species). True morels are readily distinguished from the false morels by the possession of a pitted (not lobed or wavy) cap and by the attachment of the stalk. The stalk is attached to the base of the cap in the true morels but to the top of the cap in the false morels. See MSU Extension bulletin E-2755, *May is Morel Month in Michigan*, for more information.

Coprine (Class D/ Poisindex® group 5)

Mushrooms: *Coprinus atramentarius*, *Clitocybe clavipes*, other *Coprinus* species (rarely).

Symptoms: Symptoms may occur ***shortly after the consumption of an alcoholic beverage plus the mushroom or on consumption of alcohol up to 48 hours after the mushroom is eaten***. Symptoms include a flushing of the face and neck, a metallic taste in the mouth, tingling of the extremities, rapid heartbeat and a feeling of swelling in the face and hands. The

Coprinus atramentarius (Photo courtesy Tom Volk.)

initial symptoms may be followed by nausea and vomiting. Occasionally visual disturbances, vertigo, weakness and confusion occur.

Treatment: The symptoms will subside on their own in time. Reassure the patient, who may be convinced that he or she has been seriously poisoned.

Description: Coprine is interesting in that it is not, strictly speaking, a poison. Many people can and do eat these mushrooms with no ill effect. Alcohol, on the other hand, *is* a poison. The human body deals with alcohol by quickly degrading it into a series of less toxic compounds until it is no longer harmful. Coprine interferes with this process by inhibiting one of the enzymes used in alcohol processing. Alcohol is broken down partway, to acetaldehyde, but is not completely processed. The symptoms of coprine poisoning are due to the buildup of acetaldehyde in the blood. Incidentally, disulfiram, which is used to treat alcoholism, operates in the same manner.

Coprine poisoning is not serious, though it is unpleasant and can be alarming to the victim, who may believe that he or she has eaten a truly dangerous mushroom. The poisoning will usually run its course in a couple of hours without any additional treabnent.

The mushroom responsible, *Coprinus atramentarius,* belongs to the black-spored mushroom group known as the inky caps. Shortly after the mushroom matures, the gills begin digesting themselves from the bottom edge up and the gills and cap dissolve into ink, colored black by the spores. *Coprinus atramentarius* is among the larger *Coprinus* species and possesses a smooth to finely silky, gray-brown cap. The cap doesn't expand nearly so much as that of many other mushrooms and always remains broadly conical. The mushroom commonly occurs in large groups at the bases of street trees or in grass, and we have frequently seen it fruiting on lawns and boulevards in East Lansing in the summer and fall. *Coprinus atramentarius* is edible and safe if cooked and if no alcohol is ingested within two or three days of eating the mushroom. All *Coprinus* species should be cooked and eaten very shortly after being picked, before they have a chance to autodigest.

Look-alikes: The black spores and the tendency to dissolve into ink are distinctive. *Coprinus commatus,* the shaggy mane, is a popular edible species, but it possesses a white, cylindrical, scaly cap and is not likely to be mistaken for C. *atramentarius.*

Psilocybin, Psilocin (Class E/ Poisindex® group 6)

Mushrooms: *Psilocybe* and *Stropharia* species, *Paneolus* species, some *Conocybe* and *Inocybe* species, *Gymnopilus spectabilis*.

(Photo courtesy Mike Wood.)

Gymnopilus spectabilis

(Photo courtesy Alexander Smith.)

Paneolus

Symptoms: A ***change of mood*** usually occurs beginning 20 to 60 minutes following ingestion of the mushroom. The patient may experience fear, excitement, hilarity, hallucinations, loss of coordination, dilation of pupils, rapid heart rate or rapid breathing. Children may develop a high fever and/or seizures.

Treatment: Reassurance and time are usually sufficient treatment. Children should be monitored and may require hospitalization in case of fever or seizures. Poisoning is rarely serious in adults, and, because of the disordered state of the mind, moving a hallucinating patient to the hospital may increase his or her sense of fear and confusion.

Description: With the exception of *Gymnopilus*, which is a large, yellow-brown mushroom growing in clusters on wood, psilocybin-containing species are small to moderately large brown mushrooms with dark brown to purple-black spores. Many of these species bruise bluish or are bluish at the base of the stalk. They can grow in lawns, meadows (particularly highly fertilized ones) or on manure.

Little brown mushrooms are not generally sought as food. Those who seek out and eat these deliberately are usually looking for hallucinogenic species. The primary danger is from toxic species that may look similar. Because these can fruit on lawns, they are also responsible for several child poisonings, though we have not heard any reports of this in Michigan.

Look-alikes: *Gymnopilus* is larger than most psilocybin-containing species. It grows in clusters on wood and is common

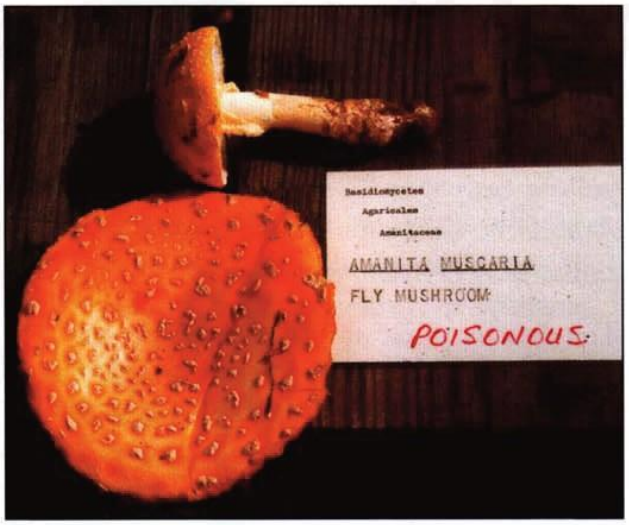
in Michigan. We have seen *G. spectabilis* mistaken for the honey mushroom, *Armillaria mellea*. The two can be distinguished by the spore color, which is yellow-brown in *Gymnopilus* and white in *Armillaria*. *Gymnopilus* also resembles the poisonous *Omphalotus illudens*.

The deadly poisonous *Galerina* species have been mistaken for *Psilocybe* species. *Galerina* grows on wood, not on soil or lawns (though there are rare reports of *Galerina* growing on buried wood in grass). *Galerina* has a bright brown to orange-brown spore print and may possess a small annulus.

Muscimol, Ibotenic Acid (Class F/ Poisindex® group 2)

Mushrooms: Primarily *Amanita muscaria* and *A. pantherina*, but similar toxins may occur in *A. cothurnata*, *A. frostiana* and *A. gemmata*.

Symptoms: A feeling of drowsiness 30 to 60 minutes after ingestion, followed by a state resembling alcoholic intoxication. Following this, a hyperactive state of confusion, muscular spasms, delirium and visual hallucinations occurs, lasting as long as four hours. Vomiting usually does not take place. Drowsiness and deep sleep follow, and recovery is usually quite rapid, though a fatality rate of 1 to 5 percent is reported.



Amanita muscaria

Treatment: Usually symptoms subside in time; overtreatment can be more damaging than none at all. Emesis or gastric lavage may be performed if the patient is brought in early on in the poisoning.

Description: Ibotenic acid occurs in the mushrooms. Muscimol, which causes the symptoms of the poisoning, is produced by the body's efforts to process ibotenic acid. Muscimol is thought to bind to receptors in the brain, causing disordered neurotransmission. *Amanita muscaria* contains less of the toxin and is therefore less dangerous than *A. pantherina*. The other species are less well studied and have rarely been eaten.

Amanita muscaria is the red-capped mushroom with white spots or patches commonly depicted in folk art. The red-capped variety is rare in Michigan, but a number of other varieties occur, including ones with yellow, orange or white caps. All varieties have whitish, removable "warts" on the cap when young, though these may wear off or be washed off in age. The volva is not obvious and cuplike,

as in the destroying angels, but appears as a series of concentric rings on the stalk, just above the swollen base. Like other *Amanita* species, it is mycorrhizal with trees and is thus usually found in the woods and clearings near trees, though we have seen *A. muscaria* under white pine in residential settings. *Amanita pantherina* looks similar to *A. muscaria* but has a grayish brown cap covered with similar whitish to grayish patches.

The people poisoned by these mushrooms are usually children, who may be attracted by the bright colors of *A. muscaria* and its "friendly", familiar appearance, and people deliberately seeking hallucinogenic substances. Rarely, people will mistake *A. muscaria* for the edible *A. caesarea*. *A. muscaria* occurs worldwide and has been widely used as a hallucinogen in parts of Europe and Asia. North American mushrooms have a somewhat different array of chemicals and are more likely to be seriously poisonous than Old World specimens; consequently, *A. muscaria* has not been so widely used as a hallucinogen here. Loss of muscular control may be pronounced. Fatal poisonings are more likely to occur with *A. pantherina*, which contains higher levels of toxin than *A. muscaria*.

Look-alikes: The edible and popular Caesar's mushroom, *Amanita caesarea*, has a reddish orange cap and may have white patches on the cap, though *A. caesarea* is likely to have one or two large patches and *A. muscaria* more often has many small patches. *Amanita caesarea* has bright yellow gills; those of *A. muscaria* are white to pale cream. Poisonings have occurred because of confusion between these two species, especially among European immigrants.

Muscarine (Class G/ Poisindex® group 4)

Mushrooms: Certain members of the genera *Inocybe* and *Clitocybe*.

Inocybe species (Photo courtesy Mike Wood.)

Symptoms: ***"PSL"*** (perspiration, salivation, lacrimation) or "SLUDGE" (salivation, lacrimation, urination, defecation, gastritis, emesis) syndrome occurs beginning 30 to 120 minutes following ingestion.

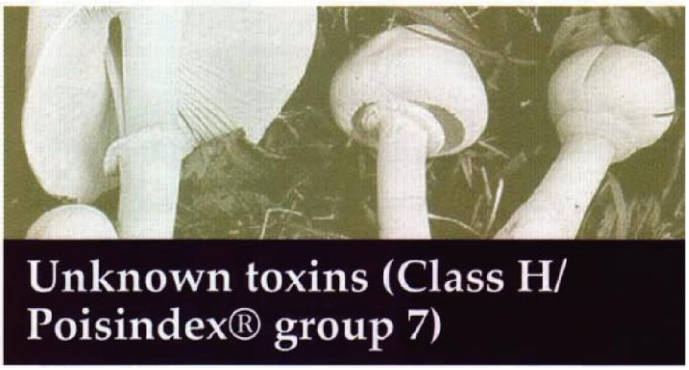
Treatment: Atropine is a specific antidote for muscarine poisoning. Atropine is toxic and should be administered only by a qualified physician.

Description: The PSL syndrome is not usually particularly dangerous but is decidedly unpleasant. There are no recorded deaths due to poisoning by these

mushrooms. For severe cases, atropine may be administered by a physician. This is the only mushroom poison for which a specific antidote is known.

Inocybe species are often called "fiber caps". Their caps and stalks are often fibrous, with fibers radiating out from the center of the cap visible to the naked eye or with a magnifying glass. Sometimes the caps may look silky. Caps tend to be conical. The caps are mostly dull gray, tan or brown. The spore print is yellowish brown, and the mature gills will be tan to brownish. *Clitocybe* species have white spores. *Clitocybe dealbata* is a small, pale mushroom with a slightly rounded cap; other *Clitocybe* species often have an upturned, funnel-shaped cap with the gills running partway down the stem (**decurrent** gills). Both *Inocybe* and *Clitocybe* species may fruit in lawns.

Look-alikes: These are mostly small mushrooms, which are not likely to be eaten by most people. *Marasmius oreades*, the fairy ring mushroom, may resemble *Clitocybe dealbata*, and the two may grow intermingled. *Marasmius oreades* has relatively few gills, which are quite thick and widely spaced and may have visible veins between the gills, while *Clitocybe* has many, thin, crowded gills.



"Unknown toxins" is a catch-all term to cover any toxin that doesn't fall into the above categories. These are gastro-intestinal irritants unless otherwise noted, and symptoms consist of abdominal cramps, nausea, vomiting and/ or diarrhea starting between 30 minutes and two hours after ingestion. Because the exact nature of the toxin is unknown, no specific antidote can be recommended. Treatment is time and reassurance. The common Michigan mushrooms in this category will be covered.

Chlorophyllum molybdites (green gill)

Chlorophyllum molybdites

The defining features of this large, attractive mushroom are the **green gills** and **green spore print.** The gills turn green

as the mushroom matures, so young specimens may still have whitish gills. The green spore print is diagnostic - no other gilled mushroom in Michigan has green spores. *Chlorophyllum molybdites* also possesses a ring around the stalk but, unlike *Amanita* species, it has no volva. It can fruit on lawns, and we have seen a large fruiting on the Michigan State University campus in July. This mushroom is very similar to the edible *Lepiota racchodes* and *L. pro cera* (C. *molybdites* is sometimes called *Lepiota morganii).* The only observable difference between C. *mol ybdites* and *L. racchodes* is the spore color: the *Lepiota* has white spores.

Lepiota (Leucoagaricus) naucina

Lepiota (Leucoagaricus) nau cina (Photo courtesy Tom Volk.)

Many books list this species as edible, but many people are unable to eat it without stomach upset, so it should be avoided . It is dingy white when young, maturing to a tannish off-white color. It possesses a small ring on its stalk and can be mistaken for the destroying angels. There is no volva, but the base is swollen. Spores are white or rarely pinkish. It usually grows in grass and can show up in lawns. *L. nau cina* should not be gathered because of the

chance of an adverse reaction and the more serious risk of accidentally gathering a deadly *Amanita*.

Omphalotus illudens (Jack o'lantern)

Omphalotus illudens

Mushrooms are medium to large and generally occur in clusters on wood or at the bases of trees. Fresh specimens possess the distinctive character of **bioluminescence** – their gills can glow in the dark. Gills, like the rest of the mushroom, range from orange to yellow-brown and may descend partway down the stalk. The spore print is creamy white.

These mushrooms have been mistaken for *Armillaria mellea*, the popular honey mushroom, which also occurs in clusters on wood or at the bases of trees. *Armillaria mellea* is part of an extremely variable species complex, but specimens usually possess a ring around the stalk, which *Omphalotus* lacks. *Armillaria mellea* has whitish (not orange) gills and forms black, shoestring-like organs called **rhizomorphs**, which may often be visible extending from the base of the mushroom.

Entoloma species

These species are characterized by a pink to red spore color and angular spores (visible under a microscope). Most species are poisonous. Many books will list as edible *Entoloma abortivum*, which occurs in association with the honey mushroom, *Armillaria mellea*. To make matters confusing, both the aborted and non-aborted forms (see picture) are called *E. abortivum*, but the aborted form is actually primarily the honey mushroom, which is being parasitized by the *Entoloma*. The aborted fruit bodies are edible; non-aborted *Entolomas* should not be eaten, because of the possibility of confusion with poisonous species. *Entoloma abortivum* grows on or near wood in the fall; other *Entoloma* species grow on the ground in humus in wasteland and fields, along edges of bogs and in woodland areas. Many small species grow on rotting wood. They can be found during all seasons from early spring until late fall.

Entoloma abortivum. Aborted form on left.

Paxillus involutus (roll-rim)

(Photo courtesy Mike Wood.)

Paxillus involutus

The cap is slightly depressed in the center and the edges of the cap roll over (see picture). Gills and cap range from yellowish brown to brown; gills run down the stalk, which is comparatively thick. The mushroom is common in lawns and in woods in the fall. *Paxillus involutus* is commonly eaten in eastern Europe, where it is pickled. It is frequently responsible for gastrointestinal distress and can also give rise to a rare but serious allergic reaction. In some few individuals – usually people who have been eating *P. involutus* for years – an antibody will form to an unknown antigen in the mushroom. The next time the person eats the mushroom, the antibody and antigen interaction will cause red blood cells throughout the body to break down.

Red-pored blue-staining boletes

Boletes differ from other mushrooms in having a spongy layer of pores instead of gills. Other fungi, such as the shelf fungi that grow on wood, may have pores but

are often too thin or woody to eat. The boletes are soft and mushroom-shaped with a stalk that is often thick or swollen. The stalk may possess netlike markings and ridges (reticulations). The cap is often velvety, though it may be smooth, felty or slimy. Boletes include many popular food mushrooms, such as *Boletus edulis*, known variably as the king bolete, porcini, cep or steinpilz. Boletes are enthusiastically collected by many Europeans.

Boletes that have red to red-orange pores and/or stain blue should be avoided because most are poisonous. The staining reaction can be easily observed by cutting the mushroom or the pore surface with a knife. This reaction can be quite dramatic (see picture). See MSU Extension bulletin E-0926, *Best of the Boletes*, for further information.

Boletus subtomentosus

Laetiporus sulfureus (chicken of the woods; sulfur shelf)

This is a shelf fungus rather than a true mushroom. When fresh, it is brilliant, bright yellow or yellow-orange and is very soft and often surprisingly heavy (much of its weight is water). In this young stage, it is often collected for food. Many people, however, are sensitive to some unknown chemical in the fungus and suffer gastric distress when they eat it. The mushroom grows on wood, and the substrate appears to have some effect on toxicity: those growing on conifers or locusts are frequently toxic. If you eat this mushroom, do not eat much the first time you try it. Do not serve *L. sulfureus* at large gatherings.

Laetiporus sulfureus

Should you collect wild mushrooms?

1. Not unless you are willing to study until you learn the positive identification of the mushroom you seek.
2. Not unless you assume the responsibility for your own safety and well-being. In addition to making sure you know the mushrooms, be sure you are prepared for collecting. Carry a compass anytime you go into the woods, and know how to use it. Dress properly. Keep track of the time, and allow enough time to get out of the woods before dark.
3. Not unless you are absolutely certain the mushroom is safe to eat. Collect carefully and do not mix collections of different species. A shallow basket or a mesh bag is best for collecting, and individual collections should be wrapped in wax paper. Never use plastic - it causes the mushrooms to decompose quickly. Promptly clean, refrigerate, cook or preserve your collection upon returning home. Unless you intend to use the mushrooms, please don't pick them.

Report poisonings

It is important to report any case of distress from eating a mushroom, particularly if you can describe or identify the mushroom. In Michigan, report to the DeVos Children's Hospital, Regional Poison Center, 1300 Michigan, Suite 205, Grand Rapids, MI 49506; (800) 222-1222 (national number - will connect you to the nearest poison control center).

Human poisoning centers

Statewide and Western Michigan
1-800-222-1222
DeVos Children's Hospital
Regional Poison Center
1300 Michigan
Suite 205
Grand Rapids, MI 49506

Upper Peninsula
1-800-222-1222
U.P. Poison Crisis Center
Marquette General Hospital
420 West Magnetic Street
Marquette, MI 48955

Eastern Michigan
1-800-222-1222
Poison Control Center
Children's Hospital of Michigan
3901 Beaubien
Detroit, MI 48201

Additional resources

Amateur mycological societies provide a setting in which you can meet and learn from others who share your interest in mushrooms. The Michigan Mushroom Hunters' Club has forays nearly weekly throughout the mushroom season.

Michigan Mushroom Hunters' Club: <http://www.sph.umich.edu/~kwcee/mmhc/>.

North American Mycological Association: <http://www.namyco.org>.

Tom Volk's Fungi: <http://www.TomVolkFungi.net>.

MykoWeb: <http://www.mykoweb.com>

Benjamin, Denis R. 1995. *Mushrooms: poisons and panaceas*. New York: W. H. Freeman and Company.

Scates, Kit. 1983. Diagnosis and treatment of mushroom poisoning on basis of symptoms and mushrooms. Poster.

Spoerke, David G., and Barry D. Rumack (eds). 1994. *Handbook of mushroom poisoning: Diagnosis and Treatment*. Boca Raton, Fla.: CRC Press.

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