Fungipedia

A Brief Compendium of Mushroom Lore

Lawrence Millman

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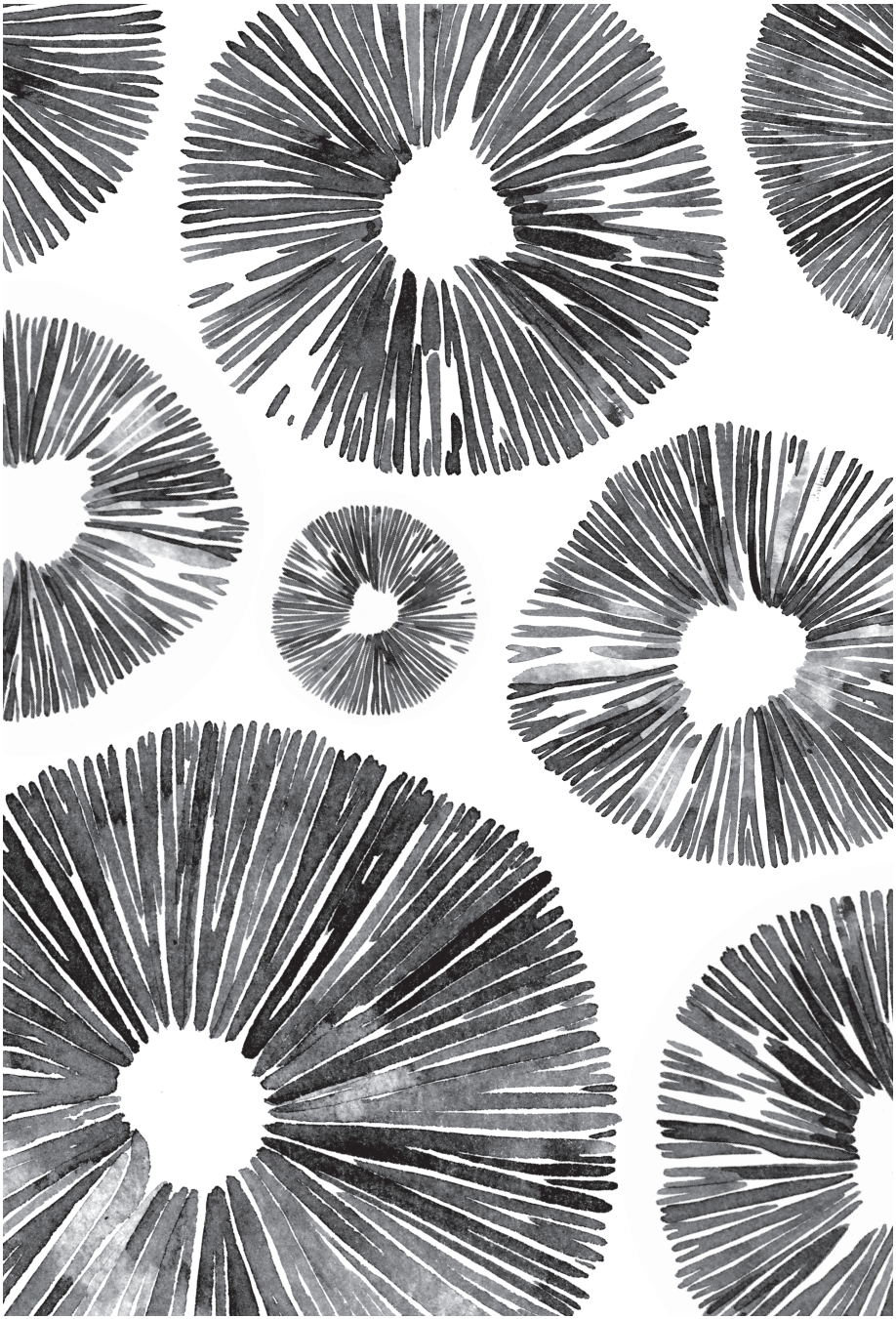

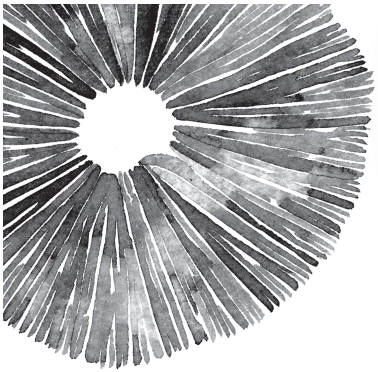
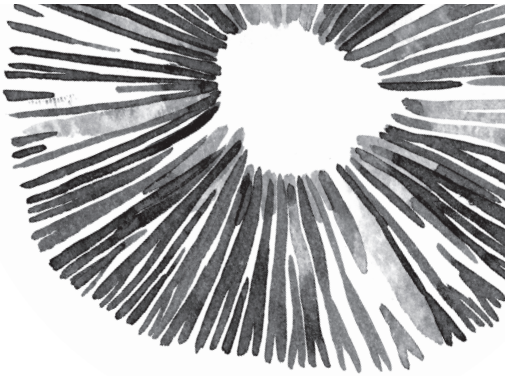

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Illustrations by Amy Jean Porter


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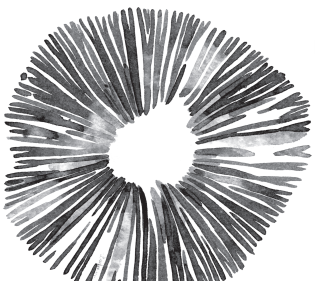
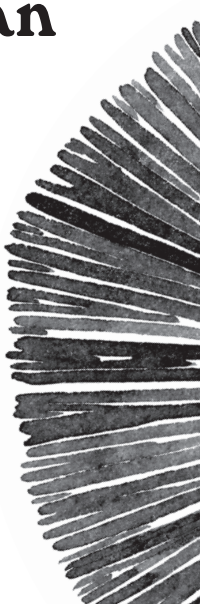

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This book is
dedicated to all fungi,
even the toxic ones, in
honor of their ability to
astonish,
amuse,
& often
humble me.

The world depends on fungi, because they are major players in the cycling of materials around the world.

—E. O. WILSON

Attend to mushrooms and all other things will answer up.

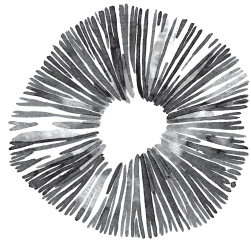
—A. R. AMMONS

There is something absolutely fascinating to me about being present at the exact moment when a mushroom is mushrooming.

—JOHN CAGE

Mycology beats urology any day.

—BRYCE KENDRICK



Preface

"The humblest fungus displays a life akin to our own," wrote Henry David Thoreau in his *Journal* in 1858. This observation shows Thoreau's usual prescience, since recent phylogenetic analyses of DNA have determined that fungi occupy a branch on the tree of life surprisingly close to our own branch. The same analyses also indicate that the reader of this *Fungipedia* and the chanterelles he or she is getting ready to cook have the same distant ancestor, probably an organism not unlike a present-day marine choanoflagellate.

But our similarity with the inhabitants of Kingdom Fungi is not simply genetic. Neither fungi nor we possess the green pigment known as chlorophyll, so we can't make sugars from sunlight or CO_2, and thus we're obliged to obtain our food from living or dead organic matter, animal or vegetable. Both of us have evolved special enzymes that allow us to digest this matter, although we tend to grab and then engulf it, while fungi turn it into liquid form.

Speaking of food, certain fungi can be extremely picky (like some of us) about their dietary needs: one species (*Herpomyces stylopage*) dines only on the hairs of cockroach antennae; another (*Cephalosporium lamellaecola*) eats only the tips of stalactites in caves; trichomycete species live in the hind guts of aquatic arthropods such as mosquito larvae; and a newly discovered species (*Aliciphila vulgaris*) can be found only on leaf litter moistened by elk urine. Such substrates might actually seem quite pleasant compared to those at the ruined Chernobyl nuclear power plant in the Ukraine, where various fungal species are currently dining on leftover radiation.

Given the similarities between fungi and our species, it's not surprising that we relate to fungi differently from the way we relate to plants. They inspire in us phobic reactions, total delight, anthropomorphic thoughts (in Russian, an old person is called a *staryy grib*—a dried-up mushroom), fictional monsters, postage stamps, disgust (the Greek physician Nicander called fungi "the evil ferment of the earth"), and—as in the case of the Mazatec *curandera* Maria Sabina, who called magic mushrooms "children of God"—deification. They also inspire animation: Walt Disney provided the fly agaric (*Amanita muscaria*) with a role in the dancing mushroom sequence in *Fantasia*, but he didn't give even a minor part in the film to a sashaying phragmites or a sedge.

How fungi arrived in our world has also been a prod to the human imagination. In Lithuania, fungi were once considered the fingers of Velnias, the one-eyed Baltic god of the dead, reaching up from the underworld to feed the poor. In parts of India, Bangladesh,

and East Asia, they are still thought to originate from a urinating dog. Far more common is the belief that they came from the world above us rather than the terrestrial or subterrestrial world. The ancient Greeks thought they were the product of seeds placed on lightning bolts by Zeus; an old Persian legend attributes them to a sky goddess shaking the lice from her trousers; and the contemporary Inuit in the central Canadian Arctic believe mushrooms are the *anaq* (shit) of shooting stars, since they often appear on the tundra the morning after a shooting star leaves a trail of detritus across the night sky. I doubt that anyone has ever proposed that a chrysanthemum or daffodil was excreted into their garden by a shooting star.

In the previous paragraphs, I've used the word "mushroom." That word usually refers to a fungus with an umbrella-shaped fruiting body as well as pores or gills beneath a cap. Examples include the king bolete (*Boletus edulis*), so-called buttons (*Agaricus bisporus*), and the beautiful but deadly destroying angel (*Amanita bisporigera*). Yeasts aren't mushrooms, but they are fungi. Likewise, rusts, polypores, mildews, puffballs, bread mold, and dead man's fingers—all members of Kingdom Fungi—aren't mushrooms, either. Such distinctions don't really matter, unless a person is writing a scholarly paper, in which case he or she would never refer to a dead man's finger (*Xylaria* sp.) as a mushroom. In this not necessarily scholarly *Fungipedia*, I'll be using the two words more or less interchangeably. Whenever possible, I'll also be using common names such as dead man's fingers and destroying angel rather than Latin binomials.

Other words I'll be using with a certain abandon are *possibly*, *probably*, *perhaps*, *maybe*, *usually*, *typically*, and *sometimes*, or their equivalents. For mycology (from Greek *mykos*, "fungus," and *logon*, "discourse") is a relatively young pursuit, and many aspects of it have not been fully or even cursorily investigated. Also, virtually every known mycological rule has exceptions. For example, a wood-inhabiting fungus that's supposed to grow on conifer logs might occasionally take up residence on deciduous logs, and vice versa. Perhaps the mycelium has made a mistake. Perhaps stressful weather conditions have made it choose any proverbial port in a storm. Perhaps the fungus just wants to be different. Or maybe it wants to confuse or even humble us humans. Anyone who has devoted long hours to trying to identify a fungal specimen can appreciate that last example of anthropomorphic thought!

By now the reader has probably finished cooking the chanterelles and might be wondering whether to put them in an omelet, serve them with a steak, or dunk them in a bean soup. To learn the answer to this question, consult James Beard or Julia Child, but you needn't bother leafing through this *Fungipedia*, because it's not a cookbook. Rather, it's a compendium of ecological, scientific, ethnographic, and occasionally just plain weird fungal lore. It also includes biographical information about mycologists, such as, for instance, the fact that bolete expert Walter "Wally" Snell was once a catcher for the Boston Red Sox.

Here I should confess that I regard edibility as (prejudice alert!) perhaps the least interesting aspect of any fungus. So I won't be discussing the edibility of

most fungi, unless the species happens to be corn smut (*Ustilago maydis*), a traditional food eaten by the Aztecs. Or unless the diner happens to be a mite, a beetle, or even an amoeba, certain species of which depend on fungi for their survival. Or unless that diner is another fungus cheerfully engaging in cannibalism. An example of a fungal cannibal is the parasite *Hypomyces lactifluorum* attacking a *Russula* or a *Lactarius* and transforming it into a lobster mushroom.

Just as we like to eat fungi, certain fungi like to eat us, or at least parts of us; they're found in our oral cavities, on our skin, in our lungs and vaginal tracts, and on our nails. Two hundred sixty-seven different species have been documented in our guts, where they probably help metabolize sugars. Occasionally, fungi even grow on our brains. I once attended an autopsy performed by a pathologist friend, and I saw a large mycelial mass embracing the fibers that connected the two cerebral hemispheres of the cadaver's brain. Remarkable! I thought.

The fungus in question (probably *Aspergillus fumigatus*) might be called a pathogen, but the brain belonged to a much-ravaged street person who, in addition to his other afflictions, had probably been a victim of AIDS. Healthy individuals possess cells called macrophages and neutrophils designed to fight off fungal infections, but not this fellow. His compromised immune system offered a welcome mat for the fungus. Indeed, a large number of otherwise mild-mannered fungi can wreak havoc on an extremely immunocompromised individual. And not only humans: numerous fungi, mild mannered or otherwise, can wreak similar havoc on other

organisms with compromised immune systems, an activity I'll mention in several entries in this *Fungipedia*.

Of course, there are significant differences between fungi and us. Not only have fungi managed to survive without availing themselves of supermarkets, mechanical transport, health care facilities, computer-type devices, or day care centers for their young, but they're also (unlike a large percentage of us) excellent ecologists. Consider trees that have been hammered by a woodpecker, struck by lightning, sideswiped by a car, or that are simply very old. You could say that such trees have compromised immune systems themselves. Were it not for the recycling abilities of fungi, they'd be perpetually standing corpses, and the soil wouldn't get the nutrients on which most plants depend. Eventually, there would be very few plants, as well as virtually none of the organisms that depend on plants for their own nutrients. Our planet would end up even more beleaguered than it already is.

Now let's look at healthy trees and other plants. Between 90 and 95 percent of them have fungi as their significant others, for they have nutrients-for-carbs relationships via their roots with those fungi. Indeed, it's possible that plants developed roots not long after they became terrestrial in order to connect with fungi. If plants could speak, they might say to their fungal partners, "I'll give you carbohydrates if you give me nitrogen and phosphates as well as help me with water uptake." To which the fungus might reply, "My pleasure, mate."

Actually, plants and fungi can speak to each other or at least communicate with each other via diffusible molecules, by which either one can express a need to

the other for nutrients. Such relationships are known as mycorrhizal, from the Greek words *mykos* (fungus) and *rhiza* (root). An ectomycorrhizal relationship is one in which the fungus forms sheaths around a plant's roots, while an endomycorrhizal relationship is one in which the fungus penetrates the cells of those roots. Without one or the other of these partnerships, trees and other plants would be at best scrawny versions of their partnered selves. Here I might add that mycorrhizal fungi also sequester vast amounts of carbon in the forest floor, thus preventing that carbon from escaping into the already too carbonated atmosphere.

In any relationship, one partner can make the other miserable. So it is with parasitic fungi and their hosts. Think of the numerous *Ophiocordyceps* species that attack insects or their overwintering larvae. Think of Dutch elm disease (*Ophiostoma* sp.), chestnut blight (*Cryphonectria parasitica*), ash dieback disease (*Hymenoscyphus fraxineus*), and beech bark disease (*Neonectria* sp.). Think of honey mushrooms (*Armillaria* sp.) obstructing the flow of nutrients from a tree's roots to its trunk. Even think of the *Cladosporium* species that degrade stained-glass windows.

It's too bad that none of the hosts can take out a restraining order against such disagreeable partners. But if the fungus were gifted with words rather than diffusible molecules, it might respond to the putative complaints of its host by saying, "Hey, we parasites gotta live, too." The more philosophical of them might add, "Life comes from dying."

Wood-inhabiting fungal parasites create homes for cavity-nesting birds such as chickadees and warblers;

they also create niches for specialist invertebrates such as beetles, spiders, and annelids. Since they usually infect older trees, wood-inhabiting fungi open the forest canopy for younger trees, and once that canopy is open, ground plants take over space that might once have been denied them. "Thanks, friends, for serving as agents of habitat restoration," both these trees and other plants might remark to the fungal parasites in question if they themselves could talk.

As the union of at least one fungus and an alga or a cyanobacterium (a type of bacteria that obtains its energy from photosynthesis), lichens represent a different type of parasitic relationship, one in which the fungus keeps its partner as a slave. More whimsically, that partner has been described as "a damsel in distress." Although lichens happen to be members in good standing of Kingdom Fungi, no less than an oyster mushroom or a destroying angel, mycologists and lichenologists are often either ignorant about or indifferent to each other's disciplines. Indeed, my own knowledge of lichens is relatively limited, so I've included only a tidbit of information about them in this *Fungipedia*. In my defense, I should say that other books about fungi, guidebooks or otherwise, don't usually include a lot of information about lichens, either. Perhaps one of these days a lichenologist will cobble together a *Lichenopedia*?

Maybe the reader of this book hasn't been cooking chanterelles at all. Instead, maybe that reader has been making a tea from chaga or reishi to cure gout or hemorrhoids, or at least stimulate his or her immune system. Or maybe he or she is taking turkey tail or cordyceps supplements in capsule form for the same purpose. For

fungal medicinals have become a global rage. "Is it medicinal?" is rapidly replacing "Is it edible?" as the most popular question asked of mycologists.

I'll investigate this last subject in the following pages, but for now let me mention my own favorite fungal medicinal—a walk in the woods in search of fungi. The experience of such an extraordinary variety of shapes (tongues! ears! erect phalluses! corals! teeth! birds' nests! orange peels!) cannot help but make a person feel, if not healthier, at least more buoyant. And since fewer than 5 percent of all fungi species have been described, there's always the chance of finding a species new to science. But even if you find only a species old to science, you might still have the same reaction to it as composer-mycologist John Cage did when he found a perfectly ordinary mushroom and exclaimed (in his diary *M*): "Supreme good fortune—we're both alive!"

Laricifomes officinalis
Agarikon

Agarikon (*Laricifomes officinalis*)
Both the ancient Scythian name and the current name for a large, pendulous polypore with a grayish, zoned cap. In western North America, agarikon's host trees are old-growth conifers, primarily larch. Although rare in eastern North America, it's common in Europe.

Probably because they contain a fatty acid called agaric acid, agarikons have long been a high-ranking fungal medicinal, about which the English herbalist John Gerard (ca. 1545–1612) wrote: "It provoketh the urine and bringeth down the menses . . . and purgeth stools." It was formerly called the quinine conk because a decoction from it was once used to bring down the

fever of malaria. Specimens were occasionally sent down to the tropics from western North America to relieve the pain of scorpion stings.

West Coast native people placed carved agarikon specimens on the graves of their shamans. In British Columbia, the Haida First Nation people personified the polypore as a deity called Fungus Man. According to the legend, Raven created men but did not know what to do next, so his friend Fungus Man took him to the island that was inhabited by female genitalia. Raven fastened some of the genitalia onto the men, and lo! those men became women. Thus humankind owes its existence to Fungus Man . . . or so the legend tells us.

See also Ethnomycology; Polypores.

Aksakov, Sergei (1791–1859)

Russian landowner and naturalist, about whose memoir *A Family Chronicle* his fellow author Nikolai Gogol wrote: "None of our Russian writers can depict nature with such strong and fresh colors."

At the end of his life, Aksakov started writing a book titled *Remarks and Observations of a Mushroom Hunter*. This uncompleted work contains the following rumination: "I believe the key to the mystery of mushroom birth lies in the roots [of trees]. . . . When they die, the mushrooms cease. . . . The complete dependence of mushrooms on the roots of trees is shown by the fact that certain trees only produce their own kinds of mushrooms."

From these words, it would appear that Aksakov recognized both the existence and the significance of mycorrhizal relationships between fungi and trees well

before actual mycologists discovered such relationships. In fact, the word "mycorrhiza" wasn't coined until 1885, by the German scientist Albert Frank.

Aksakov coined the phrase "quiet hunting," now commonly used in Russia to describe foraging for mushrooms. The phrase refers not only to the absence of rifle fire when a person is hunting mushrooms, but also to the tendency of mushroom hunters not to divulge the whereabouts of their collection sites, lest those sites be ravaged by someone else.

See also Ectomycorrhizal Fungi.

Alder Tongue (*Taphrina robinsoniana*)

Not to be confused with the plant in the lily family called an adder's tongue, alder tongues are often called mycocecidia, a word that means they create galls or gall-like structures in their plant hosts.

The species in question is an ascomycete that creates a tonguelike swelling on the catkins of several North American alder species. Initially, these swellings appear as green lumps and then become brownish as they mature. At last they harden and become black, at which point they turn their host into a collection of tongues. Catkins end up looking so distorted that they seem to be in considerable pain. Typically, however, alder tongues don't cause serious harm to their host. The distorted structures consist mostly of plant tissue forced to proliferate by the fungus so it can spread its spores.

Another *Taphrina* species, *T. deformans*, causes the disease known as leaf peach curl, which sometimes causes premature defoliation of leaves, but sometimes

doesn't. Whether it succeeds usually depends on (like so much in Kingdom Fungi) environmental conditions.

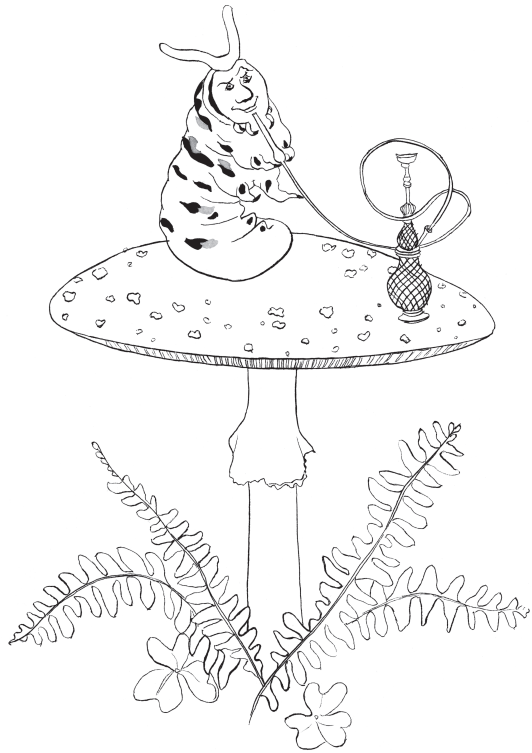
There are approximately 30 species of *Taphrina*, all of which are dimorphic—they spend half their life cycle as innocuous yeasts and the other half as plant parasites.

See also Ascomycetes; *Prototaxites*.

Alice in Wonderland

Delightfully surreal 1865 novel by the Reverend Charles Dodgson, otherwise known as Lewis Carroll, which features perhaps the most famous mushroom in all of literature. On top of that mushroom is seated an almost equally famous hookah-smoking caterpillar. "One side [of the mushroom] will make you grow taller, and the other side will make you grow smaller," the caterpillar observes to the heroine, Alice, who, being of an adventurous nature, decides to test this seemingly peculiar remark. It turns out to be correct.

It's likely that Carroll learned about the mushroom in question, probably the fly agaric (*Amanita muscaria*), from reading English mycologist Mordecai Cubitt Cooke's 1860 book *The Seven Sisters of Sleep*. This book describes the effects of eating the fly agaric as follows: "Erroneous impressions of size and distance are common occurrences . . . a straw lying on the road becomes a formidable obstacle to overcome." It should be noted that the first illustrator for Carroll's own book, John Tenniel, depicted not a fly agaric but a generic mushroom. Carroll's own illustration for *Alice's Adventures Under Ground* looks like a generic mushroom, too.



Alice evolved to become a popular countercultural figure in the 1960s. For example, Grace Slick's song "White Rabbit" includes these well-known lines: "You've had some kind of mushroom, and your mind is moving slow / Go ask Alice, I think she'll know." Grace herself certainly knew.

See also Cooke, Mordecai Cubitt; Fly Agaric.

Allegro, John (1923–1988)
English expert in the Dead Sea Scrolls as well as ancient Semitic languages whose decidedly offbeat 1970 book *The Sacred Mushroom and the Cross* proposes that Christianity was originally a deviant shamanic cult devoted to psychedelic mushrooms. The book also suggests that the word "Jesus" was actually a code name for the fly agaric (*Amanita muscaria*), and that Jesus himself probably never existed.

"The stories in the New Testament are a literary device to spread the rites and rules of mushroom worship to the faithful," Allegro wrote. Indeed, he argued that the New Testament was actually a codex for a mushroom cult. Since that cult was being persecuted, its lore had to be camouflaged.

Not surprisingly, Allegro's reputation took a sudden nosedive after *The Sacred Mushroom and the Cross* was published, from which it never recovered. Here I should say his scholarly reputation. There are still a few contrarian types who have a high regard for him.

See also Fly Agaric.

Amadou
Another name for the tinder polypore (*Fomes fomentarius*). Specimens are ash gray with concentric ridges, and they fruit on deciduous stumps and logs. Their hoof-like shape gives them another common name, hoof polypore.

The word "amadou" is probably derived from the Old French word *amator*, which means "lover." Just as lovers are quick to catch fire, so too is this polypore, which was of primary importance before the invention

of matches and other fire-making devices. Specimens were dried, pounded into fibers, and then sometimes mixed with saltpeter (potassium nitrate). Usually housed in a tinderbox, the flammable result was used as a fire starter, a kindler of one's tobacco, or—by dentists in former times—an aid in drying teeth. In eastern Europe, hats and various items of apparel are still made out of amadou.

Since tinder polypores have been found at Mesolithic campsites dating back to around 8000 BCE, the species might have been the earliest nonedible fungus used by humankind. The Tyrolean Iceman Ötzi had a specimen, or at least hyphae from a specimen, on his much-desiccated person. A smoldering specimen is still used by the Dena'ina in Alaska and the Cree in Quebec, among other native groups, as an insect smudge. Like cigar smoke, the smoldering keeps away insects.

See also Ethnomycology; Ötzi; Polypores.

Amateur

Also called a mycophile. An individual who takes delight in fungi but doesn't engage in applied or university science. Formerly, "amateur" was a somewhat derogatory term that suggested ignorance, but it tends not to have such a negative connotation nowadays. "Citizen scientist" is a phrase that's now increasingly replacing the word "amateur."

Whatever you decide to call such individuals, their interest in fungi is not associated with power, prestige, the occupational pressure to publish, or an NSF grant—they just want to learn with a capital *L*. Yes, they

may engage in rants on Facebook or argue incessantly about whether a species is a *Mycena* or a *Marasmius* at meetings of their mushroom clubs, but their ability to identify fungi often surpasses that of professionals. Increasingly, many of those professionals are so devoted to DNA sequencing that their only knowledge of actual mushrooms is (in the words of mycologist Andrus Voitk) "as a side order item in a burger joint."

Amateurs and professionals are currently combining their talents with the North American Mycoflora Project, the goal of which is to identify and map the distribution and seasonality of macrofungi in North America and put the results online. This project is admirable, but it should probably have a different name, since fungi are not even remotely "flora."

Amatoxins

Also called amanitins. A group of highly toxic, bicyclic peptides not only in *Amanita* species like the death cap (*A. phalloides*) and the destroying angel (*A. bisporigera*), but also in a trio of "deadlies"—the deadly galerina (*Galerina marginata*), the deadly lepiota (*Lepiota josserandii*), and the deadly conocybe (*Conocybe filaris*). These compounds inhibit the enzymes necessary for the production of RNA, which means cells are unable to synthesize new proteins, so they grind to a halt. Amatoxins accumulate especially in the liver, more or less causing that organ to digest itself.

Possible treatments include a liver transplant, hemodialysis in the case of kidney failure, and decontamination of the digestive tract with charcoal—but not, definitely not, eating raw rabbit brains, an early "cure"

based on the apparent ability of rabbits to eat toxic mushrooms with impunity.

Amatoxins weren't designed to kill members of our species. Rather, they're probably biochemical waste, transported by the mycelium to the fruiting body. An example of a similar transport is caffeine in a coffee bean.

Many *Amanita* species don't have amatoxins, but those that do have given a bad reputation to the others. Species such as Caesar's amanita (*A. caesarea*) and the blusher (*A. rubescens*) are in fact edible . . . with caution.

See also Death Cap; Poisonings.

Ambrosia

A Greek word meaning "food of the gods." In this case, the "gods" are scolytid (a.k.a. ambrosia) beetles, and their food happens to be a fungus, usually an asexual

stage of an ascomycete or a yeast. Long ago the material on which the beetles fed was unidentifiable, so it was believed to have come from the realm of the gods rather than from the earth. Thus the name "ambrosia" refers not only to the beetles but also to their fungal food.

Ambrosia beetles inhabit recently dead trees and freshly cut logs. They possess spore-filled pockets called mycangia, and as they create galleries in wood, they reach into those mycangia and inoculate the galleries with spores. When a mycelium begins growing, the beetles eat its surface cells, and the mother beetle feeds her larvae tidbits from those cells. The larvae grow up *en famille* in a single mycelium-filled gallery. Alien fungal species growing in such galleries are regarded as enemies and are quickly disposed of by the beetles.

Certain species of ambrosia beetles could be called kleptomycophages, since they engage in the outright theft of mycelia from other ambrosia beetles rather than attempt to grow those mycelia themselves.

Fungal species grown by ambrosia beetles include the genera *Ambrosiella*, *Rafaella*, and *Dryadomyces* as well as certain yeasts.

Anamorph

Not to be confused with the film *Anamorph*, a psychological thriller starring Willem Dafoe, this particular use of the word refers to the nonsexual phase of an ascomycete or a basidiomycete. An anamorph is also called an imperfect fungus, although that phrase is currently not much in fashion.

Some anamorphs mature and become teleomorphs (the name for their sexual phase), while others remain

asexual throughout their lives. If they decide not to reproduce in a sexual manner, this does not mean they're celibate. They will still reproduce, albeit via conidia (asexual spores) created primarily by specialized hyphae, which reproduce mainly by fragmentation. This activity is similar to cloning: the fungal offspring are no different from their parent. Even so, anamorphs do a reasonably good job of preserving genetic material.

Anamorphs tend to grow in human dwellings, where they colonize everything from stale bread to wet wallpaper to books. They can do this any time of the year, even in winter, while the teleomorph phase usually fruits only seasonally.

The anamorph and teleomorph phases of the same species once had separate Latin binomials. But in 2011 a mycological congress in Australia proclaimed "one species, one name," so the two phases are obliged to share the same binomial even though they may look very different from each other.

Aniseed Polypore (*Haploporus odorus*)

A buff-colored, ash-gray, or dingy brown perennial polypore that grows primarily on old-growth willows and ash trees in northern boreal forests in Canada and Europe. The common name of the species is derived from its strong anise-like smell, which once inspired the Woods Cree in Alberta and other tribes in the northern Great Plains to use it in medicine bundles and to ward off evil spirits. The author of this *Fungipedia* keeps a specimen on his desk to ward off evil spirits with it, too.

In Lapland, reindeer herders would once carry a bag of aniseed polypores when they went a-courting.

About this practice, Swedish scientist Carolus Linnaeus wrote: "The Lapland youth carefully keeps it in a pouch hanging in front of his pubes, that its lovely odor may render him acceptable to his favored maiden. O whimsical Venus!" But maybe not so whimsical Venus, since a favored maiden would doubtless prefer the scent of anise to the herder's characteristic odor of reindeer, which the polypore would camouflage.

The species has become endangered in Europe, not because of its amatory use by reindeer herders but because of livestock grazing, flagrant logging, and the alteration of its habitat by climate change.

Aphyllophorales

A catchall order of basidiomycetes that includes crusts, corals, polypores, cyphelloid species, and jellies. The name means "without gills," so you won't find any fungi in this order that possess gills. The "gills" of the rusty-gilled polypore (*Gloeophyllum sepiarium*) and the gilled polypore (*Trametes betulina*) are actually elongated pores. Most Aphyllophorale species are wood-inhabitors. Most, but not all. One of the exceptions is corals.

The order is now considered more or less obsolete largely because of DNA analysis, but since a mycologist may still say, for instance, "Damn, I've got another bloody Aphyllophorale to identify," it deserves a mention in this *Fungipedia*.

Actually, there are several bloody species in Aphyllophorales, although the "blood" is usually water that contains either anticoagulant pigments or unwanted chemicals such as oxalic acid. Two examples of bloody

Aphyllophorales species are the bleeding rosette (*Abortiporus biennis*) and the bleeding tooth (*Hydnellum peckii*).

See also Corals; Polypores.

Artist's Conk (*Ganoderma applanatum*)

A large perennial polypore with a brownish multizoned cap. Fruiting on hardwood trees worldwide, artist's conks can be either saprophytes or weak parasites. The species is unusually long-lived—specimens have been found that are upward of 70 years old. Each of its tube layers (but not the zones on its cap) indicates more or less a year of growth.

When it's actively sporulating, the species can produce 30 billion (!) spores a day. These spores are thick walled, which helps them withstand harsh conditions far better than the thin-walled spores of most other fungi.

Artist's conks derive their name from the fact that they're frequently removed from the deciduous tree of their choice and used as an etching board. To the author of this *Fungipedia*, however, they're far more attractive when they're connected to their host tree than when they have a cute cabin, a rutting deer, or a frieze of trees etched on them.

According to the folklore of the Susitna Dena'ina people, there's a birch tree in interior Alaska with a very large artist's conk growing on it. The specimen is not two, three, or four feet wide, but approximately a quarter mile in diameter, which would make it the largest fungus in the world . . . even, perhaps, the largest fungus in folklore as well.

See also Polypores; Saprophytes.

Ascomycetes

A fungal phylum with at least 3,200 genera whose 32,000 species come in a remarkable variety of sizes and shapes. Some look like coatings of thick black paint, some are tongue shaped, some are cup shaped, some are flask shaped, and some look like a dead person's withered fingers. A few are serious crop pathogens, like *Aspergillus flavus*, while others are highly prized edibles, such as morels. Many are modest wood decayers and engage in what's known as soft rot. Some, including *Saccharomyces cerevisiae*, a species instrumental to baking and brewing, are even yeasts.

An ascomycete produces its sexual spores inside capsules shaped like sacs, clubs, or balloons called asci (pronounced *ass-eye*) and usually launches those spores in a manner similar to a jack-in-the-box suddenly shooting upward. Remarkable as it might seem, the discharge speed of the spores can reach 70 miles per hour. With certain ascomycetes (cup fungi, for example), airflow activates this discharge, so if you blow gently on a fruiting body, you'll often see a cloud of spores. With the devil's cigar (*Chorioactis geaster*), this cloud is sometimes accompanied by an audible hiss.

See also Basidiomycetes; Discomycetes; Morels; Pyrenomycetes; Soft Rot.

Azalea Apples (*Exobasidium* sp.)

The common name for basidiomycetes that infect ericaceous plants like azaleas and rhododendrons, azalea apples do not look like apples so much as (in the words of mycologist Sam Ristich) "blown out bubble gum." In addition to the aforementioned hosts, these quasi

apples also grow on huckleberries, cranberries, whortleberries, and blueberries. All are members of the genus *Exobasidium*.

An *Exobasidium* species creates gall-like distortions on the leaves, branch tips, flower buds, and shoot tips of its host by altering that host's hormone levels. In most cases, the damage is primarily aesthetic—one's azaleas or rhododendrons end up looking like highly unappealing versions of their former selves. But if a large number of leaves are infected by the fungus, they will either fall off or lose their ability to photosynthesize, and the entire plant will probably die.

Because of the toxicity of their hosts, azalea and rhododendron-inhabiting *Exobasidium* species are inedible. But those on blueberries and cranberries are eaten by Native people in southern Alaska and coastal British Columbia, who refer to *Exobasidium* species as "ghost ears" and regard them as a sort of candy.

Banning, Mary (1822–1903)

Unsung nineteenth-century American mycologist who, being a woman, was ostracized from the scientific community. The only mycologist who acknowledged her was Charles Horton Peck, to whom she wrote, "You are my only friend in the debatable land of fungi."

In a mostly mycophobic country, Ms. Banning's interest in fungi was another strike against her. Her fellow Marylanders called her the Frog Stool Lady. Individuals who saw her hunting for mushrooms in the woods would remark to each other, "Poor thing's gone clean mad." Her own comments about hunting

for mushrooms indicate that she had not gone mad but possessed both a discerning and an aesthetic attitude toward her subject. Here's one of those comments: "The mycologist may well liken himself to a pioneer wandering through a land filled with alternately beautiful and fantastic shapes."

Ms. Banning described 23 previously unknown species of fungi and wrote a book titled *The Fungi of Maryland*, which remains unpublished. Like Beatrix Potter, she made very attractive paintings of mushrooms.

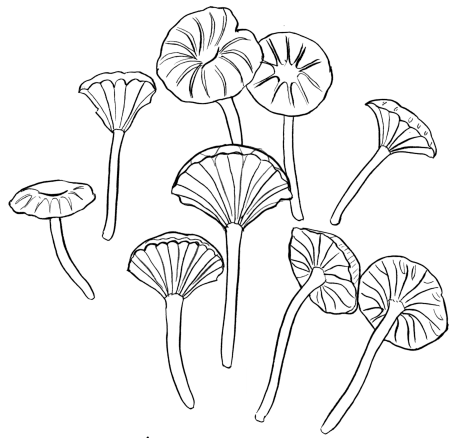
See also Mycophobia; Peck, Charles Horton; Potter, Beatrix.

Basidiolichens

Numerous ascomycetes have opted for a lichenized lifestyle, but only about 20 species of basidiomycetes have decided to form a mutualistic relationship with an alga or a cyanobacterium. Once this union has been achieved, the result is referred to as a basidiolichen.

Even though most of them are light colored, basidiolichens tend to be placed in the generic category of "little brown mushrooms." This is one reason they're often overlooked. Another reason is that they usually grow in damp, mossy, or peaty areas as well as on humid soils without vegetation—that is, places where the ordinary fungal forager seldom ventures.

Lichenomphalia and *Arrhenia* are relatively common basidiolichen species. They have wide gills that extend down their stems (mycological term: decurrent) or, if not actual gills, at least gill-like structures that do the same thing. Members of another genus, *Multiclavula*, grow gregariously on wood and look like anorexic corals. *Very*



Lichenomphalia sp.

anorexic corals. Even so, DNA sequencing has shown that they're (mirabile dictu!) relatives of chanterelles.

Basidiolichens have been included in this *Fungipedia* because, unlike most lichens, they can be mistaken for actual mushrooms.

See also Basidiomycetes; LBM.

Basidiomycetes

A fungal phylum that includes almost all umbrella-shaped mushrooms, along with puffballs, polypores, rusts, jellies, corals, and even a few single-celled yeasts. There are approximately 75,000 basidiomycete species worldwide.

Regardless of their shape or size, all basidiomycetes produce their spores on specialized, more or less club-shaped cells. Such cells, called basidia, are usually

4-spored, but 2-spored and even 16-spored basidia are not unknown.

A basidium has been described by mycologist Nick Money as resembling "an udder with a quartet of spores arranged on the teats." The fertile surface of these "udders" faces downward so that the spores can be caught by air currents at the moment of release. Such a large number of spores can be released at once that those air currents are often self-created.

As with plants, gravitropism tells a basidiomycete which way is up and which way is down. Let's say a mushroom is growing on a branch and that branch falls off the tree, so that the mushroom's spore-bearing surface ends up facing sideways or upward. The mushroom will often attempt to reorient itself so that its spore-bearing surface faces down and the spores themselves can do what their parent basidium wants them to do—that is, drop down.

See also Ascomycetes.

Beech Aphid Poop Fungus

A sooty mold variety of ascomycete whose whimsical common name was created by mycologist Tom Volk.

This species (*Scorias spongiosa*) has a very special diet—the concentrated carbohydrate solution known as honeydew from woolly aphids (*Grylloprociphyllus imbricator*) living on American beech trees and, occasionally, alder trees. When the mycelium has digested enough of this honeydew, it creates spongelike fruiting bodies with asexual spores. These fruiting bodies are cream colored, pinkish, or yellowish. Slowly they blacken, and in doing so, they become more robust and begin producing

sexual spores. These blackened fruiting bodies can be scraggly or round. They can also be almost as large as volleyballs, but unlike most volleyballs, they often have dead aphids embalmed on their surface.

See also Mold.

Beefsteak Polypore (*Fistulina hepatica*)

An unusually soft, pinkish-brown to purplish-brown polypore that looks like a marbled slab of raw meat and exudes a reddish juice when fresh—hence its common name. Sometimes it can have a stem, a feature lacking in actual beefsteaks but not in other polypores. Members of the *Polyporus* genus, for example, have stems.

The beefsteak polypore is a saprophyte that grows mostly on the heartwood of living or dead oak trees and engages in brown rot through the manufacture of acetic acid. Unlike other polypores, it can be eaten raw. The presence of acetic acid gives it a somewhat vinegary, citrus-like flavor.

Unlike other polypores, too, the beefsteak polypore's spores emerge from tubules rather than from pores. Thus it's not surprising that DNA studies indicate that the species is closely related to gilled mushrooms, with its tubules possibly being an ancient type of gill.

See also Brown Rot; Polypores; Saprophytes.

Berkeley, Rev. Miles (1803–1889)

English clergyman who coined the word "mycologist" in 1837 to describe his second calling. He carried out his mycological work by candlelight in the very early morning before venturing off to perform his parish duties.

Reverend Berkeley wrote a 433-page book titled *Fungi* as well as the highly regarded *Outlines of British Fungology*. He correctly thought the cause of the Irish potato famine might be the water mold *Phytophthora infestans*, a so-called oomycete that may or may not be related to fungi. Meanwhile, a sizable portion of Berkeley's fellow clerics believed the famine to be the work of the devil.

Toward the end of his life, Berkeley donated his personal collection of 10,000 fungi to Kew Gardens. He named the species *Agaricus* (now *Pleurotus*) *ruthae* after his daughter, the scientific illustrator Ruth Ellen Berkeley. The name of an extremely large eastern North American polypore species, Berkeley's polypore (*Bondarzewia berkeleyi*), honors the English mycologist-clergyman.

See also Darwin's Fungus.

Berserker Mushroom

A common name for the fly agaric (*Amanita muscaria*), especially in Scandinavia.

In 1784, a Swedish theologian named Samuel Ödmann proposed that the mushroom was eaten by Viking warriors in order to go berserk and thus dispatch their victims more readily than if they were in a docile mood. This idea quickly underwent the eighteenth-century equivalent of going viral, and most of the civilized world soon began associating fly agarics with maniacal behavior.

Obviously, Reverend Ödmann had never eaten the species, which usually induces the opposite of aggressive behavior. The word "euphoria" is sometimes used to describe the effect of eating it, although it can also

induce noneuphoric activities like vomiting and diarrhea. The condition induced by the mushroom has also been described as being similar to that caused by opium.

"Berserk" means "bear shirt" in several Scandinavian tongues. Rather than eat a mushroom that can cause gastroenterological issues, Viking warriors wore shirts made of bear fur inside out, and with the fur rubbing constantly against their skin, they must have felt pretty irritated. Indeed, they might have said to themselves, "I'm going to get rid of this enemy immediately so I can take off this damn shirt."

See also Fly Agaric.

Big Laughing Gym

Either *Gymnopilus spectabilis* or *G. junonius*, depending on which taxonomist is referring to it. Large, bright yellow or orange mushrooms whose gills extend down the stem (mycological term: decurrent), big laughing gyms grow in clusters on decayed wood or mulch and have a ring that collapses or falls off with age. They have a worldwide distribution, although they're found primarily in temperate regions.

Fruiting bodies contain psilocybin as well as compounds similar to the alpha-pyropes in kava. If you eat them, you might end up laughing uncontrollably, but you might alternate these laughing fits with nausea, dizziness, excessive urination, and no less excessive giddiness. In an oft-quoted incident, a woman who'd eaten several of the mushrooms said, "I'm dying, and it's hilarious." Another person laughed, "If this is what mushroom poisoning is like, I'm all for it." A man who'd eaten rather a large number of big

Gymnopilus spectabilis
Big Laughing Gym

laughing gyms suffered from severe priapism for several days—no laughing matter! In most instances, however, the mushroom's extremely bitter taste will prevent such unfortunate dining experiences.

See also Amatoxins; Psilocybin.

Bioluminescence

"Darling, I am writing this letter by the light of a mushroom," wrote an American serviceman in New Guinea to his wife during World War II. The man was not suffering from battle trauma, for certain mushrooms do

indeed give off a greenish glow in the dark. These mushrooms include the aptly named jack-o'-lantern (*Omphalotus illudens*), several *Mycena* species, and *Panellus stipticus*, the last of which apparently glows only in the eastern United States. Called foxfire, the rhizomorphs (bunched hyphae) of honey mushrooms (*Armillaria* sp.) can also glow in the dark, a fact documented by Mark Twain in *Huckleberry Finn*.

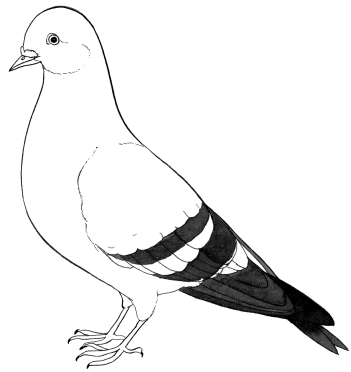
The mushrooms in question manufacture a pigment called luciferin, which, upon being oxidized by the enzyme luciferase, emits light. By doing so, these mushrooms might be trying to attract night-flying insects to come and spread their spores. Or they might be warning nocturnal fungivores to stay away. Since all bioluminescent species inhabit wood, the glow might simply be a by-product of an enzyme-mediated oxidation reaction. At the moment, the night-flying insect theory seems to be the most popular among mycologists.

According to the Bible, the so-called burning bush seen by Moses on Mount Horeb was on fire, but it did not actually burn. This paradox suggests that the shrub might have been a cluster of bioluminescent mushrooms, which Moses, whose mycological acumen was probably nil, thought was a bush.

Bird Droppings

A prime motivator, although not a substrate, for two different species of pathogenic fungi.

The first species is the yeast *Cryptococcus neoformans*, and the disease that it causes is known as cryptococcosis (called crypto by doctors). The fungus, a type of yeast, grows mostly in soil made nitrogen rich—no, *too*



nitrogen rich—by pigeon droppings. It produces a huge number of spores. A person who frequently hangs out with or near pigeons might inhale some of these spores, and nothing will happen. Or that person might inhale them, whereupon the spores will enter the person's lungs, then his or her bloodstream, and then the brain. Death is a definite possibility.

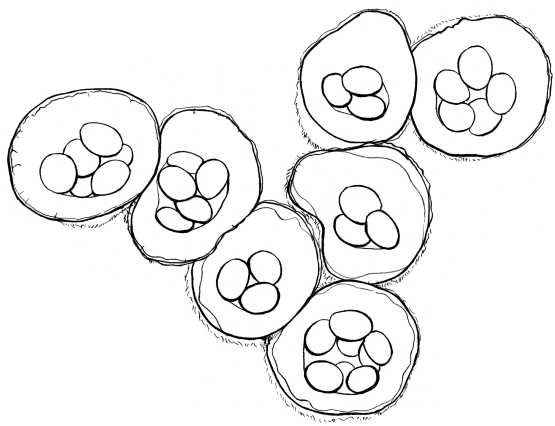
The other species is a member of the Onygenales, *Histoplasma capsulatum*, and it causes the disease known as histoplasmosis (called histo by doctors). The fungus likewise grows in the overnitrogenated soil where chickens have left their droppings, starlings have roosted, or bats have deposited their guano. Once the spores are inhaled, they may or may not cause a lung infection followed by a systemic infection of all major organs. Bob Dylan nearly died of histoplasmosis, which caused a serious infection of the sac around his heart. (Note: Dylan's song "Heart of Mine" predates this incident.)

See also Keratinophiles; Valley Fever.

Bird's Nest Fungi

So named because their shape resembles miniature bird's nests with a clutch of even more miniature eggs inside them. Each of these "eggs" is actually a packet of spores called a peridiole. As if they were nestlings, the spores eventually fly away.

Here's how the spores of two of the most common bird's nest fungi, *Cyathus* and *Crucibulum* species, succeed in flying away: affixed to the base of each peridiole is a Slinky-like strand with a sticky base called a funiculus. When a raindrop shatters the thin tissue at the top of the so-called nest, the funiculus will send one or more of the peridioles soaring through the air. It snags the first object it encounters, whereupon the periodiole



Cyathus stercoreus
Bird's Nest Fungi

smashes against that object, releasing its spores in the process. Preferred substrates for this release include branches, twigs, and garden mulch. Occasionally, the peridiole will end up smashing against a car's windshield; the result is (in the words of mycologist Elio Schaechter) "a very modern form of spore dispersal, making use of automobiles."

Certain traditional Asian cultures believe that the peridioles eventually become actual birds and fly away, albeit without a funiculus trailing after them.

Bird's nest fungi are gasteromycetes, so they're closely related to puffballs and stinkhorns.

Black Knot of Cherry (*Apiosporina morbosa*)

An ascomycete sometimes given the common name of shit on a stick, since that's exactly what specimens often look like, the black knot of cherry is a pathogen of 25 tree and shrub species in the *Prunus* genus. "Shit on a stick" is also African American slang for a tough guy, and that's how a host tree or shrub might describe the fungus, for the host has almost no chance of fighting off its lethal advances.

Fruiting bodies start out as a seemingly innocuous olive-brown swelling on a branch, and then as they get bigger, they become hard as well as carbonaceous. When this happens, the mycelium begins interfering with the transmission of water in its host tree. Not only that, but it inhibits the transfer of nutrients, especially photosynthates, from the leaves to the tree itself. In a relatively short time, the tree ends up buying the proverbial farm. The fungus is especially destructive to cultivars like the ornamental cherry.

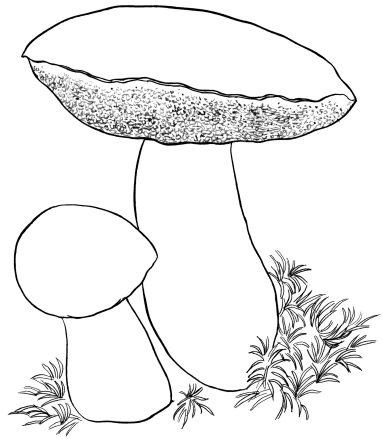
Because of its irregular black shape, black knot of cherry has occasionally been mistaken for chaga, but it's unlikely to have enough medicinal power to cure even the most common of common colds.

See also Chaga; Parasites.

Bolete

A catchall word for a fleshy mushroom with spore-bearing tubes rather than gills. These tubes, which end in a pore, give many boletes their spongy texture.

All that soft, fluffy flesh—it's not surprising that fruiting bodies are at once popular mycological condos and no less popular food sources for insects like rove beetles and maggots. In addition to hosting insects, boletes are also highly regarded human edibles, especially the king bolete (*Boletus edulis*). A few are toxic, such as Satan's bolete (*Boletus satanas*).



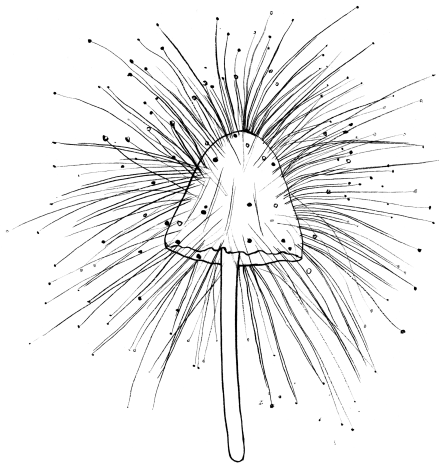
Generic Bolete

The Roman philosopher Pliny the Elder wrote that if a woman eats enough boletes, they will remove the freckles and blemishes on her face. Many boletes have blemishes themselves. Upon being bruised or even gently touched, their caps and/or pores will often turn blue, blue green, red, or brownish. This is a staining reaction due to oxidation and can be used to help identify specimens. Certain bolete species stain instantly, while others take a few minutes.

In addition to *Boletus*, bolete genera include *Suillus*, *Tylopilus*, *Phylloporus*, *Boletellus*, *Harrya*, *Bothia*, *Xerocomus*, and *Leccinum*. As a consequence of DNA sequencing, dry rot (*Serpula lacrymans*) and *Scleroderma* puffballs have recently been shuffled to the bolete clade, although neither of these fungal entities is at all spongy.

Bonnet Mold (*Spinellus fusiger*)
A parasitic zygomycete that grows on *Mycena* species, especially the bleeding mycena (*M. haematopus*), during prolonged wet periods, this species has aerial filaments that provide its host's cap with a bonnet or what looks like the fungal equivalent of a punk haircut. In fact, mycologist Tom Volk has referred to such specimens as "punk rock *Mycena*s."

At the end of the aerial filaments are the spores, housed in budlike contraptions. First white, then black, the spores are dispersed by insects as well as the wind after the breakdown of each bud's outer covering. Most of the spores will have been dispersed by the time the fungus has reduced its host *Mycena* to the equivalent of a puddly soup.



This species is not to be confused with another zygomycete, *Syzygites megalocarpus*, which mycologist Sam Ristich called the troll doll fungus. That particular fungus covers its host, which is usually some sort of *Lepiota*, with a fuzzy growth that resembles the uncombed hair of a Swedish troll doll. Other *Syzygites* species have different hosts, but none are as hair raising as *S. megalocarpus*.

See also Ristich, Sam; Zygomycetes.

Brown Rot

A brown-rot fungus feeds on the cellulose in wood but doesn't feed on the lignin, which is brownish. Thus its name derives from the color of the wood it leaves behind. It's often called cubical rot because the wood in question has lost its longitudinal strength as well as its hardness (cellulose itself being partially responsible for that hardness) and develops cracks, finally becoming little more than a collection of crumbly cubes. The fungus engages in this seemingly geometrical activity in order to turn the cellulose into edible carbon compounds.

Fewer than 10 percent of all wood-decay species are brown rotters, but they recycle 80 percent of the softwood carbon in the world. They dominate the decomposition of trees in northern forests, and their residues remain unaltered in the soil of those forests for hundreds of years. Soils with these residues have a far greater water-holding capacity than soils with white-rot residues and, as a result, tend to be highly favorable for seed germination. On the negative side, brown rot is a major form of decay in wooden buildings.

Common brown rotters are the red belted polypore (*Fomitopsis pinicola*), the birch polypore (*Piptoporus betulinus*), chicken of the woods (*Laetiporus* sp.), and the dry-rot fungus (*Serpula lacrymans* or *S. himanitiodes*).

See also Dry Rot; Polypores; Soft Rot; White Rot.

Buller's Drop

An extremely significant globule manufactured by almost all gilled mushrooms and named after the English Canadian mycologist who first described it, Arthur Henry Reginald Buller (1874–1944). Without this drop, these mushrooms could not discharge their spores.

A mushroom's spores are affixed to a projection on the basidia called an apiculus, and when this apiculus inherits a drop of fluid, the globule known as Buller's drop, the spores shoot out at a speed of approximately two feet per second. This lasts no more than a few milliseconds, but that's enough for the spores to clear the

gills and venture out into the world at large. The humidity between the gills is largely responsible for creating Buller's drops.

Buller himself was a lifelong bachelor, but he did produce offspring in the form of seven hefty volumes relating to his mycological research, of which the eponymous drops are only a part. Half of volume 6, for example, is devoted to the cannon-like ability of the so-called hat thrower (*Pilobolus* sp.) to launch its spores far from its substrate of dung.

Not only Buller's books but also his ashes currently reside at the Buller Library, a division of Agriculture Canada in Winnipeg.

See also Basidiomycetes.

Cage, John (1912–1992)

Composer–performance artist who tried to emancipate music from its, to him, turgid system of notes by using goose quills, pressure cookers, old wine bottles, rubber ducks, ice cubes, sneezes, and silence in his compositions, which have been described as being akin to a circus taken over by its clowns.

Cage often referred to the fact that the word "mushroom" precedes "music" in dictionaries. In the words of writer David Rose, "the mycological and musical are revealed by Cage as parallel universes." Indeed, the chance or indeterminate feature of Cage's music may owe some of its inspiration to mushrooms, which seem to appear or not appear owing to their own idiosyncratic whims.

Cage helped establish the New York Mycological Society in 1962. He also taught a course in mushroom identification at the New School in New York City.

Until late in life, he made his living not by his music but by collecting and selling mushrooms to upscale restaurants in New York.

Cage's attitude toward mushrooms was often worshipful. Indeed, he wrote a poem that ends with this statement about them: "So far they've remained just as mysterious as they ever were." Less worshipful, perhaps, was his belief that if you play a recording of a Beethoven quartet for a fly agaric (*Amanita muscaria*), it will become a prime edible.

See also Fly Agaric; Music.

Carver, George Washington (1864?–1943)

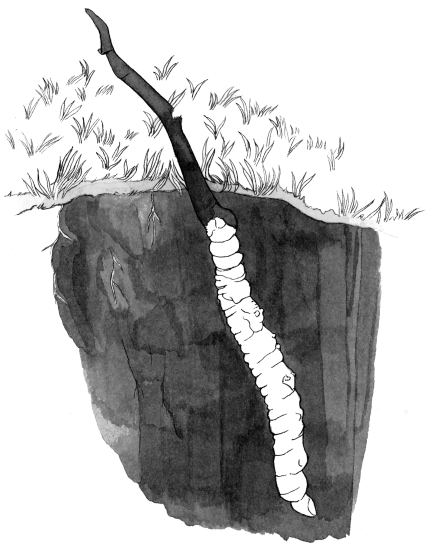
African American scientist whose extensive work with the peanut at Tuskegee Institute in Alabama has often obscured his no less serious mycological work. At Iowa State University, where he was both the first black student and the first black faculty member, he studied microfungi—that is, the fungal species that cause plant diseases. Later he specialized in the rusts and smuts that attack domestic plants.

The "Peanut Man," as Carver was called, collected and donated several thousand fungal species to herbaria around the country. He was the first mycologist to identify the fungal pathogen of soybeans as well as the first to document (no surprise) the *Aspergillus* species that attacks peanuts. Not averse to eating mushrooms, he often served up platters of edible species to his colleagues and students at Tuskegee Institute.

In 1935, the USDA named Carver the head of its Division of Mycology and Disease Survey, a remarkable honor for a man who'd been born into slavery.

Caterpillar Fungus (*Ophiocordyceps sinensis*)
An ascomycete harvested in the Himalayas, especially Tibet, where it's called *yartsa gumbu* (winter worm, summer grass) on the assumption that it's a single organism. But it's actually two organisms, a fungus and an insect. The spores of the fungus penetrate the cuticle of a hibernating ghost moth caterpillar (*Thitarodes* sp.), whereupon its hyphae digest first the caterpillar's less vital, then its more vital parts. A short while later, a fruiting body arises from the host.

The caterpillar fungus is used in China as a treatment for liver cancer and pulmonary problems. Chinese runners also consider the ingestion of the caterpillar fungus an important part of their training regimen. In



fact, several Chinese women runners broke national records after ingesting large amounts of the fungus. The question is, did the fungus boost their running strength, or was their strength already pretty good?

In Asia, men commonly use the species as an aphrodisiac. After all, it looks not unlike an eager virile member. Markets used to display huge piles of *O. sinensis*, but now those piles have gotten much smaller, and it seems only a matter of time before the fungus is wiped out as a result of overharvesting. Tiger penises are collected for the same reason, with tiger populations on the decline as well. A possible solution to this problem: Viagra.

On a more positive note, a related species, *Isaria sinclairii* (anamorph of *Cordyceps sinclairii*), manufactures the amino acid myriocin, a derivative of which has been used successfully in the treatment of multiple sclerosis.

See also Fly Killers; Zombie Ants.

Cemetery Mushrooms

Fungi are not particularly good at recycling corpses because almost all of them (the fungi, not the corpses) are aerobic, and there's not much oxygen six feet under. Thus—contrary to popular belief—the unusually large number of mushrooms often found in a cemetery aren't feeding on human remains. Instead, they're growing in a cemetery mostly because that cemetery's deceased inhabitants have released into the soil copious amounts of nitrogen and ammonia, both sources of delight for the mycelia of cemetery mushrooms. Species that fruit early in the decomposition process are called ammonia fungi, while those that fruit later are called postputrefaction

fungi. That cemeteries are constantly watered is another inspiration for fungal growth.

Into the soil, the dead also release embalming fluids such as formaldehyde, while their coffins release lead. This is not a problem for cemetery mushrooms, which happily gobble up toxic substances courtesy of their mycelia, but it could easily be a problem for the person who decides to eat them.

Although both so-called corpse finders (*Hebeloma syrjense* and *H. vinosophyllum*) are mycorrhizal species, they can occasionally be found on the corpses of birds and small mammals, but almost never on larger mammals like us. In a cemetery, they're taking advantage of the rich nitrogen in the soil. In fact, a better name for them would be nitrogen finders.

Chaga

Often confused with the woody swelling on a tree known as a burl, this is a blackish, deeply cracked, irregularly shaped structure belonging to the so-called clinker polypore (*Inonotus obliquus*). The polypore's mycelium takes betulin, the defensive compound in birch trees, and transforms it into betulinic acid, which it concentrates in this structure. Variously referred to as a false conk, a sterile conk, or a sclerotium, that structure—chaga—is the current fungal medicinal of choice. A recent Google search of the word resulted in 5,260,000 hits.

Chaga became a global phenomenon after Aleksandr Solzhenitsyn wrote about it in his 1966 memoir *The Cancer Ward*. Long before it purportedly did away with Solzhenitsyn's cancerous tumor, it was used

extensively by northern Native peoples. For example, Khanty women in Siberia would bathe in chaga-infused water to cleanse themselves during menstruation; the Ojibwa in Manitoba and Minnesota used it to relieve the discomfort of their hemorrhoids; and various tribes in northern Canada and Siberia used it as a fire starter.

Chaga may be rich in antioxidants, but it's less rich than (for example) the caffeine from coffee. Its grayish resupinate fruiting body is overlooked because it grows under the bark of its birch tree host, where it tends to be eaten by insects. Upon appearing, it looks not unlike a lengthy piece of moth-eaten cloth.

See also Medicinal Mushrooms.

Chestnut Blight

Not an actual blight but a tree-girdling canker caused by the pyrenomycete *Cryphonectria parasitica* (former name: *Endothia parasitica*). Since dead man's fingers (*Xylaria* sp.) is also a pyrenomycete, you could say that a relative of dead man's fingers destroyed virtually all American chestnuts on the continent between 1904, when the disease was first detected in New York City, and the 1950s. As a result of the fungus, the American chestnut went from a dominant forest species to a minor understory shrub.

Chestnut blight probably arrived via seeds or young plants from Asia, where it isn't a problem at all. After all, Asian trees evolved with it. American chestnuts, unfortunately, did not.

Here's how *C. parasitica* goes about its nefarious business: its mycelium eats through the bark of the

chestnut and, in doing so, kills the vascular system responsible for channeling nutrients to leaves and other parts of the tree. The tree becomes defenseless, and the mycelium can now dine on it. In the end, the chestnut's roots produce only shrubs that die back from the disease.

Strategies for restoring the American chestnut involve creating genetically modified trees resistant to *C. parasitica* and, recently, providing the tree with a gene derived from wheat that also seems to make it resistant to the fungus.

See also Dead Man's Fingers; Pyrenomycetes.

Chitin

A polysaccharide made up mostly of amino acids, chitin exists in the cell walls of fungi, giving them tensile strength—that is, rigidity. It also gives most edible mushrooms their initial crispness; without it, you would feel as if you had something limp and soggy in your mouth.

Chitin can be found in the outer shells (known as exoskeletons) of insects and spiders, in the beaks and suckers of squid, and in the shells of mollusks (including, of course, the rock inhabitors known as chitons), so it's a reminder that fungi and members of the animal kingdom are sister groups, whereas plants are only distant cousins.

The strength of chitin allows some fungi to break through asphalt and even concrete, much to the astonishment, indeed exasperation, of tennis players who occasionally see a puffball or a stinkhorn rising up on their courts. Game, set, and match to the fungus!

Chytrids
Primitive fungi in a phylum of their own (Chytridiomycota) whose spores are adapted for swimming.

Chytrids, as they're commonly called, would be known only to mycologists, except that one species, *Batrachochytrium dendrobatidis* (Bd, for short) has been implicated in population declines or extinctions of frogs in the tropics. Discovered as recently as 1998, the fungus is now believed to have come originally from the Korean Peninsula, and from there it spread to the tropics. Climate change or habitat loss could also be weakening the frogs, making them more susceptible to infection. In the last few years, a sister chytrid, *B. salamandrivorans* (Bsal, for short), has started to victimize salamanders in Europe.

Bd and Bsal seem to digest keratin, the protective part of an amphibian's skin tissue and causes it to peel away. Amphibians also breathe through their skin, so Bd is doing a number on their osmotic regulation, with organ failure likely to follow. The fungus is usually introduced to its victims through water exposure. After all, its spores can swim just as their potential host can.

Researchers have discovered that some frogs and salamanders are now producing skin secretions to block the growth of Bd and Bsal. Only a small fraction of species have evolved this defense, but at least it's a start.

Claudius (10 BCE–54 AD)
Roman emperor who may or may not have died from eating a dish that featured not only an edible mushroom, *Amanita caesarea* (so named because it was a favorite species of the Caesars), but possibly a toxic *Amanita* as well.

After Claudius executed his third wife, Messalina, for adultery, he married his niece Agrippina the Younger. Either Agrippina or a friend of hers named Locusta reputedly added a poisonous species like the death cap (*A. phalloides*) or the destroying angel (*A. virosa*, in Europe) to an *A. caesarea* dish so that another poison, her nephew Nero, could ascend to the throne.

Some historians believe that Claudius may have died of a cerebrovascular disease or simply old age rather than a poisonous mushroom. If so, then perhaps the most celebrated mushroom-related death in history is no less a fiction than the multitude of mushroom deaths in detective and mystery novels.

See also Death Cap.

Clusius, Carolus (1526–1607)

The Latinized name of Dutch botanist Charles de l'Ecluse. Clusius was a botanist who popularized tulip breeding in his country, but he was also a mycologist several centuries before the word was invented. His *Rariorum plantarum historia* is the first book devoted more or less to fungi; a sizable portion of its information reputedly came from Clusius's chats with so-called herb women, wise women, and root women. Published in 1601, it contains watercolors probably done by Clusius's nephew.

Rariorum plantarum historia laid the ground for the future scientific study of fungi in Europe, including Flemish priest Franciscus van Sterbeeck's *Theatrum fungorum*, a tome that's devoted not only to fungi but also to potatoes because (it's been suggested) Sterbeeck thought potatoes were akin to truffles—after all,

they grow underground. So they deserved a place in his tome.

Before Clusius's book appeared, references to fungi in books hardly did more than offer advice as to which species were edible and which ones could cure an ailment. Those that were neither edible nor medicinal would often be described as "excrescences." Admittedly, Clusius himself called species that weren't edible *noxii et perniciosi* (noxious and pernicious).

Clusius acquired his interest in fungi by kicking around puffballs as a kid.

Commercial Harvesting

The lucrative activity of collecting mushrooms for both local and global markets. Especially popular in China, where 300,000 or so tons of mushrooms are harvested annually. In North America, the epicenter for commercial harvesting is the Pacific Northwest, where the most commonly harvested species are the matsutake, burn-site morels, chanterelles, hedgehogs (*Hydnum* sp.), and various boletes. In a good year, a pound of dried morels or dried matsutakes will bring $100 or more on the European and Japanese markets. Collectors sometimes refer to commercially harvested species as a "crop."

It remains to be seen whether such harvesting, or rather overharvesting, will have a negative, possibly even dire, effect on future fungal fruitings. In other words, might it be more appropriate to call the harvested species a "kill" rather than a "crop"? After all, too much picking might lower the spore-producing capacity of mushrooms, which could cut down the gene flow within a particular population, which in turn might

mean even fewer mushrooms or none at all. Here's a possible analogy: a large crowd of bird-watchers with baskets filled to the brim with eggs.

See also Matsutake; Morels.

Common Names

Although often deprecated in the halls of academe because they're unscientific, common names like stinky squid, angel's wings, earth tongue, jelly baby, jack-o'-lantern, artist's conk, hedgehog, bird's nest, inky cap, pig's ears, swamp beacon, dead man's fingers, and witches butter provide reasonably accurate descriptions of what the fungi in question look like. Some common names, like shit on a stick, are sufficiently amusing that they tend to be more memorable than the Latin binomial of the same species (*Apiosporina morbosa*). They also remain in the emotional front of the mind more than most binomials. To quote mycologist Gary Lincoff with respect to a nonfungal species: "Do you say *Ursus arctos* when you see a charging bear?"

Common names can be useful in social outreach, since they can serve to attract someone who knows nothing about fungi and for whom a specimen would otherwise be hidden behind a seemingly impenetrable as well as ever-changing Latin wall. Once that person is attracted, he or she might, just might, become a serious mycologist.

This *Fungipedia* provides the reader with an egalitarian option: it usually refers to both the common name of a species and its Latin binomial, unless the species in question has yet to be given a common name, in which case only a binomial is used.

Cooke, Mordecai Cubitt (1825–1914)

An English botanist and mycologist sometimes referred to as a "Victorian hippie," Cooke documented his interests in psychoactive and/or narcotic substances in a drug classic called *The Seven Sisters of Sleep* (1860), a book that seems like an early attempt to legitimize if not legalize drugs. Since one of Cooke's "sisters" is the fly agaric (*Amanita muscaria*), his book may have inspired the scene in *Alice in Wonderland* where, at the suggestion of a hookah-smoking caterpillar, the heroine eats a mushroom that makes her grow alternately bigger and smaller. The book's title also inspired the name of a California musical group devoted to sludge/doom metal.

Cooke's books about fungi include *A Plain and Easy Accounting of British Fungi* (1862), *Rusts, Smuts, Mildews, and Moulds* (1877), *British Edible Fungi* (1891), and *Edible and Poisonous Mushrooms* (1894). A veritable polymath, he also wrote about worms, plants, wasps, reptiles, and marine life. Likewise, he edited a magazine with the amusing but somewhat oxymoronic title of *Science Gossip*.

Cooke didn't have any children with his wife, although he did father seven children with his wife's illegitimate daughter from a previous marriage.

See also Alice in Wonderland; Fly Agaric.

Coprophiles

Fungi referred to as coprophiles fruit on the dung of grazing animals and, especially, the dung of ruminants like sheep, cows, or deer. After all, that dung has undigested plant remains, a relatively high pH, and an immediate avalanche of oxygen, so what's not to like?

An animal's gastric juices tend to activate the spores of most coprophiles, whereupon a succession of species follows. Zygomycetes such as hat throwers (*Pilobolus* sp.) usually appear first, followed by ascomycetes, and then inky caps (*Coprinus* sp.) appear, after which other species don't—the inky cap (the name *Coprinus* means "living in dung") wants all the dung for itself, so its hyphae do a good job of warding off competitors. Combined with bacteria and insects, these coprophiles break down the dung and recycle its nutrients.

Coprophiles discharge their spores over long distances to prevent those spores from ending up in their substrate, which no self-respecting grazer would deign to eat. For instance, a *Pilobolus* can launch its capsule of ca. 90,000 spores as much as six feet. The vigor of this launching has inspired a contemporary dance troupe that propels itself with similar vigor to call itself Pilobolus.

The ascomycete *Sporormiella* has been found not only in the dung of contemporary animals but also in the fossilized excrement of woolly mammoths.

See also Buller's Drop; Inky Cap; Zygomycetes.

Corals

Not to be confused with the marine coral called the mushroom coral (*Heliofungia actiniformis*), although many coral fungi are shaped more or less like marine corals. In those shapes, they can be branched or unbranched; they can also be tough, rubbery, or gelatinous. Coral fungi are egalitarian in their choice of substrate and can be found on wood, in leaf litter, or on the ground.

Clavaria zollingeri
Magenta Coral

Corals are often relatively difficult to identify, a fact that's somewhat ameliorated by their diversity of colors—they can be yellow, purple, violet, red, pink, beige, tan, brown, grayish, or white. The base or trunk of a coral is sterile, but the rest of the fruiting body is covered with spore-bearing basidia. Coral look-alikes such as swamp beacons (*Mitrula* sp.) and earth tongues (*Trichoglossum*, *Geoglossum*, and *Microglossum* sp.) are ascomycetes, not basidiomycetes like corals themselves.

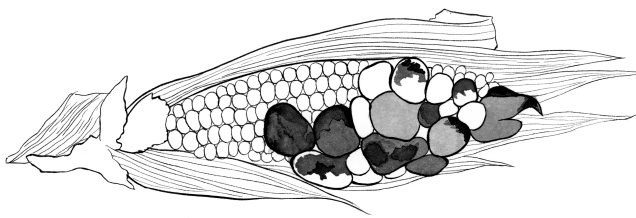
Many corals are edible, although they're valued more for their crunchy texture than for their flavor. But why would anyone want to eat, for example, *Clavaria zollingeri*, a species whose enchanting purple color seems contrived to take one's breath away?

Corn Smut (*Ustilago maydis*)
A basidiomycete that creates large, spore-filled galls on ears of corn. Each gall on an infected ear can produce upward of 25 billion spores.

Corn smut is a choice edible not only in Mexico, where it's called *huitlacoche*, but increasingly in other parts of North America and in Europe. The name *huitlacoche*, derived from the Aztec name for the fungus, is sometimes translated as "raven's excrement," since the galls tend to ooze a blackish, not necessarily appetizing fluid. (Note: actual raven excrement is usually whitish.)

Neither the phrase "raven's excrement" nor the word "smut" is particularly appetite whetting, so the species has been rebranded as "Mexican truffle" in English-speaking countries to make *Ustilago maydis* seem more palatable to potential diners.

Another smut, *U. esculenta*, grows in Asia, where it affects the buds and stems of wild rice. In China, this fungus is regarded not only as a gourmet edible, but also as a diuretic and a laxative. At the moment, *U. esculenta* is federally regulated in the United States on the assumption that it might affect American colonies of wild rice.



Ustilago maydis
Corn Smut

Cramp Balls (*Daldinia* sp.)

More or less round, reddish-brown or black pyrenomycetes so named because they reputedly relieve arthritic cramps if placed in the sufferer's pocket and occasionally rubbed. They were also thought to palliate menstrual cramps if a woman placed a specimen under her arm and kept it there. Keeping a hard, walnut-sized pyrenomycete under one's arm would at least provide a distraction from menstrual cramps.

Also called King Alfred's cakes because the monarch in question, known not for being a pastry chef but for fending off Vikings in Wallingford, England, left some cakes in the oven too long and they burned to a carbonaceous crisp, thus becoming the fungus in question.

Cramp balls are saprophytic on deciduous trees, especially ash, and thrive in dry weather, when their mycelia release chemicals to hamper the usually moribund mycelia of other fungi. Another reason they thrive in dry weather is that their tissue seems to have the ability to hold water reserves better than most other wood-inhabiting fungi. Unlike most other fungi, cramp balls discharge their spores at night.

If you cut open certain cramp ball species, you'll see a cross section that looks like (in the words of mycologist Jack Rogers) "a bull's eye shooting target."

See also Pyrenomycetes.

Crust Fungi

Also called corticioid fungi. The name refers to an assemblage of species from at least 10 different orders that don't seem to fit elsewhere, so they're bunched together as corticioid species.

Crusts usually grow on dead or dying wood and have fertile surfaces that can be smooth, convoluted, cuplike, warty, tubular, or toothlike. While most crusts are resupinate, *Stereum* species often have caps, and *Thelephora* species tend to be vaselike. At least one crust—*Cytidia salicina*—is gelatinous. Several crusts have merulioid surfaces, which means those surfaces are wrinkled in a sometimes bizarre manner. Most are saprophytes, but a few (such as *Byssocorticium* and *Tomentella* species) are ectomycorrhizal and use the host wood primarily as a perch for their fruiting bodies, while their mycelia go underground to connect with a prospective partner's roots.

Because most crusts are not particularly charismatic, colorful, or edible and also because many of them can't be identified in the field, they tend to be ignored in guidebooks devoted to North American fungi. Even so, a large percentage of them are ecologically valuable because of their talent for recycling dead wood.

See also Resupinate.

Cultivated Mushrooms

This phrase does not refer to highly educated mushrooms, but to ones grown on logs, coffee grounds, wood chips, mulched straw, recycled paper, or ammonium nitrate, and whose later substrate often tends to be soups, pastas, or pizzas. Mycorrhizal species such as chanterelles, morels, and the king bolete haven't been cultivated . . . yet.

Commonly cultivated species include shiitakes (*Lentinula edodes*), oyster mushrooms (*Pleurotus* sp.), enoki (*Flammulina velutipes*), reishi (*Ganoderma lucidum*), and button mushrooms (*Agaricus bisporus*),

the last of which have now been found growing wild in California. Portobellos are mature strains of button mushrooms that display rather than hide their blackish gills. Not so long ago, black was considered a not particularly appealing color to diners, and the mushrooms were cultivated so as to keep their gills permanently closed—hence the name "button."

Since over half of America's mushrooms are cultivated in Kennett Square, Pennsylvania, that borough refers to itself as the "Mushroom Capital of the World." A warning to less commercial cultivators: oyster mushrooms and shiitakes produce millions of spores, frequently in indoor or closed-off habitats, and allergic reactions are not unknown among those who cultivate them.

See also Maitake; Oyster Mushroom; Reishi; Shiitake.

Cyphelloid Fungi

A ragbag of species that might be described as ascomycete wannabes—they're actually basidiomycetes, but many of them are cup shaped and thus resemble

discomycetes. DNA sequencing has recently put cyphelloid fungi with gilled mushrooms.

Some cyphelloid species are tubular, some have very short stems, and many have hairy margins. Several are capable of drying up and reviving a number of times, like jellies. Except for *Merismodes anomala*, which grows on the previous year's pyrenomycetes, virtually all species tend to grow on rotting wood. Often hundreds of fruiting bodies huddle so closely together on that wood that they can be mistaken for a single resupinate polypore with very large pores. Look at those "pores" closely, however, and they'll turn out to be a huddle of cyphelloid species.

Genera include *Flagelloscypha*, *Stigmatolemma*, *Rectipilus*, *Merismodes*, and *Henningsomyces*. A white tubular species called *Henningsomyces candidus* is probably the most commonly encountered cyphelloid species in North America. It was named for Paul Hennings, a nineteenth-century German mycologist, not Paul Henning, the creator of the *Beverly Hillbillies*.

See also Discomycetes; Resupinate.

Cystidia

Sterile cells primarily in gilled or pored mushrooms, often situated between those mushrooms' basidia, cystidia have several important purposes:

— By acting as props or struts, they hold the gills or pores apart and thus prevent them from collapsing.
— By trapping air, they help provide favorable humidity for the developing spores.
— They give the spores more room when it comes time for them to drop.

— They assist the gills or pores in water retention by creating channels to enhance the movement of moisture.

There are numerous types of cystidia, including the following:

— gloeocystidia, which have a somewhat oily appearance
— cheilocystidia, which can be found on gill edges
— leptocystidia, which can be found on the faces of gills
— pleurocystidia, which are quite thin-walled

Cystidia come in a wide variety of shapes—they can be flask-like, filiform, turbinate, harpoon-like, thick walled, clavate, and horned. Knowing that a particular cystidium looks like, for example, a whaler's harpoon can help identify a specimen.

See also Basidiomycetes.

Darwin's Fungus (*Cyttaria darwinii*)

An ascomycete associated with Charles Darwin, who collected specimens in Tierra del Fuego during his *Beagle* voyage. He gave those specimens to the Reverend Miles Berkeley, who named the species after Darwin.

A weak parasite of southern beech (*Nothofagus* sp.), *Cyttaria darwinii* looks like a mass of orangish, dimpled golf balls. According to Darwin, the natives in Tierra del Fuego "appear to think these excrescences . . . an estimable dainty." He added that the Fuegians "eat no vegetable food besides this fungus," except for a few berries, and that they preferred old, wizened specimens rather than fresh ones. The taste was, he said, "mucilaginous."

De gustibus non est disputandum. Darwin had a tin of preserved meat, and the native Fuegians were repelled

both by that meat's clammy texture and by its container. Perhaps they wondered how this fellow could find this food an estimable dainty.

As it happens, the same *Cyttaria* species grows on the southern beech in Australia and New Zealand. This might seem like a considerable distance from South America unless you remember that the two regions were once connected by the supercontinent Gondwana, so—geologically speaking—the distance isn't very far at all.

See also Berkeley, Rev. Miles.

Dead Man's Fingers

A not inaccurate common name for *Xylaria* species that look like charred, somewhat arthritic fingers protruding from buried or nonburied wood (*xylos* is Greek for "wood"). Usually, *X. polymorpha* is known as dead man's fingers, while *X. longipes* is known as dead moll's fingers, at least in England. Each "finger" is spindle or club shaped, wrinkled or occasionally cracked, with a short cylindrical stem. *Xylaria* species are more common as well as more diverse in the tropics than in temperate regions.

The aforementioned fingers undergo what mycologist Michael Kuo has referred to as a "costume change." Although blackish when mature, they're covered with white powdery spores (conidia) during their asexual phase. Tanzanians believe that if you've committed a crime and you rub yourself with these whitish conidia, the police won't be able to see you even if you walk directly in front of them.

Recently, the wood of several ordinary violins was inoculated with *X. polymorpha* mycelia, and the sound

Xylaria polymorpha
DEAD MAN'S FINGERS

ended up being very close to that of Stradivarius violins. This would seem to suggest that the unaggressive wood decay engineered by these saprophytic fungi may have been responsible for the inimitable sound of the original instruments.

See also Pyrenomycetes.

Death Cap (*Amanita phalloides*)

A large, usually greenish-yellow mushroom with a ring, a bulb at the base, and a sickly sweet odor, the death cap could be called Public Enemy #1 of Kingdom Fungi, since it's responsible for perhaps 90 percent of all fungal fatalities. A single medium-sized specimen could kill not one, but two, three, or even four diners.

Several individuals on their deathbeds have reputedly said, "But it tasted so good . . ."

Initial symptoms from eating a death cap include nausea, diarrhea, and vomiting. Not a big deal, you might say, but the fruiting bodies contain amatoxins and phallotoxins (toxic cyclic peptides) that inhibit the enzymes responsible for the production of genes—specifically, genes in the liver and kidneys, which are next in line after relatively minor stomach problems. Serious cases require liver or kidney transplants, while less serious ones require blood transfusions or kidney dialysis. Amatoxins are thermostatic, so they're not destroyed if the mushroom they inhabit is cooked, baked, broiled, or put in an oven.

The death cap is not native to North America but probably arrived in the early twentieth century with trees imported from Europe. Many of its victims have been recent Asian immigrants, who mistake it for either the white caesar (*Amanita princeps*) or the edible paddy straw mushroom (*Volvariella volvacea*).

See also Amatoxins; Poisonings.

Desert Truffles

Sometimes called poor man's truffles, desert truffles are round or turbinate ascomycetes in the Tuberaceae family that are among the few food resources in the desert regions of Africa and the Middle East, where they are roasted in ashes or dried for later use. They taste somewhat sweet, probably because of their relatively high carbohydrate content—up to 21 percent.

Like other truffles, desert truffles are mycorrhizal, albeit with shrubs and herbaceous plants rather than

trees. One such shrub is the flowering desert plant known as the rock-rose (*Helianthemum* sp.), which grows with the truffle *Tirmania nivea*.

Two tidbits of ethnomycological lore: It's been suggested that desert truffles were the biblical manna, the main food that helped the Israelites survive 40 years in the wilderness. Certain inhabitants of the Kalahari Desert believe them to be the eggs of an avian called the lightning bird.

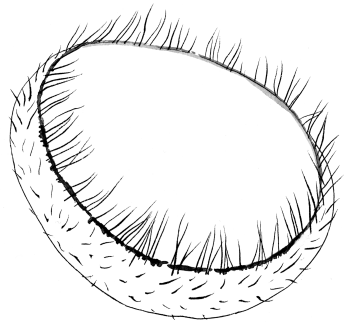
Genera include *Terfezia*, *Tirmania*, and *Choiromyces*.

See also Ethnomycology; Xerotolerant Fungi.

Discomycetes

A taxonomic class of ascomycetes whose members are commonly called cup fungi, although quite a few aren't at all cuplike. Some can look like ears (*Wynnea* sp.), orange peels (*Aleuria* sp.), golf balls (*Cyttaria* sp.), saddles (*Gyromitra infula*), and brains (*Gyromitra* sp.), among other morphologies. Morels and most truffles are discomycetes. Cuplike discos (as they are sometimes abbreviated) include the brown cup (*Peziza varia*), the violet cup (*Peziza violacea*), the eyelash cup (*Scutellinia scutellata*), gray cups (*Mollisia* sp.), orange peels (*Aleuria* sp.), and the lemon drop (*Bisporella citrina*).

Discomycete fruiting bodies are called apothecia, a word derived from the Greek *apotheke*, which means "storehouse." After all, each fruiting body is a storehouse of spores. Operculate species have a small lid or operculum at the top or side of their spore-bearing asci, while inoperculate species have a pore or irregular tear in lieu of a lid and rely on insects, raindrops, or small mammals to break open their asci.



Scutellinia scutellata
Eyelash Cup

If you blow or tap on an apothecium, you can sometimes see a synchronized discharge of spores that's like a miniature version of the cloud-like discharge of spores from a puffball.

See also Ascomycetes; Morels.

Djon Djon

The Haitian name for dark-colored *Psathyrella* species that grow in bunches at the base of a tree. This name is probably a corruption of the French word for mushroom, *champignon*.

Collected mostly in and around the Artibonite River Valley, djon djons are the most valued mushrooms in Haiti; they tend to be served at baptisms, weddings, communions, and other important occasions. They are usually not eaten alone but served with rice. The stems must be removed, or they will stick annoyingly between one's teeth. In fact, most Haitians don't eat

the mushroom, only the rice after it's been doused with water in which the mushroom has been boiled. For those in North America or even Haiti who have no access to the mushrooms themselves, the seasoning company Maggi has created djon djon–flavored cubes.

DNA studies indicate that two or more species of *Psathyrella* can be found in bags of djon djons in Haitian markets. In North America, most mycophages probably frown on the eating of *Psathyrella* species, but West African tribes like the Bantu and the Bagyeli pygmies of Cameroon commonly eat them, so it's possible that the appreciation of *Psathyrella* species arrived in Haiti with the slave trade.

Dry Rot (*Serpula* sp.)

Serpula means "serpent," a name derived from the sinuous surface as well as the insidious nature of a *Serpula* species once it arrives in one's home.

As the Gunga Din of fungi, *Serpula* species with their specialized hyphae can carry water 15 feet or more, even through plastic and masonry. Often that water can be seen dripping from the fungus or its fused hyphae (mycological name: rhizomorphs), which explains why the common indoor *Serpula* species is called *S. lacrymans*—the name means "weeping." *Serpula* species flourished in London during World War II when water from fire extinguishers made buildings already weakened by German bombs an excellent substrate for them.

As for the phrase "dry rot," it refers to the tendency of *Serpula* species to reduce wood (primary target: cellulose) to a dry powder. Having seen several ships damaged by dry rot, Samuel Pepys wrote in 1683 that those ships

had "perish'd to powder." Recent DNA studies place *Serpula* in the Boletaceae family, so it's not altogether inaccurate to say that a bolete is eating your house.

Another species, *S. himantioides*, is usually found on dead or dying wood in the wild, but not on the wood in houses . . . yet. Perhaps *S. lacrymans* itself originally grew in the wild but evolved to dine on domesticated wood, which, after all, is dead wood, and thus an easy substrate for a fungus to dine on.

Dutch Elm Disease (*Ophiostoma* sp.)
Often referred to simply as DED. A parasitic, elm-infecting ascomycete whose common name refers to the Dutch researchers who first identified it rather than to the country of its origin.

The carrier of Dutch elm disease was an elm bark beetle brought from Asia into North America and Europe, probably with infected logs used as ballast for shipments of furniture. While Asian elms hadn't been affected by the fungus, elms from other localities—especially old or weakened ones—were not so lucky. The fungus forced their xylem to plug up its cells, and thus the trees couldn't conduct water to their leaves. Thanks to the highly efficient spore vectoring of the elm bark beetles, almost all larger specimens of what had been called "America's favorite tree" were dead within 30 years of the fungus's arrival.

DED is currently being combated by fungicides as well as by the breeding of disease-resistant elms. But our planet's incessant warming might encourage the spread of the elm bark beetle that vectors the spores of the fungus. This has already happened with the scale

insect that vectors the beech bark disease fungus (*Neonectria* sp.), and beech trees are suffering considerably in the eastern United States and Europe.

See also Chestnut Blight.

Dyes

Fungal dyes have long been used by different cultures around the world. It's been suggested that Native people in western North America once obtained a reddish dye from the polypore known as Indian paint fungus (*Echinodontium tinctorium*) and stained their faces with it, which is why they were once called "red men." This is doubtless a fallacious example of ethnomycology, although Native people did use the same fungus to obtain red paint pigments.

The use of fungal dyes has recently become a popular craft, with either wool or silk as the dyeing medium. Mordants (fixatives) that aid the dyeing process include alum, ferrous sulfate, and tin chloride. Two mushroom species, *Cortinarius semisanguineus* and the tender nesting polypore (*Hapalopilus rutilans*), are currently favored, since they give ordinary-looking wool a brilliant red or purplish color. Other fungi popularly used for dyeing include the dyer's polypore (*Phaeolus schweinitzii*), the velvet-footed pax (*Tapinella atrotomentosa*), and the dyemaker's false puffball (*Pisolithus* sp.), the last of which colors wool a rich golden brown.

Virtually any fungal entity can be used for dyeing. Those who don't eat oyster mushrooms (*Pleurotus* sp.) can get a greenish-gray dye from them, and those who don't eat the king bolete (*Boletus edulis*) can get a reddish-yellow dye from it.

Earth Tongues

Not to be confused with the improvisational music group also called Earth Tongues, these earth tongues are stalked and flattened ascomycetes. They can be black, orange, or yellow and are identifiable to species usually by viewing their spores under a microscope. Those spores can be as long as 150 microns (1 micron = 1 millionth of a meter). For comparison, the period at the end of this sentence is around 500 microns wide.

Favorite earth tongue habitats tend to be mosses (especially sphagnum moss), wet grass, soil, duff, decaying conifer needles, and the mossy turf at the edges of meadows. In Europe, several earth tongue species are regarded as indicators of ancient meadows and grasslands.

Trichoglossum hirsutum
Black Earth tongue

Earth tongue genera include *Geoglossum*, *Microglossum*, *Spathularia*, *Neolecta*, and *Trichoglossum*, the last of which seems to be covered with hairs, but they're not really hairs—they're sterile cells called setae. Upon encountering one of these species rising from the ground, you might think the earth is sticking out its tongue at those who've abused it.

Ectomycorrhizal Fungi

A marriage between a mycelium and the roots of a tree or other plant that results in a fruiting body rising above the ground. A large percentage of medium-sized or large fleshy mushrooms are engaged in this marriage.

The mycelium of an ectomycorrhizal fungus (called EM, for short) and its potential host greet each other with chemical signals, and if the response to these signals is mutually agreeable, the mycelium fashions a sheath of hyphae around the host's roots. Called a Hartig net and named after the nineteenth-century German botanist who first documented it, this sheath helps the roots absorb inorganic nitrogen, phosphorus, potassium, zinc, and water from the soil. In return, the host passes on upward of 20 percent of the sugars created during photosynthesis to the mycelium, which quickly turns those sugars into trehalose and glycogen. Numerous fungal species can be connected to a single host's roots, so the marriage is one where polygamy is tolerated.

Trees associated with EM fungi take up copious amounts of carbon dioxide from the soil and pass it along to their partners. Unfortunately, air pollution and toxic waste have a negative effect on almost all soils and thus a negative effect on the relationship,

so EM fungi—the majority of mushroom-shaped mushrooms—may be on the decline.

See also Endomycorrhizal Fungi.

Endomycorrhizal Fungi

Also called arbuscular mycorrhizae (AM, for short). Although there are only 250 or so AM species, they give nutrients to 300,000 species of land plants. Most inhabit their own phylum, called Glomeromycota.

AM form branches called arbuscules that thrust their way, with the host's approval, into its roots and then provide that host with moisture and nutrients, especially phosphorus, not to mention shield it from (among other toxins) heavy metals. Almost all vascular plants as well as most cereals, vegetables, and fruit trees engage in this sort of relationship. Thus it's not surprising that bags of AM mycelia are frequently sold at garden shops.

Unlike ectomycorrhizal fungi, only a few AM have fruiting bodies, although some might seem to make up for this by producing unusually large spores. Such spores have been found in Silurian fossils from 450 million years ago, which might mean that AM or their ancestors are the oldest fungi on earth. Those fungi seem to have formed relationships with the bryophyte-like precursors of vascular plants. In fact, they may have even formed relationships with photosynthesizing aquatic plants almost a billion years ago.

Although EM may be on the decline, rising temperatures resulting from elevated levels of atmospheric CO_2 seem to be increasing the number of AM globally.

See also Ectomycorrhizal Fungi.

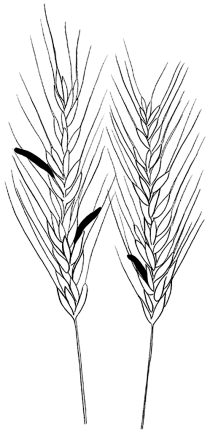
Endophytes
Mostly small fungi that colonize a plant's roots, leaves, bark, and xylem but don't damage the plant. As a result, endophytes receive no resistance from their host because they perform some of the same services as mycorrhizal species—they not only help the plant resist disease, bacteria, and environmental stress but also produce secondary metabolites that keep bark-boring and leaf-feeding insects at bay. Upon the death of their host, they usually have first dibs on that host's nutrients.

Most endophytes are ascomycetes, such as the various *Epichloë* species that live as rent-free tenants on various types of grass, or the *Trichoderma* species that gently colonize plant roots and protect those roots by parasitizing other not-so-nice fungi.

Most, but not all. A few basidiomycetes can alter their behavior and become endophytes. An example is the tinder polypore (*Fomes fomentarius*), which sometimes engages in protective behavior with European beech trees because, being a saprophyte at heart, it knows it'll eventually be able to dine on its host.

Endophytes can also be organisms other than fungi, indeed antifungal organisms. For example, there's a tiny mycophagous mite that lives in the hairs on a tree's leaf and protects the leaf by eating mildews when they start growing on it.

Ergot
The blackish, banana-shaped sclerotium of the ascomycete *Claviceps purpurea*. The fungus has transformed the female sex organ (i.e., the ovary) of its host, usually rye, barley, or some other type of grass, into this sclerotium.



Very nasty, you might say, but the nastiness does not end there. When introduced into human food, ergot's alkaloids—designed to protect it from predators—can cause all sorts of harm. They can contract blood vessels, so the diner feels as if his or her limbs are twitching convulsively, a malady once referred to as St. Anthony's fire. They can also result in a gangrene-like condition that can lead to the loss of legs and arms. Death is often imminent. Indeed, approximately 40,000 people died of ergotism (as it's called) in southern France in 944 CE, while 10,000 people died from it in Russia as recently as 1926. The eating of ergot on rye may or may not have caused the 1692 Salem witchcraft frenzy.

On the positive side, extracts from ergot have been used to ease migraines as well as the pain of childbirth. Also, lysergic acid diethylamide, otherwise known as LSD, is an ergot derivative accidentally discovered in 1943 by Swiss chemist Albert Hofmann when he was investigating the pharmaceutical properties of ergot.

See also Sclerotium.

Ethnomycology

A marriage of ethnography and mycology dedicated to investigating the customs, beliefs, folklore, medicines, and culinary use of fungi by different cultures. The current medicinal mushroom obsession indicates

that ethnomycology is alive and well in the twenty-first century. So does the not uncommon belief by some that fungi arrived on our planet from outer space.

Here are a few more traditional examples of ethnomycology: the Makah in the Pacific Northwest once used powder from the tinder polypore (*Fomes fomentarius*) as a deodorant; Germans once thought that stinkhorns grew where a stag had rutted; certain pygmies in the Congo believe the earth originated from an enormous extraterrestrial mushroom; the Yupik in Alaska refer to mushrooms as "devil's ears" and stomp them, lest the devil hear their words; the Mapuche in Chile have songs that summon mushrooms to fruit; Australian aborigines suck on a bright orange polypore to cure a sore mouth; and Inuit in western Canada once sprinkled puffball spores on a newborn infant to give it the ability to become invisible whenever it liked later in life.

The word "ethnomycology" was coined by Gordon Wasson as an alternative to ethnobotany. He is sometimes referred to as its father.

See also Agarikon; Amadou; Chaga; Fairy Rings; Fly Agaric; *Iqmik*; Puck; Sabina, Maria; *Teonanacatl*; Wasson, Gordon.

Fairy Rings

Once thought to have been created by the nocturnal frolicking of fairies, lightning strikes, love-crazed hedgehogs, dances of witches on Walpurgis Night, and—recently—UFO landings, fairy rings are actually caused by an outward-growing mycelium of a fungus that depletes the soil of its nutrients, thus creating what's called a necrotic zone in the center. When

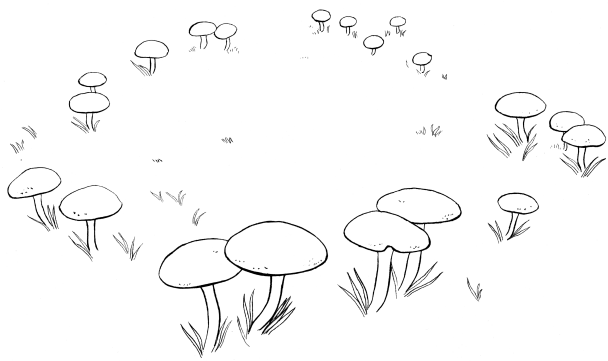
the mycelium has acquired enough nutrients, it creates a ring of mushrooms. Depending on the conditions, a fairy ring can grow a few inches or a few feet each year.

Fairy rings can be quite venerable. Purple-spored puffballs (*Calvatia cyathiformis*) can form fairy rings that survive for 400 years or more. One particularly large fairy ring near Stonehenge in southern England is estimated to be at least 1,000 years old.

The best known of the 60 or so fairy ring species is the appropriately named fairy ring mushroom (*Marasmius oreades*), which aids and abets the necrotic process by releasing prussic acid, a slayer of grasses. Fairies themselves were doubtless never capable of such obnoxious behavior.

Other fungi that create a ringlike shape are the species responsible for the skin infection known as ringworm, a condition that has no connection with the frolicking of fairies.

See also Puck.



Fairy ring

Fiction

Mushrooms figure prominently in fiction not only because they can be used to kill another person, but also because they sometimes look like works of fiction themselves. In addition to *Alice in Wonderland*, here are a few examples:

— "The Purple Pileus," a short story by H. G. Wells in which a timid shopkeeper with an odious wife uses a hallucinogenic mushroom to improve his life

— *Babar the Elephant*, a children's book by Jean de Brunhoff in which the King of Elephants dies from eating a poisonous mushroom

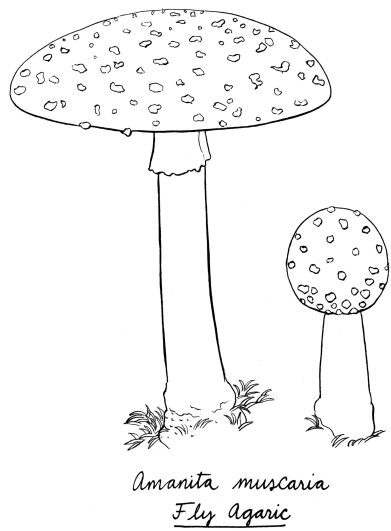
— *Anna Karenina*, a novel by Count Leo Tolstoy in which children go from being unruly to joyous at the prospect of hunting mushrooms, and a man eager to propose to a woman ends up identifying mushrooms with her instead

— *Journey to the Center of the Earth*, a novel by Jules Verne that includes a journey through a forest of giant subterranean mushrooms

— "The Voice in the Night," a horror story by English writer William Hope Hodgson that features a man shipwrecked on an island of malevolent fungi

— *Stowaway to the Mushroom Planet*, a children's book by Eleanor Cameron in which two boys take a spaceship to a planet called Basidium

— *The Documents in the Case*, a mystery novel by Dorothy Sayers where mushrooms are employed as a murder weapon—a good example of what happens when a fiction writer seems to know nothing about mycology



Fly Agaric (*Amanita muscaria*)
A relatively large mushroom whose red cap displays whitish veil remnants known as warts and whose stalk has a skirt-like ring. The common name derives from the belief that if you break up several fly agarics and put them in a saucer filled with milk, they will kill or at least stupefy flies.

Doubtless the world's most iconic mushroom, the fly agaric appears on Christmas cards and stoner websites, in the 1940 Walt Disney film *Fantasia*, and in Soviet propaganda ("We're going to kill you," an army of fly agarics tells the bourgeoisie in a cartoon). It also causes a small Mario to become a Super Mario in the popular Nintendo video game.

Native people in Siberia once used fly agarics to get in touch with their ancestors, an activity that required them to become airborne. The mushroom's alkaloids, ibotenic acid and muscimol, produce elevated levels of serotonin, which can result in either a euphoric state or somnolence as well as give the illusion of flying. Concentrations of alkaloids differ with different specimens, so while one person might feel as if he or she were flying, another might feel earthbound.

Contrary to both popular opinion and English detective novels, the fly agaric has never been implicated in the death of a single person.

See also Alice in Wonderland; Berserker Mushroom; Cooke, Mordecai Cubitt; Ethnomycology; Pegtymel; Santa Claus; Wasson, Gordon.

Fly Killers

Not to be confused with the fly agaric, fly killers are parasites that can be just as effective as fly swatters in disposing of flies.

Consider the zygomycete *Entomophthora muscae*. Its airborne spores have a mucilaginous coating that sticks to flies. Having done so, the spores create germ tubes that burrow through the fly's cuticle via enzymatic action. Soon a mycelium is blocking the fly's spiracles or breathing tubes. More often than not, the mycelium causes the fly, which is usually a male, to stagger around like a drunkard and then attach itself to a substrate with its proboscis, open its wings, and—just before dying—distend its abdomen. In other words, the fly assumes the posture of a sexually receptive female, which inspires other male flies to come and mate with it. Those

flies soon become hosts themselves. Very cunning, as Sherlock Holmes would say.

You'll often see a fly killed by *E. muscae* stuck to a windowpane, with a white halo around it. This halo does not have a religious connotation. Rather, it consists of asexual spores ejected from the specialized spore-bearing branches on the fungus.

Another species, *E. coronata*, performs a similar disservice to mosquitos.

See also Caterpillar Fungus; Zombie Ants; Zygomycetes.

Fries, Elias Magnus (1794–1878)

Swedish mycologist sometimes referred to as the "Father of Mushroom Taxonomy," whose three-volume *Systema mycologicum* was the first comprehensive catalog of fungi ever put together.

By the end of his life, Fries had described more than 3,000 species. He thought that the characteristics of fungi could be ascertained almost exclusively from empirical observation, so his descriptions were based on size, shape, and spore color. This classification method is still called Friesian taxonomy.

Most of the time, Fries preferred to use a dissecting microscope rather than a compound one, for he had virtually no interest in microfungi, which he called "inferior," as opposed to macrofungi, which he called "noble." He also had no interest in or at least didn't bother to document the odors of fungi, probably because his devotion to snuff had blocked his nasal passages and thus made him totally unaware of those odors.

See also Smell.

Gastrointestinal Tract

The location of most mushroom poisonings. The symptoms include nausea, abdominal cramps, vomiting, and diarrhea. The cause is often dining on specimens of dubious edibility or an allergy similar to a shellfish allergy.

Another cause is the internet, where erroneous identifications abound. A person with little or no knowledge of mushrooms snaps a picture with his or her cellphone camera and posts it with a binomial, perhaps any binomial. Someone finds a mushroom similar to that image and happily eats it. The result? A possible trip to the lavatory or even the emergency room.

Perfectly edible mushrooms are another common cause, especially if they're rotten or putrefied. Those mushrooms would never be bought in a supermarket, but their presence in nature somehow makes them highly edible. Also, edible mushrooms collected in an area sprayed with fungicide or insecticide or those located near a road where cars are pumping vast amounts of carbon dioxide into the atmosphere can cause a not particularly pleasant reaction in one's gastrointestinal tract.

The few fatalities from gastrointestinal poisonings occur in the very old, the very young, and the very immunocompromised.

See also Poisonings.

Gills

Also called lamellae. Radially arranged structures on the underside of a mushroom's cap, which, in the words of mycologist Elizabeth Moore-Landecker, "resemble

the pages of a half-opened book." Mushrooms with gills are sometimes referred to as agarics.

Gills are the most important structure of any mushroom that possesses them, since they're responsible for discharging that mushroom's spores. They're highly gravitropic, so if you turn a gilled mushroom slightly upside down, its gills will make every attempt to become vertical again, the better to drop their spores.

Specific words that describe the relationship of gills to a mushroom's stem include free, annexed (barely attached to the stem), adnate (broadly attached to the stem), subdecurrent (venturing a short distance down the stem), and decurrent (venturing a longer distance down the stem).

Just like us, gills tend to change color as they age. For example, the gills of a wine cap (*Stropharia rugosoannulata*) start out whitish or cream colored, then turn a gray-lilac color, and finally become blackish. Gills do not always indicate the color of spores, however. That's why it's a good idea to get a spore print from a specimen you're trying to identify.

See also Basidiomycetes; Buller's Drop; Spore Print.

Green Stain

Also called blue stain or blue-green stain. Sometimes confused with a fading trail blaze or *Leptographium abietinum*, a fungus that causes a gray-green or blue stain on the sapwood of spruce, this particular stain is actually a quinone pigment known as xylindein created by the mycelium of a *Chlorociboria* species of ascomycete.

The stain can be found on rotting deciduous wood, especially oak. It's a good example of the often

overlooked fact that wood-inhabiting fungi can be territorial beasts, for the stain says, in effect, "This wood is mine, and I want to dine on it, so stay away" to other mycelia.

If you roll over a log with green stain covering it in the autumn, there's a good chance you'll find a batch of the attractive, greenish cup fungi that have also been created by the mycelium.

The damage caused by green stain to the wood is primarily esthetic. That damage was turned into a virtue in eighteenth- and nineteenth-century England, where the stained wood was used with Tunbridge ware—decorative wooden objects and furniture inlaid with strips of green veneer originally from the fungus.

See also Spalting.

Hair Ice

Hair ice is quite an unusual phenomenon observed early in the morning on winter days either in cold places or in temperate places during cold spells. It was first documented by German geophysicist Alfred Wegener, the person who originated the notion of continental drift.

As it happens, there's a drift aspect to hair ice, albeit one that pertains to wood rather than continents. Despite freezing or even subfreezing temperatures, the mycelia of certain fungi continue to decompose the wood of their choice, and this causes moisture to drift outward via the wood's medullary rays—that is, the lines radiating from the center to the surface. Upon reaching the surface, this moisture becomes a frozen mane of ice known as hair ice. You have to be in the right place at

the right time to see this mane, since it will soon melt unless the outdoor temperature is extremely cold.

The fungi responsible for the creation of hair ice tend to be crusts such as *Peniophora* and, especially, *Exidiopsis* species.

Hairs

Fungal hairs are not actually hairs, but hyphae on the surface of fruiting bodies. They may be helping that fruiting body absorb water. Or perhaps they're serving as an obstacle to insects eager to eat portions of the fruiting body, an activity that could interfere with spore production.

Different hairs have different names based on their texture, quantity, and esthetic look. Some of these include the following:

— arachnoid (having cobwebby hairs)
— fibrillose (covered with fibrous, threadlike hairs)
— hirsute (covered with long, coarse hairs)
— hispid (covered with stiff, erect hairs)
— pubescent (having short, fine hairs)
— sericeous (covered with short, glossy hairs)
— strigose (possessing coarse, thick, stiff hairs)
— tomentose (having a dense covering of matted, soft hairs)
— velutinate (having short hairs that suggest a velvety surface)
— villose (covered with long, soft hairs)
— virgate (having light hairs that often form streaks)

You can often identify a specimen by determining that its hairs are, for example, strigose rather than fibrillose. Hairless specimens are called glabrous.

Hálek, Václav (1937–2014)
A Czech composer who wrote approximately 1,500 works inspired by fungi. His epiphany came one day when he was walking in the woods and happened to hear the discomycete *Tarzetta cupularis* engaged in singing. Soon he found himself listening closely whenever he walked in the woods because, as he said, "I believe that each mushroom has its own special melody." Most of his fungal-based compositions are for piano, but he also wrote a *Mycosymphony* in which not only a forest of mushrooms is singing, but Béla Bartók seems to be singing, too.

Might Halek's compositions be an example of synesthesia? Perhaps an example of Czech humor? Possibly a form of sophisticated madness? Halek was also a mycologist who coauthored several scientific papers, so maybe he was simply merging his two passions in a somewhat unconventional way.

See also Music.

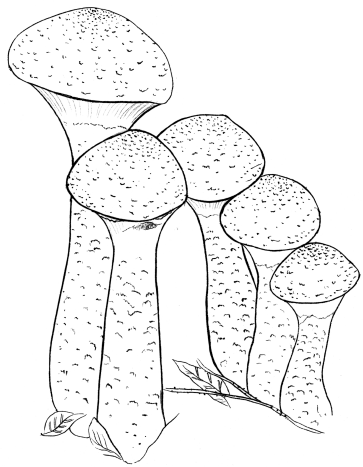
Honey Mushroom (*Armillaria* sp.)
A light brown or cream-colored mushroom usually with a slightly scaly cap and a ring on its stem. Although honey mushrooms are a species complex, virtually all honey species grow in large clusters at the base or near the base of a deciduous tree or, on occasion, a conifer.

Don't think that because they're called honeys, they're all sweetness and light. The name refers to their color, not their disposition, for they're serious parasites that engage in what's known as shoestring or bootlace rot. Their rhizomorphs (string-like cords of hyphae) travel through the soil until they come in

contact with the roots of a potential host, whereupon they proceed to cut off the flow of nutrients to that host's trunk and then move up the trunk, digesting lignin as they go. You can often see this digestive process before you see the mushrooms themselves—look for curled-up bark at the base of a tree, and investigate whether the tree's leaves are falling off much earlier than they would otherwise.

The honey mushroom's rhizomorphs are adapted to spread from one host to another. Covered with a protective laminate, they're capable of surviving for 100 years or more.

See also Bioluminescence; Humongous Fungus; Parasites.



Armillaria Mellea
Honey Mushroom

Horsetails (*Equisetum* sp.)

Equisetum arvense
Horsetail strobilus

Among the most ancient of all vascular plants, horsetails reproduce via spores rather than seeds. At the top of the stem is a cone-like spore-producing structure called a strobilus. This structure looks not unlike a mushroom and, indeed, is sometimes mistaken for one.

In perpetually moist places, horsetails tend to manage just fine by themselves, but in very dry or very cold places, or when conditions suddenly become dry or cold, their roots send out a message to mycorrhizal fungi, especially endomycorrhizal ones, asking for assistance. Whereupon one or more mycelia usually come to their aid. This is known as a facultative mycorrhizal relationship.

Horsetails are capable of dictating their fungal partners only when they're alive. After a horsetail dies, it can become a host for several ascomycete species. One such species is *Psilachnum inquilinum*, which grows on the previous year's rotting horsetail stems, and another is an indweller called *Loramyces macrospora*, which grows on dead horsetails submerged in water.

See also Endomycorrhizal Fungi; Indwellers.

Humongous Fungus

An informal phrase first used to describe a species of honey mushroom, *Armillaria gallica*, whose mycelium occupied 30 acres in Michigan and ended up on David

Letterman's Top Ten List, doubtless the first ever mycelium to be included in a television comedy show. Then the phrase was used to describe another species of honey mushroom, *A. ostoyae*, whose mycelium stretched for two and a half square miles in Washington. Currently, the phrase refers to the mycelium of another *A. ostoyae* in Malheur National Forest in eastern Oregon. This mycelium is considered the world's largest organism . . . for the moment. It covers 2,384 acres, weighs around 25,000 pounds, and is estimated to be at least 2,400 years old.

Opinions differ about the so-called humongousness of such fungi, however. Many naysayers compare them with trembling aspen trees (*Populus tremuloides*), which clone their roots. In Utah, some of the roots in a particular trembling aspen grove may be as much as 80,000 years old, but most of the roots are not nearly that old.

Sometimes the fruiting body of a noble polypore or even an artist's conk is called a humongous fungus.

See also Artist's Conk; Honey Mushroom; Noble Polypore.

Hygrophanous

A word that refers to the color change in a mushroom, especially its cap, from aging, loss of water, or even absorption of water. A species that has a brown cap one day might have a reddish cap the following day, and a cream-colored cap a day or so after that. Usually, color changes begin in the center of the cap and move outward. Certain *Psathyrella* species can undergo extreme color changes—their caps can be very dark brown early in the morning and cream colored or almost white by the evening, especially if they're exposed to the sun.

Sometimes a mushroom's stem will undergo a color change, but sometimes not.

If you know that an *Agrocybe*, a *Galerina*, a *Psilocybe*, a *Panaeolus*, a *Pholiota*, or a *Psathryella* specimen you've collected is hygrophanous, you will have a proverbial leg up on your attempt to identify that specimen.

Hyphae

Microscopic filaments of a mycelium. The flesh of each and every mushroom consists of a huge mass of hyphae, so if you're eating a chanterelle, a king bolete, or even a maitake, you're actually eating hyphae (pronounced *high-fee*).

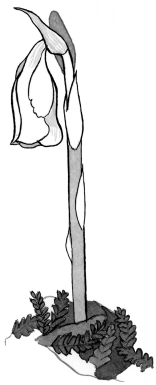
Usually divided into cells by cross-walls called septa, hyphae grow only at their tips, and as they do, they explore a variety of microhabitats, secreting various enzymes in order to digest their preferred nutrients. You can think of these enzymes as being like gastric juices, only external. All hyphae digest sugars and amino acids, but some can digest more complex substances such as starch, lignin, and cellulose. A few, such as Onygenales, can digest keratin.

In times of stress or when they wish to leave an already depleted substrate and investigate a new one, hyphae sometimes bundle themselves together in a visible structure called a rhizomorph or a cord. Compared to the width of an individual hypha, such structures can be enormous—as wide as five millimeters. Perhaps the most frequently encountered rhizomorphs are the so-called bootlaces belonging to the honey mushroom (*Armillaria* sp.).

See also Honey Mushroom; Mycelium.

Indian Pipe (*Monotropa uniflora*)
Also called corpse plant, ghost pipe, Dutchman's pipe, ice plant, or ghost flower. Distributed worldwide, the Indian pipe is an all-white flowering plant whose roots curry a mycelium's favor with the promise of a partnership and then proceed to form a hookup with that mycelium. Its prime target is the mycelium of a *Russula* species (usually *R. brevipes*) or a milk cap (*Lactarius* sp.), from which it steals sugars that would otherwise be used to create one or more mushrooms. Lacking chlorophyll, it probably offers nothing in return to the unprotesting mycelium, so you could say that it's getting a free lunch.

A related species called pine sap (*Monotropa hypopitys*) forms a similar hookup with the mycelia of *Tricholoma* mushrooms. Pine sap is reddish rather than white, and its bracts (i.e., pipelike appendages) tend to look considerably more frayed than Indian pipe's.



Monotropa uniflora
Indian Pipe

Another species, called candy stick (*Allotropa virgata*), feeds exclusively on matsutakes. Like Indian pipes and pine sap, it's sometimes referred to as a mycoheterotroph. Formally, you could say that all these species are engaged in a monotropoid mycorrhizal relationship. Informally, you could say that they're involved in an unprincipled ménage à trois with a fungus and its host.

See also Matsutake; *Russula*.

Indwellers

All fungi, even those that live in extremely dry places, need at least some water, but so-called indwellers need it all the time. A large percentage are ascomycetes that inhabit dead or dying organic matter in freshwater streams, swales, or boggy areas. Such species fruit mostly in the spring.

Probably the most charismatic indweller is the orange, more or less club-shaped swamp beacon (*Mitrula* sp.), which feeds on the stems and roots of water plants as well as rotting leaves; several species can be mildly bioluminescent, as their name suggests. Swamp beacon spores are wind dispersed, unlike the spores of *Vibrissea* species, an indweller whose spores are water dispersed. *Vibrissea* spores themselves are so long and skinny that they look like miniature snakes under the microscope.

A few basidiomycetes have chosen running water as their habitat as well. *Bulbilomyces farinosa*, the tiny, ball-shaped anamorph of the crust *Aegerita candidus*, grows on logs near the rising water of a stream. Along comes the water and off those tiny balls go, capturing an air bubble to stay afloat. Since it lives part of the time out of water, *B. farinosa* is not strictly an indweller.

A completely aquatic indweller is the recently discovered *Psathyrella aquatica*, which lives underwater in the Rogue River in Oregon. For a gilled mushroom, this is a totally new and, indeed, mind-boggling habitat.

Inky Cap (*Coprinus, Coprinellus, Coprinopsis* sp.)

A black-spored mushroom with a grayish or whitish, often scaly cap. Most inky caps drop their spores by self-digestion, otherwise known as autolysis. When the

spores are ready to be released, hydrolytic enzymes transform the cap rim into an inky black goo. At the same time, these gooey rims curl backwards and force the closely-spaced gills beneath them to spread apart, thus causing the spores to be released. The greater the self-digestion, the better the spore release. In the end, there's nothing left of the mushroom itself except a stem with bits of blackish goo perched on top of it.

It's possible that an inky cap's gills were once so close together that specimens found it difficult to drop their spores. "Not to worry," evolution informed them, "I'll turn those gills into an inky mess, and that will solve the problem."

Commonly encountered inky caps are the shaggy mane (*Coprinus comatus*), the mica cap (*Coprinellus micaceus*), and the tippler's bane (*Coprinopsis atramentaria*). The last of these contains an amino acid called coprine that interferes with the body's metabolism of alcohol. If a person eats it within 24 hours of drinking alcohol, he or she will end up with the equivalent of alcohol poisoning. Hence the name tippler's bane. Dogs often eat this species, but since they don't tend to accompany it with a merlot or a single malt scotch, they don't have a problem.

Insect Mushroom Farmers

In the tropics and subtropics, leaf-cutter ants (genera *Atta* and *Acromyrmex*) are frequently seen traveling about with leaves affixed to their mandibles. Those leaves aren't their food, however. Rather, the ants are planning to swab the leaves with their saliva and tidbits of their fecal matter and then add a piece of mycelium from an already existing fungus garden to this mix. Soon new mycelial filaments will start growing. These filaments often belong to fungi in the family Lepiotaceae, and the ants culture them so they will never produce a fruiting body. Why? Because the ants are exclusively mycelium eaters.

Tropical termites in the genus *Macrotermes* engage in a similar activity. They feed the mycelia to their young, but once those young reach a certain age, they're deprived of this delicacy, and it's then fed only to royalty (i.e., those termites capable of reproducing). Unlike ants, termites have no objection to fruiting bodies. After they leave their former nest in order to create a new one, a colossus often appears—a mushroom in the genus *Termitomyces* whose cap can be three feet in diameter. The mushroom in question, while not of interest to termites, is a highly regarded edible in Africa, where people put tags on growing specimens to indicate their ownership. It was first documented scientifically by missionary-explorer David Livingston, of "Dr. Livingston, I presume" fame.

Iqmik

Sixty percent of all Yupik adults in Alaska are polypore addicts, and a surprising number of their offspring are,

too. This does not mean they eat polypores or obsessively engage in polypore identification, but rather that they take a particular polypore, the false tinder conk (*Phellinus igniarius*), burn it down to ash, and then wrap a tobacco leaf around some of this ash, thus creating what they call *iqmik*. Placed in the mouth and chewed, the alkaline of the ash combined with the alkaloid of the tobacco provides a brief, albeit powerful nicotine blast. Too much *iqmik* can result in nicotine poisoning and even mouth or throat cancer. The word *iqmik* means "thing to be put in the mouth" in Yupik. Eight-ounce jars of *iqmik* are sometimes available in Native stores in Alaska and cost between $40 and $50.

Before contact with tobacco-trading whalers, the Yupik would wrap willow leaves around the polypore ash—a much healthier concoction, since the salicin in the leaves is an anti-inflammatory compound closely related to aspirin.

See also Ethnomycology; Polypores.

Jellies

Not fruit preserves, but gelatinous yellow, brown, and reddish basidiomycetes. In Sweden, jelly fungi were once believed to have been vomited up by the cats that accompany witches, while in eastern Europe they were thought to have been affixed to a house by a witch (hence the common name witches butter) just before she cast a spell on that house's occupants. The Canadian Inuit regard them as the snot of caribou, and quite a few cultures around the world think they're the residue of a meteor. As its Latin name suggests, the wood ear (*Auricularia auricula-judae*) is sometimes

called Judas's ear (or Jew's ear) on the assumption that it once belonged to Judas Iscariot, who hanged himself on an elder tree, one of the favorite substrates of the species.

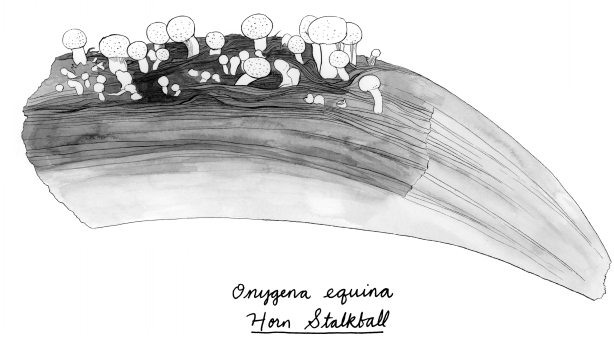
Jellies are exclusively wood inhabitors. *Tremella* species parasitize the mycelium of a crust fungus inside the wood, while others are saprophytes that dine on a recently fallen branch or twig. The basidia of most jellies are so deeply buried in their gelatinous matrix that the fungus can freeze or desiccate and then revive multiple times without damaging these spore-producing mechanisms. This is why they're commonly seen in the winter, indeed all winter long. Indeed, you can put a dried-up jelly fungus in a bowl of water, and more often than not it will revert to its old gelatinous self in only a few minutes.

Most jelly species are edible, but somewhat bland. The wood ear *Auricularia polytricha* was cultivated in China as long ago as 600 BCE, which probably makes it the first fungus to have been cultivated by humans.

Keratinophiles

Because of the production of special enzymes, fungi known as Onygenales have the ability to digest keratin, a protein virtually all other fungi find unpalatable.

Given that there's keratin in the outer layer of our skin, it's not surprising that some Onygenales are dermatophytes. All too familiar examples include ringworm and athlete's foot, which are usually caused by *Trichophyton* and *Microsporum* species. They aren't caused by *tinea pedis* and *tinea corporis*, which are medical terms rather than fungal names. The word "dermatophyte" itself indicates that the fungus doesn't travel far beneath



the surface of the skin, although if it's untreated, it can travel both far and wide around the body.

Not all Onygenales species consider humans an appropriate substrate. The horn stalkball (*Onygena equina*) grows on the shed horns and moldering hooves of certain mammals, especially sheep and cattle. It doesn't grow on antlers, which are made of bone rather than keratin. Another *Onygena* species, *O. corvina*, grows on the feathers of dead birds, tufts of animal hair, and old wool. The nineteenth-century English mycologist-clergyman Miles Berkeley discovered the latter species in Sherwood Forest on a beleaguered woolen garment belonging not, he figured, to Robin Hood but to a gypsy.

See also Berkeley, Rev. Miles; Bird Droppings; Snake Fungus.

King Tut's Curse

Several molds in the genus *Aspergillus* fruit in dry, closed-off environments such as barns and sheds, but also pharaohs' tombs. Their spores can survive

desiccation for an extremely long time, and upon being inhaled, they can cause pulmonary problems that can end up affecting other parts of the body.

Let's consider King Tut's Curse. Just before he died, the king was said to have condemned to death each and every person who violated his long-term sleeping quarters. At least six violators, including the English archaeologist Lord Carnarvon, reputedly died from this curse. However, they may have died not from the king's curse, but from inhaling the spores of *Aspergillus flavus* in the king's tomb—so many spores in such an extremely closed-off place could have caused severe

allergic reactions among the violators. If they didn't inhale the actual spores, they might have inhaled the dust from those spores, which was 3,000+ years old.

In all probability, the fungus in question was growing on the various fruits and vegetables that were buried with the king so he would have something to dine on in the afterlife.

See also Xerotolerant Fungi.

Know Your Mushrooms

Popular documentary by Toronto filmmaker Rob Mann. The film opens with footage from George Méliès's 1902 silent classic *A Trip to the Moon*, which shows the moon to be inhabited by giant mushrooms, and then it jumps to the unconventional Telluride Mushroom Festival in Colorado. It features mycologists Gary Lincoff and Larry Evans, with walk-on parts by John Cage, Andrew Weil, and Terence McKenna. The film includes hard science, soft science, and spaced-out science, the last of which is not altogether inappropriate for a film that begins with giant mushrooms fruiting on the moon.

Other films in which mushrooms play an important role include French director Sacha Guitry's 1936 dark comedy *The Cheat* (*Le roman d'un tricheur*); the 1964 Russian fairy tale *Father Frost* (or *Jack Frost*); the 1995 Australian comedy *Mushrooms*; the 2007 Irish horror movie *Shrooms*; the 2013 Estonian political comedy *Mushrooming*; the 2016 sophisticated British horror film *The Girl with All the Gifts*; and American filmmaker Taylor Lockwood's on-the-road documentaries such as *In Search of the Holey* [*sic*] *Veil* and *The Good, the Bad, and the Deadly*.

KOH
An abbreviation for potassium hydroxide. A 3–5 percent aqueous solution of KOH, by producing a specific staining reaction in certain fungi, helps identify those fungi. If, for example, you put a drop of KOH on a polypore like the tender nesting polypore (*Hapalopilus nidulans*), the spot where you've put that drop will quickly turn a brilliant purple. Many boletes produce blatant color reactions, too. Strong olive-colored reactions can help identify certain *Russula* and *Lactarius* species. *Amanita* species can often be identified by whether or not their caps react to a drop of KOH. Reputedly, liquid Drano can be used in lieu of KOH on a mushroom whose identification, like a sink, needs unclogging.

A daub of KOH can be used to differentiate *Candida albicans* from other skin infections. But don't daub yourself with it, as it can produce blisters and skin burns.

Kombucha
Sometimes called the tea mushroom or the Manchurian mushroom, although it's not even remotely a mushroom. Rather, it's a fermented bacterial-fungal consortium of at least two yeast strains, one of which is usually *Zygosaccharomyces bailii*, and whatever bacteria happen to show up in the consortium's culture. Often the bacterium is *Lactobacillus sanfranciscensis*, a species common in sourdough bread cultures. The level of fermentation in kombucha is not always carefully monitored, so kombucha cultures tend to differ dramatically from each other.

Kombucha tea reputedly cures or at least suspends AIDS, cancer, herpes, cataracts, gout, insomnia, diarrhea, type 2 diabetes, yeast infections, and hair loss. It's also said to remove wrinkles from an aging face. Despite worldwide sales of more than $400 million a year, no actual evidence of kombucha's beneficial health effects has yet been established. It has been used successfully in the dyeing of textiles, however.

Latex

A sticky emulsion from certain flowering plants, but also the mycological term for the blobs, juices, or droplets exuding from the mushrooms known as milk caps (*Lactarius* sp.). Although milk caps aren't female mammals, this activity is sometimes called lactating. Certain witty individuals have suggested that *Lactarius* should be feminine, *Lactaria*, because it produces milk.

Stored in large hyphae called lactifers, the latex emerges when the mushroom is bruised or broken. This is more or less the fungal equivalent of bleeding. Occasionally, merely touching a milk cap will cause it to lactate.

Milk caps can often be identified by whether the latex is copious or sparse. For example, the latex is copious in the weeping milky (*Lactarius volemus*), while the latex in the woolly milky (*L. torminosus*) is sparse. Milk caps can also be identified by whether there's a color change when the latex is exposed to air—for example, the latex changes from yellow orange to greenish in the delicious milky (*L. deterrimus*). Dry milk caps don't yield any milk.

While a few individuals are sensitive to the latex in plants, no one has ever had a problem from touching the latex in milk caps. On the other hand, certain *Suillus* species, slimy members of the bolete family, can cause relatively mild contact dermatitis upon being touched.

Lawnmower's Mushroom (*Panaeolus foenisecii*)
Also called the haymaker's mushroom. A small brownish mushroom with a conical or bell-shaped cap and chocolate-brown or sometimes purplish gills when it's mature. Unlike most other members of the *Panaeolus* genus, this species is not a dung inhabitor. Rather, it grows primarily on lawns, in grassy urban areas, and in cemeteries. Because of its ephemeral growth habit, it

might be fresh one day and dried up the next. Or even fresh in the morning and dried up by late afternoon.

The lawnmower's mushroom is probably the most commonly dined on mushroom by dogs and toddlers in the grazing stage because it's usually the mushroom closest to home. Also, it contains tryptamine derivatives as well as trace elements of psilocybin (it was formerly placed in the *Psilocybe* genus), an ingredient that might have a certain appeal to canine or youthful diners. (Note: the trip the mushroom offers is an extremely modest one.)

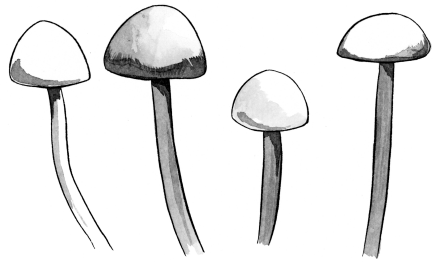
The species might appreciate its common name, since fruitings of the mushroom are reputedly stimulated by the mowing of lawns.

See also Magic Mushrooms; Psilocybin.

LBM (Little Brown Mushroom)

Not a scientific term, but a modified acronym probably stolen from the lingo of birders, who call hard-to-identify birds such as certain warblers and sparrows LBJs. LBMs are typically gilled mushrooms less than two inches in diameter. They can be not only brown but also white, gray, cream colored, beige, or tan. Genera include *Conocybe*, *Galerina*, *Collybia*, *Gymnopus*, and *Mycena*. The potential fate of anyone who eats at least one LBM species, the deadly galerina (*Galerina marginata*, formerly *G. autumnalis*), is suggested by its common name.

Most LBMs are disparaged not only because they lack charisma, but also because they can be difficult if not downright impossible to identify. That certain mycologists specialize in them indicates their bravery in



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the face of a likely taxonomic battle, although sequencing the DNA of a specimen nowadays makes that battle a lot less arduous.

As it happens, one person's LBM can be another person's source of delight. In his book *Mushrooms Demystified*, David Arora calls *Inocybe* "a large, listless, and lackluster assemblage of malodorous brown mushrooms." It would seem that this is a subjective remark, since some *Inocybes* species smell of sweet corn (malodorous?), others have a spermatic odor, and still others are not brown, but lilac. To most people, lilac is not at all a lackluster color.

Lichenicolous Fungi

A lichenicolous fungus is one that has a symbiotic, saprophytic, or parasitic relationship with a particular lichen. Some form galls made up of their mycelia and the tissue of their hosts, but typically they do not damage that host. A few, like *Blarneya hibernica*, kill the fungal part of the lichen and then join the surviving

algal cells to create a new lichen, with themselves as the fungal partner. As befits its name, one species, *Athelia arachnoidea*, covers its host with a spiderweb of mycelia, eventually killing it—like most lichenicolous species, this one has yet to be given a common name.

Almost nothing is known about the biology of lichenicolous fungi. What chemicals do they manufacture that permit them to overcome the secondary metabolites created by lichens as a defense mechanism? If they're parasites, what is the degree of their virulence? Which part of the lichen, the photobiont (alga or cyanobacterium) or the fungus, usually plays the part of host? And why are lichenicolous species common in the Arctic? With respect to this last question, lichens themselves are also common in the Arctic, so perhaps warming temperatures could be interfering with their defense.

Almost all lichenicolous species are quite small; the largest are seldom more than a millimeter in diameter, so if you venture into the field in search of them, be sure to bring a good hand lens!

Lincoff, Gary (1942–2018)

Contemporary mycological celebrity and author of the *Audubon Field Guide to North American Mushrooms*, perhaps the best mushroom field guide for beginners. Other books by Lincoff include such titles as *The Joy of Foraging*, *Mushroom Magick* [*sic*], *The Eyewitness Guide to Mushrooms*, and *The Complete Mushroom Hunter*.

Born in Pittsburgh, Lincoff moved to New York City and taught mycological courses at the New York Botanical Garden for 40 years. His teaching was both scientific and humorous (he was sometimes referred to as

the "Woody Allen of mycology") as well as embellished by his thespian talent.

Not only did Lincoff lead mushroom forays on every continent except Antarctica, he also led them in New York's Central Park, in whose confines he documented 500+ fungal species. "Why go into the wilderness," he would ask people, "when you can go into Central Park?"

Like his mentor Sam Ristich, Lincoff had a boundless enthusiasm for mushrooms. Upon being asked which one was his favorite, he would reply, "The one that's in front of me right now."

See also Ristich, Sam.

Lloyd, Curtis Gates (1859–1926)

A rattle-their-brains, self-made mycologist, Lloyd commonly ridiculed other mycologists, usually professional ones, whom he considered overly pompous or "name jugglers," in his journal called *Lloyd's Notes*, which he published on his own nickel between 1898 and 1925. In this journal, he also documented specimens sent to him by individuals from all over the world. He was especially interested in puffballs, stinkhorns, polypores, and species with unusual morphologies.

In *Lloyd's Notes*, he could be vituperative, as when he described mycologist Worthington Smith's *Synopsis of British Basidiomycetes* as being "like an attempt by someone living in the Sahara to write about the rainforest." He could also be whimsical, as when he titled an article about stinkhorns "Know Your Phalloids." That he was a noted ladies' man gives this title an extra bit of meaning.

For Lloyd, accurate descriptions of fungi mattered more than anything else. He hated taxonomic

innovation, so he would probably be rolling over in his grave in response to the name changes prescribed by many of today's DNA-obsessed mycologists. Speaking of that grave, he made his own tombstone and placed it in a cemetery in his hometown of Cincinnati. Part of its inscription reads: "A monument erected by himself for himself during his life to gratify his own vanity."

Lobster (*Hypomyces lactifluorum*)

An example of fungal cannibalism—one species attacking and then eating another. In this instance, the victim is a *Russula brevipes* or sometimes a milk cap (*Lactarius* sp.), while the cannibal is a member of the ascomycete genus *Hypomyces*. The result is a fungal entity with an orangish-red color that suggests a cooked lobster (sans claws) whose morphology is somewhat contorted. Neither species is particularly edible by itself, but their union is considered a delicacy. Occasionally, lobsters are confused with another delicacy, chanterelles, because the attacked gills end up looking somewhat like ridges, and chanterelles have ridges rather than gills.

Here are a few other fungi that engage in cannibalism:

— *Entoloma abortivum*, which parasitizes honey mushrooms
— *Volvariella surrecta*, which attacks *Clitocybes*
— *Asterophora* species, which dine on decaying *Russula* specimens and the occasional *Lactarius*
— *Collybia tuberosa*, which also dines on *Russula* and *Lactarius* specimens, albeit decomposing ones
— *Psathyrella epimyces*, which delights in eating shaggy manes (*Coprinus comatus*)

See also Parasites.

Magic Mushrooms
A generic name for certain small, brownish, dark-spored, trip-inducing mushrooms that fruit in dung as well as woody debris and leaf litter. The primary genus is *Psilocybe*, and the species include *P. azurescens*, *P. cubensis*, *P. semilanceata*, and *P. stuntzii*.

So-called magic mushrooms were once employed by traditional cultures for ritualistic purposes, but now they're used primarily to get high or to come to terms with life-threatening conditions, as in the case of cancer patients fed capsules containing their alkaloids by researchers at Johns Hopkins University.

Trips cover a variety of experiences, some positively surreal. Timothy Leary took a trip back in time and became, he said, "a one-celled organism." A woman of this author's acquaintance went back further, to the dawn of creation. Asked whether she encountered the Big Bang, she replied, "I *was* the Big Bang."

An overlooked subject is why certain mushroom species are psychoactive. It may be that the mycelium is stashing in its fruiting body chemicals that it has metastasized and wants to dispose of, lest they have a negative effect on its health. As with so many mycological questions, more research is necessary.

See also McKenna, Terence; Psilocybin; Sabina, Maria; *Teonanacatl*; Wasson, Gordon.

Maitake (*Grifola frondosa*)
A somewhat fleshy polypore whose flaring grayish caps suggest a cluster of chickens merged together, which explains the common name of the species, hen of the woods. Hens, as that name is sometimes abbreviated,

grow at the base of deciduous trees, usually oaks, and can be either a mild parasite or a saprophyte. Specimens weighing 50 or 60 pounds are not unknown.

Sometimes a maitake is confused with *Meripilus sumstinei*, a similar-looking species that invariably stains black, or the umbrella polypore (*Polyporus umbellatus*), which possesses a tuber-like underground nodule, but such errors in identification aren't a problem, since both these species are edible.

In North America, the Japanese name "maitake" is more often used nowadays than hen of the woods. The word means "dancing mushroom" because those who find maitakes tend to dance exuberantly. After all, they've found not only an excellent edible, but also a highly regarded medicinal. Since the species can be readily cultivated, this dancing can be done in one's own backyard.

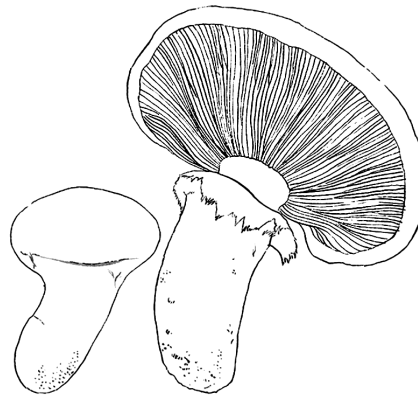
In their medicinal capacity, maitakes reputedly cure diabetes by lowering glucose levels, serve as a diuretic, get rid of hemorrhoids, reduce arthritic pain, and serve as a general stimulant to the immune system. When they're sautéed, they also stimulate taste buds.

See also Polypores.

Matsutake

From the Japanese *matsu*, "pine tree," and *take*, "mushroom." A large white mushroom with reddish-brown, flattened scales on its cap, a veil, and a tapering stalk with a thick cottony ring near the top.

Matsutakes are mycorrhizal with certain species of pine, but they often turn themselves into saprophytes when the host begins to die. Even when they're covered



with needle duff, you can usually detect them by their strong odor. Mycologist David Arora has described that odor as "a blend of red hots and old gym socks." In North America, there are three slightly different matsutake species: *Tricholoma magnivelare*, *T. murrillianum*, and *T. mesoamericanum*.

Matsutakes have been revered by the Japanese for at least a millennium. The mushroom was once considered so sacred that in the imperial court of Kyoto, women were prohibited from uttering the word "matsutake" openly. More recently, specimens in perfect condition have sold for as much as $400 apiece in Japanese markets. Such high prices are an indication that the mushroom has an excellent taste, but it also symbolizes health and happiness. Likewise, it symbolizes the male sexual member, and the more phallic a matsutake's morphology, the higher its price.

See also Commercial Harvesting.

McIlvaine, Captain Charles (1840–1905)
American mycologist who served as a captain in the Pennsylvania Infantry during the Civil War and was thereafter referred to as "Captain." The journal of the North American Mycological Association (NAMA), *McIlvainea*, is named after him.

McIlvaine's primary claim to fame is his monumental 1896 tome titled *1000 American Mushrooms*, which documents his dining experiences with almost every species he describes in the book. "I take no man's word about the qualities of a toadstool," he says, and he ate any "toadstool" that came his way. He sampled species never previously eaten and even species known to be toxic, such as the sulfur tuft (*Hypholoma fasciculare*). If, in eating a mushroom, he did not experience what he called "a violent evacuation," he would proclaim that specimen edible.

It should come as no surprise to learn that McIlvaine's nickname was Old Ironguts.

McKenna, Terence (1946–2000)
A former professional butterfly collector who became a counterculture guru because of his obsession with psychoactive substances, McKenna would eat five grams of magic mushrooms (*Psilocybe* sp.) a day on an empty stomach. This diet provided him with a sense of communion with our distant ancestors, and since the mushrooms altered his behavior, he decided that they altered the behavior of our ancestors, too. "We ate our way to higher consciousness," he wrote.

McKenna's "stoned ape" hypothesis, to his followers, lifted the veil over human evolution. As described in his book *Food of the Gods*, this hypothesis proposed

that the eating of magic mushrooms not only improved our ancestors' visual acuity and gave them the gift of language, but also made them literally high—that is, inspired them to rise up from their apelike crouches and become upright, like us. The late American comedian Bill Hicks acted out McKenna's "stoned ape" hypothesis during one of his last shows.

McKenna thought that psychoactive mushrooms or at least their spores may have journeyed to our planet from outer space, as—his detractors might argue—he seemed to have done himself.

See also Magic Mushrooms; Psilocybin.

Medicinal Mushrooms

Currently a global phenomenon, a large part of whose acclaim probably comes from a rising dissatisfaction with Big Pharma and its products. Even so, claims for medicinal fungi sometimes border on the absurd. Anything that can simultaneously cure one's gout, hemorrhoids, asthma, and incontinence would seem no less suspect than the miracle herb pantagruelion (in Rabelais's novel *Gargantua and Pantagruel*), which, among other things, can make ordinary church bells ring excitedly, launch mighty galleons from their moorings, and render the Euphrates River visible to Greenlanders. Fungal polysaccharides *can* stimulate the immune system, but how much? Serious scientific scrutiny is needed, as well as the use of humans rather than small rodents as test examples.

Traditional people around the world have long used certain fungi medicinally. But what works in a traditional culture might be akin to snake oil in a

nontraditional one. For in such cultures healing is (or was) often inseparable from religion, and a cultural and/or religious perspective on a medicine adds enormous power to its ability to cure. Millennia of use might indeed give curative powers to a particular fungus, but in a nontraditional culture, only a short time passes between a person's learning about a fungal medicinal, his or her journey to a health food store to buy that medicinal, and the subsequent use of it.

See also Chaga; Maitake; Reishi; Shiitake; Turkey Tail.

Melzer's Reagent

Usually shortened to Melzer's. Named for Czech mycologist Václav Melzer (1878–1968).

Melzer's reagent is a mixture of chloral hydrate (toxic!), potassium iodide, iodine, and water that aids in the identification of a specimen by either causing or not causing a staining reaction in that specimen's spores. The reaction is amyloid if those spores stain blue, blue gray, violet, or violet black; dextrinoid if they stain brownish, purplish brown, or dark red; and inamyloid if they stain yellow or don't stain at all.

Melzer's is best used with spores that are relatively light in color. It's especially useful for observing the ornamentation in *Russula* spores. As it happens, Melzer himself was a *Russula* specialist.

Other chemical solutions are Phloxine B, KOH, Congo Red, and Cotton Blue. As fungal cells consist mostly of water, such solutions give these cells a color they would not otherwise have and, by doing so, assist in the identification of a specimen.

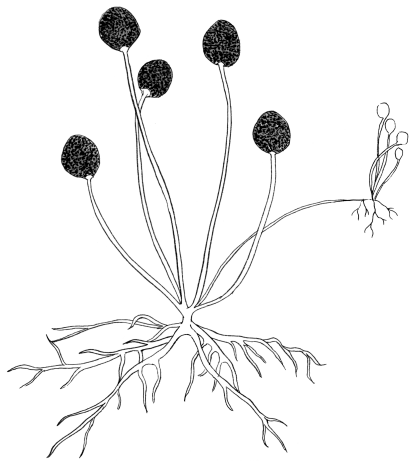
See also KOH.

Microfungi

An artificial classification based primarily on size. Microfungi tend to be a millimeter or less, which means they can be discerned in the field only by those with very strong eyes or a very good hand lens.

Most microfungi reproduce asexually by releasing or breaking off spores from their mycelia. Some provide excellent dining opportunities . . . to small insects. Others regard our own food as a dining opportunity. An example is the zygomycete *Rhizopus stolonifer*, which delights in consuming stored bread. A few microfungi, like noble rot, are economically valuable.

Microfungi include yeasts, rusts, mildews, and molds. Without them, soy sauce, tempeh, and miso, not



Close up view of bread mold
(Rhizopus stolonifer)

to mention alcoholic drinks, wouldn't exist. Without them, valley fever, rice blast, athlete's foot, and *Candida* infections wouldn't exist, either.

See also Noble Rot; *Penicillium*; Rust; Valley Fever; Yeasts; Zygomycetes.

Mildews

A thin coating of whitish hyphae that grows on a vascular plant. There are two main types of mildews, both of which are ascomycetes.

Downy mildews (family Peronosporaceae) affect the leaf tissue of certain plants without damaging the stems or petioles. They seem especially fond of plants in the grape family. Often the host dies, but just as often it doesn't. Downy mildews are especially common during dry summers, when the plant has a more difficult time fighting them off than in wet summers.

Far more harmful than downy mildews are powdery mildews (order Erysiphales), which divert their host's nutrients and water to their mycelia, thus crippling and often killing that host. Powdery mildews attack farmed crops and domestic or ornamental plants with a certain vehemence. An example is rose powdery mildew (*Sphaerotheca pannosa*), which especially likes to attack roses in greenhouses.

Why are domesticated plants such easy targets? Because they usually don't have the same ability to defend themselves against fungal attacks as plants in the wild do. After all, they're usually hybridized, and the lack of genetic diversity in hybridized organisms extends a welcome to fungal pathogens. That they're often a monoculture also provides a welcome to these pathogens,

which seem to regard them as sick or at least weak and thus easy pickings.

Mold

The generic term for the asexual phase of certain ascomycetes whose often fuzzy complexion comes from being covered with conidia (asexual spores). Formally, molds are known as hyphomycetes.

Some molds (*Botrytis* and *Penicillium* sp.) can damage commercial crops; *Aspergillus* and *Cladosporium* species can cause serious allergic and pulmonary problems; and black mold (*Stachybotrys chartarum*) showed up in New Orleans after Hurricane Katrina, causing numerous health issues and even a few deaths. On the other hand, the enzyme alpha-galactosidase, derived from *Asperillus niger*, is the most important ingredient in Beano, so you could say that molds (or at least one mold) help prevent flatulence.

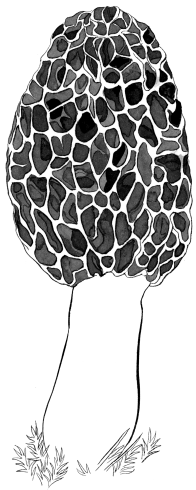
Some molds (especially *Typhula* sp.) are parasites that attack plants like turf grass under the cloak of snow, earning them the name snow molds. They create rings on turf grass that are sometimes mistaken for UFO landings.

Because the domestic mold *Trichoderma longibrachiatum* is highly resistant to antimicrobial chemicals, scientists in the Soviet Union used to joke that if their country ran out of nuclear weapons, they would simply drop a *T. longibrachiatum* bomb on the United States.

See also Noble Rot; *Penicillium*.

Morels (*Morchella* sp.)

An iconic edible ascomycete. Specifically, morels are discomycetes, which is not surprising if you think of



Morchella esculenta
Yellow Morel

an individual morel as a bunch of cups stuck upright on a stalk in a honeycomb-like manner.

Although several North American species are considered gastronomic delights, Meriwether Lewis (of Lewis and Clark fame) sampled them en route to the West Coast and proclaimed that they were a "tasteless and insippid [*sic*] food." Certain Native people refused to eat them on the assumption that they were the penises of their ancestors rising up from the ground, and who would want to eat the virile member of their (for example) great-grandfather?

Some morels fruit in vast numbers on burn sites a year or so after a forest fire for reasons that aren't altogether clear. Other morels don't need burning; they have a mycorrhizal relationship with various trees and, like matsutakes, they can become saprophytes when that tree begins to die. The common morel (*Morchella esculenta*) is often mycorrhizal with ash trees, and its fruitings are in decline in the Upper Midwest because ash trees themselves are declining as a result of a beetle known as the emerald ash borer.

Many morels contain hydrazine toxins that can cause gastrointestinal distress if eaten raw. Cooking usually, but not always, destroys these toxins.

See also Discomycetes; Matsutake.

Mushroom Websites

Perhaps the most popular mushroom website is Mushroom Observer (www.mushroomobserver.com), launched in 2006 by mycologist and techno-wizard Nathan Wilson. It has thousands of users, with perhaps a million photos posted on it, and many more will doubtless be posted by the time I finish writing this sentence. Many of the photos provide both binomials and descriptions of uncommon species, while others are accompanied by requests to identify a species.

Other freely available online sites include the following:

— Index Fungorum (www.indexfungorum.org)—A good source for the most up-to-date scientific names for fungi
— Mycology Collections Portal (www.mycoportal.org)—A user-friendly site focusing on fungal diversity in North America
— Mushroom Expert (www.mushroomexpert.com)—An excellent site dedicated to identifying fungi
— Cornell Mushroom Blog (www.blog.mycology.cornell.edu)—One of the best mushroom blogs
— *Omphalina* (www.nlmushrooms.ca/omphalina.html)—The eminently informative and sometimes highly witty newsletter of Foray Newfoundland and Labrador
— Cybertruffle (www.cybertruffle.org.uk)—A host site for numerous other fungal websites

Music

Mushrooms have inspired all kinds of music as well as names of musical groups. Here are some examples:

— Infected Mushroom, an Israeli trance band who perform what they call "psychedelic music." One of their albums is titled *Classical Mushroom*.
— A type of music called Fungi from the British Virgin Islands, so named because it's a mishmash of different types of music, and there's a local dish called Fungi that's a mishmash of different foods, including mushrooms.
— Estonian composer Lepo Sumera's "Mushroom Cantata," a work in which a chorus continuously chants the Latin names of different mushrooms.
— "Gathering Mushrooms," a song by nineteenth-century Russian composer Modest Mussorgsky.
— "How the Mushrooms Went to War," a song by Igor Stravinsky.
— Mushroomhead, an alternative metal band from Cleveland.
— Numerous compositions by Czech composer Václav Hálek.
— Mycologist Larry Evans's album *Fungal Boogie*, which features bluesy songs with titles like "I Just Like Morels Too Much" and "Stinkhorn Lowdown."

Composer Franz Schubert's nickname was inspired by mushrooms. Because he was only five feet tall, he was called Schwammerl (Little Mushroom).

See also Cage, John; Hálek, Václav.

Mycelium

A collection of repeatedly branching hyphae that might be described as the workhorse of a fungus. All macrofungi and almost all microfungi possess this workhorse.

Buried in its substrate, a mycelium draws on a variety of different enzymes to support its digestive needs, and when the time is appropriate, it creates one or more fruiting bodies. It puts a sizable portion of its biomass into these fruiting bodies, so a person who picks mushrooms promiscuously is incorrect in assuming that he or she is not damaging the mycelia of those mushrooms.

Called "Nature's internet" by Paul Stamets, a mycelium can spread over large distances, advancing and retreating by responding to environmental cues. A handful of healthy soil can contain several hundred miles of mycelia. Since a mycelium is only a single cell wide, it's invisible to the naked eye and will remain invisible unless it decides to bundle itself into rhizomorphs.

Like any animal or plant, a mycelium has one group of genes in its nuclei and a different group in the mitochondria of its cells. These genes can be highly competitive against another mycelium that happens to be in the same substrate, releasing chemicals that say, in effect, "Blow off, you bugger!" More often than not, the bugger in question does blow off.

See also Hyphae.

Mycologist

An individual, either professional or amateur, who has a scientific interest in fungi. The word was created as recently as 1837 by the English clergyman Miles Berkeley. Before that, a person who studied fungi was simply referred to as a botanist and was generally looked down on by other botanists because fungi were considered lower organisms than plants. In fact, fungi were separated from plants as recently as 1969, when they were given their own kingdom. Most systematically arranged collections of fungi are still housed in herbaria even though they are neither plants nor herbs.

A person who has a scientific interest in plant diseases, many of which are fungal, is a phytopathologist. Many phytopathologists call themselves mycologists and vice versa.

The following mycologists have entries in this *Fungipedia*: Mary Banning, Rev. Miles Berkeley, John Cage, George Washington Carver, Carolus Clusius, Mordecai Cubitt Cooke, Elias Magnus Fries, Gary Lincoff, Curtis Gates Lloyd, Captain Charles McIlvaine, Charles Horton Peck, Beatrix Potter, Sam Ristich, Walter Snell, Paul Stamets, Roland Thaxter, and Gordon Wasson.

Mycophage

Any eater of fungi. Some mycophages are obligate feeders, which means they must eat fungi in order to survive, while others are opportunistic feeders.

Obligate feeders include certain fruit flies (*Drosophila* sp.), whose diet consists entirely of yeasts; California red-backed voles (*Myodes californicus*), who eat primarily truffles and certain lichens; ambrosia beetles, whose diet consists of fungal mycelia and spores; and the various ant and termite species that devote themselves to culturing mycelia for their dining purposes.

Opportunistic feeders include mountain gorillas, who, according to Dian Fossey, regard large, robust polypores as prime edibles; Australian marsupials called woylies, who make numerous daily digs in search of hypogeous (underground) fungi; squirrels, who cache fungi for the winter, especially *Russula* species; northern flying squirrels in North America, who commonly eat false truffles and the occasional *Russula*; slugs, different species of which prefer different mushrooms;

springtails (Collembola), insects that seem willing to eat any mushroom that comes their way; and *Homo sapiens*, a creature more likely to make an error in identifying seemingly edible species than any other creature.

As it happens, many fungi benefit from being eaten, for mycophages can be vectors of spore dispersal via their body parts or excrement.

See also Ambrosia; Insect Mushroom Farmers; Poisonings.

Mycophobia

Coined by British mycologist William Delisle Hay in 1887, the word refers to an attitude of fear, loathing, or downright hostility toward fungi. A recent example of mycophobia is the sentence "There is a fungus among us," which schoolkids use to describe a bad classmate.

Mycophobia is hardly a new phenomenon. The Greek physician Nicander (circa 85 BCE) called fungi "the evil ferment of the earth"; the German friar Albertus Magnus (circa 1200–1280) believed that eating mushrooms caused "instant insanity"; the great Swedish systematist Carolus Linnaeus (1707–1778) described fungi as "beggars"; and the ancient Hindus thought that those who ate mushrooms were the most detestable of sinners. In his novel *Sir Nigel*, Arthur Conan Doyle, creator of Sherlock Holmes, described a field of scarlet mushrooms as follows: "It was as if the sick earth had burst into foul pustules." This last description might take the mycophobic cake.

Whence comes such biological racism? It's possible that proclaiming all mushrooms to be despicable is a way of preventing one's fellow humans from eating

poisonous species and, as a result, kicking the proverbial bucket. Also, such popular fungal substrates as dung and our own bodies do not exactly endear fungi to us. Then there's this last possibility: when fungi decay, their smell might suggest to us our own mortal end.

Mycoremediation

Coined by mycologist Paul Stamets, this word refers to the use of wood-rotting fungi to remove toxic substances from unhealthy habitats, thus making them healthy again. Such fungi perform this remediation by releasing enzymes capable of breaking down unwanted substances. Most fungi that have been used in this fashion are white-rot basidiomycetes.

Here are a few examples of mycoremediation: the oyster mushroom (*Pleurotus* sp.) has degraded the toxins in crude oil as well as more or less cleaned up diesel-contaminated soil; the crust fungus *Phanerochaete chrysosporium* has successfully broken down DDT pesticide residues; and the mold *Aspergillus tubingensis* has broken down polyester plastics into very small pieces. There are quite a few other examples of fungi correcting human wrongs, but whether they can perform their services on a global rather than a modest or local level remains to be seen.

While not usually considered an example of mycoremediation, the introduction of the insect-killing fungus *Entomophaga maimaiga* in the northeastern United States has been relatively successful in preventing gypsy moth caterpillars from laying waste to even more trees than they already have.

See also Stamets, Paul; White Rot.

Noble Polypore (*Bridgeoporus nobilissimus*) An extremely large as well as extremely rare polypore found in the Pacific Northwest. Specimens have been known to weigh 300 pounds and reach a diameter of five feet. Mycologist Emory Simmons once mistook one for a bear, which is not surprising since the species has an extremely hairy mat of hyphae on its huge cap. Indeed, that hairy mat serves as a microhabitat for plants such Alaska huckleberry, trilliums, and ericaceous shrubs, not to mention species of unicellular algae and other fungi.

Named for William Bridge Cooke, a mycologist who also had an ample girth, the noble polypore was once thought to have the largest fruiting body of any fungus in the world. In 2003, however, a slightly larger polypore, *Rigidoporus ulmarius*, was found in England's Kew Gardens at the base of an elm disposed of by Dutch elm disease. Then, in 2010, a polypore was found on Hainan Island in China that made both these earlier species seem Lilliputian. Believe it or not, that species, *Phellinus ellipsoideus*, had a fruiting body that was 35 feet long and weighed upward of 800 pounds.

Back to the noble polypore itself. Fewer than 100 specimens have been documented. It's possible that its highly selective substrate—it grows only on old-growth noble firs (*Abies procera*) and only at altitudes of 2,000 feet and higher—has doomed it to rarity and possibly even extinction.

Noble Rot

Caused by the grayish mold *Botrytis cinerea*, noble rot has an ignoble effect on strawberries, usually killing

them off, but a noble effect on grapes—it penetrates the skin of its host and, in doing so, causes that host to lose water, which in turns increases its sugar content. Thus the wine made from infected grapes has a far sweeter flavor than ordinary wine, which is why it is typically used as dessert wine.

On the other hand, noble rot can have a disastrous effect on grapes in extremely wet weather, when a variety called gray rot or botrytis blight goes into overdrive and often destroys the grapes.

In many orchards, grapes are held back until a plague of noble rot has done its job, whereupon those grapes are said to have been "botrytised."

See also Mold.

Orchids

Mycorrhizal plants, but with a difference. First, they connect with their fungal partners not via their roots, which most of them have long abandoned, but via their seeds and/or seedlings. An orchid gets a large percentage of its nutritional supplements (roughly one-third of its carbon, for example) from its fungal partner, but the jury is still out as to what that partner might be getting in return. Indeed, the orchid might be tricking the fungus, promising it riches but delivering nothing.

As it happens, deception is not unknown among orchids. Some species seem to offer a food reward to their insect pollinators but actually provide nothing in return for cross-fertilization.

An orchid's fungal partners can be either ascomycetes or basidiomycetes. Some of those partners are asexual

fungi such as *Monilliopsis* species; some are crusts like *Tomentella* species; some are fleshy fungi such as *Inocybe* and honey mushrooms. If the orchid is actually tricking honey mushrooms into delivering nutrients but offering nothing in return, their relationship might be described as a parasite parasitizing a parasite.

Ötzi

The name given to a frozen resident of the Neolithic extracted from the ice in the Tyrol in 1991. Ötzi had specimens of two polypores on his somewhat desiccated person. One of them, affixed to a decorated leather thong, was the birch polypore (*Piptoporus betulinus*); in all probability, Ötzi made (or planned to make) a decoction from this polypore to rid himself of intestinal worms. Likewise, he had chunks from a tinder polypore (*Fomes fomentarius*) in a leather pouch; he may have used this polypore as a fire starter, since there were traces of pyrites in his specimen's hyphal strands. Perhaps Ötzi may also have used it to try to cauterize the arrow wound in his shoulder, which eventually may have led to his demise.

That the Eastern Cree in Canada once used the same two polypores for more or less the same purposes until very recently indicates parallel evolution on opposite sides of the Atlantic.

See also Amadou; Ethnomycology; Polypores.

Oyster Mushroom (*Pleurotus* sp.)

A fleshy, wood-inhabiting mushroom with whitish gills whose name comes from its apparent resemblance to oysters.

Oyster mushrooms may be a popular edible, but they're inhabited by various popular edibles themselves. For example, they like to eat the roundworms called nematodes. Their hyphae secrete toxic droplets such as tricholomic acid that paralyze the nematode, and the hyphae then enter its mouth and digest this nitrogen-rich snack from within. Or the hyphae might simply lasso the 1/25-inch nematode.

Bacteria are also on the oyster's grocery list. Upon detecting a colony of these tasty little morsels, the hyphae penetrate it with specialized cells and transport it to the main mycelium, which proceeds to snack away on it.

Oysters are capable of dining on human mistakes as well. Since their mycelia can break down and digest polycyclic aromatic hydrocarbons, the core molecules in oil, mycologist Paul Stamets, among others, has cleaned up sites contaminated by diesel fuel by inoculating them with the mycelia from cultivated oysters.

Turnabout is fair play. Insects such as pleasing fungus beetles (*Triplax* sp.) choose oyster mushrooms not only as their place of residence but also as their food, which indicates that such insects have all their meals at home.

See also Cultivated Mushrooms; Mycoremediation; Stamets, Paul.

Parasites

Fungi that engage in a one-sided relationship with a seemingly healthy partner, sometimes killing it in the process.

Apart from honey mushrooms and polypores, rusts, molds, and yeasts are more likely to be parasites than most larger fungi. Plants, especially domestic and

agricultural ones, are susceptible to the designs of these fungi because their regulatory systems are often too simple to mount a strong defense against them. As for trees, they can defend themselves against some but not all fungal attacks by producing antifungal (also anti-insect) chemicals called phenolics.

Truth to tell, many fungal parasites are not actually parasites—they're saprophytes, since they attack already weakened organisms. Consider trees affected by strong winds, lightning, insects, rubbing ungulates, and old age as well as trees whose wood has been softened by nitrogen-fixing bacteria, or even trees with merely a wound or a break. Upon encountering one of these trees, both a saprophyte and a parasite will lick their metaphoric lips.

Many fungi are obligate parasites, attacking only rotifers, nematodes, or, as in the case of *Tremella* jellies, the mycelia of crust fungi. Obligate parasites of insects, like various *Ophiocordyceps* species, attack only particular species and not others—they're excellent insect identifiers.

See also Polypores; Saprophytes.

Peck, Charles Horton (1833–1917)

Often referred to as the "Father of American Mycology," although he was (like most mycologists in his day) regarded as a botanist. During his 48 years as New York state botanist, he described between 2,500 and 3,000 species of fungi. Several species have subsequently been named in his honor, including the so-called bleeding tooth (*Hydnellum peckii*) and the bolete *Butyriboletus peckii*.

Peck may have been the first person to climb Wright Peak in the Adirondack Mountains, but—unlike many other climbers—he made the climb not to be the first to reach the summit, but to study the fungi and plants en route to that summit. He was also the only mycologist of his day to acknowledge Mary Banning's work with fungi. All the others turned their noses up at her because she was a woman.

A devout Presbyterian, Peck didn't drink, smoke, or—even when he found himself unable to identify a fungal species—curse.

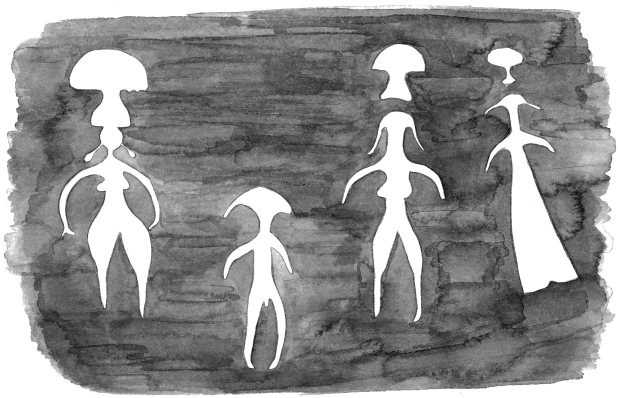
See also Banning, Mary.

Pegtymel

Carved into rocks near the mouth of Siberia's Pegtymel River are Bronze Age petroglyphs called Mushroom People by the local Chukchi reindeer herders. These petroglyphs look exactly like people who have giant mushrooms—specifically, fly agarics (*Amanita muscarias*)—perched on top of their heads.

In 2000, Russian Arctic anthropologist Andrei Golovnev, captivated by these petroglyphs, made a 32-minute documentary film titled, simply, *Pegtymel*. The film shows the local Chukchis beating drums, chanting, milking their reindeer, and eating fly agarics, along with footage of the petroglyphs. Back and forth the film travels, from the lives of these traditional people to images of the petroglyphs, thus providing a lyric window on a time-honored way of life that has all but disappeared.

Certain other examples of rock art, such as the Selva Pascuala rock shelter in Spain and cave paintings at Tassili n'Ajjer in Algeria, display individuals with



unusually large heads. Whether these heads are mushrooms or simply an indication of shamanic knowledge (the larger the head, the greater the knowledge) has yet to be determined.

See also Fly Agaric.

Penicillium

A genus with over 300 species, a goodly percentage of which are soil fungi that eagerly switch substrates to satisfy their nutritional needs. Some species cause food spoilage, others are dung inhabitors, and still others ripen Brie, Gorgonzola, and Roquefort cheeses. Speaking of cheeses, *Penicillium roqueforti* has been ranked among the top edible fungi in Finland because of its presence in Roquefort cheese.

Penicillium is doubtless best known as the source of the antibiotic penicillin. In 1929, Scottish bacteriologist and pharmacologist Sir Alexander Fleming famously

found a fruiting *P. chrysogenum* in a petri dish full of *Staphylococcus* bacteria and cultured it in order to obtain the aforementioned wonder drug, which is an antibiotic that weakens the cell walls of bacteria. Long before Fleming, however, the ancient Egyptians rubbed moldy bread on their lesions and probably got the same result they might have gotten from a prescription for a penicillin antibiotic.

Several *Penicillium* species in both the Arctic and Antarctic use glacier ice as their substrate, so they may not be long for this world, thanks to climate change.

Phallus impudicus

An upright stinkhorn with a small hole at the top of its greenish gleba (the mucus-like coating on the cap) whose Latin binomial means "shameless penis." In his 1597 *Herbal*, English botanist John Gerard (ca. 1545–1612) called it "the pricke mushroom." Upon seeing a specimen, Thoreau wrote in his *Journal*: "Pray what was Nature thinking of when she made this? She almost puts herself on a level with those who draw in privies." But if *Phallus impudicus* is offensive to our species, it's irresistible to various flying insects, which, attracted by its carrion-like odor, land on the gleba and carry off its spores, thus taxiing them to a new locale.

Not surprisingly, *P. impudicus* has inspired plenty of folklore. In the Ozarks, adolescent girls reputedly used to take off their clothes and dance around specimens on the assumption that this activity would get them virile boyfriends; in Sarawak, the Iban believe it's the penis of an enemy warrior slain in battle and tend to give it a very wide berth, lest it seek posthumous revenge

on them; and in several African countries, the gleba is spread on young women to make them fertile. Given the erectile strength of *P. impudicus*, these seemingly far-fetched notions may have a certain wisdom—specimens have been documented thrusting through asphalt with a lifting power of over 800 pounds.

Here I might add that the sight of a *P. impudicus* specimen in a Reykjavik cemetery drew this comment from an Icelandic friend of mine: "Oh well, he died happy."

See also Ethnomycology; Stinkhorns.

Phoenicoid Fungi

Not fungi associated with either ancient Phoenicia or modern-day Phoenix, but ones associated with a fire site or forest burn. The name means "rising from the ashes" and was first used in reference to fungi whose fruiting followed the 1980 eruption of Mount Saint Helens in Washington.

Phoenicoid fungi can get their jump starts from a fire's alteration of soil chemistry, the heat of a fire, fire-related nutrients, or the dearth of competition from other fungi after a fire. Once a fire is over, the pioneer fungal species tend to be discomycetes such as *Peziza violacea* and *Geopyxis carbonaria* as well as a few others with *carbonaria* as their species name. Some morel species (morels are, after all, discomycetes) grow in biblical proportions after a forest fire, inspiring biblical numbers of individuals to come and harvest them.

A few basidiomycetes, such as certain *Tephrocybe* and *Psathyrella* species, also use fire sites as their substrate.

See also Discomycetes; Morels.

Poisonings

Although most poisonous species cause only gastrointestinal problems, there are several notable exceptions. For example, *Amanita* species such as the death cap (*A. phalloides*) and the destroying angel (*A. bisporigera*) can make a diner one with Nineveh and Troy. There have also been deaths from eating the poison pax (*Paxillus involutus*), a species that destroys red blood cells and can cause kidney failure. In fact, the only documented case of a mycologist ever dying from mushroom poisoning came from German mycologist Julius Schaeffer eating a poison pax in 1944.

Errors in identification such as Schaeffer's are the cause of most serious poisonings. A recent example, much valued by the media, occurred in 2008, when the so-called Horse Whisperer, Nicholas Evans, mistook a batch of deadly corts (*Cortinarius rubellus*) for chanterelles and survived only by getting a kidney transplant. Both species are orange, and that seems to be why Evans thought the deadly corts were chanterelles. He didn't realize that you can't identify a mushroom simply by its color.

Then there are bagpipes: because *Fusarium* spores have a fondness for them, there've been several instances of a bagpiper inhaling vast numbers of those spores (disease name: bagpipe lung), with at least one fatality.

See also Amatoxins; Death Cap.

Polypores

A remarkably diverse group of basidiomycetes whose name derives from the myriad pores on their fertile surface. Polypores can be bracket-like, possess stipes, be

kidney shaped, or (in the case of most) be resupinate. All but a few are wood inhabitors, the exceptions being *Albatrellus*, *Coltricia*, and *Boletopsis* species, which are mycorrhizal, or thought to be mycorrhizal.

Most polypores are recyclers of dead branches and dead logs, but some digest the dead components in otherwise healthy wood known as heartwood. These so-called heart rotters can have a negative effect on a tree's structural integrity, so they could be called weak parasites. Often heart rotters move on to a tree's sapwood, where they become stronger parasites.

The strongest parasites of all, such as the conifer base polypore (*Heterobasidion annosum*) and the woolly velvet polypore (*Onnia tomentosa*), enter a tree through its roots and cause rotting at the tree's base that spreads upward. The not very pleasant name for this activity is butt rot.

Most polypores are annuals, although with climate change many annuals are becoming perennials. The perennials include *Fomes*, *Laricifomes*, and several *Ganoderma* species. Artist's conks (*Ganoderma applanatum*) can reach an age of 70 years, which makes them the Wise Elders of Kingdom Fungi.

See also Agarikon; Amadou; Artist's Conk; Parasites; Resupinate.

Potter, Beatrix (1866–1940)

An Englishwoman who possessed an interest not only in mycology but also in geology, entomology, and archaeology. She may have been the first person to propose that lichens are the marriage of an alga and at least one fungus. She also made exquisite illustrations

of mushrooms and very precise drawings of their spores, although she admitted that she "could not find the courage" to draw stinkhorns.

Ms. Potter couldn't present a scientific paper titled "On the Germination of Spores in Agaricinaceae" to the Linnaean Society in London in 1897 because, as a woman, she couldn't attend the proceedings in order to read the paper. Since she wasn't allowed to do serious mycological work for the same reason, she began writing as well as illustrating children's books about bunnies, badgers, and cute frogs in breeches. The best known of these books is, of course, *The Tale of Peter Rabbit*, published in 1901.

See also Banning, Mary.

Prototaxites

Possible fungus as high as 26 feet and as wide as 3 feet that flourished between 430 and 360 million years ago. Fossilized specimens look not unlike sectioned logs. So far 13 fossils have been discovered.

Originally described by nineteenth-century Canadian scientist John Dawson as a type of giant conifer, *Prototaxites* has now been placed—at least temporarily—within Taphrinomycotina, which would make it an ascomycete and a distant relative of the present-day alder tongue (*Taphrina* sp.). Dissenters have suggested that

it's really a mat of liverworts, a lichen, a giant alga, or an unusually large vascular plant. Regardless of what it may have been, the species seems to have been a popular edible and may indeed have been driven to extinction by various creatures who liked to dine on it—the marks of their nibbling can be seen on many of the fossils.

If it is indeed a fungus, *Prototaxites* is not the earliest fossilized species, however. That honor probably goes to a species called *Tortubus*, which flourished 440 million years ago and might have been the earliest of all terrestrial organisms.

See also Alder Tongue.

Psilocybin

An alkaloid that's the most potent psychoactive compound in fungi, psilocybin is present not only in *Psilocybe* species but also in certain *Panaeolus*, *Stropharia*, and *Gymnopilus* species. When it's ingested, it quickly metastasizes into psilocin, an alkaloid that jumbles up the brain's serotonin receptors, causing what's commonly called a trip. It should be mentioned that alkaloids frequently serve as stimulants. Other examples are caffeine, nicotine, and cocaine.

In 2006, Roland Griffiths, a psychopharmacologist at Johns Hopkins University, published an essay describing how psilocybin opens mystical doors in the brains of those who take it. That essay inspired an interest in psilocybin at Johns Hopkins, and researchers at the university are currently using psilocybin capsules to reduce depression in terminally ill patients. Seventy percent of those patients have rated the effect of the psilocybin as being among the top five spiritual experiences of their

lives. In fact, many who've taken the capsules have seen God, which would seem to indicate that the Supreme Being may simply be jumbled-up serotonin. An account of the ongoing psilocybin research at Johns Hopkins can be found in Michael Pollan's 2018 book *How to Change Your Mind*.

However useful they might be in therapy, psilocybin mushrooms have a Schedule 1 status in the United States, so—being dangerous drugs like LSD and heroin—they're illegal. As this *Fungipedia* goes to press, Denver, Colorado, has decriminalized their possession.

See also Magic Mushrooms.

Psychrophiles

Fungi adapted to survive, even prosper in cold environments like the Arctic, the dry valleys of Antarctica, and the upper elevations of mountains. Psychrophile specialist Robert Blanchette has documented numerous fungi in Arctic drift logs and the wood of explorers' huts in Antarctica. Another cold environment, refrigerators, provides sustenance for *Mucor* and *Aspergillus* mold species.

While many psychrophiles are in fact molds that inhabit soil rather than refrigerators, many others are mushrooms. Sometimes these mushrooms are smaller, but no less often they're larger, even much larger than the same species in a more temperate locale. For example, Arctic members of the bolete genus *Leccinum* can be twice the size of the same species in temperate regions. Such mushrooms often have sterile gills or pores, which, in providing them with the equivalent of a parka, help them withstand cold weather and strong winds.

A species often found during winter in temperate regions is the velvet foot (*Flammulina velutipes*), which manufactures trehalose, a major storage carbohydrate in basidiomycetes—it makes their cell membranes less susceptible to freezing. Other cold-adapted species probably possess high levels of fatty acids and antifreeze proteins.

Thanks to climate change, many cold-loving fungi may have a dim future.

Puck

Not the chef Wolfgang Puck, who has created numerous mushroom dishes such as his justly acclaimed *farro risotto* with wild mushrooms, but the mischievous supernatural fairy or sprite of English folklore as well as a prominent character in Shakespeare's play *A Midsummer Night's Dream*.

In paintings and illustrations, especially Victorian ones, Puck is frequently depicted as sitting on a mushroom, which would seem to indicate that the English used to associate mushrooms with mischief as well as the supernatural. In a Victorian production of *A Midsummer Night's Dream*, he rose onto the stage atop a mechanical mushroom; and in a striking painting by the artist Richard Dadd (1817–1891), a Puck with an extremely puckish grin on his face is squatting on top of a mushroom, and a number of naked men and women are dancing around him as if he were a deity on a throne.

In the past, the English often attributed Puck's origin to Ireland. After all, the mischief-making abilities of the Irish far surpassed their own . . . or so they believed.

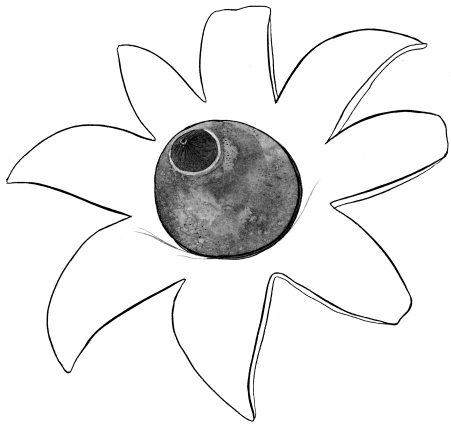
See also Ethnomycology; Fairy Rings.

after Richard Dadd

Puffballs

Formally called gasteromycetes because they manufacture their spores internally, in what might be called their stomachs, rather than on the outside, as in other basidiomycetes. Most puffball species are mycorrhizal.

A puffball's outer cover is called a peridium. A raindrop punctures that peridium and forces a cloud-like



Geastrum saccatum
Earthstar

release of spores. Such clouds made early taxonomists think of flatulence—hence the genus name *Lycoperdon*, which means "wolf fart," and the genus name *Bovista*, which means "ox fart." Nonflatulent genera include the stalked puffball in aspic (*Calostoma cinnabarina*), pigskin poison puffballs (*Scleroderma* sp.), stalked puffballs (*Tulostoma* sp.), and earthstars (*Astraeus* and *Geastrum* sp.).

Speaking of spores, the giant puffball (*Calvatia gigantea*) will produce not a million, not a billion, but trillions of them during the course of its lifetime. If all these spores were to become giant puffballs, the surface of the earth would be several feet deep with this species.

Traditional cultures all over the world have used puffballs as hemostatic agents. Chitosan, a component in their cell walls, bonds with red blood cells and creates a gel-like clot that generally stops bleeding. But the puffball must be mature, indeed sporulating; if it's firm, it probably won't have any effect. This means an edible puffball isn't a medicinal puffball.

Pyrenomycetes

Wood-inhabiting ascomycetes whose spore-filled asci inhabit a small structure called a perithecium. Given that these structures are flask shaped, it's not surprising that the common name for a pyrenomycete is a flask fungus. Most perithecia are embedded in sterile tissue called a stroma; most, too, have well-defined openings called ostioles from which their spores are released.

Many pyrenomycetes have a blackish, carbonaceous structure that looks so much like burnt wood that they can in fact be mistaken for burnt wood. They use the melanin in that structure as a sunscreen, so not only are they drought resistant, but some species can be perennial in their growth habit. Other pyrenomycetes do not restrict themselves to a blackish color. For instance, *Hypomyces leotiicola*, a species that attacks the jelly baby (*Leotia lubrica*), is greenish, while *Hypocrea sulphurea* is bright yellow.

Pyrenomycetes are much more common in the tropics and subtropics than in temperate regions. In Bermuda, for instance, they're the fungal entity that visitors are most likely to encounter.

Genera include *Xylaria*, *Daldinia*, *Diatrype*, *Hypocrea*, *Hypomyces*, *Hypoxylon*, *Camarops*, and *Kretzschmaria*,

although some mycologists think that only dead man's fingers and its family (Xylariaceae) are truly pyrenomycetes.

See also Chestnut Blight; Cramp Balls; Dead Man's Fingers.

Red List

An abbreviation for the world's most comprehensive inventory of endangered organisms. More formally, the list is called the IUCN (International Union for Conservation of Nature) Red List of Threatened Species.

The status of endangered fungi hasn't been and perhaps never can be assessed to the same degree as that of plants and animals, given their sometimes whimsical fruiting habits. Approximately 11,000 birds and 5,500 mammals are IUCN Red Listed, but as of this writing only 25 fungi have been IUCN Red Listed. Even so, most European countries have their own Red Lists of fungi threatened by pollution, habitat loss, heavy metals, artificial fertilizers, acid rain, and climate change. Unpolluted sites in Norway have double the number of species that similar sites in Germany do that are contaminated with excess sulfur and nitrogen. In fact, 35 percent of all fungi in Germany are Red Listed. There are also approximately 900 Red Listed fungal species in Denmark, 800 in Poland, and 215 in Bulgaria. Such species are protected by law, and anyone who collects them can be fined.

North America is well behind Europe in the conservation of fungi. In fact, you won't get a single hit if you Google "Red Listed North American fungi." Recently,

Field Museum of Natural History mycologist Gregory Mueller, aided by the Mohammed bin Zayed Species Conservation Fund, has attempted to remedy this situation by inaugurating a Red List project for North America.

All Red Lists are, in effect, declarations of serious ecological concern.

Reishi

A polypore in the *Ganoderma* genus, reishi has been used in folk medicine in Asia for several thousand years. Both the word "reishi" and the Chinese word for the same polypore, *lingzhi*, can be translated as "divine mushroom," because decoctions of it reputedly add many years to one's life. Although North American health food stores sometimes sell pieces of the hemlock varnish polypore (*Ganoderma tsugae*) as reishi, it's a different species from the *Ganoderma* species known as reishi (*G. lucidum* complex), which grows on deciduous wood.

With a tea made from reishi, Asian medicine treats the following litany of ailments: hypertension, asthma, sexual dysfunction, gastric ulcers, heart palpitations, tumors, loss of appetite, insomnia, nosebleeds, and constipation. A nonmedical but nonetheless serious problem is evil spirits hanging out in one's household, so hanging a specimen above the doorway keeps them from entering.

According to Robert Rogers's *The Fungal Pharmacy*, reishi has also been used as a narcotic by pig thieves in China and Vietnam "to reduce the squealing of poached porcine."

See also Medicinal Mushrooms.

Resupinate

From the Latin *resupinus*, which means "bent down, with the face upward." Resupinate fungi are not so much bent down as lying flat against a horizontal substrate. You can find them under logs, especially, with their sporulating surfaces facing downward. Such species include most polypores and crusts as well as gilled mushrooms like the black jelly oyster (*Resupinatus applicatus*) and the white oysterette (*Cheimonophyllum candidissimum*).

Most resupinate fungi tend to do just fine in the winter, for they use their log of choice as if it were a woolen coat. That means they can survive cold weather, unlike most of their ill-clad fungal colleagues; and while those other fungi often depend on the wind to spread their spores, resupinate species under logs can have their spores vectored by various insects and arthropods.

Since mycelia often make mistakes, fleshy mushrooms with caps and stems that would otherwise grow on the top or side of a log can occasionally be found under a log, splayed out in a resupinate manner. The mycelia of *Mycena* species seem particularly dedicated to such erroneous behavior.

Ristich, Sam (1915–2008)

Known as the "Guru" to mushroom aficionados in the northeastern United States because he was regarded as a sort of higher power with respect to fungal lore. In the field as well as at the New York Botanical Garden, where he taught for 15 years, he would purvey this lore through wild bursts of enthusiasm and displays of a raconteurish wit. For example, he would exclaim "Ain't

Ma Nature a fascinatin' lady!" upon finding an interesting or unusual fungus. He would call such specimens "wonderments." Since he had a doctorate in entomology from Cornell, he would refer to certain insects as "wonderments," too.

Ristich marched to the beat of his own drummer. There was often less food in the fridge at his home in South Yarmouth, Maine, than varieties of animal dung (moose, deer, porcupine, etc.) on which he was culturing fungi. He would communicate with his friends and acquaintances not by email (he didn't own a computer), but via postcards with laminated spore prints on them. In fact, he considered spore prints an art form and had an exhibition of his spore print art in a Maine gallery shortly before his death.

An *Amanita* species, *A. ristichii*, was named for Ristich. His only book, *Sam's Corner: The Public Journal of a Mushroom Guru*, is a collection of his columns first published in the newsletter of the Maine Mycological Association.

See also Spore Print.

Russula

Like Rodney Dangerfield, the fleshy mushrooms known as *Russula* get no respect. Sometimes, in fact, they're referred to as JAR (Just Another *Russula*) rather than given a specific name. There are several reasons for this disparagement. Except for Russians, who usually marinate them, *Russula* species are of limited culinary value; foragers always seem to find them when they're looking for other mushrooms; and they often tend to be difficult to identify. Although the genus name is derived from

the Latin word for "red," *Russula* species aren't only red but also green, yellow, white, gray, and brown.

Russula species are sometimes called brittle gills because they'll shatter if you throw them against a tree or even handle them roughly. This is because they possess turgid, inflated cells known as sphaerocysts. Most other mushrooms, lacking sphaerocysts, will simply break into a few pieces if you perform the same task with them.

While flinging a *Russula* specimen against a tree might help let off the steam that comes from one's inability to identify it, many *Russula* species are actually quite distinctive. For example, *R. atropurpurea* has an attractive purplish cap; *R. laurocerasi* has a smell that could be mistaken for marzipan or almonds; and the psychoactive compounds of a Papua New Guinea species, *R. agglutina*, cause what Kuma people call "mushroom madness."

Rust

Not to be confused with a coating of iron oxide on steel, a fungal rust is a parasite on plants, especially commercial ones. Almost all of the 7,000 or so species are in the order Pucciniales.

Rusts are basidiomycetes, but unlike most basidiomycetes, they have a sexual stage and two or more asexual stages. Different stages not only look different; they have different hosts. One of the best-known examples of this is the cedar apple rust (*Gymnosporangium juniperi-virginianae*), which produces jellylike horns mostly on eastern red cedars, with its alternate hosts being either crabapple or apple trees. Another is white

pine blister rust (*Cronartium ribicola*), which infects white pines through their needles before attacking the tree's bark. Since this rust's alternate host tends to be currant bushes or gooseberries (*Ribes* sp.), it's illegal to ship or grow either currants or gooseberry bushes in several states in the United States.

Rusts often exude a sweet secretion that, in mimicking the nectar of flowers, attracts bees and insects to spread their spores. Like other basidiomycetes, they also rely on the wind to spread their spores. In fact, strong winds blew the spores of the so-called coffee rust (*Hemileia vastatrix*) from Saharan Africa all the way across the Atlantic to Central America, where it's currently devastating coffee plantations.

Sabina, Maria (1894–1985)

A Mazatec *curandera* (shamaness or healer) from the Mexican state of Oaxaca, Maria Sabina used *Psilocybe* mushrooms in her rituals. She called these mushrooms her "saintly children" and reputedly had intimate conversations with them. She requested that her clients eat them in pairs so as to reflect the balance of masculine and feminine. Other Mazatecs called the same mushrooms *los pajaritos* (little birds).

In June 1955, the American ethnomycologist Gordon Wasson paid Maria Sabina a visit, ate some of her mushrooms (*Psilocybe mexicana*), and then wrote a 17-page article titled "Seeking the Magic Mushroom" for *Life* magazine in 1957. This article inspired numerous hipster types to beat a path to her door. Such rock celebrities as Mick Jagger, John Lennon, Keith Richards, and Bob Dylan all seem to have visited her. Joined by

Wasson, Swiss scientist and LSD concocter Albert Hofmann paid her a more scientifically inspired visit in 1962.

Perhaps not surprisingly, Maria Sabina felt that her children had lost their saintliness after "the coming of white man."

See also Ethnomycology; Magic Mushrooms; *Teonanacatl*; Wasson, Gordon.

Santa Claus

A celebrated Christmas gift giver who may have the fly agaric (*Amanita muscaria*) as one of his ingredients. Here's the reasoning behind this seemingly preposterous claim:

In Lapland, shamans used to visit their clients on reindeer-drawn sleds, and such would be the snow buildup around the client's front door that the shaman would be obliged to enter the domicile through the chimney. Prior to his visit, he would have ingested several fly agarics. In Saami (Lapp) lore, a shaman who eats one of these mushrooms ends up looking like one of them—that is, he becomes plump and reddish and covered with white splotches.

Such shamans would give their clients medical or personal advice rather than material objects like the latest Apple product. In addition, the mushroom frequently makes whoever eats it feel as if they're flying. Reindeer delight in eating fly agarics, and they presumably feel as if they're flying, too. Here I should add that, because reindeer are very fond of the mushroom, contemporary Saami reindeer herders create trails of fly agarics so their reindeer will go where they want them to go.

If these details don't add up to Santa Claus, they offer at least a partial facsimile of the reindeer-driving fellow.

See also Fly Agaric.

Saprophytes

From the Greek *sapros*, which means "rotten." Saprophytes (mycological name: saprobes) break down organic molecules in leaf litter, waste products, stumps and fallen logs, animal remains, and other fungi—in other words, organisms that are injured, dying, or already dead. A tree with a recently lost limb offers a prime invitation for a saprophyte. So does the organic detritus in your lawn's soil for meadow mushrooms (*Agaricus* sp.) and the lawnmower's mushroom (*Panaeolus foenisecii*). Mycorrhizal fungi can be saprophytes, although extremely modest ones.

Fungi delight in playing games with human-based terminology. It could be argued that genetically engineered or domestic plants are injured, so the fungal species that attack them could be described as saprophytes rather than parasites. The same with the domesticated wood of a house when it's attacked by dry rot (*Serpula lacrymans*), which is commonly called a parasite. On the other hand, the myriad decomposers of heartwood, the dead wood in a tree, have a negative effect on the structural integrity of the tree, so they could be called parasites rather than saprophytes. The polypore *Trametes gibbosa* could be called both, since it's a saprophyte mostly of beech logs and stumps, but it also parasitizes the mycelia of its fellow polypore *Bjerkandera adusta*.

See also Lawnmower's Mushroom; Parasites; Polypores.

Schobert, Johann (ca. 1735–1767)
A German composer who shouldn't be confused with the somewhat better known, not to mention considerably better, Austrian composer Franz Schubert. Nowadays Schobert is more famous for the manner of his death than for his music.

Although the young Wolfgang Mozart admired Schobert's music, Mozart's father, Leopold, thought that the composer's talent was, as Leopold put it, "low." But however low Schobert's musical talent was, his ability to identify mushrooms was even lower. At Le Pré-Saint-Gervais outside Paris, he picked a batch of mushrooms and brought them to a restaurant so the chef could cook them. "Poisonous," the chef said. Schobert left in a huff and brought them to another restaurant, whose chef said the same thing. Whereupon Schobert went home and cooked the mushrooms himself. The species was probably the death cap (*Amanita phalloides*), with the result that Schobert, his wife, and all but one of his children departed this world.

Sclerotium
An underground, slightly wrinkled, roughly spherical structure designed to sequester nutrients so that the parent fungus, usually a polypore, can ride out adverse environmental conditions.

Perhaps the best-known example of a sclerotium-producing fungus is the polypore *Wolfiporia cocos*, whose coconut-shaped sclerotium is called tuckahoe by Native people in the southeastern United States. These people traditionally used tuckahoe in a manner similar to the way the fungus itself uses it—as an emergency food. It

was also a survival food for runaway slaves before and during the Civil War. The similar sclerotium of *Wolfiporia extensa* is currently used in China to invigorate the spleen.

The so-called stone fungus (*Polyporus tuberaster*) has a sclerotium that's edible only when it's young and thoroughly cooked. In northern Europe, the same sclerotium was once thought to be the coagulated urine of a lynx or wolf marking its territory, and as a result it was regarded as highly inedible.

Other species that produce an underground sclerotium are the umbrella polypore (*Polyporus umbellatus*) and the Australian polypore (*P. mylittae*); the latter is called blackfellows' bread because it was once a popular food among local Aborigines. The sclerotium of the king tuber mushroom (*Pleurotus tuber-regium*) is still used as an ingredient in body paint in parts of Nigeria.

Sequencing

A contemporary mycological god, worshipped especially in the halls of academe. It consists of extracting genetic information from a small fragment of fungal tissue in order to give a name, preferably a new one, to a specimen. Such information also determines the evolutionary relationship between that specimen and its fungal colleagues. Thus the identity of that fungus no longer needs to be inferred from physical characteristics.

Subjecting a fungus to molecular study is, among other things, an attempt to stabilize nomenclature, but it seems to be having the opposite effect. Genus names, especially, are changing with such reckless abandon that it's almost impossible to keep up with them. On that

subject, mycologist Gary Lincoff said, "I know fewer names each year," adding, "I feel like I'm suffering from early onset Alzheimer's."

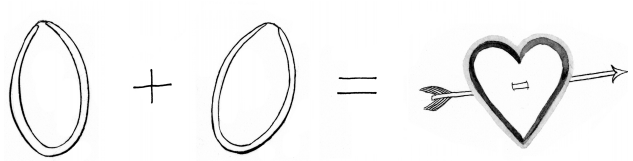
On a positive note, sequencing has resulted in some remarkable discoveries, such as the uncovering of a new phylum of primitive fungi called Cryptomycota, and the fact that such gilled mushrooms as *Lentinus* are more closely related to polypores than they are to other gilled mushrooms. Likewise, gilled mushrooms like *Paxillus* and *Tapinella* turn out to be closely related to boletes.

At present, 35,000 or so fungal species represented by DNA sequences occur in public databases.

Sex

An obligatory activity for virtually all fungi except certain yeasts, molds, and endomycorrhizal fungi, which usually reproduce by cloning themselves.

Most fungal spores are heterothallic, which means they need to mate with a compatible spore. As with humans, pheromones come into play prior to the actual mating. Just as we can sense a potential partner from a distance, so a spore can sense a partner with a different haploid set of chromosomes and move inexorably in its direction. Upon meeting, they perform no activity that even remotely resembles foreplay. Rather, the two spores, which by now have germinated to become



hyphal filaments, immediately engage in the fungal equivalent of a sexual act—they fuse and, combining their genetic information, become a mycelium.

When a spore walks into a proverbial bar, it usually leaves that bar by itself, for the chances of two spores mating is very slim. This is one reason fungi produce them in vast quantities. Another reason is that those spores won't ever meet each other, since one or both are likely to end up in an inappropriate substrate.

The mating types of spores are sometimes called genders. To ensure their survival, most fungi have many genders, but the split gill (*Schizophyllum commune*) takes the proverbial cake by having 28,000 genders.

See also Split Gill; Spores.

Shiitake (*Lentinula edodes*)

A Japanese word that translates as "oak mushroom." Shiitakes are light- or amber-colored basidiomycetes that grow in the wild in certain parts of Asia, but they can also be found on log piles in backyards and in mushroom-growing facilities around the world, for they're relatively easy to cultivate—all you need to do is drill a hole in an oak (or hornbeam) log and then insert a plug of wood with a shiitake mycelium into that hole. In a year or less, shiitakes will probably be fruiting on the log.

Shiitakes are regarded not only as a good edible, but also as a good medicinal. Lentinan, a compound derived from the mushroom, is reputedly effective in the treatment of cancer, heart disease, diabetes, and high cholesterol. Whether because of lentinan or some other, perhaps mystical ingredient, shiitakes are also thought to promote youthfulness and virility.

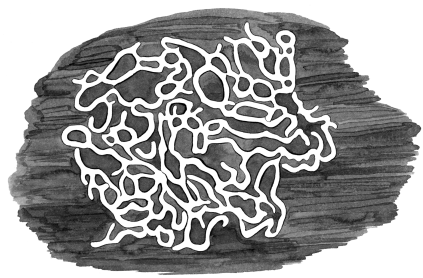
On the other hand, the mushroom has been known to give some people an unpleasant allergy known as shiitake flagellate dermatitis. This allergy looks like whiplash marks on the skin and is caused by a toxic reaction to lentinan. Likewise, people with autoimmune disorders have sometimes developed abdominal ailments and joint pain from eating shiitakes.

See also Medicinal Mushrooms.

Slime Molds

Also known as myxomycetes, these protozoa-like organisms are often confused with fungi, so they've been included in this *Fungipedia*.

Unlike fungi, slime molds crawl about in search of their food, which is mostly bacteria, protozoa, and other microorganisms. One species has been clocked at the not very brisk speed of one millimeter per hour. In this stage, called the plasmodial phase, they can make good



Hemitrichia serpula
Pretzel Slime Mold

pets, according to mycologist Bryce Kendrick, who feeds them old-fashioned rolled oats rather than bacteria. Doubtless he doesn't need to housebreak them or throw a tennis ball for them.

The next stage, called the sporangial phase, is nonmobile. Here slime molds metamorphose into their own equivalent of fruiting bodies and begin manufacturing spores. These two phases are so dissimilar that mycologist Gary Lincoff compared them to Dr. Jekyll and Mr. Hyde.

In their movements, slime molds look for the most efficient route between food sources, so they've been used to map transportation routes in cities. For example, the species *Physarum polycephalum* has been used to re-create Tokyo's rail system in miniature.

The 1958 sci-fi film *The Blob* would seem to be based on the behavior of slime molds. In that film, an extraterrestrial "blob" swallows the earth's human inhabitants as if they were, in fact, bacteria.

Sloths

Arboreal mammals whose outer layer of fur provides a rich substrate for various insects, but also a rich substrate for fungi, especially if the sloths are living in the tropics. A sloth's hairs have grooves that serve as hydroponic gardens for fungi. Sarah Higginbotham at the Smithsonian Tropical Research Institute has found as many as 84 different fungal species in the fur of three-toed sloths in Panama's Soberanía National Park. Some of these species are doubtless acting as a defense against particularly nasty bacteria, malaria, and Chagas disease, the last of which is an inflammatory parasitic

disease in the tropics, not the consequence of drinking too much chaga tea.

Thus it would appear that sloths—like many humans—use fungi in a medicinal manner.

Smell

Just as fungi come in a variety of sizes and shapes, they also come with a variety of smells. While the carrion-like odor of stinkhorns is designed to coax insects into spreading their spores, the smell of certain other mushrooms may be saying to the prospective diner, "If you eat me, you'll be sorry." Still other mushroom smells may be no more than a by-product of mycelial action.

Here are some examples of mushrooms and their smells: *Lactarius hibbardae* smells like coconuts; several *Inocybe* species have a spermatic odor; *Cortinarius vulpinus* has the odor of a sow in heat; *Trametes suaveolens* and the aniseed polypore (*Haploporus odorus*) have the odor of anise; chanterelles smell like peaches or apricots; *Amanita citrina* smells like raw potatoes; *Cortinarius paleaceus* smells like geraniums; *Mycena alcalina* smells like Clorox; and *Russula xeromphalina* smells like cooked crab. The generic mushroom smell tends to differ from nose to nose, although it is often described as farinaceous, musty, or mushroomy. Chemically, that smell is oct-1-en-3-ol.

Finally, there's the odor of a veiled stinkhorn (*Phallus* sp.) in Hawaii, which (according to a not particularly reliable 2001 article in the *International Journal of Medicinal Mushrooms*) obliges many of the women who smell it to experience spontaneous orgasms.

See also Aniseed Polypore; Stinkhorns.

Snake Fungus (*Ophidiomyces ophiodiicola*)

A soil-dwelling species in the order Onygenales. First documented in 2006, the fungus affects virtually all snake species, from rattlers to garter snakes, in the eastern and midwestern United States. Recently, it has been detected in European snakes as well.

Snakes pick up the spores of the fungus either by contact with each other or from the soil. The result? Eventual lesions in their bodies, ulcers in their skin, abnormal molting, dehydration, and blindness. The mortality rate is close to 100 percent. On the positive side, snakes are able to rid themselves of the fungus if they molt before it penetrates their tissues.

Since *Ophidiomyces ophiodiicola* is native in North America, it would seem that snakes weren't susceptible to it before the twenty-first century. This would suggest that they might have lost their immunity in more or less the same way that amphibians infected by chytridiomycosis seem to have lost theirs—as a result of habitat destruction, pollution, and human encroachment, among other anthropogenic factors.

See also Chytrids; Keratinophiles.

Snell, Walter (1889–1980)

Mycologist and major league baseball player. In the latter capacity, he was one of five catchers used by the Boston Red Sox in 1913. Subsequently, he became both head baseball coach and a professor of mycology at Brown University in Providence, Rhode Island.

In addition to tree diseases and decay in building timber, Snell specialized in boletes. In 1941, he married another bolete expert, Esther A. Dick (1909–1985), and began coauthoring papers with her. In 1957, they cowrote *A Glossary of Mycology*. They also cowrote the highly regarded monograph titled *The Boleti of Northeastern North America*.

You could argue that Snell's mycological batting average was considerably better than his baseball one, for "Wally," as Snell was called in his baseball days, had a batting average of only .250 in the big leagues.

Soft Rot

Not bacterial soft rot, which often requires treatment, but a usually unaggressive activity performed by certain ascomycetes on wood. Unlike the mycelia of most

wood-inhabiting basidiomycetes, ascomycete mycelia tend to inhabit a relatively small area, usually the outermost layer, of their host. As a result, they break down only a small amount of wood and, in doing so, create equally small cavities in that wood. An exception is soft-rotting molds like noble rot (*Botrytis cinerea*), which are considerably more aggressive than rotting ascomycetes.

Unlike white or brown rotters, most soft rotters tend to prefer cool conditions, which is one reason you frequently see discomycetes like morels in the spring, a time when most other fungi don't fruit. Another reason is that they don't need to compete with those other fungi, which are usually basidiomycetes with far more aggressive mycelia.

On a historical note, soft-rot fungi are the major form of decay in the tomb of King Midas, who ruled Phrygia nearly 3,000 years ago. Apparently, the fungi used nitrogen from the king's body to assist them in colonizing this ancient wooden chamber.

See also Ascomycetes; Brown Rot; Discomycetes; Noble Rot; White Rot.

Spalting

A sign of the chemical warfare engaged in by various fungi in dead or dying wood. The type of spalting most likely to be noticed by the casual observer is known as zone lines. More formally, it's called pseudosclerotial plates (PSPs, for short). These typically winding lines are much prized by woodworkers and indicate a particular mycelium's territory of decay, more or less saying, "This is my territory, so no trespassing" to other mycelia. The mycelia exude various chemicals to insulate

that territory from other mycelia, preventing (in the words of mycologist Jens Petersen) "a hostile takeover by those mycelia."

The most commonly spalted wood comes from birch, maple, and especially beech trees, and the most common fungal spalters include the turkey tail (*Trametes versicolor*), the beefsteak polypore (*Fistulina hepatica*), and the carbon cushion (*Kretzschmaria deusta*), the last of which is an especially eager spalter.

Since spalted wood is commonly used by woodworkers, several US companies have acquired patents for inoculating wood with spores on the assumption that there will eventually be spalting in that wood.

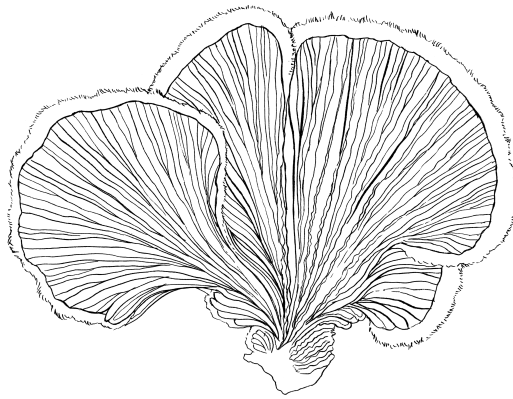
See also Green Stain.

Split Gill (*Schizophyllum commune*)

A relatively small, gregariously fruiting mushroom with a fuzzy cap and gill-like folds that are often mistaken for actual gills. The species name (*commune* = common) is a reminder that the split gill can be found on every continent except Antarctica.

In the 1950s, Harvard mycologist John Raper determined that the split gill's spores have 28,000 mating types (genders), a fact that probably makes it the world's most promiscuous mushroom. This is one reason for its ubiquity. Another is that split gills can dry up and rehydrate a number of times, sending out spores each time they revive.

Split gills usually colonize rotting wood, where they engage in a very modest form of white rot. They've occasionally been found on grass silage as well as in human sinuses and lungs. The author of this *Fungipedia* has found



them growing on skulls taken long ago by headhunters in Borneo. Likewise, they've been known to parasitize fungi that are plant pathogens by more or less strangling the hyphae of those fungi with their own hyphae.

The split gill's somewhat leathery texture makes it a prime edible in Southeast Asia, where taste and texture are often regarded as synonymous. In North American guidebooks, however, it is always listed as "inedible."

See also Sex.

Spongiforma squarepantsii

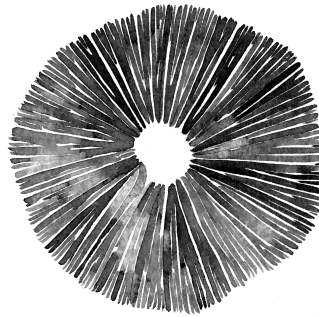
A bright orange, extremely spongy member of the bolete family first discovered as recently as 2011 in Sarawak, Malaysia, by mycologist Tom Bruns and named after the well-known Nickelodeon cartoon character SpongeBob SquarePants.

The species name *squarepantsii*, created by Bruns and two of his colleagues, annoyed certain mycologists. After all, science shouldn't be amusing, or so they argued. But science is a vast, multifaceted discipline, and there's no reason it can't be amusing, indeed downright hilarious if the situation calls for it. After all, a subspecies of the American cottontail ("bunny") is named *Sylvilagus palustris* var. *hefneri*, after Hugh Hefner, and there's a slime mold–inhabiting beetle named *Agathidium bushi*, after George W. Bush.

Spore Print

The practice of placing a mushroom on white or dark paper with the fertile surface down so the spores can be liberated and their color determined. That color can serve as a diagnostic feature that might help identify a specimen. Historically, the classification of fungi was based partially on spore color. The nineteenth-century mycologist Elias Fries was especially devoted to this method of classification. It should be noted, however, that a very old mushroom or an immature one might not yield any spores.

One very important reason to make a spore print is that the color of a mushroom's gills or pores when immature is not always the same color as when mature. An example is the false parasol (*Chlorophyllum molybdites*), a toxic species whose gills are whitish when they're young, but green when they're mature. The excessively eager mycophage who mistakes a specimen for an actual parasol (*Macrolepiota procera*), which has white gills when mature, is likely to pay the medical consequences.



Often a spore print seems like a work of art and, indeed, mycologist Sam Ristich once had a showing of his spore prints at an art gallery.

See also Fries, Elias; Ristich, Sam; Spores.

Spores

Tiny seedlike propagules created by algae, plants, and bacteria as well as fungi. If there were no spores, there would be no fungi, so fruiting bodies manufacture as many as possible, knowing that 99.9 percent of them will end up in the wrong place, in (for example) a parking lot or on someone's outdoor trampoline rather than on an oak log. The pillow on which you lay your head at night may have as many as 500,000 spores, virtually none of which want to be there.

A typical mushroom in the prime of its life might produce upward of 30,000 spores *per second*. Certain spores can remain viable for 100+ years, so when they walk into a bar, they can simply sit down on a stool and wait, and then wait some more, until a compatible mating type also walks in.

Words used to describe spores include smooth, globose, angular, elliptical, tuberculate, ornamented, starlike, rhomboid, hexagonal, allantoid, fusiform, and warty. The spores of many *Inocybe* species are often shaped like gummy bears. Although the typical length of a spore is around only a thousandth of a millimeter, each one carries the entire genome of the parent fungus.

Insects are good vectors of spore dispersal, but so are human beings. A spore gets into the air, lands on a tank top or three-piece suit, or rests on a pram or bicycle, and it might, just might, be conveyed to the appropriate substrate.

See also Sex; Spore Print; Substrate.

Stamets, Paul (1955–)

Often referred to as a Renaissance mycologist because of the diversity of his fungal interests, which include mycoremediation, culturing mushrooms, fungal medicinals, insect-fungal relationships, and magic mushrooms. With respect to the last of these subjects, his book *Psilocybin Mushrooms of the World* is a standard guide. Stamets has delivered numerous TED talks and holds what might be the world record for fungal patents. He's also the founder and CEO of Fungi Perfecti, a company in Shelton, Washington, that specializes in mushroom-related products.

Stamets once told the author of this *Fungipedia* that the first thing we'll see when we arrive on another planet will be fungal mycelia. Indeed, in his book *Mycelium Running*, he predicts that there will be a future publication titled *The Interplanetary Journal of Astromycology*. So it's not surprising that an astromycologist

named Lieutenant Paul Stamets should make an appearance on the TV show *Star Trek: Discovery*. An expert in space mushrooms, Lieutenant Stamets observes that "all galactic life springs from spores."

In real (as opposed to reel) life, Stamets is dedicated to the belief that fungi can be instrumental in saving our own planet. For example, he's currently working on a plan to use fungi to prevent colony collapse in bees. If there were a Nobel Prize for mycology, Stamets would be a highly eligible candidate.

Stem

Also called a stipe or a stalk, a stem is a common feature of gilled mushrooms, boletes, a few ascomycetes, and even several polypores. If a mushroom is growing on the ground, the stem will usually be obvious, for the elevation of that mushroom's spore-bearing cap is an all-important requirement. Many mushrooms on wood either don't have stems or have only modified stems, since the typically elevated nature of the wood—branch, stump, snag, or actual tree—serves the same purpose.

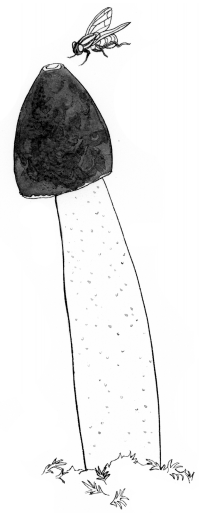
Diagnostic terms for different kinds of stems include fleshy, tough, scaly, scurfy, fibrillose, silky, hollow, cartilaginous, leathery, swollen, viscid, and off-center. The stem of Russell's bolete (*Boletellus russellii*) has among the shaggiest of all stems; it sometimes looks like a backbone whose vertebrae have gone awry. Certain *Amanita* species have a prominent saclike structure at the base of the stem called a volva. Some *Amanita* species also have a radicating (rooting) stem, and in order to identify them, you need to dig into the ground and

collect the entire mushroom rather than just cut off the cap and a portion of the stem.

The stems of *Hymenopellis* and *Paraxerula* (formerly *Xerula*) species are more deeply radicating than those of any *Amanita*. The author of this *Fungipedia* once found a specimen of *Hymenopellis furfuracea* nearly two feet long, only seven or so inches of which appeared above the ground.

Stinkhorns

Basidiomycete inhabitants of the order Phallales, whose name indicates the shape of some stinkhorns. Other shapes suggest starfish, baskets, cigars, lizard claws, and squid. But whatever their shape, all stinkhorns have one thing in common—a noisome smell emanating from a slimy mass of spores called a gleba. Described as being akin to ripe carrion, this smell attracts flying insects, especially carrion-loving flies, to vector the spores. The veiled stinkhorn (*Phallus duplicatus*) has a drooping, curtain-like feature that may serve as a ladder so that nonflying insects can also reach its gleba (very democratic!).



Human beings do not share insects' enthusiasm for stinkhorns. In New England, a specimen found on one's land was once thought to indicate a forthcoming death in the family. Charles Darwin's daughter Etty

famously collected stinkhorns on her estate and burned them, lest their phallus-like shapes corrupt the morals of her maids. Upon sniffing the species *Phallus ravenellii*, an early American naturalist said that it was as if "all the bad smells of the world have been turned loose."

Their "eggs"—the round, underground structures from which the fruiting body emerges—are reminders that stinkhorns are puffball relatives. Those eggs are sometimes sold as truffles in Europe.

See also Phallus impudicus; Smell.

Substrate

"Tell me the landscape where you live, and I'll tell you who you are," wrote Spanish philosopher Ortega y Gasset. You could say something similar if you're talking to a fungus: tell me your substrate, and I'll often be able to identify you.

A substrate is the place where a fungus lives and from which it obtains its nutrients. Since anything organic or even slightly organic will do, fungal substrates include not only wood, dung, and soil but also keratin, caves, paraffin, insects, sewage, algal blooms, wallpaper, cable casement, curtains, binocular lenses, old books, coffee grounds, wet bathrooms, jet fuel contaminated by water, animal burrows, space stations, pine resin, and even our own guts, where 267 different species of fungi have been documented (you'll never be alone, Greta Garbo!). The space between our toes is home for approximately 40 different species, each of which has decided to live there rather than anywhere else on the planet. Even the wreck of the *Titanic* is not without fungi: the marine species *Halomonas titanicae* is currently eating away at

its remains. Other marine fungi seem to be eating seaweed rather than sunken passenger ships.

Typically, there's more fungal diversity in an urban park than in an old-growth forest. This is because the park has a much larger variety of substrates—some natural, some damaged, and some brought from elsewhere—and fungi are nothing if not opportunists in their search for an appropriate home.

Tar Spot (*Rhytisma* sp.)
An ascomycete that looks not unlike a black splotch of tar. It can be found mostly on the leaves of red, silver, sugar, big leaf, and Norway maples, as well as sycamores. To affix itself to these leaves, each of a tar spot's spores exudes a tiny amount of mucilage. Those spores are among the most anorexic in all of Kingdom Fungi—200–300 microns long and only 3 microns wide.

Tar spots don't have much adverse effect on leaves still on tree branches other than to cause premature defoliation, which occurs only a short time before the normal defoliation period. It's only when the leaves have fallen to the ground that a tar spot shifts to a genuine dining mode. That occurs when its spores germinate, which they do via germ tubes—structures that infect the already dead leaf's epidermal cells.

But sulfur dioxide emissions have an adverse effect on tar spots, so you're unlikely to find them growing on leaves in a highly polluted area. As a result, tar spots can be regarded as indicators of air quality.

Teonanacatl

Aztec word usually translated as "flesh of the gods." This flesh refers to psychoactive mushrooms, the use of which by the Aztecs early Spanish missionaries tried to suppress, calling the mushrooms in question "flesh of the Devil." Once they were Christianized, some Aztecs reputedly heard Jesus talking to them after they consumed some *teonanacatl*.

According to the Dominican friar Diego Durán, the coronation of Emperor Montezuma featured not only the usual human sacrifices but also copious amounts of *teonanacatl*, which he said affected people "more than if they had drunk much wine."

The Aztecs seem not to have restricted themselves to a single species but used several *Psilocybe* and *Panaeolus* species for ritualistic purposes. Mazatec *curandera* Maria Sabina fed ethnomycologist Gordon Wasson only *Psilocybe* mushrooms, calling them her "saintly children," rather than *teonanacatl*.

In Mexico and Guatemala, stone and ceramic figures known as *piedras hongo* (fungus stones) have been discovered in the form of mushroom caps, with apparent spirit figures on the stems. The artifacts in question may or may not have some connection with *teonanacatl*.

See also Magic Mushrooms; Sabina, Maria; Wasson, Gordon.

Thaxter, Roland (1858–1932)

A Harvard mycologist nicknamed the "Squirt Gun Botanist" because he was responsible for introducing fungicide sprays to US agriculture. With respect to documenting rather than getting rid of fungi, he devoted much of his scientific career to ascomycetes. He specialized in the order Laboulbeniales (often abbreviated as Labouls), which form a thin chitinous layer on the exoskeletons of certain insects. Between 1896 and 1931, Thaxter published a five-volume survey of this order that includes some 3,000 meticulously drawn pen-and-ink illustrations.

When not occupying his laboratory at Harvard, Thaxter would make collecting tours, especially to remote places in the Southern Hemisphere. Specimens he collected from the Falkland Islands, Patagonia, and Tierra del Fuego occupy a privileged place in Harvard's Farlow Herbarium.

Thaxter had a retreat in Kittery Point, Maine, where he would go skinny-dipping promptly at 11:00 a.m. each morning, year round, in the frigid waters of the North Atlantic. This indicates that he didn't restrict his remarkable precision merely to pen-and-ink illustrations.

Toadstool
A term of derision for a mushroom, especially a poisonous one, although the word was used in England until recently to mean any sort of mushroom, even edible species.

The word's etymology is obscure. It may be derived from the Old German words *tode*, which means "death," and *stole*, "chair." Or it could be a fusion of the Old Icelandic word for dung, *tad*, and the word *stoll*, which means "stool," particularly one in a lavatory. It could also relate to the fact that toads, which are sometimes venomous, are known to sit on mushrooms; in the old days, people doubtless thought they were purposefully imparting their venom to this seat. Thus if you ate them,

indeed only touched them, you might end up in deep trouble. Each of the word's potential origins has the same meaning—mushrooms are utterly vile entities, so don't mess with them.

The origin of the word "mushroom" is clouded in mystery, too. It could be derived from the Old French word *mousseron*, which means "moss." It could come from the Latin word *mucus*, which means "slippery" or "slimy." Or it could be derived from the Old English, Old German, or Old Norse words for moss.

Because they're not associated with edibility, polypores, crusts, and microfungi tend not to have been given negative euphemisms.

See also Mycophobia.

Tooth Fungi

An assemblage of basidiomycetes from at least eight different orders, tooth fungi have one thing in common—they possess slender, nonbiting projections called teeth (mycological name: aculei) that face vertically downward. These teeth are an evolutionary adaptation that makes this statement: "I can do a better job creating and spreading spores with my downward projections than I could ever do with gills or pores."

Some teeth are pointed, some are flattened, and a few (such as those of *Hyphodontia barba-jovis*) look as if they're desperately in need of dental help. Fruiting bodies can be resupinate or bracket-like or have stalks. At least one species, the bleeding tooth (*Hydnellum peckii*), exudes droplets of oxalic acid.

Several polypores, such as the white-toothed polypore (*Irpex lacteus*) and the purple-toothed polypore

(*Trichaptum biforme* and *T. abietinum*), manufacture toothlike projections around their pores, but they're not actually tooth fungi.

Tooth fungi can either inhabit wood or be ectomycorrhizal. In the latter capacity, they do not form fairy rings, so they've never been the subject of jokes about tooth fairies. Genera include *Hydnum*, *Hydnellum*, *Steccherinum*, *Phellodon*, *Sarcodon*, and *Climacodon*.

Train Wrecker (*Neolentinus lepideus*)

The common name of a fleshy mushroom with a scaly white to buff-colored cap and a no less scaly downward-tapering stalk that has a ring. Being serrated, the gills look as if they've been gnawed on by some very small, but very ravenous critter.

While no mushroom has ever been known to wreck a train, this species is capable of wrecking railway ties because it has no problem digesting creosote-treated coniferous wood such as, for instance, the wood in railway ties. Since train wreckers have also been known to digest coniferous telephone poles, they could just as readily be called telephone pole wreckers.

Train wreckers are a robust cousin of the shiitake (*Lentinus edodes*). This led the USDA to ban shiitake mushrooms from entering the United States from Asia until the early 1970s, lest they wreck, if not trains, at least railway ties.

Train wreckers are edible, unless they're growing on railway ties, in which case they might have absorbed creosote, a not particularly pleasant stew of chemicals to have in one's stomach.

See also Shiitake.

Truffles

Underground tuber-shaped ascomycetes that form mycorrhizal relationships with a variety of trees, especially oaks. The two most gastronomically prized species, the Périgord truffle (*Tuber melanosporum*) and the white truffle (*Tuber magnatum*), have sold at Sotheby's auctions for thousands of dollars. False truffles like the deer truffle (*Elaphomyces* sp.) and *Melanogaster* species are fairly common, but dealers at Sotheby's consider them worthless.

Truffles advertise their presence with a panoply of odors. One odor of the Périgord truffle is remarkably similar to that of a rutting male pig, which is the reason that sows have long been used to sniff it out. The purpose of a truffle's odor is not to attract sows, but to inspire insects and small rodents to come and eat its spores. Those spores pass unperturbed through the diner's digestive system, and the truffle hopes that as a result of this passage, spore-rich fecal matter will be deposited near a mycorrhizally appropriate tree. Coincidentally, a chemical compound found in certain truffles, alpha-androstenol, is also found in the underarm sweat of men and the urine of women.

If truffles are an aphrodisiac for female pigs, once upon a time they were also thought to be an aphrodisiac for male humans. In the Middle Ages, monks were prohibited from eating them, lest they forget their celibate ways and begin courting women.

Turkey Tail (*Trametes versicolor*)

An annual polypore whose common name is derived from its resemblance to the flared tail of a tom turkey.

Recognizable by their zoned caps, small round pores, and range of colors (*versicolor* is Latin for "various colorings"), turkey tails cause white rot in deciduous logs and stumps. That they are not only common all over the world but also tend to grow in large quantities is due to the powerful enzymes secreted by their mycelia. Those enzymes either ward off or kill other mycelia that share the same woody substrate as the turkey tail, except for the gilled polypore (*Trametes betulina*), whose mycelia tend to ward off or kill turkey tail mycelia.

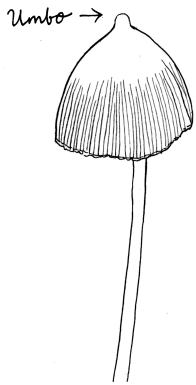
Enzymes in the turkey tail's fruiting bodies are sometimes used to bleach blue jeans in order to give them a fashionable prewashed look. Native people such as the Dakotas used the species not to bleach their garments but to give texture to their soups and stews. Since their polysaccharides reputedly have a talent for stimulating the immune system, turkey tails are also among the most popular fungal medicinals in Asia and, increasingly, the rest of the world.

Given the remarkable variety of its fruiting bodies, it's not surprising that the turkey tail is actually a species complex rather than an individual species.

See also Medicinal Mushrooms; Polypores; White Rot.

Umbo

A common abbreviation for umbonate, this word refers to a raised knob or nipple-like protrusion at the center of a mushroom's cap. If an umbo is pointed, it's acute; if it's rounded, it's cuspidate; and if it resembles a female breast, it's either mammillate or papillate.



Umbos may have evolved so that a rising mushroom could push aside leaf litter and duff prior to releasing its spores. Umbonate species are more common in the fall, when there's more leaf litter and duff, than at other times of year, which would seem to support this theory.

Examples of mushrooms with umbos include certain *Hygrocybe*, *Conocybe*, *Inocybe*, and *Cortinarius* species. It's been suggested that *Amanita penetratrix* has such a hard umbo because the species starts out deep in the ground, and it needs to rise quite a distance before it can end up out of the ground. Christina's rootshank (*Phaeocollybia christinae*) has an umbo so sharp and pointed that it seems capable of drawing blood from a person who collects a specimen too vigorously.

Valley Fever

Formally called coccidioidomycosis (cocci, for short), valley fever is especially common in California's San Joaquin Valley, where upward of half the population may be infected. This explains the other name for the disease—San Joaquin Valley Fever.

Valley fever is caused primarily by *Coccidioides immitis*, a fungus that inhabits highly alkaline soils. During dry spells, *C. immitis* remains in the soil, but during and immediately after rain its conidia (asexual spores) become airborne and are easily inhaled, whereupon they

can result in respiratory problems. On certain occasions, the disease can affect the rest of the body, where it's been known to cause lesions and abscesses in the bones, joints, internal organs, and meninges. It should be noted, however, that most cases of valley fever go unnoticed because of the similarity of symptoms to those of the common cold or the flu.

In addition to rain, construction activity has been implicated in the current spike in the disease. After all, rain tends to kick up lots of spores. Excessive farming has also been implicated in this spike.

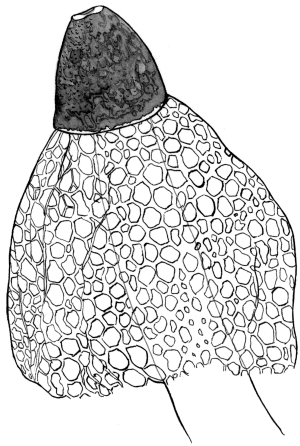
First documented in 1893 in Argentina, valley fever is endemic to arid regions in the Western Hemisphere.

See also Bird Droppings.

Veil

Also called an annulus, this is a protective membrane that covers certain mushrooms, particularly *Amanita* species, when they're immature. When a veil covers the entire mushroom, it's called a universal veil, but when it only connects the cap to the stem, it's called a partial veil. Both protect the mushroom's most fertile parts, its gills or pores, until such time as the fruiting body decides to sporulate. At this point, the veil ruptures, usually leaving a pendent, skirt-like, flaring, or evanescent ring around the stem. Sometimes this rupture will leave scales or wart-like protrusions on the cap or, as in the case of certain *Amanita* species, a saclike bulb called a volva at the base of the stem.

Of all veils, perhaps the most eye catching is the one belonging to the stinkhorn species *Phallus duplicatus*. Drooping most of the way down its stem, it looks like



Phallus duplicatus
Veiled Stinkhorn

an unsuccessful attempt by the stinkhorn to conceal its penis-like morphology from censorship.

Wasson, Gordon (1897–1986)
Ethnomycologist and Wall Street banker. Best known for his devotion to psychoactive mushrooms, Wasson was vice president of J. P. Morgan & Company for 20 years, a conservative in politics, and a multimillionaire. You might expect such a person to be interested in expensive truffles, not in magic mushrooms. Quite the contrary. Indeed, he kindled the global interest in magic mushrooms by visiting Mazatec *curandera* Maria Sabina in 1955 and writing up his

visit in an article for *Life* magazine, which he paid the magazine to publish.

Wasson was particularly fascinated by the fly agaric (*Amanita muscaria*), which he found almost everywhere in the historical woodwork, including the Stone Age. His book *Soma* argues that it was the ancient Vedic intoxicant known as *soma*. He also surmised that Eve may have tempted Adam not with an apple, but with a fly agaric; he thought the former might be the New Testament's substitution for the latter. Obviously, speculation was where Wasson's mycological virtues lay.

Wasson's friends and acolytes included such notable individuals as LSD synthesizer Albert Hofmann, Harvard ethnobotanist Richard Evans Schultes, and counterculture icons Terence McKenna and Timothy Leary.

See also Allegro, John; Ethnomycology; Fly Agaric; *Teonanacatl*; Sabina, Maria.

Waxy Caps

A common name for certain small or medium-sized mushrooms whose typically wide gills often feel waxy upon being touched. Genera include *Hygrophorus*, *Gliophorus*, *Cuphophyllus*, *Humidicutis*, and *Hygrocybe*, the last of which, being the most colorful, is the most commonly noticed. The parrot mushroom (*Hygrocybe psittacina*) is greenish, the aptly named golden waxy cap (*H. flavescens* or *H. chlorophana*) golden yellow, and *H. coccinea* reddish or scarlet. Regardless of their color, all waxy caps have white spores.

Since waxy caps often fruit when the weather is cold or at least chilly, their frequently viscid or slimy caps

may serve as an antifreeze. Many continue to fruit well after the first frost.

Waxy caps tend to be saprophytes or endophytes, not, as was once thought, mycorrhizal species. They inhabit not only forests, where they seem to associate mostly with moss, but also different types of grassland. Since they're good indicators of ancient or unfertilized grasslands, and since such habitats are on the decline, certain waxy cap species appear to be on the decline, too.

White-Nose Syndrome

Often abbreviated as WNS. A disease in bats caused by the cold-loving ascomycete *Pseudogymnoascus destructans*, whose mycelium covers the wings and skin, but primarily the noses (muzzles), of its victims, making those noses appear white and, as a result, giving the species its common name. An especially unfortunate consequence of this mycelial topping is that cave-inhabiting bats tend to lose the fat resources essential for their winter hibernation.

So far seven million bats of 15 different species have died from the disease in North America. *Pseudogymnoascus destructans* is probably a Eurasian species, but it hasn't caused a bat die-off in Europe, which suggests that North American bats either haven't evolved to deal with it or have weakened immune systems because of such factors as habitat loss and environmental degradation.

WNS is not transmissible to humans, but it might have been transmitted via spores to the initial bats by human cave visitors. An opposite situation involves the fungus *Histoplasma capsulatum*, which grows in bat

guano–impregnated soil and can cause histoplasmosis, a disease transmissible to humans via spores.

As of this writing, some bat species seem to be developing either resistance to WNS or strategies to cope with it, such as waking up together each night to generate group warmth.

See also Bird Droppings; Chytrids.

White Rot

Lignin is the proverbial glue that holds the cellulose in wood together. Fungi capable of breaking it down are called white rotters, since the activity of their enzymes gives the affected wood a whitish color. Wood attacked by white-rot fungi can be described as soft, spongy, and stringy. A word that can be used to describe a white-rot fungus itself is exceptional, since only fungi and a few bacteria have the ability to degrade lignin. Enzymes such as laccase and various peroxidases are highly important tools in this degradation. Lignin, even for a white rotter, is difficult to digest, so the mycelium is obliged to use these tools to turn it into more-digestible carbon compounds.

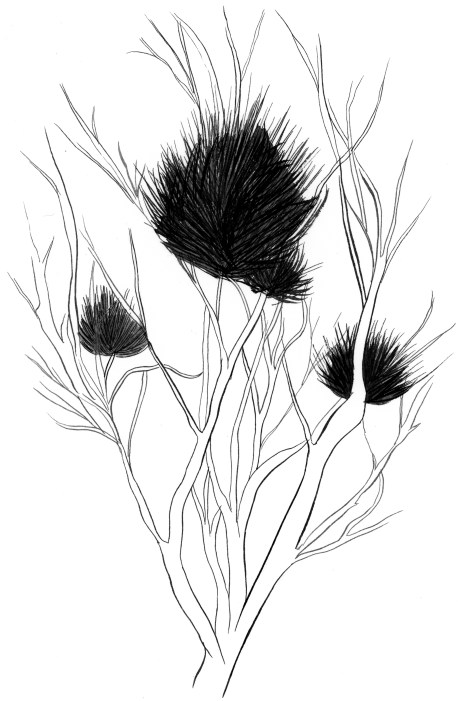
A serious white-rot fungus is the honey mushroom (*Armillaria* sp.), which attacks healthy trees. Less serious examples of white-rot fungi are turkey tails (*Trametes versicolor*) and oyster mushrooms (*Pleurotus ostreatus*), which usually attack dead or dying wood.

A number of white rotters also engage in brown rot, which means they can digest cellulose as well as lignin. Such species are sometimes called simultaneous rotters.

See also Brown Rot; Honey Mushroom.

Witches Broom

A fungal disease that resembles an upside-down broom. These brooms look battered, so much so that they were once thought to have been discarded by witches because they were useless. The flight of a witch over a tree or other plant was also thought to infect it with witches broom. Numerous deciduous and coniferous trees play host to the brooms in question.



Witches brooms are caused by basidiomycete species such as *Melampsora* and ascomycete species like *Taphrina*. Their mycelia release hormones that stimulate extra growth in the host, mostly in the host's small branches and twigs, and then they feed on that growth. Usually, this feeding doesn't do any serious damage to the host itself. Sometimes a tree might already be weakened, and its frail condition will attract the fungi responsible for witches brooms. For example, certain *Melampsora* species form witches brooms only on trees that have been through a fire.

A virtue of witches brooms is that they're used as both rest stops and nesting sites by the northern flying squirrel.

Xerotolerant Fungi

Not a reference to fungi that refuse to tolerate bad behavior by other fungi, but species that thrive in dry conditions. Most are mycorrhizal and possess mycelia capable of extending deep into dry or desert soils so as to connect with the roots of their partners. Such species are also called xerophiles.

Xerotolerant species include the desert shaggy mane (*Podaxis pistillaris*), various stalked puffballs (*Battarrea* and *Tulostoma* sp.), desert truffles, the sand dune–inhabiting mushroom *Montagnea arenaria*, and the barometer earthstar (*Astraeus hygrometricus*). The last of these species has rays that close in dry weather but open in moist or humid weather, which explains its common name.

Certain less conspicuous xerotolerant species are not particularly pleasant. Consider the various fungal

species that inhabit house dust, in which they compete with bacteria for tidbits of food. Also consider the *Aspergillus* molds on stored food—the longer that food is stored and the more cut off its storage chamber, the better. In fact, an *Aspergillus* species may have grown on the food buried with King Tut over 2,000 years ago and caused the king's famous "curse." Because of such substrate choices, mycologist Bryce Kendrick has described *Aspergillus* as "perhaps the most xerotolerant of all organisms."

See also Desert Truffles; King Tut's Curse; Mold.

Yeasts

Single-celled fungi in approximately 100 genera that reproduce by either budding or fission (the splitting of cells). Almost all yeasts are invisible to the naked eye. They were probably the first organisms observed by Anton van Leeuwenhoek after he invented the compound microscope.

Geneticists love yeasts, since they're quite easy to grow in the laboratory. Brewers also love yeasts, since they can use them to make alcohol, which they have done for at least 8,000 years. Baker's yeast (*Saccharomyces cerevisiae*) has been used to make bread for almost as long—it gobbles up the sugars in bread dough and then burps out a bubble of CO_2, forcing the dough to rise. The ancient Egyptians believed the god Osiris gave humans yeasts to upgrade their lives.

If humans love yeasts, yeasts love humans, too. An inhabitant of our so-called mycobiome (note: bacteria inhabit our microbiome), the yeast *Trichosporon inkin* grows on our pubic hairs, eyelashes, and eyebrows.

Candida albicans is an opportunistic yeast that causes infections in our mouths, colons, and reproductive organs. A recently discovered yeast, *Candida auris*, can often be lethal, since it's resistant to antifungal drugs.

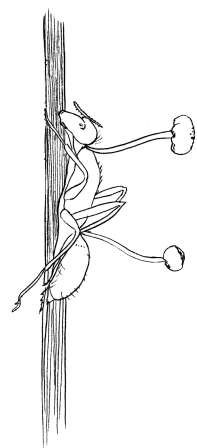
A number of yeasts live in the soil and dry lakes of Antarctica, thus reminding us of the seemingly endless adaptability of fungi.

See also Microfungi.

Zombie Ants

Ants infected by an *Ophiocordyceps* species, often *O. unilateralis*, whose mycelium controls the ants like a puppet master controls his puppets.

The fungus, an ascomycete, is so knowledgeable about ant taxonomy that it releases different chemicals to control different ant species. These chemicals act on the ants' neural networks. Upon being infected, an ant sways back and forth like a zombie and then begins crawling up a nearby tree, where it fastens its mandibles on a leaf or branch. The time between the initial infection and the creation of the fruiting body is between four and ten days.



The ant typically clamps onto the north side of the tree at a height of at least 11 inches above the ground. It also does so when the temperature is between 68 and 86 degrees Fahrenheit and when the time is almost exactly 12:00 noon. Such remarkable specificity would seem to be ideal

for dropping spores on the ant trails immediately below the fungus's fruiting body and causing the zombification process to repeat itself.

With enzymes that eat through their host's cuticle, *Ophiocordyceps* species also attack grasshoppers, spiders, beetles, locusts (transforming their rear ends into a spore mass), and many other arthropods. As with ants, they affect their host's muscles but seemingly leave its brain intact, which means the host remains conscious of its doomed state.

See also Caterpillar Fungus; Fly Killers.

Zygomycetes

So named because their hyphae form a bridge with a spore in the middle (*zygos* is Greek for "yoke"), zygomycetes are an extremely diverse fungal phylum whose

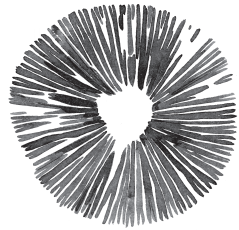
Pilobolus

members don't share a common morphology. Nor do they share a common method of spore production, for some produce their spores asexually, while others do so sexually. Some zygomycetes are decomposers of dead organic matter, like Mucorales, and others, like *Pilobolus*, grow on dung. Trichomycete species inhabit the guts of arthropods, living off the food ingested by their host. The grayish fuzz known as bread mold (*Rhizopus stolonifer*) and the fly killer (*Entomophthora muscae*) are zygomycetes. One species, *Endogone pisiformis*, is mostly a parasite of mosses and produces fruiting bodies that have sometimes been confused with truffles.

On the commercial front, tofu is fermented with the zygomycete *Mucor racemosus*, and tempeh consists of soybeans fermented by species of *Rhizopus*. On the uncommercial front, certain *Mucor* and *Rhizopus* species cause infections of human sinuses that occasionally proceed to the brain.

Here it should be noted that "Zygomycota" has recently been divided into two phyla, Mucoromycota and Zoopagomycota, but since most mycologists continue to use the word "zygomycete," this *Fungipedia* uses it, too.

See also Bonnet Mold; Fly Killers.

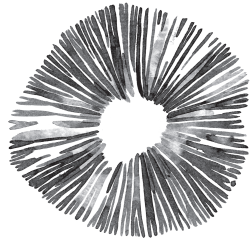


Afterword

Fungi are utterly remarkable organisms, but we understand very little about them. Why, for instance, are certain species yellow, others red, still others white, and a few purple? Are they trying to attract insects, or send insects a message to shove off? Maybe their color simply represents a metastasizing of chemicals by their mycelia. And why are certain mushrooms psychoactive? Probably not because they delight in getting our own species high.

Such questions don't really have answers . . . yet. Mycology is a relatively young science, and fungi are such complex organisms that they (anthropomorphism alert!) might be waiting for it to become somewhat more mature before they decide to yield their secrets.

But the goal of this *Fungipedia* has not been to surround its subject with a plethora of question marks. Quite the contrary. The goal has been to provide the reader with a basic window on fungi and, in doing so, inspire that reader to gaze on all fungi, even the nasty ones, in wonder.



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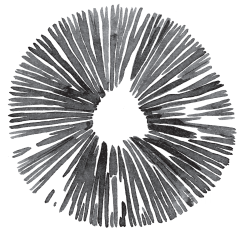

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