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Fungi in Focus: Coprinoid Mushrooms

In This Issue:

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MAW President

Common Name: Shaggy Mane, lawyer's wig, inky cap. The unusual bullet shape of the cap bears some resemblance to the pate so that the cascading scales become disheveled locks or a "shaggy mane".

Scientific Name: *Coprinus comatus* – The generic name is from the Greek koprinos, meaning "of dung," as many of its constituent fungi grow on animal feces. Comatus is Latin for "hairy," referring to the texture of the cap. Family: Coprinaceae (now Agaricaceae).

Potpourri: The Coprinaceae was widely known as the inky cap family for the notable and unique characteristic behavior of some of the larger species like the shaggy mane. Rather than open out into the umbrella shape of a typical mushroom for the air-borne dispersal of spores, the inky caps slowly dissolve into a black, gelatinous fluid that oozes slowly to the ground below. The gradual decomposition of plant and mushroom tissues into a gooey mass is called deliquescence, a specialized case of decomposition. This term is sometimes applied to the inky caps but it is somewhat of a misnomer. Stinkhorns also prematurely degrade to a syrupy liquid that is redolent — the aroma attracts insects that crawl through the muck and then fly away, dispersing the spores as they go. The inky cap or, coprinoid mushrooms, have a similar purpose absent the smell and the flies. The cap dissolves from the bottom up so that the gills and their attached spores are sequentially uncovered to allow for gradual spore dispersal by air currents. It is considered likely that this is an improvement over the typical mushroom arrangement with spore-bearing gills that extend from the underside of the cap. Once the caps open, the spores, which had been protected during the extension from their hypogeal origination in the mycelium, become exposed to environmental degradation. The inky cap spores remain covered and thus protected until they are ready for deployment, probably as an evolutionary enhancement to improve survivability.

Shaggy Mane mushroom. Photo: William Needham

It is wholly logical that a peculiar characteristic like …

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Book Review: "Finding the Mother Tree" by Suzanne Simard

Elizabeth Hargrave
MAW First Vice President

As a reader of this newsletter, there's a good chance you've already come across Suzanne Simard. Her TED Talk, "How Trees Talk to Each Other," has nearly 5 million views. She was in the movie Fantastic Fungi describing mycorrhizal networks. Her work was on the cover of the New York Times Magazine earlier this year, and now she's making the book-tour rounds of shows like NPR's Fresh Air. Will you get anything new out of reading her new book, *Finding the Mother Tree*?

If you want to get straight to the mycorrhizal networks, it will take a few chapters. This is a memoir, and Simard first tells stories of her childhood and her logging family – whose selective logging with cross-saws stands as a clear contrast to the clearcuts that Simard encounters in her first forestry job. A story of digging her childhood dog out of an outhouse pit turns out to be Simard's first glimpse of a cross-section of the forest floor and the brightly colored mycelial networks hidden there. She watches her brother dislocate his shoulder at the rodeo – and manages to connect even that to her larger story, later.

Ultimately this book is about connections, both above and below ground. Through births and deaths, love and divorce, Simard spends decades researching the deeply important connections within the forest communities of the Pacific Northwest. Readers curious about her research will…

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Mushrooms

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cap dissolution into inky black fluid would unite a group of fungi in having a common ancestor. The taxonomic system devised by Carolinus Linnaeus in the eighteenth century relied on such similarities to establish the hierarchical relationships that are still used today; the common traits defined and established family trees with genera of species below and classes of orders above. Darwin's observations of these similarities led to his evolutionary theory based on random mutations and survival of the fittest to explain trait radiation from an originator. All was well with biology until about fifty years ago when the secret life of the genome was slowly but inexorably exposed. While the complexity of inky cap relationships is far from settled, the inky cap family Coprinaceae is no more. The shaggy mane, *C. comatus*, which had been the type specimen for the genus Coprinus, is one of the few that remain but it is now in a different family – Agarciaceae. *Coprinus* is therefore now the inky cap genus in a different family.

The coprinoid mushrooms that have a different DNA profile have been moved to three new genera named *Coprinopsis*, *Coprinellus*, and *Parasola*, the first two retaining the scatological association of the original. Based on their DNA similarity to the genus *Psathyrella,* they have been included in a newly created family named Psathyrellaceae. The most common example of the newly minted "Coprinus-like" genus is *Coprinopsis variegatus* (also *quadrifidus*), which fortunately goes by the much more mnemonic common name "scaly inky cap." They appear in large clusters the day after a good soaking rain from decaying hardwood debris, the shaggy domed shapes like a conclave of bewigged nobility or a battery of ballistic missiles. Although they are considered edible, this would only be for the adventuresome, as they are noted for frequently having an unpleasant odor and taste presumably extracted from the substrate debris from which they erupted.

Coprinoid fungi. Photo: William Needham

The "little coprinuses" of the new genus *Coprinellus* are at the opposite end of the larger, maned sporocarps of Coprinus and Coprinus-like fungi of the once majestic inky cap family dining room table. While retaining the deliquescing inkiness of spore dispersal, the bullet shape is absent in most species in favor of a more typical cap and stem mushroom arrangement. The most well-known is the mica cap, *C. micaceus*, which takes its name from the Latin micare meaning "to flash or sparkle." The silicate mineral mica is a primary constituent of igneous rocks like granite that are characterized by scintillation. Mica caps have evanescent speckles that are the remnants of the partial veil, a barrier employed by some mushrooms to protect the spore-bearing gills on the underside of the cap until the stem is fully extended and the cap opens. They are widely dispersed and quite common on stumps and woody debris and even indoors … David Aurora noted that "bountiful crops sprout periodically from the woodwork of a popular café in Santa Cruz, California." *C. micaceus* may be the world's first scientifically described mushroom, appearing as a woodcut illustration in *Rariorum plantarum historia* by Carolus Clusius that was published in the early seventeenth century.

Even as it has been removed from the patriarchal position as the

Upcoming Events

The events listed below may change, so read MAW emails and check our website at **http://mawdc.org** for up-to-date information on events.

Upcoming Scheduled Programs

August 3 **Monthly Meeting** featuring Eugenia Bone, a nature and food journalist, who was featured in the documentary *Fantastic Fungi* and is working on a mushroom-focused cookbook.

Sept 6 **Monthly Meeting** featuring WVU professors Brian Lovett and Matt Kasson, who will present their lecture "The Zombie Ant Apocalypse" about fungi that are pathogenic to insects.

Sept 10-12 **Annual Weekend Retreat at Sequanota in Boswell, PA** featuring forays and special presentations by Thomas Roehl & Django Grootmyers. For more information, including cost and COVID-19 prevention measures, please visit www.mawdc.org.

For the time being, monthly meetings will be held on the first Tuesday of the month at 7:00 PM online via Zoom (www.zoom.us). Links will be emailed to members before each meeting, posted on the club's Facebook page, and can also be found on the MAWDC website. Members of the public are welcome to attend. To participate in the virtual mushroom ID session, email pictures of mushrooms ahead of time to forays@mawdc.org.

quintessence of the inky cap family that is no more, the shaggy mane *Coprinus comatus* retains it notoriety. It is certainly the inspiration for a stanza on mushrooms in Shelley's *The Sensitive Plant*:

Their moss rotted off them, flake by flake
Till the thick stalk stuck like a murderer's stake
Where rags of loose flesh yet tremble on high'
Infecting the winds that wander by

Coprinoid fungi. Photo: William Needham

The importance of inky caps extends to the laboratory and they have accordingly been the subject of numerous foundational fungal research efforts over the years. particularly in the area of sporulation. The formation of the "ink" is due to gill autolysis, the removal of interference for sequential spore ejection in all gilled mushrooms. The spores are held in place by club-shaped structures called basidia that extend outward on both faces of the vertical gill. The inky caps are masters of spores and spore release — the shaggy mane produces roughly nine thousand million spores in about three days. That works out to 30,000 spores per second.

Dung is a potent source of nutrition for significant swaths of the Kingdom Fungi, the genus name *Coprinus* is not coincidental. Although feces as food is repugnant to people, coprophagy is standard fare for some fungi, some beetles (one of the scarabs is named dung beetle), and rabbits. For one thing, there is a lot of it, deposited daily by roving bands of herbivores leaving cow pies and horse "road apples" in their wake. While most of the proteins are gone, feces is replete with cellulose that animals can't digest but fungi can, and nitrogen, a vital element for all things living. Dung can contain up to four percent nitrogen, which is more than the original ingested plant material. There are almost two hundred genera of fungi, mostly ascomycetes or cup fungi, that are primarily coprophagous. One of the more intriguing examples of nature's insidious exploitation is the zygomycete *Pilobolus crystallinus*. Called "the hat thrower," it is one of several species of fungi that have evolved to grow in dung, shoot their spores up to two meters away toward light, and germinate in the grass away from the dung pile where they are consumed by grazing animals. Passing unaffected through the animal's digestive system, the spores are deposited in new dung in a new place to perpetuate the cycle. Once the zygomycetes and ascomycetes are done, basidiomycetes like the coprinoid mushrooms take over, a succession based on resources needed for fruiting body formation. Ultimately, the dung is recycled ecologically — a good thing, for otherwise we would be buried in it.

Shaggy manes are one of the more noted edible mushrooms, characterized as "choice" in the more popular mushroom field guides, one of which calls it "an excellent substitute for asparagus, it can also be pickled." As with all edible fungi, however, caveats apply and there are doppelgängers that entice the ill-informed neophyte. In this case, it is the "alcohol inky," *Coprinopsis* (nee *Coprinus*) *atramentarius* that looks more or less like a shaggy mane with a haircut. As mushrooms are somewhat variable in appearance according to age and disposition, one might well mistake this for its cousin *C. comatus*. This would not be a serious problem since it is also edible unless your gourmet meal of wild mushrooms includes a glass of wine. The problem is that the alcohol inky contains the toxin coprine, which is similar in effect to disulfiram, the chemical used in drugs administered to enforce alcohol abstinence in those suffering from its addiction. When alcohol is consumed under normal conditions by most people, it is converted to acetaldehyde which is then metabolized to acetate resulting in a pleasant light-headed feeling of mild euphoria. Coprine blocks the metabolic pathway so that acetaldehyde builds up in the body causing "flushing of the face, headache, nausea, vomiting, chest pain, weakness, blurred vision, mental confusion, sweating, choking, breathing difficulty, and anxiety" known as the disulfiram-ethanol reaction. Eating wild fungi has always been a challenge, but some find it worth the time and trouble. Once the subtleties of identification have been mastered, it is the joy of the hunt that prevails.

References available upon request.

Book Review Continued from Page 1

…find satisfaction when Simard describes how she thought up and carried out studies that would go on to prove her hunches, again and again: that forests are cooperative communities that do better in groups of mixed ages and species, not monocultures.

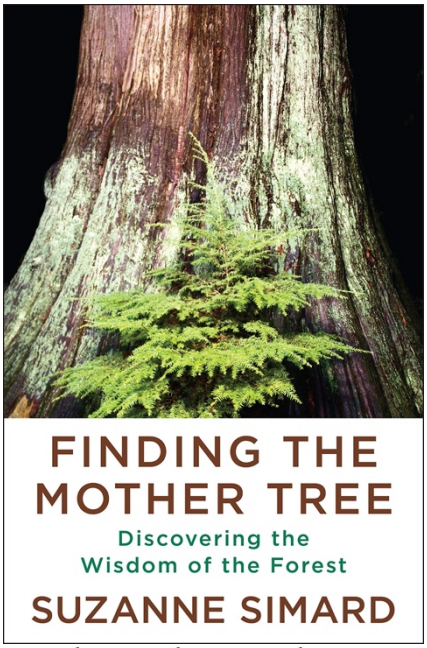
Simard's first controlled experiment found that Douglas fir trees had a better survival rate when birches were allowed to grow in the same plots, compared to plots where the "competitor" birches were killed. The same was true for alder and pine. Using different carbon isotopes, she was able to show that carbon photosynthesized by birch ended up in nearby Douglas fir, and vice versa. Later experiments showed nutrient transfer from established "mother" trees to seedlings, as well as other chemical signals that trees use to warn each other about threats.

Throughout these experiments, mycorrhizal fungi were crucial in carrying out the nutrient transfer. Simard and her colleagues grew seedlings in different bags that allowed or did not allow mycelium to penetrate – and showed that only trees that were connected in a mycorrhizal network were able to share with each other. While fruiting bodies are mentioned a few times in passing, the action here is all underground. Simard waxes poetic about the mycelium that she uncovers in her work, remarking on the bright yellow mycelium of *Piloderma*, creamy white *Lactarius*, "eerily translucent" *Phialocephala*, and jet-black *Cenococcum* with "bristles as stout as a hedgehog's."

Although Simard's findings may seem compelling to fans of fungi, they were harshly rejected for decades by policy makers and foresters. Simard describes her reluctant transformation from curious forester to passionate advocate as she tried to convince people that the logging practices they were using were bad both for the environment and their bottom line. Over time, as her work was corroborated by others, heckling and ostracism gave way to real policy change.

The biggest controversy hanging over Simard's work now is the level of intentionality that she describes in the trees' nutrient sharing. Just in the last 5 years, experiments by Simard's students, including Amanda Asay and Monika Gorzalek, have found that trees preferentially send more carbon to kin than to strangers, even when they are all connected by the same mycorrhizal network within a single pot in a greenhouse. Somehow, they seem to be actively choosing where to send nutrients.

With that research in mind, Simard calls on us to transform our thinking, to align with the teachings of the First Nations people who considered trees people. "Trees and plants have agency," she writes. "They perceive, relate, and communicate; they exercise various behaviors. They cooperate, make decisions, learn and remember – qualities we normally ascribe to sentience, wisdom, intelligence." In her ongoing work with the Mother Tree Project, Simard is continuing to work on demonstrating how this is true, how forest systems are deeply connected… and how fungi are at the heart of those connections.



Finding the Mother Tree: Discovering the Wisdom of the Forest is available in print, digital, and audiobook formats from retailers nationwide. Consider purchasing from local DC bookstore, Politics and Prose.

MAW Board of Directors

The Best Yields of Sweet Tooth Mushrooms

Larry Goldschmidt
Former MAW Member

This article is about harvesting the *Hydnum repandum* (Hedgehog) and *Hydnum umbilicatum* (Sweet Tooth) mushrooms.

Hydnum repandum. Photo: Larry Goldschmidt.

Please refer to the last publication of Hedgehog Mushrooms in 2017 of the Sporophore newsletter (available on the MAWDC website). The Sweet Tooth is one of my favorite edible, wild mushrooms. It has a mild, meaty, and sweet taste. The smaller variety is sweeter in taste than the larger variety. The Hedgehog is one of the best edible, wild mushrooms in the Mid-eastern United States. In my wife and my own experience during 2020, this mushroom can be recognized easily by its pale orange color and its teeth-like structure on the underside of the cap. The color can vary from white to orange. Its cap is slightly depressed in the center as seen in the photo to the left. Its stalk is generally short. It can be found in the ground in quantities under deciduous or coniferous trees during the September-October time frame.

You can find the larger ones in mixed woods on a hillside of oaks with scattered beech and a few pines at the top of or on the side of hills. The smaller ones can be found in areas in the vicinity of fallen or damaged pine trees. Once in a while, they were found right next to fallen oak trees. Some were found in oak woods. My wife and I collected about 3 pounds of them in October 2020. All together my wife and I collected about 70 pounds of them during the season. During the last 18 years, my wife and I found a total of only about 4 ounces of Hedge Hog mushrooms as they are a rare find. But during October 2020, we had our greatest year ever. Our most fruitful outings were on October 3 and October 28, 2020, when we found approximately 11 lb and 18 lb, respectively, in Prince William Forest Park, Virginia. The 2020 season beat our previous record of Sweet Tooth mushrooms found in one year, which was 11 lbs in 2017. The ground cover was mostly leaves with spongy ground and some broken branches and pine trees laying on the ground. The forest had plenty of rainfall during the previous three or four weeks.

A couple of important things we learned about finding the Sweet Tooth mushrooms is that you must look in the proper habitat with the right conditions and ample rainfall. It is also possible that in some good years they might be found in habitats with mountain laurels.

Editor's note: Please only consume foraged mushrooms when you are 100% sure of their identity. Both *H. repandum* and *H. umbilicatum* have a white spore print. Both species have white flesh, while *H. repandum* flesh stains orange and *H. umbilicatum* flesh does not stain. More features of the Hedgehog/Sweet Tooth mushrooms can be found at: http://mushroom-collecting.com/mushroomhedgehog.html. You can also consult your local field guide for more information.

H. repandum (left) and *H. umbilicatum* (right) shown side-by-side to illustrate the difference in size relative to a penny (far right).
Photo: mushroom-collecting.com

Fungi in the News

Marisa Bello
MAW Member

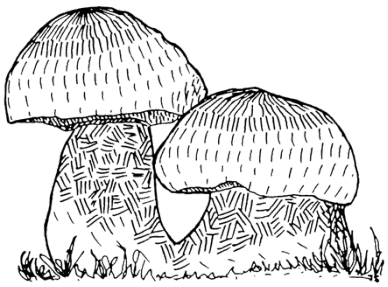
Editor's Note: This article contains summaries of notable fungus-related news from March through June 2021. Visit the URL following each topic below for a closer look.

Researchers at Northwestern University synthesize melanin from fungi

Melanin, a pigment found in human hair and skin that imparts a brown color, exists in a multitude of life forms. Melanin has been found in fungi living in hostile conditions, notably Chernobyl and on spaceships, leading researchers to believe that it serves as a protectant from harmful toxins in these environments. When researchers at Northwestern University attempted to synthesize melanin in fungi, they were surprised that the melanin found in these fungi was its porosity. The majority of melanin is non-porous, meaning that the material is not breathable and cannot let in vital nutrients. Having a material that would both protect from outward toxins while letting in vital nutrients such as air and water would be extremely advantageous. These researchers at Northwestern have developed a method synthesize this porous form of melanin, called allomelanin, and utilizing fungi to synthesize the allomelanin is much more efficient than synthesizing the material from scratch. Not only could the synthetic melanin serve as a cover for space suits to protect astronauts against radiation, but also as a coating for face masks, used to block out heavy metals, and more. **Read more at: https://scitechdaily.com/new-form-of-synthetic-melanin-fungal-ghosts-protect-skin-fabric-from-toxins-radiation/**

Study indicates that each city has a unique microbial fingerprint

Public transport centers tend to be one of the most microbially active spots in every city: turnstiles, seats, poles, and railings are the perfect place for a variety of microbes, including microscopic fungi. A recently published article in the scientific journal *Cell* highlights that every city has a "core urban microbiome" which tends to be a reflection of the city's features such as climate, wildlife, and demographics and patterns of human life. In 60 different cities, the researchers found over 14,000 undocumented species thriving in public transport centers. Results indicate that cities closer to the equator had a much more diverse microbiome than cities far away from it, and that coastal cities had unique species that non-coastal cities lacked. However, the findings are no cause for concern. Many of the undocumented microbes found are not pathogens and really have no effect on humans. Humans depend on a variety of microbes in order to maintain health. **Read more here: https://www.nytimes.com/2021/05/26/science/microbes-subway-metasub-mason.html**



Fungi photographer documents a fungus believed to be extinct

History was made when Amy Rossman, the head of the National Fungus Collection, saw fungi aficionado and professional photographer Taylor Lockwood's photo of *Hypocreopsis rhododendri* on the website Mushroom Observer. The fungus has only been seen three times since 1888 and has some rare behaviors. *H. rhododendri* is a parasitic fungus that lives off of crust fungi that grow on branches of trees, and it may go years without fruiting. **Read more at: https://www.npr.org/2021/05/23/999563120/amateur-mushroom-photographer-makes-a-big-discovery**

Cicadas infected with a behavior-altering fungus

Periodic cicada season has come to a close in the DMV area for the next seventeen years, along with the cicada-infecting parasitic fungus *Massospora cicadina*, which causes deaths in the cicada population. *M. cicadina* is a fungus with hallucinogenic properties believed to change the behavior of cicadas across North America. If you attended the May 2021 Monthly Meeting, you may recall this fungus being discussed by the researchers at WVU who study the fungus (and if you missed the meeting, check out the recording on the MAWDC YouTube page!). Infected cicadas bear semblance to zombies: the fungus destroys and replaces the bottom half of cicadas with spores while keeping the cicadas alive. Infected male cicadas mimic the behavior of females in attempts to attract other male cicadas for mating, therefore spreading the spores and infecting other cicadas. Although the sight of a zombie-like cicada can be pretty repulsive, the infected cicadas are not harmful to humans. **Read more at: https://www.news-medical.net/news/20200805/Zombie-cicadas-infected-with-mind-controlling-fungus.aspx**

Meripilus sumstinei (a.k.a. black-staining polypore) fruiting prolifically around the base of a tree in Wheaton Regional Park. Photo: Annie Greene

Black-Staining Polypore Prep

Black-staining polypore (*Meripilus sumstinei*) has been found in our region this season, right on schedule! If you happen to find some, and are not sure how to prepare it, here are a few ideas. Please consult your local field guide and only consume foraged mushrooms when you are 100% sure of their identity.

When this mushroom is very young and just beginning to emerge, the whole fruiting body is tender and great for sautéing. As the mushroom grows and fans out into a much larger structure (like the mushroom seen in the photo above), the thin edges of the fronds are tender, while the parts closer to the base can be very tough. Therefore, the best method of preparing this mushroom for consumption will depend on its age when you harvest.

Young black-staining polypore:

Clean and chop up the mushroom for use in a stir-fry, a risotto (see the last Sporophore issue for a risotto recipe!), or sauté for use in a creamy pasta sauce.

Mature black-staining polypore:

Clean and trim approximately 1-2 inches from the edges of the fronds, the part of the mushroom furthest from the base. This part can be cooked in all the ways mentioned for young *M. sumstinei* listed above.
You will probably have a lot of tough, chewy mushroom left over. This part of the fruiting body can be simmered in salt water to create a delicious mushroom stock for use in soups or gravies. The tough parts can also be dehydrated (on your oven's lowest temperature or by using the settings recommended for mushrooms in your dehydrator's instruction manual), then ground into a powder using a blade coffee grinder or food processor. This powder stores well at room temperature and can be used to season rice dishes, sauces, or any other dish you think could use a mushroom boost!

Tales of the Fun Guy

by Loretta E. Chi