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Sporophore
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In This Issue:

Coffee Rust in Central America

Thomas Roehl
MAW Newsletter Editor

Coffee Rust, also known as Coffee Leaf Rust and in Spanish as *roya*, is a disease of coffee plants that is caused by the fungus *Hemileia vastatrix*. *H. vastatrix* is, as its common name implies, a member of the rusts. Unlike most rusts, however, it has a simple infect-sporulate life cycle, which is likely one reason the disease has been so successful. Coffee Rust is a particular problem in Central America, produces 15% of the world's Arabica coffee and exports roughly 476,000 tons of coffee to the United States annually. The region suffered a devastating outbreak of the disease in the early 2010's and has yet to fully recover.

History

Coffee Rust was first recorded in 1861 on wild coffee trees in the Lake Victoria region of Africa. Eight years later the disease was identified on the leaves of coffee trees in British-owned Ceylon (now Sri Lanka) and the pathogen was described as *Hemileia vastatrix*. By 1879 it had become too well established in Ceylon to eradicate. Eventually coffee was no longer a profitable enterprise on the island and the British planted tea there instead. It is not known how the disease was able to travel across the Indian Ocean, but humans probably played a crucial role. Within a few years the disease had spread to India, Sumatra, and Java.


Smartse, CC BY-SA 3.0

Coffee rust, caused by the fungus *Hemileia vastatrix*, is a significant disease of coffee trees (*Coffea* spp.). The fungus infects leaves and can severely decrease harvest yields.

The resulting decline in coffee production led to the rise of Central and South America as major coffee growing regions. Strict quarantine protocols kept *H. vastatrix* from colonizing the Americas until 1970, when it managed to get a foothold in Bahia, Brazil. At that time, almost every coffee tree in the Americas was descended from one rust-susceptible cutting, so the disease spread across the region like wildfire. *H. vastatrix* managed to escape all the quarantine measures imposed upon it, using the wind to spread long distances. Thankfully, Coffee Rust was unable to spread to trees grown at high altitudes, like most of the Arabica trees.

In 2014, an ongoing outbreak of Coffee Rust in Central America made headlines as it infected 60% to 75% of the region's coffee trees. Over the years leading up to 2017, better weather, resistant trees, and Continued on Page 9

The Mushroom Chronicles: Toxicity, Part 1: Deadly Mushrooms

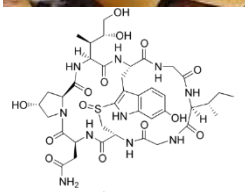
William Needham
MAW President

Editor's Note: This is the first part of a two-part series on mushroom toxicity. Part 2 will discuss milder toxins.

Among the hundreds of thousands of fungal species and the tens of thousands of those recognizable as gilled mushrooms, only about 100 would qualify as poisonous of which only about 10 are deadly. Nonetheless, poisonous mushrooms cast pallor on the consumption of fungi as food; the epithet toadstool elicits emotions that inappropriately and unfortunately associate the innocent mushroom with loathsome warty uncleanliness and therefore promotes mycophobia, the fear of fungi. The word toadstool itself has an etymology that is suggestive of Stygian origins; it is a calque word of German provenance. *Todesstuhl* means "death stool." One reason for mycophobia is uncertainty in identification since many of the deadly variants are similar in appearance to those that are edible; in Continued on Page 2

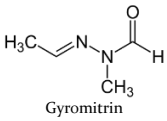

Thomas Roehl

There are many different toxins found in mushrooms. The deadliest toxins are the protoplasmic poisons such as amanitin. Destroying Angels, which include *Amanita bisporigera* (pictured above), are well known for containing amanitin.



α-Amanitin

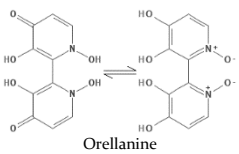
Amanitin is primarily found in *Amanita*, but it also exists in a few other mushrooms like the Deadly *Galerina* (*G. marginata*, pictured above). There are several Amanitin varieties, but they are all based on the same double ring structure.
Top photo: William Needham. Left photo: public domain.



Gyromitrin

Monomethylhydrazine

Mushrooms in the genus *Gromitra*, including the False Morel (*G. esculenta*, pictured above), contain gyromitrin. When ingested, gyromitrin is metabolized to the toxin monomethylhydrazine (which can be used as rocket fuel).
Top photo: William Needham. Left photos: public domain.



Orellanine

Orellanine is produced by the Sorrel webcap (*Cortinarius orellanus*, pictured above), among other mushrooms. The chemical naturally exists in two forms, although the form depicted on the right is a bit more abundant.
Top photo: Michaelll, CC BY-SA 2.5. Left photo: PubChem.

Continued from Page 1 many cases only an expert can tell them apart and even they can make mistakes. Another reason is lack of indication; there are no *sine qua non* simple proofs of mushroom toxicity, poisonous mushrooms do not all blacken silver spoons and do not all taste bitter, popular nostrums aside.

History has impugned the mushroom as the source of the poison that has dispatched any number of notables, among them Claudius, the fourth Roman Emperor. The perpetrator is alleged to have been his fourth wife Agrippina who wanted her son Nero to succeed to the throne in lieu of Britannicus, the son of Claudius by his third wife Messalina (who had incidentally been put to death for her part in a previous assassination attempt). The death is recounted by the philosopher Seneca the Younger in December 54, only two months after the event occurred. According to his account, it happened quite quickly, the onset of illness and death being separated only by about an hour. The idea that mushrooms were the cause is perpetrated in later writings by Tacitus, Suetonius and Dio Cassius, the latter adding a description of Agrippina serving Claudius a plate of mushrooms. The mushroom death of Claudius is almost certainly apocryphal, as deadly mushrooms are relatively slow to act; those that act rapidly generally cause gastrointestinal distress that is rarely if ever fatal.

It is more likely the case that mushroom poisoning occurs as a result of volition, the decision to consume a mushroom of dubious identification resting with the victim. There have been occasions where arrogant decisiveness has overridden caution. The most notable case is that of Johann Schobert, a composer who was employed by the Prince of Conti in Paris in the latter half of the 17th century. He wrote harpsichord concertos, opera and sonatas that purportedly served as the basis for some of the later work by Mozart, his contemporary. Schobert may have had a talent equal to that of Mozart; we shall never know, as he succumbed to mushroom poisoning. According to the historical account, he had gathered some mushrooms in Pré-Saint-Gervais near Paris with his family and proceeded to a restaurant to have the chef prepare them. When he was told that they were poisonous, he proceeded to a second restaurant with like result. Undeterred, he went home to Paris and made mushroom soup for dinner. He was joined in death by his wife, one of his children, and a friend, who was a doctor; fittingly, it was the doctor who had proffered the erroneous mushroom identification.

Mushroom poisoning is generally categorized into four types according to the symptoms that result. It is not practical to use the type of toxin as a basis for classification, since there is a paucity of knowledge about the nature and chemistry of fungal toxins in general; this is particularly true for fungi whose consumption may yield an unpleasant though not fatal result.

Additionally, the identification of the mushroom that caused the condition under evaluation is usually a matter of conjecture since the victim has succumbed to disease after having destroyed the evidence by eating it. The four types are protoplasmic poisons, neurotoxins, gastrointestinal irritants, and those that are toxic only in combination with other substances, notably alcohol.

Protoplasmic Poisons

The protoplasmic poisons are those that destroy cells that can lead to the failure of major organs. These are the deadly mushrooms. They are mostly of one genus, the *Amanita*, though there are some deadly species in the genera *Lepiota* and *Galerina*. The common names of the most prominent of the *Amanitas* are grim evidence of their virulence: the Death Cap (*A. phalloides*) and the Destroying Angel (*A. virosa*). The common names of the mushroom of the other genera are equally foreboding: Deadly Lepiota (*L. josserandii*) and Deadly Galerina (*G. autumnalis*). The so-called amatoxin is the chemical amanitin, reflecting the primary generic provenance - *Amanita*. It is a bicyclic octapeptide, which essentially means that it is comprised of ring-shaped structures with eight amino acids (the building blocks of proteins). Cell destruction is incident to the inhibition of RNA polymerase, which normally produces messenger RNA. The resulting lack of messenger RNA precludes protein synthesis; without new proteins to replace old ones, cell activity ceases. Since the liver is one of the primary areas of protein synthesis in the body, it is particularly susceptible to amanitin.

Amanitin poisoning is characterized by a long latency period ranging from about 6 to 15 hours during which there are no adverse symptoms (it is for this reason that the rapid death of Claudius is not likely of mycological origin). This is followed by symptoms that are typical of a gastrointestinal irritant: abdominal pain, vomiting, diarrhea, and dehydration. A period of apparent recovery ensues, only to be followed about a day later by a gradual deterioration that includes a loss of strength, restlessness, and jaundice, the result of irreversible liver damage. The mortality rate is about 10% in the United States, although that changes according to the amount of toxin consumed, age, health, and access to prompt effective treatment.

Treatment follows diagnosis which usually depends on an evaluation of the symptoms and a knowledge of dietary history. Although there is a commercially available radioimmunoassay (RIA) test kit available, it takes about two hours to get a result; since the timeliness of treatment following poisoning is crucial, it is rarely used for initial diagnosis. If immediate and determined remedial action is taken, the mortality rate is reduced to as low as 5 percent. There is no standard course of treatment, but doctors often try to remove amanitin from the intestines using a stomach pump or activated charcoal. In theory, this treatment interrupts the vicious cycle of amanitin poisoning: the impairment of the kidneys causes amanitin to be recirculated to the liver where the bile carries it to the intestines, which send the toxin back to the blood stream.

At least two other types of protoplasmic poisons are found in mushrooms: hydrazines and orellanines. Gyromitrin, which breaks down in the body to form monomethylhydrazine (MMH), is found in the False Morel, *Gyromitra esculenta*. MMH is a small molecule but has enough energy to be used as rocket fuel. It damages many organs and can severely impair the functions of the liver, kidneys, and red blood cells. Orellanine is found in the Sorrel webcap, *Cortinarius orellanus*, and primarily damages the kidneys. In severe cases, both toxins can be fatal.

Mycology Vocabulary

Taxonomic Shape Words

Many taxonomic names seek to describe the thing they name; understanding root words can help you remember both the name and the organism. Shape words commonly appear in taxonomic names, since we often recognize different organisms by their distinctive shapes. There are way too many to include them all here, so the list below contains a few of the most common ones.

Word	Meaning	Example
brevi-	short	*Russula brevipes*
derma	skin	*Scleroderma citrinum*
-folia	leaves (or gills, in mushrooms)	*Russula densifolia*
-formis	the shape of	*Lycoperdon pyriforme*
gaster	belly	*Gastroboletus turbinatus*
imbricatus	tiled	*Sarcodon imbricatus*
longi-	long	*Leccinum longicurvipes*
macro-	large	*Macrolepiota procera*
marginatus	bordered	*Galerina marginata*
micro-	small	*Microglossum viride*
minor	smaller	*Cantharellus minor*
morpho-	shape	*Xylaria polymorpha*
-odon, -odus	tooth	*Climacodon septentrionalis*
ped, pes	foot (or base/stipe, in mushrooms)	*Harrya chromapes*
phyllo-	leaf (or gill, in mushrooms)	*Chlorophyllum molybdites*
pubescens	downy	*Trametes pubescens*
rhiza	root (or root-like structure, in mushrooms)	*Scleroderma polyrhizum*
umbonatus	with a raised central bump (umbo)	*Cantharellula umbonata*
velut-	velvety	*Flammulina velutipes*

Recent MAW Events

Mason Neck Eagle Festival

Thomas Roehl
MAW Newsletter Editor

On May 20, MAW hosted a table at the 20th Annual Mason Neck Eagle Festival. The festival was a free event held at Mason Neck State Park in Fairfax County, Virginia, and focused on the environment and history of the region. Thousands of people from across Northern Virginia turned out to see the live animal shows, make crafts, and visit the booths staffed by various environmental groups.

Mason Neck State Park is situated on a peninsula that juts out into the Potomac River just south of Fort Belvoir and across the river from Potomac Heights, Maryland. The park hosts a diversity of wildlife, including the bald eagles that are celebrated by the Eagle Festival.

At the Eagle Festival, MAW members William Needham, Thomas Roehl, Agnes Demianski, and Clay Williamson introduced festivalgoers to the world of fungi. The event drew many families and MAW's table entertained children with the wide array of mushroom shapes and textures. Children visiting the table were encouraged to examine mushrooms using hand lenses and were given a brief overview of basic mushroom types.

MAW's table also introduced adult attendees to the vital role of mushrooms in a healthy forest. Using posters, identification books, and the mushrooms on display, the MAW members explained the role of mycorrhizas, parasitic fungi, lichens, etc. in the food web that includes bald eagles and all other life at Mason Neck State Park.


Clay Williamson

MAW President William Needham talks mushrooms with the Virginia State Parks mascot at the Mason Neck Eagle Festival.

Spring Wild Foods Tasting

Thomas Roehl
MAW Newsletter Editor

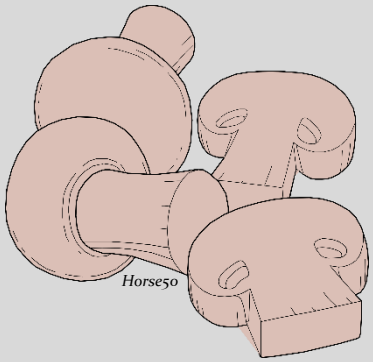
MAW's spring culinary event was held on June 11 at the Sandy Spring Museum in Sandy Spring, Maryland. Because wild mushrooms are scarce at this time of year, the Wild Foods Tasting featured edible plant dishes as well as dishes made with cultivated mushrooms.

Before the tasting, MAW member Matt Cohen led a foray at Lake Needwood to look for edible plants. Those present got to taste thistle, common milkweed, sassafras leaves, mulberries, wild garlic, wild carrots, and other plants. Like mushrooms, these plants have poisonous look-alikes and you should not eat them unless you know what you're doing. Unlike mushrooms, many of these plants are edible when raw and need very little preparation.

In the afternoon, about 40 MAW members gathered at the Sandy Spring Museum to cook and eat mushroom (and plant) dishes. Matt made a wild salad with violet, sassafras, lamb's quarters, and cattails. He also cooked some common milkweed flowers. Other members collected mulberries from the museum grounds. One chef made a dish using both foraged plants and cultivated mushrooms, but the rest of the dishes focused on mushrooms. A supply of cultivated mushrooms for the tasting was graciously donated by Phillips Mushroom Farms. MAW

Julien Portabella Mushrooms

Editor's Note: This recipe was contributed by MAW member Vera Cherkasova. Vera won first place at this year's Wild Foods Tasting for this dish.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Ingredients

- Mayonnaise
- Vegetable oil
- Onion
- Portabella mushrooms
- Sour cream
- Salt
- Pepper
- Chopped garlic

Instructions

Attention! Secret ingredient: Mayonnaise has to be from a Russian store.

1. Warm vegetable oil in a large, deep skillet. Add onion, mushrooms and sauté on high heat, stirring, until the onions have decreased in volume and caramelized evenly and the mushrooms are browned, about 10 minutes.
2. Wisk together sour cream and garlic chive Mayonnaise (1:1 ratio), and add the mixture to the skillet. Season with salt and pepper and add chopped garlic. Stir and cook, covered, over low heat for about 15 minutes.
3. Preheat the oven. Distribute the stew evenly. It is meant to be served in individual mini-crocks or ramekins, but mini-crocks are best (at the tasting, I did not do that and instead cooked it in a large dish). Top with cheese (I used Romano cheese) and bake, uncovered, until the cheese has melted and formed a deep yellow crust with brownish blisters. Julien is typically served as a hot appetizer dish.

Wild Foods Tasting photos, from left to right: 1) Ahead of the tasting, MAW members scour a field, looking not for mushrooms but for edible plants! 2)Members collect fresh mulberries to bring to the tasting. 3) Mmm! A plate full of edible wild plants and mushrooms! 4) Chicken of the Woods simmering on a stove. 5) Vera Cherkasova wins the Spring 2017 Waldemar Poppe Culinary Award. *Photos: Thomas Roehl*

members prepared a wide variety of mushroom dishes at the Wild Foods Tasting, including: mushroom quesadillas, mushroom coffee cupcakes, mushroom pâté, mushroom and chicken soup, and many different preparations of fried mushrooms.

Those present at the tasting voted for their favorite dishes and the event ended after the winners were announced. Third place went to Jared Urchek for his Chaga Wine. Second place was awarded to Carol Giffen for her Lion's Mane with Toasted Sesame (recipe on page 10). Vera Cherkasova won first place and received the Spring 2017 Waldemar Poppe Culinary Award for her preparation of Julien Portabella Mushrooms (recipe on page 4).

North Cove Mushrooms Tour

Thomas Roehl
MAW Newsletter Editor

On July 15, about 20 MAW members made the roughly two-hour drive down to Madison County, Virginia, to tour North Cove Mushroom Farm. The tour was led by Robin and Eason Burke, the owners and operators of North Cove Mushrooms.

Robin had previously worked in organic farming but settled on mushrooms because they can be grown year-round. Robin and Esan designed and built the mushroom growing building, which took about one and a half years and was finished in mid-2011. Building the farm themselves helped keep down costs and was enjoyable; as Robin said, "Building is fun!"

MAW was lucky to find North Cove Mushrooms, since most mushroom farms do not allow tours and keep their growing conditions secret. "The mushroom business is cutthroat," said Robin. "We try to be the friendly farm and do things differently, even though there have been people who went on a tour and then set up a competing mushroom farm."

North Cove Mushrooms is a small farm, so it uses a barebones setup: all the mushrooms are grown in a single room. Even though this system works, Robin quipped that "[mycologist] Paul Stamets would not approve."

In the grow room, MAW members listened as Robin explained the mushroom growing conditions, which were primarily settled on through trial and error. The mushrooms are kept happy using three pieces of equipment: a misting fan to keep the humidity around 100%, an outside air intake to bring in fresh air, and an HVAC system to keep the temperature around 68°F.

Despite its small size, the farm produces 400-500lbs of mushrooms each week. They are currently growing six varieties of mushrooms: king oysters, yellow oysters, shiitake, maitake, lion's mane, and pioppino. The mushroom variety at North Cove Mushrooms is limited by what the spawn provider sells. Eason explained that they recently began making their own oyster mushroom spawn, but other types of spawn require more rigorous sterilization that can be done only with expensive equipment. However, the process could become easier once the farm builds a dedicated spawn facility.

Eason and Robin currently sell to seven farmers markets, including four in DC and Maryland. Farmers markets account for about 98% of the farm's business, but they also sell to some local restaurants and operate a food truck. Mushrooms not sold in the markets are cooked for sale in the food truck or made into value-added products like tinctures. For more information on the farm and to find North Cove Mushrooms near you, visit **http://northcovemushrooms.com/**.

North Cove Mushrooms tour photos, from left to right: 1) MAW members gather outside the mushroom farm that Robin and Eason built themselves. 2) Robin Burke (left) shows a bag of pioppino mushrooms to MAW members. 3) The grow room at the farm contains multiple species in various stages of growth. 4) Yellow oyster mushrooms almost ready to be harvested. *Photos: Agnes Demianski*

Meetings

Meeting Files

June 6: Britt Bunyard's "Deep Dark Secret" Love of Insects

Thomas Roehl
MAW Newsletter Editor

At the June 6 monthly meeting, Britt Bunyard – publisher and editor of the *Fungi* magazine – entertained MAW members with *Dr. Strangelove*-themed stories of interactions between insects and mushrooms.

Insects and mushrooms have a very close relationship, but not many people pay attention to it. Britt, however, has been studying insects just as long as fungi. To introduce this unusual aspect of mycology, Britt chose three examples of bizarre mushroom and insect interactions: chaga reproduction, *Cerrena unicolor* and two wasps, and amatoxin-eating flies.

Britt first examined the mystery of chaga reproduction. Chaga is a sterile mass of fungal and plant tissue called a 'clinker' that is produced by the fungus *Inonotus obliquus*. Clinkers do not produce any spores, so the fungus has to make a separate fruiting body in order to reproduce. This happens only once after the fungus' host tree dies. The fruiting body is a thin mat of pores and forms just underneath the bark – not an ideal location for releasing spores into the air.

Recently, an amateur mushroom hunter helped discover another piece to the chaga puzzle. Sarah Dole found a huge *I. obliquus* fruiting body and worked with Britt to characterize the insects on it. Britt identified most of them as various stages the beetle *Orchesia cultriformis*. These insects were found to have gorged on *I. obliquus* tissue and the spores from the insects' guts were still viable. This suggests that insects could be the main way *I. obliquus* spores are carried from one place to another.

Britt then moved on to examine the "bizarre love triangle" that exists between the fungus *Cerrena unicolor*, the horntail wasp *Tremex columba*, and the ichneumon wasp *Megarhyssa atrata*.

The fungus *C. unicolor* is a rather boring mushroom that looks like an old Turkey Tail but has maze-like pores. It is a white rot fungus that decomposes the wood of hardwoods.

T. columba is a thumb-sized stingless wasp known as the "giant horntail wasp" or the "pigeon tremex wasp." The female has a special pouch called a *mycangeum* in which she stores a sample of the fungus *C. unicolor*. When the wasp lays eggs inside a tree, it also inoculates the tree with some of the fungus. *C. unicolor* begins decomposing the tree, which provides a ready meal for the grubs when they hatch after a year or more.

The stingless wasp *M. atrata* is known as the "giant ichneumon wasp." Although it is smaller than *T. columba*, *M. atrata* has a huge ovipositor (a long thin structure for laying eggs) that can

Upcoming Events

The events listed below may change due to weather, speaker availability, etc., so read MAW emails and check our website at **http://mawdc.org** for up-to-date information on events. Exact foray dates and locations will be set closer to the event in order to take weather conditions into account.

Aug. 1 **Monthly Meeting** featuring a presentation by **Noah Siegel** on mushrooms of the redwood coast

Sep. 5 **Monthly Meeting:** Mushroom identification workshop

Sep. 7-10 NAMA Northwoods Foray in Cable, WI (*SOLD OUT*). Visit **http://www.namyco.org/** for more information, to add your name to the waitlist, and to join NAMA.

Sep. 16 Fall Forays Begin

Sep. 17 **Mushroom Culinary Event:** At MAW's second tasting event of the year, members prepare and eat mushroom dishes. The previous tasting event sold out, so register early! A morning **foray** will precede the tasting.

Sep. 28 Board Meeting

Sep. 29 – Oct. 1 MAW's annual **Camp Sequanota Foray** in Jennerstown, PA. This popular weekend foray is the most immersive mycological event offered by MAW. Join us as we improve our identification skills, learn about (and maybe participate in) scientific research, and enjoy some mushroom dishes prepared on-site! This year's guest mycologist will be Shannon Nix, MAW's Science Advisor! Registration and more information can be found online at **https://mawdc.wildapricot.org/Sequanota**.

Oct. 3 **Monthly Meeting** featuring a presentation by **Rick Kerrigan**

Oct. 7 **Foray** to collect mushrooms for the Mushroom Fair

Oct. 8 **Mushroom Fair:** Annual event where MAW members share their love of mycology with visitors to Brookside Gardens. There will also be a **foray** beforehand to collect mushrooms for the Fair.

Unless otherwise noted, monthly meetings will be held on the first Tuesday of the month at 7:00 PM in the ***Kensington Park Library, 4201 Knowles Avenue, Kensington, MD****. Attendees are encouraged to bring mushrooms for sharing and identification. Members of the public are welcome to drop in.*

be 15-16cm long. The female *M. atrata* sniffs out a chemical emitted by *C. unicolor*, drills into the infected wood with her ovipositor, and lays her eggs on the larvae of *T. columba*. Once they hatch, the larvae of *M. atrata* eat the other wasp's larvae.

Finally, Britt embarked on a discussion of the wisdom of mycophagous (fungus-eating) insects. Insects and mushrooms have coevolved for as long as both organisms have existed and insects evolved mycophagy multiple times.

After introducing fly morphology, Britt examined research on how some flies can eat amatoxins. Amatoxins are fatal to humans and it is reasonable to expect the same to be true for insects. However, there are some insects that are unharmed by amatoxins, including the mycophagous flies.

Recently, scientists found that the only difference between mycophagous flies and related flies that were poisoned when fed amatoxins was the amount of cytochromes and GSTs they produced. Animals (including humans) use these compounds to detoxify a wide range of harmful chemicals. The mycophagous flies are able to survive eating amatoxins simply because they produce a lot more cytochromes and GSTs. Britt hopes that this research can be used to find ways to more effectively treat severe mushroom poisoning.

July 11: Gary Emberger Gives Tree Identification Tips

Thomas Roehl
MAW Newsletter Editor

Gary Emberger, a professor at Messiah College and author of the Fungi Growing on Wood website, gave an entertaining talk on tree identification at the July 11 monthly meeting. Every mushroom hunter knows that trees are important for mushrooms, but many people struggle to identify trees. Gary's talk – complete with tree jokes – provided a starting point for learning to identify trees; he introduced terminology, major groups, and walked through the steps of identification.


Thomas Roehl

Britt Bunyard answers questions about insect/mushroom interactions after his talk at the June 6 monthly meeting.

According to Gary, tree identification is easy, thanks to easily visible characteristics and a relatively small number of species. The process starts with three basic features of leaves: arrangement, complexity, and margins.

Arrangement refers to how leaves are positioned on a branch. *Opposite* leaves appear in pairs with one leaf on each side of the branch. Only a few species have opposite leaves and these can be remembered using the mnemonic **MAD Horse**: **M**aple, **A**sh, **D**ogwood, and **Horse** chestnut. *Alternate* leaves are staggered so that any point along the branch has at most one leaf attached to it. The leaves also switch sides, so that a leaf on the left of the branch is followed by a leaf on the right side of the branch. *Whorled* leaves are attached to the branch in a spiral.

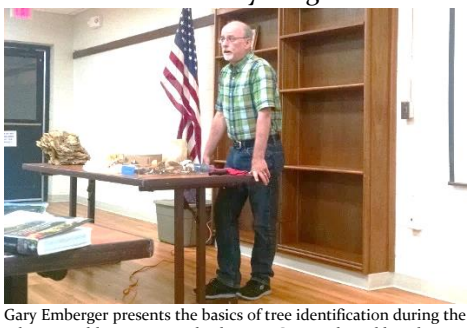
Complexity describes whether or not the leaf is divided into smaller leaflets. *Simple* leaves are not divided into sections. *Compound* leaves look like a bunch of normal leaves attached to a short stem that connects to the branch. Spotting compound leaves takes some practice. First, check the area where the leaf connects to the stem for a tiny bud. All leaves have this axillary bud but leaflets do not. The bud therefore marks where the leaf begins; in compound leaves, the bud is present at the base of the true leaf and absent at the bases of the leaflets. Second, leaflets of compound leaves always grow in the same plane while simple leaves are not so restricted.

Leaf margins vary greatly from one species to the next and are therefore useful in identification. Leaf margins can be smooth ('entire'), lobed, toothed, doubly toothed, wavy, and so on. Whether or not the leaf is lobed is more important than the other margin descriptions, so lobes should be assessed first. Lobed leaves can be either pinnate (lobes spread in a single plane along a central shaft, like the vanes of a feather) or palmate (lobes radiate from a single point, like fingers on a hand, as in maples).

Trees can also be identified based on a number of other factors. Wood structure often varies and assessing it is very helpful in identifying trees that have been cut down. Oak trees, for example, have distinctly large veins running through the wood. Galls made by insects can also inform identification. Eyespot galls are small bumps on a leaf encircled by red rings and are found on red maples. Mushrooms can also help identify trees; *Phellinus robiniae*, for example, grows only on black locust trees and can be found on almost every mature tree.

If you want to learn more about tree identification, buy a field guide (Gary recommends ones with line drawings of leaves rather than pictures) or consult online resources. Gary suggested consulting Virginia Tech's dendrology site (**http://dendro.cnre.vt.edu/dendrology/idit.htm**) and the guides from the Virginia Department of Forestry (**http://dof.virginia.gov/tree/index.htm**).

Although Gary's talk focused on trees, he is also adept at mushroom identification. His mushroom interests and expertise are shared with the world on his website, Fungi Growing on Wood **https://www.messiah.edu/Oakes/fungi_on_wood/**, which features detailed descriptions and pictures of common wood decay fungi.


Thomas Roehl

Gary Emberger presents the basics of tree identification during the July 11 monthly meeting. In his lecture, Gary explained how lea identifying trees can improve your mushroom hunting skills.

Book Review: Boletes of Eastern North America

David Wasilewski
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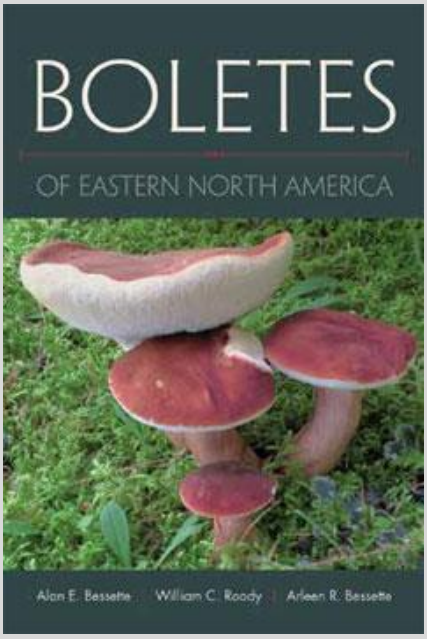

Boletes of Eastern North America
By Alan E. Bessette, William C. Roody, and Arleen R. Bessette
Publisher: Syracuse University Press
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A period of only 16 years separates the initial publication of *North American Boletes* from the recently published *Boletes of Eastern North America*. So, one may wonder why the authors, Alan E. Bessette, William C. Roody, and Arleen R. Bessette, chose to update their classic edition of 2000. Presumably, the main reason for this is to reflect the many changes in nomenclature that have been adopted over the past fifteen years. In *Boletes of Eastern North America*, I counted twenty-seven preferred genus names that had not appeared as such in the older book. In a few cases, this may just be a function of some long-standing debate over authorship of a given species. Is the correct name for the "ash tree bolete" *Boletinellus merulioides* or *Gyrodon merulioides*? However, most of the changes in genera have come about due to relatively newly discovered relationships among subgroups of boletes as per genetic analysis. If one deems it important to know the current scientific name for their "two-color boletes," then it's *Baorangia bicolor*.

So, does *Boletes of Eastern North America* offer any new revelations about *Baorangia bicolor* other than the name? For one, this new book does not attempt to split bicolor into named varieties. Instead, the heading for this type of bolete is *Baorangia bicolor* complex. (*Boletus bicolor* var. *borealis* – which had seemingly been generically misplaced to begin with – is listed in the new book under genus *Lanmaoa*.) The authors have added new bicolor photos, and these are really nice photos that exhibit some of the morphological variability within this species complex. Moreover, the implication is that classification by variety – or perhaps even at the level of species – is an issue which will require additional study, presumably from the genetic perspective.

All this rapidly-changing nomenclature leads to a question: How long will the names found in *Boletes of Eastern North America* remain relevant? The book still documents the species (complex) *Boletus subtomentosus*, but two very similar species formerly included within *Boletus* are now combined into a single species of *Xerocomus*, *X. illudens*/*X. tenax*. Does *B. subtomentosus* belong in *Xerocomus*? Some sources believe so. But even if this answer is no, it is still likely that *subtomentosus* will not remain within *Boletus*. Current research indicates that genus *Boletus* in North America will eventually be whittled down to include only the "kings" – *B. edulis*, *B. variipes*, *B. separans*, and a few others.

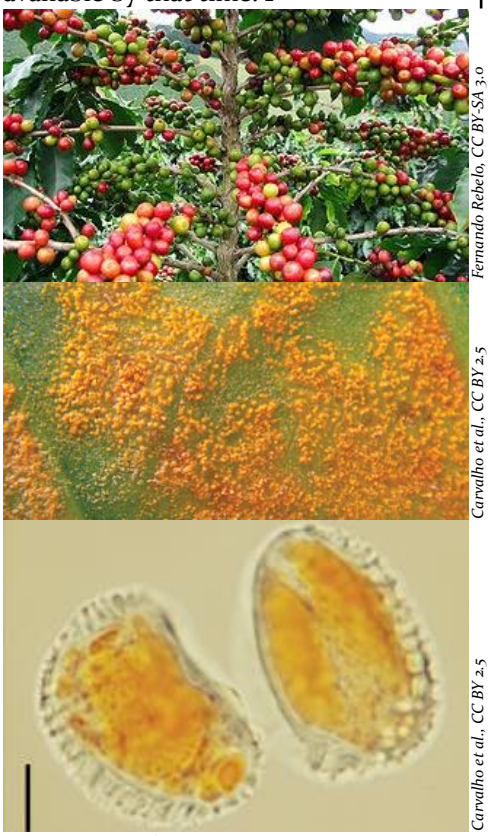
So does it make sense to purchase a book that uses names that may be depreciated within the near future? I believe so. For the casual mushroom enthusiast, this future shock within the world of mushroom names takes some getting used to. If one wishes to get up to date with respect to these changes, then using *Boletes of Eastern North America* as one's new standard of bolete identification is a very reasonable beginning. The species descriptions are representative of what we have come to expect from a Bessette field guide. Whenever possible, terminology is non-technical, which makes for easy reading. Of course, when discussing observable mushroom traits, it is occasionally impossible to avoid vocabulary geared toward precision. To this end, an extensive glossary is provided. Many new excellent photos are included in *Boletes of Eastern North America*. In some cases – especially for uncommon types of boletes for which few good images exist – one finds the same photo that appears in the older book. Photos accompany species descriptions, as opposed to having separate text/photo sections as in the older book.

A noted change in this new book is the absence of the "chemical reactions" category. The older book included a separate category documenting color changes associated with application of chemicals for nearly all of the species descriptions. But, this new book only occasionally mentions chemical reactions within the "overview" section. In the appendix, one finds a short section devoted to chemical reagents. The authors point out that color changes associated with application of a given chemical may not be as consistent as one would hope. They offer a few potential explanations for this, and include specific recommendations for storage and expected shelf life of chemicals. A specific suggested technique for applying chemicals to mushrooms is included.

One thing I was hoping to find in this new bolete book is the status of at least some of the "undescribed boletes," of which twenty-seven different types were pictured in the 2000 edition of *North American Boletes* (NAB 1-27). I browsed *Boletes of Eastern North*

America, looking for mention of them, but I found none. Have one or more of them been lumped into an existing species concept? Perhaps when summer comes and I'm actively using this book to try to understand my bolete collections, I'll run across a reference to one of the NAB species. The new book includes eight "undescribed species" (UB 1-8). There is no indication which, if any, of these are the same as the undescribed species in the older book.

My own copy of *Boletes of Eastern North America* is a paperback version, which cost me around $50. The hardcover version is significantly more expensive. I figure that the pages in my book will eventually become dog-eared, the binding will begin to fail, and there will be rips, stains, and pieces of mushroom stuck here and there. But by that time, I should be ready for yet another new edition of a North American bolete book. With additional changes in the understanding of these mushrooms, a new book will likely be available by that time.



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Carvalho et al., CC BY 2.5

Carvalho et al., CC BY 2.5

From top to bottom: 1) A healthy *Coffeea arabica* plant producing plentiful berries. 2) *H. vastatrix* releases spores from the underside of a leaf. 3) The fungal spores are half smooth and half spiky.

Coffee Rust (Cont'd)

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learning to live with the fungus improved coffee production in certain Central American countries. However, production has yet to return to pre-outbreak levels.

Pathogen Biology

To understand what is driving the Central American epidemic of Coffee Rust, you need to know a little about the biology of the organisms involved. *H. vastatrix* is a rust fungus and as such is an obligate plant pathogen. It can infect only species of *Coffea* trees, including *Coffea arabica* and *Coffea canephora*. Both *C. arabica* and *C. canephora* are tropical plants native to Africa that are cultivated for their seeds. *C. arabica* produces the higher quality Arabica beans, is highly susceptible to Coffee Rust, and prefers slightly higher altitudes than *C. canephora*. *C. canephora* produces the lower quality Robusta beans and is more resistant to disease. Arabica makes up about 65% of coffee production, with Robusta accounting for the remainder.

Unlike other rust fungi, *H. vastatrix* has a simple life cycle: infect, produce spores, repeat. A spore lands on the leaf of a host plant and grows hyphae that enter the leaf through a stoma. Inside the leaf, the hyphae digest and kill the host cells.

The earliest sign of the disease is a yellow, circular spot on a leaf. The spot grows larger as the fungal hyphae extend outward to new areas of the leaf. If too much of the leaf has been colonized by the fungus, the leaf will drop prematurely. In severe infections, this can cause defoliation and death of twigs or entire plants. Even if the fungus doesn't kill the plant, it still harms the tree and results in reduced yields.

Once the fungus has colonized enough area, it begins producing spores on specialized hyphae that grow out of the leaf's stomata. The spore masses appear as orange, powdery spots on the undersides of leaves. Although *H. vastatrix* produces both sexual and asexual spores, only the asexual spores can infect coffee leaves.

The spores are disseminated by both wind and rain. The effect of rain hitting leaves will propel spores a short distance, while wind can carry the spores long distances. Once the spores land on a new leaf, they need access to liquid water for one to two days in order to successfully germinate. Because of this, they usually germinate during the rainy season, which is also when most leaf growth happens.

Disease Management

There are multiple ways to mitigate the effects of *H. vastatrix*, but so far none has proved successful at eradicating the fungus. The simplest method involves pruning the trees to increase spacing between the leaves. This increases air flow, which allows the leaves to dry quicker. As a result, spores have access to water for less time, making it less likely that they will germinate. Shade-grown trees appear to be less susceptible thanks to their lower bean yields. A tree that produces fewer beans has more resources available and is therefore healthier in general. Fungicides are also effective against Coffee Rust. However, fungicides are too expensive for small farmers.

There are also rust-resistant cultivars of coffee trees available, but these alone cannot stop the disease. No single variety is resistant to all of the more than 40 strains of *H. vastatrix*, so farmers have to choose which varieties to plant based on which strains of the fungus are present in the region.

Central American Outbreak

Global climate change has been proposed as one of the factors driving the recent epidemic of Coffee Rust in Central America. Because of higher temperatures linked to climate change, the fungus has been able to infect trees at high altitudes that had previously been too cool for *H. vastatrix* to survive. This allowed the fungus to decimate Central America's highly susceptible and more

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Lion's Mane with Toasted Sesame and Ground Sumac Berries

Editor's Note: This recipe was contributed by MAW member Carol Giffen. Carol won second place at this year's Wild Foods Tasting for this dish.

This is a dredged pan-fry, and so the amounts of all ingredients truly depend on how many mushrooms are being made. Don't be shy with the seasoning in the dredge, as this mushroom eats flavors.

Ingredients:

- Lion's Mane mushrooms, sliced lengthwise by ½ inch or slightly less, if possible – thinner is better but they need to be thick enough to hold together.
- Cornstarch for dredge (rice flour would also work; also a quick press after dredge into panko might help with texture – I didn't have any available at the time of the tasting)
- Ground dried sumac berries (available at Penzey's Spices and Middle-Eastern grocers, as well as online) – sumac gives a nice, sour, almost citrusy note with a bit of a berry/earthy plus
- Dried marjoram and/or thyme
- Garlic salt
- Green onions – thinly slice the whites, slice the green parts diagonally at about ½ inch. For estimation purposes assume at least one reasonably-sized green onion per two reasonably-sized mushrooms.
- Butter
- Vegetable oil
- Kosher salt and fresh-ground black pepper to taste
- Toasted sesame seeds (I find it easier to buy pre-toasted seeds, such as McCormick's Gourmet Collection at Giant)

Instructions:

You will be working in small batches to try to get some crispness or at least some texture to the mushrooms. Do not crowd the pan or they will be sodden. The mushrooms should be at least ¾ inch apart from each other to start; they will shrink a bit.

1. Prepare a dredge on a work surface or plate, starting with an appropriate pile of cornstarch for the mushrooms you are preparing. Aim a little high as lion's mane has more liquid than it seems. Season the dredge liberally with the sumac, dried marjoram, garlic salt, and ground pepper. Firmly dredge your first batch or two of sliced mushrooms.
   I used a 12-inch skillet at the tasting, and chose NOT to use non-stick because I wanted to encourage some degree of crust and carry-over of pan bits from batch to batch. (NOTE: you will pay for this later with the pan-cleaning but I thought it was worth it! Or try non-stick, if you like.)
2. On medium-high heat, bring about 2 teaspoons each of butter and vegetable oil to temp, and add a batch-size portion of the white part of the spring onion to sauté briefly until a bit softened. Add some of the green onion and continue cooking for a minute or two. Push the whole lot to a pile on the side of the pan, out of the way. Check the fat level in the pan and add some butter/oil if it seems appropriate; these mushrooms have an eggplant-like appetite for oil, to be indulged to a point.
3. Re-dredge the first batch of mushrooms if it seems necessary and add to the pan, cooking for a couple of minutes on each side. You're looking for some golden and a bit of crust.
4. Transfer the mushrooms to serving platter, top with the green onions and refresh with a final seasoning of the sumac, a bit of marjoram leaf dusted between finger and thumb, and a sprinkle of kosher salt and pepper. Finish with a liberal sprinkle of toasted sesame seeds. Repeat as needed.

Continued from Page 9 valuable Arabica trees.

Parts of Central America were also dealing with drought related to climate change. Although the fungus struggles to germinate in dry weather, drought can actually make the fungus more virulent. Drought increases stress on the trees, which lowers their natural resistance to infection. This makes Coffee Rust all the more dangerous when rain does arrive.

Economics also played a role in the recent outbreak in Central America. Coffee prices have been low for years, leaving farmers without enough money to replace diseased trees. The result is more susceptible trees contracting and spreading disease for a longer time.

Production remains low in Guatemala, El Salvador, and Costa Rica, where since 2014 farmers have continually battled Coffee Rust, drought, and low market prices. Honduras, Mexico, and Nicaragua, on the other hand, have been successful at recovering from the Coffee Rust outbreak, and all three countries are forecast to return soon to pre-outbreak production levels.

However, Coffee Rust remains a threat to production across the region. In May, the *Lempira* variety of coffee was found to be susceptible to *H. vastatrix* infection. *Lempira* trees were widely planted in Honduras during the recent outbreak because they were resistant to Coffee Rust. Now, that resistance has somehow vanished. This could be because either a new strain has arrived or a strain already present has mutated. Either way, Coffee Rust still presents a significant threat that Central American coffee farmers will have to deal with for years to come.

Fungi in the News

Thomas Roehl
Newsletter Editor

Editor's Note: This article contains summaries of the biggest fungus-related news stories from May through June 2017. Visit the link following each topic below for a closer look.

Microwave or Grill Mushrooms to Increase Antioxidants

Scientists at the Mushroom Technological Research Center of La Rioja in Spain determined that mushrooms should be microwaved or grilled to retain more health benefits. The study examined how well various ways of cooking common cultivated mushrooms retained antioxidants and beneficial carbohydrates and proteins. When the mushrooms were fried in oil or boiled in water many of the beneficial compounds were removed from the mushroom by the liquid. This may not be a problem if you are making a soup, but makes a difference if you are planning to eat just the mushrooms. The one exception to this general trend was that boiling increased the glucans in the mushrooms. Microwaving or grilling the mushrooms, on the other hand, kept the beneficial compounds sealed inside the mushrooms. The researchers noted that adding a small amount of olive oil while grilling actually added antioxidants. Read more at: **http://www.bbc.com/news/health-39998669**

Gut Fungi Worsen Alcoholic Liver Disease

New research from the University of California San Diego School of Medicine and the J. Craig Venter Institute used a mouse model to demonstrate that gut fungi can worsen alcohol-related liver disease. Previous studies have shown that gut bacteria play a role in exacerbating alcohol-related liver disease, but this was the first paper to do so with fungi. Mice with long-term exposure to alcohol were found to have very high levels of fungi in their guts. This caused beta-glucan, a compound found in fungal cell walls, to enter the blood stream. Once the beta-glucan traveled to the liver, it triggered an immune response that caused inflammation in the liver. Inflammation kills liver cells, which worsens disease symptoms and ultimately leads to death. Importantly, the researchers were able to prevent the mice from developing alcohol-related liver disease by using an antifungal to kill the fungi in their guts. To assess if their results were relevant to humans, the scientists assessed how many gut fungi lived in humans with alcohol-related liver disease. The researchers discovered that people with the disease had an overabundance of fungi in their guts that was dominated by *Candida* spp., some of which can be pathogenic. Furthermore, the authors found that a larger overpopulation of fungi was correlated with a higher mortality rate. The human part of this study was conducted with only a small group, so the authors encouraged further trials to corroborate and refine the data. Hopefully, a better understanding of how microbial gut communities impact alcohol-related liver disease will help develop new treatments. Read more at: **https://health.ucsd.edu/news/releases/Pages/2017-05-22-intestinal-fungi-worsen-alcoholic-liver-disease.aspx**

Engineered Fungi Fight Malaria

In studies conducted in Burkina Faso, scientists have tested the ability of genetically engineered fungi to kill mosquitos that can transmit malaria. The effort brought together an international team of researchers and included Raymond J. St. Leger, who spoke to MAW last year about fungi that infect insects. For their study, the researchers selected the fungus *Metarhizium pingshaensei*, which naturally infects mosquitos but is harmless to other animals. The researchers inserted a toxic gene into the fungus to improve its ability to kill its host. Various toxins were trialed, including one from a scorpion and a few from spiders. These toxins attack the mosquito's nervous system and prevent it from feeding before it dies. This means that once the mosquito is infected it will not be able to spread the malaria parasite while it remains alive. In the Burkina Faso trials, the researchers found that their engineered fungi could kill their mosquito hosts in a few days even if the mosquito only contacted a single spore. The researchers will now consult with local governments and residents to find the best way to use the modified fungi. One possible method of deploying the fungi is to smear the spores onto mosquito nets. Read more at: **http://www.newsweek.com/malaria-africa-genetic-engineering-625697**

NASA Studies Mycobiome During Simulated Space Travel

In a recent experiment, the National Aeronautics and Space Administration confined four people to a simulated extraterrestrial settlement for a month. During this time, researchers also monitored changes to the mycobiome – the fungi that naturally live in the environment. At the end of the experiment, they found that the total number of fungi had decreased, but that certain fungi had actually increased their numbers. These fungi include species that have the potential to impair respiration or cause infection in people with weaker immune systems. Long term space travel tends to weaken the immune system, so any future mission to another planet will need to consider ways to deal with an increasingly hostile mycobiome. The relatively short study did not have time to witness any appreciable impacts of the new mycobiome on either the people involved or their equipment, so the real significance of these changes remains unknown. Read more at: **http://www.smithsonianmag.com/smart-news/fighting-space-fungus-180964017/**

Correction
Gary Emberger is a professor at Messiah College. The July Meeting Files article originally stated incorrectly that he taught at Temple University. This version was updated July 31, 2017.