



Winter 2020

# Fungi Kingdom News

*The newsletter of the Pioneer Valley Mycological Association*

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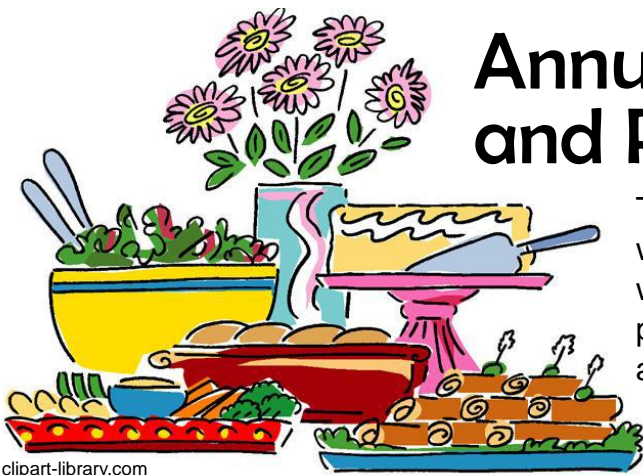
There are plenty of interesting fungi out in the middle of winter, like this unusual tiny basidiomycete in the genus *Merismodes*, discovered flourishing under the ice by Jess Benson Evans. See page 7 for more winter fungi.

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## Annual Membership Meeting and Potluck Dinner



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To help chase away those midwinter blues, reconnect with your mycophile friends and meet new ones, and whet your appetites for the upcoming 2020 season, please join us at our fun annual membership meeting and potluck dinner on **Saturday, February 1st** from 4 to 6 p.m. at Dianna's home in Leeds. All members and their families/significant others are welcome, so please come! We have a few items our membership must vote

on (see article on page 5), so it's important that you be there! Jess will share a short presentation on the elusive fungi of 2019. Looking forward to seeing you there!

**When: Saturday, February 1 (Foul weather date: Saturday February 8)**

**Location: 441 Kennedy Road, Leeds, MA**

**Time: 4-6 p.m.**

**RSVP: [JessicaBensonEvans@gmail.com](mailto:JessicaBensonEvans@gmail.com)**

We certainly won't complain if everyone brings dessert 😊 but let us know what you plan to bring if you can!



## Pioneer Valley Mycological Association

### BOARD OF DIRECTORS

**Jessica Benson Evans, *president***

**Mary Obrzut, *vice president***

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Stephanie Reitman, *Hospitality*

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### OUR MISSION STATEMENT

The Pioneer Valley Mycological Association is dedicated to enhancing the public's knowledge and appreciation of the fungal kingdom by providing ongoing educational programming in the form of guided mushroom walks, lectures, newsletters, information on multi-day regional and national forays, and citizen science projects. Because fungi are integral components of complex ecosystems, we are committed to advocating for responsible and sustainable study and collection methods. We focus on, but are not limited to, the three counties of the Pioneer Valley in western Massachusetts (Franklin, Hampshire and Hampden).

PVMA is a member of the Northeast Mycological Federation ([www.nemf.org](http://www.nemf.org)) and the North American Mycological Association ([www.namyc.org](http://www.namyc.org)).

[www.PVMAmyco.org](http://www.PVMAmyco.org)

### We Welcome Your Submissions!

This is your newsletter; we'd love to have you contribute to it!

Prose, verse, photos, drawings, recipes, scientific observations – send them all to:

[jessicabensonevans@gmail.com](mailto:jessicabensonevans@gmail.com)

[sue.lancelle@gmail.com](mailto:sue.lancelle@gmail.com)

### *From the President...*

These past few months have brought a wild array of weather conditions to my house in Shutesbury; we were buried under more than 2 feet of snow in early December, then encased in ice for several days just before New Year's. That didn't stop the fungi, though. If you've been following along on our club's Facebook page, you'll have noticed that many members are still sharing their finds regardless of the weather! For more examples, be sure to check out our feature on page 7 on common winter fungi!



For me, wintry weather also means time to go back through photographs I took this past season in hopes of making more identifications. In reviewing my files, I found that while the season seemed sparse, there were still plenty of mushrooms to celebrate! I'll be sharing some of these treasures in a short presentation at our annual membership meeting and potluck, coming up in just a few weeks.

This winter, club members have also been hard at work creating our new website (thanks, Sue!) as well as drafting our walk schedule, coming in early Spring!

Hope you'll join us at the potluck – see you soon!

*- Jessica*

## It's Time to Renew!

Please renew your membership now. The exception is if you are a new member who signed up on or after October 1, 2019; your membership is good through 2020.

Benefits include weekly guided fungi identification walks, access to our most recent newsletter, eligibility to participate in Fungi Kingdom University seminars, programs with leading experts in various mycology topics, access to free PVMA late August 5-day Foray in White Mts. of NH, information on multi-day regional forays, and scholarship opportunities to attend multi-day forays.

Membership dues remain just \$15 for an individual and \$25 for a family. There are two ways to renew. You may renew online at our new website by [clicking here](#). You may also print out the form on the last page of this issue and mail it in along with your payment. We hope you'll consider joining us for another year of friends, fun, and fungi!

# 2020 Fungi Kingdom University Workshops

Each year, the PVMA conducts a series of 3-4-hour workshops on mushroom identification for novices as well as experienced students of fungi. Join us to learn about their edibility or toxicity, their potential medical uses, their preferred habitats and tree associations, their functional roles in the environment, and other fascinating topics each spring under the guidance of excellent respected teachers. These sessions take place on Sundays in late March, April and May between 9:45 AM and 1:30 PM at Dianna Smith's home in Leeds (Northampton), MA. Jump-start or radically enhance your understanding of our connections with the world of fungi by taking this unique opportunity to expand your knowledge and appreciation of these important organisms. An educational series of this caliber can cost several hundred dollars elsewhere. To keep the price within everyone's means, we are charging just enough (\$85 per person) to cover the costs of giving our deserving guest speakers a fair honorarium in return for sharing their wisdom and passion for fungi with us.

There is limited space available for this popular fungal educational offering, and it always fills to capacity and beyond. To avoid being put on a waiting list, please register as soon as possible. You must be a current PVMA member to attend the workshops, so if you are not, sign up and pay [here](#) for membership first. Then register and pay for the workshops [here](#). If you prefer to pay by check, print and fill out the registration form on page 13 of this newsletter and send along with your payment to Membership Chair and Treasurer, Michael Ostrowski, 27 East Street, South Hadley MA 01075.

This year, in addition to Dianna, five knowledgeable guest mycologists will be leading a workshop. They include Noah Siegel, Robert Gergulics, Elinor Shavit, Susan Goldhor and Gary Emberger. [Bring your lunch and something to share for each session.](#) We will provide unlimited coffee and tea.

## **Sunday, March 29, Dianna Smith: Evolution of Fungi: 5 Billion Years in the Making!**

Our understanding of the evolution of fungi and their complicated roles in fostering life on our planet is still in its infancy. Our club's chief mycologist has been studying the available scientific literature on this and related topics over a period of several years. Dianna aims to present you with The Big Picture illustrating the changing forms and functions of fungi and their interactions with plants and animals that have occurred over immense spans of time to the present.

Dianna will introduce you to several important concepts that will serve as a foundation for getting the most out of the other workshops. You will never look at fungi the same way again!

Dianna Smith is PVMA's chief mycologist and is currently chair of the North American Mycological Association's (NAMA) Medicinal Mushroom Committee. She has written four essays on this topic published NAMA's peer-reviewed journal *Mycologia* in 2018, 2019 and 2020. She is co-founder of the PVMA with club treasurer and former president Michael Ostrowski. She served as president of the Connecticut-Westchester Mycological Association (COMA) for several years and president of the Northeast Mycological Federation for three years. Hundreds of her fungi photographs have appeared in published field guides including Gary Lincoff's *The Complete Mushroom Hunter*, Michael Kuo's *100 Edible Mushrooms*, and Michael Beug, Alan and Arleen Bessette's *Ascomycete Fungi of North America*.

## **Sunday, April 5, Noah Siegel: Chanterelles, *Craterellus* and *Mycena*: Oh My!**

Mycologist Noah Siegel will talk with us in the morning session about identifying features and clues to finding everyone's favorite edible fungi: chanterelles and the related trumpet-shaped species of *Craterellus*! Until quite recently most golden chanterelles were considered to be *Cantharellus cibarius*, a species native to Europe. Recent work has shown that we have a number of unique species in North America with particular morphological and ecological characteristics, as well as cryptic diversity in many of our charismatic chanterelle species. Noah will help us understand how to identify ones we are most likely to encounter in our region. Following lunch, he will introduce us to common species of *Mycena* that can be identified without using a microscope.

Noah's expert photographs have appeared on the covers and have been featured in articles of multiple issues of *Fungi* and *Mushroom*, the *Journal of Wild Mushrooming* (the primary mushroom enthusiast magazines in the United States), in numerous mushroom books, as well as many club publications. He authored, along with Christian Schwarz, *Mushrooms of the Redwood Coast, a Comprehensive Guide for the Northern California Coast*. Noah travels and lectures throughout the world and extensively across America, following the

mushrooms from coast to coast, and everywhere in between.

### **Sunday, April 19, Elinoar Shavit: Fossilized Mushrooms in Amber and Copal: A Fantastic Journey**

Fossils of mushrooms are extremely rare, and less than a decade ago fewer than a handful were known to science. It is thus no wonder that these rare fossils are coveted by collectors and scientists alike. Fossilized mushrooms in amber and copal are also unique because they offer science an exceptional opportunity in the study of natural history and evolution: even when fossilized, they look life-like as they are suspended in the seldom clear or transparent amber material. When mushrooms fossilize in transparent and light-colored amber, their every detail can be seen. Their contents can be studied in minute detail by electron microscope or MRI imaging. As a both a mycologist and a professional gemologist, Elinoar has been in a unique position to spot, identify and collect rare pieces of fossilized and sub-fossilized mushrooms inside copal and amber, some over 25 million years old and others perhaps less than 10 thousand. In her talk, Elinoar will present some fascinating pieces from her one-of-a-kind collection, which has become famous when she published details about some of this unique collection in the April 2019 issue of *Fungi* (Vol. 11, No. 5).

Elinoar Shavit is an ethno-mycologist. She specializes in research regarding medicinal mushrooms, edible wild mushrooms, and ethno-mycology, particularly desert truffles and the preservation of the culture of the indigenous people who use them. Elinoar has published numerous articles, recently contributing chapters to *Desert Truffles: Phylogeny, Physiology, Distribution and Domestication*. She is past president of the New York Mycological Society, a contributing editor at *Fungi* on medicinal mushrooms and ethno-mycology, and past chairperson of the Medicinal Mushrooms Committee of the North American Mycological Association. Elinoar is also a professional gemologist, holding a graduate gemologist degree from the Gemological Institute of America, and she is a past member of the American Gem Trade Association.

### **Sunday, April 26, Robert Gergulics: Bolete Forensics**

Robert will provide both new and experienced mycophiles with tips for identifying the various kinds of fungi in the family of boletes. We will look at the morphological features of boletes under the magnifier with the aim of seeing, understanding and learning the

characteristic features of different bolete genera, such as glandular dots, scabers, reticulation, raised ridges, color changes, staining, pores, and more. The lesson continues by comparing similar species of boletes side by side and examining their differences.

Robert is an amateur field mycologist with over 8 years of experience seeking, photographing, and identifying mushrooms, especially boletes. Robert has won numerous awards in the North American Mycological Association photography contest. His photographs have appeared in a European science magazine, have been featured in many articles in different publications, and in more than 7 mushroom and wild edible plants books, including *The Boletes of Eastern North America*. Robert is also known as one of “The 3 Foragers” along with his family. Together, they write a blog and have published their own book of wild edible plants.

### **Sunday, May 5, Susan Goldhor: Inter-Kingdom Dating or What's the Fungal Hook Up App? (Timber!)**

Susan is a biologist, whose professional work has concentrated on animals, looking both at biochemistry and behavior. Being active in the Boston Mycological Club got her interested in fungi, and now she thinks of fungi zoologically: what do fungi need and how do they behave in order to get it? Learning about fungi got her interested in plants for the first time and it turns out that plants – like fungi – behave pretty rationally (that's where they differ from humans). A lot of what's happening in the ecosystem stems from plant-fungal interactions; i.e., dating behavior. Or, to put it more accurately, hooking up.

Susan is the president of the BMC, a title she's held for ten years, since no one else wants the job. She's been an occasional columnist for both *Mushroom*, the *Journal of Wild Mushrooming* and *Fungi*. (Spoiler Alert: She's the rare person who's invited to write and speak about fungi, but has very little interest in or knowledge of their fruiting bodies).

### **Sunday, May 17, Gary Emberger: The Mycologist and the Trees**

Although they are usually surrounded by trees, mushroomers may not always realize how helpful knowing the trees can be in identifying the mushrooms and other fungi they seek. Many fungi are in such tight parasitic, pathogenic, saprotrophic, or mutualistic relationships with specific trees that knowing the identity of the tree contributes greatly to identifying the fungus. Today's presentation will discuss the basics of tree identification, how tree identification is similar to

and different from mushroom identification and illustrate the importance of knowing the trees as an aid in identifying the fungi.

Gary Emberger taught mycology, plant taxonomy, medicinal botany, and other biology courses at Messiah College from 1981-2018. He maintains an active interest in the diversity of fungi that utilize the woody stems and roots of trees as a substrate and

created the online identification guide "[Fungi Growing on Wood](#)" which includes keys, photographs, and descriptions of over 250 species of fungi typically found associated with wood. He completed a B.S. in biology at Pennsylvania State University and earned a M.S. and a Ph.D. in plant pathology at Pennsylvania State University and North Carolina State University, respectively.

## Important! Proposed Changes to PVMA By-Laws

The PVMA Board of Directors met on November 3, 2019 and discussed a number of "housekeeping" changes that we agreed we should make to clarify the club's by-laws. Some of the proposed changes involve changing the requirement that every director position be elected by the general membership, to having just the officers be elected while other board positions may be appointed by the existing board.

Other changes involve changing the wording around timing of the annual membership meeting, which we have held in December in the past but have voted to change to January or February (or less specifically, "early in the year") to avoid the holiday season. At least 20% of our current members must vote on these changes, so it is really important that you attend our annual meeting! The changes will pass with a simple majority of those present to vote. Please read the changes as detailed below and be prepared to vote on them at the annual membership meeting and potluck dinner, scheduled for Dianna Smith's house in Leeds on Feb. 1 (see notice on front page). The full by-laws are available to read [here](#).

Here are the proposed changes:

1. We propose changing the wording so that the Board of Directors consists of the officers, who are *elected by the general membership* for two-year terms, and other directors such as board chairpersons, who are *appointed by the board* for two-year terms:

**Item 7d.** Currently reads "Directors may be elected at any board meeting by the majority vote of the existing board of directors. The election of directors to replace those who have fulfilled their term of office shall take place in November or December of each year."

Change to: "Directors who are not officers may be appointed at any board meeting by the majority vote of the existing board of directors. The election of officers to replace those who have fulfilled their

term of office shall take place at the next scheduled general membership meeting each year."

2. Clarify that only non-elected positions may be appointed:

**Item 7e.** Vacancies (add: *in non-elected positions*)  
The board of directors may fill vacancies due to the expiration of a director's term of office, resignation, death, or removal of a director or may appoint new directors to fill a previously unfilled board position, subject to the maximum number of directors under these By-laws.

3. Clarify that even officer positions may be appointed for the balance of a term:

**Item 7f.** Currently reads: "Vacancies in the board of directors due to resignation, death, or removal shall be filled by the board for the balance of the term of the director being replaced."

Change to: "Vacancies in any board of director position, including officers, due to resignation, death, or removal shall be filled by the board for the balance of the term of the director being replaced."

4. Clarify that nominations and elections are for officer positions on the board. The other positions are appointed:

**Item 7h(iii).** Currently reads: "Nominating Meeting. The board shall meet in October or November to develop a list of nominees for the Board of Directors. This meeting may be incorporated into a regularly scheduled board meeting. Each member so nominated shall affirm willingness to serve in the office for which nominated. The board shall present this list of Board nominees at the November/December general membership business meeting when elections are scheduled. This action does not

preclude additional nominations from the floor.”

Change to: “Nominating Meeting. The board shall meet in October or November to develop a list of nominees for the *open PVMA officer positions*. This meeting may be incorporated into a regularly scheduled board meeting. Each member so nominated shall affirm willingness to serve in the office for which nominated. *The board shall present this list of officer nominees at the next general membership business meeting when elections are scheduled.* This action does not preclude additional nominations from the floor.”

5. Clarify that officers are elected by the *general membership* for two years:

**Item 8a.** Currently reads: “Officers will be elected by the Board of Directors at the November/December meeting and will serve for a period of two years commencing on the first day of January.”

Change to: “Officers will be elected by *the general membership at the annual membership meeting and will serve for a period of two years commencing on the day of the annual membership meeting and ending at the annual membership meeting two years hence.*”

6. Allow flexibility in the timing of newsletter publication:

**Item 10a.** Currently reads: “The newsletter editor

shall be responsible for the timely solicitation and editing of articles and notices for the newsletter and sending it 3 times per year (January, June, and November) to all active and honorary members.”

Change to: “The newsletter editor shall be responsible for the timely solicitation and editing of articles and notices for the newsletter and sending it *several times per year* to all active and honorary members.”

7. We propose changing the wording to reflect that the annual meeting is now held early in the year, and that a quorum will be 10% of active members, rather than the current 20%:

Item 11a: Voting Quorum: “A quorum for the annual business meeting in October or November shall consist of 20% of the Active members.”

Proposed change: “A quorum for the annual membership meeting early each year shall consist of 10% of the Active members.”

8. Change wording so that it is clear that proxy voting by email is allowed (proposed additions in italics):

**Item 11b:** “Proxies: If a member cannot attend a meeting when a quorum is required, such member may forward a written proxy or vote by email to any other active member in good standing. This written proxy or email vote will have the same effect as attendance at the meeting.”



## New Year, New Logo, New Website!

We are excited to start the new year with a fresh new simplified PVMA logo, the clump of mushrooms seen at the left. You will see this logo in various places in the newsletter, as well as throughout our new website, [PVMAmyco.org](http://PVMAmyco.org). Our goal for the

new website is that it be an easy-to-navigate tool for you to find up-to-date club news and events; registration information and forms; educational presentations; resources like our local checklists, glossaries, selected articles, back issues of the newsletter, and more. We welcome feedback, and you can contact us through the contact page on the website. Bookmark the new website and return often!

Dianna Smith's [pvmafungikingdom.org](http://pvmafungikingdom.org) and [fungikingdom.net](http://fungikingdom.net) will continue to be the repositories for her amazing collection of fungi photographs.

# Frosty Fungal Finds

It may be bitterly cold through the winter, but fungi still thrive under logs, behind bark, and on fallen sticks and branches. For the intrepid folks able to hike through the winter, a fascinating array of crusts, polypores, jellies, and ascomycetes and even a few hardy gilled mushrooms await. I generally hike at least once a week throughout the winter, depending on weather conditions and the depth of the snow cover. As long as I can make it down the trail, I'm always game to give it a try (sometimes with the ever-enthusiastic Ella alongside.) This winter's hikes have brought a wide variety of fungi, from the more commonly seen, to the new-to-me, to the still-unidentified. I share a selection here; perhaps this year, we'll learn some of these together! — Jessica Benson Evans

© J Benson Evans

*Panellus violaceofulvus*



© S Lancelle

*Trametes cinnabarinus*



© J Benson Evans

*Lentinus brumalis*



© J Benson Evans

Unknown crust



© J Benson Evans

*Punctularia strigosozonata*



© J Benson Evans

*Phyllotopsis nidulans*



© J Benson Evans

*Exidia nigricans*



# Social Media-Assisted Identifications: Gleaning Facebook for Clues

By Jess Evans

I know what you're thinking. Facebook? Not just an endless stream of advertisements and memes flashing by as you scroll? A hotbed of intellectual conversation on topics related to fungal identifications? Actually, sometimes, yes! It all depends on where you look.

There are myriad groups available to join for the mushroom enthusiast, with group names such as "Mushroom Identification," "I Love Wild Mushrooms!" and "Lichens, Mosses, Ferns, and Fungi." Each encourages folks to share their wild finds, often with the goal of helping members identify what they have found. Joining these groups does offer the danger of misidentifications and bandwagon theories, but also often helps narrow down identifications and connect like-minded mycophiles.

For accurate and interesting information, I really enjoy the daily postings from Rob Hallock's group entitled "Mycological Word of the Day." Dr. Hallock is the author of *A Mushroom Word Guide* (2015 and 2019 editions) and he shares content from his books as well as additional information based on the etymology and meanings of words pertaining to fungi. Each daily post includes photographs, definitions, and connections to articles or mushroom specimens collected by amateurs.

One such post from this past November caught my eye. Dr. Hallock posted a picture of what appeared to be a small, brown-grey mushroom with very distant, waxy gills. It looked very similar to a mystery mushroom I'd had on my mind since a foray in September. Dr. Hallock's mushroom was "possibly *Hodophilus*." *Hodophilus*? Further discussion revealed a recent Rhode Island find by amateur mycologist Joshua Hutchins, whose *Hodophilus hymenocephalus* (Fig. 1) was confirmed via DNA sequencing. I had never heard of that genus or species before. Did my mystery fungi belong to this new-to-me group?

I was inspired to do some research and found that the genus *Hodophilus* fits within the family Clavariaceae, and its place within this group was confirmed with DNA sequencing studies done in 2016 by Birkebak *et al.* Clavariaceae, within the Agaricales order, contains such familiar species as *Clavaria zollengeri* and *Clavulinopsis fusiformis*: coral fungi! Wait a second ... waxy, gilled fungi that are closely related to corals? The more I read on the topic, the



© Joshua Hutchins

Figure 1. *Hodophilus hymenocephalus*, collected by Joshua Hutchins of Rhode Island.

more intrigued I was. By morphology alone, I might never have considered that the widely varying fruiting bodies might belong within the same family.

Fungi within Clavariaceae have either a single club-shaped fruiting body, a multi-branched or coralloid shape, or an agaricoid fruiting body with stem and gills. Since 1986, several *Hodophilus* species were grouped within another new-to-me genus: *Camarophylloopsis*, which still exists within Clavariaceae as well. Looking farther back, these same species were previously placed in *Hygrocybe* (1969), *Armillariella* (1951), and *Hygrophorus* (1950). What's in a name? Before DNA studies, fungi were placed and re-placed into genera based on their morphology, or their forms and structures, both macro- and microscopically. The 2016 study simply confirmed the rightful place of *Hodophilus* species within Clavariaceae and separate from other genera in that family. Although *Hodophilus* and a few other genera within Clavariaceae have visible gills rather than coral-like shapes, their microscopic features and now DNA sequences place them firmly within that family.

My mystery mushroom was collected during the joint foray with the Boston Mycological Club in September, at the Harvard Forest in Petersham. I'd brought it back to the tables, and Chris Neefus and I discussed its possibilities. It was small, grey-brown, with distant waxy gills (Figure 2). I was fairly certain I'd seen it only once before, in 2018 on another club walk. This little gal was certainly intriguing, but that particular specimen was just one of many collected that day,



Figure 2. Specimens collected by Jess Evans in Petersham, MA, September 2019.

and I unfortunately did not keep it for further study. I wish I had done so – even if it meant waiting a few months with a dried specimen in storage to conclusively identify my mystery mushroom.

The single posting on “Mycological Word of the Day” was enough to spark connections in my mind with *Hodophilus*, and I shared my observation on Mushroom Observer. Within a few hours, CA-based mycologist Alan Rockefeller confirmed what I had suspected. His sequencing work had also confirmed Joshua Hutchins’ find. My mushroom, just based on visual characteristics and my description of its habitat and morphology, was very likely *Hodophilus hymenoccephalus*. A mystery solved – thanks to Facebook!

#### For more information:

Link to 2016 study by Birkebak, et al.

<https://pdfs.semanticscholar.org/2bd8/060c22047c0757b0c8de242152df0d12a620.pdf>

Link to my Mushroom Observer observation of *Hodophilus hymenoccephalus*:

<https://mushroomobserver.org/394649?q=14xoN>

Link to Joshua Hutchins’ Mushroom Observer observation of *Hodophilus hymenoccephalus*:

<https://mushroomobserver.org/393662>



Figure 3. First collection of the genus *Hodophilus* by Jess Evans, September 2018.

### Another beauty in the ice . . . *Tectella patellaris*





## The hidden life of *Cerrena unicolor*

By Sue Lancelle

*Cerrena unicolor* is a rather unassuming polypore that you can easily pass by, but there is a lot more to it than initially meets the eye. The common name of *C. unicolor* is "mossy maze polypore" because the caps often turn greenish with age (Fig. 1). However, the green comes from an algae and not a moss. It looks "mossy" because the caps are densely velvety to downright furry looking (figure above). Caps are 2-10 cm wide, with concentric hairy zones of various shades of brown when not overtaken by algae (Fig. 2).



Figure 1. *Cerrena unicolor*, the "mossy maze polypore," often looks green with age because of algae that grown on the cap.

The pores on the underside of the cap form a maze-like structure on younger caps (Figs. 2,3) and can elongate into tooth-like structures on older caps. It is

widely distributed throughout Europe, Asia and the Americas.

*C. unicolor* is a white rot fungus that grows on various species of hardwood trees and can initially be a parasite on living trees, later becoming a saprophyte as the trees die. White rot fungi are able to digest all



© Dianna Smith

Figure 2. Caps of *C. unicolor*, showing the maze-like structure of the spore forming tissue on the lower surface and the concentric rings in shades of brown on the upper surface of the caps.

of the cell wall components of wood, leaving behind whitish-looking rotting wood (as opposed to brown rotters, which cannot digest lignin) (Blanchette 2019). The ability to digest all of these components in various



Figure 3. The maze-like structure of the spore forming tissue on the underside of the cap of *C. unicolor*.

species of wood requires many different enzymes and metabolic pathways, and indeed, *C. unicolor* is being investigated as a possible source of economically important industrial enzymes (reviewed in Pawlik *et al.* 2019). In addition, in studies with cultured mammalian cells, various compounds produced by *C. unicolor* show promise as antiviral, anticancer and immune system modification drugs (Mizerska-Dudka *et al.* 2015, Matuszewska *et al.* 2016).

The story of *C. unicolor* becomes even more interesting when you consider its involvement in a fascinating mutualistic association with an insect in the family Siricidae, or “wood wasps.” Wood wasps are large, nonstinging wood boring insects. Members of several genera of wood wasps in the subfamily Siricinae attack conifer wood, while species in the subfamily Tremicinae almost exclusively attack hardwoods (Gilbertson 1984). The eggs of wood wasps are coated with specialized fungal spores (arthrospores) so that as the female deposits the eggs in the wood, she also introduces the fungus. The fungus benefits from this relationship because the wood wasp disperses it to new sites that it would otherwise have difficulty colonizing, while the developing insect larvae have a ready-made food source in the form of proliferating fungal hyphae and perhaps partially digested wood.

Buchner (1928, in Francke-Grosmann 1939) first described specialized organs containing hyphal fragments (the arthrospores) in adult female wood wasps. These organs are now called “mycangia” and they occur in most species of wood wasps. Francke-Grosmann (1939) showed that wood wasp eggs deposited in wood have fungal arthrospores stuck to

them. Once deposited in the wood, the fungi immediately start proliferating and breaking down wood components, providing a food source for the developing larvae once the eggs have hatched. Francke-Grossman (1939) showed that extracts from wood wasp intestines readily digest fungal hyphae. But it is not clear that this is the only source of larval nutrition. The larvae bore through the rotting wood, leaving behind undigested fragments. Martin and coworkers (reviewed in Martin 1992) have shown that ingested fungal enzymes can remain active in the gut of wood boring insects and these may contribute to the digestion of wood components, since insects do not produce the necessary enzymes on their own. Thus it is likely that wood wasp larvae are able to digest fungal hyphae as well as at least some components of the wood, especially cellulose, utilizing enzymes from the ingested fungus.

The wood wasp larvae are completely dependent on the presence of the fungus for development; in the absence of the fungus, the wood wasp eggs hatch, but the larvae do not complete development (Stillwell 1967). During normal development in the presence of the fungus, female wood wasp mycangia become re inoculated with the fungal hyphae (references in Gilbertson 1984).

The polypore *C. unicolor* attacks hardwoods, and thus its wood wasp symbiont is in the Tremicinae. In our geographical area, the species is *Tremex columba*, the “pigeon tremex” or “pigeon horntail” (Fig. 4). Stillwell (1964) first established that the fungus carried



Figure 4. *Tremex columba*, the “pigeon tremex” or “pigeon horntail,” the symbiont of *C. unicolor*. Note the impressive ovipositor and shorter “horn” emerging from the abdomen.

by *Tremex columba* is *C. unicolor*, but other species of *Tremex* in other parts of the world also associate with the same fungus (Kuramitsu *et al.* 2019, Pažoutova and Šrůtka 2007, Tabata and Abe 1995).

The pigeon horntail is fierce looking but harmless to us (Fig. 4). They are rather large, up to several cm long, and the females have two distinctive abdominal appendages: a “horn” at the tip of the abdomen and a longer ovipositor for drilling into wood and laying eggs. In their native range, wood wasps generally attack wood that has already been weakened by other forces (Gilbertson 1984), but when introduced into exotic areas, they can become destructive pests (Schiff *et al.* 2006). Native wood wasps have natural enemies that keep them under control, and this is where our *C. unicolor* story takes another turn: it appears that the fungus itself may attract the natural predators of the wood wasps!

The predator of the pigeon horntail is an even larger, fiercer looking wasp, the giant ichneumonid wasp, actually several species of the genus *Megarhyssa*

larvae of their prey. How do they find these larvae, deeply embedded in the wood? The mechanism hasn’t been clearly established for *Megarhyssa*, but in a study of another parasitic wasp in the genus *Ibalia* (Kuramitsu *et al.* 2019), researchers found that the parasitoid is attracted to volatile compounds produced by *Cerrena unicolor*. Other studies suggest that *Megarhyssa* can detect subtle vibrations or sounds emanating from the movement of the larvae in the wood (Heatwole *et al.* 1964). Perhaps the giant ichneumonids are initially attracted to volatiles produced by the fungus *C. unicolor*, and then can more precisely pinpoint the location of their prey larvae using sound or vibration detection. In any case, this natural enemy of the pigeon horntail keeps the population of this native wood borer in check.

While you are out hunting for fungi, keep your eyes open not only for the “mossy maze polypore,” *C. unicolor*, but also for the impressive wasps that are associated with it. You can find the wasps most easily while they have their ovipositors drilled into wood. They are a wonderful reminder that when it comes to fungi, there is almost always a fascinating story going on “behind the scenes!”

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Figure 5. The giant ichneumonid wasp, *Megarhyssa atrata*. Note the very long ovipositor stuck into the wood.

(Fig. 5). The most striking thing about these wasps is their very long ovipositor, up to several inches long. And while the ovipositor looks like a “stinger,” these wasps do not sting and are harmless to humans.

Giant ichneumonids are parasitoids, that is, their larvae feed on the larvae or pupae of other insects. In our area there are at least three species of *Megarhyssa*, and they all parasitize only the pigeon horntail, drilling into the wood with their long ovipositors and depositing eggs into or near the

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