Winter 2019

Fungi Kingdom News

The newsletter of the Pioneer Valley Mycological Association

Mary Obrzut, PVMA vice president, finds a beautiful clump of the jelly fungus *Exidia recisa* on the recent PVMA winter walk with Larry Millman. See article on page 6.

In this issue ...

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 August 25, 2018 (the day of Bill Yule's talk at Arcadia Wildlife Sanctuary); your membership is good through 2019.

Benefits include weekly guided fungi identification walks, access to our newsletter, eligibility to participate in Fungi Kingdom University seminars, programs with leading experts in various mycology topics, possible 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 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!

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) and the North American Mycological Association (www.namyco.org).

www.PVMAfungikingdom.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
sue.lancelle@gmail.com

From the President…

Happy New Year, friends! I am so excited for the coming year. Our membership doubled over the last few months of 2018, so there are many new friends to meet and get to know in the coming year. Our new members come from Westfield, Belchertown, Northampton, Chicopee, and many places in between. Welcome!

We'll start our season with the Fungi Kingdom University workshop series, a set of six workshops held between March and May highlighting a variety of topics on mushrooms and ecological partnerships. Look for more information on these workshops in this issue of the newsletter- sign up soon, as space is limited. Hope to see you there!

We've had a rainy winter so far, with little snow accumulation lasting longer than a few days. This makes for muddy and icy hiking conditions, but also makes it possible for members to get out and enjoy the fungi that exist year-round! You can find examples of these winter fungi such as crusts and stereums in this edition. I love rolling logs over to find surprises underneath!

We're already hard at work planning walks for this coming summer and fall; if you'd like to suggest a new walk location or lead a walk, please get in touch with me. I'm always excited to check out your favorite trails.

Looking forward to seeing you soon,

- Jessica

SCHEDULE for 2019 FUNGI KINGDOM WORKSHOP SERIES

The PVMA conducts a series of 3-4-hour workshops on mushroom description, identification, edi-bility/toxicity, medicinal fungi, associated habitat and tree associations, and the functional roles of fungi every spring. The topics vary from year to year. Excluding religious and national holidays, these take place on Sundays in March, April and May between 9:45 AM and 1:30 PM at my home in Leeds (Northampton), MA. If you want to jump-start or radically improve your understanding of our connections with the world of fungi, you will want to take this unique opportunity to expand your knowledge and appreciation of these important organisms. Programs of this quality are typically hundreds of dollars. We want to keep the price within everyone's means and are charging just enough 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. The classes are geared toward beginners, but even more experienced members have chosen to sign up for new courses annually.

There is limited space available for this popular fungal educational offering, so if you are interested in participating in the series you are advised to secure your inclusion by sending in the $85 fee for all 6 sessions along with your $15 membership fee (if you haven't already renewed for 2019) immediately (total cost $100). You can pay by credit

Continued on next page ...

card via PayPal at http://pvmafungikingdom.org/we-invite-you-to-join-the/ **(click here)** or by sending your money to Membership Chair and Treasurer, Michael Ostrowski, 27 East Street, South Hadley MA 01075.

March 10, Dianna Smith, **Myco-Speak.** A review and expansion of one of last year's most useful programs for both beginning and intermediate mycophiles. We will learn the meaning of commonly used terms employed in field guides to describe the parts of fungi and their functions. Participants who study and use these terms to describe fungi will be better prepared to see, accurately describe, and identify fungi encountered during our scheduled walks. This session will be particularly useful for members who might wish to consider joining the PVMA's pioneering Citizen Science Project, which involves the collection, drying, description and documentation of fungi in our area for DNA analysis. Specimens will be stored in the NY Botanical Garden's fungal herbarium and be available for current and future mycologists to study.

Dianna is PVMA's co-founder and club mycologist.

March 17, Jessica Benson Evans, Edible Mushrooms and Poisonous Look-alikes. Join Jessica as she helps us answer the question, "Is it edible?" The not-so-simple answer is "maybe, but…" Before we should eat any "edible" fungi, it is important to know which look-alikes we may encounter. Effects from consuming these poisonous look-alikes can range from discomfort to death, so it's important to know how to spot the differences! This introductory workshop will detail common edibles and regionally occurring fungi that look similar, with a few bonus fungi just in case.

Jessica is an amateur mycologist who coincidentally eats very few edible fungi. It's not that she doesn't enjoy eating mushrooms, it's just that she likes studying them more! Jessica is the current President of PVMA and has been seriously studying mushrooms in the Pioneer Valley for three years.

March 24, Noah Siegel, **Taking the Trickiness out of *Tricholoma*: An overview of Northeastern *Tricholoma*, and Heebie-jeebies No More: A look into *Hebeloma.*** Noah will help us learn to recognize and identify species of these two difficult genera.

Noah's expert photographs have appeared on the covers and have been featured in articles of multiple issues of FUNGI Magazine and Mushroom the Journal, the primary mushroom enthusiast magazines in the United States, 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 extensively across America, following the mushrooms from coast to coast, and everywhere in between.

March 31, Bill Yule, **An introduction to the morphology and ecology of the genus *Amanita* and a survey of the common species of the Northeast.** We will start with a look at some of the famous and infamous species and then go through a survey of the seven sections that the genus can be divided into and explore the characters of each. After lunch we can go through a species list and try to place individuals in the proper section.

Bill is an environmental educator, naturalist and amateur mycologist from CT. He teaches at The Connecticut River Museum and works on three educational boats on the CT River. He has been active in mycological education for 25 plus years and has given programs throughout the Northeast. He is a member of three local "mushroom clubs", CVMS, COMA and PVMA, as well as the North American Mycological Association.

April 7, Tom Bigelow, **Resistance is Futile: The Allure of Corticioid Fungi.** This presentation is an introduction to the amazing world of corticioid fungi, exploring what they are, the role they play in the environment, their diverse lifestyles – and how to go about finding and identifying them. Part of my fascination with fungi is photographing them, so this presentation includes images of many of the common and not-so-common crust fungi I have come across in the field.

Tom has been a member of the New York Mycological Society for 11 years. He has served as the club's president for the past four years. Tom was deeply influenced by Gary Lincoff, who instilled in him the necessity for a comprehensive fungal survey of the five boroughs of New York City. This means going out almost every weekend, all year round, chronicling the finds of the NYMS.

April 28, Susan Goldhor, The Hidden Fungal Forest. Most of us walk through the woods with our eyes focused on the search for fungal fruiting bodies. But the fungi we see in the forest are only a tiny fraction of the fungi that are there. Susan will talk about the invisible fungi that actually run the forest ecosystem. Where are these fungi and what are they doing? This talk will cover the real meaning of symbiosis; the truth about lichens; how to blame fungi for global warming (if you want to duck the human connection), and how to have healthy relationships. We guarantee that you'll never look at the forest the same way again!

Susan is president of the Boston Mycological Club, the oldest such club in the world, and a contributing editor to Fungi magazine. She is a biologist who is fascinated by fungal effects on ecosystems and by the fact that so many folks who manage ecosystems know nothing about fungi (which accounts for the many mistakes they make).

Get to know your PVMA Board of Directors!

Dianna Smith, cofounder of PVMA and club mycologist
Dianna Smith did her doctoral work in a comparative analysis of pre-modern Chinese and European science and technology at Tufts University and with Professor Nathan Sivin of MIT. She taught history at Tufts and later the sciences for young people during summers at "Creative University" from her home in NY. She was later producer and editor of her community cable television program for twenty-two years called SCAPES, which featured half-hour shows on gardening, botany and mycology. At the Connecticut-Westchester Mycological Association's (COMA) "Mushroom University," which she created and fostered with Gary Lincoff roughly ten years ago, she studied mycology with the master himself. She also studied with Alan and Arleen Bessette, authors of numerous field guides of mushrooms of the northeast as well as of individual mushroom genera. She taught introductory mycology lessons with Dr. Roz Lowen for two summers at Eagle Hill Research Center in Maine.

Dianna is President Emeritus of COMA, past editor of The Mycophile, newsletter of the North American Mycological Association (NAMA); a mycology educator; winner of national photography awards for fungi photos; a frequently published mushroom photographer of numerous field guides in both Britain and the US; winner of 2012 NAMA Harry and Elsie Knighton Service Award for her extraordinary contributions to COMA; 2012 recipient of the NAMA President's Award for her work on The Mycophile; creator of PVMA's website; served as President of the Northeast Mycological Federation (NEMF) of clubs for four years until 2018; was webmaster of http://www.nemf.org and a consultant to poison control centers and hospitals in Massachusetts. Currently she is Chairperson of NAMA's Medicinal Mushroom Committee.

Jessica Benson Evans, president

Jessica grew up in Connecticut and moved to the Pioneer Valley in 2016 to finish her undergraduate degree in Early Childhood Education at UMass – a career change after ten years working in the medical field. Jessica and her daughter Ella live in Shutesbury.

Jessica grew up in a family that loved the outdoors; her dad would often bring in mushrooms to try to identify, and the Audubon guide was always on the bookshelf among many other nature guides. However, she didn't become serious about fungi until just prior to moving to Massachusetts. A friend suggested she look up Dianna Smith's club when she moved to the area and began seriously studying mushrooms after joining PVMA in 2016.

Jessica is passionate about mushrooms! She enjoys mushroom photography and collecting and identifying specimens for the citizen science project. Jessica loves leading walks that include family groups, as Ella, age 8, is an avid mushroomer as well. In addition, she works with young children during the week in a mixed age care setting. The yard at work provides many opportunities to talk to these kiddos about fungi! Although she enjoys some edible mushroom species, her primary interests are in broadening her skills at identifying fungi and learning more about fungal ecology.

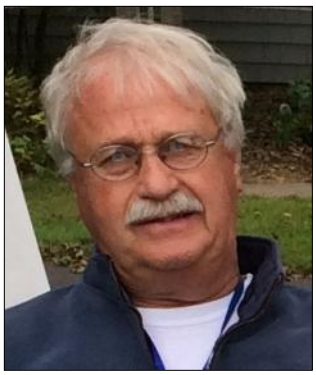
Mary Obrzut, vice president
Mary's favorite saying is, "If I have to be somewhere let it be outdoors." She has loved the outdoors since she was a young child. Her family would go on camping trips, go fishing and picnics out in nature. Today she enjoys all that plus hiking, birdwatching and mushrooming. She remembers some years ago borrowing an Audubon mushroom field guide and taking it with her hiking. She was more confused than ever, with so many look-alikes to puzzle through. In 2016 she came upon a post for a PVMA mushroom walk at the Federated Women's Club State Forest in Petersham. She and her partner, Lloyd, joined the walk that day and have been hooked ever since. She enjoys the edibles but is also fascinated with all fungi, as they are so beautiful and amazing. Mary loves spending time out on walks with the group, and says that they are wonderful people willing to share their knowledge to help others. She looks forward to learning more about fungi now that she is retired. Mary lives in Warren with her two dogs and grandson (a future mycologist!) close by.

Michael Ostrowski, cofounder of PVMA and treasurer/membership secretary

A Holyoke, MA, native and avid outdoor person, Mike enjoys hiking, walking, bicycling, cross country skiing, camping, kayaking, fishing, geocaching, and gardening. He epically enjoys going on mushroom walks and meeting so many fascinating people who are interested in learning to identify mushrooms. Mike says, "It has been very satisfying to see PVMA grow from 2 to 142 members in such a short time. It speaks to the growing interest people in our area have for mushrooms and mycology." Mike resides in South Hadley with his wife, Judy.

Joan Adler, secretary

Joan's interest in mushroom hunting and education about mycology is simply to enjoy more parts of the outside world when she goes walking with her dog, Windsor, and her friends. She also enjoys teaching her friends what she knows about mycology when they go hiking together. There is also the added benefit of getting to eat a few edibles! Joans started mushroom hunting for morels when she lived in Indiana (morels are everywhere out there!). Joan and her husband live in Greenfield.



Philip Hadley, scholarship committee

Phil enjoys hunting and fishing and considers himself a beginner to the world of mushroom foraging. He became interested in learning more about the mushrooms that he encountered while in the field. His primary interest is edible fungi, and he joined PVMA to expand his knowledge of mushrooms. He says he found a great group of people who enjoy being outside and are willing to convey their knowledge of the fungi world.

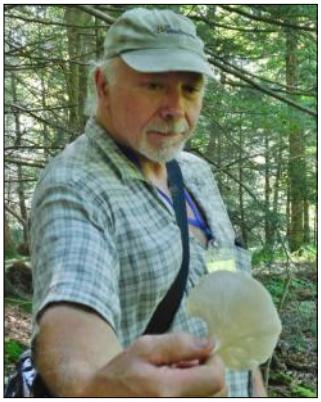
Phil lives in Westfield and was instrumental in planning and implementing two great new events in PVMA's 2018 season; a well-attended public walk at Stanley Park in Westfield, and our first-ever Fungi Kingdom Festival at Arcadia Wildlife Sanctuary.

Sue Lancelle, newsletter editor and citizen science committee

Originally from Wisconsin, Sue moved to western MA in 1978 to pursue graduate studies in botany, and never left! After many years working as a light and electron microscopist at UMass, she changed gears and became a laboratory instructor in the biology department at Mt. Holyoke College, teaching in the cell biology, electron microscopy, and introductory biology courses. While these courses covered many topics, mycology was not among them! Sue decided to pursue mycology as a challenge in retirement, and is enjoying every minute of it, especially focusing on the scientific aspects. She is also an avid gardener, birder and hiker, and lives in Belchertown with her husband, Dale Callaham.

Stephanie Reitman, hospitality

Stephanie has been a member of PVMA since early on and has been our hospitality chairperson since last spring. She lives in Williamsburg and can often be found riding her bicycle to club workshops and walks. She has also given presentations on mushroom topics at various events in the Pioneer Valley. Stephanie is interested in mushroom cultivation and remediation along with her study of wild fungi, and attended the New Moon Mycology Summit last summer which focused on these topics and others. She is also a crafter who creates beautiful knitted mushrooms!



Paul Thomas, citizen science committee

As he grew into his teens and early adulthood years, Paul was affectionately stricken by the first "from orbit" image of the Earth while simultaneously embracing his Dad's Great Depression-informed lessons as to "this (effectively 'organic' philosophy) is how you farm" approach to gardening.

A geekishly excessive fascination with how composting worked ultimately moved him to focus on soil microbiology in graduate studies, but his ultimate focus on the "bacterial" aspect of how Nature recycles nutrients left a need to revisit what the heck all of those fungi were doing in the rhizosphere!?

Subsequent to a long, strange trip through the study of legume microsymbionts and a move to Massachusetts, it was the science of why tree carcasses just don't keep piling up on themselves that re-tweaked his research muscles, near-contemporaneously with the formation of our wonderful Pioneer Valley Mycological Association.

BUT, along the way, elections happened and with a continuing involvement in, and obsession with, election integrity and reform efforts, Paul's equally an activist in the non-partisan campaign to make MA the second state in the country to adopt ranked-choice voting as the statewide method of electing our representatives.

Balancing these agenda keeps him up at night!

A Tale of Two Forays: Hunting for Winter Fungi

By Jessica Benson Evans

As the guest of PVMA friend, mycologist and author Lawrence Millman, I was invited to a Christmas fungi count at Wachusett Meadow Wildlife Sanctuary in Princeton, MA, hosted by the Boston Mycological Club in late December. I didn't quite know what to expect as this was my first organized winter foray at a site I'd never visited. What might we find in winter, beyond frozen specimens in need of forensic determination? On previous solitary winter walks over the last two years, I've spotted various crusts, jellies, and the occasional ascomycete, but I haven't had the skills to identify many of them. The Christmas fungi count with Larry and his crew served to both broaden my ID skills and invigorate my desire to share the joys of winter fungi hunting with our own club members.

With a dedicated crew of nine hardy souls, the Wachusett Meadow site yielded about 80 species of fungi and slime molds. Eighty species, in the depths of winter? Absolutely! Although we were hiking on December 23rd, the daytime temperatures were well over freezing and the sun shone beautifully through much of our day. Thawing temps meant we could roll over every log in search of fungi if we chose – and some of us did! Every underside of a log, every well-insulated crook of a stump offers an opportunity to discover hidden fungal treasures. In just over five hours of hiking, we upended countless branches and logs to find and identify such treasures as *Belonidium sulphureum*, *Mollisia cinerea,* and even a few *Hydnum repandum*. One profoundly dedicated member of the party, who shall remain nameless, even took flight, momentarily, in pursuit of the perfect polypore (good thing I always carry bandages!).


© Rand Workman

Belonidium sulphureum

I returned from the Christmas fungi count ready to host a similar hike for my PVMA friends. Thirteen adventurous and well-bundled-up souls (including five new members) braved below-freezing temperatures to join Larry and I on January 13th to explore the trails of Mt. Holyoke Range State Park in Amherst. Our walk began auspiciously; within the parking lot we discovered *Hymenochaetopsis olivacea* and just a few feet down the trail we spotted *Exidia recisa*, *Tectella patellaris*, and *Tyromyces chioneus*. Most of the larger logs and branches were frozen to the ground, but these small finds and others like them were enough to keep us going for almost two hours, stomping our feet and rubbing our hands as we stopped every few feet to study Larry's most recently found specimen.


Larry and friends

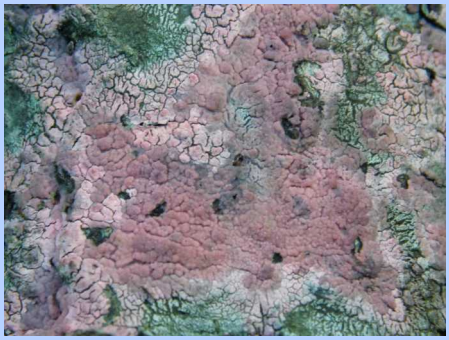

© Jessica Benson Evans

Tectella patellaris

We concluded our walk just after new member Jork N. spotted the "find of the day:" a beautiful lilac-pink crust fungus which Larry identified as *Tulasnella violea* (see sidebar). The specimen will go to the Farlow Herbarium at Harvard for long-term storage and accession by professional mycologists. Citizen Science in action! The two-inch diameter log was cheerfully hoisted by new member Brian B. after I proclaimed it "a bit heavy" to be comfortably carried in my already overloaded basket. In the end, we found 25 species, and celebrated Larry's birthday with a round of chocolate cupcakes!

Tulasnella violea

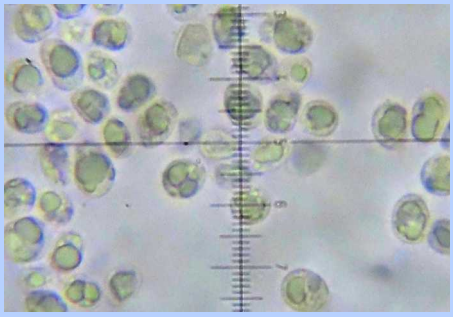
By Lawrence Millman


© Jessica Benson Evans

Tulasnella violea is a cold-adapted species whose basidia are imbedded in a gelatinous matrix (like jellies), so it can happily deal with temperatures such as what we had on our highly productive winter foray. Indeed, I've found it only in the winter or in northern places … and not very often at that. My mycologist friend Bob Blanchette has also documented it as growing on the wood in explorers' huts in Antarctica.

Here's another interesting aspect of *T. violea*: it has either a mycorrhizal or endophytic relationship with orchids, no one quite knows yet which. Most fungi associated with orchids tend to be soil fungi or micro-fungi, not crusts.

Finally, I should mention that DNA sequencing has placed *T. violea* (as well as all the other *Tulasnellas*) with the Cantharellales. I dare say the sequencers didn't ask for its permission before they performed this deed! In any event, its bi-guttulate (containing two oil droplets) spores (see image below) are far more attractive – at least to me – than the bland hyaline spores of a chanterelle. Also, its color is far more attractive than the blatant orange of a chanterelle!



Fantastic Fun Facts about

Corticioid Fungi

by Lawrence Millman

1. Corticioid fungi are an assemblage of species from at least 10 different orders. Some mycologists regard the Corticiaceae as a “dustbin taxon” for fungi that don’t seem to fit in anywhere else. Commonly called crusts, these fungi often inspire this sort of derision, but knowledge makes the heart grow fonder …

2. 88.7% of all crusts grow under logs. This means that they wear parkas (i.e., those logs themselves), and thus they do just fine in cold weather, which is why they tend to reign supreme in Christmas Mushroom Counts!

3. Most crusts have either effused (spreading without a regular form) or resupinate (flattened on the substrate) fruiting bodies. An exception: cyphelloids. This is not a sexual disease, but a term that describes the cup or disc-like morphology of a *Henningsomyces*, a *Rectipilus*, or a *Merismodes*.

© Bill Sheehan

Henningsomyces sp., showing cup-like morphology

4. Another exception: the Stereaceae. They’re often (but not always) pileate (with a cap) and likewise have a dimitic hyphal system (two types of hyphae), whereas most other crusts have a monomitic (single) one.

© Dianna Smith

Stereum ostrea, the "false turkey tail," has a cap structure but is smooth on the underside, rather than having pores like a polypore would.

5. Hymenophore (fruiting body) terms: appressed (difficult to remove); byssoid (cottony); hydnoid (prominent teeth); irpicoid (irregular or flattened teeth); grandinoid (gifted with granules); tuberculate/verrucose (gifted with warts); fimbriate (fringed with rhizomorphs); rimose (cracked); and merulioid (having netlike folds).

6. Most crusts are white rotters. The few brown rotters include *Plicatura*, *Coniophora*, and *Leucogyrophana* species. You can often tell how eagerly a crust rots its substrate by how difficult it is to remove from that substrate.

© Heather Waterman

Plicatura nivea, a "brown rotter."

7. 91.9% of all crusts are saprobes. As with other fungal decomposers, our planet depends on their ability to recycle the compounds in plant materials.

8. A small percentage of crusts are mycorrhizal, including *Byssocorticium*, *Piloderma, Tomentella, Amphinema, Athelia* (maybe), and *Trechispora* (maybe) species. A diagnostic feature: most mycorrhizal crusts are byssoid.


© Austin Helm

Piloderma sp.


© Chris Neefus

A mycorrhizal crust, *Byssocorticium* sp., showing the byssoid growth form.

9. *Piloderma* species sometimes can be identified by the yellowish mats of hyphae they produce near the log of their choice.

10. A few crusts are parasites, including *Chondrostereum purpureum, Serpula* (Wet Rot), and *Coniophora* (Dry Rot) species. The most infamous of these, *Serpula*, degrades injured wood in a forest — might it consider the wood in a house injured, too?

11. Some crusts only grow on the bark of living trees. Examples: *Aleurodiscus, Corticium*, and *Dendrothele* species.


© Andrew Khitsun

Serpula himantioides, a parasite.


© Irene Andersson

Cytidia salicina

12. Certain crusts — for instance, many *Peniophora* species — are harmless endophytes. Only when the wood dies do their mycelia spring into action.

13. Newly fallen wood seldom boasts crusts.

14. *Cytidia salicina*, which grows mostly on willows, is a gelatinous(!) crust.

15. A few crusts are plant rotters. *Laetisaria fuciformis* is the cause of “red thread” disease in turf grass (location: major league ballparks), while *Butlerelfia eustacei* causes “fisheye rot,” a post harvest disease of stored apples.

16. Some crust species, like *Bulbilomyces*, produce sclerotia as asexual propagules. For more details, **click here**.

17. Being (mostly) under logs and almost flush against the ground, crusts use insects as one of their primary vectors of spore dispersal.

18. Who says crusts can't be colorful? *Terana caerulea* is a royal blue, *Byssocorticium atrovirens* is green-blue, and *Phlebia radiata* is peachy-orange.


© Martin Livezey

Tarana caerulea


© Jessica Benson Evans

Phlebia radiata

19. And who says crusts can't be dramatic? The teeth of a *Hericium* or *Radulodon copelandii* would be considered fangs if they existed on an animal.

20. So let's celebrate "dustbin diving!"


© Jessica Benson-Evans

Radulodon copelandii

GUIDEBOOKS/REFERENCES

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Breitzenbach, J., Kranzlin, F. *Fungi of Switzerland*, *Volume 2: Non-Gilled Fungi*

Burt, E.E., *The Thelephoraceae of North America* (excellent for its field details). Available at:
https://www.biodiversitylibrary.org/item/64440#page/7/mode/1up

Ginns, J. "Genera of the North American Corticiaceae," *Mycologia* 1998, 90(1)

Hjortstam, K., Ryvarden, L. *The Corticiaceae of North Europe*, available online:
http://www.mykoweb.com/systematics/literature/Corticiaceae of North Europe vol 1.pdf
http://www.mykoweb.com/systematics/literature/Corticiaceae of North Europe vol 2.pdf

Citizen Science Project Update

By Sue Lancelle

Earlier in the fall, we applied to the North American Mycoflora Project for a grant to pay for DNA sequencing of 30 fungal specimens, and in late November, we were notified that we received the grant. Jess and I had already done most of the work of documenting, drying and storing the specimens, now we had to decide for certain which ones we wanted to have sequenced and which ones would be submitted to the New York Botanical Garden as voucher specimens only. How to decide? There are two very useful sources of information that we used. The first is the **Mycoportal**. This is the first step we used to determine if a specimen should be vouchered. Here you can search for herbarium specimens by genus and species and designate which geographical location you are interested in, whether it be country, state, county or town. We tried to determine if, how many and how recently our various specimens had been collected in our area. It was often interesting to discover that even fairly common fungi had never been vouchered or hadn't been vouchered in a very long time. Once we determined what to voucher, we decided which ones to sequence by accessing **GenBank**. Here you can search the "Nucleotide" section to see how many and what type of DNA sequences have already been performed for the species of interest. Those specimens for which we could not determine a species at all were given top priority. Then we ranked our collections based on how much information seemed to be already available. If there were few or no sequences done for a species, we put that in our priority pile. In the end, it wasn't hard at all to come up with 30 specimens to have sequenced! The DNA sequencing data will eventually be available to anyone interested in accessing it through GenBank. Those specimens will also be vouchered at The New York Botanical Garden, along with an additional 28 that will be vouchered only and not sequenced. The vouchers, even if not sequenced, provide important information for researchers who are interested in distribution and timing of fruiting of fungi. The specimens are also then available for scientists who may wish to borrow them for further study, including doing sequencing if it hasn't already been done.

Now that we have been through the whole process once, we are very excited to continue collecting, documenting, vouchering and sequencing our local fungi! We hope that more of you might be interested in contributing next year.

We will give you an update on the results once the sequences have been returned to us. Here are the specimens we submitted:

For DNA Sequencing and Vouchering:

Amanita submaculata Peck
Armillaria gemina Bérubé & Dessur.
Boletopsis grisea (Peck) Bondartsev & Singer
Boletus vermiculosus group
Cantharellus cibarius group
Clitocybe robusta Peck
Conocybe macrospora (G.F. Atk.) Hauskn.
Cuphophyllus lacmus group
Cystodermella granulosa (Batsch) Harmaja
Flammulaster erinaceellus (Peck) Watling
Gloiodon strigosus (Sw.) P. Karst.
Gomphidius smithii Singer
Inocybe tahquamenonensis D.E. Stuntz
Lactarius atroviridis Peck
Lactarius sordidus Peck
Lepiota (Pers.) Gray
Mycena epipterygia var. *lignicola* A.H. Sm.
Neoalbatrellus caeruleoporus (Peck) Audet
Neolentinus lepideus (Fr.) Redhead & Ginns
Pholiota lenta (Pers.) Singer
Pholiota limonella (Peck) Sacc.
Protostropharia alcis (Kytöv.) Redhead, Thorn & Malloch
Psathyrella conissans (Peck) A.H. Sm.
Rimbachia Pat.
Tricholoma caligatum (Viv.) Ricken
Tricholoma davisiae Peck
Tricholoma odorum Peck
Tricholoma pullum Ovrebo
Tricholoma subresplendens (Murrill) Murrill
Xanthoconium Singer

Vouchers Only:

Amanita banningiana Tulloss *nom. prov.*
Amanita cokeri (E.-J. Gilbert & Kühner) E.-J. Gilbert
Amanita frostiana (Peck) Sacc. (two specimens from different locales)
Amanita onusta (Howe) Sacc.
Armillaria gallica Marxm. & Romagn.
Boletus ferrugineus Schaeff.
Boletus longicurvipes Snell & A.H. Sm. (two specimens from different locales)
Butyriboletus brunneus (Peck) D. Arora & J.L. Frank
Butyriboletus roseopurpureus (Both, Bessette & Roody) K. Zhao, Z.L. Yang & Halling, *comb. nov.*
Clitopilus prunulus (Scop.) P. Kumm.
Cortinarius torvus (Fr.) Fr.
Cyptotrama asprata (Berk.) Redhead & Ginns
Hypholoma lateritium (Schaeffer) P. Kummer
Lactarius gerardii (Peck) Kuntze
Leccinellum albellum (Peck) Bresinsky & Manfr. Binder
Leccinum holopus (Rostk.) Watling
Leccinum rubropunctum (Peck) Singer
Oudemansiella furfuracea (Peck) Zhu L. Yang, G.M. Muell., G. Kost & Rexer
Psathyrella delineata (Peck) A.H. Sm.
Pseudomerulius curtisii (Berk.) Redhead & Ginns
Retiboletus griseus (Frost) Manfr. Binder & Bresinsky
Suillus subaureus (Peck) Snell
Tricholoma davisiae Peck
Tricholomopsis decora (Fr.) Singer
Tylopilus plumbeoviolaceus (Snell & E.A. Dick) Singer
Tylopilus violatinctus T.J. Baroni & Both

Setting the record straight on Ling Zhi (*Ganoderma lingzhi*), the "Chinese Mushroom of Immortality"

By Dianna Smith

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The history of classic medicine in pre-modern China is extremely rich and complex. It is intimately associated with long-standing beliefs and hygienic practices[1] of the political elite, scholars, powerful landowners, merchants and the many specialists that catered to the physical and psychological health of the privileged during their lives and afterward. Some were founded on quasi-religious or mystical ideas and superstitions, focused on living a balanced life that incorporated consumption of a wide variety of health promoting foods in moderation and in accordance with their seasonal and regional availability. Others were based on interpretations of an integrated theory of cosmological change systematized during the Later Han Dynasty that tied the synchronization of political, social and health activities and ideals to the celestial movements and natural observable changes that occurred over the course of the seasons.

During the Han Dynastic period (202 B.C.-9 A.D.; 25 A.D.-220 A.D.), classical medical theory was developed in a hierarchically defined, authoritarian socio-political culture dependent upon the labor of a rural peasantry to feed many urban centers and maintain infrastructure to ensure the continued existence of the reigning dynastic family. It reflected the ideals of the entitled and the desire of at least some Han Dynasty political advisers to establish control over the whims of tyrannical rulers. It entailed sociopolitical ideals that would become manifest in a world united by compliance to rituals honoring Heaven, Earth and Man, moderation in all activities, and respectful obedience to the ruler, the ancestors, the family elders and particularly the laws of nature.[2] Deviations from the norm, whether from an emperor's or a commoner's misbehavior, resulted in social uprisings, political chaos, war, widespread illness and famine. Restoration to order and health required compliance to the laws of nature and the adoption of behavioral and dietary practices as recommended by sagely physicians. If unheeded, irregularities would transform into more virulent disorders from which one would perish before reaching one's predetermined life-span of one hundred years. (Most Chinese men, it was said, died by age 50. Most Chinese women died by 49).[3] Controlling one's fate, reputation and legacy required following recommended rituals throughout the year by the emperor and the people. These were designed to maintain order, appease ancestors, show respect for authority, and prolong one's natural lifespan of one hundred years with continued physical and emotional vigor. Failure to do so in an exemplary manner, would invite Heaven's wrath, causing earthquakes, invasions, epidemics, uprisings and famine, and would result in the ruler losing the Mandate of Heaven.

There were others, especially ardent followers of numerous Taoist sects, who were less interested in being compliant with patterning their lives after behavioral norms proposed by dictates of Confucian-Legalist government authorities. Their numbers grew in times of war, famine and other catastrophes and they were often suspect in being associated with political rebellions.[4] Some sought to make the most of circumstances that threatened survival. They found refuge in uninhabited mountainous regions south of the Yangtze River. There they searched for foods and medicines consisting of its unfamiliar plants, insects, colorful stones, minerals, metals and fungi to sustain and to cultivate themselves physically and spiritually.

Shennong chewing a branch (1503). The short horns on his head are a consequence of his acquiring a feature of immortal tortoises. Painting by Guo Xu (1456-1529). Shennong is the mythological ancestor of Chinese medicine and is called the Divine Farmer and a Sage King. In addition to inventing the plow, the hoe, the axe and various other items of civilization, he is credited with teaching the people farming practices, irrigation techniques, how to dig wells, and how to preserve and store food. He is also said to have personally tested hundreds herbal drugs for the benefit of the people. The legendary Yellow Emperor, Huang Di, believed to be his son, is known for inventing wheeled chariots, astronomy, the compass, the calendar and is known for promoting the secrets of dietetics, immortality and golden elixirs. He is believed to be an Immortal.

Cut off from access to grains and rice, the basic foods of the masses, they ate no starches, fish or pungently favored foods, and intentionally fasted for days at a time. They practiced purification rites, and sought to lengthen their lives, or better yet, become spiritual

beings by creating elixirs of immortality. Quite a few even envisioned sustaining themselves in perpetuity as etherealized god-like spirits. Many methods and recipes were developed over the centuries to achieve these lofty ambitions and they appealed to anyone willing to devote their entire lives to spiritual self-cultivation. Some of these men were at least partly responsible for fostering the adoption and use of many of the drugs employed in China's corpus of pharmaceutics in the past and in the present. In fact, some attained reputations for living hundreds of years and knowing exactly where these secret immortality substances could be found. Emperors were especially desirous of locating and rewarding shamans, doctors, and other wizardly men and women to find and make the elixirs spoken of in legendary tales in hopes of becoming immortal.

Given the esteem in which fungiphiles especially hold "medicinal fungi" longevity drugs like *Ganoderma lingzhi*, you may be thinking these immortality substances consisted mainly of fungi and certain herbs. Most popular books and articles – even those by Chinese medical researchers writing about the potential medicinal compounds found in *Ganoderma lingzhi* – are insistent on convincing us this is a fact. Belief in the antiquity of use is somehow supposed to make this polypore more acceptable as an empirically verified scientific medicine. This is unfortunate. Certainly, there are numerous fungi used in Chinese cooking, which are also recommended for maintaining health and even enhancing it if not in tip-top shape. However, it is impossible to find supporting evidence that *Ganoderma lingzhi* has a two- to seven-thousand-year history of use in China. Despite the often-repeated passages regarding its antiquity of use, it is not in fact mentioned in any original Chinese medical source prior to recent times, and it certainly was never recommended as a cure for heart disease or cancer!

There are just two references to which scholars and researchers of Chinese medicinals point when they declare that *Ganoderma lingzhi* had been used from early imperial times onward. The first was recorded during the Han dynasty (206 BC – 9 AD). In a prose poem about the mythical Islands of the Immortals called "Western Metropolis Rhapsody", Zhang Heng (AD 78-139) wrote:

> *Raising huge breakers, lifting waves,*
> *That drenched the stone mushrooms on the high bank,*
> *And soaked the magic fungus on vermeil boughs.*[5]

Precisely what the terms "stone mushrooms" referred to is seriously open to question. Despite its possible later association with a species of *Ganoderma* from the late fifteenth century onward, no one can be certain that the characters referred to the polypore in its earliest documented reference.[6] According to Xue Zong, a scholar and high official of the state of Eastern Wu during between 220 to 243, the characters *dan zhi* referred to drugs of immortality.

Today the character for *zhi* means fungus or lichen or iris. Two thousand years ago, however, it referred to a variety of super mundane substances often described as immortality substances. Depending on the historical period in which it was used, the term denoted different substances made from minerals, precious stones, petrified fossils, lichens and fungi. The following passage, however, is the one usually referred to when authors and researchers mention the long use of *Ganoderma lucidum* in China. It consists of this translated passage from the *Huang Di Nei Jing*, also known as *The Yellow Emperor's Classic of Health*, which is believed to have been compiled during the second half of the Han Dynasty:

> *Tiny excrescences. These grow deep in the mountains, at the base of large trees or beside springs. They may resemble buildings, palanquins and horses, dragon and tigers, human beings, or flying birds. They may be any of the five colors ... When dried in the shade, powdered, and taken by the inch-square spoonful, they produce spirithood. Those of the intermediate class confer several thousands of years, and those of the lowest type a thousand years of life."*[7]

The "tiny excrescences" or *zhi* referred to above refer to a variety of "auspicious" spiritual substances in the earliest dictionaries. In medicine, they have the power to confer immortality. Generally, they refer to substances that have charismatic powers of transcendence.[8] In other words, the square-spoonful of dried substances which conferred on the Taoist at least a thousand years of life, or even immortality definitely was not ground-up *Ganoderma*!

Might the author have been referring to hallucinogenic mushrooms, such as *Gymnopilus junonius*, or even hallucinogenic plants, which some groups of Taoist alchemists are known to have used?[9] Joseph Needham mentions an illustrated Liang dynasty (502-587) publication called "On the Planting and Cultivation of Magic Mushrooms," which unfortunately is no longer extant.[10] So it is possible, but it is difficult to believe that even a hallucinogenic out-of-body experience would result in the proliferation of so many writings laying out the detailed ritual and material requirements of achieving everlasting immortality by standing over a continuously glowing crucible of metallic liquid.

What were immortality elixirs made of?

The earliest immortality elixirs were not made with herbs or fungi. Herbs could only provide longevity. After all, they turned to ash when cooked or rotted when allowed to naturally decompose. The ingredients employed for forging a physical compound through metallurgical processes to fashion "Pills of Immortality" were durable, long-lasting substances not subject to decay. They were a class of supernatural drugs made from metals, minerals, stones and pearls. These could be ground up and melted down and transformed in the caldrons of seekers of immortality. According to Ge Hong (284-363), who wrote a book on emergency medicine, *Zhou hou beiji fang* (*Handbook of Prescriptions for Emergency*), the superior medicine is cinnabar, followed by yellow gold, white silver, the various excrescences, the five jades, followed by mica, pearls, realgar, limonite, burnet, quartz, and softer metals...[11]

Taoist adherents engaged in ritualized alchemical practices involving the manufacture of a golden elixir out of cinnabar, mercury, realgar (disulphide of arsenic), salts, orpiment and sulphur in crucibles kept going over fires for many years at a time. Some elixirs were said to be so potent that lost teeth would regrow, and white hair would become black again. Immortals could also walk on water, ice or snow, become invisible at will, change form and travel the heavens and earth without being hampered. These powers were known through ancient stories to have been achieved by the mythical adepts who lived in the depths of legendary time. Devotees aimed to become so light that they would dematerialize.[12] They ate so little that they occasionally wrote about seeing ghosts and gods. The metallic compounds and particularly arsenic breathed in while cooking their preparations may have been accompanied by hallucinations. Drinking the elixir over time probably also prevented their bodies from decomposing as they would if they died naturally.[13]

The practice of consuming mineral elixirs was mainly carried out by rulers and the well-to-do, who had the ability to procure expensive substances employed to make golden elixirs of immortality. Emperors, like many of the rest of us, were concerned, especially toward the end of their lives with prolonging their existence forever. Like most human beings, emperors preferred to take short-cuts in hopes of getting instant results. Theoretically, all that was required was that while living, the ruler perform the prescribed annual rituals and govern in accordance with the Tao and Confucian principles.[14] After all, why give up all the pleasures of exotic foods, wines and an unlimited number of beautiful concubines too before one reached old age to take magical substances that promised eternal life?

The first emperor of a unified empire was the Chin Dynasty (221 B.C.-206 B.C.) Emperor Shi Huang (259 B.C.-210 B.C.) was the first of numerous rulers obsessed with finding and taking an elixir of immortality. According to legend, well before Shi Huang Di declared himself emperor of China's first unified empire, he allegedly met a thousand-year-old wizard who invited him to come to the mythical Penglai mountain, a mystical island to imbibe on its immortality substances. The Taoist spirits were said to be living there in gold and platinum palaces surrounded by magical fauna, flora and stone-shaped mushrooms as well as ancient trees with branches that dripped with colorful jewels. After trying three times to find it, in 219 B.C. he sent Xu Fu and an armada of ships out to sea filled with hundreds of young boys and girls to collect the treasured antidote to death. They never returned.

Near the end of his life, he was in eastern China on another search for the elixir. He is supposed to have drunk the golden alchemical elixir and died of mercury poisoning.[15] He was buried with a life-sized terracotta army of 2,000 individual soldiers, stone and bronze horses, chariots, weapons, incense burners and mirrors. His tomb also held the sacrificed bodies of his concubines who never bore him a son, so he would have their companionship and heirs in the afterlife.[16] Bodies were often buried with a large amount of mercury in the form of rivers and lakes, a key ingredient of immortality drugs. Mercury served to prevent decomposition. The body of a 2100-year-old wife of a Han Dynasty leader represents the best-preserved mummy ever found anywhere in the world.[17]

Although there are no historical records in existence of any Chinese emperor managing to actually attain a life of either immortality or even a hundred years, as we have seen several are infamous for going to extraordinary lengths to procure and create magical substances that promised to protract and even perpetuate their lives forever. Immortality drugs were consumed in preparation for ascending to the celestial firmament as a winged immortal. An ultimate and 'ideal' goal of emperors, theoretically at least, was to rule at the center of an orderly celestial government centered at the pole star.[18] It would be managed by loyal, righteous and ethical spirit-bureaucrats and protected by strong defending celestial armies.

Legendary tales of miraculous elixirs suggested this was a goal that could be attained. Imperial chroniclers reasoned that emperors who consumed these substances were too worldly, too immoderate, too acquisitive, too connected to the here and now to become immortals. They all failed to become spirits and were poisoned instead, presumably because they were unworthy. In fact, of the 66% who were not

murdered or who died by suicide, 82 out of 88 emperors who died early in life had a history ofoverindulgence in drinking or/and sex and died between 31.4 and 38.6 years of age, depending on the mode of extravagance. This contrasts with the mere six out of 240 emperors who managed to live an average of 81 years (range: 69-89).

By the ninth and tenth century, many Taoist alchemists started to look for antidotes to elixir poisoning resulting from consuming toxic metals. Others abandoned the attempt to attain physical and/or immaterial immortality altogether and focused instead on internal "alchemy." It supposedly led to longevity, if not immortality. It involved less expense as no materials were required. There were many different "schools," but most involved complex embryonic breathing exercises, gymnastic calisthenics, and sexual techniques requiring retention of semen (primal-quintessential life). The visual and temporal terminology used to describe the processes necessary to achieve longevity through controlled breathing practices were borrowed from that of the metallurgical alchemists. This method also required many years of diligent practice for those who hoped to achieve a long life. There nevertheless continued to be others who persisted in the attempt to live forever by taking dangerous immortality drugs in the Sung Dynasty period (960-1279) and even up through the eighteenth century. Kuo Zongshi, who worked as a minor official as Drug Inspector for the Imperial Medical Service during the Sung, wrote *Dilatations on Materia Medica* (*Bencao yanyi*) in which he discussed the functions and traits of what he considered were the most important drugs. He criticized the continued practice of popular healers' promotion of longevity drugs:

> *I do not know from which generation of the Daoist practice of longevity drugs began. [However,] the number of people this practice killed is legion. In spite of that, generations have admired and valued these practices. This is bewildering…[they] pray [hoping the patient] will not die but actually he dies quickly. They call this wisdom. How can that be?*[19]

His conservative – more Confucian – and practical philosophy of medicine follows that expressed in earlier classical canonical literature in reminding physicians that they should not treat those already ill, but instead treat them with education on maintaining health before they are sick: "Dispensing drugs in a perfect way is not as good as maintaining health."[20]

The (1444) Ming Dynasty edition of the Taoist Canon mentions 127 varieties of immortality drugs in the chapter entitled "Classifications of the Most High Divine Treasure Mushroom Plant." A Ming reprint from 1598 includes woodblock pictures of them. Most are herbs that are also employed in many commonly used prescriptions for a variety of diseases. Some of them could elicit hallucinations – including *Cannabis sativa, Datura stramonium, Phytolacca acinosa* (poke weed) and *Gymnopus junonius* (the latter may be a different species, but it was known as the "laughing mushroom"). I find it interesting that the book illustrates several cap and stem mushrooms – possibly hallucinogenic – as well as edible fungi still widely used and revered in Chinese cooking (*Tremella fuciformis, Auricularia* sp., and *Polyporus umbellatus*). However, there is no representation of a strain of any species of *Ganoderma*, life-extending or not.[21]

Li Shizhen's *Ben cao Gang mu* (*Compendium of Materia Medica*) from 1596 discusses the six differently colored immortality excrescences or *zhi* (green, red, yellow, white, black, and purple) written about in the no longer extant Han medical classic, *Shennong ben cao*. Again, the term *ling zhi* is not listed, but he relates the effects of *chi zhi*, the "red mushroom."[22] Li Shizhen reports that early sources say it "affects the life-energy (*ch'i*) of the heart region, repairing and benefiting those with a knotted and tight chest. Taken over a long period of time, agility of the body will not cease, and the years are lengthened to those of the Immortals."[23] Interestingly, the *chi zhi* or "red mushroom" is also associated in his mind with *dan zhi*, the cinnabar immortality substance, which is also called the "stone mushroom."[24]

The term *zhi*, interestingly, is often also used with plant names where it means 'seed'. By the late sixteenth century, the term *zhi* referred mainly to a variety of plants, fungi, lichens and excrescences. At this point in time, the red fungus currently called *Ganoderma lingzhi* seems to be suddenly and fairly reliably associated with the polypore in question. But, like most 21st century authors, Li Shizhen of the late sixteenth and early seventeenth century believed that the red immortality substance that was mentioned in the 2,000-year-old classic is the same as the one the Ming Dynasty emperors accepted as symbolic of their reign.

In any case, the polypore retained all the associations previously assigned to things that are red: the emperor in politics; the heart in medicine; cinnabar (the # 1 supernatural medicine), the red ore that releases silvery blobs of toxic mercury upon heating and which was still used in royal immortality recipes; fire; the sun; summer; noon; heat; growth; expansive energy; circulation; the planet Mars; happiness; joy; laughter; long life; vitality; money; prosperity; good luck; the south; marriage; the bridal color; cherry blossoms; red carnations; peaches; a musical note; mythical flying birds; fertility; bitter taste and scorching odors among a plethora of similar correspondences.[24]

In an effort to convince us of its medicinal efficacy, modern authors are fond of discussing its symbolism as a feature of Chinese imperial art and architecture over many thousands of years:

> *As a symbol of good health and long life, it is represented throughout ancient Chinese and Japanese art. It was woven into the silk robes and carved into the official scepter of Chinese emperors. At the Forbidden City of Beijing and at the Emperor's Summer Palace, reishi is symbolized across the doors and door lintels, archways and railings. Reishi has been called the king of herbal medicines and was ranked in the Chinese Herbal Classic as the superior adaptogen, placed at the top of the list above ginseng. Reishi is regarded by Ganoderma lucidum advocates as the most revered medicine in the Chinese materia medica."*[25]

To be perfectly clear, the decorative art referred to in the preceding passage was not a feature of any imperial period until the Ming Dynasty (1368-1644). Contrary to the impression given by writers of the popular book and movement called *Radical Mycology,* Beijing was not the capital city of China throughout its imperial history. It first became the capital of the empire after the Mongol ruler Kublai Khan installed himself in the northeastern corner as emperor of the Yuan Dynasty (1279-1368). Following the overthrow of the Yuan, the third Ming dynasty ruler, Zhu Di, moved his capital from Nanking to Beijing in 1420 with the goal of deterring renewed threats of invasion from his foreign predecessors. It was built from 1406-1420 on the ruins of the former Yuan Forbidden City with the aid of Chinese architects, engineers, stone masons, brick-layers and at least a million workers ordered to take down the *Phoebe zhennon* forests in the southwest to build the capital city from scratch. Incidentally, the first Ming ruler was reported to have sent out envoys into various mountains to find Zhang Sanfeng, a renowned Taoist immortal, to offer him a post in the royal court. It was said he went into hiding until their departure. The third emperor Cheng Zu also tried to find him, but it was rumored he escaped by pretending to be a beggar. Others claimed he ascended to the sky. The emperor honored him by building a Taoist monastery on Wu Dang Mountain in 1420. All the Ming rulers admired him.[26]

Exactly when the image of a *Ganoderma* appeared on buildings and palace furniture during the Ming isn't clear. But there was a renewed interest in pursuing some of the Daoist longevity practices once the political situation settled. The painting by Chen Hongshou (1598–1652) of a fully realized Taoist adept sitting on a cloud holding a *Ganoderma* in hand is among the most famous:

This, coincidentally, is also about the time we see first see the polypore represented in Japanese art. As in China, it is treated as a symbol of good luck, health and longevity. The art of 400-500 hundred years ago in China or Japan is not contemporary, but it also isn't exactly 'ancient' either.

In any case, in the fifteenth century the fungus was considered rare and only the emperor was permitted to possess it. It is revealing that Ming emperor, Jia-Jing, who ruled from 1521 to 1567, looking to prolong his life forever, did not take the so-called 'King of Herbs' or 'Immortality Drug', the *Ganoderma* mentioned in the *Ming Compendium of Materia Medica*. Rather, at the recommendation of his physician, he ate and drank from vessels made from alchemical gold and silver and like rulers before him suddenly died of poisoning.[27] The last known emperor to have taken immortality drugs was Yong-cheng of the Ching Dynasty (1636-1912). He ruled from 1722 until his sudden death also from metallic-mineral elixir poisoning in 1735.[28] In other words, *Ganoderma* was not employed as a medicine or as a longevity drug, even for emperors.

Basically, there is a lack of recorded evidence that *Ganoderma lingzhi* (or any of the several other species of *Ganoderma* known to exist in the Chinese empire) was ever employed as a longevity or immortality substance prior to the late twentieth century. By then, the wealthy paid a fortune to

procure *Ganoderma* from all parts of the world. The fact that it had previously been forbidden to commoners, made it especially valuable and a sign of one's exalted economic and socio-political station in life. Attempts to cultivate *ling zhi* to be used medicinally by the Chinese began in the late 1960s, but its first successful cultivation in China was in 1992. Thereafter techniques of cultivating the polypore were transmitted all across China and its use has rapidly spread throughout Asia and elsewhere. Thanks to the continued desire to "self-medicate" with ancient supplements associated with happiness, wealth and longevity and to the proficient marketing techniques of Chinese pharmacists, nearly everyone today knows of its alleged energizing, health promoting, preventative and curative powers.[29]

Despite the frequently mentioned use of *Ganoderma lucidum* (*G. lingzhi*) in "ancient China" to cure cancer,[30] there is absolutely no evidence to back up this assertion. No pharmaceutical prescription was ever created specifically for cancers! There was not even a word for cancer in the Chinese literature until the late twentieth century. Its absence doesn't mean cancer didn't exist. It just was not recognized as a distinct disease. In fact, none of our modern disease concepts match those described in pre-modern Chinese books on medicine, theory or drugs. But had there been a recognized disease condition representing life-threatening cancers or any other debilitating pathogenic process, *Ganoderma lingzhi* would definitely not have been the drug of choice prescribed to treat or cure it. As a so-called 'superior' drug, it would not even have been considered robust enough to fight the effects of a growth that made it difficult for the patient to breathe. A patient diagnosed with potentially terminal illnesses would have been prescribed a combination of militant – even toxic ingredients to fight his condition – or nothing at all.[31]

The point is, *ling zhi*, the spirit-excrescence, or spirit seed of a sublime substance, was highly regarded for its super-mundane mystical powers, and not for its ability to boost the immune system, to cure cancer or to act as "the superior adaptogen."[32] It was not used as a medicine or longevity drug even by emperors! The aura and mythology surrounding *ling zhi* as an immortality substance has nevertheless inspired Asian researchers to find evidence for its ability to serve as a modern medicine capable of curing us of diseases biomedicine continues to find daunting. In any case, assertions that *Ganoderma lingzhi* has a 7,000 to 2,200+-years-long history of successful use is misleading and does little or nothing to buttress arguments regarding its medicinal efficacy. Saying this, does not, however, mean that it should be ignored by researchers looking to continue to discover medicinal compounds that may prove useful in helping us live healthier and longer lives.

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Health Effects of Reishi: *Ganoderma lucidum* and its Many Relatives

by Dianna Smith

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Nowadays, many health products with *Ganoderma* (often called "reishi") as an ingredient are readily available, especially in East Asia, Europe and North America. They are taken for their perceived anti-cancer, anti-aging, anti-microbial and anti-viral functions, among many others. It is often hailed as "the king of herbs" (a 21st century marketing slogan), and a panacea for many ailments. Researchers studying the medicinal properties of *Ganoderma lucidum*, or *ling zhi*, claim it has a long history of use in China. Mention is repeatedly made of its antiquity of use as referenced in the no longer extant medical treatise of the first or second century A.D., the *Shen Nong Ben Cao* Classic on Health. However, as explained in the article on page 11, it is unlikely that any mushroom, much less a *Ganoderma* was the subject of the two-thousand-year-old text. The term *ling zhi* historically refers to a large number of different substances believed to be Elixirs of Immortality. They do not necessarily refer specifically or only to species of fungi, much less any *Ganoderma*.

Purported medicinal effects

The active medicinal compounds in *Ganoderma* include diverse secondary metabolites, including sterols, alkaloids and terpenoids. Which of the numerous different compounds are responsible for the recorded effects on health continues to be illusive. Although it is commonly implied in research articles that extracts of *Ganoderma* species have been used to treat numerous diseases over the past two thousand years, the fact is that it has only been used as a medicine within the past 30 years. *Ganoderma lucidum* (*G. lingzhi, G. sechuanese, G. sinense*, etc.) is used in Asian hospitals to treat HIV and AIDS. Asian laboratory studies suggest that it may stimulate certain cells of the immune system, but evidence is lacking on its ability to fight infections.[1] The polypore is believed to prevent cardiovascular disease by lowering high blood pressure, high glucose levels and cholesterol. Unfortunately, quality-controlled human trials employing placebos are lacking.[2]

Existing, if poorly designed, studies suggest that cancer patients are slightly more likely to respond positively to chemotherapy and radiation than those who do not take the *G. lucidum* extract because of immune system stimulation. But it does not have a significant effect on killing cancer cells when used alone. Patients taking the *G. lucidum* have reported that they enjoyed a better quality of life than patients who were in the control group. No studies recorded whether or not patients who took the *Ganoderma* medicine lived longer than those who did not.[3] It said to have extended the lifespan of mice.[4]

G. lucidum has also been used to reduce inflammation and it may have antihistamine effects. While there are some testimonial affirmations that taking a *Ganoderma* tincture may alleviate allergic symptoms, this feature has not been scientifically tested in humans.[5] The polypore is also employed to increase strength and stamina, although no scientific evidence with humans supports this use. However, there is a study done on mice that is said to have "improved the anti-fatigue capacity without any effect on weight loss/gain."[6] *G. lucidum* has also been used to treat lower urinary tract symptoms: one study suggests that extracts may improve urinary flow in men with slight-to-moderate LUTS.[7] Larger, long-term studies are needed to see if it can improve LUTS in men who have more severe symptoms. It is said to protect rat brains from trauma-induced oxidative stress.[8] Extracts have led to an increase weight gain of birds infected with *Eimeria tenella*.[9] Late twentieth century purported benefits also include control of blood glucose levels, immune system immunomodulation, anti-bacterial properties, and protection of the liver.[10] It is also available without prescription on Amazon for making your teeth brilliant.

A study conducted with 18 healthy adults between ages of 22-52 years given a commercially available capsule containing 1.44 grams of dried *G. lucidum* over a four-week period determined there was no liver, renal or DNA toxicity.[11] According to reviewers of studies involving the use of *G. lucidum* for cancer treatment, evidence suggests that it is generally well tolerated by patients and may enhance the immune system of patients when also taken with chemotherapy and radiation.[12] Except for a few minor reactions, one reference to toxicity with *Ganoderma* being used medicinally involved a case where it was found that the cancer patient was taking an adulterated commercially produced powder formulation over a period of a month that resulted in elevated liver enzymes. Another study by Canadian researchers suggested that toxicity was observed in peripheral blood monocular cells of healthy adults, healthy children and pediatric patients undergoing chemotherapy for cancers. They advise that *G. lucidum* extracts be used with caution as there appears to be potential for toxicity.[13] It is not recommended for those who are pregnant, take a blood thinner, or use an immunosuppressant. It may also make chemotherapy drugs less effective. When used alone, it does not demonstrate the same level of effectiveness as standard medical treatments. In classical Chinese medicine practitioners employed hot water to make a tea. Most proponents of using *G. lucidum* recommend combining preparations made by ethanol extraction with those of hot water extraction methods. Further studies using improved methods of measuring results are needed to know if using *Ganoderma* tinctures prolong the lives of patients.[14]

But which is the "true" *Ganoderma*, and does it matter?

The species concepts in the *G. lucidum* complex lack consensus in morphology and taxonomy.[15] There are as many as 219 species of *Ganoderma* in the world, of which 80 are in commerce – all are morphologically similar (their spores are double-walled), but phylogenetically they form 6 monophyletic lineages not mirrored in their geographic distributions.[16] Most species are tropical. *Ganoderma 'lucidum'* (Curtis) P. Karst. (1881) *sensu stricto* grows on hardwoods in Europe. Although mycologists throughout the world have argued that *G. lucidum* is present in China, DNA analysis has recently confirmed that they are not conspecific. Not knowing for certain which one was referred to in premodern Chinese medical texts limits both further research on the medical usefulness of these different species. For example, the widely used medicinal species in biochemical and pharmaceutical studies has been assumed to be *G. lucidum*, but evidence has emerged that what everyone has been calling *G. lucidum* is, in fact, a different species.[17] In 2012 Cao *et al.* named the Chinese medicinal *G. lucidum* as *G. lingzhi.*[18] The fungus mentioned in a late sixteenth century Pharmacopeia seems to be a Chinese *Ganoderma*, but we do not know which one it is.

To complicate matters further, there are now known to be several species of *Ganoderma* in China including *G. lingzhi*; *G. mastoporum* (Wang *et al*. 2012); *G. multipileum* (Wang *et al*. 2012); *G. sichuanense* (Yao *et al.* 2013); *G. sichuanense* (Zhou *et al.* 2015); *G. foricatum* (Wang *et al*., 2014); *G. lucidum* (Yang & Feng 2013); *G. tropicum* (Jungh.) Bres., *G. sinense*, *G. flexipes* (Cao & Yuan 2013), *G. hoehnelianum*; *G. leucocontextum* (Li *et al*. 2014); *G. multipileum* D. Hou, *G. tsugae* Murrill, and *G. mutabile* (closely related to *G. applanatum*).[19] To confuse matters more, Chinese mycologists disagree on whether or not *G. lingzhi* and *G. sichuanense* are the same or different species based on morphological considerations. Zhou *et al*. (2015) argued that they are different based on their respective ecological environments. Richter *et al.* (2015) pointed out that according to the rules of nomenclature, the new taxon name for *G. lingzhi* should be the oldest valid name, *G. sichuanense*. Currently, Index Fungorum lists *G. lingzhi* as a later synonym of *G. sichuanense.*[20] Meanwhile, most researchers continue to refer to "*ling zhi*" as *G. lucidum*!

A study conducted in China comparing 32 batches of commercially grown *G. lucidum* and 12 batches of *G. sinense* revealed that the two mushrooms are chemically different. The highly lauded triterpenes of *G. lucidum* were found to be completely absent from the native Chinese *G. sinense*.[21] *G. sinense* is quite possibly the one referred to in the Ming Dynasty Pharmacopeias.[22]

Given that different species of *Ganoderma* have different collections of compounds, and the fact that we are not anywhere near certain which compounds might be helpful medicinally, why would anyone take any product for an extended period – or till the bottle is empty – without knowing whether or not there is fact-based evidence proving its universal effectiveness in either preventing or curing a plethora of illnesses? At any rate, it is reasonable to ask healthy mycophiles what they think they are getting from their *Ganoderma* tinctures. On the east coast of North America, many who consume teas, tinctures and pills don't differentiate between *G. tsugae*, the "hemlock varnish shelf," and *G. lucidum*, a species that grows on hardwoods in Europe, and that many mistakenly assume exists in North America. Everyone is blindly assuming all have the same medicinal properties that will improve us spiritually as well as physically. Incidentally, a study conducted last year called "Evaluation on quality consistency of *Ganoderma lucidum* dietary supplements collected in the United States" found that the vast majority of supplements sold in the U.S. do not have the purported medicinal compounds in them. Just 8 of 19 product samples contained the triterpenes of the reishi fungus. Only six of the 19 were free of starches from the combined mycelium and its rice or grain substrate. Just 5 of the 19 products were authentic. The remaining 14 contained no high molecular weight beta-glucans.[23] So buyer beware!

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Book Review

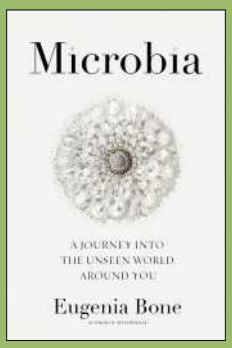
Microbia

A Journey into the Unseen World Around You

by Eugenia Bone

2018, Rodale Books

$25.99



By Lawrence Millman

In her previous book, *Mycophilia*, Eugenia Bone refers to my mustache as being akin to "a baby hedgehog that refuses to lie down." An apt description, but what does such a personal remark have to do with her latest book, *Microbia*? Well, that latest book is no less personal. Despite its title, it is as much a memoir as it is an introduction to the hidden world of microbes.

At the age of 55, Ms. Bone decides to return to college in order to study micro-organisms and their lifestyles. She is at least twice the age of the other students in her classes, a fact that makes her feel not only old, but a bit clumsy at managing the most up-to-date technologies. Yet it also gives her a much broader context — she sees the proverbial forest for the trees — than if she were simply one of the other students in the class. Thus we experience the slow advance of her learning, a *pas de deux* of advance and retreat, just as if we were taking the class ourselves. The book is so good that we often do indeed seem to be taking the class ourselves...

We learn that microbes inspire our feeding habits, our fight or flight strategies, some of our prejudices, and even our preference for our own farts to other peoples' (we have an intimate relationship with the molecular composition of our own farts). We learn that bacteria are like ants not because they enjoy biting us, but because they behave collectively, like ants in a nest. We also learn that most of the bacteria in our immediate environments are absolutely harmless. Another thing: we learn that too much washing is not good for our health.

But don't think the book ignores mycology. There are several pages about the role of fungi in our guts as well as quite a bit of information about the symbiosis of fungi with bacteria. One reference I particularly like, by the late, great Gary Lincoff, concerns the currently promiscuous fungal name changes created by genetics. "It's like early onset Alzheimer's," Gary remarks. "I know fewer mushrooms each year ..." Ms. Bone describes the Boston Mycological Club's president, the inimitable Susan Goldhor, as the kind of person "whose end of the dinner table you want to sit at."

Microbia is an instant classic — by all means, go out and buy a copy!

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