SPORE PRINTS

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CAN SNAILS SAVE COFFEE FROM A FUNGUS?

Jim Erickson

Futurity.org., Jan. 2020
via *The Spore Print*, L.A. Myco. Soc., Feb. 2020

Zachary Hajian-Forooshani

(left) Untreated coffee leaf infected with rust; (right) a leaf exposed to B. similaris, with requisite poop.

While conducting fieldwork in Puerto Rico's central mountainous region in 2016, ecologists noticed tiny trails of bright orange snail poop on the undersurface of coffee leaves afflicted with coffee leaf rust, *Hemileia vastatrix*, the crop's most economically important pest.

Intrigued, they conducted field observations and laboratory experiments over the next several years and showed that the widespread invasive snail *Bradybaena similaris*, commonly known as the Asian tramp snail and normally a plant eater, had shifted its diet to consume the fungal pathogen that causes coffee leaf rust, which has ravaged coffee plantations across Latin America in recent years.

Now the University of Michigan researchers are exploring the possibility that *B. similaris* and other snails and slugs, which are part of a large class of animals called gastropods, could be used as a biological control to help rein in coffee leaf rust. But as ecologists, they are keenly aware of the many disastrous attempts at biological control of pests in the past.

"This is the first time that any gastropod has been described as consuming this pathogen, and this finding may potentially have implications for controlling it in Puerto Rico," says doctoral student Zachary Hajian-Forooshani, lead author of a paper in the journal *Ecology*.

"But further work is needed to understand the potential tradeoffs *B. similaris* and other gastropods may provide to coffee agroecosystems, given our understanding of other elements within the system," says Hajian-Forooshani, whose advisor is ecologist John Vandermeer, a professor in the department of ecology and evolutionary biology.

Vandermeer and ecologist Ivette Perfecto, a professor at the School for Environment and Sustainability, lead a team that has been monitoring coffee leaf rust and its community of natural enemies on 25 farms throughout Puerto Rico's coffee-producing region.

Those natural enemies include fly larvae, mites, and a surprisingly diverse community of fungi living on coffee leaves, within or alongside the orange blotches that mark coffee leaf rust lesions. Hajian-Forooshani has been studying all of these natural enemies for his doctoral dissertation.

"Of all the natural enemies I have been studying, these gastropods in Puerto Rico most obviously and effectively clear the leaves of the coffee leaf rust fungal spores," he says.

Chief among those gastropods is *B. similaris*, originally from Southeast Asia and now one of the world's most widely distributed invasive land snails. It has a light brown shell that is 12 to 16 mm (roughly one-half to two-thirds of an inch) across. In the paper, Hajian-Forooshani, Vandermeer, and Perfecto describe experiments in which a single infected coffee leaf and a single *B. similaris* snail existed together inside dark containers. After 24 hours, the number of coffee leaf rust fungal spores on the leaves had gone down by roughly 30 percent. However, the snails were also responsible for a roughly 17 percent reduction in the number of lesions caused by another natural enemy of coffee leaf rust, the parasitic fungus *Lecanicillium lecanii*.

"With the data we are collecting now, we seek to find out if there are any apparent tradeoffs between these two consumers of the coffee leaf rust," Hajian-Forooshani says. "For example, if the fungal parasite is especially efficient at reducing the rust, and the snail eats it along with the rust itself, that could be a tradeoff: promote the snail to control the rust and face the possibility that the snail eats too much of the other controlling factor." In the paper, the authors say they're cognizant of "the many disastrous attempts at classical biological control" in the past.

One of the best-known examples of a biological backfire was the introduction of the cane toad, *Rhinella marina*, into Australia in the mid-1930s to control a beetle that was destroying sugar cane. Long story short, the cane toad was completely ineffective at controlling the beetle and became a pest in its own right by multiplying dramatically in the absence of natural enemies.

So, it's too soon to tell if the fungus-eating appetite of *B. similaris* and other snails could be harnessed in the fight against coffee leaf rust. One big unanswered question: Do the fungal spores remain viable after they pass through the guts of the snails?

"The gastropods seem to reduce the number of spores on the leaf, but it's not clear if the spores can still germinate in the excrement," Hajian-Forooshani says. "Also, we don't know how the effect of the gastropods on coffee leaf rust scales up to impact the pathogen dynamics at the farm or regional scale."

iNaturalist.ca

B. similaris.

And the potential role of gastropods in the fight against coffee rust elsewhere in Latin America remains unknown. But the researchers hope their findings in Puerto Rico will stimulate further research in other coffee-growing regions.

Spore Prints

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BOARD NEWS

Luise Asif

The **Survivor's Banquet** is scheduled for Saturday, March 14. It will again be a potluck, with a Northwest theme. A banquet registration notice has gone out with options for dishes to bring. New officers and trustees will be introduced. A silent auction to benefit the Ben Woo Scholarship fund is planned**.** Daniel Winkler and Danny Miller, along with members from the **Bridle Trails Study**, prepared another 160 specimens for DNA analysis. We are looking forward to Danny's report once results are received. People attending the February membership meeting heard Danny's exciting results from the initial group of analyzed samples. **Mushroom Maynia**, chaired by Jeremy Collison, is scheduled for Sunday, May 17, at the Phinney Center Community Hall (lower building). Volunteers are needed for food, cultivation, and children's activities to name a few. Ready to help? Contact volunteers@psms.org or secretary@psms.org. The PSMS board is continuing to implement **suggestions** from the Five-Year Plan and Derek's 2018 Retreat; some are complete, but some still need clarification and work. Kudos to Paolo Assandri for stepping in to manage **Book Sales** for Erin and Brady Raymond.

Remember, *voting closes March 8th. Vote!*

PSMS SURVIVORS' BANQUET AND ANNUAL MEMBERSHIP MEETING

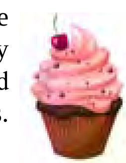
Saturday, March 14, 2020, at 7:30 pm, at the Center for Urban Horticulture, 3501 NE 41st Street, Seattle, WA 98105 (doors open at 6:30 pm for the social hour). This replaces our March general membership meeting.

This is the time we gather to celebrate our good fortune in "surviving" another season of hunting the elusive mushroom and sharing the woods with our friends! Our potluck theme this year is "Pacific Northwest Cuisine." You will find our potlucks to be among the finest you have experienced, with tables laden with the treasured contributions by our members who are from a bounty of cultures and backgrounds.

We will have a short presentation (or two), introduce the newly elected board members and officers for 2020–2022, announce the winner of the 2020 Patrice Benson Golden Mushroom Award for outstanding service to our society, and hand out a few door prizes. This promises to be a fun evening with friends and family, so come join us! There will also be a silent auction which will include some of our monocular microscopes with all proceeds going to the Ben Woo Scholarship Fund.

For any mushroom dishes, we ask that you label your dish according to the mushrooms used. We want PSMS members to restrict the mushroom varieties used in dishes to the following mushrooms: Hedgehog mushrooms, Porcini, Lobster mushrooms, Chanterelles, Black Trumpets, Delicious Milky Caps, Bears Tooth or Lions Head, Oyster mushrooms, Cauliflower mushrooms, Truffles, Morels.

This event is for PSMS members only, but if your significant other or dinner partner is not a member, you can still include and register them. Seating is limited so register early to guarantee your place. You must be pre-registered to attend. The cost is $5/person to cover incidentals. Sorry, no refunds.



CALENDAR

Mar. 8	Election deadline
Mar. 14	PSMS Survivor's Banquet, 7:30 pm, CUH
Mar. 16	Board meeting, 7:30 CUH board room
Mar. 24	*Spore Print*s deadline

NEW RULES FOR MUSHROOM HUNTERS AT OREGON CEMETERY

Katie Streit
https://kobi5.com/, Feb. 6, 2020

JACKSONVILLE, Ore. - Jacksonville's historic cemetery is enacting new rules after it says mushroom hunters are disturbing the property.

Jacksonville city officials say mushroom enthusiasts search the cemetery for morels, a fungus often found in luxury food. However, they're hurting the environment by parking on gravestones and disrupting funerals.

"I mean if they want to come up and pick mushrooms that's their choice. But just follow the rules and understand there's other reasons the cemetery's there than mushroom picking," said Max Woody, Public Works Operational Manager for the City of Jacksonville.

The cemetery commission is asking mushroom hunters to park in designated areas, keep noise levels to a minimum, and keep an eye on their children.

[*Ed note: PSMS member Denis Benjamin once got sick as a dog after eating some Agaricus campestris from a Seattle cemetery that had just been sprayed with weed killer. Be cautious picking in places where insecticides, herbicides, and fungicides can be spread.*]

WHY ARE PEOPLE PUTTING MUSHROOMS IN THEIR COFFEE?

Sarah Pitts

https://www.baltimoresun.com/, Feb. 16, 2020

[abridged] Mushrooms have long been a popular pizza topping or salad bar option, but these days, people are adding them to their coffee or drinking them in tea. In fact, superfood mushroom powder is currently one of the more popular products on Amazon.

What's the deal?

Certain mushroom strains have been deemed a superfood, meaning mushrooms have taken their place alongside kale, spirulina, wheatgrass, and all those other veggies that claim to be packed with micronutrients and promise miraculous health benefits.

Wondering what the claimed benefits of mushrooms are and debating whether it's worth it to add fungi to your morning cup of coffee…or if you're better off skipping this trend? Here's what you need to know.

The four primary micronutrients in mushrooms are vitamin D, selenium, glutathione, and ergothioneine. These are all known antioxidants, and ergothioneine contains an amino acid that humans need and can only acquire through dietary sources. Besides the micronutrients just listed, mushrooms contain fiber, protein, and B vitamins, all of which are good for you.

Antioxidants prevent oxidative stress, which is a key cause of diseases like cancer, dementia, and heart disease. Fiber helps maintain digestive health, lowers cholesterol, and helps control blood sugar. B vitamins promote red blood cell growth, higher energy levels, and improved brain function.

While we doubt mushrooms will reverse major diseases or drastically improve your quality of life overnight, a balanced and nutrient-rich diet can only help you. Mushroom powder is a convenient way for busy people to add key micronutrients to their diets without too much effort; meaning if you prioritize your well-being but don't always have time to prepare thoughtful, healthy, home-cooked meals, it might be a good idea to add a mushroom superfood supplement to your diet.

SCIENTISTS UNCOVER NEW MODE OF EVOLUTION

Nicoletta Lanese

https://www.livescience.com/, Jan. 21, 2020

Evolution and natural selection take place at the level of DNA, as genes mutate and genetic traits either stick around or are lost over time. But now, scientists think evolution may take place on a whole other scale—passed down not through genes, but through molecules stuck to their surfaces.

These molecules, known as methyl groups, alter the structure of DNA and can turn genes on and off. The alterations are known as "epigenetic modifications," meaning they appear "above" or "on top of" the genome. Many organisms, including humans, have DNA dotted with methyl groups, but creatures like fruit flies and roundworms lost the required genes to do so over evolutionary time.

Another organism, the yeast *Cryptococcus neoformans*, also lost key genes for methylation sometime during the Cretaceous period, about 50 to 150 million years ago. But remarkably, in its current form, the fungus still has methyl groups on its genome. Now, scientists theorize that *C. neoformans* was able to hang on to epigenetic edits for tens of millions of years, thanks to a newfound mode of evolution, according to a study published Jan. 16 in the journal *Cell*.

The researchers behind the study didn't expect to uncover a well-kept secret of evolution, senior author Dr. Hiten Madhani, a professor of biochemistry and biophysics at the University of California, San Francisco, and principal investigator at the Chan Zuckerberg Biohub, told *Live Science*.

The group typically studies *C. neoformans* to better understand how the yeast causes fungal meningitis in humans. The fungus tends to infect people with weak immune systems and causes about 20 percent of all HIV/AIDS-related deaths, according to a statement from UCSF. Madhani and his colleagues spend their days digging through the genetic code of *C. neoformans*, searching for critical genes that help the yeast invade human cells. But the team was surprised when reports emerged suggesting that the genetic material comes adorned with methyl groups.

"When we learned [*C. neoformans*] had DNA methylation … I thought, we have to look at this, not knowing at all what we'd find," Madhani said.

In vertebrates and plants, cells add methyl groups to DNA with the help of two enzymes. The first, called "de novo methyltransferase," sticks methyl groups onto unadorned genes. The enzyme peppers each half of the helix-shaped DNA strand with the same pattern of methyl groups, creating a symmetric design. During cell division, the double helix unfurls and builds two new DNA strands from the matching halves. At this point, an enzyme called "maintenance methyltransferase" swoops in to copy all the methyl groups from the original strand onto the newly built half.

Madhani and his colleagues looked at existing evolutionary trees to trace the history of *C. neoformans* through time, and found that, during the Cretaceous period, the yeast's ancestor had both enzymes required for DNA methylation. But somewhere along the line, *C. neoformans* lost the gene needed to make de novo methyltransferase. Without the enzyme, the organism could no

cont. on page 4

New Mode of Evolution, *cont. from page 3*

longer add new methyl groups to its DNA—it could only copy down existing methyl groups using its maintenance enzyme.

In theory, even working alone, the maintenance enzyme could keep DNA covered in methyl groups indefinitely—if it could produce a perfect copy every single time.

In reality, the enzyme makes mistakes and loses track of methyl groups each time the cell divides, the team found. When raised in a Petri dish, *C. neoformans* cells occasionally gained new methyl groups by random chance, similar to how random mutations arise in DNA. However, the cells lost methyl groups about 20 times faster than they could gain new ones.

Within about 7,500 generations, every last methyl group would disappear, leaving the maintenance enzyme nothing to copy, the team estimated. Given the speed at which *C. neoformans* multiplies, the yeast should have lost all its methyl groups within about 130 years. Instead, it retained the epigenetic edits for tens of millions of years.

"Because the rate of loss is higher than the rate of gain, the system would slowly lose methylation over time if there wasn't a mechanism to keep it there," Madhani said. That mechanism is natural selection, he said. In other words, even though *C. neoformans* was gaining new methyl groups much more slowly than it was losing them, methylation dramatically increased the organism's "fitness," which meant it could out-compete individuals with less methylation. "Fit" individuals prevailed over those with fewer methyl groups, and thus, methylation levels remained higher over millions of years. But what evolutionary advantage could these methyl groups offer *C. neoformans*? Well, they might protect the yeast's genome from potentially lethal damage, Madhani said.

Transposons, also known as "jumping genes," hop around the genome at whim and often insert themselves in very inconvenient places. For instance, a transposon could leap into the center of a gene required for cell survival; that cell might malfunction or die. Luckily, methyl groups can grab onto transposons and lock them in place. It may be that *C. neoformans* maintains a certain level of DNA methylation to keep transposons in check, Madhani said.

"No individual [methylation] site is particularly important, but overall density of methylation on transposons is selected for" over evolutionary timescales, he added. "The same thing is probably true in our genomes."

Many mysteries still surround DNA methylation in *C. neoformans*. Besides copying methyl groups between DNA strands, maintenance methyltransferase seems to be important when it comes to how the yeast causes infections in humans, according to a 2008 study by Madhani. Without the enzyme intact, the organism cannot hack into cells as effectively. "We have no idea why it's required for efficient infection," Madhani said.

The enzyme also requires large amounts of chemical energy to function and only copies methyl groups onto the blank half of replicated DNA strands. In comparison, the equivalent enzyme in other organisms does not require extra energy to function and sometimes interacts with naked DNA, devoid of any methyl groups, according to a report posted on the preprint server *bioRxiv*. Further research will reveal exactly how methylation works in *C. neoformans*, and whether this newfound form of evolution appears in other organisms.

SNAKES SUFFERED AFTER A FROG-KILLING FUNGUS WIPED OUT THEIR FOOD

Jonathan Lambert

https://www.sciencenews.org/, Feb. 13, 2020

Karen Lips knew a wave of frog death was coming.

The frog-killing *Batrachochytrium dendrobatidis*, or chytrid fungus, had begun ravaging amphibian populations in Costa Rica in the early 1990s, and by all indications would eventually reach Panama. So in 1997 Lips, a herpetologist now at the University of Maryland in College Park, and her colleagues scrambled to take stock of the biodiversity at El Copé, a tropical forest field site in central Panama, before the wave hit.

Chytrid did hit El Copé in 2004, eliminating more than 75 percent of the frog population there. But Lips and her colleagues' foresight allowed them also to assess chytrid's impact on another part of that ecosystem—snakes.

These elusive frog-eating reptiles can be difficult to detect. Still, the team found that both snake diversity and average body size dipped after chytrid wiped out the frogs, a major food source, researchers report in the Feb. 14 *Science*.

"When there's a collapse [like that in frogs after chytrid], the focus is usually on the group that collapsed," says Kelly Zamudio, an evolutionary biologist at Cornell University who wasn't involved in the research. But the new study makes key strides toward documenting the effects of a collapse on other parts of an ecosystem. "It's an intuitive idea," she says, but one that has been difficult to demonstrate because biologists need good before-and-after data.

To get such data, Lips and her colleagues looked for amphibians and reptiles along 200-m to 400-m paths around El Copé each year from 1997 to 2012. The team caught whatever they could, noting the species and measuring body size. The final analysis excluded data from 2005–2006, just after chytrid had swept through the region.

"The tropical snake community here is incredibly diverse," Lips says, "but also really poorly studied." In part, that's because the reptiles can be really hard to detect. "Many of these species are rare to begin with. They hide out in hard to reach places, and they've evolved to be camouflaged," Lips says.

So while the effects of chytrid on frogs were obvious—"dead frogs were everywhere," Lips recalls—it wasn't clear what the consequences of the fungus were for snakes. (The fungus doesn't directly harm reptiles.)

The scientists' surveys show that the number of observed snake species went down after chytrid, from 30 to 21. But since encounter rates are low for many of these species—a dozen of the 36 species ever observed at the site were seen only once in 13 years—simple statistics can't tell the full story.

So Elise Zipkin, a quantitative ecologist at Michigan State University in Lansing, devised a different strategy. "Instead of trying to definitively document the absolute number of species that were there before and after, we switched things up and asked what's the probability that there are less there than there used to be."

She and her colleagues used the transect data to run statistical simulations estimating the probability that both observed and unobserved snake species were present in a particular transect before and after chytrid. "We can say with 85 percent probability that there are fewer species present after chytrid," she says.

Average body size also went down, perhaps due to lack of food, for four of the six species encountered often enough to measure. One of those species was the Argus goo-eater (*Sibon argus*), which relies heavily on amphibian eggs for food.

While most snake species were likely harmed, a handful benefited from the disappearance of so many frogs. Five observed species became more common, perhaps because they have more generalist diets. The biggest winner, the eyelash viper (*Bothriechis schlegelii*), is known to dine on birds, bats, and rodents in addition to frogs.

"Overall, chytrid has probably left things worse off for snakes," Zipkin says. Rare species have disappeared, leaving a smaller, more homogeneous community behind. Similar patterns may be occurring elsewhere, she says. "The biodiversity crisis is probably worse than we're even able to estimate."

But just as the collapse of one group can send shock waves throughout an ecosystem, lifting the health of a species or community could also benefit the whole. "I really don't think it's hopeless," Zipkin says "There's still so much we can do, like preserving remaining habitats, to preserve biodiversity."

Clint Otto

The Argus goo-eater (Sibon argus) snake dines on gooey amphibian eggs. After the chytrid fungus wiped out over 75 percent of frogs at a field site in central Panama, researchers found that the goo-eater declined both in number and in average body size-

FUNGI AS FOOD SOURCE FOR PLANTS: BIOLOGISTS OF THE UNIVERSITY OF BAYREUTH PUBLISH SURPRISING FINDINGS

Christian Wißler

Idw-online.de, Jan. 2020

*The Spore Prin*t, L.A. Myco. Soc., Feb. 2020

The number of plant species that extract organic nutrients from fungi could be much higher than previously assumed. This was discovered by researchers from the University of Bayreuth and the University of Copenhagen through isotope investigations on *Paris quadrifolia*, otherwise known as Herb Paris or True Lover's Knot. This forest-floor plant, which is widespread in Europe, is regarded in botany as a prototype for plants that have a specific exchange relationship with fungi, which in fact accounts for around 40 percent of all plant species. In *The New Phytologist* journal, the scientists report on their surprising results.

The research results show that the ecological importance of fungi is still considerably underestimated. "If it is confirmed that far more plant species than previously known obtain part of their organic nutrients from fungi, fungi will be shown to have a major impact on the biodiversity and function of ecosystems. Programs and measures in nature conservation and environmental protection should therefore also increasingly consider fungi," says Philipp Giesemann M. Sc., the lead author of the study, who is currently doing his doctorate in biology at the University of Bayreuth and has been awarded a scholarship from the Elite Network of Bavaria.

Well over 90 percent of all plant species are linked to fungi via their underground root systems. Such a symbiosis of plants and fungi is called "mycorrhiza." Very often it is advantageous for both partners: While fungi supply the plant with minerals and water, the plant supplies local fungi with carbonaceous nutrients it has previously produced by photosynthesis. However, it also happens that plants "unfairly" exploit the fungi crosslinked with them. They then extract organic nutrients from their fungal partners instead of producing them themselves through photosynthesis. These nutrients have been transferred from trees to fungi, for example, and are now being tapped by a third plant using an underground root network. Such plants are therefore called "mycoheterotrophs." The best known example are the orchids: Because they can be partially or completely fed by fungi via underground root networks, they are not exclusively dependent on photosynthesis. Hence, they can thrive even in the darkest forests.

However, of the 80 percent of all green plant species that utilize a form of mycorrhiza, researchers have up to now assumed it to always involve "fair" exchange relationships between plants and fungi. In this "arbuscular mycorrhiza"—so it was believed—the green plants are always completely autotrophic partners, producing vital organic nutrients themselves and partially releasing them to their fungal partners. But the studies on *Paris quadrifolia* now published refute this general assumption. The Bayreuth researchers were able to prove beyond doubt that this plant obtains part of its carbon-rich nutrients from fungal partners.

"This finding could have far-reaching consequences for botany," explains the Bayreuth biologist Prof. Dr. Gerhard Gebauer, who coordinated the research work. "This is because experts distinguish between two forms of arbuscular mycorrhiza, each of which is used by about 40 percent of all plant species. In a sense, Herb Paris is considered a model for one of these two forms of plant symbiosis with fungi. In this respect, it is a prototype for far more than a third of all plant species. This raises the

Wikimedia Commons

Paris quadrifolia aka Herb Paris or True Lover's Knot.

cont. on page 8

A BEAUTIFUL RESUPINATE POLYPORE FRUITING IN WINTER FROM WESTERN WASHINGTON

Brian S. Luther

PSMS member Stephen Dorsey was hiking in January on Squak Mt. near Issaquah, when he came across a standing dead Alder partially covered with a bright yellow-orange resupinate fungus. He requested help identifying it from photos he'd taken; these were sent to Danny Miller and others, who forwarded them me. Resupinate fungi have countless look-a-likes, and it was not possible to nail down a precise identification from photos alone. I had to have a specimen to study microscopically. Wren Hudgins (who lives near Squak Mt.) made arrangements with Stephen to meet him and go collect some of the specimen. They did, and Wren sent a portion to me for ID. Stephen took several gorgeous photos, one of which I'm showing here, with his permission. The following is a description, photos, a photomicrograph and illustrations I did on the fresh material.

All colors in quotes are from Ridgway (1912). If you're reading the hard copy of *Spore Prints* which is in black & white, please go online to see and appreciate this in living color.

Description of Collection

Perenniporia medulla-panis (Jacq.: Fr.) Donk.

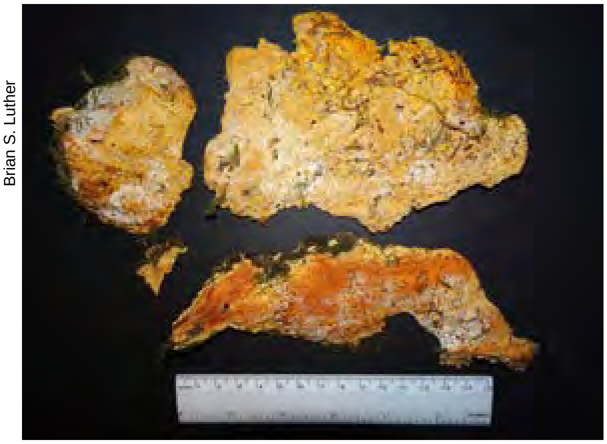
BSL coll. #2020-119-1. Squak Mt., King Co., WA. Growing on *Alnus rubra* (Red Alder) at approx. 1,700 ft. January 19, 2020. *Etymology:* having perennial pores with a felt-like context or medulla.

Basidiocarp

Resupinate, poroid, annual to perennial, from 2–10 mm thick, but if perennial then the pore layers are stratified and in cross section up to 5 mm thick and "Yellow Ocher" in color, with the medulla or context below up to 5 mm thick and a slightly darker shade, as "Buckthorn Brown"; texture firm and corky and easily peeling from the substrate; surface smooth to more often irregularly lumpy; color pale ochraceous to bright orange, as "Pale Yellow Orange" to "Orange Buff" to "Xanthene Orange" to "Ochraceous Orange," with the margin distinctly paler as "Antimony Yellow"; pores round to slightly irregular or elongate in places, 2–5 per millimeter, but up to 1 mm or more wide when elongate, sometimes stuffed with white mycelium, dissepiments (pore walls) thin when mature; tubes mostly from 0.20–0.5 mm deep.

Stephen Dorsey

Perenniporia medulla-panis.



Brian S. Luther

Perenniporia medulla-panis.

Brian S. Luther

Perenniporia medulla-panis basidiocarp in cross section. Lighter stratified pore layer above with slightly darker context below.

Brian S. Luther

Specimen tested positive with tincture of Guaiac resin, turning green, showing it's a white rot fungus.

Microstructures

Hyphal system mostly dimitic, to rarely trimitic[1]: generative hyphae 2–4 µm wide, hyaline, thin walled with clamp connections, branching and non-dextrinoid; skeletal hyphae 2.5–5 µm wide, thick-walled with some appearing nearly solid, smooth, but occasionally with irregularities, unbranched, aseptate and without clamps, hyaline in KOH and NH_4OH, but strongly dextrinoid[2] in Melzer's reagent; binding hyphae up to 2 µm wide, thick walled and irregularly branching but rare and difficult to distinguish from the much more abundant skeletal hyphae, strongly dextrinoid in Melzer's reagent. Basidia were rarely seen and not mature, but those that I was able to locate were clavate and approx. 18 × 5 µm. Basidiospores 5–6 × 3.5–4 µm, broadly ellipsoid to ovoid to somewhat irregular and slightly to noticeably truncate, thick-walled, hyaline in KOH or NH_4OH, smooth, very lightly dextrinoid to nearly hyaline in Melzer's reagent, apiculus observable based on spore orientation, with the spore wall thinning near the apiculus.

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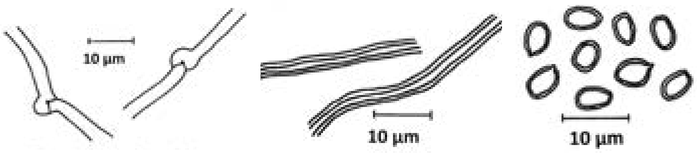
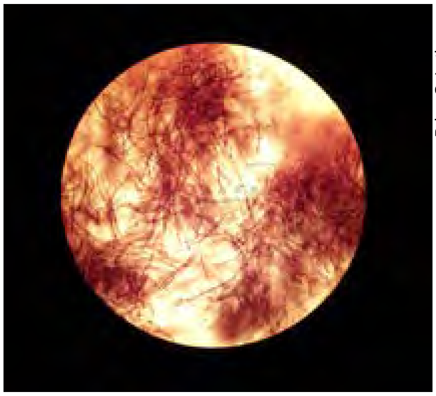
[1]Having three different kinds of hyphae making up the tissue: generative, skeletal and binding hyphae. Monomitic=having only generative hyphae. Dimitic=with generative and skeletal, or generative and binding hyphae only.

[2]Dark or warm reddish-brown reaction of fungal tissues to Iodine solutions, such as Melzer's reagent or IKI.



Generative hyphae with clamp connections **Skeletal hyphae** **Basidiospores**

dwgs by Brian S. Luther



Brian S. Luther

Perenniporia medulla-panis. Strongly dextrinoid skeletal hyphae at 400×.

This is a white rot fungus, which means it decays lignin and reacts positively to polyphenol oxidase testing reagents. I tested this fungus using tincture of Guaiac resin (Gum Guaiac) which resulted in a positive greenish color confirming this (see photo).

Discussion

I had a suspicion about the identity of this fungus because I previously found and photographed it in 2011 and have it in my collections. BSL coll. #2011-326-2 is similar in color, but just slightly paler orange compared to the collection studied here.

Being found in mid-winter, the specimen studied here was dormant and thus was not producing mature basidia. The few basidia I was able to observe after making numerous mounts were immature and on the low end of the measurement range for this species, but seeing mature basidia was not necessary for a positive ID.

I found a lot of variation in some characters for this species in the literature. The pore size per millimeter is quite variable in this species, measuring from 4–7/mm, but some of the pores in this collection on average were a bit larger. There are discrepancies also concerning the presence or absence of binding hyphae and the reaction of these and spores to iodine reagents, especially comparing the European concepts. Binding hyphae are very rare and were difficult to locate in this collection, so the specimen is mostly dimitic. Ryvarden (1978) says this species is “di-trimitic”; he makes no mention of dextrinoid hyphae at all and states that the spores are “non-dextrinoid.” He does however make an interesting observation that the spores are noticeably swollen in KOH and thus the size range is increased (giving a false reading) compared to mounting in non-KOH media. Breitenbach & Kranzlin (1986) state that this species is dimitic, but with some skeletal hyphae “strongly branched” (indicative of binding hyphae), but they also say the spores and skeletal hyphae of this species are negative in iodine solutions. Hansen & Knudsen (1997) also make no mention of dextrinoid skeletal or binding hyphae, but do mention the dextrinoid spores. Bernicchia (2005) also states that this fungus is dimitic, not trimitic, yet her illustration for this species clearly shows branched hyphae which she calls “skeleto-binding hyphae” and goes on to say that they are “indextrinoid” but with “an amyloid reaction in the cellular lumen.” She also gives more variation in basidiospore shape, saying they’re “subglobose to ovoid” but “usually strongly dextrinoid.” Lindsey & Gilbertson (1978), Gilbertson & Ryvarden (1987), and Ryvarden & Gilbertson (1994) all agree that this species is trimitic, with dextrinoid skeletal and binding hyphae. According to Gilbertson & Ryvarden (1987) the spores vary from “weakly to strongly dextrinoid.” In this collection the basidiospores are very weakly dextrinoid to nearly hyaline, as noted in my description. So, there’s quite a bit of variation within the species.

The distinguishing characters for this species are growth on hardwood substrates; the brightly colored basidiocarp, normally yellow, yellow-orange, or orange (but lighter colored specimens are sometimes found) that often has more than one layer of pores (perennial with stratified pores) and thus is normally quite thick and tough with strongly dextrinoid skeletal and binding hyphae; and thick walled, often somewhat truncated basidiospores that are variably shaped and often, but not always, dextrinoid to some degree.

Similar species include *Perenniporia tenuis* var. pulchella which is also brightly colored (lemon yellow) but has very different spores that are slightly larger, distinctly thin walled, and not dextrinoid. *Antrodia radiculosa* is another fungus that resembles *P. medulla-panis* that’s found in our area and is bright orange-yellow, but it has a thinner basidiocarp, a different hyphal system, non-dextrinoid skeletal hyphae, and thin-walled, non-dextrinoid spores that are not truncated. It’s found almost entirely on conifer substrates, not on hardwoods. We have many other bright yellow or orange-colored resupinate polypores that occur here, but they either have significantly larger pores or much thinner and softer basidiocarps, as well as different microscopic features.

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Fungi as a Food Source for Plants, *cont. from page 5*

question of whether the number of plant species living at the expense of fungi is possibly much higher than previously thought. We have already discovered that another plant utilizing arbuscular mycorrhiza, the wood anemone, also enjoys a mycoheterotrophic way of life," said the biologist from Bayreuth.

In parallel, the researchers have also carried out analogous investigations on *Arum maculatum*, also known as Cuckoo Pint or Wild Arum. This plant is regarded as a prototype for the second form of arbuscular mycorrhiza, which is preferred by numerous agricultural crops. It behaves in a clearly autotrophic way and supplies itself by photosynthesis with all the carbonaceous nutrients it needs.

The research results on the mycoheterotrophic lifestyle of Herb Paris are based on isotope studies. It has long been known that plants supplied with carbon and nitrogen by fungi have a comparatively high proportion of heavy carbon, hydrogen, and nitrogen isotopes. In autotrophic plants the proportion of these isotopes is lower. The Laboratory for Isotope Biogeochemistry at the Bayreuth Center for Ecology and Environmental Research is specialized in determining nutrient fluxes within ecosystems using isotopes.

A CREAMY MUSHROOM PASTA **Elizabeth Jaime**

https://www.bonappetit.com/, Feb. 26, 2016

Begin by browning a good chunk of **butter** in a skillet—exactly how much depends on what kind of week you've had. As the butter begins to brown, add a handful of **sliced mushrooms** and let them cook down. Cremini work great, but any mix of mushrooms (such as maitake, shiitake, and king trumpet) would work. After the mushrooms are nice and browned, add a bit of **heavy cream**—not too much, just enough to make everything creamy.

While the mushrooms are browning, boil a pot of heavily salted water (you always need more salt than you think!) and add a box of **orecchiette**. I like my pasta *al dente*, so cook it a minute under the suggested boiling time. Once the pasta's done, add the drained orecchiette to the skillet with the buttered mushrooms and a *bunch* of **grated Parmesan** and mix it all up. A sprinkle of **chives** on top lends a pop of color. Once plated, top it with as much Parmesan as you can physically grate and give it another good stir.

PSMS Survivor's Banquet!

March 14, 2020, CUH

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