

SPORE PRINTS

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THESE MYSTERIOUS FUNGI BELONG TO AN ENTIRELY NEW BRANCH ON THE TREE OF LIFE

Tessa Koumoundouros

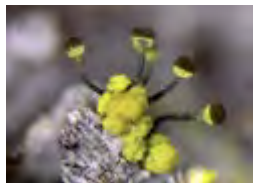
<https://www.sciencealert.com>, Nov. 29, 2022

Some of Earth's weirdest fungi, including types of lichens, mycorrhizals, and insect symbiotes, never quite seemed to fit in our current tree of life.

But a new genetic analysis discovered that despite the extreme differences between these oddballs, they actually all belong together on an entirely new branch that parted ways with other fungi more than 300 million years ago.

"I like to think of these as the platypus and echidna of the fungal world," says University of Alberta mycologist Toby Spribille, because of the fungi's peculiar traits.

Some live with algae or cyanobacteria to form the composite organism we all know as lichen. These fungi rely on their symbiotic partner to receive carbohydrates from photosynthesis, while the fungi in turn provide the algae or cyanobacteria with moisture and nutrients from the environment.



Díaz-Escandón et al.

Pin lichen (Chaenotheca chrysocephala).

Others, like members of a class of eerie earth tongue fungi (Geoglossaceae), live independently, licking the air straight up from the ground with their dark grooved fruiting heads.



Alan Rockett/eller

Earth tongue fungi.

While species like *Symbiotaphrina buchneri* also live in a mutually beneficial relationship, in this case with the biscuit beetle (*Stegobium paniceum*) providing the insect with B vitamins in exchange for a home within the beetle through all stages of its life cycle.



Nikolai Vladimirov

Stegobium paniceum.

And then there are the endophytes—like *Xylona heveae*—that live their lives entirely dependent on plants.

"What is really fascinating is that despite these fungi looking so different, they have a lot in common at the level of their genomes," explains Spribille. "Nobody saw this coming."

University of Alberta biologist David Díaz-Escandón and colleagues sequenced and analyzed the genomes of 30 different species of fungi from nine different countries around the globe.

The results suggest that 600 species of fungi, previously placed across seven different classes, should all belong together on the same evolutionary branch, called Lichinomycetes. Since

the class Lichinomycetes was the oldest name in the bunch, the researchers decided to use it as a new category.

"They were classified, but they were classified into such different parts of the fungal side of the tree of life that people never suspected they were related to each other," says Díaz-Escandón.

This taxonomic level of class is equivalent to the difference between us and frogs and this new class parted ways with the Eurotiomycetes class of fungi—a group that includes the antibiotic-producing *Penicillium rubens*—300 million years ago.

One of the key characteristics Lichinomycetes share is their really small genomes. This may explain why a high proportion of them rely on symbiotic relationships with other species to survive, the researchers suggest.

"Their small genomes mean this class of fungi have lost much of their ability to integrate some complex carbohydrates," says Spribille. "When we go back to look at each of these fungi, suddenly we see all of them are in a kind of symbiosis."

BEFORE BEER BECAME LAGER, A MICROBE TOOK A MYSTERIOUS JOURNEY

Veronique Greenwood

The New York Times, Dec. 10, 2022

A long time ago in Bavaria, beer underwent a transformation. Dark ale turned into a paler, gold-hued drink, and the beverage grew much more common around the time when a ducal edict restricted brewing to the winter months. The lager, as the new beer was called, had begun its journey to world domination.

Centuries on, geneticists have found that the yeast responsible for fermenting lagers is a hybrid of the traditional brewer's yeast [*Saccharomyces cerevisiae*] and another, cold-hardy yeast, *S. eubayanus*. The lager yeast appears to be the result of a chance mating in a chilly brewery, where low temperatures allowed the hybrid to thrive.

But while brewer's yeast is common enough, how *S. eubayanus* wound up in Bavaria has been harder to trace. It was first spotted in the wild in 2011 in South America. Then traces were found in the Italian Alps, Tibet, western China, and North Carolina.

So far, European sightings are next to nonexistent. But in a new paper, biologists reported they found *S. eubayanus* in the dirt of the University College Dublin campus in Ireland. The finding may provide a clue about the microbe's travels. If other samples are found, we may get a better picture of what led to that fortuitous meeting in a cold Bavarian cellar.

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MEMBERSHIP MEETING

Scott Maxwell

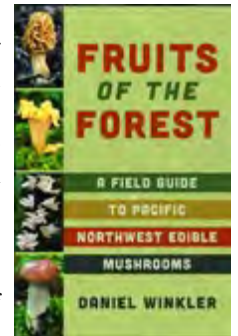
Happy New Year! The January 10, 2023, general meeting will once again be a hybrid meeting including both in-person and Zoom at the Center for Urban Horticulture. We will start letting members in at about 7:00 pm.



Daniel Winkler with
Boletus rubricep.

This month one of our members, Daniel Winkler, will be presenting on his newly published field guide titled *Fruits of the Forest—A Guide Book to Edible Pacific Northwest Mushrooms*. Daniel will talk in detail about our choice edible mushrooms such as morels, chanterelles, hedgehogs, king boletes, etc., which are easy to identify, helping one to overcome fungiphobia and truly appreciate wild mushrooms. He will also report on the newest taxonomy of these great mushrooms. Within his field

guide the reader will find many other mushrooms which may be harder to identify, requiring more experience and knowledge for safe identification. Per Daniel, his presentation and his guide will help you find and identify many great edible mushrooms while steering you clear of dangerous look-alikes. Additional information on preferred habitat, how to collect, transport, prepare, and store your mushrooms will also be discussed. Following Daniel's presentation, he will be offering copies of his field guide for \$27.50.



Daniel grew up collecting and eating wild mushrooms in the Alps, so early on began developing his passion for fungi. In 1996 he joined the Puget Sound Mycological Society, which has been instrumental in exposing Daniel to formal mycology and inspired him to further contour his interests and career to those ends, including educator, photographer, guide, and author. Daniel has served as a PSMS board member, was PSMS vice president for three terms, and was winner of the PSMS Golden Mushroom Award. He has published a series of fold-out field guides including: *Edible Mushrooms of the PNW*, *Edibles of California*, *Amazon Mushrooms*, and *Medicinal Mushrooms of North America*, as well as MycoCards on "Boletes of Western North America." And now, he has added the subject field guide to his repertoire.

As an ecologist and geographer, Daniel has been involved with research and development of Tibet's enormous fungal economy. His ethno-mycological research on *Cordyceps* species has been featured in *National Geographic*, *The New York Times*, and *The Economist* and on NPR, and BBC World Service. In the last decade Daniel has been exploring neotropical fungi. With his travel agency MushRoaming, Daniel has been organizing mushroom-focused eco-adventures since 2007. Currently planned destinations are Bhutan and Colombia.

Every lungful of air...is likely to contain a few stray viruses in transit between their hosts, four or five common bacteria, fifty or sixty fungi...one or two minute algae...and possibly a fern or moss spore, or even an encysted protozoan.

— Jacobson's Organ, Lyle Watson,

CALENDAR

- Jan. 10 Membership meeting, in-person and via Zoom, 7:30 pm. CUH
- Jan. 16 PSMS board meeting, 7:30 pm, CUH
- Jan. 24 *Spore Prints* deadline

A mushroom expert is not just anyone who says they are. They eat the mushrooms first.

—Pat Neal, *Sequim Gazette*

MUSHROOM ASTROLOGY

Bob Lehman, LAMS



Capricorn (Dec. 22–Jan. 19): You are plodding but thorough in your mushroom hunting. While Aries has gone off to explore a distant grove of trees and Sagittarius is busy extolling the virtues of mushroom hunting, you work your way through well-tested hunting grounds and find a respectable number of mushrooms. Your organizing and planning abilities can be valuable in making a foray successful. You make careful identifications before eating anything.

UPCOMING TRAINING FOR PSMS FIELD TRIP GUIDES

Wren Hudgins

In the 1970s our club had an informal guiding program under which experienced members would take out newbies on a space available basis. My wife and I attended a field trip in 1975, and Monte Hendrickson, husband of Hildegard Hendrickson, took us out for chanterelles. He showed us a chanterelle, pointed out its chief characteristics, and then ushered us into the woods while following behind. We went through that patch of woods, ended with empty baskets, and then looked back at Monte's full basket. He had walked behind us the whole way. I was hooked, not only on mushroom hunting but also on the value of guiding.

In the past 15 years or so, we have managed to rebuild a guiding program that is actually stronger than any in my 50 year memory of the club. The first group of guides were folks I personally knew and tapped on the shoulder. They continue to be a strong group today. The second group came from an invitation issued to the general membership and I knew none of them. They are now full guides for the club and all are terrific.

In the spring of 2023, I'd like to start training group #3. Since we are all volunteers and everyone has a personal life, I never know how many guides I will have for a given field trip until just before the trip, and only half the time do we have enough guides to take out the folks for whom this is their first field trip (newbies). The top priorities for guides are (1) safety (managing people in the woods) and (2) teaching habitat. Newbies need to learn appropriate habitat so as to become independent hunters, hopefully always in a group. It's helpful to know the main edibles that could be found that day, but ID beyond that is not necessary. Brian will ID all specimens coming in to a field trip and I can help with that.

All this being said, we could use more guides and I'm inviting interested members to contact me about this (email preferred). The training is as follows:

1. Attend my "Forest Navigation" class for 4 hours (probably only offered once) and practice skills learned.
2. Read all my emails and create a file for them. I send out a lot of information.
3. Follow one of the experienced guides on a field trip to see how we manage expectations and people.
4. Lead a group yourself on a field trip and be shadowed by an experienced guide, followed by a short talk about how it went.

In order to participate in this program you must be willing to guide at least once a year. Usually we have about 4 field trips in Spring and another 4 in Fall. If you are only guiding once a year, it will take longer to build up your skill levels, so we encourage more active participation in that. But once a year is the minimum. There are some perks that come with being a PSMS guide. Perhaps the biggest of these is education. The club needs to develop more intermediate level identifiers, and the guide group is probably the best place to look for identifier candidates. When we offer our 101 class series or the 201 class, guides get in for free. You can attend classes multiple times if you like. You may have seen those cool red name tags that some members wear at meetings and field trips. We'll get your one of those too.

What exactly are the guide responsibilities? As soon as I have the schedule of field trips, I'll send it out to guides and guide candidates. You will email me back, indicating which trips you can guide for. About two days before a field trip I'll re-send my list of which guides said that they could attend the upcoming field trip. You recheck your availability and inform me of any changes. Then on Saturday morning of the field trip, regardless of whether it's a one day or multi day event, we will have a guide meeting at 8:30am, pair guide candidates w/ guides and discuss where we could take groups to hunt. Group size is a maximum of 10, but guides are free to set a lower limit. Brian gives a collecting talk at 9 am and I follow with a safety talk. Then guides break away with their groups, organize car pools, and either walk or drive to start hunting. Groups typically stay out hunting about 3 hours, but guides are free to set their own schedules. Guides can control the character of their groups as well. One guide may indicate she is leading a family-friendly hunt where children are welcome. Another may prefer no dogs in the group. Still another may have a far away destination in mind. So there is a fair amount of guide freedom. The only thing you absolutely must do is bring them all back. Your guiding responsibilities end when you bring them back.

When you email me your interest in joining our ranks, I'll put your name on my list. Then the first step would be attending my forest navigation class which is not yet scheduled, but I'll give you at least a month of advance notice on that.

Sound good? Sign up. Questions? Ask me, Wren Hudgins, Co-chair, of Field Trip Safety, at wren.hudgins@gmail.com.

FUNGI IN SINK DRAINS ACT AS RESERVOIRS FOR MOLD

<https://www.sciencedaily.com/>, Dec. 1, 2022

Five University of Reading undergraduate students and a Ph.D. student tested more than 250 restroom sinks for fungi such as black molds and relatives of baker's yeast. Each of the sinks had a very similar community of yeasts and molds, showing that sinks in use in public environments share a role as reservoirs of fungal organisms.

Dr. Soon Gweon led the project. Gweon said: "We spend 90 percent of our time indoors, so we are exposed to fungi in our homes and workplaces. For most people, this isn't a problem, but for those who are immunocompromised, certain fungal species can cause serious infections.

"It isn't a big surprise to find fungi in a warm, wet environment. But sinks and P-traps have thus far been overlooked as potential reservoirs of these micro-organisms. This could be a really important finding for those who are trying to help immunocompromised people avoid infections by some of the opportunistic pathogens that may be lurking in sinks, such as *Fusarium*."

The types of fungi that live in sinks can tolerate high temperatures, low pH (acidic), and limited nutrients. Some will even use soaps and detergents as a source of carbon-rich food.

No difference was observed between male and female restrooms. The population of fungi in all of the 250 sinks tested was very similar.

A RHIZOPOGON RODENT CACHE IN OUR BARN

Brian S. Luther

Where we live surrounded by forest in the mountains in Chelan Co., WA, we have abundant wildlife, including lots of different rodents. Several times throughout the years, I've found mushrooms impaled on tree or shrub branches here and there, being put there to dry by rodents, mostly Douglas Squirrels I believe, for later use.

Recently when I was in our barn (with a couple of feet of snow on the ground outside), I noticed a small empty box on the counter and picked it up to discard it. To my surprise, inside was a stash of false truffles, collected by a rodent for future use, all nicely tucked away along with a chunk of rodenticide I'd put out someplace else. It's well known that a number of rodents worldwide collect, dry, hide, and stockpile fungi for food in the future.

The cache contained 11 fruiting bodies of the false truffle *Rhizopogon*—all the same species. This genus is large, with many species. They're all primarily hypogeous (subterranean), but will often break through the soil surface enough to be partially seen when mature. Rodents can also smell hypogeous fungi and will dig them out.



Brian S. Luther

Rhizopogon sp. found cached in a box in our barn.

Rhizopogon is a Basidiomycete (Division Basidiomycota) and thus is a false truffle, of which there are many different genera. True truffles are Ascomycetes and are unrelated. Almost always when people bring me what they hope are truffles for ID, they're actually false truffles. Most false truffles are inedible or don't taste good, but a few can be eaten, and even fewer are tasty.

Smith & Smith (1973) have a key to and list around 109 different species and many varieties just in the genus *Rhizopogon* for North America. They're difficult to identify to species, and most of the features are microscopic. It helps to have fresh specimens as well. The basidiospores in this collection are 6–8.5 × 3–4 μm, elliptical to fusiform-elliptical, some often slightly truncated at one end, lightly colored in mass, smooth, and slightly thick walled.

Rodents sun dry the mushrooms they find, which increases the nutritional value significantly. In particular, sun drying creates massively higher amounts of Vitamin D compared to just drying without the sun involved. There was no way to tell whether the false truffles in the stash I found had been dried ahead in the sun or not.

For a detailed study on the subject of fungi and rodents (and other creatures), you may be interested in a review I did in *Spore Prints* (Luther, 2009) of a truly fascinating book *Trees, Truffles, and Beasts: How Forests Function*, which might encourage you to get a copy of the publication and read it.

References

Luther, Brian. 2009. Book Review: *Trees, Truffles, and Beasts: How Forests Function*, by Chris Maser, Andrew W. Claridge, and James M. Trappe. Rutgers Univ. Press, 2008, 280 pp., \$26.95. *Spore Prints* 454 (September), p. 4.

Smith, Helen V. & Alexander H. Smith. 1973. *How to Know the Non-Gilled Fleshy Fungi*. Wm. C. Brown Company, Dubuque. 402 pp.

NEW EDITION OF THE NORTHWEST'S CLASSIC FIELD GUIDE

Dick Sieger

Timber Press has just released a revised edition of its best-selling field guide, *Mushrooms of the Pacific Northwest*. It's written by Dr. Steve Trudell, our PSMS scientific advisor, and is the Northwest's classic field guide.

This edition is more than 60 pages longer than the first, has a greater proportion of large photos, and is meant to be used either as a stand-alone book or in conjunction with the first edition. Together the two editions cover 740 species, with 247 only in the first edition, 275 only in the second, and 218 in both. Of the latter, 210 of them are illustrated with a different photo in the new book.



Steve Trudell

To help ensure the continued usefulness of the first edition, the second edition includes an appendix with updates, such as name changes, to the earlier edition. PSMS will have copies for sale at meetings or you can order directly from Timber Press or your favorite independent bookseller.

Field guide illustration of *Spinellus fusiger*.

THE NEWEST TOOL IN THE FIGHT AGAINST RAPID OHIA DEATH: A CHAINSAW MOUNTED ON A DRONE

Jim Mendoza

<https://www.hawaiinewsnow.com>, Dec. 13, 2022

HONOLULU - University of Hawaii at Hilo Professor Ryan Perroy's fight to save Hawaii's iconic ohia trees from a deadly fungus is a task that requires pinpoint precision.

"Ohia trees can die for all kinds of different reasons," he said. "You can't really tell at this point why until you get that physical sample."

The physical samples Perroy seeks are cuttings from ohia trees that show signs of Rapid Ohia Death, the fatal condition caused by the fungus *Ceratocystis fimbriata*. Until now, crews could only access diseased trees on foot.

"Sometimes we've identified trees that we think are infected with the fungal pathogens responsible for Rapid Ohia Death, but we can't get to them on the ground," he said.



UH-Hilo

That's where the new device comes in handy. Licensed pilots fly this drone into forests where Rapid Ohia Death is occurring to collect cuttings.

Licensed pilots fly it into forests where rapid ohia death is occurring to collect cuttings.

The cutting-edge method is just getting off the ground.

“We haven’t deployed it for miles and miles away from where our crews are at this point. I think as the regulations change we’ll have the capability of doing that,” Perroy said.

The chainsaw clips branches from sick ohia trees, which are then tested for presence of the deadly fungus. Samples need to come from large limbs to be accurate.

Perroy and his team teamed up with researchers in Switzerland and R&R Machining/Welding in Hilo to perfect the chainsaw drone device, which they named Kukuau.

“Kukuau is a type of crab. Because the device has a claw that is sort of natural. Kukuau is also the name of an ahupuaa [traditional land division] here in Hilo, so it also reflects its place of origin,” Perroy said.

Since 2016, his team has monitored plots of ohia trees on the Big Island where Rapid Ohia Death was detected.

“In essentially all of those plots we continue to see cases of mortality, so it hasn’t stopped. It’s continuing,” he said.

That makes this chainsaw drone a very important tool for pinpointing the tree disease. And it can also help to keep forests from being disturbed by human intrusion.

“The hope is that these types of things can be used to keep people safe, so they don’t have to go out in the forests to do other things. We can have these types of devices carry out these tasks,” Perroy said.

The faster Rapid Ohia Death is diagnosed, the quicker land managers can decide on how to protect surrounding ohia trees that are still healthy.

BUOYS MADE OF MUSHROOMS STAY AFLOAT IN MAINE WATERS

Ethan Genter

<https://www.bangordailynews.com/>, Dec. 1, 2022.

A pilot test of buoys made from fungal root networks showed promise as an effective and less wasteful alternative to plastic. Now, a cadre of Maine ocean farmers is hoping to expand prototype testing next year.

This year a handful of oyster farms along the Maine coast grew buoys made of mycelium, the thread-like root systems that sprout mushrooms, and deployed them on a small scale this oyster season. The trial was done to see if the environmentally friendly buoys could be a substitute for some of the thousands of plastic foam buoys used across the Gulf of Maine.



Sue Van Hook

Buoys made with mushroom mycelium.

For the most part, the mushroom buoys worked fine, according to the two main farmers who participated, though more testing is needed and they want to fine tune the shapes and sizes of the buoys in 2023.

“They stayed buoyant, which was a big piece of it,” said Abigail Barrows, an oyster farmer based on Deer Isle. “But there’s definitely some tweaks we can do.”

The idea to try alternatives to plastic buoys has risen from an environmental movement in Maine’s growing oyster industry.

Oysters and other seafood can take in plastics that are found in the ocean and a Bowdoin College study from earlier this year found oysters at nine farms in Casco Bay all contained microplastics.

The so-called myco buoys are grown by putting mycelium in a mold and feeding it with hemp stock or other types of plant waste. The mycelium then grows into a floating material that’s biodegradable.

Smithereen Farm, which grows oysters in Pembroke, hosted mycelium expert Sue Van Hook earlier this spring, and she showed local aquaculturists the ropes with the mushroom buoys.

The farmers have since been testing out the buoys and trying out different coatings for them, Smithereen farmer Severine Fleming said. The hope is to find a fully biodegradable sealant that can withstand months in the water. Normal buoys are usually made from Styrofoam and have plastic, waterproof coatings.

Finding a good non-toxic sealant has proved elusive, but Fleming’s initial findings may indicate it’s not actually needed.

“After five months in the water, I was surprised the uncoated myco buoy was floating fine,” Fleming said.

How long an uncoated buoy would last isn’t clear though, according to Fleming, as some of the oyster cages with the buoys went missing at the end of the year.

Myco buoys do seem to attract birds more than any other type of buoy though, and it’s unclear if that had any effect on the oysters growing below the surface.

Fleming plans to also try out the buoys on her seaweed farm this winter and expects to grow about 400 more buoys for sea trials in April.

She hoped the alternative buoys could be shown off at the Maine Fishermen’s Forum next year, possibly attracting more farmers to the experiment. If that happens, it could give Fleming and Barrows a better sense of if the floats are feasible on a large scale and at a variety of farms.

PORCINI MUSHROOMS HAVE EVOLVED WITH A PREFERENCE TO LOCAL ADAPTATION

University of Utah

<https://www.sciencedaily.com/>, Nov. 17, 2022

The Dentinger Lab at the Natural History Museum of Utah has published a provocative new paper in the journal *New Phytologist* that describes their work with the much beloved mushroom *Boletus edulis*, better known by gastronomers as the porcini. In the paper, Keaton Tremble and Bryn Dentinger, Ph.D., present a first-of-its-kind genetic survey of porcini mushrooms across the Northern Hemisphere. By evaluating the genetic code of these samples from across the globe, they learned that these delicious fungi evolved in surprising ways—contrary to the expectations of many who might think that geographic isolation would be the primary driver for species diversity. In fact, there are regions in the world where porcini maintain their genetic distinctiveness in local ecological niches even if they are not isolated geographically from other genetic lineages.

MYSTERY PARASITES ON ZOMBIE ANT FUNGUS IDENTIFIED

Kate Golembiewski

<https://www.cnn.com/>, Nov. 18, 2022

Around the world, a parasitic fungus transforms ants into “zombies.”

The fungus is like something out of a horror movie: The organism hijacks the body and brain of its ant host, mind-controlling it into abandoning its nest and climbing a nearby tree. There, the infected ant clamps its jaws around a leaf, dangling above the forest floor, and dies in a matter of days as the fungus digests it. Bursting through its host’s body, the fungus then sends down a shower of spores to infect the next generation of ant prey.

Scientifically categorized in the genus *Ophiocordyceps*, the more than two dozen species of zombie ant fungus populate the globe, including Florida, Brazil, and Japan; scientists suspect that each of the dozens of ant species affected has its own specialized *Ophiocordyceps* strain.

So far, scientists have figured out the molecular mechanism of the parasitic interaction between fungus and ant that forms the basis of the behavioral manipulation. How exactly these parasites systematically operate, however, is poorly understood.

Now, scientists have revealed that the ant-attacking fungus is infected with fungal parasites of its own, which could be helping to keep ant zombification in check, according to a new study.

Mystery Fungus

Dr. João Araújo, an assistant curator of mycology at the New York Botanical Garden, has been trekking through tropical forests in search of zombie ants for more than a decade. Over the years, he kept noticing something strange: a fuzzy white fungus growing on top of the zombie ant fungus.

Other scientists have noted the mystery fungus for decades, but Araújo and his colleagues decided to become the first scientists to systematically dig into the matter, zeroing in on a strain of zombie ants from Florida. The researchers described the physical structure of the fungi growing on top of the zombie ant fungus and sequenced their DNA in a study published November 9 in the journal *Persoonia*.

In doing so, the team discovered two new genera of fungus previously unknown to science.

“We realized that there were two different lineages of fungi, novel lineages of fungi, infecting one species of zombie ant fungus in Florida,” said Araújo, the study’s lead author.

Each of the two newly discovered fungi belongs to its own genus. One of the new fungi, *Niveomyces coronatus*, is responsible for the fuzzy white coating on the zombie ant fungus—a component of its name (“niveo”) comes from the Latin for “snowy.” The second new fungus, *Torrubiellomyces zombiae*, is harder to spot: The little black blobs “look like fleas,” according to Araújo.

A fuzzy white fungus growing on top of the parasitic fungus that attacks and turns ants into “zombies.”



João Araújo

Checks and Balances

The fungi attacking the zombie ant fungus don’t, in turn, zombify their host, but they do feed on its tissues and appear to cause it harm. “Every time we see these new genera we described growing on the fungus, the fungus looks pretty beaten up, really consumed by this other fungus,” Araújo said.

“In some cases, it castrates *Ophiocordyceps* (the zombie-making fungus) first, so it cannot shoot the spores anymore, and then it grows and then consumes the whole fungus.” Since *Niveomyces* and *Torrubiellomyces* are so new to science, it’s not yet clear how much of an effect they have on populations of zombie ant fungi overall.

These new genera are the first parasites officially described as infecting the zombie ant fungus, but the researchers suspect there could be others out there. “I think it’s more common than we think. Parasitism is a super lucrative sort of lifestyle,” said senior study author Dr. Charissa de Bekker, an assistant professor at Utrecht University in the Netherlands. “It might be the most dominant lifestyle on the planet.”

Additional Research Needed

What’s more, she said, parasites in general and parasitic fungi in particular are poorly studied. “The fact that we had to invoke two new genera tells you how little we know about this part of the fungal tree of life,” de Bekker said.

“*Ophiocordyceps* has basically over evolutionary time become an expert neuroscientist. It knows exactly what buttons to push and how to get the ant to do what it wants,” she said. “By studying how it’s figured out how to solve this problem, we can have insight into our more general goal of trying to understand how brains work or produce behavior.”

IN FORESTS FULL OF MINES, UKRAINIANS FIND MUSHROOMS AND RESILIENCE

New York Times, Dec. 5, 2022

Deep in a pine forest to the north of Kyiv, the Ukrainian capital, a beautiful mushroom warmed its brown cap in the gentle autumn sun—it was an all but irresistible scene for Ukrainian mushroom hunters.

But all around there was danger. Cut through the mossy forest floor were line after line of trenches from the battle for Kyiv last winter, and countless mines and unexploded projectiles. Weighing the risk of mines and the allure of their quarry, thousands of Ukrainians in the first mushroom season since the Russian invasion hunted for mushrooms.

Now, they are in the post-picking phase of the season, tallying their spoils and setting out to preserve them for the hard winter ahead. The risk may seem extreme for what was so long seen as a pastoral pastime, but Ukrainian mushroom hunters view it differently. They are passionate about their tranquil walks in the forest, and see in them a sign of Ukraine’s resilience and a way to preserve ordinary life during wartime.

“I wanted to go back to a peaceful life,” said Dmytro Poyedynok, 52, a yoga teacher from the Kyiv suburb of Bucha who was out mushroom hunting on a late-fall day.



New York Times

Dmytro Poyedynok and his wife, Yana Poyedynok, search for mushrooms in the Bucha area of Ukraine

He said he saw such mushroom excursions as “symbolic for me as it’s a peaceful hunting” in a forest that saw so much violence. In glades and meadows, blown-up tanks rust. Earlier this fall while looking for mushrooms, he stumbled on the makeshift grave of a child.

People who have lived through the horrors of the war often find great solace in routine. But many now have lost their jobs and rely on mushrooms to earn money and to preserve food for winter. Mushroom hunters may have lost loved ones, but they were not ready to lose the glimpses of their former lives they found in the misty, damp autumnal forests.

As the war drags into a 10th month, Ukraine’s government and people remain defiant, even as electricity blinks, water taps go dry, and apartments hover around freezing temperatures from lack of heating as Russian missiles attack infrastructure targets.

Ukrainians, many of whom have second homes in villages and feel an attachment to the countryside, even if they live in towns or cities, said they knelt for no one—but would do so to pick potatoes or photograph mushrooms.

And so Poyedynok rode his bicycle into the pine forests around Bucha, carrying a few plastic bags, something he has done all of his life.

He lived through the occupation of Bucha, a month of horror during which Russian soldiers shot civilians and left their bodies on the streets. He said that his uncle was killed and that he was detained and threatened with execution.

The forests in areas that were occupied remain heavily mined. Mines and unexploded ordnance cover thousands of square miles of Ukrainian land, according to the interior minister, Denys Monastyrsky.

The Ukrainian government pleaded with people not to pick mushrooms, and the government agency for forest resources imposed formal restrictions on walking in forests in nine Ukrainian provinces, including the region around Kyiv where Poyedynok goes.

But specialists say it will take at least a decade to demine the forests—and many Ukrainians were not ready to wait that long before returning to their favorite hobby.

Reports of mushroom hunters stepping on mines came regularly from all of the nine provinces where walking in the forest was banned. The numbers are not very high by the measure of a war that is believed to have killed tens of thousands: three to four people per region have stepped on mines, dying or losing legs, while searching for mushrooms, local officials said.

“Generally people are careful, but not all of them are,” said Viktoria Ruban, a spokesperson for the Kyiv province’s emergency service, which has responded to calls when mushroom hunters step on mines.

Poyedynok used to teach packed classes of yoga, but only a few of his students have stayed in Ukraine. With the money he is able to earn from teaching drastically decreased, mushrooms, as they have so often in times of famine or distress in Ukraine, have helped.

He said he was able to pick 550 pounds of mushrooms. His family preserved much of the bounty for winter for themselves and gave a lot to friends and relatives. They also started selling mushrooms.

Some of the purchasers are mushroom pickers who long for the sensations of the pastime but are too cautious to enter the forests.

“Those who always go mushroom picking but now are scared started coming to us just to smell the mushrooms, look at them,” said Poyedynok’s wife, Yana Poyedynok, “and eventually started buying them.”

The family earned about \$1,000 this season selling mushrooms.

“It is not a lot,” Yana Poyedynok, 44, said, “but covered some small expenses.”

Most of the time, Dmytro Poyedynok went mushroom hunting on his own.

After the excursion with his family when he came across the child’s grave, his wife and son became afraid of the forests, and now seldom join him. They go only to the forests they have already been to, and to those they believe to be safe.

As Russian soldiers pull back from parts of Ukraine, the celebration generally proves short-lived. Soon enough, the bodies are found, and the accounts of atrocities against civilians emerge. But those are deaths past. The dangers in the forests threaten death today, and for any number of tomorrows.

In September, when most of the Kharkiv region in the northeast was recaptured, it was just on the cusp of mushroom season. Within weeks, reports began coming in of mushroom pickers stepping on mines. Three were maimed in October in the newly retaken forests, local officials said.

In one forest on the outskirts of Izium, a city in Kharkiv, investigators found hundreds of graves bearing civilians and a mass grave where Ukrainian soldiers appeared to be buried, officials said.

Next to this forest lives Raisa Derevianko, 65. In September, she looked on from a bench outside her house as the human remains were exhumed. Now, she can watch the demining work.

Mushroom season came and went, but she never made it into the forest.

“All of this is very horrible,” Derevianko said of the mass graves. “But what I want the most is for them to finish clearing my forest. I miss mushrooms so much.”



New York Times

Yana Poyedynok with jars of mushrooms at their home in Stoyanka, Ukraine



SCIENTISTS MAP FUNGAL NETWORKS ON WORLD'S MOST REMOTE ISLAND

<https://www.eurekalert.org/>, Dec. 12, 2022

ALMYRA ATOLL - In the middle of the Pacific Ocean is an uninhabited atoll that houses underground mycorrhizal networks that may have evolved a unique ability to cycle nutrients between seabirds, rainforest trees, and coral reefs. The Society for the Protection of Underground Networks (SPUN) travelled to this remote atoll—a place so untouched that researchers had to freeze their clothes each night to prevent the introduction of non-native species to the protected islands—for a recent research expedition.

In partnership with The Nature Conservancy Climate Adaptation Lab, SPUN is mapping the diversity of mycorrhizal fungi across Palmyra Atoll, 1,000 miles south of Hawaii. This atoll, the Earth's most remote, is the site of much lore, including a double murder, sunken treasure, and disappearing aircrafts. It is also home to a million seabirds, untouched coral reefs, and a fish population that is 44 percent sharks.

“Never could I have imaged sampling fungi while small sharks swam around my feet. As we hiked in the ocean between forested islands, we could hardly hear ourselves talk because the birds were so loud,” says Dr. Toby Kiers, Executive Director of SPUN. “Visiting Palmyra allows you to go back in time when other organisms—not humans—dominated the landscape.”

The scientists sampling Palmyra hope to understand how mycorrhizal fungi facilitate nutrient movement between the sea and the rainforest—and how remote island ecosystems are coping with climate change, invasive species, and rising sea levels. During the course of the expedition, SPUN scientists collected samples from across 27 islands. These have been sent off for DNA sequencing so that the fungal players can be identified.

Among the island's species is the towering *Pisonia* tree. *Pisonia* is a native rainforest species that has been reported to digest seabirds that get trapped by the sticky substance secreted by its seeds. Kiers and her team conducted extensive sampling of the symbiotic fungi that colonize *Pisonia* roots to test how nutrients from birds and their guano are captured and fed back to the rainforest trees. Scientists believe that these mycorrhizal fungi create nutrient feedback loops that not only support the island's rainforests, but also the plankton communities and coral reefs offshore.

“On these remote islands—out of reach of human interference—we see an extreme form of interdependence among organisms on land and sea,” says Kiers. Lose any of these organisms—fungi, crab, birds, tree, corals—and we may witness a devastating cascade effect.

The waters surrounding the atoll host some of the most pristine coral populations in the world. “We know fungi play an important role in mediating the transport

Toby Kiers says fungi on Palmyra atoll in the Pacific control the nutrient supply between the rainforest and the coral reefs.



<https://www.thetimes.co.uk>

and availability of beneficial nutrients to plants. Now, an understanding of similar fungi–coral interactions is emerging,” says Dr. Alex Wegmann, lead scientist for the Nature Conservancy's Palmyra Program. “Palmyra's intact reef system provides an excellent opportunity to more fully understand the beneficial role of fungi in island and reef ecosystem resilience to climate impacts like rising ocean temperatures and changing ocean chemistry.”

Palmyra Atoll is also home to the largest crab species in the world. Coconut crabs grow up to a meter wide and are prolific hunters and tree climbers. The science team has hypothesized that these land crabs are helping to distribute the symbiotic fungi to new roots through their digging, re-enforcing the cycling of nutrient among birds, crabs, coral reefs, and native rainforest.

Until now, the fungal communities of the atoll had never been studied, and researchers anticipate the discovery of new species able to withstand extreme heat, salinity, and low nutrient conditions. Despite being so remote, the islands have been threatened by invasive species. The Nature Conservancy has removed over one million non-native coconut palms and eradicated large populations of introduced brown rats. And, as sea levels around the islands rise, erosion is beginning to eat away at Palmyra.

“As the world continues to push past atmospheric carbon thresholds tied to near-future climate impacts, we need to steady for what's to come,” says Wegmann. “Understanding the role fungi play in the transport and mediation of beneficial nutrients on land and in the ocean will help prioritize conservation actions that promote and safeguard ecosystem resilience.”

Tom Volk 1959–2022

It is with deep regret that we report that Prof. Tom Volk of the University of Wisconsin passed away on November 28, 2022, at the age of 63. He had been in ill health for several years.



A prominent figure worldwide throughout the field of mycology, Dr. Volk was a fascinating individual widely admired for his exceptional teaching ability, modesty, compassionate nature, and last, but not least, his keen sense of humor. Mycologists, both professional and amateur, were always welcome to attend any of his lectures. He was able to travel extensively and gave lectures or workshops in 32 different states.

For 26 years he was a professor in the Department of Biology at the University of Wisconsin-La Crosse, where he taught courses on General Mycology, Medical Mycology, Organismal Biology (with Greg Sandland), Plant-Microbe Interactions, Advanced Mycology, Food & Industrial Mycology (with S.N. Rajagopal), Organismal Biology, and Latin & Greek for Scientists, as well as Plant Biology.

Rest in peace, Tom, you will be greatly missed.