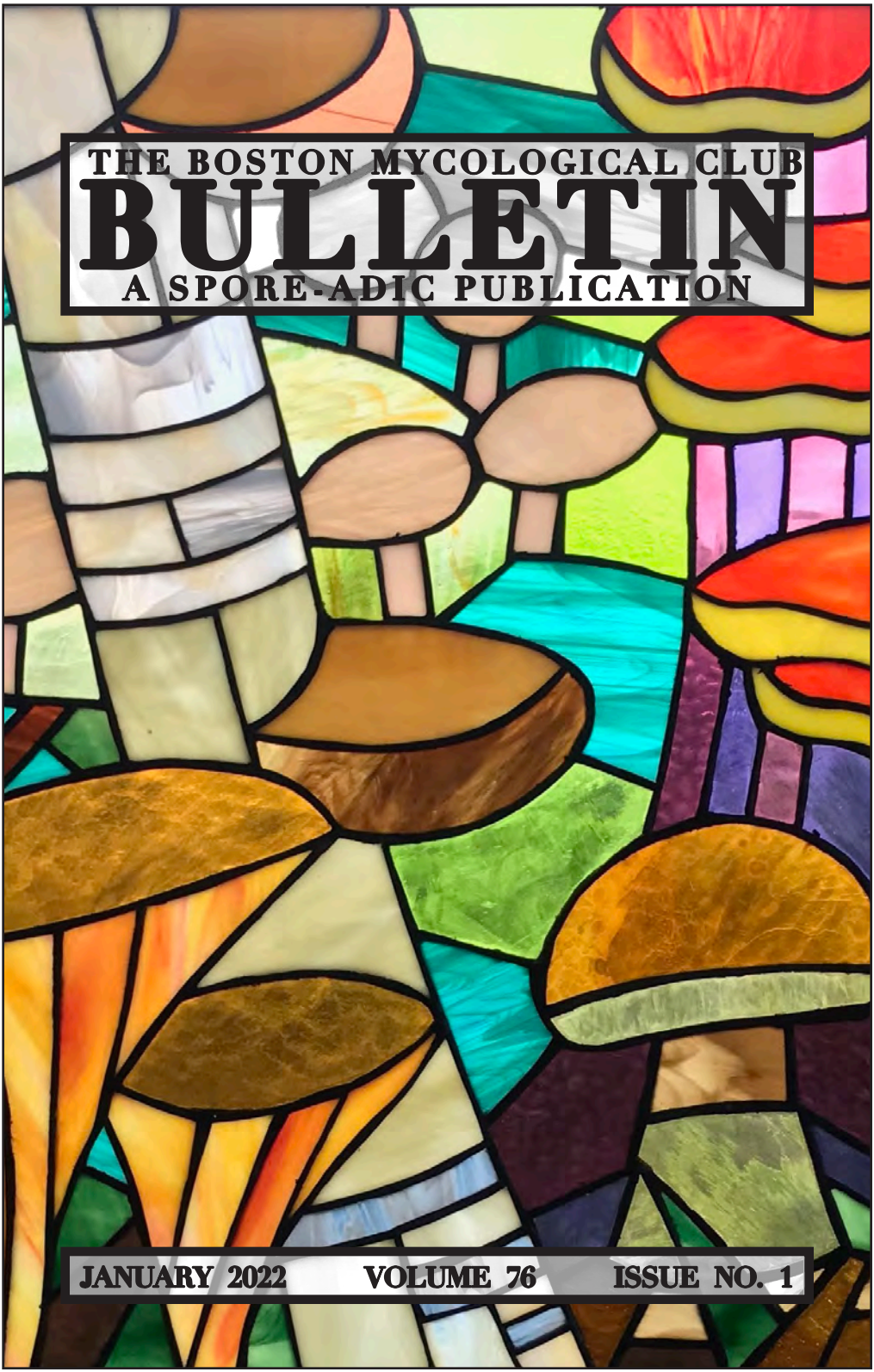

THE BOSTON MYCOLOGICAL CLUB
BULLETIN
A SPORE-ADIC PUBLICATION
JANUARY 2022 VOLUME 76 ISSUE NO. 1

IN THIS BULLETIN

ON THE COVER

Joshua Winer, a local artist, generously provided this Bulletin's cover image, a photo of a stained glass window he created. Joshua holds a degree in Painting from Yale and a Masters in Architecture from Harvard, and his career has combined these interests. He now specializes in commissioned artwork, particularly mosaics and murals for building facades and lobbies and works of public art, in which he explores themes of history, culture, and community. Joshua writes:

The style of my window is based on Art Deco, which is common for stained glass. The forms have been simplified and abstracted, and show some key elements for identification. I've depicted 5 kinds of mushrooms. I've tried to position them in typical habitats along with typical tree types.

I am planning to do more mushroom windows. Mushrooms offer fantastic opportunities to explore color, texture, form and setting. Now that I am becoming more knowledgable about mycology, I want to add detail into my artistic depictions of mushrooms and to be more precise about capturing the specific distinguishing characteristics. I hope my work will inspire other artists to try new media using the beauty and mystery of the fungal kingdom as their inspiration.

I love having this new mushroom stained glass window in my loft in the Waltham Mills. It's positioned facing south, so the light changes all day long, making the colors shift and glow, spilling long shafts of colored light across the room. At night moonlight shines through the glass, creating new effects that are evocative of walking through the woods at night.

Can you identify all five mushroom types? Message us at bulletinbmc@gmail.com.

A Publication of the Boston Mycological Club

Prepared diligently — at times, relentlessly — by your faithful Editorial Board.

Beryl Lipton
Editor-in-Chief

Susan Goldhor
Editorial Advisor

Lawrence Millman
Editorial Advisor

Many thanks to...
Zaac Chaves
Lauren Georgiades
Jana Harris
Charlotte Ikels

FROM THE PRESIDENT OF THE BOSTON MYCOLOGICAL CLUB

Dear Fellow BMC Members,

I am delighted to see the publication of a new issue of our Club Bulletin, with a new Editor. We were sorry to lose Zaac Chaves who developed a new format and saw the emergence of so many elegant and beautiful issues, but we welcome Beryl Lipton, who will put her own imprint on our venerable (and ever-evolving) club magazine.

Unlike most clubs, whose publications tend to focus on reprinting articles from various journals, our publication is almost completely by us. Whether we put in our own thoughts about science or recount our adventures from the hunt, create myco-art or compose poems or stories, it's as original and unique and as varied as our membership. And you are part of that membership. Please consider contributing to the next Bulletin. Covid means that we can't meet in a room, but we can meet in a variety of forums, and the BMC Bulletin is one of those. So please join us within its pages!

Miss Mustard (pictured) is a handsewn soft sculpture creation by Lindsay Blevins. Want one of your own? She's open to commissions! Send a message to lindsayblevinsillustration@gmail.com

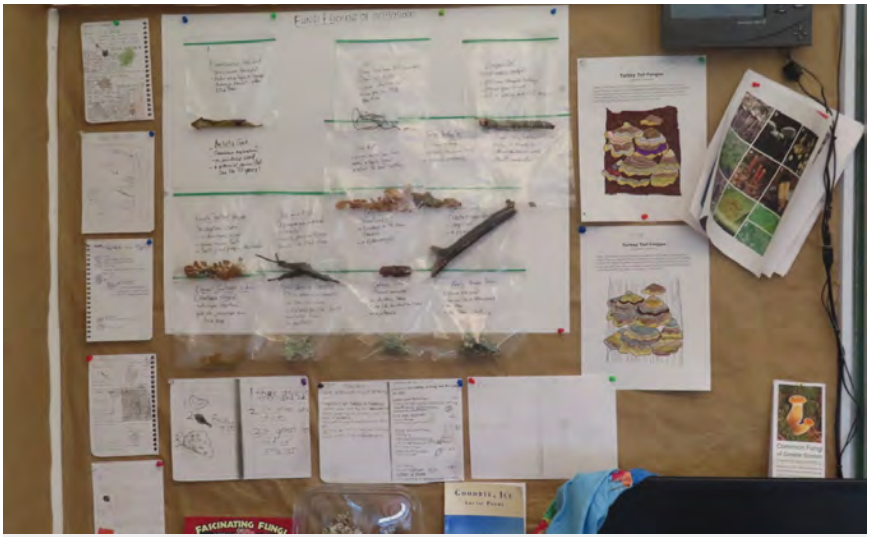
Thank you, Beryl, for this issue and for those to come! And thanks to all who contributed and those who will contribute.

This is the 125th year of publication of the Bulletin — long may it continue to evolve and flourish!

Susan Goldhor, BMC President

Fungi for the Whole Family

Lindsay Blevins provided this photo of a spring peeper in a black trumpet mushroom. Of the experience, she writes, "One lovely August day while gathering Craterellus fallax for my basket, I gasped as I realized that the trumpet I was about to pluck was occupied by a tiny inhabitant. I admired this impossibly magical scene for several minutes before the little spring peeper decided he was through with the lack of privacy and hopped away (for it is, of course, far nicer to nap in a trumpet without paparazzi about). These two black trumpets did not make it to my basket — I could never bear to uproot such a perfectly cozy abode!"



In the spring, mycologist Lawrence Millman taught seven kids, between eight and 11 years old, about fungi and lichens in a one-room schoolhouse on Cuttyhunk Island. The kids made drawings of specimens they had collected and, with Larry's help, identified. Pictured: a bulletin board with some of the specimens and the kids' descriptions.

I originally drew this for my friend's birthday, because she loves mushrooms. I also like mushrooms because of their different and beautiful colors and the interesting places they grow. The shapes, colors, and textures of mushrooms help me to express myself when I draw. Maybe if I'm sad, I will draw a droopy willow-looking mushroom. If I'm happy, I might draw a mushroom that's all perky. When I drew this picture for Shanna, I was feeling adventurous, and I wanted to create something outside of my comfort zone. I tried to draw from multiple angles, which I'm not used to, and experimented with different patterns and shapes. Another goal I had was to create a wide variety of mushrooms. I already knew some of them, like morels, and I looked up some more exotic mushrooms to add some spice to the picture.

— Flora Kerwin, Age 10
This piece was submitted by friend and BMC member Shanna Mazurek.

CONTRIBUTE TO THE BULLETIN!

Do you have an experience, writing, photos, artwork, or other fungi-related materials or thoughts you'd like to share with your fellow BMCers? You can contribute to the Bulletin! We cannot guarantee that all submissions will be included, but we'll certainly seriously consider what you have. Please get in touch at bulletinbmc@gmail.com.com. Please make your submission by March 1, 2022.

THE FIRST BMC CHILDREN'S WALK

Jana Harris

We have a brand new generation of mycophiles growing right under our feet! They are shorter than most of the adult BMC members but very eager to learn and discover. Here is the proof all in black and white!

We just had to organize the first ever BMC Kids' Walk for these enthusiastic fungi lovers. It was a pleasure to take them out for a walk around the Gordon College trails this October. Even before we took off I was surprised how much these kids between ages six and 13 already knew! I heard scientific names like Armillaria and Helvella flying left and right! Excuse me? They did put me into shame a bit.

There were also those completely new to foraging and enthusiastic about going on real first foray. They ran for hills looking for mushrooms,

Our young foragers on the hunt. Photo courtesy of Jana Harris.

and they found them. Kids yelled, "Hen, Hen, Hen! " at the sight of Hen of the Woods and we split up the find amongst all that came to walk! No one wanted to take home Stinkhorns, but everyone wanted to see them and smell them, as you can imagine. It was heartwarming to see smiling kids with small paper bags holding their finds. Bags were filled with black trumpets and even yellowfoot chanterelles. I hope many of those kids will come back and tell us more about their newest finds, because there will be more finds! There will be more BMC walks for mycophiles and mycologists-in-the-making next season!

Thank you for letting me lead you and your parents on this walk!

Itai Alon, 12, and Ellah Alon, 8, display their basketful of finds.

Sarah Black and Madeline Black, 8, smile for the camera with their find, Hericium, a bearded tooth fungus.

Hope Black, 6, pictured in her parents kitchen with her fungal finds.

Fungal Experience

MAY THE LICHENS BE WITH YOU

Lawrence Millman

If flowers are commonly placed on a loved one's final resting place, why shouldn't lichens be allowed to reside on that loved one's gravestone? After all, a lichen on a gravestone occupies a branch on the tree of life considerably closer to the branch occupied by that loved one than a chrysanthemum. Plus, that lichen could have an esthetic quality similar to an attractive mosaic.

Mt. Auburn Cemetery in Cambridge, Massachusetts has a plenitude of gravestones, some of which host a plenitude of lichens. North, south, east, and west-facing gravestones host different lichen species. So do granite, marble, limestone, and sandstone gravestones. Some of these lichens are typical inhabitants of trees who've decided it mightn't be a bad idea to inhabit a rock surface for a change.

As I was walking around Mt. Auburn's capacious plot of land (174 acres), I noticed quite a few gravestones that weren't hosting lichens. Why was this? Because fertilizers as well as automotive exhaust can result in a nitrification of a lichen's habitat, and many lichen species (the large rosettes of Flavoparmelia caperata, as shown in the photo, being an exception) don't have the ability to deal with such pollutants. Likewise, the cemetery's staff might have removed the lichens from many gravestones because lichens can camouflage names and dates, much to the displeasure of family members, as well as the cemetery's photo-taking tourists.

Let me add this tidbit of information: certain lichen species like Rhizocarpon geographicum have such a consistent growth rate that, if they're measured, they can provide a good estimate of the data on the gravestone they might have camouflaged.

Lichens not only can conceal a gravestone's names and dates, but they can also damage their substrate, i.e. the gravestone itself. In particular, the ones on calcareous stones can alter that substrate chemically with oxalic acid, thus aiding and abetting its deterioration. Since the degree of deterioration tends to increase with age, older stones are more susceptible to colonization by lichens that previously hadn't been able to get a foothold — or, more ac-

curately, hypha-hold — on the stone. (Note: A lichen uses the endolithic hyphae on its lower side to penetrate a rock surface.).

Here I should mention that the removal of lichens from a gravestone can damage not only the stone itself but also the environment, particularly if a biocide like bleach is used. Fortunately, no biocides are used at Mt. Auburn Cemetery, but it's a different story at many other cemeteries. If a cemetery's crew uses metal tools or even wire brushes — well, good luck. The lichen's thallus (vegetative tissue) might be removed, but its hyphae may still remain in the stone, penetrating as deeply as 20mm. Penetration by these hyphae can cause a slow fragmentation of a gravestone's surface.

I should also mention that certain lichens can serve as guardians of their gravestones, especially if those gravestones happen to be made of porous rocks like limestone. They're able to perform this duty by reducing the water level inside the stone, an act that helps deter abrasion from wind, rain, and other abiotic factors. Some lichens might, just might, be capable of stabilizing poorly cemented gravestones, too.

I suspect that one's dear departed granny would be quite happy if the marker of her final resting place was decorated by a bright orange Xanthoria parietina lichen, far happier than if that marker was simply a sterile upright marker. And if that granny had been a supporter of "green" causes, it's likely she'd also be pleased to have a nice green Xanthoparmelia cumberlandii decorating her gravestone. Less pleasing to her, perhaps, would be the white residues of calcium oxalates left on her gravestone by dead lichens.

As for myself, I'd also be pleased — no, delighted — to have lichens adorning my own gravestone. In addition to their esthetic appeal, they'd be an indication of the biodiversity of the natural world, whereas flowers from a florist shop wouldn't be an indication of anything other than a business transaction.

Lawrence Millman recommended that we publish this article, which first appeared in Fungi Magazine.

Photo courtesy of Lawrence Millman.

Scientific Study

ON THE DECLINE OF ALPHATAXONOMY

Danny Newman

The following is a rant on the subject of the decline of morphological taxonomy and taxonomists in mycology. The 4% of you still reading may continue to the next line.

We all seem to recognize and agree that there is no longer any job or academic post in the world that will pay a person to go out and look for, find, describe and study fungi, at least not regularly, and not without tacking on a litany of other responsibilities, be they administrative tasks, the teaching or taking of unrelated courses, the writing and obtaining of grants, or self-flagellating upon the altar of impact factor. After 12 years of conversations with people in professional mycology, I've concluded that these add-ons constitute the bulk of their jobs, and that mycology — particularly field mycology — is the add-on. Naturally, that can only go on for so long before mycology fundamentally changes, at least in academia, and certain aspects of the field start to change and disappear.

What I see vanishing most rapidly everywhere I look are the classical components of taxonomy. The number of people who can competently put the International Code of Nomenclature (ICN) to use to create new, correct existing, or better govern nomenclature; the number of people who deeply understand and can readily recognize the salient macroscopic, microscopic, chemical and ecological features that are characteristic and diagnostic of one or more fungal groups; the number of people who have a deep working knowledge of past, present and possible future concepts of how their fungi have been/are/will be/should be delimited — is dwindling. People in command of all of those skills, resources and information are sometimes referred to as alphataxonomists. Alphataxonomists, therefore, are dwindling. Of the few who are left, the majority are at or above retirement age (which is when they tend to finally be able to do the work that their academic career perennially got in the way of), and they are seldom being replaced by those imbued with their knowledge and experience.

It is not enough to have any number of dozens or hundreds or thousands of less-experienced people still around when the alphataxonomists go extinct, because the training they

received is a necessarily dynamic and interactive process that takes years to complete (if such a thing is ever truly completable). Once these alphataxonomists are gone, it will be much harder than we realize to revive their craft from nothing more than the texts and collections and libraries they've left behind.

A morel and a rubber duck found in a local garden. Photo courtesy of Jana Harris.

The best, briefest exercise I can think of to demonstrate what I mean is to pick a page in this Rolf Singer article — https://www.zobodat.at/pdf/Sydowia_4_0130-0157.pdf — and start reading. You will be outdone and undone by Singer. Almost everyone is. To call his premolecular mastery of macrofungi and their interrelationships "encyclopedic" would be a major understatement. If I could pick three people, living or dead, to spend one day each with, I would spend a long weekend with Rolf Singer. There is undoubtedly overlap in the fungi he and I have observed and collected, having covered much of the same terrain, but being a young and still inexperienced parataxonomist*, I struggle to lift enough meaning from Singer's fifth-dimensional descriptions and comments to be able to paint a visual picture in my head and then match that picture to anything I've seen. (We won't talk about his drawings.) For reasons outside the scope of this rant, I've not been able to appreciate and compare his microcharacters to my own material, but I've no reason to think this would be any easier. One walk in the Andes or Amazon with Rolf Singer could save anyone interested in Neotropical fungi anywhere from hours to years of labor in identifying described species and recognizing novel ones, but to attempt the same with what's left of the late Rolf Singer could take a lifetime. It is taking a lifetime — my lifetime.

Singer is far from the sole occu-

pier of this echelon of mycological taxonomy. I use him as an example principally for his proximity to my research interests. Other heavyweights occupy his rank to varying extents in the level of intricacy, vastness, and attention to detail evident in their work.

The commonest cry to put these cares to bed is that the molecules will save us. Like so many weekend-warrior ufologists with hand-painted signs of salvation turned skyward, these blind believers await the day when Sigourney Weaver's great Avatar pocket sequencer will come, rendering the shapes and sizes and contours and contexts of things ultimately subordinate to the order of their nucleotides. I too await that day — partly because it sounds a lot less expensive than $10 per forward and reverse read per locus — but I will continue to consider molecular tools and techniques to be precisely that: tools and techniques. Criminology did not stop sketching subjects, taking fingerprints, performing behavioral analyses and building psychological profiles with the advent of DNA sequencing. Forensic science did not wither and die in the shadow of the pipette and thermocycler. On the total and absolute contrary. One came about to enrich, not replace, the other. Why is this not happening in the entire wide-open field of fungal systematics? By what logic can the freight train of mycology disconnect cars from the caboose forward and expect to carry the same amount of cargo? I have no answer.

In practical terms, I am left to ponder, then, what will become of Entolomataceae without Tim Baroni, whose position his university specifically did not wish to renew with a new hire despite him finding and personally recommending a replacement mycologist. His multicontinental collections are now in the process of a great diasporic relocation effort. What will become of Amanitaceae without Rod Tulloss, who has funded his own studies and the training of students/assistants directly out of his engineering pension, hoping to give someone the unenviable job of trying to live up to his towering reputation after he's gone? What will become of boletology without Roy Halling, lepiotology without Else Vellinga, or marasmioids, mycenoids, reduced agarics and the untold hordes of little, white-spored, saprotrophic tropical curiosities after Denins Desjardin? Can polyporology survive without Leif Ryvarden? Will anyone be able reliably to discern from one another any of the literal dozens of nectrioid genera without Amy Rossman or Priscila Chaverri to consult? What has become of the study of jelly fungi since the death of Bernard Lowy? (Answer: almost nothing!)

Before anyone dreams of placing the blame for the absence of heirs to these alphataxonomic thrones on the shoulders of the outgoing monarchs, ask them how many graduate

students they've had or how many were feasible to take on the more their universities demanded of them, the more the money dried up, the thinner the incentives or job prospects became for young people contemplating a 2- to 6-year degree in fungal taxonomy. Ask them how many grants they didn't get even after dutifully reapplying and abiding by reviewer commentary, or how many of them got tenure to study fungi. Chastising our giants for there being no one to inherit their legacies is like blaming a woman from Chernobyl for being unable to bear children. There are real reasons for the disappearance of mycological alphataxonomy, and they are resoundingly NOT the failings of the outgoing alphataxonomists. The reasons are systemic.

I can think of a few people whose lives I am grateful for (and whose deaths I prefer not to think about), which helps to alleviate some of this anxiety by offsetting some of our past and pending losses: Björn Wergen, Roo Vandegrift, Brian Perry, Luis Quijada, lots of bright young people in Latin America, people I'm forgetting but whose absence on this list is no indication whatsoever of their not deserving to be here. There are also very, very bright parataxonomists out in the world growing big and strong on a diet of digital literature, discussion fora, and more time out in the field and hunched over the microscope than anyone in academia has been allowed to do for the last half century. But we will be inheriting a different world than the one inhabited by our predecessors, a world in which, if recent history is any indication, there will be less and less science funding to go around by the year, and of what remains, only that which is considered "transformative" by the many-faced funding gods will be given the time of day.

"Transformative" is the National Science Foundation's new one-word criterion for research to be meritorious of public funding. Taxonomy is largely not considered to be "transformative" enough to meet the bar, and so it is increasingly left out in the cold. When taxonomy forms a part of a grant it is basically hitchhiking, brought aboard out of what often feels like pity. Perhaps the dumbest part of this new dressage course for scientists is the apparent failure on the part of the NSF — to say nothing of other funding bodies which follow the NSF's lead — to appreciate what transforming is. Transformative science, by definition, calls upon untransformed, naturally occurring, preexisting things, in order that our understanding of these things may be transformed. Taxonomy, and exploratory fields like it, are the providers of these things, the prima materia, for any transformations that are to follow. We make possible the first variable on the left side of the equals sign in the transformative science equation of multiplying, dividing, subtracting and adding things to get new

results. The discovery, manufacture and distribution of penicillin necessarily required not just information on how Penicillium works, but the knowledge that Penicillium is a thing in the first place. Sometimes the fundamentalness of a thing can make it almost invisible, taken for granted, while its absence would be instantly and universally felt. Take a look at old episodes of the Pyramid or Password game shows and watch the brains of full-grown, educated, human adults turn to momentary mush when tasked with making their teammates recite a word that they themselves cannot utter aloud. Imagine a pre-Internet city with no phone books or all the goods in a supermarket with no aisles or labels. Restricting science funding only to those who are pursuing or can promise transformativeness in their research is akin to rewarding hips for being taller than feet.

I have no great proclamations or predictions for what to do with this world the more that we careen toward it. In all honesty, I experience double as much existential dread as joy in this field with my small place in it. It will never pay my bills or those of my fellow (para)taxonomists without great compromise, the objects of our curiosity are in as much trouble as most living things on Earth, and natural history writ large is being relegated to museums that are being literally set on fire by governmental contempt**. It will be a curious thing if we who truly, carefully study living things out in the world go extinct before our subjects do. I always pictured taxonomy riding a final crescendo as life and habitats started to sundown out of existence, but it's sadder, and perhaps more realistic, to imagine a near future in which we vanish first, unnoticed except by each other, as human civilization moves further and further away from the sort of conditions that produced a love of nature for its own sake, and more toward the constant panic and fever of survivalism, of last-minute solution-seeking. The irony is how crucial the quaint, antiquarian, naphthalene-scented taxonomist could be to those species- and society-saving solutions, and how inherently — and regrettably — human of us it will be not to have realized that until it's too late.

** 'parataxonomy' is defined by Wikipedia as "the use of less qualified assistance to taxonomists in the practice and science of classification."*

*** see https://www.mintpressnews.com/the-price-of-austerity-rio-museum-destroyed-by-fire-dryhydrants/248749/*

Danny Newman is an independent mycologist primarily interested in Andean-Amazonian fungi. He has provided research assistance to graduate students of San Francisco State University, SUNY College of Environmental Science and Forestry, and the University of Oregon. He has presented at workshops, academic conferences and mycological societies throughout the western hemisphere. Lawrence Millman recommended that we publish this extremely topical article, which first appeared in The Mycophile in 2019.

MISIDENTIFICATION

Loren Hoekzema

Rediscovering my backyard forest, I was taken by a garden of
some split-top cream mushrooms.
Then, on second glance, a bright shiny orange thing
Poked through old red string, bottle caps, and tossed
Snickers Bar wrappers.

My first encounter with Aleuria aurantia, I thought.
But more orange emerged from the rotting soil–
A patch of orange peel, and not just garbage from my neighbor's yard.
A mystery of color in decay.

One year later, my friend was
dying of cancer, stoically
Accepting the inevitable.
I was an amateur of death and
Misnamed common things–a
plastic tube, a living cup.

It took two experts to tell me I
was wrong.
A rare species
An ascomycete in a new-found
place.
All we can do is smile back.

Photo courtesy of Loren Hoekzema.

TREE TALK

Susan Goldhor

It's almost 40 years since botanists first realized that trees were sending each other airmail. The messages were pretty straightforward: "Someone's chewing on me; beef up your defenses".

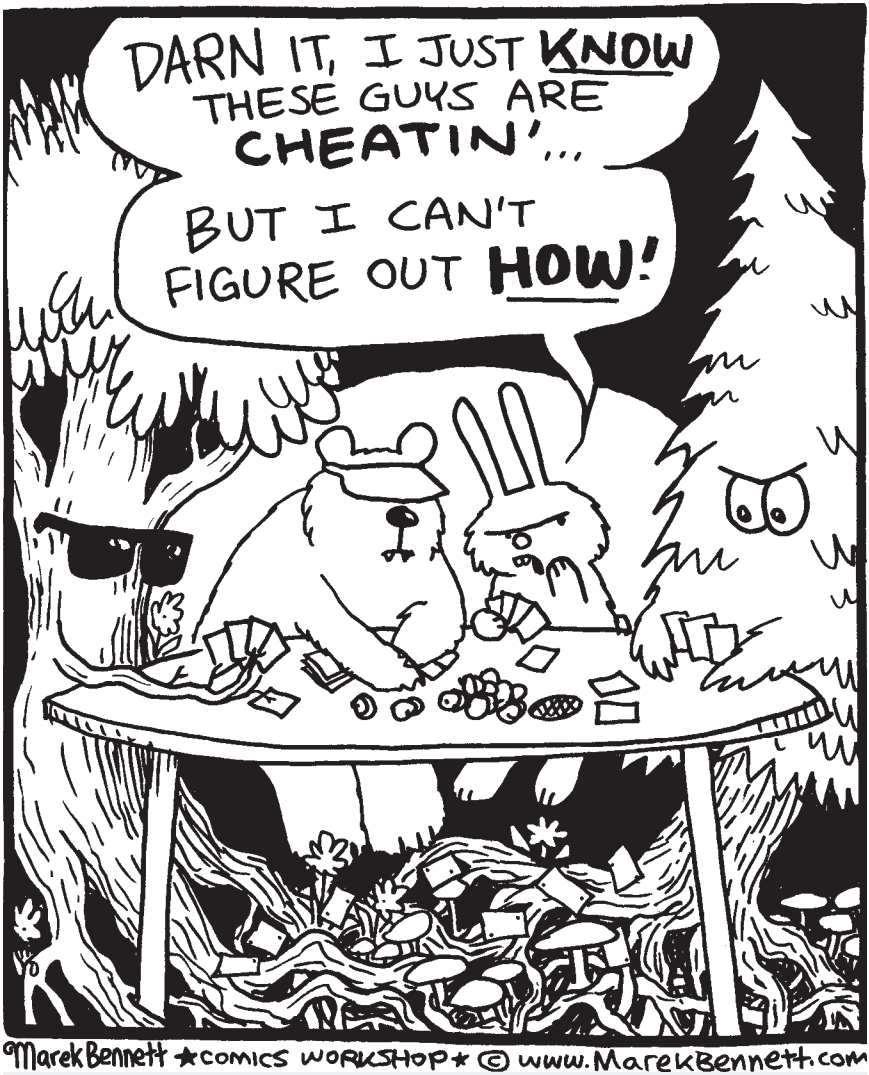
Of course, it might be more accurate to say that a very small number of botanists realized this. One of them was David Rhoades at the University of Washington. (Maybe it's meaningful that Rhoades was actually a zoologist interested in the insects that do the chewing.) Another report — this one by botanists — coming out in the same year from Dartmouth, showed that tree seedlings grown in the lab next to seedlings with damaged leaves started to produce chemicals in their leaves that would repel herbivores.

As it happened, about the time this work was published, I was working with a forester who told me about it. Since I was also a zoologist who knew no botany and therefore had no preconceptions, it seemed perfectly reasonable to me that chewed upon leaves might emit volatile chemicals that signaled their neighbors. Unfortunately, the botanical establishment, which had plenty of preconceptions, did not share my opinion. They condemned the idea, the research leading to it, and the researcher who'd done it. Rhoades actually lost his funding, left science and went on to run a B&B.

But times have changed. A recent article in Wired summed up 40 years of research as, "The evidence for plant communication is only a few decades old, but in that short time it has leapfrogged from electrifying discovery to decisive debunking to resurrection."

Rhoades's original work was done on alders and willow; the Dartmouth work was done on poplars and sugar maples. Since then, much of the research on this topic has been carried out on shrubs and crop plants. The signals appear to cross all sorts of boundaries; damaged sagebrush tells tomato plants to gear up for attack and so on. And this despite the fact that the mix of volatiles emitted is (somewhat) species specific. The receptors seem to cross genus as well as species lines.

Why should this phenomenon occur? Plants — or at least most of them — live surrounded by enemies who'd like to eat them. Why don't they all produce protective chemicals all the time? Well, that production is expensive. The metabolic



The illustrations for this piece were generously contributed by Marek Bennett, a New Hampshire-based cartoonist, musician, and educator. His comics work includes the graphic novel series, The Civil War Diary of Freeman Colby, as well as drawing, translating, & editing for The Most Costly Journey (2021) with the bilingual El Viaje Project. His crowd-funded cartoon travel memoirs include Sharjah Sketchbook (2020) and SLOVAKIA: Fall in the Heart of Europe (2013). Marek is the recipient of the 2021 New Hampshire Governor's Arts Award for Art Education.

costs of manufacturing protection are high. Just look at the US budget and how we put so much of what could be spent on social welfare into defense. What are we defending against? This is precisely the issue for plants. Most of the time those herbivorous enemies are either ab-

sent (like 17 year cicadas for 16 of those years) or present, but in low numbers. Plants being smarter than humans, they don't ramp up defense until it's needed. (And someday we might take up in these pages the question of who's actually making those defensive chemicals: is it the plant itself or its endophytes (the tiny fungi that live inside every leaf, every petiole, every needle of every plant, forming the plants' microbiome)?)

(Parenthetically, one of the reasons that this research was dropped and mocked earlier was that it was taken up by what was, if not the lunatic fringe, some fringe of the lunatic fringe: the folks who insisted that their houseplants responded to speech and music, etc. Who am I to say they're wrong? But when non-scientists jump in on revolutionary concepts, it's the concepts and the scientists working on them that take the heat. Just think about Timothy Leary and his followers on LSD and magic mushrooms. It took 50 years for research on these amazing chemicals to be decriminalized.)

Meanwhile, an even more revolutionary plant communication network has come to light. Well, not exactly to light since it functions in the dark. For a decade or so now, a different group of researchers; mycologists rather than botanists, have been working on an parallel story that takes place underground, where the fungal network that connects the forest seems to serve the same function of carrying the news of attack to other members of the community. This is welcome news since it solves some of the biggest problems facing tree talk via airmail; the fact that transport of volatiles is iffy in a forest with other trees blocking pathways, the short distances most volatiles travel before dispersion, and the variability of wind and weather.

When Suzanne Simard first started talking and writing about her research on that underground fungal network (an unknown Nature editor was the one who headlined her first paper in 1997 as "The Wood Wide Web", and that's been its name ever since), focusing on what she now calls "Tree Talk" (and yes, I stole that title), the response was not exactly enthusiastic. She was young, she was a woman and her idea was clearly nuts. Furthermore, she put forward the socialist idea of what can be best described as child care in the forest, with the larger trees up in the canopy sharing sugars with the smaller trees down in the dark understory. Maybe it was the socialism of it all that made US (male) scientists the last to accept her work. (Suzanne is Canadian and is now a faculty member at the U. of British Columbia in Vancouver.)

For a long time, the forest was viewed as being a capitalist ecosystem, with sunlight as capital and all trees vying for a place up in the canopy where they could grab as big a share of that capital as possible. When Suzanne showed undeniably,

using radioactive tagging, that the forest was underpinned by a complex fungal network that connected large numbers of trees and was transferring capital (carbohydrates) between them, some deniers were placated by the idea that after all, for a tall tree to transfer nutrients to its children, who were down in the dark nursery of the understory, was understandable — if not quite believable — in the light of evolutionary fitness and genetic survival. However, Suzanne and her students and colleagues then went on to show, via DNA analysis, that the recipients of the tall trees largesse were not necessarily their seedlings, although it turns out that the seedlings do get a somewhat larger portion. And this was only the beginning. More recent work has shown that trees share their excess photosynthates with trees (and even shrubs!) of different species, so that — for example — a group of scientists applying labeled carbon to the canopy of tall spruces, found sugars being traded over to neighboring beech, larch and pine via the underground fungal web. These resource shares were not trivial; they were calculated to be about 280 pounds/acre/year of carbohydrates being transferred around the forest, out of view.

As scientists started examining more forests and more species, they discovered a more surprising transfer of nutrients, where partnerships seemed to support each other in turn, remembering what was owed and paying it back in different seasons. For example, maple trees often coexist with trout lilies, a native flowering bulb. In the spring, the lilies flower under the bare branches of the maple, dying back as the maple leafs out. When researchers looked underground, they found that in spring, the dying back lilies donated sugars to the maple to help fuel its leafing out; in fall, when the maple sucked nutrients out of its leaves prior to dropping them, some of those nutrients were given to the lilies which were building up their bulbs.

Then things started to become even more complicated. For example, in the Scottish Highlands, where Scottish pine lives in the impoverished soils of heathland, along with an understory of Cowberry, it was discovered that the pine, photosynthesizing up in the canopy, was sharing sugars with the Cowberry. The Cowberry, which has a different type of fungal net, specialized for survival in heaths and bogs, was repaying the pine with some of the nitrogen it was able to extract from the soil. In different ecosystems, nitrogen-fixing or fertilized plants have been shown to share some of their N with plants that were N deprived.

All of this has profound effects for forests. "In the interior Douglas-fir forests of western North America, the transfer of carbon, nitrogen and water from older trees to regenerating seedlings through fungal networks has been associated with rapid increases in net photosynthet-

ic rates, shoot water relations and shoot and root growth of the young seedlings. These responses were linked to improved seedling survival and productivity, and hence regenerative capacity of the forest"

Once scientists realized that wood wide webs were transferring a variety of nutrients, they started to look for other other types of chemicals that might be moving along these underground highways from tree to tree and shrub to shrub. And — of course — they found them. To quote from an article by Simard and colleagues, "interplant resource and signal fluxes through mycorrhizal (fungal) networks have the potential to alter plant behavior. These fluxes have been shown to include carbon, water, nitrogen, phosphorus, micronutrients, stress chemicals and allelochemicals, and can occur between plants of the same or different species." (Allelochemicals are stress or attack

Illustrator Marek Bennett's self portrait as a rabbit.

agents; life in the forest isn't all childcare and gifts of food.)

So how about those warning signals sent out by damaged leaves? Are comparable signals also transmitted underground? Of course. The same article states:

"Using experimental designs that prevent the aboveground transfer of volatile organic compounds, stress signals have been shown to transfer from injured to healthy plants through fungal networks even more rapidly than carbon, nutrients or water. Herbivore- and pathogen-induced stress responses were up-regulated in undamaged neighbors in as little as 6 h following insect or fungal infestation of donor plants linked by fungal networks...For instance, broad beans (Vicia faba) responded to aphid attack by swiftly transferring defence signals to neighboring bean plants, which responded in turn by producing aphid-repellent chemicals and aphid-predator attractants. In a different study, defoliation of Douglas-fir resulted in simultaneous transfer of defense signals and carbon to neighboring healthy ponderosa pine through fungal networks, resulting in increased defense enzyme production by ponderosa pine, possibly orchestrated by the networking fungus as a strategy to protect itself against the loss of healthy hosts."

And this last sentence brings us to the heart of the matter. Does Tree Talk really tell us about the generosity, cruelty, family feelings and negotiating strategies of plants, or are the plants just the sources and sinks of materials manipulated by the fungal networks that connect them? Because fungi, like animals, depend on plant partners for their survival, it's clearly advantageous to the fungi to maintain a healthy ecosystem and to ensure that if one partner or one species of plant dies out, that others survive.

Sorry, folks. We can't answer this question yet. And the answer may not be a simple one. But to end with yet another quote from Simard's group, "The hierarchical integration of this phenomenon (the fungal network) with other biological networks at broader scales in forest ecosystems, and the consequences we have observed when it is interrupted, indicate that underground 'tree talk' is a foundational process in the complex adaptive nature of forest ecosystems."

For those who'd like to learn more, much of the material in this article is available on the web.

- *The work on airborne volatiles is accessible at: www.quantamagazine.org/the-secret-language-of-plants-20131216/*
- *The work on the underground fungal network is summarized in the paper from which I've quoted at: academic.oup.com/aobpla/article/doi/10.1093/aobpla/plw050/201398*
- *For those who'd enjoy watching Suzanne Simard talk about her research in a non-technical way, please do go to: www.ted.com/talks/suzanne_simard_how_trees_talk_to_each_other?language=en*

GALAPAGOS FUNGAL TOURS

Zaac Chaves

Back in 2009 I attended a lecture by Gary Lincoff, author of the Audubon Guide to Mushrooms, called Darwin and the Mushroom. This talk noted the paradox that while Darwin mentioned only two mushrooms in his Voyage of the Beagle, he collected and preserved many more than he wrote about.

These specimens are still being discovered in herbaria today and I left this lecture in wonderment: how many more mushrooms did Darwin and others find which have gone missing?

This was my most immediate thought when I found myself on a flight to the Galápagos this past Spring.

A few weeks prior | asked for advice from Carol Gracie, a botanical explorer who had led nearly three decades of South American ecotours including many on the Galápagos. Carol is an author of several books including Florapedia, which may be familiar to mycological readers because the series launched with Lawrence Millman's Fungipedia.

Carol urged me to bring the same careful attention we constantly learn to use here at home. Tourists were often inclined to check-off the most common species they allege having seen rather than using the scrutiny that we amateur mycologists know best. This work is essential for recognizing new species. Among other books Carol fittingly lent me a complete flora comprising all the vouched plants known on the Galápagos. A vital tome carried on my three-week trip however menacing for the small backpack comprising my entire belongings.

A pandemic worked somewhat to my advantage. One of my naturalist guides admitted that the rate of tourism had dropped to a mere 1% wherein I found a fleeting opportunity of being unusually well attended to. So against their rehearsed nature, with tactful nudging, our intended reptile and bird tours were transformed into botanical and fungal tours. Thus I had discovered a more special opportunity than I had expected. What luck!

There were some challenges I didn't prepare for. To find mushrooms on the Galápagos you need to have a naturalist guide. It's not only useful, it is a federal crime not to have one. And while these guides

A carapace of a tortoise showing a scoot. Photo courtesy of Zaac Chaves.

all have well-rehearsed tours, I increasingly redirected these so that I could continue to learn about what I came for. Naturalist guides were polite enough however some were cunning too.

One of my guides shared native (Kitchwa) names with me. What a unique privilege! Mushroom is ala. Mushrooms are alakuna. Good! However part way through I realized mushrooms with the same colors had identical names. I brought this up and my guide pointed out the error as my own. That is while thought I was learning species names I was actually learning "red mushroom," "white mushroom," "brown mush-

room," etc. Lawrence Millman, the enthnomycologist later told me this naming convention happens among native languages; names are often reserved for those specimens with either physical or cultural importance. Somehow in that moment I was still so amused by this misunderstanding that I took delight here despite having already recorded pages of careful notes.

On another level however all my naturalist guides seemed in part relieved not to be leading their usual tour. Some were quite interested yet were so often pressed by tourists to talk about a same few charismatic creatures instead. So how pleased I was to uncover this enthusiasm for the unfamiliar. I asked one for a write up and have transcribed it here.

> *My name is Erika Arias and I work as a freelance naturalist guide on the Galápagos Islands. During this pandemic, I decided to offer my guiding services at el "Chato 2 Ranch" in the highlands of Santa Cruz, a very safe open-air visiting site. Here you can find tortoises in the wild which migrate to this private Eco-reserve. Currently Visitors now enjoy the added value of learning about the natural history of tortoises and lava tubes. Also, Zaac, a field mycologist, inspired me to learn about mushrooms. I was surprised to find many varieties after downpours. Some of them grow in tortoise droppings, on decayed wood or at the entrance of our lava tunnel. All this is a bonus to the birding, botany and great cuisine and local Galápagos coffee !!*

What Erika did not note is how when I asked her about mushrooms she immediately knew where many were throughout this property and led me right to them. She was so keenly observant that she even led me to spots where they once grew and were no longer present. This showed that Erika had been paying careful attention to mushrooms even before I visited.

For those interested in seeing the mushrooms | saw for themselves I posted all my fungal finds on the online forums Mushroom Observer and iNaturalist **(https://www.inaturalist.org/observations?%20created%20d1=2021-04-01&created%20d2=2021-05-26&place%20id=anv&subview=-map%20&user_id=zaac&verifiable)**. I want to point out that the most exceptional part of my work is its organized on a single weblink. Beyond my work however as I have described here many people are also observing fungus, even when not featured prominently. Like back home there is still a lot of work to do. Yet everywhere I looked I found people were doing some of this fascinating work already. This proves true in unlikely places.

Melville, author of Moby Dick who visited the Galápagos Archipelago around the same time as Darwin, noted fungi. To Melville this was a diabolic place. What Mel-

ville interpreted was very different from Darwin. It's a phenomenon in which the viewers' own ideologies entirely transform what they see and experience. Darwin's paradise was the opposite for Melville.

To Melville, tortoises were monsters, the reincarnates of cruel sea captains forced to suffer by simply by existing on these islands. Toadstools and fungus things grew beneath their feet. Yet what sounds like pure fantasy has scientific accuracy. To my surprise, I found this in past Bulletin editor Elio Schaechter's Memoirs (https://schaechter.asmblog.org/eliosmemoirs/). As discussed there, nearly one hundred years later Schaechter studied and published an important document on Galápagos foot fungus.

Like the Kitchwa, Melville saw the supernatural in the life of the Galápagos. Melville took this far, conjuring reincarnated sea captains and monsters from the tortoises. Yet at the same time Melville is, somehow, startlingly ahead of his time when it comes to fungus.

> *I then pictured these three straightforward monsters, century after century, writhing through the shades, grim as blacksmiths, crawling so slowly and ponderously that not only did toadstools and all fungus things grow beneath their feet, but a sooty moss sprouted upon their backs. - Melville, The Encantadas, 1854*

The plasmodium of a slime mold of the Order Physarales. — what Melville would call a fungus thing. Photo courtesy of Zaac Chaves.

LONG TRAIL FUNGUS

Lauren Georgiades

Setting out on a 273-mile journey in the woods takes a whole lot of planning, a whole lot of research, and a little bit of crazy. I had attempted The Long Trail once before in 2019 and started in late August with hopes to avoid the black flies and the notorious Vermont mud season. I was met with VERY cold nights after just a week on trail. This year, we planned to start just a bit earlier, to avoid too many cold nights and perhaps still miss the wet weather. But who are we trying to kid? The Green Mountains of Vermont are always wet.

In fact, this particular July happened to be the rainiest ever in the recorded weather history of Vermont with nearly 11 inches of rain in most of the state. It's a good thing we stuck to an August 1 start date to head north. Many earlier hikers were almost literally washed off the

Black trumpet mushrooms, *Craterellus cornucopioides* **(left), and golden chanterelles,** *Cantharellus cibarius*

trail, cutting their end to end hikes short. We only got caught hiking in the rain twice in 22 days!

Another unexpected or less obvious benefit of starting after the rain would be the mass abundance and variety of mushrooms and fungus that we would happen upon, right on trail, along the way!

We started the trail from the Greylock Community Center in North Adams, Massachusetts along the Appalachian Trail, which follows the Long Trail for 105 miles to the Maine Junction just past Route 4 in Killington, VT, in the late afternoon. Within a half a mile from the road, the forest filled with various fruiting bodies of all shapes and sizes. We walked through fields of scaly chanterelles, black trumpets, hawk wing mushrooms, these cool tall bright yellow tubes, and even a lone young Old Man of the Woods.

It took forever to hike the two miles into camp as I documented everything I was witnessing. I pulled out my iPhone and started consulting iNaturalist as a start and then I quickly started posting to the Boston Mycological Club Facebook page in excitement to learn!

I picked a few HUGE (for East coast) golden chanterelles to cook at camp and black trumpets to examine. The X factor may have been what appeared to be a recent widespread smoldering wildfire that wiped out all of the underbrush up until Pine Cobble in Williamstown, MA.

The next day we hiked a bit past the Vermont border and saw beautiful shiny, wet, purple mushrooms EVERYWHERE. It seemed each day would hold a new discovery, more chanterelles, tons of what I think was ramaria strictus and may-

Violet corts, *Cortinarius violaceus*

Common puffball, *Lycoperdon perlatum*. **Photos courtesy of Lauren Georgiades.**

Old man of the woods, *Strobilomyces floccopus* **(above). Yellow coral mushrooms (bottom).**

be even crown tipped coral, more tall yellow tubes too. I haven't been a forager for very long, but out here it's hard to ignore the questions that enter your mind when you're quite literally surrounded by new and interesting specimens, both specimens you've seen in photos and specimens you never imagined. Suddenly, I realized I wasn't just hiking a long distance trail, I was now immersed in a month-long mushroom hunt and mycology study!

As the first week came to a close I tried to notice all of the delicate gilled mushrooms, the boletes, and the Russula genus. I find as a novice it's easier to focus on one genus at a time. I had started with polypore and shelf fungus first, like Pleurotus, Maitake and Laetiporus. Then I looked for cantharellus and craterellus and slowly now hericium sp...

It's all very overwhelming and a lot to take in and feel confident in. I joined the BMC this spring after a few massive COW and HOW finds in late 2019, began studying my Audubon Field Guide to Mushrooms, started watching hours of "Learn Your Land" on YouTube and referencing the iNaturalist app. The responses I received from BMC and other mushroom ID groups helped give me leads for various Google searches along the way.

Enter week two on trail past Manchester Center, VT along the AT/LT and I'm still finding golden chanterelles, coral mushrooms (even in the violet variety), Italian Oysters—a massive fresh flush just north of RT 140 outside of Wallingford, VT. And

then the Lobster Mushrooms began to appear north of RT-103 outside of Clarendon. And if it couldn't get any cooler, a massive Bear's Head Tooth specimen appeared about 12' up in a tree weighing about a full pound just before the Governor Clement Shelter right in broad daylight on a country or maybe private road we crossed.

To say I was excited was an understatement.

I have cooked my "tramily" (trail family, people you hike with or meet up with at camp) chanterelles, chicken of the woods, and the Bear's Head Tooth. Everyone is so excited to learn what little I know too. We all share in the bounty and I've never had to walk more than four feet from the trail to collect.

The magic of edible mushrooms is contagious. The tramily and I talk

Bear's head mushroom, *Hericium americanum*. Photos courtesy of Lauren Georgiades.

about key ID factors like appearance, texture, smell, gills (or lack thereof, color), tree associations and look alikes. Everyone was on the lookout now for the next mushroom discovery and our phones lit up daily with new finds from our friends as we headed north.

105 miles into my 273-mile journey toward the Canadian border I became so excited to see what discoveries might come next and how much more I might learn. Past the Maine Junction, it seemed drier. At first there were far less fruiting bodies than before the Long Trail and Appalachian Trail separated. There was a lone bolete or russula here and there but nothing I felt confident to ID. The next day, things changed and they changed rapidly. Suddenly we were riding the ridge FULL of Bear's Head Tooth, fresh ones too! We collected specimens every day it seemed like and tried various ways of preparing it with the little ingredients we had to make it work. Adding it to our ramen after sauteeing it in soy sauce in our titanium pots seemed to be a favorite! In the Breadloaf Wilderness, web caps DOMINATED the landscape. The moss was covered in beautiful purple mushrooms both alone and in clusters. It was exciting to see but, I can't say I was excited to find out they were not the edible wood blewits I was hoping they were.

The only way to experience the wonderful world of mycology is to just immerse yourself in it and be curious. Vermont is wet, filled with old growth untouched forest, and many many many species of fungi, not far from home. Hiking has long been a cornerstone to my life and never in a million years did I think it would morph into a lifelong mushroom hunt but the trees in the forest brought us all together.

The author, Lauren Georgiades, on a hike full of fungal finds. Photo courtesy of Lauren Georgiades.

OVERCOLLECTING

Lawrence Millman

Not too long ago, I led a mushroom foray in central Massachusetts for the North Country Land Trust. Just prior to my foray, there'd been a Boston Mycological Club foray at the same site, and the vast number of mushrooms collected by that foray's participants lay in waste on the ground near a picnic table. As a result, my own group encountered very few mushrooms.

Why were so many of the mushrooms exactly the same species? Because the BMCers had branched out in all directions and then brought back their specimens for a so-called expert to identify. Nobody knew what anyone else had collected, so it was grab whatever you see and toss it into your capacious basket. (Speaking of baskets, I found collection slips in a nearby trash basket that indicated one substrate was "Near a tree" and another was "On the ground." Elementary, as Sherlock Holmes might have said, shaking his head.)

Well, at least the BMCers didn't disturb the mycelia, you might say. But the mycological jury has not reached a verdict on this subject. Truth to tell, much of a mycelium's biomass and an undetermined portion of its energy is transferred to its fruiting bodies, the vehicles for spore production and thus, in effect, a fruiting body's reproductive organ. How would you like it if someone came along and yanked off your reproductive organ? Here's a perhaps less depressing analogy: a group of bird-watchers filling their baskets to the brim with eggs.

Personally, I think it's better, much better, to observe mushrooms in the field. That way you can study a specimen, smell it, and even taste it when it's utterly fresh. You can also photograph that specimen with its actual substrate rather than with an artificial substrate — i.e., a picnic table. Not only will you learn more that way, but later visitors to the same site will actually see mushrooms rather than a fungally-bereft landscape. They might even become mycological converts! Let me add that the overcollecting of mycorrhizal fungi might have a very negative effect on the trees with which they have engineered a symbiotic relationship.

So, please, let's try to collect less promiscuously. For, in the end, too much collecting might mean fewer mushrooms, which could result in less genetic diversity, which in turn might result either in still few-

er mushrooms or in mushrooms so compromised that they can't perform their environmental services any better than a certain brash hominid I know.

With too few mushrooms, there's always the possibility that a species might become critically endangered or even go extinct. And — to quote Oscar Wilde — you don't want to kill the thing you love, do you?

Illustration provided by Joshua Winer.

THE REGISTRY OF MUSHROOMS IN WORKS OF ART

Elio Schaechter

Some 20 years ago, one of us (Elio) had amassed a list of some 200 paintings with mushrooms in them. He found out that a German mycologist, Hanns Kreisl, had collected about the same number of such works. A quick exchange of emails revealed that the two gatherings differed significantly, which was not surprising because the two collectors had used dissimilar sources. But this fact suggested that the total number of such works may be quite large. The two decided to combine forces and create an internet-based Registry of Mushrooms in Works of Art. Notable former contributors with like interests were Tjakko Stijve, Daniel Thoen, and Nancy Mladenoff. To ensure consistency in style, the entries were (and continues to be) redacted by Marjorie Young.

In time, the Registry of nearly 1500 artworks came under the sponsorship of NAMA, which it enjoys to this day. The purpose of the Registry is to contribute to the understanding of the relationship between mushrooms and people as reflected in works of art from different historical periods. Many artists simply expressed appreciation of fungi's forms and beauty. Finding mushrooms in paintings should augment our awareness of the symbolic as well as gastronomic role that mushrooms may have played in various cultures through the ages. Thus, a study of the Registry may well supplement the written record.

Included in the Registry are works with demonstrable artistic value as judged by one or more of the following criteria:

- In the possession of a museum or an established organization or collector
- Mentioned and preferably reproduced in a book or an exhibition catalog
- Shown in an exhibition at a museum
- Seen in a private collection by a person with reliable credentials in mycology or art history

The Registry consists almost entirely of Western paintings. With rare exceptions, it does not include illustrations for books or posters. It does include works other than paintings (e.g., sculptures, engravings, tapestries) that have a special historical, scientific, or artistic interest. These items are noted in bold capital letters.

This Registry is a work in progress. It is an open-ended endeavor. We are trying to increase the numbers of images related to the artworks and over a hundred more items await inclusion in the Registry.

The Registry is meant to provide enjoyment to anyone interested in the subject. We hope that it will stimulate you to look for mushrooms in works of art. Note the criteria for inclusion mentioned above.

You are welcome to share your "finds" with us by email (addresses below). If possible, please include:

- Name of artist, if possible with nationality, place and dates of birth and death
- Title of the work
- Brief description of the mushroom(s)
- Reference to books or catalogs and, if available, website(s)
- Location of the work

For a deeper look at two Baroque artists' work in the Registry, see Fungi magazine articles on Philipp Ferdinand de Hamilton (Summer 2019) and Otto Marseus van Schrieck (winter 2020.)

The current curators of the Registry are Pat Nolan, David Rust, Elio Schaechter, Bonni Thoresen, Lucas Vanhevel, and Jacquelene Verna. The redactor is Marjorie Young.

For more, visit the Registry of Mushrooms in Works of Art on the North American Mycological Association website: https://namyco.org/art_registry.php

Autumn (1573)

Giuseppe Arcimboldo

Mushroom description:
Human face. The ear is a gilled mushroom.
Location:
The Louvre, Paris
Reference:
Krigeskorte. G. Arcimboldo, Cologne, 1988. Schneider. Stilleben, Cologne. 1989.
Note: A painting by the same title is mentioned as missing in Krigeskorte. G. Arcimboldo, Cologne, 1988. A similar one is in a private collection in Bergamo, Italy (see Krigeskorte).

From the Registry of Mushrooms in Works of Art

"Our almost 5-year-old son is huge fungi lover and was so proud of his find!" Photo courtesy of Jana Harris.

Photo courtesy of Loren Hoekzema.

Photo courtesy of Loren Hoekzema.

Fiction

AN ALTERNATIVE GUIDE TO WILD MUSHROOMS

Lisa Allen

Amanita virosa,
"Destroying Angel"

Take this as an IOU—I Owe You a housewarming gift.

I'll start there. You'd laugh if you saw me practicing to write you, but I can't ruin this mushroom card. It was the only one of its kind in a bin of 70's stationery at an antique barn in the Hudson Valley. That's where I was when I texted you a photo of the hat rack, the jockey cap that would have looked cute on you. You texted back right away, told me to try the blue pillbox with face netting for myself, and then the red sun hat with silk lilies. A mom with two bratty kids walked by and looked at me funny for trying on silly hats alone, and it was a new way to miss you.

I drove up to the Hudson Valley to find a gift. I thought about sending you something from the city, whiskey from the distillery near your old apartment, beaded earrings from that shop across from Juno's, key lime pie from the bakery by the pier. But you chose to leave those places behind.

My next stop was a "general store" selling "local provisions." You'd see right through the handwritten labels pasted crooked on jam jars, the caramel sauce that listed the name of every single cow that made the milk that made the butter. I bought nothing.

Pop quiz: what did you think when you opened the card and saw the white stem and parasol cap? Did you think, A tasty field mushroom! I'd sautée that with garlic and olive oil and sea salt! If so, check the caption: Amanita virosa, the destroying angel. Eight to twenty-four hours after dinner, violent vomiting and diarrhea would begin, and then subside for a day or two. You'd think you were fine. You would go about your business while the amatoxins killed your liver and kidney cells. By the time the pain sent you to the hospital, it would probably be too late. Half of one mushroom is all it takes. There is no antidote.

Armillaria mellea,
"Honey Fungus"

You mailed me honey from your new neighbor's hives—the cute one, you said in your note. I thought it would be funny to respond by sending you mushrooms from a honey fungus. Did you know that the largest living thing on earth is a honey fungus? Its mycelium filaments thread through 3.4 square miles of dirt in the Blue Mountains of Oregon. It's thousands of years old. Hon-

ey fungus feeds itself by infiltrating trees, spreading a white film between the bark and the wood. The trees die, but the mushrooms are supposed to be delicious. I did more research and learned that the funeral bell is a dangerous lookalike. The spore prints are different but it made me nervous.

So, your new neighbor is training you to help out with his hives on the weekends. You have this whole back-to-the-land narrative about moving to California. Like you hadn't seen a tree in years. Didn't we forage in Prospect Park, and upstate too? And last summer we drove a few hours from the city to camp in the mountains, twice. Are you going to forget everything that doesn't fit?

Pleurotus eryngii,
"King Trumpet Mushroom"

The week before our trip to the Adirondacks, a woman swimming in the Catskills was infected with the brain-eating amoeba Naegleria fowleri. I brought my swimsuit anyway—I know how you are about mountain lakes—but you wanted to go swimming as soon as we got to the campsite.

"Can we relax a little first?" I had my eye on the fire pit and the beer cooler. Our campsite was sheltered by a thicket of tall pines and it was just so cozy. We'd pitched your tent and mine across from each other, framing a little courtyard where we could sit by the fire and look out at the view.

"Oh my god, you're thinking about the amoeba."

"No, I just wanted—"

"Come on: It's. So. Hot."

"They like the heat."

"You know it could be anywhere, it's in shower water too, are you going to stop showering?"

I know when to stop arguing with you. We changed in our tents. I came out in my daisy-print bikini and you were waiting in your racing one-piece. I followed you into the lake. Shin-deep, our feet disappeared in the murk. I slowed down to test the rocky mud with my toes and you ran as fast as you could against the water. Waist-deep, you dove under. I walked in up to my chin and you popped up for air further out, hair slicked to the back of your neck. You swam freestyle and I doggypaddled along the shoreline.

"Your hair is dry," you said, bursting up from the water next to me.

"So?"

You went under again. I felt a pinch at my knee and then there you were on my other side.

"Did you notice anything? Was that an amoeba?"

You skimmed your forearm across the surface to splash my face and I held my nose—it enters through the nose, that's how it gets to the brain—and dropped under. I let the water sink into my hair, all the way down to the roots, before I came up.

We dripped down the path to the campsite. After the lake, the heat felt good again.

"What's that?" you pointed off-path.

I followed you into the brush. A bramble scratched my ankle. We stopped in front of a tree with a patch of mushrooms growing between the roots, tall girthy stalks with small caps. You severed the largest mushroom with your foot; it lay prone in the dead leaves. You gave it one hard stomp and left it there.

Pictured: Chicken of the Woods

Laetiporus sulphureus,
"Chicken of the Woods"

We'd bought two bundles of firewood at a roadside stand but we needed kindling, so as soon as we dried off we went deeper into the woods. I was picking up twigs, and you were breaking up a larger branch into bundles when you pointed at a stack of fan-shaped orange fungi coming off the roots of a maple tree.

"Chicken of the woods!" you said.

I made chicken-dance arms.

"No that's what they're called, for real. They're beginner mushrooms. No poisonous ones look like this." You snapped off the smallest shelflet.

"Oh, you're a mushroom expert now?"

"Aaron showed me. I should have made him teach me more mushrooms."

Getting your mind off of him was the unstated point of this trip.

"The baby ones are the best. See? No gills." The underside was egg-yolk yellow. You snapped it in half. "No bug-holes."

Before I could say anything, you took a big bite. You chewed, watching me, and then you shrugged. "I bet it would be good cooked. It'll go with our dinner." You held it out like a poison apple, making innocent eyes. "The amoeba's eating your brain, what's to lose?"

Goddamned Aaron. I took a tiny bite—too little, I hoped, to kill me. Who would drive us to the hospital? We had no cell signal at the campsite, so it's not like we could have called an ambulance. You started picking off young mushrooms and putting them in our kindling bag. It tasted like nothing.

While you arranged firewood in the pit, I said I was getting more kindling. Around the bend in the road I started looking for a cell signal. At the visitor's center I finally got enough bars to google "chicken of the woods"—AKA Sulfur Shelf Fungus. It's a saprobic parasite, which means it feeds on decaying organic matter. First, the mycelium attacks the tree and rots its heart. By the time mushrooms fruit on the bark, the tree is probably done for. I looked at three different mushroom hunting sites. Most of what you said checked out. The chicken of the woods has no poisonous lookalikes, but it can be toxic when it grows on conifers and eucalyptus. Did you know that? I couldn't ask you without giving myself away. I brought back a few broomy branches for my alibi and rinsed the mushrooms at the spigot, chopped them on our little cutting

board. Remember that creepy song you made up while you heated the oil? "Toadstools at dusk...fungi sublime, mystery mushroom musk." You didn't think I'd eat them. I speared a big slice, held it up in the firelight for you to see, and took the first bite. Then you speared one and went right for it. This surge of adrenaline seemed to hit when you swallowed, and you looked at me like this might be our last night on earth. You hadn't looked that happy since the breakup. I felt guilty not telling you what I knew but I didn't want to bring you down. Stirred into our packet curry, the mushrooms were actually pretty good.

Lactarius rubidus,
"Candy Cap"

I don't know how to tell you I want to take back your birthday present. I thought I would be there to help you use it. Could we negotiate a trade? I'll give you a new gift and you'll give it back. And then I'll have two mushroom hunting guides, but the point is you won't have one. I know, it's the last thing that turned into a "thing" for us before you left. But you text me pictures all like, "Candy caps!!" and it scares me; they look so much like deadly skullcaps. You assured me your haul had the telltale maple smell and brittle stipes, distinct from the cartilaginous stipes of questionable lookalikes. Nothing I could see in a photo. Maybe I should give you more credit. You have a good eye, you say you take spore prints, and I'm impressed by your command of stipes. The thing is, I can't forget the way you used to commute from Brooklyn into Manhattan on your bike with no helmet, because it made you feel alive, and what did I do? I got you into mushroom hunting.

Calvatia gigantea,
"Giant Puffball"

You learned that your birthday was during the peak of the Perseid meteor shower, and you wanted to see it. We booked another campsite in the Adirondacks. We both forgot to bring corkscrews so we looked for twist-offs in the refrigerator case at the liquor store. You picked up a bottle wrapped in metallic foil and did what I thought was a jack-off hand motion but then you said "Pop top!" We bought two.

The ranger told us the best time to see the meteors was the period after midnight but before moonrise.

"The witching hour," you said.

Our campsite was a rocky clearing on the edge of a pond that carved a bowl of open sky into the treeline. After a swim and a dinner of campfire nachos, I gave you the guidebook with a post-it marking your favorite mushroom, the chanterelle.

We made a mug of weak pourover to stay awake and then we had some birthday Champagne. Technically Brut—I know how some people are about the Champagne region of France. We filled the coffee mug with bubbles and kept refilling until my head hurt from the sugar.

"Let's take a walk," I said. I needed a break.

Our flashlights cut a path around the lip of the pond. I paused my beam on a cluster of round leather-brown mushrooms with little holes on top.

"Puffballs," you said. "I loved those when I was a kid."

You squatted in front of them and read the guidebook by flashlight. "The average giant puffball contains seven trillion spores."

"Trillion?"

You squeezed a puffball; a white cloud swirled up into my flashlight beam.

"It says here that spores travel all the way up into the clouds. They can change the weather by agitating a cloud to make raindrops, or snow or hail."

"Let's see if it starts raining." My head was spinning. I lay down on the ground, resting my head on a mossy patch, and you leaned back against a rock. There were a few puffy clouds in the sky. I imagined the spores floating up and getting lost in the white haze, suspended in the heavens until the cloud flushed them down in a burst of rain to perpetuate their species.

Something bright flashed across the sky.

"A shooting star!" I said.

"Comet debris burning up in the atmosphere."

"Let's a make a wish on the next one. A birthday wish."

"Secret wish?"

"Secret."

When the next meteor streaked past I made a wish that we would come back to the Adirondacks every summer. It was a bad choice for a secret wish. I couldn't tell you I wanted that, because then the wish wouldn't come true. You know I'm superstitious. Not that it matters now. Now, you're a six-hour flight away and I'll be lucky if I see you anywhere every year. I can't ask what you wished.

Back at the campsite, when we finished the Brut you threw the bottles one after the other at a big rock and they shattered, and then you crawled into your tent and I went into mine and the last thing I remember thinking is someone's going to have to clean that up.

In the morning I came out of my tent and you were already awake, pouring steaming water from the kettle into the pourover. Camping, the first person to get up claims moral high ground. The plastic bag hanging off the edge of the picnic table had long shards poking out at its sides. Plausibly two complete Brut bottles worth of shards, but what do I know. I was never anywhere close in the how-many-jellybeans-in-the-jar contests at my orthodontist's office, which always seemed cruel. We couldn't eat jellybeans with braces. Remember when my braces came off and my parents took me and you—you, who never needed braces—on a tour of the Jelly Belly factory? We stood on a glassed-in catwalk above the factory floor, staring down into stacked white crates filled with jellybeans and I wanted to plunge my hand in and feel the smooth pebbles clink around my fingers. The crates were organized in rows separated by color, and I named the flavors for you: cherry, lime, blueberry, cotton candy. I wasn't sure about cotton candy, it could have been bubblegum, but you looked impressed until I said, thousands of them. You shook your head: millions. I decided that it was a significant day in my life: the first time I'd ever seen millions of anything. The tour guide could have told us how many, but I just wanted to believe you.

I figured it would be rude to check the bushes like I didn't trust your bottle cleanup, you the first-to-wake-up, so I just sat down at the picnic table and watched the coffee drip. I opened the guidebook, began at the beginning. What is a mushroom? To make a mushroom, the reproductive "fruit" that spreads spores, the hyphae give up their individual questing underground. They weave themselves into a fabric that forms the flesh of the mushroom, their final unity.

Boletus edulis,
"King Bolete"

You started mushroom hunting by yourself in the woods near your new house, and you swore you'd find chanterelles before the year was up. Your first edible find was a king bolete. It's an upstanding forest citizen. Fungi aren't always agents of parasitic rot. Until I read the guidebook, I didn't know that fungi like king boletes and chanterelles provide an underground communication network between trees and other plants. The relationship is called "mycorrhizal mutualism." In this symbiosis, mycorrhizal hyphae—fungal tendrils that spread through the earth in search of food—connect the roots of plants and trees. These networks conduct information and nutrients and facilitate cross-species exchanges, such as a phenomenon called fir-birch mutualism. Paper birches, rather than siphoning off Douglas firs' resources, actually donate more photosynthetic carbon through the hyphae than they take in, helping their neighbors survive. For their troubles, fungi take a small cut of photosynthesized material. In a mycorrhizal economy, everything connected benefits. Doesn't

Pictured: A King Bolete

that sound utopic? I don't know exactly how fungi and trees communicate their needs but I know it's limited by proximity. With you so far away, if I'm being honest I don't even know what you need any more, much less how I could give it to you.

Agaricus campestris,
"Field Mushroom"

When you texted "Field mushrooms!" with a photo of suspiciously generic specimens I called you. Lots of mushroom hunters won't touch round-topped white mushrooms with gills. Especially young ones.

"What if they're destroying angels or death caps?"

"It's fine! There were no sacs at the base! They're in the pan already. I'm trying to have a nice night!"

"But—"

"I have papers to grade." You hung up.

Both varieties are common in California, I was going to say.

Morchella esculenta,
"true morel"

I had this feeling walking back to my apartment the night you left the city. It was cold and dark and I was passing these beautiful warm-lit restaurants and bars and each one was just a place I'll never go with you. When you visit we will go out on the nights you aren't catching up with other friends, but those places won't be part of our lives. Our only future in this city is nostalgia, and nostalgia is the dusty dried morels I buy when I think of the honeycomb-tops we found growing in the shade of a dead sycamore in Cold Spring. You left me in a place produced by the dialectic of our life in it, and now I don't know where I am. Reality isn't something that can be experienced alone. Reality is a shared space. You left and the city is bleeding significance. Juno's could shut down and before, that would have meant now we'll have to find a new place to end up on Friday nights but now—what would it mean? For you, it would mean I'll never see Juno's again and for me, I'll never see Juno's again with you; is it even Juno's without you. I'd watch something else replace it, something that means nothing. I haven't been back since you left. If I went back and texted you a picture of Marta mixing your favorite whiskey sour, you'd text me a photo of yourself in your sunny kitchen three hours earlier in Pacific Time, chopping vegetables from your garden. By the time you finish your second glass of wine after dinner I'll be asleep. And I kind of want to text you right now to say Remember the Perseids? but it's 2 a.m. on a Sunday night and we both have work in the morning. The text would find you watching TV. Or maybe you finally invited your beekeeping neighbor over. 2 a.m. texts look unhinged at any other hour. Across these time zones the only time of day that feels the same way at the same time for both of us is the afternoon, a static time. Possibility is nocturnal.

Cantharellus cibarius,
"Golden Chanterelle"

It's been raining all month and you know what that's good for? Chanterelles. It's 3 a.m. but I can't sleep and I feel them out there, calling to me. I'll get dressed and take the subway to Prospect Park. I'll enter at 15th Street and find the lake from the north, shine my flashlight around tree roots until I catch a flash of gold, a fluted underside. I'll check for false gills that fuse to a smooth stem, make sure I haven't mistaken them for true-gilled toxic jack-o'-lanterns. The trees around them will be healthy, well-nourished by the mycorrhizal network. I'll gather tender ones in my basket, enough for two. They won't last long. Tomorrow morning I'll wrap half of the chanterelles in bubble wrap to protect them from bruising. I'll seal them in a box with an ice pack from my freezer. I'll send them by two-day mail and you won't believe I found them, your favorite, right here. I'll wait until it's dinnertime in California. Then, we'll make them together.

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