Spores Illustrated

WINTER 2020/2021

COMA SURVIVES THE PANDEMIC

Here we are. COMA hunkered down through a complete fungal season marred by the pandemic. To date there has been no report of the passing of any of our members, for which we are very thankful.

A MESSAGE FROM THE COMA PRESIDENT

Friends:

I believe that the word "unusual" does not quite describe 2020 adequately. Fortunately, we *did* manage to squeeze in some great walks, which was undeniably more than most clubs in the Unites States were able to offer, and definitely more than any club in the Northeast. Because of COVID restrictions and some last-minute venue changes, it was "touch and go" more than a few times, but with a considerable amount of extra effort, it all worked out well, and with any luck, we will be able to return to at least *some* semblance of normalcy for next year - although I'm sure that we will still have to exercise plenty of caution, and deal with new restrictions. From all indications, things may not really get back to "normal" (whatever *that* was) for a full year from now.

I do not know of a single person who has been left unscathed by the pandemic. Our lifestyles have all been affected; some of us have lost family or friends, and many of us have experienced very real economic hardships as the result of a tanking economy, or social distancing regulations that made certain activities untenable, causing the collapse of many retail businesses. Following sensible restrictions, our modest group activities have been impacted, and some things (the *Clark Rogerson Foray*, for example) have been "tabled" out of necessity, at least until next year. Some of our most "at risk" members were forced to make the decision to sit out any of our organized "live" activities, until such a time when a reliable vaccine will become widely available.

Meanwhile (back at the ranch), we intend to offer a "beefed up" schedule of evening programs (via Zoom) from now until our season kicks off again in late April, aided and abetted by our new Zoom coordinators, Nicole and Jan Zahour. Another change is that Lindy Lipka will be our new COMA News Editor, so you will be kept up to date on important news of events and friends from your favorite mushroom club.

So here's the bottom line: *hang in there*. Things will absolutely get better, and your friends at COMA will be here to help get you through. Yes, we all know people who look at us a little askance ("You like to do *what?*?"), but we know how rewarding our avocation (obsession?) can be, and there's actually this far-flung *community* of like-minded mycophiles ready and willing to act as a mental safety net whenever we get the chance. When we think about mushrooms (and especially when we can do it while interacting with our mushroom-foraging pals), troublesome issues manage to either disappear or (at the very least) shrink to a manageable size.

Have patience, and keep warm (and *safe*) this winter. Rest assured, we have good things in store, just ahead.

Joe Brandt

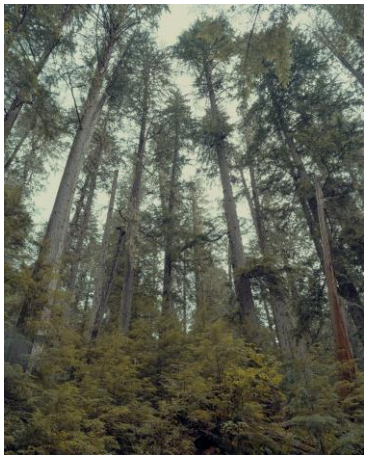
FIRST COMA BOARD MEETING VIA ZOOM

We are joining the 21st century and having a virtual meeting of the club's board on January 20th at 7 pm. It was decided that all members are welcome to sign in and observe and maybe even participate (if everybody behaves). Keep an eye out for an email with the link.

Trees appear to communicate and cooperate through subterranean networks of fungi. What are they sharing with one another

The following article was already shared to our group by Lisa Solomon (thanks Lisa) but it bears repeating if you missed it.

From the NY Times Magazine of December 6, 2020



The Social Life of Forests

By Ferris Jabr
Photographs by Brendan George Ko

As a child, Suzanne Simard often roamed Canada's old-growth forests with her siblings, building forts from fallen branches, foraging mushrooms and huckleberries and occasionally eating handfuls of dirt (she liked the taste). Her grandfather and uncles, meanwhile, worked nearby as horse loggers, using low-impact methods to selectively harvest cedar, Douglas fir and white pine. They took so few trees that Simard never noticed much of a difference. The forest seemed ageless and infinite, pillared with conifers, jeweled with raindrops and brimming with ferns and fairy bells. She experienced it as "nature in the raw" — a mythic realm, perfect as it was. When she began attending the University of British Columbia, she was elated to discover forestry: an entire field of science devoted to her beloved domain. It seemed like the natural choice.

By the time she was in grad school at Oregon State University, however, Simard understood that commercial clearcutting had largely superseded the sustainable logging practices of the past. Loggers were replacing diverse forests with homogeneous plantations, evenly spaced in upturned soil stripped of most underbrush. Without any competitors, the thinking went, the newly planted trees would thrive. Instead, they were frequently more vulnerable to disease and climatic stress than trees in old-growth forests. In particular, Simard noticed that up to 10 percent of newly planted Douglas fir were likely to get sick and die whenever nearby aspen, paper birch and cottonwood were removed. The reasons were unclear. The planted saplings had plenty of space, and they received more light and water than trees in old, dense forests. So why were they so frail?

Simard suspected that the answer was buried in the soil. Underground, trees and fungi form partnerships known as mycorrhizas: Threadlike fungi envelop and fuse with tree roots, helping them extract water and nutrients like phosphorus and nitrogen in exchange for some of the carbon-rich sugars the trees make through photosynthesis. Research had demonstrated that mycorrhizas also connected plants to one another and that these associations might be ecologically important, but most scientists had studied them in greenhouses and laboratories, not in the wild. For her doctoral thesis, Simard decided to investigate fungal links between Douglas fir and paper birch in the forests of British Columbia. Apart from her supervisor, she didn't receive much encouragement from her mostly male peers. "The old foresters were

like, Why don't you just study growth and yield?" Simard told me. "I was more interested in how these plants interact. They thought it was all very girlie."

Now a professor of forest ecology at the University of British Columbia, Simard, who is 60, has studied webs of root and fungi in the Arctic, temperate and coastal forests of North America for nearly three decades. Her initial inklings about the importance of mycorrhizal networks were prescient, inspiring whole new lines of research that ultimately overturned longstanding misconceptions about forest ecosystems. By analyzing the DNA in root tips and tracing the movement of molecules through underground conduits, Simard has discovered that fungal threads link nearly every tree in a forest — even trees of different species. Carbon, water, nutrients, alarm signals and hormones can pass from tree to tree through these subterranean circuits. Resources tend to flow from the oldest and biggest trees to the youngest and smallest. Chemical alarm signals generated by one tree prepare nearby trees for danger. Seedlings severed from the forest's underground lifelines are much more likely to die than their networked counterparts. And if a tree is on the brink of death, it sometimes bequeaths a substantial share of its carbon to its neighbors.

Although Simard's peers were skeptical and sometimes even disparaging of her early work, they now generally regard her as one of the most rigorous and innovative scientists studying plant communication and behavior. David Janos, co-editor of the scientific journal Mycorrhiza, characterized her published research as "sophisticated, imaginative, cutting-edge." Jason Hoeksema, a University of Mississippi biology professor who has studied mycorrhizal networks, agreed: "I think she has really pushed the field forward." Some of Simard's studies now feature in textbooks and are widely taught in graduate-level classes on forestry and ecology. She was also a key inspiration for a central character in Richard Powers's 2019 Pulitzer Prize-winning novel, "The Overstory": the visionary botanist Patricia Westerford. In May, Knopf will publish Simard's own book, "Finding the Mother Tree," a vivid and compelling memoir of her lifelong quest to prove that "the forest was more than just a collection of trees."

Since Darwin, biologists have emphasized the perspective of the individual. They have stressed the perpetual contest among discrete species, the struggle of each organism to survive and reproduce within a given population and, underlying it all, the single-minded ambitions of selfish genes. Now and then, however, some scientists have advocated, sometimes controversially, for a greater focus on cooperation over self-interest and on the emergent properties of living systems rather than their units.

Suzanne Simard in Nelson, British Columbia, holding a Douglas fir seedling, right. She studies the way trees exchange carbon, water and nutrients through underground networks of fungus.

Before Simard and other ecologists revealed the extent and significance of mycorrhizal networks, foresters typically regarded trees as solitary individuals that competed for space and resources and were otherwise indifferent to one another. Simard and her peers have demonstrated that this framework is far too simplistic. An old-growth forest is neither an assemblage of stoic organisms tolerating one another's presence nor a merciless battle royale: It's a vast, ancient and intricate society. There is conflict in a forest, but there is also negotiation, reciprocity and perhaps even selflessness. The trees, understory plants, fungi and microbes in a forest are so thoroughly connected, communicative and codependent that

some scientists have described them as superorganisms. Recent research suggests that mycorrhizal networks also perfuse prairies, grasslands, chaparral and Arctic tundra — essentially everywhere there is life on land. Together, these symbiotic partners knit Earth's soils into nearly contiguous living networks of unfathomable scale and complexity. "I was taught that you have a tree, and it's out there to find its own way," Simard told me. "It's not how a forest works, though."

In the summer of 2019, I met Simard in Nelson, a small mountain town not far from where she grew up in southern British Columbia. One morning we drove up a winding road to an old-growth forest and began to hike. The first thing I noticed was the aroma. The air was piquant and subtly sweet, like orange peel and cloves. Above our heads, great green plumes filtered the sunlight, which splashed generously onto the forest floor in some places and merely speckled it in others. Gnarled roots laced the trail beneath our feet, diving in and out of the soil like sea serpents. I was so preoccupied with my own experience of the forest that it did not even occur to me to consider how the forest might be experiencing us — until Simard brought it up.

"I think these trees are very perceptive," she said. "Very perceptive of who's growing around them. I'm really interested in whether they perceive us." I asked her to clarify what she meant. Simard explained that trees sense nearby plants and animals and alter their behavior accordingly: The gnashing mandibles of an insect might prompt the production of chemical defenses, for example. Some studies have even suggested that plant roots grow toward the sound of running water and that certain flowering plants sweeten their nectar when they detect a bee's wing beats. "Trees perceive lots of things," Simard said. "So why not us, too?"

I considered the possibility. We'd been walking through this forest for more than an hour. Our sweat glands had been wafting pungent chemical compounds. Our voices and footsteps were sending pressure waves through the air and soil. Our bodies brushed against trunks and displaced branches. Suddenly it seemed entirely plausible that the trees had noticed our presence.

A little farther along the trail, we found a sunny alcove where we stopped to rest and chat, laying our backpacks against a log plush with moss and lichen. A multitude of tiny plants sprouted from the log's green fleece. I asked Simard what they were. She bent her head for a closer look, tucking her frizzy blond hair behind her ears, and called out what she saw: queen's cup, a kind of lily; five-leaved bramble, a type of wild raspberry; and both cedar and hemlock seedlings. As she examined the log, part of it collapsed, revealing the decaying interior. Simard dug deeper with her thumbs, exposing a web of rubbery, mustard-yellow filaments embedded in the wood.

"That's a fungus!" she said. "That is Piloderma. It's a very common mycorrhizal fungus" — one she had encountered and studied many times before in circumstances exactly like these. "This mycorrhizal network is actually linked up to that tree." She gestured toward a nearby hemlock that stood at least a hundred feet tall. "That tree is feeding these seedlings."

The trees, plants, funghi and microbes in forests are so thoroughly connected some scientists describe them as superorganisms. Mycorrhizas in the soil, right, provide the network.

In some of her earliest and most famous experiments, Simard planted mixed groups of young Douglas fir and paper birch trees in forest plots and covered the trees with individual plastic bags. In each plot, she injected the bags surrounding one tree species with radioactive carbon dioxide and the bags covering the other species with a stable carbon isotope — a variant of carbon with an unusual number of neutrons. The trees absorbed the unique forms of carbon through their leaves. Later, she pulverized the trees and analyzed their chemistry to see if any carbon had passed from species to species underground. It had. In the summer, when the smaller Douglas fir trees were generally shaded, carbon mostly flowed from birch to fir. In the fall, when evergreen Douglas fir was still growing and deciduous birch was losing its leaves, the net flow reversed. As her earlier observations of failing Douglas fir had suggested, the two species appeared to depend on each other. No one had ever traced such a dynamic exchange of resources through mycorrhizal networks in the wild. In 1997, part of Simard's thesis was published in the prestigious scientific journal Nature — a rare feat for someone so green. Nature featured her research on its cover with the title "The Wood-Wide Web," a moniker that eventually proliferated through the pages of published studies and popular science writing alike.

In 2002, Simard secured her current professorship at the University of British Columbia, where she continued to study interactions among trees, understory plants and fungi. In collaboration with students and colleagues around the world, she made a series of remarkable discoveries. Mycorrhizal networks were abundant in North America's forests. Most trees were generalists, forming symbioses with dozens to hundreds of fungal species. In one study of six Douglas fir stands measuring about 10,000 square feet each, almost all the trees were connected underground by no more than three degrees of separation; one especially large and old tree was linked to 47 other trees and projected to be connected to at least 250 more; and seedlings that had full access to the fungal network were 26 percent more likely to survive than those that did not.

Depending on the species involved, mycorrhizas supplied trees and other plants with up to 40 percent of the nitrogen they received from the environment and as much as 50 percent of the water they needed to survive. Below ground, trees traded between 10 and 40 percent of the carbon stored in their roots. When Douglas fir seedlings were stripped of their leaves and thus likely to die, they transferred stress signals and a substantial sum of carbon to nearby ponderosa pine, which subsequently accelerated their production of defensive enzymes. Simard also found that denuding a harvested forest of all trees, ferns, herbs and shrubs — a common forestry practice — did not always improve the survival and growth of newly planted trees. In some cases, it was harmful.

When Simard started publishing her provocative studies, some of her peers loudly disapproved. They questioned her novel methodology and disputed her conclusions. Many were perplexed as to why trees of different species would help one another at their own expense — an extraordinary level of altruism that seemed to contradict the core tenets of Darwinian evolution. Soon, most references to her studies were immediately followed by citations of published rebuttals. "A shadow was growing over my work," Simard writes in her book. By searching for hints of interdependence in the forest floor, she had inadvertently provoked one of the oldest and most intense debates in biology: Is cooperation as central to evolution as competition?

Simard is studying whether preserving some older trees in plots that are logged will improve the health of future saplings. Here, 60 percent of veteran trees in the foreground have been retained, while behind them a vast majority have been cut.

The question of whether plants possess some form of sentience or agency has a long and fraught history.

Although plants are obviously alive, they are rooted to the earth and mute, and they rarely move on a relatable time scale; they seem more like passive aspects of the environment than agents within it. Western culture, in particular, often consigns plants to a liminal space between object and organism. It is precisely this ambiguity that makes the possibility of plant intelligence and society so intriguing — and so contentious.

In a 1973 book titled "The Secret Life of Plants," the journalists Peter Tompkins and Christopher Bird claimed that plants had souls, emotions and musical preferences, that they felt pain and psychically absorbed the thoughts of other creatures and that they could track the movement of the planets and predict earthquakes. To make their case, the authors indiscriminately mixed genuine scientific findings with the observations and supposed studies of quacks and mystics. Many scientists lambasted the book as nonsense. Nevertheless, it became a New York Times best seller and inspired cartoons in The New Yorker and Doonesbury. Ever since, botanists have been especially wary of anyone whose claims about plant behavior and communication verge too close to the pseudoscientific.

In most of her published studies, Simard, who considered becoming a writer before she discovered forestry, is careful to use conservative language, but when addressing the public, she embraces metaphor and reverie in a way that makes some scientists uncomfortable. In a TED Talk Simard gave in 2016, she describes "a world of infinite biological pathways," species that are "interdependent like yin and yang" and veteran trees that "send messages of wisdom on to the next generation of seedlings." She calls the oldest, largest and most interconnected trees in a forest "mother trees" — a phrase meant to evoke their capacity to nurture those around them, even when they aren't literally their parents. In her book, she compares mycorrhizal networks to the human brain. And she has spoken openly of her spiritual connection to forests.

Some of the scientists I interviewed worry that Simard's studies do not fully substantiate her boldest claims and that the popular writing related to her work sometimes misrepresents the true nature of plants and forests. For example, in his international best seller, "The Hidden Life of Trees," the forester Peter Wohlleben writes that trees optimally divide nutrients and water among themselves, that they probably enjoy the feeling of fungi merging with their roots and that they even possess "maternal instincts."

"There is value in getting the public excited about all of the amazing mechanisms by which forest ecosystems might be functioning, but sometimes the speculation goes too far," Hoeksema said. "I think it will be really interesting to see how much experimental evidence emerges to support some of the big ideas we have been getting excited about." At this point other researchers have replicated most of Simard's major findings. It's now well accepted that resources travel among trees and other plants connected by mycorrhizal networks. Most ecologists also agree that the amount of carbon exchanged among trees is sufficient to benefit seedlings, as well as older trees that are injured, entirely shaded or severely stressed, but researchers still debate whether shuttled carbon makes a meaningful difference to healthy adult trees. On a more fundamental level, it remains unclear exactly why resources are exchanged among trees in the first place, especially when those trees are not closely related.

In their autobiographies, Charles Darwin and Alfred Russel Wallace each credited Thomas Malthus as a key inspiration for their independent formulations of evolution by natural selection. Malthus's 1798 essay on population helped the naturalists understand that all living creatures were locked into a ceaseless contest for limited natural resources. Darwin was also influenced by Adam Smith, who believed that societal order and efficiency could emerge from competition among inherently selfish individuals in a free market. Similarly, the planet's dazzling diversity of species and their intricate relationships, Darwin would show, emerged from inevitable processes of competition and selection, rather than divine craftsmanship. "Darwin's theory of evolution by natural selection is obviously 19th-century capitalism writ large," wrote the evolutionary biologist Richard Lewontin.

As Darwin well knew, however, ruthless competition was not the only way that organisms interacted. Ants and bees died to protect their colonies. Vampire bats regurgitated blood to prevent one another from starving. Vervet monkeys and prairie dogs cried out to warn their peers of predators, even when doing so put them at risk. At one point Darwin worried that such selflessness would be "fatal" to his theory. In subsequent centuries, as evolutionary biology and genetics matured, scientists converged on a resolution to this paradox: Behavior that appeared to be altruistic was often just another manifestation of selfish genes — a phenomenon known as kin selection. Members of tight-knit social groups typically share large portions of their DNA, so when one individual sacrifices for another, it is still indirectly spreading its own genes.

Kin selection cannot account for the apparent interspecies selflessness of trees, however — a practice that verges on socialism. Some scientists have proposed a familiar alternative explanation: Perhaps what appears to be generosity among trees is actually selfish manipulation by fungi. Descriptions of Simard's work sometimes give the impression that mycorrhizal networks are inert conduits that exist primarily for the mutual benefit of trees, but the thousands of species of fungi that link trees are living creatures with their own drives and needs. If a plant relinquishes carbon to fungi on its roots, why would those fungi passively transmit the carbon to another plant rather than using it for their own purposes? Maybe they don't. Perhaps the fungi exert some control: What looks like one tree donating food to another may be a result of fungi redistributing accumulated resources to promote themselves and their favorite partners.

"Where some scientists see a big cooperative collective, I see reciprocal exploitation," said Toby Kiers, a professor of evolutionary biology at Vrije Universiteit Amsterdam. "Both parties may benefit, but they also constantly struggle to maximize their individual payoff." Kiers is one of several scientists whose recent studies have found that plants and symbiotic fungi reward and punish each other with what are essentially trade deals and embargoes, and that mycorrhizal networks can increase conflict among

plants. In some experiments, fungi have withheld nutrients from stingy plants and strategically diverted phosphorous to resource-poor areas where they can demand high fees from desperate plants.

Several of the ecologists I interviewed agreed that regardless of why and how resources and chemical signals move among the various members of a forest's symbiotic webs, the result is still the same: What one tree produces can feed, inform or rejuvenate another. Such reciprocity does not necessitate universal harmony, but it does undermine the dogma of individualism and temper the view of competition as the primary engine of evolution.

The most radical interpretation of Simard's findings is that a forest behaves "as though it's a single organism," as she says in her TED Talk. Some researchers have proposed that cooperation within or among species can evolve if it helps one population outcompete another — an altruistic forest community outlasting a selfish one, for example. The theory remains unpopular with most biologists, who regard natural selection above the level of the individual to be evolutionarily unstable and exceedingly rare. Recently, however, inspired by research on microbiomes, some scientists have argued that the traditional concept of an individual organism needs rethinking and that multicellular creatures and their symbiotic microbes should be regarded as cohesive units of natural selection. Even if the same exact set of microbial associates is not passed vertically from generation to generation, the functional relationships between an animal or plant species and its entourage of microorganisms persist — much like the mycorrhizal networks in an old-growth forest. Humans are not the only species that inherits the infrastructure of past communities.

Western larches being commercially grown in Procter, British Columbia.

The emerging understanding of trees as social creatures has urgent implications for how we manage forests.

Humans have relied on forests for food, medicine and building materials for many thousands of years. Forests have likewise provided sustenance and shelter for countless species over the eons. But they are important for more profound reasons too. Forests function as some of the planet's vital organs. The colonization of land by plants between 425 and 600 million years ago, and the eventual spread of forests, helped create a breathable atmosphere with the high level of oxygen we continue to enjoy today. Forests suffuse the air with water vapor, fungal spores and chemical compounds that seed clouds, cooling Earth by reflecting sunlight and providing much-needed precipitation to inland areas that might otherwise dry out. Researchers estimate that, collectively, forests store somewhere between 400 and 1,200 gigatons of carbon, potentially exceeding the atmospheric pool.

Crucially, a majority of this carbon resides in forest soils, anchored by networks of symbiotic roots, fungi and microbes. Each year, the world's forests capture more than 24 percent of global carbon

emissions, but deforestation — by destroying and removing trees that would otherwise continue storing carbon — can substantially diminish that effect. When a mature forest is burned or clear-cut, the planet loses an invaluable ecosystem and one of its most effective systems of climate regulation. The razing of an old-growth forest is not just the destruction of magnificent individual trees — it's the collapse of an ancient republic whose interspecies covenant of reciprocation and compromise is essential for the survival of Earth as we've known it.

One bright morning, Simard and I climbed into her truck and drove up a forested mountain to a clearing that had been repeatedly logged. A large tract of bare soil surrounded us, punctuated by tree stumps, saplings and mounds of woody detritus. I asked Simard how old the trees that once stood here might have been. "We can actually figure that out," she said, stooping beside a cleanly cut Douglas fir stump. She began to count growth rings, explaining how the relative thickness reflected changing environmental conditions. A few minutes later, she reached the outermost rings: "102, 103, 104!" She added a few years to account for very early growth. This particular Douglas fir was most likely alive in 1912, the same year that the Titanic sank, Oreos debuted and the mayor of Tokyo gave Washington 3,020 ornamental cherry trees.

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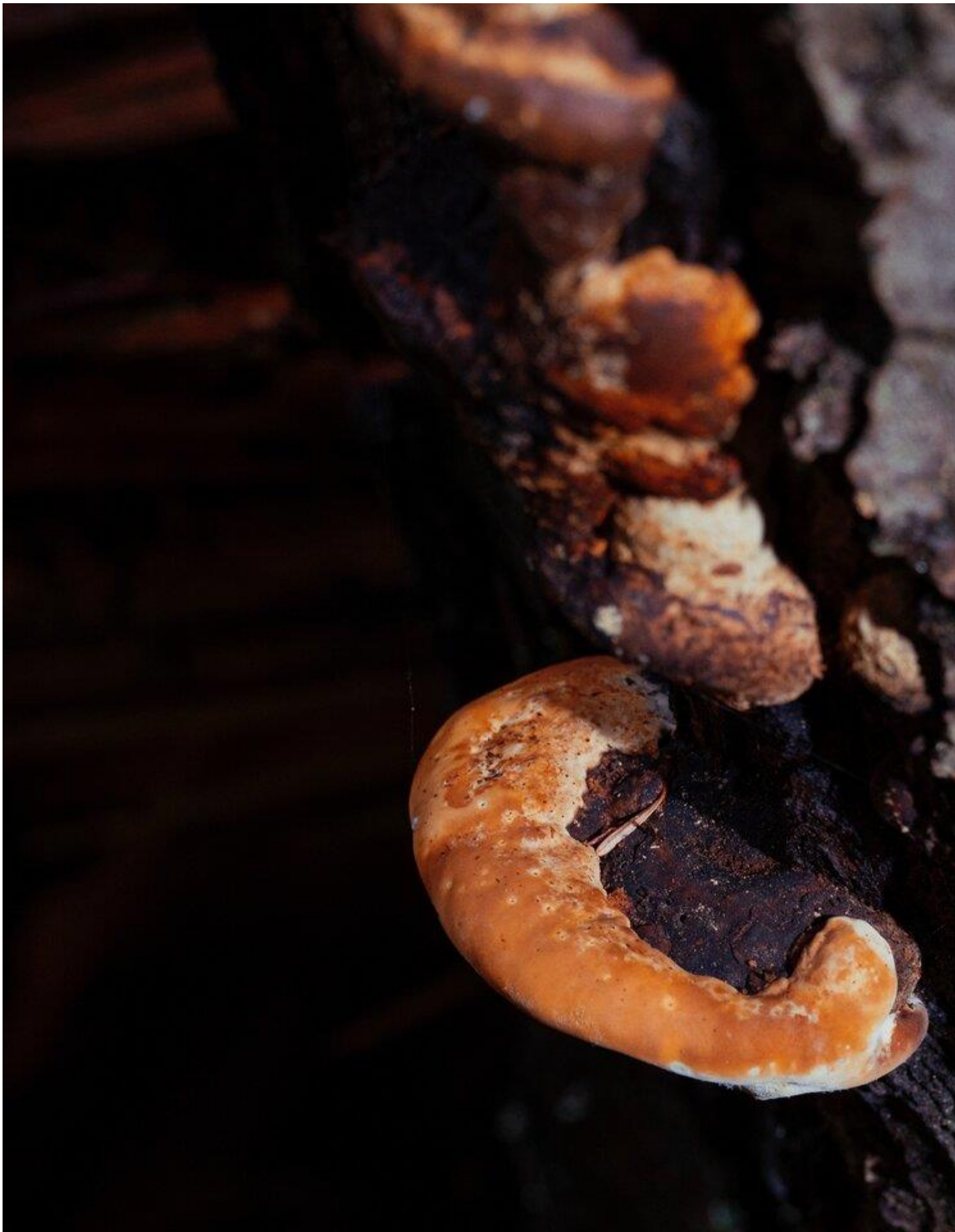

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Mushrooms and conks are the fruiting bodies of fungi. Their underground filaments form networks among the root systems.

Looking at the mountains across the valley, we could see evidence of clearcutting throughout the past century. Dirt roads snaked up and down the incline. Some parts of the slopes were thickly furred with conifers. Others were treeless meadows, sparse shrubland or naked soil strewn with the remnants of sun-bleached trunks and branches. Viewed as a whole, the haphazardly sheared landscape called to mind a dog with mange.

When Europeans arrived on

And though clearcutting is not as common as it once was, it is still practiced on about 40 percent of logged acres in the United States and 80 percent of them in Canada. In a thriving forest, a lush understory captures huge amounts of rainwater, and dense root networks enrich and stabilize the soil. Clearcutting removes these living sponges and disturbs the forest floor, increasing the chances of landslides and floods, stripping the soil of nutrients and potentially releasing stored carbon to the atmosphere. When sediment falls into nearby rivers and streams, it can kill fish and other aquatic creatures and pollute sources of drinking water. The abrupt felling of so many trees also harms and evicts countless species of birds, mammals, reptiles and insects.

Simard's research suggests there is an even more fundamental reason not to deprive America's shores in the 1600s, forests covered one billion acres of the future United States — close to half the total land area. Between 1850 and 1900, U.S. timber production surged to more than 35 billion board feet from five billion. By 1907, nearly a third of the original expanse of forest — more than 260 million acres — was gone. Exploitative practices likewise ravaged Canada's forests throughout the 19th century. As growing cities drew people away from rural and agricultural areas, and lumber companies were forced to replant regions they had logged, trees began to reclaim their former habitats. As of 2012, the United States had more than 760 million forested acres. The age, health and composition of America's forests have changed significantly, however. Although forests now cover 80 percent of the Northeast, for example, less than 1 percent of its old-growth forest remains intact.

a logging site of every single tree. The day after viewing the clear-cuts, we took a cable ferry across Kootenay Lake and drove into the Harrop-Procter Community Forest: nearly 28,000 acres of mountainous terrain populated with Douglas fir, larch, cedar and hemlock. In the early 1900s, much of the forest near the lake was burned to make way for settlements, roads and mining operations. Today the land is managed by a local co-op that practices ecologically informed forestry.

The road up the mountain was rough, dusty and littered with obstacles. "Hold on to your nips and your nuts!" Simard said as she maneuvered her truck out of a ditch and over a series of large branches that jostled us in our seats. Eventually she parked beside a steep slope, climbed out of the driver's seat and began to skitter her way across a seemingly endless jumble of pine needles, stumps and splintered trunks. Simard was so quick and nimble that I had trouble keeping up until we traversed the bulk of the debris and entered a clearing. Most of the ground was barren and brown. Here and there, however, the mast of a century-old Douglas fir rose 150 feet into the air and unfurled its green banners. A line of blue

paint ringed the trunk of every tree still standing. Simard explained that at her behest, Erik Leslie, the Harrop-Procter Forest Manager, marked the oldest, largest and healthiest trees on this site for preservation before it was logged.

When a seed germinates in an old-growth forest, it immediately taps into an extensive underground community of interspecies partnerships. Uniform plantations of young trees planted after a clear-cut are bereft of ancient roots and their symbiotic fungi. The trees in these surrogate forests are much more vulnerable to disease and death because, despite one another's company, they have been orphaned. Simard thinks that retaining some mother trees, which have the most robust and diverse mycorrhizal networks, will substantially improve the health and survival of future seedlings — both those planted by foresters and those that germinate on their own.

For the last several years, Simard has been working with scientists, North American timber companies and several of the First Nations to test this idea. She calls the ongoing experiment the Mother Tree Project. In 27 stands spread across nine different climatic regions in British Columbia, Simard and her collaborators have been comparing traditional clear-cuts with harvested areas that preserve varying ratios of veteran trees: 60 percent, 30 percent or as low as 10 percent — only around eight trees per acre. She directed my attention across Kootenay Lake to the opposing mountains, where there were several more experimental plots. Although they were sparsely vegetated, there was an order to the depilation. It looked as though a giant had meticulously plucked out particular trees one by one.

Since at least the late 1800s, North American foresters have devised and tested dozens of alternatives to standard clearcutting: strip cutting (removing only narrow bands of trees), shelterwood cutting (a multistage process that allows desirable seedlings to establish before most overstory trees are harvested) and the seed-tree method (leaving behind some adult trees to provide future seed), to name a few. These approaches are used throughout Canada and the United States for a variety of ecological reasons, often for the sake of wildlife, but mycorrhizal networks have rarely if ever factored into the reasoning.

Sm'hayetsk Teresa Ryan, a forest ecologist of Tsimshian heritage who completed her graduate studies with Simard, explained that research on mycorrhizal networks, and the forestry practices that follow from it, mirror aboriginal insights and traditions — knowledge that European settlers often dismissed or ignored. "Everything is connected, absolutely everything," she said. "There are many aboriginal groups that will tell you stories about how all the species in the forests are connected, and many will talk about below-ground networks."

Dusky fork moss, left. Powderhorn lichen near Kokanee Glacier Provincial Park in British Columbia, right.

Ryan told me about the 230,000-acre Menominee Forest in northeastern Wisconsin, which has been sustainably harvested for more than 150 years. Sustainability, the Menominee believe, means "thinking in terms of whole systems, with all their interconnections, consequences and feedback loops." They maintain a large, old and diverse growing stock, prioritizing the removal of low-quality and ailing trees over more vigorous ones and allowing trees to age 200 years or more — so they become what Simard might call grandmothers. Ecology, not economics, guides the management of the Menominee Forest, but

it is still highly profitable. Since 1854, more than 2.3 billion board feet have been harvested — nearly twice the volume of the entire forest — yet there is now more standing timber than when logging began. “To many, our forest may seem pristine and untouched,” the Menominee wrote in one report. “In reality, it is one of the most intensively managed tracts of forest in the Lake States.”

On a mid-June afternoon, Simard and I drove 20 minutes outside Nelson to a bowl-shaped valley beneath the Selkirk Mountains, which houses an active ski resort in winter. We met one of her students and his friend, assembled some supplies — shovels, water bottles, bear spray — and started hiking up the scrubby slope toward a population of subalpine conifers. The goal was to characterize mycorrhizas on the roots of whitebark pine, an endangered species that feeds and houses numerous creatures, including grizzly bears, Clark’s nutcracker and Douglas squirrels.

About an hour into our hike, we found one: small and bright-leaved with an ashen trunk. Simard and her assistants knelt by its base and began using shovels and knives to expose its roots. The work was slow, tiring and messy. Mosquitoes and gnats relentlessly swarmed our limbs and necks. I craned over their shoulders, trying to get a better look, but for a long time there was not much to see. As the work progressed, however, the roots became darker, finer and more fragile. Suddenly Simard uncovered a gossamer web of tiny white threads embedded in the soil.

“Ho!” she cried out, grinning broadly. “It’s a [expletive] gold mine! Holy [expletive]!” It was the most excited I’d seen her the whole trip. “Sorry, I shouldn’t swear,” she added in a whisper. “Professors are not supposed to swear.”

“Is that a mycorrhiza?” I asked.

“It’s a mycorrhizal network!” she answered, laughing with delight. “So cool, heh? Here’s a mycorrhizal tip for sure.”

She handed me a thin strip of root the length of a pencil from which sprouted numerous rootlets still woolly with dirt. The rootlets branched into even thinner filaments. As I strained to see the fine details, I realized that the very tips of the smallest fibers looked as though they’d been capped with bits of wax. Those gummy white nodules, Simard explained, were mycorrhizal fungi that had colonized the pine’s roots. They were the hubs from which root and fungus cast their intertwined cables through the soil, opening channels for trade and communication, linking individual trees into federations. This was the very fabric of the forest — the foundation of some of the most populous and complex societies on Earth.

Trees have always been symbols of connection. In Mesoamerican mythology, an immense tree grows at the center of the universe, stretching its roots into the underworld and cradling earth and heaven in its trunk and branches. Norse cosmology features a similar tree called Yggdrasil. A popular Japanese Noh drama tells of wedded pines that are eternally bonded despite being separated by a great distance. Even before Darwin, naturalists used treelike diagrams to represent the lineages of different species. Yet for most of recorded history, living trees kept an astonishing secret: Their celebrated connectivity was more than metaphor — it had a material reality. As I knelt beneath that whitebark pine, staring at its root tips, it occurred to me that my whole life I had never really understood what a tree was. At best I’d been aware of just one half of a creature that appeared to be self-contained but was in fact legion — a chimera of bewildering proportions.

We, too, are composite creatures.

Diverse microbial communities inhabit our bodies, modulating our immune systems and helping us digest certain foods. The energy-producing organelles in our cells known as mitochondria were once free-swimming bacteria that were subsumed early in the evolution of multicellular life. Through a process called horizontal gene transfer, fungi, plants and animals — including humans — have continuously exchanged DNA with bacteria and viruses. From its skin, fur or bark right down to its genome, any multicellular creature is an amalgam of other life-forms. Wherever living things emerge, they find one another, mingle and meld.

Five hundred million years ago, as both plants and fungi continued oozing out of the sea and onto land, they encountered wide expanses of barren rock and impoverished soil. Plants could spin sunlight into sugar for energy, but they had trouble extracting mineral nutrients from the earth. Fungi were in the opposite predicament. Had they remained separate, their early attempts at colonization might have faltered or failed. Instead, these two castaways — members of entirely different kingdoms of life — formed an intimate partnership. Together they spread across the continents, transformed rock into rich soil and filled the atmosphere with oxygen.

Eventually, different types of plants and fungi evolved more specialized symbioses. Forests expanded and diversified, both above- and below ground. What one tree produced was no longer confined to itself and its symbiotic partners. Shuttled through buried networks of root and fungus, the water, food and information in a forest began traveling greater distances and in more complex patterns than ever before. Over the eons, through the compounded effects of symbiosis and coevolution, forests developed a kind of circulatory system. Trees and fungi were once small, unacquainted ocean expats, still slick with seawater, searching for new opportunities. Together, they became a collective life form of unprecedented might and magnanimity.

After a few hours of digging up roots and collecting samples, we began to hike back down the valley. In the distance, the granite peaks of the Selkirks bristled with clusters of conifers. A breeze flung the scent of pine toward us. To our right, a furtive squirrel buried something in the dirt and dashed off. Like a seed waiting for the right conditions, a passage from “The Overstory” suddenly sprouted in my consciousness: “There are no individuals. There aren’t even separate species. Everything in the forest is the forest.”

Ferris Jabr is a contributing writer for the magazine. His previous cover story on the evolution of beauty is featured in the latest edition of “The Best American Science and Nature Writing.” He is currently working on his first book, which explores how living creatures have continually transformed Earth throughout its history.

Brendan George Ko is a visual storyteller based in Toronto and Maui who works in photography, video and installation. His first art book, “Moemoea,” about traditional voyaging in the Pacific, will be published next year by Conveyor Editions.

ARE WE SAFER FROM COVID THAN THE AVERAGE PERSON ? MAYBE

So as far as we know we mycophiles are all still alive and kicking in a pandemic which has taken far too many. One of the many benefits of consuming mushrooms is their anti-viral properties. It is not unreasonable to suggest that they may have the ability to combat COVID. The following journal article which I got off PubMed and have ruthlessly pared down (it gets very technical), explores that topic.

The Antiviral, Anti-Inflammatory Effects of Natural Medicinal Herbs and Mushrooms and SARS-CoV-2 Infection

Fanila Shahzad, Diana Anderson, and Mojgan Najafzadeh* Journal of Nutrients

Abstract

The 2019 novel coronavirus, SARS-CoV-2, producing the disease COVID-19 is a pathogenic virus that targets mostly the human respiratory system and also other organs. SARS-CoV-2 is a new strain that has not been previously identified in humans, however there have been previous outbreaks of different versions of the beta coronavirus including severe acute respiratory syndrome (SARS-CoV1) from 2002 to 2003 and the most recent Middle East respiratory syndrome (MERS-CoV) which was first identified in 2012. All of the above have been recognized as major pathogens that are a great threat to public health and global economies. Currently, no specific treatment for SARS-CoV-2 infection has been identified; however, certain drugs have shown apparent efficacy in viral inhibition of the disease. Natural substances such as herbs and mushrooms have previously demonstrated both great antiviral and anti-inflammatory activity. Thus, the possibilities of natural substances as effective treatments against COVID-19 may seem promising. One of the potential candidates against the SARS-CoV-2 virus may be *Inonotus obliquus* (IO), also known as chaga mushroom. IO commonly grows in Asia, Europe and North America and is widely used as a raw material in various medical conditions. In this review, we have evaluated the most effective herbs and mushrooms, in terms of the antiviral and anti-inflammatory effects which have been assessed in laboratory conditions.

Previous research has shown that bioactive components and extracts derived from mushrooms exhibit strong anticancer activities. In addition, extracts from mushrooms have also been shown to display antibacterial, antiviral, anti-inflammatory, antiatherogenic and hepatoprotective effects. Thus,

mushrooms have a great potential for use as successful antiviral treatments with a reduced chance of adverse side effects.

A study conducted in 2018, determined the structural characterization of lentinan from *Lentinus edodes* mycelia (shiitake) as well as looking at the antiviral activity against infectious hematopoietic necrosis virus (IHNV)

Overall, the results indicate the antiviral activity of LNT-1 and its regulation of the innate immune response. As previously said, the innate immune response is a critical factor for COVID-19 disease severity and disease outcome

Another species of mushroom that has shown promising antiviral effects is *Grifola frondosa,* (hen-of-the-woods, ram's head and sheep's head) a species of *Basidiomycotina.*

In a study, the effects of GF-D were analyzed on 35 HIV-infected patients, 85% of patients reported an increase in sense of wellbeing with regard to symptoms and also secondary diseases that are linked to HIV, further suggesting the positive impact this extract can have against viral disease.

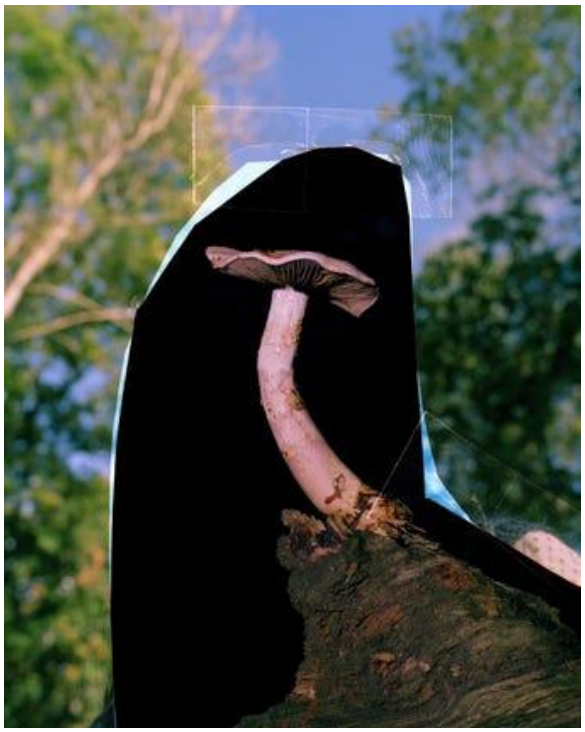
A potential candidate against the SARS-COV-2 virus may be *Inonotus obliquus* (IO), also known as the chaga mushroom. Chronic inflammation is the underlying pathogenesis of a series of diseases. *Inonotus obliquus* polysaccharides (*IOP)* were shown to alleviate inflammatory responses. As *IOP*s have shown promising results in treating various viral diseases, the effect of this mushroom in COVID-19 infection could prove to be beneficial. With the current pandemic, many scientists have rushed to the development of a potential vaccine and therapeutic agent that is effective against COVID-19; however, herbal agents should not be overlooked. The data presented in this review show the promising effects many herbs and mushrooms have against a variety of viral infections. This review has highlighted the therapeutic potential of *Inonotus obliquus* as a natural antiviral treatment against SARS-COV-2.

Refinery 29 is a very hip operation I've had the pleasure of dealing with for one of the charities I represent. I think you'll enjoy this article they posted.

Why You're Suddenly Seeing Mushrooms Everywhere

Sadhbh O'Sullivan

Mushrooms are everywhere you look right now.
There's mushroom life drawing and mushroom-focused supper clubs; a growing fetish for 18th century mushroom illustrations; mushroom adaptogenic teas, mushroom skincare and fashionable foraging. There is currently even a free exhibition at Somerset House dedicated to fungi-inspired art and design, which culminates in a shop full of mushroom paraphernalia and the opportunity to enjoy a mini mushroom facial from skincare brand Origins. Mushroom fever doesn't stop there; the psychedelic properties of some species are a legitimate area of interest for scientists working out how to treat a range of mental health issues.



Photographed by Luke & Nik for Refinery29

The thing is, mushrooms have always been here and people have always been fascinated by them. We share an evolutionary history; in fact, scientists say mushrooms have more DNA in common with humans than with plants. Without fungi there would be no trees (they can't grow without them) and no antibiotics. Before restaurants worked out there was more to feeding non-meat-eaters than marinating a portobello, no mushrooms would have meant no 'veggie' burgers, too.

The history of humankind is dramatically interwoven with the history of mushrooms and the West is *finally* waking up to them, thanks to the looming climate crisis and unstoppable rise of the wellness industry. 2020 is on its way to being the year we catch up with the rest of the world's fondness for fungi.

In 1957, Robert Gordon Wasson published an article in *Life* magazine in the US titled "Seeking The Magic Mushroom". In it, the former banker chronicles his visits to a remote Mexican village where he first encountered the ritual of consuming mushrooms for their psychedelic effects. While Wasson was hardly the first to discover these effects, and the whole piece is a particularly '50s example of tone-deaf cultural tourism, he is credited with bringing the idea of mushrooms as more than just a vegetable to the minds of the Western world. It led Wasson to write his book, *Mushrooms, Russia and History*, where he described how the world as he sees it falls into two distinct cultures: mycophobic (mushroom phobic) and mycophilic (mushroom loving).

In the UK we live in a mycophobic culture. This is not to say that we avoid mushrooms at all costs: we happily eat the agaricus genus (the common button mushroom, of which white, brown, cremini and portobello are all forms) but beyond certain contexts, most mushrooms have retained an aura of mystery and even disgust. This is diametrically opposed to the reverence for mushrooms in mycophilic cultures like Russia and plenty of countries throughout Asia, where people not only consume a much wider variety of mushrooms and see them as medicinally important, but hunt them as a national sport and even use them to adorn Christmas trees.

According to Francesca Gavin, the curator of the Somerset House exhibition, mushrooms have always been seen as "something witchy, something darker, something that's about decay." She points to the scene in *Alice's Adventures In Wonderland* (published in 1865) where Alice comes across a caterpillar atop a giant mushroom as a "gateway moment" for mushrooms beginning to be seen as something strange but friendly in our society, reflecting the rise of amateur botany which started in the 18th century.

Francesca believes it is an attempt to fix our technology-driven dissociation from the natural world – see "forest bathing" and the millennial houseplant obsession – that's driving us to look at mushrooms now. "I think mushrooms are a really fun, weird, strange reminder of a) how interesting nature is but also b) how [it] will always force [itself] back into the culture... Your brain [is] essentially connected to it."

Our impulse to re-engage with the natural world around us is both aesthetically nostalgic (as with the botanist illustrations) and forward-thinking as urgency grows to tackle the impending climate crisis. "We're so conscious of the disaster we're making of the world [that] I think mushrooms are being looked at almost as a kind of saviour, or a metaphor," Francesca tells me. "Mushrooms cover both the poetic and the practical."

Some of the pieces in the exhibition focus on the possibility that can be found in mushrooms in the face of environmental disaster. Artist Jae Rhim Lee, for instance, has created a decomposable mushroom burial suit, designed to combat the ecological impact of burying someone. On a less sombre note, Kristel Peters explores the possibility of using mycelium to create sustainable shoes.

Sebastian Cox & Ninela Ivanova, Mycelium + Timber © Petr Krejci Photography

Mycelium is the main part of the mushroom organism (think of the actual mushroom like an apple fruiting off a tree) and is a white thready network of filaments beneath the forest floor. It's sometimes called the Wood Wide Web and is currently being explored for its potential as a sustainable material. There is already moulded packaging, which is 100% compostable at home, made from mycelium and the agricultural byproduct of hemp. On the fashion side, Mycoworks is an LA-based brand making leather with Reishi, a high quality material made of fine mycelium that is neither animal nor plastic. Since our interest in buying things (especially clothes) shows little sign of abating, mushrooms are providing the building blocks for less wasteful consumption.

Mushrooms are also a sustainable food source, especially when grown within the UK. According to the Mushroom Miles Report, the growth and harvesting of mushrooms is not only a recyclable farming process but important for environmental sustainability: "While green plants sustain life on the planet, microorganisms, especially fungi [mushrooms] play a vital role in recycling organic matter produced by the green plants on earth." The same report states that 75% of retail mushrooms are supplied within the 'green zone' of under 12 hours and fewer than 400 miles transit. Given that 62% of us are making an effort to reduce food miles, mushrooms are a natural choice. They are also one of the few dietary sources, besides oily fish, of vitamin D.

However, these health and environmental benefits only go some way to explaining the revived interest in mushrooms; in wellness terms, we must look further afield to understand the more radical health claims being made.

Mushrooms have long been consumed for their medicinal benefits in mycophilic cultures. They play a great part in traditional Chinese medicine and have a strong presence in the wellness space, with new and left-field brands selling teas, powders and capsules that boast of mushrooms' curative properties. The claims range from boosting our immune system to helping defend against cancer.

Dr Andrew Weil is a pioneer in the field of integrative medicine and one of the leading proponents of mushrooms' health and medicinal benefits in the English-speaking world. At a seminar delivered in conjunction with Origins Skincare (with whom he collaborated on the Mega-Mushroom range), he outlines his work as taking a holistic look at the many different ways we could support our bodies beyond what a GP might prescribe. Crucially, he doesn't propose *rejecting* Western medicine but using holistic and conventional treatments in conjunction.

Graham Little, ‘Untitled (Wood)’ 2019, courtesy of Alison Jacques Gallery, London

He points to several mushrooms which are of special interest to the integrative medicine community. Mushrooms from the polypore family are very important, he says, as they "increase immune resistance to viral and bacterial infection, and also increase our defenses against cancer." Turkey tail, reishi, birch and shelf or bracket fungi have long been consumed for their immune-boosting effects in traditional medicine, either eaten or boiled into teas if they’re too woody or bitter to eat.
Turkey tail is one of the best researched mushrooms and studies suggest that a component of turkey tail, polysaccharide-K (PSK), may stimulate the immune system. Further evidence of mushrooms' benefits comes from a 2017 study which found that they contain unusually high amounts of the antioxidants

ergothioneine and glutathione. Antioxidants protect cells from damage associated with illnesses such as cancer, heart disease and Alzheimer's.
The divide between traditional and current medicine over medicinal mushrooms is false. Penicillin is derived from fungi. Statins, which thin the blood and lower cholesterol, have their origins in fungi. And you only have to look at the strong psychoactive effects of psilocybes (so-called magic mushrooms) to recognise the biochemical impacts of fungi and the potent power that might be found through further research. However, current evidence is still lacking for many of these claims as research has not gone beyond test tube or animal studies.

Hamish Pearch, 'Cochlea Brick Tuft', courtesy of the artist

Depending on how you feel about wellness fads, the validity of mushrooms as a medicine is easy to embrace or dismiss. I fall more on the sceptical side, but I'm mindful of what is at the root of my scepticism: is it from seeing too many fads come and go (hi CBD oil) which seem to have only placebo effects? Or is it rooted in a subconscious belief that anything not sanctified by Western medicine must be a con? It's probably a mixture of both. There is some compelling evidence and a long history to

suggest that mushrooms shouldn't be rejected out of hand. Yet while there seems to be limited harm in consuming mushrooms for their claimed wellness benefits, taking them to 'cure cancer' is far from a good idea if you forgo other treatments. It is always wise to be mindful of hyperbolic claims and think about where you are getting these mushrooms from. With every new health or wellness interest comes a flurry of related products, often with little to no evidence to support their claims.
A quick trip to the Somerset House exhibition will be enough to convince you that mushrooms, the strange fleshy growths that sprout from rotting trees, hold within them the mystery of nature we've lost in the modern world.
Where once we may have fled from that mystery into the arms of sterilised certainty, it makes sense to want to return to the earth, to find roots in an increasingly chaotic world. It's compelling to think that the answer to so many of our woes has been growing below us, untouched by our worries.

> We mycophiles seem to have captured the interest of the NY Times Magazine. Here's another recent article.

Mushrooms, the Last Survivors

Neither plant nor animal, mushrooms have confounded humans since ancient times. Now, they're a reminder of our tenuous place in an uncertain world.

. By Ligaya Mishan

- Sept. 18, 2020

The mushrooms sit on high, behind glass, above bottles of Armagnac and mezcal in a bar at the Standard hotel in Manhattan's East Village. They are barely recognizable at first, just eerie silhouettes resembling coral growths in an aquarium, blooming in laboratory-teal light: tightly branched clusters of oyster mushrooms in hot pink, yolk yellow and bruise blue, alongside lion's mane mushrooms, shaggy white globes with spines like trailing hair.

This isn't décor, or only incidentally so; the 15-foot-long shelf is a miniature farm, installed by the New York-based start-up Smallhold as part of a larger, sprawling system made up of remote-controlled nodes at restaurants and grocery stores across the city, each producing from 30 to 100 pounds of mushrooms a week. Thousands of data points — on temperature, humidity, airflow — are transmitted daily to the company's headquarters, to be recalibrated across the network as needed. At the Standard, where the crop goes into plates of chilaquiles and mushroom-infused bourbon cocktails, diners might stop midbite, look up and take note of their meal's origins a few feet away. It's a glimpse of the future of agriculture, further collapsing the distance between diner and ingredients, doing away with the cost and waste of packaging and transportation in hopes of alleviating pressure on an overtaxed environment.

The T List: A weekly roundup of what the editors of T Magazine are noticing and coveting right now.

Still, the solemnity of the vitrines suggests a more complicated story, framing the mushrooms as art or sacred relics — or, in this high-design environment, luxury merchandise. The market for edible fungi is projected to reach $69 billion worldwide by 2024, the biologist Merlin Sheldrake notes in "Entangled Life: How Fungi Make Our Worlds, Change Our Minds and Shape Our Futures," published this past spring. In the United States, the boom may be credited in part to the beginnings of a shift toward less meat-heavy diets but also to the broadening of the American palate to embrace the Japanese notion of umami, the flavor beyond flavor: rich, carnal and briny at once, hinting at some dark ripening beneath the earth or sea. For decades, diminutive button mushrooms — pallid and "bred for the back of a truck," as Andrew Carter, the chief executive officer of Smallhold, describes them — have dominated American sales; now, meatier species like shiitakes, hen of the woods and wild matsutakes are increasingly finding a place on the table. (That is, if you can afford them: Prices for foraged Japanese matsutakes, which grow in pine forests and, like truffles, have thus far resisted attempts at commercial cultivation, hit $395 per pound in Tokyo last September.)

In the East, mushrooms have always been prized, but only recently have they become objects of fascination in the West. Some manifestations of this are merely aesthetic, like the glossy magic-mushroom handbag in the fall 2020 Kate Spade collection or the New York jeweler Brent Neale Winston's trippy pendants, evoking childhood nostalgia with a wink. On a more serious note, the increasing costs of health care and an erosion of faith in the medical-industrial complex have driven greater numbers of people to homeopathy, itself a multibillion-dollar industry, one in which fungi are promoted as aphrodisiacs and immunity boosters — the latter more urgent in our new age of Covid-19. Traces of so-called functional (i.e., medicinal) mushrooms already suffuse the likes of high-end skin care (to soothe and brighten) and coffee (to tamp the jitters brought on by caffeine); now, amid fears of contagion, demand for over-the-counter vitamins and dietary supplements has spiked, and sales of capsule forms of shiitakes, cordyceps and turkey tails may well rise, although there is no scientific evidence to suggest that they offer any protection against the coronavirus. Psilocybin mushrooms, illegal in America, have been touted as a treatment for anxiety and depression, both conditions likely to be exacerbated by our current crisis. At the same time, they, too, have become status symbols, co-opted by capitalism, stocked in the bathroom cabinet and taken in microdoses — no longer a conduit to the divine but simply an enhancement of creativity and productivity, shoring up the very structures and systems that, in the countercultural era of the 1960s, hallucinogens were supposed to help dismantle.

As mushrooms proliferate — symbolically and literally — in the worlds of fashion, art and technology, so do our interpretations of what they represent. This risks turning them into nothing more than commodities and hollow signifiers, projections of our anxieties and desires. Yet however we try to explain and exploit these organisms, they continue to confound and resist us.

Brent Neale's Magic Mushroom Pendant in 18k yellow gold with tiger's eye, amethyst and sapphires.Credit...Matthew Novak

To the ancient Egyptians, mushrooms were totems of immortality, reserved for the plates of pharaohs and their kin; to the Indigenous Mazatecs of southern Mexico, they are "holy children," speaking through the mystics who eat them. A few scholars have suggested that the prototype for Santa Claus can be traced back to the healing rituals of Sami shamans near the Arctic Circle, who, fueled by the psychotropic red-and-white-capped Amanita muscaria, "flew" across the snow in their reindeer-drawn sleighs — supposedly the animals ate the mushrooms, too. The British philologist John Marco Allegro went so far as to argue in a controversial 1970 book that Christianity arose from a mushroom-worshipping cult, with Amanita muscaria, not the proverbial apple, as the fruit of the tree of knowledge of good and evil.

As emissaries from the underworld and creatures of the in-between, even ordinary, nonhallucinogenic mushrooms defy the binaries we often use to organize the universe. Among the known species — around 14,000, with possibly another 150,000 yet to be named or described — there is no fixed shape: Beyond the archetypal umbrella, mushrooms take on a panoply of profiles, from woolly trumpets and shaggy beards to fascinator veils and black-tipped cigarettes. Some glow in the dark. Lacking chlorophyll and a vascular system, they are unclassifiable as plants, despite their historic inclusion in the

study of botany. Nor are they animals, although the fungi and animal kingdoms share a common ancestor dating back somewhere between 650 million and 1.5 billion years.

There is something uncanny, too, about the speed with which they appear. In the wild, mushrooms emerge practically overnight, en masse, a sudden army out of nothing. Such innocents they seem, so close to the ground, fit to shelter only ants and fairies. But they are neither tiny nor powerless: Beneath those charming buttons and listing stalks grow the skinny filaments that make up the mycelium, the vegetative part of the fungus, branching and spreading in a great cobweb inside the earth. According to the mycologist Paul Stamets, based in Olympia, Wash., more than eight miles of mycelium can twist through a single cubic inch of soil. In West Africa, mushrooms have been measured with caps more than three feet in diameter, but the largest fungus on record (and the largest living organism by area) is the mostly invisible Armillaria ostoyae in Oregon's Malheur National Forest, whose mycelium spans more than 2,300 acres, announcing its presence above ground in scattered clusters of pale little parasols — each capable of shedding 30,000 spores per second, each carrying within it a future colony. A mushroom is an iceberg.

From left: clusters of royal trumpet, yellow oyster and pink oyster mushrooms rising from a bed of moss, with blue oyster and lion's mane mushrooms in the foreground.Credit...Mari Maeda and Yuji Oboshi

Today, those microscopic strands are being repurposed as biodegradable textiles like the Dutch designer Aniela Hoitink's 3-D-molded MycoTEX, so malleable it requires neither scissors nor needles, and Reishi, developed by the San Francisco-based company MycoWorks and is as buttery as leather. Mycelium can be made into bricks, too, suggesting the possibility of architecture with a minimal ecological footprint: The artist Philip Ross, one of MycoWorks' founders, once built a teahouse out of mushroom materials for an art exhibition, then boiled the bricks to make tea for viewers. The idea that fungi could be ecological saviors — some species are capable of breaking down plastics, petrochemicals and toxic waste, filtering streams and even absorbing radiation — ran through "Mushrooms: The Art, Design and Future of Fungi," an exhibition mounted earlier this year at the Somerset House in London. Francesca Gavin, the curator, juxtaposed mycelium shoes and lampshades with the British artist Hamish Pearch's sculptures of mushrooms sprouting out of charred-black toast and the South Korea-born artist Jae Rhim Lee's Infinity Burial Suit, a death shroud reimagined as pajamas and suffused with mushroom spores to hasten decomposition and break down the toxins our bodies absorb over the course of our lives so they're not returned into the earth.

"I think humans take for granted how much work is done by other organisms to make the world livable," says the Minnesota-based artist Liz Sexton, whose work includes hyper-realistic mushrooms fashioned out of papier-mâché, part of a larger project to recreate wildlife in urban habitats as a way of underscoring our displacement of and alienation from the natural world. Mushrooms, she says, "remind us that we're hardly at the center of it all." Lee's burial suit inverts the traditional relationship of humans and mushrooms: Instead of feeding on them, we are the food. She's gone so far as to train a special cadre of mushrooms to recognize her body, feeding it her cut fingernails and sloughed-off skin in hopes that they'll make quicker work of her eventual corpse as a result. It's her way of accepting responsibility for contributing to the environmental crisis — what Gavin calls "the mess we have made" — but also a

realignment of how we perceive the inevitability of death, as something to be accepted rather than feared, and of the hierarchy of the world, in which we are not the masters or even stewards of nature but simply part of it.

A spread from Phyllis Ma's "Mushrooms & Friends 2" featuring a closeup of *Daedaleopsis confragosa* (left), found in upstate New York, and *Lepista nuda* (right), commonly known as "blewit," found in Berlin.Credit...Phyllis Ma

Mushrooms were once spurned in the West for their associations with rot. The entry on them in the magisterial 18th-century French Encyclopédie declares that no amount of cooking could redeem them and advises sending them "back to the dung heap where they are born." In fact, the dung heap may be where they do their best work; as the Portland, Ore.-based mycologist Peter McCoy notes in the 2015 documentary short film "Fungiphilia Rising" (directed by Madison McClintock), fungi are "nature's alchemists," playing an essential role in transmuting decay into nutrients and keeping entire woodlands alive. Those nutrients are sent in multiple directions over acres of land via the mycelium, which Stamets has called "Earth's natural internet" and others describe as the Wood Wide Web. This living network has uncanny similarities to latter-day technologies like blockchain, but for mushroom advocates like McCoy, who founded the grass-roots organization Radical Mycology with the naturalist Maya Elson in 2006, it has philosophical implications as well: no less than the restructuring and rehabilitation of society itself.

Larry Millman's latest book is here courtesy of Princeton University Press. At a price of $12.50 for a Kindle version (I plan to also buy a paper copy for his eventual autograph of course), it's a real bargain. The book is an alphabetical order grouping of short dissertations on anything fungal related that Larry finds worthy of discussion. (In the "A's" you have Agaricon, Artist's Conk and Alice in Wonderland) Of the three reviews they use in the book's advertising Eugenia Bone hit it on the head (as usual) calling it "Millman's witty, wry and wonky compendium of all things fungal. I take slight issue with the other two reviews which each call it "useful". That might lead you to believe that it is the "Encyclopedia Britannica" of the study of fungi. At 184 pages that would be an impossible task to accomplish and it isn't intended to do that. It's just fun. Not to say it isn't informative, the book is very much so and you will go away from it thinking "wow I didn't know that" every few pages. What it would definitely be useful for, is for anyone preparing a talk on fungi for a non-myco group (like I do with my Boy Scouts) because it gives you quick bites of tasty facts. Otherwise just read it for pleasure knowing that Larry will instruct you, inform you but above all else entertain you.

So I got this Williams Sonoma "Agrarian" Shitake Log for Christmas. After I opened the box, I looked down my nose and declared "this must be an outdoors kit because you can't grow shitake indoors." Once again proving "what the hell do I know?" Having earlier turned my basement into a laboratory set for "Breaking Bad" while only managing to grow all manner of yukky molds in my substrate (the home Kombucha Kit was likewise a gloppy disappointment). I am more than ready to try out this relatively foolproof log. This is what they say:

"Savor the rich, meaty flavor and delicate texture of homegrown shiitake mushrooms. Grow them indoors or outdoors with little effort and no mess using our hand-cut hardwood log, which is

inoculated with spores that produce a crop of organic shiitake mushrooms every two to three months for possibly two to three years. Simply soak the log in water to start the growing process, and you'll be ready to harvest in just a few weeks. Shiitake mushrooms are delicious in everything from stir-fries and soups to pasta dishes and stews."

AND NOW FOR SOMETHING COMPLETELY DIFFERENT

As you may have noticed there is a little cabal that formed consisting of myself, Lou, Vito and Ksousha. She calls it our "rat pack". We came together out of a love for good walks, good food and the occasional adult beverage (I know I just described all of COMA but maybe more so). In the downtime caused by the pandemic and in our normal off-season between the last hen and the first morel we stay in contact and try to find reasons to get outside in the fresh air. Lou brought up a fascinating curiosity that I was aware of but may not be known to the rest of the club. In the area where we frequently do walks, that being Putnam County and upper Westchester there are more than 100 "stone chambers". These mysterious structures (picture a stone igloo built into a hillside) were here when the first settlers arrived. The local native Americans did not build in stone and nobody knows for sure who built them, but some suggest Vikings or Druids who crossed the Atlantic centuries before Columbus. Each structure is roofed by a single slab of stone weighing many tons and in each chamber there is buried a magnetic lodestone such that a compass brought into the chamber spins in lazy circles.

Lou raised an interesting fact. These chambers are aligned so that the rising sun's rays on the Winter Solstice penetrate directly to the back wall of the chamber (sort of like in Raiders of the Lost Ark). Weird but true. He proposed a viewing and while I couldn't attend, Ksousha was predictably game and so they went out on December 21 (the Winter Solstice-shortest day of the year). Unfortunately it was overcast so no light show but Ksousha went into a chamber barefoot (of course she did) and reports that she could sense the energy hiding within.

For those who are curious, there is a large and easily accessed chamber right on Route 301 (literally ten feet off the road) a couple of miles past our old foraging favorite Fahnestock Park's Pelton Pond close to the intersection of Route 301 with Farmers Mills Road.

A typical stone chamber greets the Winter Solstice

NEWS FROM THE MUSHROOM FRONT

COMA now has Zoom Coordinators, Nicole and Jan Zahour and a Science Officer, our longtime member Zaac Chaves . We also have a new Webmaster (our longtime member, Alex Krupp), and COMA News Editor (new member Lindy Lipka).

In his latest edition of MUSHROOM The Journal of Wild Mushrooming (a truly excellent journal rivaling all other similar publications) our friend Leon Shernoff reports that he was very ill this past year, possibly from COVID and struggled to find the time and energy to publish his quality product. Still he did so and he is also launching a "Fungal Data System" to simplify mushroom identification. Supposedly there is a demo on the Mushroom Journal website although I couldn't find it. Leon we wish you much success.

COMA officers and committee members are:

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Science Officer	Zaac Chaves
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Zoom Coordinators	Nicole & Jan Zahour
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