THE MYSTERIOUS EXISTENCE OF A LEAFLESS KAURI STUMP, KEPT ALIVE BY ITS FOREST NEIGHBORS
Sebastian Leuzinger & Martin Karl-Friedrich Bader

Plants use their leaves to make food from the sun’s energy and carbon dioxide. With very few exceptions of parasitic plants, no tree is known to grow without green foliage—or to be more precise, no tree can start life without leaves or some sort of green tissue containing chlorophyll.

But some may end up as “zombie trees” long after they lose all leaves and large parts of their trunk, either to disease or to the chainsaw.

Such undead tree stumps have been observed for almost 200 years, but the evolutionary and physiological processes leading to their existence remain a mystery. One reason is because they are rare. Another is because whatever happens on their journey from feeding themselves to being fed happens out of sight—likely below ground.

American forest ecologist Suzanne Simard has shown that trees send each other signals through a network of fungi buried among their roots. This underground communication includes warning signals about environmental change and the transfer of nutrients to neighboring trees before they die.

We suggest this supply can continue beyond the apparent death of an individual tree. By measuring water flow in the stem of a living kauri (Agathis australis) stump and its neighboring trees, we show underground connections are indeed likely responsible for the survival of the stump.

A living tree stump is clearly a biological oddity, and our key question is why such root grafts form.

Who Profits?

It is unlikely a tree that has lost its foliage (through wind-throw, disease, or when it is felled) subsequently knocks on its neighbors’ door (or, more accurately, roots) to ask for carbohydrates. Instead, we must assume that these root connections had been in place earlier, while the stump was still a normal tree.

If that is the case, we can assume root grafting to be the rule rather than the exception, at least in species in which living stumps have been observed. But what are the evolutionary advantages? And why are the connections maintained when a leafless stump is no longer actively contributing resources?

cont. on page 3

FUNGUS CREATES FAKE FRAGRANT FLOWERS TO FOOL BEES
https://www.theguardian.com/, Feb. 17, 2021

Fungi have been discovered making fake flowers that look and even smell like the real thing, fooling bees and other pollinating insects into visiting them.

The fungus Fusarium xyrophilum infects the beautiful yellow-eyed grasses of Xyris species from Guyana in South America. The fungus stops the plant making its flowers and then hijacks the plant’s reproductive system to create its own forgeries made entirely of fungal tissue.

The fake flowers are a similar size and shape with petal-like features that reflect ultraviolet light to attract pollinators, especially bees. The phony flowers even use fragrances to make themselves even more attractive.

The fraud is so convincing the bees and other pollinators visit them, expecting to get rewarded with nectar and pollen but instead become coated with fungal spores, which they unwittingly carry off to other Xyris plants and infect them.

This type of hoax is not unique but it is by far the most elaborate fungal mimicry known. The leaves of blueberries can be infected by Monilinia fungi, turning the leaves into hoax flowers that reflect ultraviolet light, give off a fragrant scent, and ooze sugar to attract insects that normally pollinate the plants but instead carry off the fungal spores.

Two orange-yellow “blooms” at right are fungal mimics of flowers produced by yellow-eyed grasses, such as the one at left.
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Zombie Tree, cont. from page 1
The short answer to these questions is we don’t know. Root grafting, a phenomenon well known to foresters and gardeners, has barely been studied on a physiological basis. Much remains speculation.

A few evolutionary advantages for root grafting have been suggested, including increased resistance to wind-throw, kin selection (I will help you if you are related to me), and increased access to water and nutrients coupled with the ability to shift those resources among trees.

The former two are more easily explained because graft members benefit. But the latter is more difficult to understand.

Forests as Superorganisms
If forests feature interconnected root networks where water, carbon, and nutrients are exchanged, this would be equivalent to power, water, and gas grids supplying a city.

But what mechanisms control who gives and who takes? There is evidence that shaded trees are supported by non-shaded trees and the fact that stumps (pensioners) are still supplied with resources gives rise to much bigger ideas that forest act and survive as a whole—much like a single bee or ant has no chance to survive without being part of its colony.

Our discovery of the tight hydraulic coupling through root grafts suggests exactly that: a communal physiology among connected trees. This is a game changer for our general understanding of forest functioning. It shifts our perspective toward forest ecosystems as superorganisms.

But with all the advantages this may bring for the superorganism forest, root connections obviously imply a lack of social distancing. As with COVID-19, this makes it easy for pathogens to spread, especially in cases where the pathogen penetrates the vascular tissue, a tree’s main transport route for water and carbohydrates.

Well into the 21st century, some great mysteries remain about how forests function. Research is particularly timely and relevant, given the rise in climate-induced forest dieback events for more frequent and severe droughts, increased vulnerability to pathogens, and exposure to pests that come with warmer temperatures.

Calendar
Mar 9 Virtual Survivors’ Banquet, 7:30 pm, via Zoom
Mar 15 Board meeting, 7:30 pm, via Zoom
Mar 23 Spore Prints deadline

Board News
Luise Asif

Remember to vote for the 2021–2023 Board! Voting closes Sunday, March 7. Brief reminder instructions:

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We will offer a short lecture from one of our club members, announce our new board members, announce our Golden Mushroom recipient, showcase culinary creations (either sweet or savory, bonus for mushroom-looking creations), and last but not least, a mushroom-themed dress up contest. I will give the award forthe best mushroom costume with something artistic created with mushrooms in mind. We may also offer a short slide show of pictures from members of foraging finds and other fungi related interests. This will be a very casual event free to come and go.

There will be time to mingle with other club members as well. The link to join will go out to all current club members a day before. We hope to see you there!

Since we are unable to hold an in-person Survivors’ Banquet, we have decided to hold a virtual social event in its place. This meeting will be casual and will be held on Tuesday, March 9, 2021, from 7:30–9:00 pm PST via Zoom.

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BRAZILIAN MUSHROOM STAMPS  Brian S. Luther

Brazil is the largest country in South America and the 5th largest in the world and has an unbelievable biodiversity. My research has found five sets of Brazilian postage stamps (so far) that show fungi on them, with two of these being rather cryptic and requiring careful observation to see.

In the following table and text, M=mushrooms or fungi as the main illustration; MID=mushrooms or fungi in the design of the illustration, background, or border, but not the main stamp illustration; FDC—a first day cover, an envelope (cover) with the stamps affixed and cancelled on the day of issue, often with a cover illustration (cachet) of the same theme as the stamps; maxicard=a postcard with the stamps affixed and cancelled on the first day of issue, also often with a colorful illustration of the same theme; PP=presentation pack, an information brochure discussing the stamps, along with a set of stamps. All catalog numbers are from the Scott Postage Stamp Catalogue. RS=Brazilian Real; c=centavos.

### BRAZILIAN MUSHROOM STAMPS

<table>
<thead>
<tr>
<th>Scott Cat.</th>
<th>Issue Date</th>
<th>No.</th>
<th>Value</th>
<th>Type</th>
<th>Subject</th>
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</thead>
<tbody>
<tr>
<td>10/22/1984</td>
<td>1955</td>
<td>120 c</td>
<td>M</td>
<td>Pycnoporus cinnabarinus</td>
<td></td>
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<tr>
<td>10/22/1984</td>
<td>1956</td>
<td>1050 c</td>
<td>M</td>
<td>Calvatia sp</td>
<td></td>
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<tr>
<td>10/22/1984</td>
<td>1957</td>
<td>1080 c</td>
<td>M</td>
<td>Pleurotus sp</td>
<td></td>
</tr>
<tr>
<td>10/23/1984</td>
<td>1958</td>
<td>120 c</td>
<td>MID</td>
<td>Intl. Book Day (see text)</td>
<td></td>
</tr>
<tr>
<td>10/12/1995</td>
<td>2558</td>
<td>R$0.15 M</td>
<td>Gymnopilus ventricosus</td>
<td></td>
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</tr>
</tbody>
</table>

#### Scott 1955-57

The first is identified to species and is a very common fungus. The second 1984 issue commemorates the International Book Day and shows a girl on an open book with many other things and organisms, including a purple mushroom up in the far right-hand corner, which for some reason is covered with a fine mesh veil (you have to look carefully to see it). Except for having the stamp itself, the FDC issued for this does not show any fungi.

In the table and discussion below I’ve provided the species ID for these as best I can determine. Geastrum violaceum is known only from S. America. Pycnoporus cinnabarinus is found widespread worldwide in both tropical and temperate zones. The 2021 Scott Catalogue incorrectly lists this mushroom as “Luetogus Gilb-ertsonii.” That species does not occur in S. America. The stamp photo shows only a pileal (cape) view, but the form of the conks’ attachment is not like that species at all. Because of its color and form I believe the correct identification of the fungus on Scott 3416b is as I’ve listed both in the text and table. For an absolute confirmation I’d need to see the pores underneath, which are not shown. Since, as I’ve mentioned, none of the stamp photos are labelled in this set, the Scott Catalogue must have gotten this info from the PP which erroneously listed it as that species. Oudemansiella cubensis is known from North and S. America. Clathrus chrysomyces is known from Central and S. America, and Hydnoleptopus forbesi is found in South America, Central America, North America, and Europe.

I was told by a Brazilian stamp dealer that neither FDCs nor maxicards were issued for this set, but the Brazilian postal authority did issue a PP for this set, which is fortunately in both Portuguese and English. It shows the stamps in color on the cover and provides a brief introduction about fungi in a few paragraphs, as well as discussing each of the six species illustrated in the set.

I’ve previously discussed the mushroom stamps from two other S. American countries: Uruguay (Luther, 2013) and Peru (Luther, 2015).

#### References

Luther, Brian S. 2013. Uruguay mushroom stamps show a Dermatophyte. Spore Prints 497 (Dec.), p. 4. Online and in color at www.psms.org


#### Advice to the Novice Mycologist

In fields and in woods, in fall and in spring, A mushroomer’s guide I used to just bring. To help me best know, right on the spot. Whether this one, or that, was edible, or not. On each it took me quite some time. To key in on color, size shape, or the slime. But absolute certainty had never resulted. Only when experts were later consulted. So my basket contained only those few that I took, After cautiously studying some pages in a book. While my comrades ran round and quickly collected. Baskets of goodies that I must have neglected. I thus would advise you, if you are able. To take new finds home, and, laid out on the table. With guides and spore prints, allaying all fears. Learn a few new species for following years.

—Boris Subbotin

The Spore Print. LA Myco Soc.
In the isolated fords of southeast Alaska, lush rainforests plunge down to meet the cold Pacific. There, among the fog and raven calls, is a glut of biodiversity. Tattered, leafy lichens stretch out on cedar limbs or hang as unkempt, verdant beards. Other varieties blanket rocks as tangerine freckles and carpets of seafoam antlers. According to new research, this cold coastal region harbors more lichens—composite organisms composed of algae or cyanobacteria living in symbiosis with fungi—than almost anywhere else on Earth.

More than a decade ago, Toby Spribille, a mycologist at the University of Alberta, answered a call from the U.S. National Park Service to inventory the lichens of Alaska. In their initial sweep, he and his colleagues found a staggering 766 different lichens in just 52 square kilometers of the Klondike Gold Rush National Historical Park. That find made the team wonder if temperate rainforests nearer to the water-drenched coast were equally rich—if not richer—in lichens.

So in 2012, Spribille and an international team of researchers set out to survey much of Alaska’s Glacier Bay National Park and Preserve. After months spent hunting down lichens, they collected nearly 5,000 specimens representing 947 species.

The team’s efforts, published recently in the Proceedings of the Royal Society B, are thought to have been spared from severe climatic swings, which may allow them to thrive where other species can’t. In their initial sweep, they found that the diversity of southeast Alaska is written in its fungi and in its moss,” Spribille says. “You can’t assume that you’ve found everything.”

**IMMUNE SYSTEM PRIMED AGAINST INFECTION BY GUT FUNGI**

**Fungi**

Common fungi, often present in the gut, teach the immune system how to respond to their more dangerous relatives, according to new research from scientists at Weili Cornell Medicine. Breakdowns in this process can leave people susceptible to deadly fungal infections.

The study, published Feb. 5 in Cell, reveals a new twist in the complex relationship between humans and their associated microbiomes and points the way toward novel therapies that could help combat a rising tide of drug-resistant pathogens.

The new discovery stemmed from work on inflammatory bowel disease, which often causes patients to carry larger than normal populations of fungi in their guts. These patients often develop strong antibody responses against mannan, a molecule common to pathogenic yeast. The antibodies bind them and target them for destruction by cells of the immune system. In patients with suppressed immunity, the anti-fungal antibodies may decline, leaving them vulnerable to fungal infection. New therapies that involve stimulating the production of anti-fungal antibodies, or injecting such purified antibodies directly into patients’ bloodstream, could potentially help combat these increasingly common infections.

If that approach works, it would be a welcome development. "Many fungal infections in immunosuppressed patients and elderly patients are happening by the production of pathogenic Candida species from the gastrointestinal tract, and the survival rates upon systemic spreading are alarmingly low," said Dr. Iliev.

**EUROPE’S LARGEST METEORITE CRATER IS HOME TO DEEP ANCIENT FUNGI**

**Hank Drake**

Remnants of impact craters have been suggested as suitable environments for deep colonization of microbial communities. In a new study published in Communications Earth & Environment, a team of researchers shows that fungi have colonized deep parts of the largest impact crater in Europe, the Siljan impact structure in Sweden. Intriguingly, the fungi seem to have been fueling methane production in the crater. At the scenic Swedish lake of Siljan, an impressive impact structure of more than 50 km in diameter formed almost 400 million years ago. In newly retrieved bore cores from drillings deep into the crater, a team of researchers has found fossil evidence of fungi. The researchers examined an intensively fractured rock section at 540 m depth level in the crater and noted fine filamentous structures in the rock. After closer examination in the laboratory, it became clear to them that the filaments were fossilized remains of fungi—that is, fungi that withstand the oxygen-free environment at these depths.

The relative abundance of different isotopes of carbon and sulfur within minerals found in relation to the fungi suggested to the researchers that the fungi were involved in methane and sulfur-forming processes in relationships with other inhabitants of the deep biosphere—bacteria and archaea.

Henrik Drake, of the Linnaeus University, Sweden, and lead author of the study, explains the discovery: “The findings suggest that fungi may be widespread decomposers of organic matter and overlooked symbiotic partners to other, more primitive, microorganisms, thereby capable of enhancing the production of greenhouse gases in the vast rock-hosted deep biosphere.”

Radioisotopic dating of tiny calcite crystals formed following microbial methane formation revealed an age of the fungi fossils to around 39 million years ago, more than 300 million years after the meteorite impact. Fractured rocks of impact craters have been suggested as suitable environments for deep colonization of microbial communities.
“We propose that the anaerobic fungi decomposed organic bituminous material in the fractures and produced hydrogen gas that fueled methanogens. This would be the first in situ finding of ancient anaerobic fungi linked to methanogenesis at great depth in the continental crust,” says Magnus Ivarsson, at the Swedish Museum of Natural History and co-author of the study.

The impact structure, with a ring zone of down-faulted Paleozoic sediments, has been optimal for deep colonization of fungi, because energy sources in the form of organics and hydrocarbons from overlying shales have migrated throughout the fractured crater.

“The preserved organic molecules that we could detect in the fungal remains give us additional evidence for a fungal origin and also for the proposed biodegradation pathway of shale-derived hydrocarbons, ultimately leading to production of methane at depth,” adds co-author Christine Heim of the University of Cologne, Germany.

Drake says, “Microorganisms and their strategies for survival and colonization of Earth’s most hostile environments continue to amaze and surprise us, and here we add another fungal piece to the deep biosphere jigsaw puzzle.”

The results are presented in the article “Fossilized anaerobic and possibly methanogenesis-fueling fungi identified deep within the Siljan impact structure, Sweden” in the Nature journal Communications Earth & Environment.

Try ’em

There are mushrooms that can kill you.
Some will nauseate or chill you.
And there’s others that will fill you with delight.
Some are simply unhygienic.
And a few hallucinogenic
Which will land you in a clinic in a fright.

So the thing to do is fry them.
Get the wife and kids to try them.
Then it’s easy to identify them.
Right?

—Ralph Nolan