SPORE PRINTS

BULLETIN OF THE PUGET SOUND MYCOLOGICAL SOCIETY
Number 521 **April 2016**

"A LOAD OF ROT": FOSSIL OF OLDEST KNOWN LAND-DWELLER IDENTIFIED

http://www.cam.ac.uk/research/news/, March 2, 2016

An early type of fungus likely kick-started the process of rot and soil formation, which encouraged the later growth and diversification of life on land.

A fossil dating from 440 million years ago not only is the oldest example of a fossilized fungus, but is also the oldest fossil of any land-dwelling organism yet found. The organism, and others like it, played a key role in laying the groundwork for more complex plants, and later animals, to exist on land by kick-starting the process of rot and soil formation, which is vital to all life on land.

This early pioneer, known as *Tortotubus protuberans*, displays a structure similar to one found in some modern fungi, which likely enabled it to store and transport nutrients through the process of decomposition. Although it cannot be said to be the first organism to have lived on land, it is the oldest fossil of a terrestrial organism yet found. The results are published in the *Botanical Journal of the Linnean Society*.

"During the period when this organism existed, life was almost entirely restricted to the oceans: nothing more complex than simple mossy and lichen-like plants had yet evolved on the land," said the paper's author Dr. Martin Smith, who conducted the work while at the University of Cambridge's Department of Earth Sciences and is now based at Durham University. "But before there could be flowering plants or trees, or the animals that depend on them, the processes of rot and soil formation needed to be established."

Working with a range of tiny microfossils from Sweden and Scotland, each shorter than a human hair is wide, Smith attempted to reconstruct the method of growth for two different types of fossils that were first identified in the 1980s. These fossils had once been thought to represent parts of two different organisms, but by identifying other fossils with 'in-between' forms, Smith was able to show that the fossils actually represented parts of a single organism

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Spore Prints

is published monthly, September through June by the

PUGET SOUND MYCOLOGICAL SOCIETY
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CALENDAR

April 12	Membership Meeting, 7:30 pm, CUH
April 18	Board Meeting, 7:30 pm, CUH Board Room
April 19	*Spore Prints* deadline
April 25	Monday ID clinics open, 4–7 pm, CUH atrium
April 30	Field Trip (see website)
May 7	Field Trip (see website)

BOARD NEWS

Luise Asif

Popcorn sales are back for the Membership Meetings starting in April. More lectures are being planned for this year's PSMS wild mushroom exhibit in October. The All Sound Ben Woo Foray is planned for Oct. 21–23, 2016. Details are being worked out by James (Animal) Nowak. PSMS is working on a "Conflict of Interest" policy, which is recommended for non-profits. Mushroom Maynia is set for Sunday, May 22, and a second planning meeting is scheduled for March 30 at CUH. In 2012 PSMS developed a "5-Year Plan" which is being revived. The Bridle Trails Funga study has begun, with scouting trips the week of March 20.

MEMBERSHIP MEETING

Tuesday, April 12, 2016, at 7:30 pm at the Center for Urban Horticulture, 3501 NE 41st Street, Seattle.

Our speaker for April will be truffle expert Alana McGee, who will speak on "Truffles & the Truffle Industry in the United States."

In addition to enlightening us about culinary (and non-culinary) truffles of the Pacific Northwest, Alana will provide a survey of global culinary truffle species and how they are linked. She'll discuss challenges in harvesting and getting to market as well as why she hunts with dogs and the importance of sustainability and ethical harvesting. The talk will be a window into the rarely seen world of cultivated truffles in the US. It'll be an up-close look at truffle orchards and production in the United States highlighting the complexities of growing truffles on a commercial scale and what's ahead for the industry.

Alana McGee, a Seattle native, is a driving force behind the emergence of using dogs to locate truffles in the Pacific Northwest and for use in scientific discovery in other parts of North America. She is an expert in locating, identifying, and harvesting truffles and an expert in training truffle dogs for use on commercial orchards. In 2013 Alana made history with her dogs harvesting the first ever cultivated Perigord truffles located in Canada.

Alana is a regular speaker at truffle festivals and seminars, and presents papers at various truffle- and mycorrhizal-related conferences worldwide. She works closely with leading mycologists and scientists on the developing science and understanding of truffle cultivation, sustainability of wild harvests, canine olfaction regarding truffles, and the practical application of trained truffle dogs on commercial truffieres.

She is currently gathering scientific data on the distribution and density of various native truffle species across North America and creating standards for truffle dogs working on truffieres in North America.

Will persons with last names beginning with the letters A–K please bring a plate of refreshments to share after the meeting.

MONDAY ID CLINICS TO OPEN APRIL 25

Brian S. Luther

The spring 2016 Hildegard Hendrickson ID Clinic will begin on Monday, April 25. It will run continuously on Mondays until sometime in June, except for the Memorial Day Holiday on Monday, May 30, when it will be closed. ID Clinic hours will be 4:00 to 7:00 pm. This is a free public service, compliments of the Puget Sound Mycological Society. PSMS members and the public are invited to bring in fungus specimens for identification during these hours. Mushroom experts will be on hand to answer your questions. The ID clinic will be held at the Miller Library atrium at CUH, located at 3501 NE 41st St., just south of University Village on the east campus of the University of Washington

When collecting samples for ID, please be sure to bring the entire fruiting body, which may involve digging it up to get the whole specimen. Be sure to segregate different species (but you can put several samples of the same species together) in individual paper or wax paper bags. Avoid using plastic bags because they don't breathe and the specimens can start decaying. Pay attention to habitat and associated trees (bring in a small sample of trees or write a simple data slip for collections) because this information helps us to identify your specimens.

PRESIDENT'S MESSAGE **Kim Traverse**

It's Mushroom Maynia time, and we need still a number of volunteers for that day, Sunday, May 22, from 8 am to 5 pm (includes the setup and cleanup). There is volunteer sign-up on our website. Come give us a couple of hours! This is probably our most family friendly event, and our goal is to normalize fungi in everyone's life and have a lot of fun doing it! We have a long way to go before the natural sciences are understood and appreciated to the point where everyone is connected to the wide world we live in. Fungi remain one of the least noticed kingdoms of life. A big secret to a whole lot of people.

We got bumped from the Main Hall of CUH for our May meeting which is Tuesday, May 10th. They are having a very big event and needed the extra day to prepare. To make it up to us we're getting the Graham Visitor's Center at the Arboretum for free for our meeting. This is just an early warning as we are still a month away. I know it doesn't hurt to tell people twice when there is a change. The address is 2300 Arboretum Drive, and if you take Lake Washington Blvd north through the Arboretum and at the "Y" go to the right on Foster Island Drive you'll find it. Maps and Google work too.

RECENT PSMS GRANTS **Marian Maxwell**

At the end of 2015 the PSMS Board approved two grants for the Ben Woo Scholarship Fund and received the first request for the new K–12 grants.

A Ben Woo Scholarship grant for $2,445.00 was awarded to Josh Harrison (Dept. of Biology, University of Nevada) to examine whether vertical stratification of endophytic fungi exists within the coastal redwoods (*Sequoia sempervirens*). Harrison hypothesizes that the fungal assemblage at the tops of redwoods will differ markedly from the assemblage present in lower branches and will analyze foliar samples of coastal redwoods collected by Dr. George Koch in Northern California. The money from the grant will pay for sample preparation and genetic sequencing of these samples.

A Ben Woo Scholarship grant of $1,903.00 was awarded to University of Washington grad student Korena Mafune for her PhD research in identifying species of fungi in adventitious roots collected from canopy soils and species collected from forest floor root tips of old growth Big Leaf Maple (*Acer macrophyllum*) and Sitka Spruce (*Picea sitchensis*). In addition she will conduct a literature review of the types of species recorded in both instances as to the efficiency in nutrient/water acquisition of the fungi found and in nutrient and water contents of the soils. Many of the ectomycorrhizal sequences identified from initial samplings lacked vouchered references which may suggest that these species of mycorrhizas that were identified have not been previously documented. Money from the PSMS grant will be used to fund some climbing equipment, travel expenses, chemical supplies, and some imaging facility fees. Ms. Mafune also received some funding from the Daniel E. Stuntz Memorial Foundation for costs associated with processing these samples.

We are excited to contribute to these research projects and eagerly await the findings of both researchers in these cases. The limit for these grants is normally $2,000.00 each, but we had not spent all funds from previous years so we had some flexibility in granting a bit to cover all of Harrison's proposed costs in sample prep and analysis.

Our first K–12 grant, for $307.50, was awarded to science teacher Tracey Landboe at Roosevelt High School for 30 sets of prepared slides and a fungal biorama for a mycology unit in her science class. Rather than purchasing mushroom growing kits for the class, PSMS Cultivation Chair Milton Tam graciously volunteered to help Ms. Landboe build kits from supplies that PSMS purchased. We were able to build more kits for the extra supply cost of $37 than if we had paid for purchasing the kits outright. In addition, the teachers benefited in learning how to easily assemble their own growing kits.

Since this was the only request in 2015 for this newly established grant, we also had flexibility here to grant more than the normal $200 limit per class.

RECOMMENDED BY-LAWS CHANGE **Kim Traverse**

The Board voted to recommend a slight by-laws change. We discovered a small discrepancy that should be resolved. The vote on this change will be held at the May membership meeting.

ARTICLE V Section 1 - Annual Meeting says that *An Annual meeting of the Members will be held each year in March at the time and place selected by the board for the purpose of installing Officers and Trustees...*

This is later contradicted:

ARTICLE VIII Section 2 (Second to last line) *The new Board members will take office at the regular April Board Meeting,*

The Board is recommending changing the by-laws so that ARTICLE V Section 1 will read: *An Annual meeting of the Members will be held each year at the time and place selected by the board for the purpose of introducing the newly elected Officers and Trustees...*

This should eliminate the contradiction between the two sections and make clear that the previous Board remains in power until the April Board meeting when those newly elected take over.

GOLDEN MUSHROOM AWARD **Kim Traverse**

The Golden Mushroom Award for 2016 goes to Luise Asif, and did we have a time keeping it secret from her until the Survivors Banquet! We had to lead her to believe that the award was going to another person so she wouldn't wonder who had won. Luise has been Hospitality Chair longer than I have been a member, she has served on the Board Since about 2010 and is currently Secretary. She has been Coordinator of Volunteers for Fall Shows, worked on committees to plan the Nama Foray, and Mushroom Maynia. Congratulations, Luise!

ITALY'S FIRST TRUFFLE STAMP
(and other myco-postal items from Italy)

Brian S. Luther

On October 31, 2015, Italy issued its first postage stamp dedicated to truffles. It's surprising that it took them so long, knowing what a valuable crop truffles have always been and the long-standing Italian traditions related to their harvest and use. In a recent article (Luther, 2014a) I documented all postage stamps showing truffles, known at the time, but a few more have been issued since then.

As popular as mushrooms are in Italy, the country has few postal items illustrated with fungi. The following table lists those I'm aware of. All catalog numbers are from the Scott Postage Stamp Catalogues: M=mushrooms or fungi as the main illustration; MID=mushrooms or fungi in the design of the illustration, in the background, border, or selvage but not the primary illustration; FDC=first day cover, an envelope (cover) cancelled on the first day the stamp was issued and with a main illustration (cachet) of the same theme; maxicard = a postcard with an illustration of the same theme and also cancelled on the first day of issue.

Official Postal Items from Italy Showing Fungi
(*=Scott Cat. no. not assigned yet).

Issue Date	Cat. #	Value	Type	Subject
9/5/1977	1272	170 L	MID	Polypore conk in painting
5/24/1984	1590	450 L	MID	Forest preservation
3/25/2011	3047	€0.60	M	*Penicillium roqueforti* veins in Gorgonzola
5/9/2011	3058	€ 0.60	M	*Armillaria mellea*, squirrel & forest
10/31/2015	*	€0.95	M	*Tuber magnatum* & *T. melanosporum*

Comments

The 1977 stamp (Scott 1272) shows a painting by artist Giuseppe Arcimboldi titled "L'hiver" (winter) that was completed in 1573; the original is at the Louvre Museum in Paris, France. It depicts a man's bust composed of a montage of miscellaneous plant parts and fungi, with the mouth area and lips formed from a conk, or possibly two conks (with the pore surfaces facing or touching each other). The conks resemble *Ganoderma applanatum*, but may simply be stylized by the artist. McKenzie (1997) says it has "lips of *Fomitopsis* ? sp." The artist also did similar paintings for the other seasons, as well as many other works of art.

The 1984 stamp (Scott 1590) is part of a four value set (Scott 1587–90) issued to commemorate forest preservation (salvaguardiamo i boschi). Scott 1590 has five small stylized mushroom caps with some of the stems visible on the lower bottom left of the stamp.

This first 2011 issue (Scott 3047) shows a wedge of Gorgonzola cheese that's cut open so you can see the pale bluish veins of the anamorphic mold *Penicillium roqueforti* throughout. This mold plays a large part in flavoring Roquefort, Stilton, Bleu/Blue, Gorgonzola, and other cheeses (along with specific bacteria). To view another postage stamp showing this mold on cheese, please refer to Luther (2015).

The second 2011 issue (Scott 3058) is one of a two value set (Scott 3058–59) titled "Le Foreste" and was issued to commemorate the 2011 Year of the Forest. It shows five *Armillaria mellea* mushrooms all growing on a stump (or some forest woody debris), along with a squirrel in the foreground and a forest in the background. Because the mushrooms and the squirrel equally dominate the main illustration, I put this stamp in my M category. I've previously mentioned another set of stamps showing fungi commemorating the 2011 Year of the Forests from Canada (Luther, 2014b).

The 2015 stamp is titled "Tartufo" (truffle in Italian) and shows both White Truffles (*Tuber magnatum*) and Black Truffles (*Tuber melanosporum)*, with a forest scene in the background. The painting on the stamp is distinctly undetailed, not showing any clear characters except for color and actually looking more like a couple of small piles of dirty potatoes that are out of focus. It shows some of the truffles cut open, but the illustration is so totally unclear that you can't see any details of the gleba marbling for either species. It's a self-stick stamp, but has die cut perforations.

The maxicard issued with this stamp shows basically a similar scene as on the stamp, except it's a much better, clearer photographic image of the truffles. The cancel on the maxicard and FDC is circular and has an illustration somewhat similar to that on the stamp.

Over the years personal collectors, mushroom enthusiasts, and Italian mushroom clubs have privately created, printed, and sold envelopes or postcards with a variety of mushroom artwork or with cancels showing fungi. There are many examples of these, including some bogus stamps, which are not official and thus will never be listed in philatelic catalogs, such as the Scott Postage Stamp Catalogue.

Just for your interest, entirely inside Italy lies the tiny country of San Marino, which has issued two different sets of attractive mushroom stamps.

Brian S. Luther

Scott 1272.

Brian S. Luther

Scott 1590.

Brian S. Luther

Scott 3047.

Brian S. Luther

Scott 3058.

Brian S. Luther

2015 "Tartufo" stamp.

2015 truffle cancel on maxicard.

Brian S. Luther

References

Luther, Brian S. 2014a. Truffles on Postage Stamps. *Spore Prints 498* (January), pp. 4–6. Online and in color at www.psms.org and also on this website under "Education."

Luther, Brian S. 2014b. Canadian Postage & Postal Items with Fungi. *Spore Prints 505* (October), pp. 4–6. Online and in color at www.psms.org and also on this website under "Education."

Luther, Brian S. 2015. Fungus-Illustrated Stamps from Great Britain (excluding British Crown dependencies, territories, possessions, etc.). *Spore Prints* 511 (April), pp. 4–6. Online and in color at www.psms.org and also on this website under "Education."

McKenzie, Eric H. C. 1997. Collect Fungi on Stamps (2nd Ed.). A Stanley Gibbons Thematic Catalogue, Stanley Gibbons Ltd., 86 pp.

Oldest Fossil Fungus, *cont. from page 1*

at different stages of growth. By reconstructing how the organism grew, he was able to show that the fossils represent mycelia— the root-like filaments that fungi use to extract nutrients from soil.

It's difficult to pinpoint exactly when life first migrated from the seas to the land, since useful features in the fossil record that could help identify the earliest land colonizers are rare, but it is generally agreed that the transition started early in the Paleozoic era, between 500 and 450 million years ago. But before any complex forms of life could live on land, there needed to be nutrients there to support them. Fungi played a key role in the move to land, since by kick-starting the rotting process, a layer of fertile soil could eventually be built up, enabling plants with root systems to establish themselves, which in turn could support animal life.

Fungi play a vital role in the nitrogen cycle, in which nitrates in the soil are taken up by plant roots and passed along the food chain into animals. Decomposing fungi convert nitrogen-containing compounds in plant and animal waste and remains back into nitrates, which are incorporated into the soil and can again be taken up by plants. These early fungi started the process by getting nitrogen and oxygen into the soil.

Smith found that *Tortotubus* had a cord-like structure, similar to that of some modern fungi, in which the main filament sends out primary and secondary branches that stick back onto the main filament, eventually enveloping it. This cord-like structure is often seen in land-based organisms, allowing them to spread out and colonize surfaces. In modern fungi, the structure is associated with the decomposition of matter, allowing a fungus colony to move nutrients to where they are needed—a useful adaptation in an environment where nutrients are scarce and unevenly distributed.

In contrast with early plants, which lacked roots and therefore had limited interaction with activity beneath the surface, fungi played an important role in stabilizing sediment, encouraging weathering, and forming soils.

"What we see in this fossil is complex fungal 'behavior' in some of the earliest terrestrial ecosystems—contributing to soil formation and kick-starting the process of rotting on land," said Smith. A question, however, is what was there for *Tortotubus* to decompose. According to Smith, it's likely that there were bacteria or algae on land during this period, but these organisms are rarely found as fossils.

Additionally, the pattern of growth in *Tortotubus* echoes that of the mushroom-forming fungi, although unambiguous evidence of mushrooms has yet to be found in the Paleozoic fossil record. "This fossil provides a hint that mushroom-forming fungi may have colonized the land before the first animals left the oceans," said Smith. "It fills an important gap in the evolution of life on land."

Martin R. Smith

Filaments of Tortotubus.

COULD BREAD MOLD BUILD A BETTER RECHARGEABLE BATTERY?

PhysOrg, March 17, 2016

You probably don't think much of fungi, and especially those that turn bread moldy, but researchers reporting in the Cell Press journal *Current Biology* on March 17, 2016, have evidence that might just change your mind. Their findings suggest that a red bread mold could be the key to producing more sustainable electrochemical materials for use in rechargeable batteries.

The researchers show for the first time that the fungus *Neurospora crassa* can transform manganese into a mineral composite with favorable electrochemical properties.

"We have made electrochemically active materials using a fungal manganese biomineralization process," says Geoffrey Gadd of the University of Dundee in Scotland. "The electrochemical properties of the carbonized fungal biomass-mineral composite were tested in a supercapacitor and a lithium-ion battery, and it [the composite] was found to have excellent electrochemical properties. This system therefore suggests a novel biotechnological method for the preparation of sustainable electrochemical materials."

Gadd and his colleagues have long studied the ability of fungi to transform metals and minerals in useful and surprising ways. In earlier studies, the researchers showed that fungi could stabilize toxic lead and uranium, for example. That led the researchers to

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Bread Mold Battery, *cont. from page 5*

wonder whether fungi could offer a useful alternative strategy for the preparation of novel electrochemical materials too.

"We had the idea that the decomposition of such biomineralized carbonates into oxides might provide a novel source of metal oxides that have significant electrochemical properties," Gadd says.

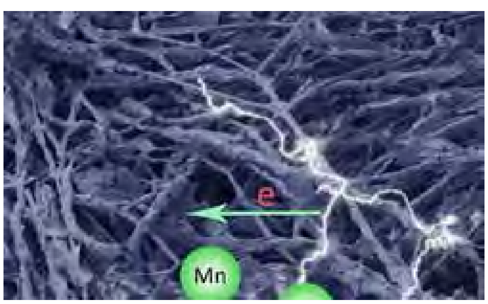
In fact, there have been many efforts to improve lithium-ion battery or supercapacitor performance using alternative electrode materials such as carbon nanotubes and other manganese oxides. But few had considered a role for fungi in the manufacturing process.

In the new study, Gadd and his colleagues incubated *N. crassa* in media amended with urea and manganese chloride ($MnCl_2$) and watched what happened. The researchers found that the long branching fungal filaments (or hyphae) became biomineralized and/or enveloped by minerals in various formations. After heat treatment, they were left with a mixture of carbonized biomass and manganese oxides. Further study of those structures show that they have ideal electrochemical properties for use in supercapacitors or lithium-ion batteries.

"We were surprised that the prepared biomass-Mn oxide composite performed so well," Gadd says. In comparison to other reported manganese oxides in lithium-ion batteries, the carbonized fungal biomass-mineral composite "showed an excellent cycling stability and more than 90% capacity was retained after 200 cycles," he says.

The new study is the first to demonstrate the synthesis of active electrode materials using a fungal biomineralization process, illustrating the great potential of these fungal processes as a source of useful biomaterials.

Gadd says they'll continue to explore the use of fungi in producing various potentially useful metal carbonates. They're also interested in investigating such processes for the biorecovery of valuable or scarce metal elements in other chemical forms.



Qianwei Li & Geoffrey Michael Gadd

An artistic rendering of a carbonized fungal biomass-manganese oxide mineral composite (MycMnOx/C) can be applied as a novel electrochemical material in energy storage devices.

HULA COMPETITORS AVOID ICONIC FLOWER BECAUSE OF FUNGUS

Honolulu Star Advisor, March 16, 2016

In years past, hula students would make pilgrimages into ohia forests on Hawaii's Big Island to gather blossoms and leaves from ohia lehua trees to adorn dancers' leis, hair, hands, and feet for the world's most prestigious hula competition. They would also pay respects to Laka, the goddess of hula, and seek inspiration. But at this year's upcoming Merrie Monarch Festival, the red and yellow blossoms that normally adorn dancers will be missing.

That's because many competitors are heeding calls to avoid the flowers so they don't spread *Ceratocystis fimbriata*, a fungus that's killing the trees that grow them. Scientists are worried what's known as rapid ohia death will wipe out the backbone of Hawaii's native forests and watersheds—the islands' source of fresh water.

"It doesn't grow anywhere else in world," said Sam Ohu Gon III, senior scientist and cultural adviser for the Nature Conservancy of Hawaii. "If it goes extinct here, that's it globally. It's gone."

Metrosideros polymorpha, *aka Ohia lehua.*

IRON-EATING FUNGUS DISINTEGRATES ROCKS WITH ACID AND CELLULAR KNIVES

Eric Hand

http://www.sciencemag.org, March 14, 2016

When a hungry fungus anchors itself to an unsuspecting rock, it has a plan of attack. First, it unleashes acid, dissolving surface minerals to get to its food. Then, it releases chemicals that extract that food—in this case, iron. Finally, its fast-growing fungal filaments cut into the remaining rock like a knife, carving deep channels that break up iron-depleted surfaces and expose fresh layers for consumption. Step by step, the fungus *Talaromyces flavus* knows how to get what it wants. "These organisms, they don't have a brain, but they're pretty smart," says Henry Teng, a geochemist at George Washington University in Washington, D.C.

Microbial geochemists have long known that fungi, bacteria, and other microbes are crucial to weathering, the chemical and physical breakdown of rock. But most experiments have calculated that contribution at arm's length, mixing microbes and minerals in solution in the lab as an analogy for the watery soil and rock pore spaces in which scientists assumed microbes were doing most of their work. A new study has zoomed in to scrutinize the zone where microbes meet minerals, and showed which chemicals fungi release after they attach to mineral surfaces. It suggests that scientists have underestimated how much fungal weathering goes on at this interface, and that microbes could be more important extractors of nutrients than researchers suspected.

No one has looked at the interface in such detailed fashion," says Teng, who published the study with colleagues this week in the journal *Geology*. Outside experts are impressed. "It's one of the most comprehensive looks at the specific fungal–mineral interaction," says Philip Bennett, a microbial geochemist at the University of Texas, Austin.

The research team found the fungus in a serpentine mine in Donghai, China, while searching for microbes good at extracting magnesium metal from rocks. Magnesium could be useful in sequestering atmospheric carbon dioxide in a stable solid form (such as magnesium carbonate), and microbes could represent an energy-efficient and environmentally friendly way of getting it.

The team cultured several dozen microbes and found that *T. flavus* was the best at extracting magnesium and iron from a silicate mineral called lizardite.

Back in the lab, they stuck fungus cells on top of lizardite samples and watched with special microscopic tools. They measured the pH in areas around fungal cells that hadn't yet attached themselves to the lizardite. But once cells attached to the mineral surface, pH levels dropped sharply—evidence that the fungus was releasing mineral-dissolving acid. The researchers documented a similar surface-triggered release of siderophores, chemicals that leach iron from the mineral. Teng says previous studies have measured weak, diffuse levels of acid and siderophores when mineral and fungus are put together in the same solution, but none had measured this concentrated release at the fungus–mineral interface. "[The fungi] don't want to use energy before they see the food," he says. Bennett says it's an explicit demonstration of a two-way symbiosis. "It gets to the heart of the microbe–mineral relationship," he says. "The microbe influences mineral weathering, and the mineral influences the microbial community."

After the iron leaching, the fungus wasn't finished with the rock. The researchers documented the pits in the lizardite left by fungal spores and the channels left by long, filamentous fungal cells called hyphae. Pressures at hypha tips can be 100 times that of car tires, Teng says—perfect for busting up tough iron-depleted mineral crystals to expose fresh layers beneath.

The study stresses the importance of surface interactions, scientists say. Previous studies have suggested that as much as 99 percent of microbial bio-weathering takes place in pore space solutions, as microbes release acid near, but not right up against, mineral surfaces. The new study suggests that as much as 50 percent of the weathering occurs at the surface, where the microbes can more efficiently and selectively target nutrients like iron. This means that microbes may be more responsible for extracting nutrients and moving them through soil ecosystems than previously thought, says Jennifer Roberts, a microbial geochemist at the University of Kansas, Lawrence. "It has implications for the health of soils and any symbiosis with plants," she says.

AIRBORNE BACTERIAL SIGNAL ENCOURAGES FUNGAL GROWTH CRITICAL IN LUNG INFECTIONS

http://phys.org/news/, March 15, 2016

Researchers in France have discovered that volatile compounds released by a bacterial pathogen stimulate the growth of a fungal pathogen found in lung infections in cystic fibrosis (CF). The findings, published this week in *mBio*, an online open-access journal of the American Society for Microbiology, show for the first time that one pathogen can emit a signal through the air that acts as a direct fuel for another pathogen to grow.

The bacteria *Pseudomonas aeruginosa* and the fungus *Aspergillus fumigatus* are both opportunistic pathogens often found together in the lung microbiota. When the two pathogens come into direct contact, previous research has shown that the bacteria produce compounds that inhibit fungal growth. Because microbes often produce volatile compounds that can travel through the air, Jean-Paul Latgé Christoph, Heddergott and Benoit Briard, members of the *Aspergillus* unit at the Pasteur Institute in Paris, wondered if these two pathogens could also communicate via volatile signals.

"To our big surprise, volatiles produced by *Pseudomonas aeruginosa* were promoting the growth of the *Aspergillus fumigatus* fungus," says Latgé. "Even more surprising, we found that these volatiles were actually taken up by the fungus to support growth."

To test how volatile compound signals might travel between and influence the microbes, Heddergott and Briard placed a small Petri dish of *Aspergillus* to one side inside a larger Petri dish of a *Pseudomonas* culture. Physically separated by the plastic dishes, the microbes shared common airspace above the dishes' surfaces.

"We simply put these two organisms together and in a couple of days, we were surprised to see the fungus growing faster and growing towards the bacteria," says Heddergott. "This really indicated something stimulatory [coming from the bacteria]."

To find out what it might be, he used special fibers to absorb the volatile compounds released from each pathogen and then identified them. Heddergott then tested each of the volatiles produced by *Pseudomonas* individually on the fungus alone.

"The most stinky ones containing sulfur stimulated the fungus to grow at the same concentration as co-growing with the bacteria," says Heddergott. He narrowed it down to just one airborne compound mainly responsible for the growth—dimethyl sulfide.

Because sulfur is an essential component that *Aspergillus* needs for growth, the team tested whether dimethyl sulfide was actually being taken up and used as food by the fungus. Heddergott and Briard placed the fungus on a plate of food lacking sulfur, then pumped dimethyl sulfide into the airspace. They showed that the fungus grew better with dimethyl sulfide present and sucked the dimethyl sulfide directly out of the air as fuel.

"Before now, no one thought that a fungus could grow on volatile compounds bringing sulfur," says Latgé. In the context of CF lung infections, Latgé says, this might explain why the bacteria usually colonize lungs first and the fungus colonizes later: "When the fungus reaches the patient's lung, having bacteria that are releasing this volatile will help the fungus establish itself."

Understanding the relationships between these microorganisms and how they colonize lungs could lead to better ways to prevent these bacterial-fungal co-infections, which are responsible for acute worsening of symptoms and declining lung function in CF patients.

"This opens our eyes to look not at just a single organism in human infections, but rather a series of microorganisms," says Latgé. "They can be far away from each other, communicating over a distance, and even using volatile compounds produced by another microbe to grow."

WOODPECKERS CARRY WOOD-EATING FUNGI THAT MAY HELP THEM DIG HOLES

New Scientist, March 23, 2016

If a woodpecker wants a home, it does more than just knock on wood—it takes some tiny helpers with it. The red-cockaded woodpecker seems to carry spores of fungi that rot wood in what appears to be a symbiosis that benefits both partners.

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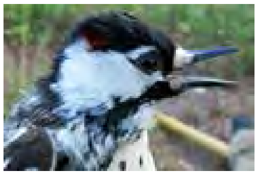
Woodpeckers Carry Fungi, *cont. from page 7*


Michelle A. Jusino

Red-cockaded woodpecker.

Red-cockaded woodpeckers live in the pine forests of the south-eastern US. They have an important role as "eco-system engineers," digging tree cavities that they use for many years and that are then used by other species when they move out.

The birds live in family groups, and each group usually has several cavities at different stages of construction. It's no quick job—carving out the holes can take eight years.

Some people think that woodpeckers get help from fungi to make their cavities, but evidence for this has been lacking—until now.

What's on Your Beak?

Michelle Jusino of the US Forest Service Center for Forest Mycology Research in Wisconsin and her colleagues have caught woodpeckers at a field site in North Carolina, swabbing their beaks, wings, and feet. The team found a wide range of fungal spores, including many that cause wood decay and are found in cavities that woodpeckers excavate.

To see whether the birds bring the fungi to their cavities, the team drilled holes through the sapwood into the heartwood in 60 trees near cavity clusters maintained by woodpeckers. Thirty of these cavities were covered with steel screens with openings too small for woodpeckers to get through.

After 26 months, the holes that were accessible to the birds had fungal communities living in them that were more similar to those found in natural woodpecker excavations than to the communities in the inaccessible holes. This suggests that woodpeckers do disperse fungi, but any benefit to the birds is still unproven.

Researchers would have to inoculate trees with different fungi and show that birds could excavate more readily in some than others. "Something like that would take many, many years, maybe a decade to test out," says Jusino. "I would very much like to do it, but doing this kind of work in a field study is extraordinarily difficult."

Shortage of Homes

Red-cockaded woodpeckers are endangered in the US, and one of the factors limiting their population size is the need for a cavity for each individual. Conservation managers try to help out by drilling holes through sapwood to help them get started.

"For those particular birds to ever be independent of cavity management, we need to know what is limiting excavation and why," says Jusino. "I didn't necessarily expect to find this result but it's very, very exciting. If our birds are shown to carry fungi, more than likely there are very many other birds that carry fungi."

But Teresa Lorenz, an ornithologist at the University of Idaho in Moscow, says that while the study is important and well-designed, the findings shouldn't be extrapolated to other woodpeckers. "Most woodpeckers I work with rapidly create a cavity, from start to completion within one week," she says.

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