

SPORE PRINTS

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HOW THE BUILDINGS OF THE FUTURE COULD HEAL THEMSELVES USING MUSHROOMS

Sydney Pereira

Newsweek, Jan. 18, 2018

Mushrooms could solve America's crumbling infrastructure. Yes, mushrooms—or at least a type of fungus scientifically known as



Could *T. reesei* someday be used to self-mend micro-cracks?

Trichoderma reesei. A new technique uses fungi to fill the cracks in concrete—creating a self-healing concrete. The self-healing concrete would be low-cost, pollution-free, and sustainable, according to the researchers.

“The idea was originally inspired by the miraculous ability of the human body to heal itself of cuts, bruises, and broken bones,” Congrui Jin, mechanical engineering professor at Binghamton University-State University of New York, said in a statement.

The human body repairs its damaged skins and tissues with nutrients—and similarly, Jin and her colleagues have developed a way for concrete to heal itself with some fungi and nutrients to help it grow. The fungus homes in on micro-cracks, which are often the start of much larger structural issues in buildings and bridges.

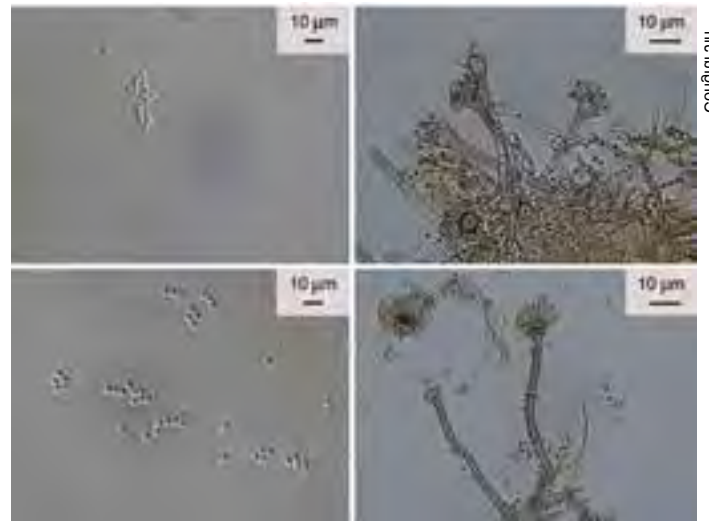
“If micro-cracks expand and reach the steel reinforcement, not only will the concrete will be attacked, but the reinforcement will be corroded,” Jin said. The steel is exposed to outside elements—like oxygen, water, carbon dioxide, and chlorides—which cause the reinforcement to rust and break down more quickly. By filling in these micro-cracks, the fungi would ideally be a permanent self-healing solution for the concrete.

The process works by mixing *T. reesei* into the concrete along with nutrients that help the fungus grow. When structures begin to break down, the micro-cracks leave room for water and oxygen to seep their way into the concrete. The once-sleeping fungal spores can then sprout and grow throughout the cracks, filling the gaps.

“When the cracks are completely filled and ultimately no more water or oxygen can enter inside, the fungi will again form spores,” Jin said. “As the environmental conditions become favorable in later stages, the spores could be awakened again.” Whenever cracks open up in the concrete, the fungus has all the materials it needs to grow.

The technique, which will be published in the March volume of *Construction and Building Materials*, is still in the early stages of research, but the self-healing concrete has “great potential importance,” Jin said.

The current challenge is ensuring the fungi can survive; the harsh conditions within the concrete make that difficult. More research into various microorganisms, including fungi and yeasts, could make a self-healing concrete product viable for commercial use. If it works, concrete stitched together with fungi could be the answer to infrastructure problems across the country.



Once the spores (left) germinate with the addition of water, they grow into threadlike hyphal mycelium (right).

B.C. COURT TO LIFT LOGGING INJUNCTION GRANTED TO MUSHROOM PICKERS

<https://luxoraleader.com/>, Jan. 21, 2018

Logging trucks will return to a community forest on the Sunshine Coast later this month, after a judge agreed to lift a temporary injunction granted to a group of mushroom pickers.

B.C. Supreme Court Justice Lisa Warren has ruled work can resume in the so-called Chanterelle Forest on January 25, according to activist Ross Muirhead.

He said the decision came after he and his fellow plaintiffs were unable to prove they could pay more than \$200,000 in potential damages to the logging company

“We’re disappointed that the courts forced us, as private citizens, to show that we were in a position to undertake to pay for the inflated damages that the logging company... was claiming,” Muirhead told CBC News.

He and fellow mushroom enthusiasts Hans Penner and Laurie Annette Bloom are asking the court for a judicial review of the forests ministry’s decision to grant a cutting permit for the 25.3 hectares of Crown land known as EW28.

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MEMBERSHIP MEETING

Tuesday, February 13, 2018, at 7:30 pm at the Center for Urban Horticulture, 3501 NE 41st Street, Seattle

Our speaker for February is our own Vice-President, Daniel Winkler, who will present “Stunning Stinkhorns—A Valentine Day’s Special.”



Daniel Winkler

Stinkhorns are in a class of their own. Unique, very diverse, often perplexing structures arise out of an egg in only a few hours. Colorful, weird, filigree, and sometimes suggestive structures are crowned by a sticky, stinky slime insects seem to regard as sublime! The eggs of many species are regarded as edible and are known in Germany as “Hexen-Eier” (Witch Egg). In China, the porous stems of the Cross-Dressing Stinkhorn aka Veiled Stinkhorn (*Phallus indusiatus*) are sought-after soup center pieces. In the old world, *Phallus impudicus* was associated with the devil, and its common name in the Bolivian Amazon is “Pene del diablo,” the devil’s phallus. In Victorian England maidens were protected from exposure to this fungus. However, in this presentation we will delicately celebrate their outrageous appearance and their evolutionary trajectory. Recent DNA studies are clearing up relationships of the Phallales and offer clarity to their taxonomy. Note: Presence of young children might make the presenter uncomfortable.

Daniel grew up mushroom hunting in Bavaria. A PSMS member since 1996, he is actively involved in the education program. He works on environmental issues of the Tibetan Plateau and also runs MushRoaming LLC, a travel agency specializing in myco-tourism for fungophiles. He is the author of field guides on edible mushrooms in the PNW and California. Daniel’s special interest is to further develop PSMS’ Bridle Trail State Park survey in order to improve members’ I’D skills, offer engagement in mycology, and contribute to the North American Mycoflora Project.

CALENDAR

- Feb. 13 Membership meeting, 7:30 pm, CUH
- Feb. 19 Board meeting, 7:30 pm, CUH board room
- Feb. 20 *Spore Prints* deadline
- Feb. 25 PSMS retreat, Snohomish
- Mar. 10 Survivors’ banquet, CUH



BOARD NEWS

Luise Asif

The Annual Membership Meeting will be held April 10 during the regular general meeting. The decision to separate the Annual Meeting from the Survivor’s Banquet is to ensure more people will be able to attend. The Survivor’s Banquet will be Saturday, March 10, at 7:00 pm. It will be a potluck and have a pescovegetarian theme. New officers and trustees and the Golden Mushroom awardee will be introduced. Planning is continuing for the retreat; if you have suggestions or comments please send them to feedback@psms.org. Plans are under way to digitize show and club videos. If you would like to help or lead the project contact Kim or Daniel or president@psms.org. The Bridle Trails project will continue the end of February. The schedule will be sent out the beginning of February.

PSMS PLANNING FEEDBACK

PSMS Board

Every once in a while, PSMS undergoes a self-review to celebrate and improve upon efforts to fulfill our mission—to foster an understanding and appreciation of mycology as a hobby and a science. Our next review will occur in early 2018! Board members and leaders will meet for a planning session to recognize these efforts and to implement improvements. While we have lots of thoughts from the board and other leaders, we need your thoughts too!

Please email your comments to feedback@psms.org or simply print and write out feedback on this sheet and hand to a PSMS board member. You can tell us how we are doing with both strengths and weaknesses to help us focus on actions moving ahead. Some thoughts to consider:

- What events have you attended that were great or disappointing, and why (i.e., general meetings, field trips and forays, ID clinics, classes, Mushroom Maynia, and the Wild Mushroom Show)? Would you like to see more activities of a certain type?
- How do you feel about the way you interact with PSMS (i.e., email, the website, *Spore Prints* newsletter, etc.)?
- What ways can we better encourage participation and leadership from you and other members?

- What do you think of the services PSMS offers (i.e., outreach, grants & scholarships, harvest regulations, sustainability & ecology, programming/speakers, member services, library, etc.)?
- Are there any directions you would like the organization to go in the future?

Thank you in advance for your thoughts. Comment sheets will also be available at our general meeting in February. We will get back to you soon on the planning results and the directions we will go together for the love of mycology!

HOW DID A DEADLY TROPICAL FUNGUS GET TO THE TEMPERATE ENVIRONS OF THE PACIFIC NORTHWEST?

<https://www.sciencedaily.com/>, Jan. 18, 2018

In what is being described as “The Teddy Roosevelt effect,” a deadly fungus in the Pacific Northwest may have arrived from Brazil via the Panama Canal, according to a new study led by the Translational Genomics Research Institute (TGen).

Cryptococcus gattii—which until a 1999 outbreak in British Columbia’s Vancouver Island was considered primarily a tropical fungus primarily found in places like Brazil, New Guinea, and Australia—can cause deadly lung and brain infections in both people and animals.

Researchers used genomic analysis and advanced statistics to trace the likely evolution of the disease, correlating it in time to the 1914 opening of the Panama Canal and a surge of shipping trade between Brazil and the Pacific Northwest. The results were published today in the journal *mSphere*.

Cryptococcus gattii infections first appeared in Washington in 2007 and in Oregon in 2010, with isolated incidents in Idaho and California. Symptoms include cough, shortness of breath, chest pain, fever, headache, neck pain, nausea, vomiting, sensitivity to light, and confusion or changes in behavior. Treatment can include months of intravenous and oral anti-fungal drugs, and in some cases surgical removal from the lungs and central nervous system.

“Understanding the emergence and continual evolution of this pathogen into a new environment is critical to the understanding of the ongoing spread of cryptococcal disease, and may be important to studying the evolution of other emerging health threats,” said Dr. David Engelthaler, Director of TGen’s Pathogen and Microbiome Division, TGen North, in Flagstaff, and the study’s senior author.

Researchers performed whole genome sequencing on 134 *C. gattii* samples. They then estimated fungal mutation rates and used evolutionary analysis to calculate the arrival of *C. gattii* in the Pacific Northwest within the past 60 to 100 years, which the authors posit, “makes a strong case for an anthropogenic (human-caused) introduction.”

The source and timing of the emergence of *C. gattii* in the Pacific Northwest have been a challenge to public health researchers since cryptococcosis seemingly first appeared in British Columbia in 1999.

Nearly 3 million years ago, the Isthmus of Panama rose to create a land bridge between North and South America, and a barrier between the Atlantic and Pacific oceans.

The study results suggest that the completion of the Panama Canal in 1914 may have provided the perfect migratory path for the fungus. Trade between North and South America via the Panama Canal initially included hardwood lumber, minerals, coffee, and rubber. However, researchers in this study propose that contaminated ballast water—which has spread animals, algae, and microbes across the globe—is one hypothetical way *C. gattii* may have moved from Brazil to the Pacific Northwest. *Cryptococcus gattii* fungus survives in seawater and has caused infections in marine mammals in the Pacific Northwest and elsewhere.

“Whatever the cause of *C. gattii* to the PNW, it is clear that those populations are neither ancient nor very recent (less than 25 years) arrivals to the region,” the authors state, and dispersal in the last 100 years “would strongly suggest” a human cause, rather than animal migrations, as proposed with the slower evolution and spread of Valley Fever and other disease-causing fungi. In a similar genomic-evolution study, TGen researchers last year determined that the Valley Fever fungus moved from North America to South America hundreds of thousands of years ago, after the formation of the land bridge but well before humans were known to be in the Western Hemisphere.

“As North American populations of *C. gattii* continue to evolve and disperse, it will be useful to continually apply genomic dating to understand the nature of these events and the expanding impact of these fungi on human and veterinary health,” Dr. Engelthaler said.

LAKE COWICHAN SALMON MUSHROOM FESTIVAL CALLS IT QUITS

Robert Barron

cowichanvalleycitizen.com, Jan. 17, 2018

After 18 years, the Lake Cowichan Salmon Mushroom Festival Society has decided to call off its annual festival.

The creation of mycologist Ingeborg Woodsworth, the festival attracted hundreds of people each year who came to celebrate the large variety of mushrooms that grow in the Cowichan Valley and the many species of salmon that are also here.

Woodsworth said she is now 84 years old and decided that “enough is enough.”

She said the festival, which had grown to be a two-day event each September that included mushroom tours, a full kitchen operation, and two floors of vendors at Centennial Hall, had grown too big for her to handle.

“I thought that since this was my baby since day one, it was time to end it,” Woodsworth said.

“I do intend to carry on with my [mushroom] workshops because a lot of people depend on them. I expect that I’ll be into mushrooms as long as I live.”

Woodsworth said the mission of the festival has always been to share and educate the public about Vancouver Island’s natural resources.

“As a non-profit society, one of the festival’s goals was to provide a scholarship to a local student desiring to further their education in environmental studies,” she said.

“In dissolving the society, we decided that a donation will be made to the Georgia Klap Memorial Fund.”

MUSHROOMING'S UNSPOKEN ETHICS

Wren Hudgins

In this geeky little hobby that we share, there are ethics, both obvious and hidden, spoken and unspoken. The obvious ethics include guidelines such as:

1. Don't tear up the forest floor; leave it intact.
2. Don't take more than you need.
3. Don't take all you find; leave the small and the old.
4. Don't leave behind any trash. An even higher standard would be to remove trash others have left.

However, at least for beginners, there are some unspoken ethics.

1. Don't ask mushroomers where they found that big haul of edibles.

Sometimes a mushroomer is lucky and finds a prime spot on the first day of looking. For the vast majority of us, however, we'll walk and drive hundreds of miles over a period of months, investing countless hours, before finding a new productive spot. Feeling protective of your investment is understandable. The question "Where did you find these?" puts the responder in an awkward position. The honest response runs the risk that news of the location will leak out and many people will come. Another response option is the purposely vague one: "near a river," "east of the mountains," "on a west facing slope," and the like. A variation on this allows the responder to give helpful information yet maintain secrecy regarding exact location, such as "on the eastern side of the mountains in a mixed conifer forest at 1000 ft elevation on south facing slopes." Still another response option is to be purposefully misleading, such as giving exact directions to the wrong spot. A nonverbal variation I have seen is to park your car ½ mile away from where you go in the woods instead of at the spot where you enter the woods. Most mushroomers I know opt for the purposefully vague response, often with some helpful information attached.

2. When a mushroomer does find a nice patch of delicious edibles, that patch belongs to them. If you are in the hunting group and hear the cries of delight, you may not rush over there and start picking, unless, possibly, you are married to the finder.

Others have asked me "How close may I go?" There certainly is no rule or agreement on this, and the answer may depend on how well you know the finder and how many mushrooms are there. In any event, if forced to guess at an answer here, I'd say no closer than 30 ft. Of course the dilemma is solved if you are invited over.

3. If someone gives you specific information about a productive mushroom spot, how do you handle that information?

First, pause and appreciate what a tremendous gift this information represents. This is a goose that lays a golden egg every Spring and/or Fall. One school of thought says that you should not revisit that site on your own in the future without calling the giver first and asking permission. If you later decide to go on your own, it may be that the finder/giver was planning to go that spot the following day. Another school of thought would say you can go on your own to this spot. The wise plan is to talk it over.

4. No re-gifting of spots.

If someone gives you a spot, you may not re-give it to someone else, at least not without the consent and knowledge of the original giver. This gift may represent 150 miles of walking over two years; it is indeed a treasure.

If you hunt with regular friends, chances are you will have worked out your own informal rules (which could vary from one set of friends to the next). Many friends regularly share their spots with other hunting friends and invite them to help pick a patch. The above guidelines apply more to beginning foragers going out in groups where they don't know everyone well. Following these guidelines will result in behavior respectful of the forest and of the other hunters and will increase your chances of being invited back.



Election

For our elections, **we vote online electronically.**

This year we will be voting for a Vice-President, a Treasurer, and five Trustees. Please read the following candidate profiles carefully.

To vote electronically, go to the PSMS website at www.psms.org and click on "Members' Page" under the heading "Membership." You will need to log in with your username and password. If you have forgotten your password, please fill out the section "Forgot your password?" at the bottom of the page and click on "Reset your password." If you cannot remember your username, contact Alyssa at membership@psms.org or Marian at outreach@psms.org. When you successfully log in to the Members' Page you will see an icon named "Elections" at the bottom of the page under "Engagements." Click on the icon and follow the instructions to

Election

vote. It will be helpful to have your *Spore Prints* issue with the candidates and bios available to view when voting. You may only vote once. There are two votes per family membership, but you will each have to log in separately and use your individual user IDs to vote.

Members who do not have computers or who have not provided an email address will receive their ballots by mail. Please contact Marian Maxwell at outreach@psms.org if you have any difficulties voting. These mailed ballots need to be returned in person at the February meeting to Alyssa Panning at the Membership desk or be mailed to Marian Maxwell at 14269 145th PI SE, Renton, WA 98059 by February 28. Votes received after that date will not be counted. Election results will be announced at the Survivor's Banquet on Saturday, March 10, 2017.

Daniel Winkler Vice-President



A PSMS member since 1996, Daniel is actively involved in the education program and initiated the PSMS Bridle Trails State Park survey. He works on environmental issues of the Tibetan Plateau and also runs MushRoaming LLC, a travel agency specializing in myco-tourism for fungophiles. He is the author of field guides on edible mushrooms in the PNW and California. Currently Vice-President, he welcomes the chance to serve again.

Treasurer

Donna Naruo

This past year, it has been my pleasure to serve as treasurer of PSMS. It keeps me involved in all the activities of PSMS and working closely with the various committees, and I would be like to serve another term as treasurer to help promote the goals of our organization.



Trustees

Sweta Agrawal

Since joining PSMS in 2013, I have met wonderful, passionate people and learned so much. I have tried to return the favor by acting as a field trip guide, volunteering at the spring and fall shows, chairing the PSMS scholarship committee, and serving on the board for the past two years. I would be honored to continue to serve on the board!



Anne Tarver

I joined PSMS in 2014 and love how welcoming, helpful, and informative our members are. As a trustee since 2017, I have worked to serve the diverse interests at PSMS. I especially enjoy working to preserve access to the areas we use and on finding new opportunities for our club to give back through volunteer projects that help maintain those areas.



Paul Hill

Since joining PSMS I have enjoyed many field trips, helped out at meetings, and for many years at the Fall Show. As chair of the PSMS Photography Committee, I have organized mushroom photo walks in local parks and added the Photo Exhibition to the annual show. I have served on the board since 2015 and would enjoy serving again.



Milton Tam

Milt previously served as PSMS Vice President and as a trustee. He currently chairs the Cultivation Committee and is co-chair of our Annual Fall Mushroom Show. He believes that "fun" is an integral part of "fungi," and if elected he will serve as your advocate to improve and expand club activities, classes, and interest groups.



Chiara DeNeve

I am an aquatic biologist, which just means I've studied a lot of different things. I've been interested in fungi since I was ~2. I have been a PSMS member since 2016, and have been very happy to help whenever possible. The jobs I've held combine research science, education, outreach, funding, and volunteer coordination; I look forward to using these skills to assist PSMS in their mission.



Lauren Re

I am currently pursuing a Bachelor's of Science at The Evergreen State College with a focus in Biology, Ecology, and Mycology and am a coordinator of the Myco-Collective, Evergreen's Mycology Club that focuses on all aspects of the field including foraging, identification, and education. I look forward to the chance to bring creative new ideas to PSMS! Thank you!



US STAMP SHOWING A BIOLUMINESCENT MUSHROOM COMING IN 2018

Brian S. Luther

Many of you are familiar with Taylor Lockwood and his amazing and award-winning mushroom photography. I'm pleased to announce that one of Taylor's photos will be featured in a set of ten different US stamps showing bioluminescent organisms. All of these stamps simply say "Bioluminescent Life" and are not identified to species. The mushroom shown is *Mycena lucentipes* and was photographed in Brazil. All of the stamps in this set are Forever stamps and cost 49¢ each now. This set is scheduled to be officially issued at Fort Pierce, Florida, on February 22.

For a "sneak preview" of up-and-coming stamps about to be issued by the U.S. Postal Service, go to

https://about.usps.com/news/national-releases/2017/pr17_079.htm

A previous article on current US stamps showing fungi can be found on www.psms.org/Education/Fungi on Postage Stamps. After this new set of stamps is officially issued, I'll revise the article to include it and the stamp, along with other details.

See Luther (2014) for a previous article devoted to bioluminescent fungi on postage stamps.

Acknowledgment

Thanks to Taylor Lockwood who gave me advance information on this stamp.

Reference

Luther, Brian S. 2014. Bioluminescent fungi on stamps. *Spore Prints* 507 (December), pp. 4–5. Online and in color at www.psms.org.



Soon-to-be-released mushroom stamp by Taylor Lockwood.

AGAINST FUNGAL INFECTIONS, SNAKES MAY HAVE AN EDGE

Robin Lloyd

<https://undark.org/>, Jan. 18, 2018

Deadly fungal infections are indisputable threats to bats in North America and to frogs, toads, and salamanders globally. Over the past three decades, such diseases have contributed to the extinction of numerous amphibian species—and for now, scientists have uncovered no clear way to halt the losses.

One glimmer of hope, however, might be found in some 30 species of snakes, which have also been struggling with fungal disease in recent years. Compared with amphibians and bats, it appears that certain snakes, if not virtually all of them, could have a decent shot at surviving their fungal affliction—particularly if scientists and wildlife managers get ahead of the pathogen in ways that they haven't with bats and amphibians.

In the past decade or so, scientists have found the fungus *Ophidiomyces ophiodiicola* on wild snakes primarily in the northeastern United States. Cases also have been reported in wild snakes in Europe and in captive snakes in Australia, Germany, and the U.K. "We know that snake fungal disease negatively impacts individuals and causes mortality in some cases," says Eric Hileman, a population ecologist and herpetologist with the U.S. Geological Survey in Guam. The fungus can lead to lesions and irregular scaly buildups that remain even after skin is shed.

The incidence of the fungus among wild eastern Mississauga rattlesnakes at three sites in Michigan ranged from 3 percent to 17 percent, according to a study by Hileman and colleagues that was published this month in the *Journal of Wildlife Management*. Another estimate put the extent of lesions on snakes coming out of hibernation at sites in Florida at about 40 percent, and the majority of those lesions were caused by *Ophidiomyces* fungus.

Wildlife managers and biologists are concerned that fungal disease in snakes, if left unstudied and unchecked, could wipe out large populations as fungal infections have done to bats and to amphibians. Insights into the fungal disease in bats, called white nose syndrome, often do not pertain to similar diseases in snakes, amphibians, and other affected species. Different fungal species are involved, and it is unclear whether they evolved in the same region as the animals or instead were introduced from somewhere else. That distinction can result in differences in susceptibility and immunity to problematic fungi.

But those responses might be just what makes it easier for wildlife managers to help snakes overcome disease caused by *Ophidiomyces* infections, says Jeffrey Lorch, a microbiologist at the U.S. Geological Survey in Madison, Wisconsin. It's possible that many snake species developed an immunity to the fungus because they co-evolved with it, unlike in, say, the case of bats, where the pathogen was introduced. And while some snakes are carriers of the fungus and apparently suffer no ill effects from it, scientists now suspect that many individuals might be losing their native immunity due to external stressors—typically habitat loss, climate change, and other human-driven influences.

"Snakes might have mechanisms that they would normally use to cope with that pathogen," Lorch says, "but something is off, be it a changing habitat or changing climate, that they are just not able to deal with it as they normally would."

If those external conditions can be addressed, researchers theorize, some measure of native immunity might be preserved. Interventions to help snakes regain that advantage against *Ophidiomyces* infections could include thinning forests so snakes are exposed to more sunlight. Some research shows that infected snakes are more likely to bask in the sun, which could help them better fight off infection—although other research shows the opposite relationship between infections and basking. Clearly, more research needs to be done.

Meanwhile, the prognosis for bats did get a little brighter this month. In lab experiments, a pulse of ultraviolet light was able to kill most of the *Pseudogymnoascus destructans* fungus that is wiping out populations of bats, a team of scientists reported in a paper published January 2 in *Nature Communications*. Tests of the effects of the treatment directly on laboratory bats with white nose syndrome are now under way, says study co-author Jonathan Palmer, a botanist at the U.S. Forest Service in Madison.

If effective, ultraviolet light lamps placed inside caves or at their entrances could defeat the fungus, says Daniel Lindner, a plant pathologist also at the U.S. Forest Service in Madison, and the study's lead author.

It's unclear if the light could be shone on enough bats and caves to save large populations from disease and death, Palmer says.

But Palmer and colleagues see a partial solution in simply continuing to study the basics of the fungus and the disease. For example, the fungus's vulnerability to ultraviolet light was a serendipitous finding during a standard study of the genomes of *P. destructans* and closely related fungi.

"By continuing to ask and answer fundamental biology questions about white nose syndrome together as a community of scientists we will advance our knowledge of the disease, which will lead to additional potential treatment options," Palmer says

MEALWORMS MAY TURN FUNGUS-INFECTED WHEAT INTO CASH

Federica Giannelli

Saskatoon Star Phoenix, Jan. 17, 2018

Fusarium fungus contamination in wheat caused more than \$1 billion in economic losses in Canada in 2016, affecting almost 80 percent of Saskatchewan and Manitoba cereal crops and leaving farmers scratching their heads about how to dispose of tons of worthless wheat.

The potential solution discovered by University of Saskatchewan researchers for producers stuck with unsellable *Fusarium*-infected wheat may actually put cash in the farmers' pockets and open up a new, worm-based niche market in the feed industry.

"We want to help producers by making use of grain that is worth nothing and that no one knows how to dispose of safely," said animal and poultry science professor Fiona Buchanan.

Buchanan and her master's student, Carlos Ochoa, have found that yellow mealworms can eat wheat infected with the fungus, whose mycotoxins are harmful. The worms remain unaffected after eating the grain, regardless of the level of mycotoxins, which usually cause vomiting and abdominal pain in humans and affect the growth of livestock.



Christina Weese, University of Saskatchewan

Fiona Buchanan and Carlos Ochoa have found use of crawling critters to get rid of salvage wheat.

The fattened mealworms—the offspring of a flightless beetle—could be a new, nutritious source of protein for chickens or fish.

"Yellow mealworms are a safe, more sustainable, and cheaper feed, and can eliminate a contaminated product from the environment at the same time," Ochoa said.

Buchanan added that farmers usually bury or burn the contaminated wheat, but these are not great options. Burying the grain does not eliminate the fungus, and it may spread to next year's crops; burning it causes pollution, worsening the environmental impact.

Buchanan got the idea of using mealworms for wheat disposal after talking over coffee with a farmer friend, who referred to a small study that showed a few mealworms eating contaminated wheat.

Using 10,000 mealworms, Buchanan and Ochoa proved that, regardless the level of contamination in the wheat the crawlers ate, they always showed only 0.13 parts per million of mycotoxin in their bodies—well below recommended safety levels for animal consumption.

Ochoa, who presented his research at a U.S. conference last summer, said he and Buchanan bought a ton of contaminated wheat from a farmer, then used a machine to concentrate the mycotoxin levels and fed it to mealworms.

If additional funding becomes available, Buchanan would like to test even higher toxicities to determine the threshold of the mealworms for consuming infected wheat and start trials on chickens by feeding them crawlers grown on contaminated wheat.

The project was funded by the Saskatchewan Agriculture Development Fund. If all goes well with the research and if the researchers get approval from the Canadian Food Inspection Agency, their goal is to start a company selling worms to chicken farmers in four or five years.

MYCOREMEDIATION IN ACTION Mino de Angelis

Mycena News, Myco. Soc. of San Francisco, Jan. 2018

The catastrophic wildfires we witnessed this past October changed lives and left an altered landscape for the foreseeable future. We see the visible destruction to home and vegetation, but what's occurring now is the more invisible damage as environmental pollutants—in the form of ash, freed heavy metals, solvents, and plastics—potentially enter the watershed and contaminate far beyond the points of origin.

One positive in all this is the community response—a coming together in volunteerism to deter and counteract these threats before they overwhelm environmental safeguards. Eric Ohlsen, of Permaculture Skills Center, organized an effort to forestall these dangers by partnering with Clean River Alliance, Russian Riverkeepers, Sonoma Compost, West Marin Compost, Gourmet Mushrooms and others to form the Fire Remediation Action Coalition.

One solution now utilized is to place wattles (straw barriers) in vulnerable areas. For the most part this is not just diversionary, although they use that technique as well, but in the most crucial regions the wattles are made with a combined preparation of straw, Oyster (*Pleurotus ostreatus*), and Turkey Tail (*Trametes versicolor*) mycelia in substrate, compost, and manure—mycoremediation.

It is hoped that this combination can transform the toxins through absorption of the heavy metals, chelation to make them less volatile, and microbes to aid in biodegradation and enzymic degeneration. The resulting mushrooms and substrate can then be harvested and removed to a proper disposal location. Reviewable data from this project will be evaluated and made available as processed.

Not all the straw wattles are myceliated. Over time it is hoped that the myceliated ones will transfer to the straw-only ones.

A project of this scale (1000 bales of straw for the myceliated wattles) takes an enormous amount of people power. It may be the largest of its kind for this purpose. Of prime importance is the stuffing of wattles. This is mostly mechanized but some physical

labor is needed. There is also the installation of the wattles in the fire zone. There are many opportunities to volunteer should you wish to become involved. Check the Fire Remediation Action Coalition Facebook page for signup information:

<https://www.facebook.com/groups125252661524817/>



Fire Remediation Action Coalition

The green wattle atop this water barrier has been inoculated with mycelium, the weblike network of fungi that sprouts mushrooms. The wattles reduce the flow on the creek, allowing for less turbidity and longer uptake of toxins.

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