SPORE PRINTS

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The Extravenganza is open to PSMS members only.

Spore Prints

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PUGET SOUND MYCOLOGICAL SOCIETY

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CALENDAR

Dec. 12	PSMS Holiday Extravaganza (members only), 7:30 pm, CUH
Dec. 12	*Spore Prints* deadline (early)
Dec. 18	Board meeting, 7:30 pm, CUH board room

BOARD NEWS

Luise Asif

Shannon Adams has planned a microscopy class for the beginning of the year. Plans are under way for PSMS to create our own teaching kits along with aids for K–12 teachers to be accessed through the PSMS website. In conjunction, Sweta Agrawal is developing educational activities for the website. James Nowak has booked the 2018 Ben Woo Foray for the weekend of October 20–21 at Camp Barachah again. Shannon is working on the video from the PSMS Show to be completed by the time of the Survivor's Banquet/annual business meeting in March. The Bridle Trails State Park Survey will continue under the leadership of Daniel Winkler. James is developing new spawn for the upcoming Cultivation Class. Derek Hevel is working on the 2018 fall show. The Board will be hosting the Holiday Extravaganza for members at the meeting on December 12. This year will be finger foods and sweets.

MEMBERSHIP MEETING

Shannon Adams

Tuesday, December 12, 2017, at 7:30 pm at the Center for Urban Horticulture, 3501 NE 4lst Street, Seattle

PSMS HOLIDAY SOCIAL! It's that time of year again! Please join us on Tuesday, December 12, at the annual PSMS Holiday Extravaganza for great company, door prizes, a fun edible art competition, and a light supper. This year, instead of a full dinner with catered main course, we are asking you to whip out your cookbook and create your favorite holiday finger food, sweet or savory. You can bring wine and beer for service at the bartenders table.

The Extravenganza is open to PSMS members only. To book your place, please sign up through the registration portal on the PSMS website which will be set up shortly. The cost is $5 a head, and space is limited.

Don't forget to start planning your best edible artwork for submission to the edible art competition (meringue mushrooms? *Amanita*-shaped cupcakes? bûche de Noël?) and lining up your favorite mushroom photos from the past year for the slide show. Photos can be submitted to photography@psms.org and should be received by Saturday, December 9.

Doors open at 6.30 pm.

We hope to see you there!

THREE WHITE TRUFFLES SELL FOR $87,400 AT ITALIAN CHARITY AUCTION

Lily Rose

The Daily Mail, Nov. 13, 2017

Three white truffles have sold for $87,400 at the 18th annual World Alba White Truffle Auction in Italy. The 1.9 pounds of fungi were foraged by truffle hunter Mario Aarile and his dog, Lady, a mere two days before the auction. The smart dog was able to find the delicacies 16 inches underground. It is reportedly one of the biggest truffle discoveries in the hills of Alba, Italy's white truffle capital.

The *New York Post* reports that Italy is going through its worst truffle season in years after a rainless summer and fall, with truffle prices increasing to $3,000 to $4,000 per pound.

"It's not an exceptional year. It's a poor year, with very high prices and very few truffles," truffle hunter and seller Gianluca Sacchetto told Reuters.

Still, the specific tasting fungi are in high demand. The auction not only included in-person attendees at the Grinzane Cavour Castle, but also included a live satellite link to Hong Kong and Dubai.

The high-priced truffles were bid on and won by Hong Kong billionaire Eugene Fung. All proceeds from the event will go to charitable causes.

FIELD TRIP REPORT, Oct. 28 **Brian S. Luther**

Alexandra O'Heney-Egger

Brian Luther at the ID table.

This last field trip of the fall season was especially pleasant, with mild conditions and no rain. When I got down to the big shelter at 7:10 am, Charlie, the head park ranger, had already opened the gate, turned on the lights and water, and made a big fire for us in the fireplace—wow, what service! We had a large turnout with 126 signing in. Quite a few were brand new members who had just joined at the PSMS exhibit the previous weekend.

Our host was Rowena Erhard, who lugged all the supply tubs and a large assortment of breakfast munchies over to the field trip all by herself. At the shelter she had a lot to do, so Irene and Andy Iwata and others pitched in to help get the coffee going and food set out, etc. Thank you, Rowena and all others who helped her.

Five field trip guides volunteered to lead groups. Two groups, led by Wren Hudgins and Dick Sieger, collected within the park while the others went to different locations.

It was a pleasure to see Dick Sieger (former PSMS President from 1992–1994) and Agnes Sieger (*Spore Prints* editor). Because they live in Port Angeles, WA, they can't often come to the field trips.

Alexandra O'Heney-Egger

Russ O'Heney—Wow!

Many members found chanterelles, but unlike previous years no matsutake were brought in. A nice diversity of approx. 75 species was collected and displayed on several picnic tables. Special thanks to Wren Hudgins not only for heading the field trip guides, but for diligently helping me do the final species ID after potluck, documenting all the specimens found within the park.

The usual great potluck was a fitting and welcome end to a wonderful day.

Hosting Co-Chairs Carolina Kohler and James Rumbaugh graciously took all the hosting supplies home with them and will be refreshing everything for next year.

Thanks to all members who helped on the field trips. We hope that everyone had a fun fall mushroom season and look forward to seeing you next spring.

Wishing you the best for the holiday season and a happy new year.

WHY MUSHROOMS MAY BE THE BEST FOOD TO HELP FIGHT AGING **Kastalia Medrano**

Newsweek, Nov. 9, 2017

New research reveals that mushrooms are "without a doubt" the highest known single source of the antioxidants ergothioneine and glutathione, which are both associated with anti-aging properties. A team of researchers from Pennsylvania State University found that mushrooms are surprisingly full of both compounds, and that some of the 13 species they tested contained vastly higher levels than others. Common white button mushrooms, for instance, had low levels of the two antioxidants compared to some other mushrooms but still higher levels than your average non-mushroom food. The winner "by far" was the wild porcini mushroom, which is convenient since it's also delicious. And even though some foods lose their health benefits when you cook them, the antioxidants in the mushrooms appear heat-stable and thus unaffected. The research was recently published in the journal *Food Chemistry*.

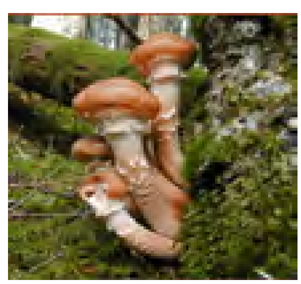
"There's a theory—the free radical theory of aging—that's been around for a long time that says when we oxidize our food to produce energy there are a number of free radicals that are produced that are side products of that action and many of these are quite toxic," said Robert Beelman, professor emeritus of food science and director of the Penn State Center for Plant and Mushroom Products for Health, in a Penn State news release. "The body has mechanisms to control most of them, including ergothioneine and glutathione, but eventually enough accrue to cause damage, which has been associated with many of the diseases of aging, like cancer, coronary heart disease, and Alzheimer's."

CHECK OUT THE GENES ON THIS HUGE 'SHROOM **Diana Gitig**

https://arstechnica.com/, Nov. 9, 2017

As is the case with most titles that end in "-est," the competition for The World's Largest Organism is fierce. The Great Barrier Reef certainly has its proponents, most of them Australian. There's a stand of quaking aspens growing in Utah that's a single clonal organism, rather than genetic individuals. If it does not merit the title of largest organism, it can at least claim to be the most Borg-like.

The real winner does not capture the popular imagination as much as a besieged coral or a forest of yellow-leafed trees: it is somewhat less scenic and probably won't appear as the backdrop of an inspirational poster any time soon. It kills plants and lives underground in Oregon. It is the humongous fungus, and we now have its genome.



Honey mushroom.

Armillaria species—honey mushrooms—kill all kinds of plants. Conifers, ginkgos, grasses, and shrubs, in National Forests and in your backyard, all are susceptible. The fungus attacks its prey by sending out rhizomorphs, underground structures that leach onto the plant's roots and kill them. Then it eats the dead woody tissue of its decomposing host.

What with the agricultural implications of a fungus that attacks plants underground, scientists thought that maybe we should learn

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Humongous Fungus, *cont. from page 3*

more about how and why it does what it does. So they sequenced the genomes of four *Armillaria* species and compared them to those of twenty-two related fungi.

Turns out that *Armillaria* have an outsized number of genes that encode enzymes in order to degrade plant cell walls, as well as other genes that control pathogenicity. Most of these genes arose via gene duplication, rather than through transposable elements (genes that jump from one location to another). This is surprising, since the genome expansion in other plant pathogens is driven by transposon proliferation.

The rhizomorphs are unique to *Armillaria* and allow them to grow so large by bridging the distances between potential host plants. However, their development, morphology, and even function are still up for debate. The genes they express were found to be unique and evolutionarily quite young, but all four *Armillaria* species examined had them (so they are assumed to be important).

Rhizomorphs express some proteins that degrade plant cell walls, but not as many as the branching part of the fungus, where the mushrooms come from. This supports the speculation that the rhizomorphs not only attack new hosts but may also take up and transport nutrients.

So, this is a case when the genome provides some hint of what has allowed an organism to evolve such a distinctive lifestyle. But, since all the genes are unique, they don't give us a clear picture.

ANTARCTICA WAS ONCE COVERED IN FORESTS. WE JUST FOUND ONE THAT FOSSILIZED.

Elaina Zachos

https://news.nationalgeographic.com, Nov. 15, 2017

It was summer in Antarctica, and Erik Gulbranson and John Isbell were on the hunt.

Bundled up in parkas to brave negative temperatures, fierce winds, and blinding days of 24-hour sunlight, Gulbranson, Isbell, and an international team of researchers searched for fossil fragments. Between November 2016 and January 2017, they scaled the snow-capped slopes of the McIntyre Promontory high above the ice fields and glaciers, sifting through the Transantarctic Mountains' gray sedimentary rocks for clues. By the end of the expedition, they had uncovered 13 fossil fragments from trees dating back more than 260 million years, around the time of the world's greatest mass extinction event.

The fossil discovery hints at the coldest, driest continent's green and forested past.

"The continent as a whole was much warmer and more humid than it currently is today," says Gulbranson, a professor at University of Wisconsin-Milwaukee. The landscape would have been densely forested with a low-diversity network of resilient plants that could withstand polar extremes, like the boreal forest in present-day Siberia.

"Oddly enough, these field sites would have actually been very close to what their current latitude is," he adds

The fossils preserved the biology and chemistry of the ancient trees, which will help the researchers investigate more on these high-latitude ecosystems to figure out how some plants survived the extinction event and why others didn't. What's more, fossil microorganisms and fungi have been preserved inside the wood.

The specimens look similar to the petrified forests in Yellowstone National Park, which were fossilized when volcanic materials buried the living trees.

"They're actually some of the best-preserved fossil plants in the world," Gulbranson says. "The fungi in the wood itself were probably mineralized and turned into stone within a matter of weeks, in some cases probably while the tree was still alive. These things happened incredibly rapidly. You could have witnessed it firsthand if you were there."

The researchers found the prehistoric plants could transition rapidly between seasons, perhaps within the span of a month. Whereas modern plants take months to transition and conserve water differently depending on the time of day, the ancient trees could fluctuate quickly between pitch black winters and perpetually sunny summers.

BED BUG PREVENTION METHOD BASED ON FUNGI SEES POSITIVE RESULTS

John Shumway

http://pittsburgh.cbslocal.com, Nov. 20, 2017

A Pennsylvania company formed by Don McCandles and Penn State entomologists Nina Jenkins and Giovanni Bellicanta is marketing a revolutionary concoction that prevents bed bugs.

Without getting too technical, Jenkins and Bellicanta figured out a way to bring *Beauveria bassiana*, a natural fungus found in soil, inside safely.

While the fungus is commonly used in agricultural battles against insects, Jenkins said, "This formulation is different. It's specifically designed to be used inside homes. It is harmless to humans and pets."

In the hands of a pest-control expert, the concoction, called Aprehend, is sprayed in about a 2-inch wide band around the baseboard, mattress, and headboard of a bed. The spray contains "at least 24 million spores per square inch," said Bellicanta. It creates sort of a bed bug barrier, and when the bug walks through it gets coated in the spores.

"They try to shake them off, and the more they try to get rid of them the more they pick up," Bellicanta said.

Being communal by nature, the now distraught bed bug heads for its den and proceeds to spread the spores to all the other bed bugs. Within days, the spores have penetrated the bugs and killed them.

Jenkins said even they were surprised when they tested it on bed bugs. "Bed bugs coming into contact with the fungal barrier we'd put down, even three months later, die of the fungal disease," she said.

McCandless says the pest-control world has seen their results and has only one question.

"The biggest question is when can we get it?" McCandless said.

The trio at Conidiotec are currently the only employees of the company. They are filling orders as fast as they can work out of their small warehouse workspace north of State College.

NEW TECHNOLOGY MAKES OAK WILT DETECTION FASTER, MORE AFFORDABLE

https://phys.org/, Nov. 9, 2017

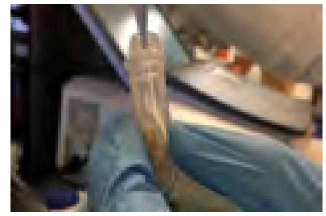
Oak wilt fungus (*Ceratocystis fagacearum*) is an invasive plant pathogen that often goes unnoticed until it's too late. Not anymore. New technology developed by University of Minnesota College of Food, Agricultural and Natural Resource Sciences (CFANS) Assistant Professor Abdennour Abbas and his research team offer a simple, affordable diagnostic test utilizing nanotechnology and gold.

"Oak wilt is the second greatest invasive disease threat to Minnesota's plants, second only to Dutch elm disease. The loss of elms transformed many of our urban and hardwood forests. We don't want our oaks to be next," said Robert Venette, Director of the Minnesota Invasive Terrestrial Plants and Pests Center (MITPPC) at the University of Minnesota.

The spread of oak wilt is sobering and serious. According to the USDA Forest Service, oak wilt fungus is present in 21 eastern states. More than 266,000 oak trees were infected by oak wilt fungus between 2007 and 2016 in Minnesota. The fungus is found spanning 25 counties including Sherburne, Anoka, Isanti, and northwestern Dakota counties.

Currently, oak wilt detection is performed by visual diagnostic (naked eye observation), which is only possible two to three weeks after infection, or with laboratory techniques that take from six hours to two weeks and cost $60 to $120 per sample. In the field, the symptoms of oak wilt can be confused with drought stress or insect damage.

The cost of infected tree removal alone is estimated to be up to $60 million at around $400 to $500 per tree. That doesn't include the impact on related economic activities. Oak trees not only represent an important natural habitat for wildlife, but also are a natural resource for firewood, furniture, construction, and livestock feed.



Microfluidic device used to isolate the oak wilt fungi from wood chip samples.

The innovation by Abbas' research lab enables oak wilt detection within 30 minutes of sampling and at a fraction of the cost: less than five dollars per sample. The technology uses the agglomeration of gold nanoparticles to generate a chemiluminescent signal that can be read by a hand-held reader in the presence of the oak wilt fungus DNA. The team is now refining a portable system that allows early detection of the disease in the field without sending samples to the laboratory. The new technology requires only dipping wood chips obtained from infected trees into a first solution to extract the DNA, then mixed with a second solution of gold nanoparticles to allow detection using a hand-held luminometer.

"When it comes to disease detection, time is a crucial factor that decides whether lives will be saved or not. However, making a rapid detection technology is not enough. The other challenge is to make the technology affordable and easy for people to use it," said Abbas.

"This is exactly the kind of innovation that we knew would be possible when our Center was created. MITPPC brings new talent and new solutions to the threats posed by terrestrial invasive species," said Venette.

SYNTHETIC SEX IN YEAST PROMISES SAFER MEDICINES FOR PEOPLE

Ian Haydon

The Conversation, via https://www.salon.com/, Nov. 10, 2017

Our old friend *Saccharomyces cerevisiae*—the yeast that's helped people bake bread and brew beer for millennia—has just had its sex life upgraded.

Bioengineers at the University of Washington have reprogrammed the mating habits of this single-celled organism, letting the fungus get it on like never before. The result? A sexual revolution that could lead scientists to safer future medicines.

Yeast as Lab Guinea Pig

We already rely on yeast for a lot more than just fermented food. Much of our modern understanding of genetics and cell biology has come from careful study and manipulation of the fungus.

Scientists and drug designers love working with yeast because of its rapid cell cycle (a new generation is born every 90 minutes) and the relative ease with which its genes can be tweaked. Even human genes and genes encoding protein-based drugs can be spliced in, allowing researchers to study them in the lab in detail. Anti-cancer drugs have been optimized this way.

One of the most popular techniques for this type of biomolecular research is known as yeast surface display. Using this method, a gene can be added to yeast and the protein that results will appear on the easily accessible outer surface of the cell. With a new protein displayed on the surface, researchers can easily determine what other biomolecules the protein interacts with.

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Synthetic Sex in Yeast, *cont from page 5*

This method, pioneered in the laboratory of Dane Wittrup, exploits aspects of the fungus' sexual machinery.

Yes, even single-cell microbes can have sex. But as is often the case outside the animal kingdom, the way DNA gets swapped can seem unusual to human observers.

Fungal Fornication

The terms "male" and "female" don't really apply to budding yeast. Instead of forming sperm or eggs, the sex cells of yeast all look the same—like tiny, single-cell blobs. What makes two yeast blobs able to sexually reproduce are their so-called mating types.

The proteins that decorate the outside of a yeast sex cell, or gamete, determine that cell's mating type. Put on copies of one protein and you're one mating type; swap them out for a different protein and you're the other. Agglutination (the unsexy term for yeast sex) only happens when the surface proteins of yeast gametes from opposite mating types interact.

Inspired by this molecular precision, a team of synthetic biologists led by University of Washington graduate student David Younger realized they could convert the natural yeast mating system into a new tool that would let them precisely measure molecular interactions at a much larger scale.

Though tiny and difficult to measure, molecular interactions are a big deal in drug design. Virtually every drug works via specific interactions with its target, and drugs that bind where they shouldn't can be lethal.

Some experts blame off-target interactions for last year's failed phase III clinical trial of Alnylam Pharmaceuticals' revusiran, an RNA drug designed to treat a rare heart disease. Nineteen people died before the trial was called off, and the company's stock took a US$3 billion hit.

Figuring out whether a new drug binds what it's supposed to is relatively easy; figuring out whether it binds anything else in our cells is tough. Established laboratory techniques like yeast surface display have helped scientists screen new drugs for potentially dangerous off-target interactions before they make it to clinical trials, but that technique lets you look for off-target interactions only one at a time. Younger's team envisioned a way to test hundreds of drugs against thousands of potential targets, all by redesigning yeast sex.

Redesigning Yeast Sex with Multiple Mating Types

To start, Younger needed a way to precisely measure mating efficiency in lab-grown yeast. Perfect efficiency would mean every cell that could fuse would do so. The more efficient the mating, the better matched the two mating types.

The team linked genetically encoded fluorescent markers—one blue, one red—to each of the natural yeast mating types. That made it simple to measure mating efficiency for a whole yeast population: They could just count the cells that stayed blue or red (unmated) versus those that turned purple (mated). It turns out for typical yeast grown in the lab, mating efficiency is around 60 percent.

The team then deleted the natural agglutination proteins and replaced them with a pair of foreign proteins known to interact weakly. The mating efficiency dropped tenfold to 5.7 percent. They swapped in another pair and saw it rise to 19 percent. When they tried a third pair of proteins known to interact with much higher affinity, mating efficiency rose to 51.6 percent—close to what was seen in natural agglutination.

Just by tracking mating efficiency, the team could tell how strongly any two protein molecules interact. When they checked a pair of proteins that shouldn't interact at all, mating efficiency was a meager 0.2 percent.

Now, instead of just the two natural mating types, scientists can quickly engineer thousands of "sexes" by coaxing individual yeast to decorate the outside of their cells with new, human-specified proteins. If a pair of new mating types are sexually compatible—meaning the proteins decorating their cell surfaces interact—their offspring will rise in number. By tallying up each genetically distinct offspring in a tube not much bigger than a thimble, thousands of potential molecular interactions can be quantified.

Improving Drug Safety

To show that their new tool could aid in drug development, the team generated 1,400 distinct variants of an emerging anti-cancer drug known as XCDP07. The drug is supposed to disrupt the unrestrained growth of cancer cells by binding specific cellular targets, but as with every drug, significant off-target interactions could render it useless. By mixing yeast displaying different versions of the drug with other yeast displaying human proteins, the team was able to identify versions of XCDP07 which bound only to the intended target.

Younger is working to get his new tool into the hands of more scientists. He's already gifted his engineered yeast strains to eager researchers at Stanford, Yale, UCSD, and beyond. Concerns over the cost and safety of emerging drugs have motivated him to start a company—funded by scientific grants, not investors—to turn his results into the next generation of medicines. Younger says the goal is to provide "comprehensive preclinical drug screening, rather than the current practice of screening a very small subset of possible off-target interactions."

The next blockbuster drugs may owe a debt to yeast and their mating practices. Who says you can't teach an old fungus new tricks?

HOW THE ZOMBIE FUNGUS TAKES OVER ANTS' BODIES TO CONTROL THEIR MINDS

Ed Yong

https://www.theatlantic.com, Nov. 14, 2017

To find the world's most sinister examples of mind control, don't look to science fiction. Instead, go to a tropical country like Brazil, and venture deep into the jungle. Find a leaf that's hanging almost exactly 25 centimeters above the forest floor, no more and no less. Now look underneath it. If you're in luck, you might find an ant clinging to the leaf's central vein, jaws clamped tight for dear life. But this ant's life is already over. And its body belongs to *Ophiocordyceps unilateralis*, the zombie-ant fungus.

Katja Schultz

Zombie ant with Ophiocordyceps unilateralis growing out of its head.

When the fungus infects a carpenter ant, it grows through the insect's body, draining it of nutrients and hijacking its mind. Over the course of a week, it compels the ant to leave the safety of its nest and ascend a nearby plant stem. It stops the ant at a height of 25 centimeters—a zone with precisely the right temperature and humidity for the fungus to grow. It forces the ant to permanently lock its mandibles around a leaf. Eventually, it sends a long stalk through the ant's head, growing into a bulbous capsule full of spores. And because the ant typically climbs a leaf that overhangs its colony's foraging trails, the fungal spores rain down onto its sisters below, zombifying them in turn.

The fungus's skill at colonizing ants is surpassed only by its skill at colonizing popular culture. It's the organism behind the monsters of the video game "The Last of Us" and the zombies of the book *The Girl With All the Gifts*. It's also an obsession of one David Hughes, an entomologist at Pennsylvania State University, who has been studying it for years. He wants to know exactly how this puppet master controls its puppets—and his latest experiments suggest that it's even more ghoulish than it first appears.

Hughes's student Maridel Fredericksen used a special microscope to julienne infected ants into slices that were just 50 nanometers thick—a thousandth of the width of a human hair. She scanned each slice, compiled the images into a three-dimensional model, and painstakingly annotated which bits were ant and which bits were fungus. It took three months to mark up just one muscle. To speed things up, Hughes teamed up with computer scientist Danny Chen, who trained an artificial intelligence to distinguish ant from fungus.

"Something much more intricate must be going on."

When the fungus first enters its host, it exists as single cells that float around the ant's bloodstream, budding off new copies of themselves. But at some point, as Fredericksen's images show, these single cells start working together. They connect to each other by building short tubes, of a kind that have only ever been seen before in fungi that infect plants. Hooked up in this way, they can communicate and exchange nutrients.

They can also start invading the ant's muscles, either by penetrating the muscle cells themselves or growing into the spaces between them. The result is ... a red muscle fiber, encircled and drained by a network of interconnected yellow fungal cells. This is something unique to *Ophiocordyceps*. Hughes's team found that another parasitic fungus, which fatally infects ants but *doesn't* manipulate their minds, also spreads into muscles but doesn't form tubes between individual cells, and doesn't wire itself into large networks.

Whenever Hughes or anyone else discusses the zombie-ant fungus, they always talk about it as a single entity, which corrupts

and subverts a host. But you could also think of the fungus as a colony, much like the ants it targets. Individual microscopic cells begin life alone but eventually come to cooperate, fusing into a superorganism. Together, these brainless cells can commandeer the brain of a much larger creature.

But surprisingly, they can do that without ever physically touching the brain itself. Hughes's team found that fungal cells infiltrate the ant's entire body, including its head, but they leave its brain untouched. There are other parasites that manipulate their hosts without destroying their brains, says Kelly Weinersmith from Rice University. For example, one flatworm forms a carpet-like layer over the brain of the California killifish, leaving the brain intact while forcing the fish to behave erratically and draw the attention of birds—the flatworm's next host. "But manipulation of ants by *Ophiocordyceps* is so exquisitely precise that it is perhaps surprising that the fungus doesn't invade the brain of its host," Weinersmith says.

In retrospect, that makes sense. "If such parasites were merely invading and destroying neuronal tissue, I don't think the manipulated behaviors that we observe would be as compelling as they are," says Charissa de Bekker from the University of Central Florida. "Something much more intricate must be going on." She notes that the fungus secretes a wide range of chemicals that could influence the brain from afar.

So what we have here is a hostile takeover of a uniquely malevolent kind. Enemy forces invading a host's body and using that body like a walkie-talkie to communicate with each other and influence the brain from afar. Hughes thinks the fungus might also exert more direct control over the ant's muscles, literally controlling them "as a puppeteer controls a marionette doll." Once an infection is under way, he says, the neurons in the ant's body—the ones that give its brain control over its muscles—start to die. Hughes suspects that the fungus takes over. It effectively cuts the ant's limbs off from its brain and inserts itself in place, releasing chemicals that force the muscles there to contract. If this is right, then the ant ends its life as a prisoner in its own body. Its brain is still in the driver's seat, but the fungus has the wheel.

FLOWER ATTRACTS INSECTS BY PRETENDING TO BE A MUSHROOM

https://www.sciencedaily.com/, Nov. 15, 2017

The mysterious flowers of *Aspidistra elatior* are found on the southern Japanese island of Kuroshima. Until recently, scientists thought that *A. elatior* has the most unusual pollination ecology among all flowering plants, being pollinated by slugs and amphi-

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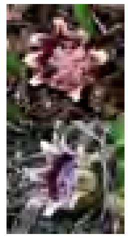
Flowers That Imitate Mushrooms, *cont. from page 7*

pods. However, direct observation of their ecosystem has revealed that they are mainly pollinated by fungus gnats, probably thanks to their resemblance to mushrooms.



Aspidistra elatior.

This discovery was made by Project Associate Professor Suetsugu Kenji (Kobe University Graduate School of Science) and Senior Researcher Sueyoshi Masahiro (Forest Zoology Group, Kyushu Research Center). The findings were published on November 14, 2017, in the online edition of *Ecology*.

Aspidistra elatior is a popular houseplant, known as the “cast iron plant” for its ability to withstand neglect. Its purple, fleshy flowers bloom directly above the soil, almost burrowing into the ground and often hidden by leaf litter. Their appearance has been compared to mushrooms—one of the foods of choice for the fungus gnats that visit these flowers. The oddly shaped flowers of *A. elatior* are probably a clever strategy: mimicking mushrooms in order to trick fungus gnats into pollinating them.

Reports of slug pollination for *A. elatior* date from over 100 years ago, when slugs were observed visiting plants in Europe. This theory is still widely accepted and even appears in textbooks. However, the observation has a flaw—it was not made in the plant’s natural habitat. Furthermore, slugs are known for eating leaves and flowers, and they may have been damaging the plants, not pollinating them.

In 2009 there were reports of fungus gnats visiting *A. elatior* flowers. But this observation was also made outside the plant’s native habitat, and was only a single report.

This time the research team took a different approach. “For two years we observed the animals that visited these flowers in their native habitat, continuously, day and night.” The result? “We discovered that no slugs visited, and hardly any beach fleas. The candidate that emerged as an effective pollinator was the fungus gnat. Fungus gnats that visited the plants quickly dived into the center of the flowers, attached a large amount of pollen to their bodies, and flew away.” The team also saw fungus gnats arriving at *A. elatior* flowers carrying pollen from other flowers, and observed that the flowers they visited produced fruit. This proved that fungus gnats were the true pollinators.

Professor Suetsugu comments: “We believe that the similar appearance of *A. elatior* and mushroom fruit bodies may help attract fungus gnats. In addition, *A. elatior* emits a strong musty odor. Therefore, the fungus gnats may be deceived by both visual and chemical mimicry.”

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