

# SPORE PRINTS

BULLETIN OF THE PUGET SOUND MYCOLOGICAL SOCIETY  
Number 550 March 2019



## A FLEET OF MUSHROOM FARMS IS SPREADING ACROSS NEW YORK **Brian Kahn**

<https://earther.gizmodo.com/>, Feb. 7, 2019



Hannah Shuffro/The Guardian

*Smallhold Minifarm unit at a Whole Foods store.*

BROOKLYN, NY - Between the pasta and deli counters in the middle of a Whole Foods store is the last place you'd expect to find a contraption that simultaneously evokes a rave and a forest floor, let alone a brand-new way of farming. Yet Smallhold's Minifarm is all of these things.

The sleek metal and Plexiglas case holds blue, pink, and yellow oyster mushrooms. Their alien forms are striking enough, but bathing them in psychedelic hues to mimic lunar cycles and pumping in mist to keep them comfortably moist gives you your warehouse rave vibe. Slide open the door, close your eyes, and the rich scents of decay and growth mingle, transporting your mind to a childhood summer's day in the woods, flipping over logs and churning last year's leaf litter.

Smallhold, a Brooklyn-based company that builds high-tech, climate-controlled "Minifarms" that grow mushrooms, has been rolling out its wares in the New York area in restaurants and, more recently, Whole Foods. The fungus-filled devices hardly look like farms in the traditional sense, but that's kind of the point. A sliver of the growing urban agriculture movement, the Minifarms aim to cut the distance from farm to table, reduce food waste, and use tiny sensors to perfect growing mushrooms.

Smallhold aims to transform how mushrooms are grown. The Minifarms come in single stories, like the one that snakes through Mission Chinese restaurant in Manhattan, or they can be stacked like a recently-installed unit I visited in Whole Foods. To stock the shelves of the Minifarms, the company builds its own bricks of sawdust and inoculates them with mycelium, which are essentially

the tree mushrooms grow from. Those bricks then get delivered to the Minifarms where the mycelium puts out its mushroom fruit for harvest. Under the right conditions, it takes just seven days to sprout mushrooms from the mycelium-laced sawdust bricks. Smallhold will also take back the sawdust bricks once the mushrooms have been harvested and turn them over to a local compost operation.

In addition to mushrooms, the Minifarms harvest data. The sensors inside each one measure temperature, carbon dioxide, and humidity. Some units even have cameras that snap photos every few minutes. All that information—some 30 million data points total—is routed to a central nervous system and used by the company to create what Adam DeMartino, cofounder of Smallhold, calls "recipes" of temperature, humidity, light, and more that can be used to max out mushroom growth. Once the company hits on a winning recipe, it can replicate it at any of its Minifarms.

"So if you take a block of yellow [oyster mushrooms] and then you multiply that by however many is on a shelf, what we can do is within reason right now reliably predict how much you're going to get off of a shelf off of a unit in a spot somewhere in New York City," DeMartino told *Earther*.

That targeted data allows anyone with a Minifarm to harvest their mushrooms at peak growth and wring the most profit per square inch out of the system (which is important because complex units can run thousands of dollars). The Whole Foods version is capable of churning out 40–80 lb of mushrooms each week. Optimizing growth also allows the farms to use less water and energy and cuts down on food waste by helping growers pluck their mushrooms at just the right time.

"We're still using transportation, but it's a different type of transportation," Andrew Carter, the other Smallhold co-founder told *Earther*, referring to having to deliver the inoculated sawdust blocks. "We don't have to refrigerate it, we don't have to have the same sort of climate control, we don't have to pack it in the same way that you would if you harvested a product, and you have a considerably less food waste in the distribution process."

## LOOK WHO ELSE LIKES MUSHROOMS

<https://www.facebook.com/YosemiteNPS/>, Feb. 10, 2019

Look who else likes mushrooms! This Douglas squirrel was caught harvesting a mushroom and squirreling it away high in a tree to dry. When the ground is covered by snow, squirrels return to their larders of dried mushrooms and pine seeds to survive the winter.



#WildScience #Scat

# Spore Prints

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## PSMS SURVIVORS' BANQUET AND ANNUAL MEMBERSHIP MEETING

Saturday, March 9, 2019, at 7:30 pm, at the Center for Urban Horticulture, 3501 NE 41st Street, Seattle, WA 98105 (doors open at 6:30 pm for the social hour). This replaces our March general membership meeting.

It's time again to gather and congratulate each other for making it through another season of finding, cooking, and eating mushrooms.



Seating will be limited, so register early to guarantee your place. You must be pre-registered to attend. The cost is \$5/person to cover incidentals. No refunds. As in previous years, the event will be a potluck dinner for PSMS members only, but if your significant other or dinner partner is not a member, you can still include and register them. We will have a banquet permit, so bring your favorite wine or beer, but no hard liquor, please!

Our banquet theme this year is "Celebrating Mushrooms in Asian Cuisine." PSMS will be providing some Asian entrées to supplement the meal. Please label your contributions with the ingredients and species of mushrooms used, if any. We will have a short presentation (or two), introduce the newly elected board members and officers for 2019-2021, announce the winner of the 2019 Patrice Benson Golden Mushroom Award for outstanding service to our society, and hand out a few door prizes. This promises to be a fun evening with friends and family, so come join us!



There will also be a silent auction with all proceeds going to the Ben Woo Scholarship Fund.



## CALENDAR

- Mar. 1 PSMS Scholarship deadline
- Mar. 3 PSMS Election voting deadline
- Mar- 9 Survivors' Banquet, 6:30-10:00 pm, CUH
- Mar. 18 PSMS Board meeting, 7:30 pm, CUH board room
- Mar. 19 *Spore Prints* deadline

### *A Variety of Mushrooms*

*There are mushrooms that are pretty;  
There are mushrooms that are not.  
There are mushrooms that smell gorgeous,  
And some that stink a lot.  
There are mushrooms that are commonplace,  
And some that are incredible.  
But the mushrooms that attract me most  
Are the species labeled "edible."*

—Don Goetz, *The Fungus-Amungus*,  
Spokane Mush. Club,  
April 2001

## MAN ACCUSED OF FATALLY SHOOTING FRIEND WHILE HIGH ON MUSHROOMS

<https://flatheadbeacon.com/>, Feb 4, 2019

BILLINGS - Montana authorities say a 30-year-old Billings man shot and killed a friend and wounded himself with a military-style AR-15 carbine while they were tripping on mushrooms last fall. William Eugene Kenney told a detective that he and 25-year-old John Smathers "got kinda crazy" and thought they were dying after getting high on psilocybin mushrooms on Nov. 21.

Kenney pleaded not guilty on Friday to negligent homicide with a weapons enhancement. An autopsy showed Smathers died of a single gunshot wound to the back of the head. Kenney had a gunshot wound to his chin.

He is in jail on a \$50,000 bond.

## POTENTIAL RISKS OF RECREATIONAL “MAGIC” MUSHROOMS

Sophia Mitrokostas

Businessinsider.com., Jan. 2019 via

*The Spore Print*, L.A. Myco Soc., Feb. 2019



Magic mushrooms are hallucinogenic fungi containing a compound called psilocybin that can trigger hallucinations, a sense of euphoria, and changes in your perception of space and time.

Because magic mushrooms are illegal and not monitored, there’s a risk you could ingest a fake mushroom or the wrong kind.

It’s possible to have a “bad trip” or experience hallucinogen-induced persisting perception disorder, or HPPD. Because studies done on magic mushrooms are done in controlled environments, it’s hard to know all the risks of using the drug recreationally.

Magic mushrooms contain a compound called psilocybin that, when ingested, becomes psilocin. This chemical activates serotonin receptors in your brain, triggering vivid hallucinations, a sense of euphoria, and changes in your perception of space and time.

Because they can be found growing in the wild, magic mushrooms are sometimes thought of as a safe alternative to harder drugs. There are, however, still potential risks associated with tripping on these psychedelic fungi.

Further, it’s important to note that the limited studies done on magic mushrooms, or psychedelics in general, are done in a controlled environment with a controlled dosage and those using the drugs recreationally likely will have different outcomes.

The most commonly reported negative side effect of taking magic mushrooms is having a bad trip. This might involve unpleasant physical symptoms such as nausea, chills, vomiting, or headaches. The user might also experience negative psychological effects such as paranoia, anxiety, or even extreme terror.

“Psychological distress is the most common adverse effect reported after use of psilocybin. This can range from a ‘bad trip’ to disturbing hallucinations that can last for days,” Dr. Lawrence Weinstein, chief medical officer of American Addiction Centers, told *Business Insider*.

Under normal circumstances, the mind-altering effects of psilocybin-containing mushrooms usually last from six to eight hours depending on dosage, preparation method, and personal metabolism. The first three to four hours of this period are usually the most intense. However, the effects can seem to last much longer to the user because of psilocybin’s ability to alter time perception, according to Weinstein.

The way you feel while under the effects of magic mushrooms can be affected by a number of things, including the dose, your environment, who you are with, and what your mood or mental state was like before taking mushrooms. Being in a fearful or gloomy state of mind before taking psilocybin mushrooms may intensify any negative feelings you already have, leading to a bad trip.

Anyone dealing with psychological problems or mood disorders should think twice before taking magic mushrooms. Because of the way psilocybin works on the brain, taking mushrooms might

have negative consequences for someone whose mental health is already compromised.

“The interaction of psilocin with serotonin receptors in the prefrontal cortex can alter brain chemistry and can make conditions such as panic disorder, bipolar disorder, or anxiety worse,” said Weinstein.

Even people without preexisting mental health problems might experience increased panic attacks after taking magic mushrooms.

“When the mushrooms interact with your system, you are subjecting your body to the possibility of severe anxiety or panic attacks, including dizziness and lightheadedness,” Dr. Cali Estes, Ph.D., addiction specialist and founder of *The Addictions Academy*, told *Insider*.

Some research, however, claims magic mushrooms given under the supervision of a professional can help with anxiety, though more research is likely needed.

Because magic mushrooms are illegal in most countries and not regulated like other pharmaceuticals, there is no way to tell what you’re getting when you buy a batch of mushrooms.

“Some drugs sold as ‘magic mushrooms’ have turned out to be store-bought mushrooms laced with another hallucinogen such as PCP or LSD, or a different drug entirely,” warned Weinstein.

This means that purchasing magic mushrooms carries the risk of ingesting a range of other drugs, some of which may carry the very real risk of a fatal overdose or bad reaction. If you’re worried about the authenticity of a psilocybin mushroom, it’s better to not risk ingesting it.

When it comes to taking magic mushrooms, one of the worst-case scenarios is accidentally ingesting a poisonous mushroom instead of one containing psilocybin.

Weinstein warned that users who try to harvest their own mushrooms in the wild are especially at risk of accidental poisoning from toxic species since it can be easy to mistake a harmful fungus for a hallucinogenic mushroom.

The symptoms of mushroom poisoning—including muscle weakness, confusion, gastrointestinal issues, and delirium—can sometimes be mistaken for those of a bad trip, so it’s important to seek medical attention immediately if ingestion of a toxic mushroom is suspected.

There’s a common misconception that taking magic mushrooms carries no risk of overdose. However, that’s actually not the case.

“Overdosing on mushrooms is entirely possible, but it is rare. Some signs of mushroom overdose include panic attacks, paranoia, psychosis, vomiting, agitation, and seizures,” said Weinstein.

“Effects of taking ‘too many mushrooms’ last between six and eight hours, but some of the effects can take days to subside,” he added.

If you do accidentally ingest more psilocybin than intended and start to exhibit negative side effects, seeking medical attention is always the best call.

It might be possible that taking psychedelic substances such as magic



*cont. on page 4*



## Risks of Magic Mushrooms, *cont. from page 3*

mushrooms can induce psychosis, though recent studies done in controlled environments say the drugs and the development of psychosis aren't associated.

"The use of psychedelic drugs can trigger psychosis brought on by psilocybin, which is very similar to schizophrenia. Individuals with a family history of schizophrenia or other psychotic disorders are at risk of experiencing a psychotic episode," said Weinstein. A person is more at risk of experiencing this serious side effect if they have taken a large amount of psilocybin or mushrooms.

"Depending on the amount and frequency of mushroom intake, you can cause permanent brain damage as a result of magic mushrooms," cautioned Dr. Estes.

Studies have confirmed that taking magic mushrooms can permanently alter your brain, though this isn't necessarily said to always be negative.

Another rare but serious potential side effect of taking psychedelic mushrooms is the possibility of developing something called hallucinogen-induced persisting perception disorder, or HPPD.

"This disorder causes an individual to have flashbacks of their experiences under the influence of a hallucinogen days, months, or years after their last use, even if they no longer take the drug. This disorder can lead the individual to suffer severe distress and experience frightening hallucinations," warned Weinstein.

Risk factors for developing this disorder include having other mental health issues or regularly using a hallucinogen over a long period of time. Unfortunately, there is no formal treatment for this disorder.

Users of magic mushrooms typically welcome the hallucinations and sense of altered reality that the fungi can bring. However, this altered perception of the world can potentially lead individuals to take unusual risks or unknowingly placing themselves in dangerous situations.

Mushrooms can increase your risk of injury by impairing your judgment, as well as causing confusion, drowsiness, and loss of motor coordination.

No research, however, has been done on the correlation of recreational mushroom use and risky behaviors.

There isn't anything in magic mushrooms that can lead to a chemical addiction, as can happen with drugs like nicotine or heroin. Despite this fact, mushrooms do have the potential to disrupt your life if using them frequently causes you to neglect or ignore other hobbies and responsibilities.

"The signs of addiction are someone who is spending more time obsessing or thinking about them, missing work to get high, or overusing or misusing mushrooms on a daily basis," said Estes.

However, Weinstein pointed out that there has been no research-based evidence that mushrooms, or other psychedelic drugs, are considered to be addictive physically or psychologically.

If you take magic mushrooms regularly, you might become less sensitive to other mind-alternating recreational substances.

"Individuals may develop a cross-tolerance from continued use of mushrooms, meaning they will have a high tolerance to similar substances such as LSD or marijuana," said Weinstein.

As it can be difficult to know the strength of unregulated substances like marijuana or LSD, developing a cross-tolerance can put you at risk of accidentally taking too much of another psychoactive drug in an effort to feel its full effect.

## MILT TAM'S MAKE YOUR OWN MUSHROOM KIT Julia, Green Thinker

<http://re-thinkgreen.com/>, Feb. 24, 2016

Hello mushroom lovers! I'm excited to share this super easy method of creating your own mushroom kit, which I stumbled upon recently.... at a Hands-On Skills Fair organized by Sustainable NE Seattle! The other 20 participants and I were guided in this project by Milton Tam of the Puget Sound Mycological Society. Check out the pics below as well as the following directions for building the mushroom kit.



*Do-it-yourself mushroom-growing kit: recycled newspaper pellets, alfalfa pellets, water, mushroom spawn, blue newspaper bag.*

Here are a few caveats before I lay it out. Tam developed this easy technique to be used with groups. Any group of kids at a school or summer camp could do this on a picnic table after a trip to Petco and an online order of mushroom spawn or a few previously used kits which now contain mushroom spawn. His emphasis was on making kit instructions out of materials that would be easy to procure, simple to prepare, and not so messy to use. In the Sustainable NE Seattle workshop, people asked all kinds of questions about what post-consumer products they could use instead of buying stuff at Petco. It is possible to make a substrate out of coffee grinds and/or shredded newspaper. The Fungi Perfecti reference booklet mentioned below has professional instructions on that.

### DIY Mushroom Kit Supply List

- 4 cups of Purina Yesterday's News recycled newspaper pellets, unscented, no artificial fragrances, softer texture (violet color on package). One big bag of this product will make 20–22 mushroom kits.
- 4 cups dechlorinated tap or well water. (Use warm water or water that has sat out overnight uncovered so chlorine could dissipate.)
- 1/2 cup alfalfa pellets (guinea pig or rabbit food, such as these or these organic ones). This is optional but improves "vigor and yield of mushrooms and allows for a second fruiting 2 weeks after the first," according to Tam.
- 1 cup oyster mushroom grain spawn (or sawdust spawn) from a reputable supplier. A 5 lb bag of just the spawn is \$20 from

Fungi Perfecti in Olympia, WA, which also offers a “mushroom patch kit” consisting of spawn and an extensive instruction booklet. NW Mycological Consultants sells 7 lb of grain spawn for \$20, which will make 22–24 kits. Alternatively, you can break up a kit that you previously made with this recipe that has finished producing mushrooms. A list of other potential suppliers of spawn can be found at <http://mycology.cornell.edu/fsupplies.html>.

- A large, clean plastic bin for mixing
- Plastic newspaper bags. These are the right size and shape and have not been treated with antimicrobials as some other plastic bags are.

## DIY Mushroom Kit Instructions

### Part 1: At the workshop

Combine the newspaper pellets and water in the plastic mixing bin and let them sit for 5–10 minutes until they absorb all the water (no pooling).

Mix the soaked mixture to fluff it up a little, then add the alfalfa pellets (optional) and 1 cup grain spawn.

Mix well, then fill the newspaper bag with this mixture. (You’ll have to use your hands—make sure they’re clean.)

Pack down gently to remove air pockets, then twist and tie a knot at the end.



Mix well, fill bag, pat, tie, and take home.

### Part 2: At Home

Cut 4 slits about 1-in. long in the plastic bag. Place kit in a dimly lit or dark, cool area (60–70°F). Mark with the date.

After 2.5–4 weeks, the bag should be filled with white mycelium. At this point, move the mushroom kit to a cool, well-lit room but keep it out of direct sunlight (not on a windowsill).

Inspect daily for signs of baby mushrooms (primordia) growing at slits or elsewhere. Cut more holes in the bag if necessary to free the growing mushrooms. Use boiled and cooled water (or water that has stood out overnight) to mist mushrooms several times a day, as evaporation stimulates growth, but do not soak or over-wet.

Mushrooms should double in size every day. Pick whole clusters when each mushroom is about 2-in. in diameter. Cook in your favorite mushroom dish and enjoy!

Once this first fruiting is over, you can return the kit to a cool, dark place for another 2–3 weeks and repeat the whole process a second time. Once you are done with the kit, you can break it up and use 1 cup of the material as the “mushroom spawn” ingredient for a new kit (so maybe make 5 new kits out of one spent one?), or break up and add to your garden soil or compost pile as a soil amendment.



The yield.

## Tips I Wish I Had Known

These things grow REALLY fast. Get your ruler or other measuring device out when you set up the kit so you’ll be ready to measure and harvest when the biggest mushrooms are 2–2.5 in. in diameter.

The mushroom organism will “abort” most primordia to allow one or two dominant ones to grow to their full potential. So don’t cut lots of holes in the plastic everywhere you see primordia, cuz they won’t turn into much anyway, and it just makes the kit dry out.

Harvest the mushroom bunch by twisting it off instead of cutting it. If you cut it, there’s a stem that stays there and may rot if you try to keep using the kit.

**Update:** This yielded 3 cups of oyster mushrooms, which I used to make *gomba paprikás*!



*Gomba paprikás with oyster mushrooms.*

## DARWIN’S FORGOTTEN FUNGUS FOUND AT CAMBRIDGE UNIVERSITY HERBARIUM

Alex Spencer

<https://www.cambridgeindependent.co.uk/>, Feb. 6, 2019

A priceless specimen collected by Charles Darwin on the *HMS Beagle* voyage has been discovered in the back of a cupboard.

The find was made by the curator of Cambridge University Herbarium, Dr. Lauren Gardiner, who will discuss it and other highlights of the collection during the Cambridge Science Festival, which is supported by the Cambridge Independent.

She spotted the fungus in a dried out pickling jar, which had likely remained untouched since it first came into the university’s possession more than 150 years ago.

Gardiner said: “I found this specimen last year, at the back of a cupboard. It was part of the Botanical Museum we used to have in Cambridge and it used to be preserved in alcohol but had completely dried out. The seal was broken, all the alcohol had gone, and it looked revolting.

“But I took it out and looked at it and realized immediately it was a Darwin specimen.”

What’s more, Gardiner found out that the fungus was part of the original “type” material, which means it is the original physical example of an organism, known to have been used when the species was first described and named.

Darwin’s fungus—formally named *Cyttaria darwinii*—is an orange golf ball-like fungus that he collected in Tierra del Fuego during his voyage on *HMS Beagle*.

Previously, it was thought that Royal Botanic Gardens, Kew, had the only type material for this specimen. But Gardiner has the original publication by Darwin’s friend, the mycologist Miles Berkeley, which describes the *Cyttaria* fungus found on the *HMS Beagle* voyage and backs up Cambridge’s claim by mentioning the specimen at Cambridge.

cont. on page 6



## Darwin's Fungus, cont. from page 5

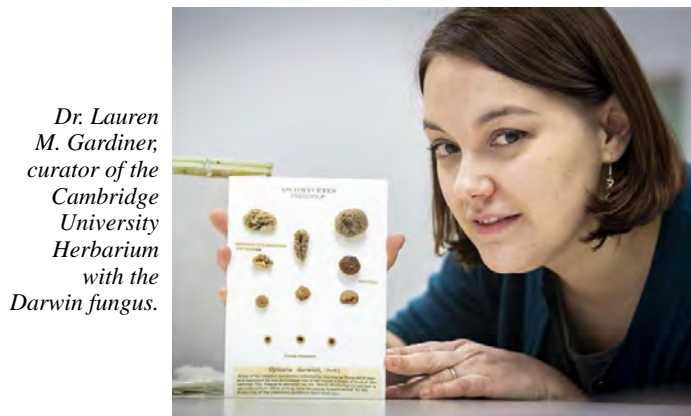
"It is a very exciting discovery but all natural history collections have all sorts of things in cupboards—even if you have a huge complement of staff, there are so many things in the collection you do not have the capacity to curate and there are plenty of exciting discoveries to be made here.

"A lot of our tropical material and our 19th century material was in storage for most of the last 150 years and there is so much material to look at. We quite likely have more Darwin samples in this collection that we haven't identified yet."

Gardiner is the only full-time member of staff looking after the herbarium, which has 1.1 million plant specimens in the collection. She hopes eventually to raise funds for more staff to document and research undiscovered gems held by the Herbarium.

One important resource that is yet to be fully researched is the collection that belonged to eminent botanist, John Lindley.

"The Lindley collection is really significant," she says. "It is much of the historic herbarium of the what is now the Royal Horticultural Society. It was actually in John Lindley's personal collection and Cambridge University purchased it from his family after he died in 1865. It is laden with thousands of these important "type" specimens."



Dr. Lauren M. Gardiner, curator of the Cambridge University Herbarium with the Darwin fungus.

Keith Heppell

## MATSUTAKES, Now More Clearly

*FUNGI*, Spring 2018  
via *Mycolog*, Humbolt Bay Myco. Soc., Feb. 2019

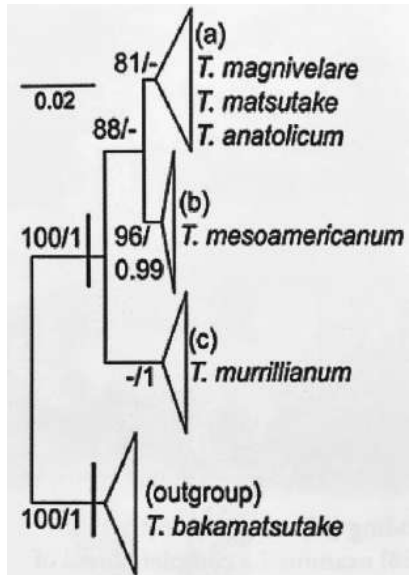
The matsutake mushroom (or "pine mushroom" to Canadians) is one of the most recognizable and highly prized edible mushrooms of North America. It is even more highly revered in Japan. Worldwide, there are a few species that go by this common name.

Because Japanese production of native *Tricholoma matsutake* is insufficient to meet the high domestic demand, morphologically similar mushrooms, that we over here have always called *T. magnivelare*, are imported from western North America. However, molecular data produced since the early 2000s have indicated that more than one species of matsutake occur in North America. This raises the question of correct naming for the different species.

To address this question, Trudell et al. assessed the phylogenetic diversity within North American matsutake using morphological characters and DNA sequence analysis of a large number of isolates collected (and amazingly not eaten!) from the wild. They

even made use of newly obtained sequences from the original type collections made long ago for what was then described as *Agaricus ponderosus* and *Armillaria arenicola*.

Their results agree with earlier indications that three matsutake species occur in North America: *T. magnivelare* from the eastern USA and Canada (which we used to call *T. matsutake*), *T. murrillianum* from the western USA and Canada (which we used to call *T. magnivelare*), and a brand-new species they described and named as, *T. mesoamericanum* from Mexico. So, at long last, these are the names we should be using for our matsutake mushrooms!



Matsutake family tree.

The existence of the three North American species is further supported by the results of evolutionary divergence analysis, geographical distributions, and morphological characters. A phylogenetic tree inferring relatedness of matsutake species is helpful to show who is more closely related to whom. Most closely related to matsutake of eastern North America (*T. magnivelare*) is *T. matsutake* of Asia and *T. anatolicum* of Turkey and North Africa. Next closest relative is *T. mesoamericanum*, the matsutake of southwestern North American, including Mexico. Curiously, the most distantly related to eastern matsutake is the matsutake of the Pacific Northwest, *T. murrillianum*.

## TO FIGHT FOES LIKE FUNGI, WASP EGGS SPEW DEADLY GAS

Jake Buehler

<https://www.nationalgeographic.com/>, Feb. 5, 2019

Wasps have rather obvious defenses, such as venomous stingers. But their eggs—soft, oblong, and motionless—are vulnerable to foes like fungi.

Enter the beewolf. New research shows that this wasp has evolved an incredible way to protect their young: The eggs act like living gas grenades, fumigating their nursery chamber with anti-fungal fumes.

European beewolves (*Philanthus triangulum*) are solitary wasps that get their name from the females' habit of hunting down bees, stinging them with paralytic venom, and dragging them into a dirt burrow.



Deskgram

Beewolf wasp carrying a paralyzed bee to its nest.

The beewolf lays an egg on the ill-fated bee, which feeds the carnivorous larva upon hatching. While it's a good place to hide, the warm, dank chamber is the perfect environment for mold to grow.



Wikipedia

*Beewolf dragging paralyzed honeybee to its nest.*

## Stink Bomb

Erhard Strohm, a biologist at the University of Regensburg in Germany, has studied beewolves for more than 30 years, rearing the insects in the laboratory to observe their parasitic reproductive cycle. It was in the lab that Strohm first got an inkling that the eggs themselves were doing something odd. And stinky.

“While opening the observation cage I noticed a strange smell [that] emanated from the egg,” Strohm says. Because the odor was reminiscent of a chlorinated swimming pool, Strohm suspected the cause was some sort of strong oxidant (like chlorine), which all smell similar.

Strohm and his colleagues dug deeper, comparing relative mold growth on paralyzed bees incubated with or without an egg laid on top. Bees carrying eggs stayed mold-free far longer than those without a wasp egg, demonstrating that the egg itself was doing something special.

When the researchers incubated paralyzed bees in chambers with an egg that *wasn't even touching them*, they still thwarted the mold, confirming what Strohm's nose uncovered—the eggs' weapon was airborne.

Next, the team searched for the gas's identity. Based on the strong smell, they guessed it might be nitrogen dioxide (NO<sub>2</sub>). Many organisms produce the compound's precursor, nitric oxide (NO)—which becomes pungent nitrogen dioxide once it reacts with oxygen in the atmosphere.

The precursor is used in everything from immune responses to regulating the heart, but it—like nitrogen dioxide—is also an effective antimicrobial in the right dosage.

To see if both gases were involved, the researchers performed a chemical test that marked them with a rouge fluorescent dye. Sure enough, the freshly-laid eggs gave off an intense red glow in the laboratory.

The findings, described in a new study published in BioRxiv, which allows scientists to share results before they are peer-reviewed, stunned the team.

## Surprising Weapon

“Every colleague whom I told about the brood cell fumigation... was really astonished,” says Strohm, the paper's lead author.

Andrew Forbes, an evolutionary biologist at the University of Iowa not involved with this study, says he's fascinated by the fact the beewolves have multiple innovations to protect their eggs, apparently including fumigation. Besides the gas, the wasps also embalm the paralyzed bees before laying any eggs with secretions

that help dehydrate the hapless prey and make it less susceptible to fungus.

Beewolves aren't the only insects to use gas-based defenses. Strohm's group also found a different species of parasitic wasp that fumigates its nursery with a different sanitizing chemical, but does so as a larva (and not an egg). Andreas Vilcinskas—an entomologist at Germany's University of Giessen who wasn't involved in this study—notes that adult earwigs and some larval beetles also create antiseptic gases.

But the fortification of the egg stage and use of nitrogen oxides is an unusual, new take on a vapor-based security system—and it may have some key advantages. Some parasitic fungi can digest the very chemicals made to kill them, but nitric oxide synthesis is very difficult to overcome, says Vilcinskas.

That may be especially true in this case, as the eggs spew out nitric oxide at a high rate, four orders of magnitude greater than background levels in human tissues, for example.

“How the beewolf eggs survive in the highly toxic atmosphere is not yet known,” says Strohm, “but might become important, since under certain circumstances [nitric oxide] can be overproduced and become harmful in humans.”

The finding illustrates the importance of close study of species not typically targeted for research (“non-model” species). Focusing only on a familiar subset of the Tree of Life may miss the most incredible innovations evolution has to offer—many of which may be valuable for technical or medical applications, Strohm says.

“Looking at only a handful of species is certainly not enough to capture the huge variety of adaptations that might yield fundamentally novel and totally unexpected processes,” he adds.

## FISHLESS “FISH AND CHIPS” MADE WITH PROTEIN FROM A FUNGUS, *Fusarium venenatum*

James Wood  
Dailymail.co.uk./, Jan. 2019 via  
*The Spore Print*, L.A. Myco. Soc., Feb. 2019

Fish and chips are set to go vegan as Quorn launches an alternative made with protein derived from the fungus *Fusarium venenatum* to help create a similar flaky texture.

The meat-free brand is set to release breaded and battered fishless fillets, both of which took five years to produce.

Both will come in packs of two, with the battered version flavored with salt and vinegar, and the breaded version flavored with lemon and pepper.

Announcing the new product, which is due to launch in March, Geoff Bryant, technical director of Quorn Foods, said the new product should deliver “incredible taste and texture.”

He continued: “It has been five years in the making and marks the next logical step in helping people reduce our reliance on our seas and oceans for protein. “It will instead meet people's desire to reduce meat consumption and eat sustainably, with this delicious Quorn Vegan Fishless Fillets range.”

Stored frozen, all products in the fishless range can be oven-cooked in 22 minutes.

**ASIAN STIR-FRIED MUSHROOMS** Sommer Collier  
<https://www.aspicyperspective.com/>

A fabulous side dish, steak topper, or vegetarian main course! Low fat (11 g), low carb (14 g), and easy to love!

*Ingredients:*

- 2 lb fresh button mushrooms, quartered
- 3 TBs sesame oil
- 1 TBs black bean garlic sauce
- 1 TBs honey
- 1 TBs chili garlic sauce
- 1 cup sherry
- 3 TBs chopped scallions



*Instructions:*

Place a wok or large skillet over medium-high heat. Add the sesame oil. Once hot, add the mushrooms and sauté until caramelization marks form, about 3–5 minutes. Stir regularly.

Stir in the black bean sauce, honey, chili sauce, and sherry. Simmer until the liquid is mostly absorbed. Then sprinkle with chopped scallions and serve immediately.

*Serves 4*

*Calories: 213*

**THIS MUSHROOM GROWS ONLY IN TEXAS AND JAPAN, AND SCIENTISTS CAN'T EXPLAIN IT**

<https://www.sciencealert.com/>, Feb. 3, 2019

The *Chorioactis geaster* is the only mushroom species in the *Chorioactis* genus, and it's found only in Texas and Japan.

The two locations are on the same latitude, but mycologists have not been able to figure out why these mushrooms grow only in these two spots. A 2004 study of the mushroom's DNA, published by Harvard University Herbaria, suggested that the populations were separated into two lineages about 19 million years ago.

In Texas, the mushroom is known as the "devil's cigar," since it looks like a cigar before it opens into a star shape.



*Chorioactis geaster.*

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