

Q&A: Mycologist and evolutionary biologist explains why he's a fan of fungi

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Phyllobaeis lichen growing in Ecuador. Credit: Matthew Nelsen

Scientists have formally described about 120,000 species of fungus. There might be millions more out there, but fungi are largely hidden. When you think about fungi, you might picture showy mushrooms, but those are just the fungal version of fruit, sprouting when it's time to reproduce. Most of the time, fungi live underground or inside logs.

At the Field Museum, mycologist and evolutionary biologist Matthew Nelsen, Ph.D.'14, is working to bring these obscure organisms to light. His comments have been edited and condensed.

A fungus is not an animal, and it's not a plant. What is it?

Its own thing! It's its own kingdom. But yeah, it's like, where do these go? They're not running around like animals; they generally seem to just sit there like plants. Here at the Field Museum, I'm in the botany section, but when we look at DNA evidence, we can see that [fungi](#) and animals are each other's sister groups, essentially. In the mycological community, there's a big push to recognize fungi as another dimension of biodiversity, especially in the context of conservation.

What specific aspect of fungi fascinates you?

How fungi have evolved to form different types of long-standing partnerships—mutualism with some organisms, parasitism with so many others. What's the underlying genomic basis for this ability? I work a lot with lichen—which are organisms made from symbiotic fungi and algae—but I've been branching out into the partnerships between fungi and plant roots, and I'm in the very early stages of studying a group of fungi that attacks other fungi and different invertebrates.

How do plants and fungi help each other out?

Nearly all plants form deeply rooted evolutionary partnerships with fungi, which helps the plants access nutrients and water that they aren't very good at getting on their own. So the plant can grow bigger and faster, and in return, the plant feeds the fungus sugar, which it can't make on its own. This partnership is thought to extend back to when

plants first evolved on land. There are 400-million-year-old fossils showing some of these partnerships.

Fungi are well known to provide food, medicine, psychedelics. What are some lesser-known benefits of fungi?

Farmers are starting to recognize the worth of fungus-plant partnerships. The timber industry can also benefit from this knowledge. People used to take a tree from one part of the world and plant it in another region, and it wouldn't grow very well. They realized you need to take some soil with it, some of the microbial community to maintain these partnerships. But now mycologists are starting to recognize that fungi are growing in places they weren't before, and they can disrupt the ecosystem.

The video games and TV series 'The Last of Us' ascribe the apocalypse to a zombie fungus called Cordyceps. Does this help or harm fungi's reputation?

I'm torn. I really like that it's popularizing fungi and getting people's attention, but it's unfortunate that it's from a detrimental perspective. I hope that we can still leverage that to draw people in to learn what's real and what's fiction.

Zombie-ant fungus—*Ophiocordyceps unilateralis*—which inspired 'The Last of Us,' is real. How does it work?

It's thought that the spores land on an ant and the fungus grows through

its exoskeleton. Eventually it spreads through the ant's body, decomposing it from the inside, and the insect starts acting strangely. It might convulse or wander randomly.

Ultimately the fungus exhausts its food supply and will need to move on. So, it makes the ant climb up a small shrub, pinch onto a big leaf vein with its mandibles, and hang upside down, where it dies. A long fungus stalk grows out of its head, and the spores rain down on other ants below. This has been going on for at least 48 million years. There's a fossil leaf with these bite marks in it.

'The Last of Us' implies that infected people are psychically connected to each other and to a vast underground network of the fungus. Does that have roots in reality?

Some fungi do form vast underground networks, but not Cordyceps. There's this tree parasite nicknamed the Humongous Fungus, a species of honey mushroom from a group called Armillaria, and they form huge colonies. The first one was found in the Upper Peninsula of Michigan, and now they found an even bigger one in Oregon. It's estimated to be a thousand years old and miles across.

There are also fungi that form mutualistic relationships with roots that can connect multiple trees together. This underground network is called the Wood Wide Web. There's an idea that maybe sugar and chemical signals could travel from one tree through the fungus to another tree, but in the past few weeks there's been a lot of activity calling that idea into question, asking how much data we really have to support the hypothesis.

Can zombie-ant fungus infect humans?

We're very warm, and a lot of these fungi can't survive in environments that hot for that long. Our body temperature proves to be a barrier for a lot of fungi.

Could climate change drive its evolution enough to overcome that barrier?

There are protective factors other than body temperature. We have a really good immune system. We are constantly breathing in microscopic spores around us, and most of us don't get sick because our bodies fight off the fungus.

What fungal infections pose the most danger to us?

I'm not a medical mycologist, but I know of a few nasty ones, like *Candida auris*, which has been going around hospitals quite a lot. *Coccidioides* and *Pneumocystis* aren't good—they get in your lungs. Less aggressive ones like athlete's foot, ringworm, or nail [fungus](#) aren't super terrible.

But they take forever to treat. Why is it so hard to cure fungal infections in humans?

Because we share a lot of biochemical similarities with fungi. When we're trying to kill a fungal cell, we need to make sure we're not killing our own as well. We're far less similar to bacteria.

Why don't more people study fungi?

They're not as endearing as things with big eyes and lots of fur. I grew up kind of thinking fungi were gross. It varies across cultures around the

world, but a lot of folks probably feel like I did. That's something I'm trying my best to change.

Provided by University of Chicago

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