The Natural Laboratory Podcast Transcript: Death Cap Mushrooms at Point Reyes National Seashore

Introduction

This is the Natural Laboratory, a podcast exploring science for Bay Area National Parks. I'm Cassandra Brooks.

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Death cap mushrooms (also known as *Amanita phalloides*) are found throughout the Point Reyes region and are the most poisonous mushrooms in the world. But they're fairly new arrivals here. They invaded the San Francisco Bay Area in the late 1930s, likely brought over on cork trees from Europe for the wine industry. By the late 1960s, death caps were found in Tomales Bay State Park and have since spread throughout the Point Reyes Peninsula.

Benjamin Wolfe, a graduate student at Harvard, is studying the mushroom's invasion here in Point Reyes. He's using genetics to study their abundance and distribution, trying to understand what controls and confines heir invasion.

I sat down with Ben in his mushroom lab at Harvard to find out more.

Benjamin Wolfe Interview

Benjamin Wolfe: We're pretty much the CSI of mushrooms. So, we go out...instead of working with criminals and murderers and crime scenes, we're just trying to figure out where mushrooms have gone. And we use similar techniques. So, we use a lot of DNA bar-coding that they use in forensics labs to figure out: is this actually *Amanita phalloides*, or is it a different species? And then, we go to our herbaria and look back in time at records that people have collected to track where it's spread over time. And then, we often go into the soil and probe the soil with these DNA bar-codes to figure out: does this soil sample have *Amanita phalloides*? Has it been invaded?

Ectomycorrhizal fungi

Cassandra Brooks: Ben does his fieldwork in Point Reyes because *Amanita* are incredibly abundant and large here. But it's also a real hotspot for ectomycorrhizal fungi in general, he says.

So, what are ectomycorrhizal fungi? This tongue-tying term refers to fungi that form a symbiotic relationship with tree roots. Many of the mushrooms you see throughout the forest are ectomycorrhizal fungi, but you're only seeing part of the story. If you could peak below the soil, you would see white cobwebby mushroom roots, called hyphae, snaking out in all directions. On one end, they're grabbing nutrients from nooks and crannies that tree roots can't get to. On the other end they're connected to the trees, sharing their nutrients and stealing sugars produced from the trees' photosynthesis. They use those sugars to make the mushroom you see throughout the forest, which are used for spreading spores and reproducing.

Amanita phalloides is one of, perhaps, ten thousand species of ectomycorrhizal fungi, but it stands out, Ben says, because it's managed to move from one part of the world to another and suddenly take over and become very abundant.

Benjamin Wolfe Interview (continued)

BW: And when we went into Point Reyes and looked at it in more detail and we actually went into the soil and extracted DNA to see what trees it was growing with, it was really, clearly picking and choosing—from the entire community available—just these oak roots, which is really surprising for one of these fungi to be that specific.

We are also just looking at general patterns of how it associates with different hosts. So, it's really different on the East Coast. So, on the West Coast it loves the coast oak. But when you come on the East Coast, it's only associating with pine. And then, when you look at the native range where it grows in Europe, it only generally associates with oaks. So, it seems like it's gone from its native habitat with oaks, moved to North America, and on the West Coast where it's invading, it seems to really associate mostly with oaks; on the East Coast only with pines. So, it's almost like it's made a host shift.

That's what we're broadly interested in the lab, is fungal symbioses. What controls them ecologically? And then, from an evolutionary perspective: how did they come to be? What genes and what processes have allowed these things to evolve this symbiotic lifestyle?

So, it's sort of like the Human Genome Project for fungi.

CB: Right.

BW: You can ask these really broad questions about, you know, what genes give me a certain eye color, but, in this case, we're asking: what genes are making this thing associate with an oak versus a pine?

CB: Maybe you can talk a little bit about...when this mushroom is so well known—it's called the death cap—I mean, how is it that it's still the most amount of people get poisoned by it?

BW: Right. Right. I think the main reason is that the people who have immigrated to North America from other countries get confused, because there are things in their native range that look like the death cap mushroom but aren't poisonous.

CB: Right.

BW: And so, there is a lot of confusion. And, unfortunately, it's hard to educate people in so many different languages and warn them about it. And in areas where it is so abundant, people encounter it very frequently, they pick it, and they think it looks like this thing they ate back at home which was really tasty.

CB: In your understanding, is it the most poisonous mushroom?

BW It is. It, you know, in terms of the amount of toxin and how toxic it is per amount that you eat...

CB: It is. OK

BW: it is considered the most poisonous one. Yeah, 'cause, once you get poisoned, once you've ingested about half a cap of mushroom, it goes in your body and the toxins are really concentrated in your liver. And, essentially, your liver just starts to dissolve, it just, sort of, falls apart.

The story is that you eat it, you get really sick at first, you're like, "Wow! This does not feel good." And the second day, you'll apparently start to feel a little bit better. And then the third day you die.

The other thing about these mushrooms in California, they're really robust, they're huge and they're just so...you're intrigued by them.

Conclusion

Ben and his colleagues are indeed intrigued by the mushrooms, not for eating, of course, but for understanding the ecology and evolution of symbiosis. They've even recently put together a review paper showing that ectomycorrhizal fungi invasions occur across the globe. They have yet to see if invasive mushroom species act similar to plant and animal invasions, but with more CSI-like investigation, they're sure to find out.

With the Pacific Coast Science and Learning Center, I'm Cassandra Brooks.