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Fungi, From Killer to Dinner Companion

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According to Roman legend, there once was a cruel boy who tortured a fox by tying straw to its tail and then setting the straw ablaze. The god Robigus was so outraged that he punished humanity with wheat rust, a fungal nightmare that leaves crops looking as though they had been burned. For centuries afterward, the Romans sought to appease the deity through annual sacrifices of dogs and cows unlucky enough to have rust-colored fur.

Robigus, Lord of Fungus, is still furiously among us, but these days he's collecting his sacrificial spoils personally. In the eastern United States, thousands of cave-dwelling bats have died of an aggressive fungal disease called white-nose syndrome, and hundreds of thousands if not millions more are at risk of contracting the condition. Frogs and salamanders worldwide are dying in catastrophic numbers, very likely of a fungal disorder called chytridiomycosis, which clogs an amphibian's skin and deranges its blood chemistry. Forests along the western and southern coasts of North America are withering as a result of fungal blooms injected into the wood by pine-boring beetles.

We have already lost our majestic American chestnut trees to blight and our favorite shade trees to Dutch elm disease. Can't we just break out a few giant bombs of Ajax and wipe the world clean of its infernal fungus, its allergenic mold and sporulating mildew, its rot and blight, smut and rust, its jock itch and athlete's foot that can plague even the most devoted couch morel?

We can never rid the world of its fungus, of course, nor would we want to. Fungi represent a kingdom unto themselves, up there in taxonomic sovereignty with the kingdoms Animalia and Plantae, the bacteria and the protists. Some 100,000 species of fungi have been tallied, and scientists estimate that at least another 1.5 million remain to be discovered.

Fungi are everywhere, on every continent and in every sea, floating in the air, lacing through the soil, resting on your skin, colonizing mucosal cavities within, and festively decorating that long-neglected peach. And though some fungi are pathogenic and will kill the living tissue they have penetrated, the vast majority are benign, and many are essential to the life forms around them.

"They are the major decomposers," outdoing even bacteria, worms and maggots in their saprophagic industry, said David J. McLaughlin, a mycologist at the University of Minnesota. If you want true antisepsis, look to the fruits of *Robigus*.

Fungi also have a talent for symbiosis, for establishing cross-kingdom quid pro quos that keep the fungus fed and happy while lending its partner vast new powers. Maybe 90 percent of all land plants depend on the so-called mycorrhizal fungi that stipple their roots and feed modestly on their plant sugars to in turn supply them with nutrients from the soil like phosphorus and nitrogen. And botanists suspect that plants might never have made the leap onto land some 500 million years ago without their mycorrhizal assistants.

Fungus may well have given rise to human culture, or at least the comedy of human comity. For a loaf of bread to break with old friends and a jug of wine to help forge new ones, we can thank the fungus *Saccharomyces*, baker's and brewer's yeast.

More recently, *Saccharomyces* has served as an agreeable model organism in the laboratory, an excellent way to explore how genes behave and cells divide and a much cheaper date than a rodent. Fungal cells turn out to be surprisingly similar to animal cells, and researchers recently determined that the fungal and animal lineages didn't split from each other until millions of years after both had branched away from the plants.

The defining traits of a fungus are gustatory and architectural. Whereas animals ingest a meal first and then digest it internally, fungi do the reverse. After latching on to a suitable food source, they release enzymes to break down the substance into a soupy mash of sugars and amino acids, which they can then absorb through the membranes of their filamentous hyphae. Some fungi remain simple, even unicellular, but others can sprout elaborate fruiting bodies packed with billions of microscopic spores, billions of wistful homuncular fungi.

The most familiar fruiting bodies are the mushrooms, with their vivid pigments of inscrutable purpose and their still more inscrutable forms — here a swollen pink pincushion or a bird's nest filled with eggs, there a protruding black tongue or a batch of bright butter coral. Given sufficient food and room, the filaments of a founding fungus may grow over thousands of acres of soil and persist for centuries or millennia, all the while spawning genetically identical mushrooms above ground, and biologists have argued that such hyphal masses qualify as some of the largest and most ancient organisms on Earth.

Most fungi are adapted to grow in cool or foresty temperatures, maybe 60, 70 degrees Fahrenheit, which is why the pathogens among them tend to prey on plants, or cold-blooded animals like insects, reptiles or amphibians.

Even then, most fungal diseases are not fatal, and the virulent strain that is thought to be involved in today's mass amphibian die-offs may have been introduced into natural populations by frogs used in medical research.

With their hot body temperatures, mammals and birds suffer from few fungal diseases save those confined to the coolish epidermis. Bats are mammals, but the species now afflicted by white-nose syndrome are cave-hibernating bats, and when the bats lapse into their hibernation torpor, said David S. Blehert, a microbiologist with the United States Geological Survey's National Wildlife Health Center in Madison, Wis., their core body temperature drops down to just a couple of degrees above cave conditions, as low as 44 degrees.

"This pathogen is treating the bats as if they were forgotten tubs of cottage cheese in the back of the refrigerator," Dr. Blehert said. Moreover, the fungus appears to be unusually virulent. "We're seeing in excess of 90 percent mortality at some sites," Dr. Blehert added.

Since the disease was first identified west of Albany in March 2007, it has spread to bats in nine states and is on the cusp of reaching bat populations that aggregate in groups 300,000 strong, "the largest colonies of hibernating mammals known on the planet," Dr. Blehert said. In an effort to block the pathogen's passage, wildlife authorities are closing off caves to human traffic, for now the only measure they can think of to keep the wrath of Robigus at bay.

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Questions for Article: Fungi, From Killer to Dinner Companion

1. What is the name of the fungal disease that killed thousands of cave-dwelling bats?
2. What does the fungal disorder, chytridiomycosis, do to frogs and salamanders?
3. Currently, how many fungi species have been found and tallied by scientists?
4. What type of fungi do about 90 percent of all land plants depend on?
5. What is the cooking benefit of the fungus called Saccharomyces?
6. How is Saccharomyces used in a laboratory setting?
7. How do fungi eat and digest?

8. What structure helps the fungus to absorb food through their membranes?

9. What type of environment do most fungi grow in?

10. What are wildlife authorities currently doing to try to contain the white-nose syndrome affecting bats?