TRACKING BIODIVERSITY

FUNGI—UNDERAPPRECIATED AS FRIENDS, OVERRATED AS FOES

TERRY SHISTAR, PHD

Fungi are all around us—mostly invisible to our eyes—but we rarely take notice of them, aside from the occasional attack of athlete's foot or a couple of edible species available in the grocery store. They are often viewed as mostly harmful—poisonous toadstools, molds spoiling food, and pathogens attacking our skin. However, fungi perform essential ecosystem functions. As decomposers, they not only perform the essential housekeeping function of breaking down dead organic matter, but their disassembling of complex organic molecules also releases simple compounds that feed plants.

Once classified as plants, fungi now have their own biological kingdom, considered to be more closely related to animals than plants. Mushrooms are the fruiting bodies of fungi. The vegetative body of the fungus is a mycelial mat, made up of threads known as **hyphae**. You can see **mycelium** in a pile of rotting leaves or wood chips, or spreading through a rotting log. Knotted hyphae form fruiting bodies (mushrooms) capable of producing spores.

CATEGORIES OF FUNGI

Fungi are placed into four categories, according to how they acquire nutrition. **Saprophytes** are decomposers, feeding on dead organic matter. Most of the familiar edible mushrooms—the ones that can be easily cultivated—are saprophytes. These include the field mushroom—and most common mushroom in grocery stores (*Agaricus bisporus*), which grows on composted manure, as well as shiitake (*Lentinula edodes*), oyster (*Pleurotus ostreatus*), and maitake (*Grifola frondosa*), all of which decompose wood. Shiitake, oysters, and maitake are **primary decomposers** because they are the first to consume the dead plant, while the common field mushroom is a **secondary** decomposer because it consumes resources left after manure has been composted.

Parasitic fungi consume living tissue. A spectacular example is the honey mushroom *Armillaria ostoyae*, which may be the largest organism in the world. One 2,400 acre site in Oregon had a contiguous mat of mycelium, estimated to be 2,200 years old, before logging roads dissected it. Some saprophytic mushrooms may start their meals on dying trees, thus appearing to be parasites. Others, including maitake, may consume dead parts of living trees.

Mycorrhizal fungi form symbiotic relationships with trees and other plants. Mycorrhizal fungi may form external sheaths around plant roots (*ectomycorrhizal fungi)* or penetrate root cells (endomycorrhizal fungi). Either way, the mycelium vastly increases the surface area available for absorbing nutrients and moisture, transporting them to the plant. In return, the plant supplies the fungus with secretions of sugars. Most plant species participate in mycorrhizae. (The term applies to the association, not the fungus.) They grow faster and resist disease better than plants that do not have mycorrhizal partners. Mycorrhizae communicate among trees of different species, help to combat pests, and transport needed nutrients from one to another.

Mycorrhizal species include truffles (*Tuber spp.* and others), chanterelles (*Cantharellus spp.*), and morels (*Morchella spp.*)—although some speculate that morels may also be saprophytes. Many of the highly toxic Amanitas are also mycorrhizal. Mycorrhizal species are not easily cultivated because of the necessity of maintaining the association with the plant partner, so they are generally harvested from the wild.

Endophytic fungi are similar to mycorrhizal fungi in that they form associations with plants. However, endophytes never perforate cell walls of plants. Their mycelia thread among plant cells, enhancing plant growth and nutrient uptake, while producing mycotoxins that protect the plant from herbivores. Most endophytes do not produce mushrooms, though some wood conks once classified as parasites—such as the tinder polypore (*Fomes fomentarius*) are now considered to be endophytes. Endophytes are of special interest because plants inoculated with them—for example, turf grasses such as perennial ryegrass, tall fescue, and fine fescue—are protected from insects, drought, and disease. On the other hand, when those grasses are used for pasture, they may poison horses or cattle.

MYCOMEDICINALS

The first question most beginning mycologists usually ask about a mushroom is, "Can I eat it?" Mushrooms are great to eat, but they are also potent medicine. Like plants, mushrooms are subject to attack by other organisms, including bacteria and other microorganisms. Just as humans can take advantage of compounds produced by herbs, humans can also take advantage of compounds produced by mushrooms. Paul Stamets, author of *Mycelium Running* and founder of the company Fungi Perfecti, has created a table that categorizes the medicinal effects of 18 mushrooms. In addition to fighting infections, medicinal fungi may fight cancer, normalize blood pressure and blood sugar, and act as tonics to the immune,

cardiovascular, respiratory, nervous, and reproductive systems, and aid in detoxification by supporting the kidneys and liver. Reishi (*Ganoderma lucidum*) is an example of a mushroom that performs almost all of these functions. Other medicinal mushrooms include *Cordyceps sinensis*, maitake, shiitake, and turkey tails (*Trametes versicolor*). Many of the medicinal mushrooms are not edible because they are too tough, but their medicine can be consumed in the form of teas or extracts.


© iStockphoto/empire331

MYCORESTORATION

Terrestrial life comes from the soil. When that soil is damaged—by clearcutting forests, use of poisons in industrial agriculture, or bulldozing for development—the introduction of fungi is an important step in rebuilding it. Rebuilding soil means rebuilding the capacity of the soil to feed plants, hold water, and sequester carbon. Mycorestoration includes the use of fungi to filter water, rebuild forest communities, and remediate environmental contamination.

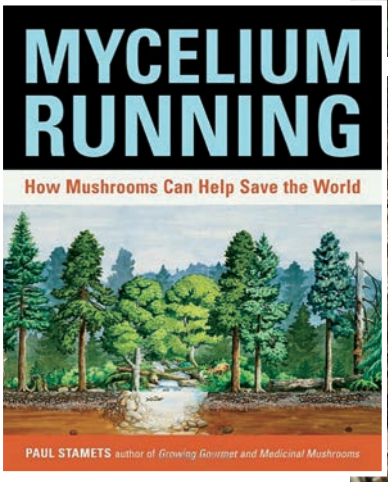

© iStockphoto/James Mahan

Mycofiltration can be used to prevent pollutants from entering streams and other waterbodies. Bunkers of organic substrate—such as woodchips in burlap sacks—are inoculated with spawn, and placed in such a way that they intercept the flow of water. This technique can be used to prevent excess bacteria and nutrients from flowing off feedlots and into streams.

Mycoforestry helps to preserve and enhance forest ecosystems by incorporating fungi into forest practices. For example, selective harvesting of trees in a way that minimizes disturbance to mycorrhizal fungi and inoculating new trees with mycorrhizal fungi help trees to regrow. Introduction of saprophytes that help plant communities, feed insects, and compete with parasitic fungi can help build biodiversity. Leaving some dead wood in contact with the soil helps to conserve native fungi and feed insects, birds, and mammals.


© iStockphoto/stefanholm

Mycoremediation is a particularly exciting use of fungi. Fungi are voracious consumers of organic (carbon-containing) chemicals and can be used to break down toxic chemicals, such as those found in oil spills. For example, the Washington State Department of Transportation tested the decomposition of diesel-contaminated soil, layered with wood chips inoculated with oyster mushrooms (*Pleurotus ostreatus*). After eight weeks, total petroleum hydrocarbons went from the original 20,000 parts per million (ppm) to less than 200 ppm.



For information about fungi and how to use them, see *Mycelium Running* by Paul Stamets.


© iStockphoto/lensblur