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Magical Mushrooms: The Role of Fungi in Our Past and Future

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The Role of Fungi in Our Past and Future

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Mushrooms are magical. And not just in that way. Mushrooms sustain life by decomposing dead organisms, connect thousands of organisms throughout the world's ecosystems, and do almost all of it completely unnoticed, submerged in the dirt. Life on earth would not be possible without a system for recycling dead organic matter, so without mushrooms, life as we know it would not exist.

The mushrooms we see sprouting in the forest or on our dinner plates are the smallest and arguably least consequential part of the actual fungal organism, which extends expansively below the ground. The word mushroom generally produces an image of the fruit (or rather a spore) of a vast, interconnected network of microscopic rootlike structures called mycelium. Though many parts of the mycelium network are only one cell wall thick, they weave intricately together and can extend over 300 overlapping miles below the dirt.

Mushrooms themselves are extremely diverse in physical appearance, location, and edibility. While many species can be found by a well-trained eye on a forest walk, some blossom exclusively underground. This subterranean fruiting is characteristic of truffles; pigs or dogs are often employed to sniff out these truffles. Truffles' hidden fruit explains why they are so expensive in the supermarket. Despite the many differences, all mushrooms send microscopic spores into the air to procreate. Fungi are so prominent in the natural world surrounding us, and so frequently sporulating, that we are nearly constantly breathing in spores. Inhaling spores is a common cause of allergies and some species' spores are able to induce illness but most spores are completely harmless and integrate peacefully into the ecosystem and our bodies.

Without mushrooms and other detritivores (organisms that decompose dead organic matter), we would be drowning in corpses. Detritivores are nature's recyclers and have helped the planet stay afloat for millions of years. In fact, without fungi, there would not even be terraneous organic matter in the first place. Millions of years ago, Earth was largely uninhabitable due to extreme levels of carbon dioxide in the atmosphere. While the land itself proved to be a harsh environment, life on Earth thrived in the oceans. Fungi were some of the first organisms to pull themselves ashore, using acids and enzymes to break apart

large rocks and consume the resulting nutrients. These newly crumbled stones created the foundation for liveable soil. Soon, mycelium began to form mycorrhizal relationships — a fungi-specific symbiosis—with rootless water plants. In these mycorrhizal relationships, mycelium served as pseudo root systems for plants long before they were able to develop their own, allowing algae and similar organisms to creep landward. These first dirt-inhabiting plants began the long process of carbon sequestration (or carbon dioxide capture) that would make the atmosphere habitable for animals. By the time plants first developed their own official roots, they had already been sustained by these mycorrhizal relationships and the mycelium network for 50 million years.

While mycorrhizal relationships first formed millions of years ago, they are still astoundingly prevalent today. Around 80 percent of modern plant species remain largely dependent on this symbiotic relationship. Mycelia dig deep into the Earth to provide necessary minerals for the plants, fulfilling up to 80 percent and 100 percent of nitrogen and phosphorus needs, respectively, which plants generally trade for carbon obtained through photosynthesis. These fungal networks proceed to store around half of the carbon sequestered by their associate plants, keeping it out of our atmosphere. Some plants, however, have managed to sidestep providing anything and are instead completely reliant on fungi for nutrients. The albino ghost plant, Monotropa uniflora, has no chlorophyll and thus cannot photosynthesize. It obtains not only mineral nutrients but also all of its carbon needs, from the fungi it has partnered with.

In addition to their symbiotic relationships with plants, fungi greatly impact human health. Though many people hold reservations about mushrooms due to occasional toxicity, many cultures across the globe, including the peoples of native Central America, Siberia, and even Ancient Greece, hold great respect for mushrooms due to their healing powers. Multiple studies have recently been published examining the impact of mushrooms on cancer treatment. Some species of mushroom, such as Agarikon, Reishi, and Turkey Tail, have all long been used as medicinal mushrooms. These mushrooms have been found to increase the presence of cytokines, which help cells communicate and increase immune responses to cancer and other serious illnesses. While none of these mushrooms will be able to cure cancer on their own, they have thus far been found to increase the effectiveness of chemotherapy and stimulate immune responses that translate to better survival rates. In this sense, the modern western world is just catching up.

Aside from physical health, mushrooms also have a great capacity to treat mental diseases. A few species of mushroom have been found to stimulate neurogenesis, which, in conjunction with their anti-inflammatory properties, shows promise in beginning to tackle the treatment of severe degenerative diseases like Alzheimer's and Parkinson's diseases, though more research is needed. Psilocybin, the active ingredient in psychedelic mushrooms, also has strong neurogenetic capabilities and has eliminated conditioned fear in mice populations, effectively treating severe post-traumatic stress disorder (PTSD). When properly administered, one dose of psilocybin can practically eradicate all symptoms of depression and anxiety for six months. Psilocybin has further been shown to ease the anxiety of terminal patients as they grapple with death.

In addition to treating chronic illnesses, fungi are crucial to disease prevention. Penicillin was discovered through human–fungi interactions; we would not have any vaccines or antibiotics without a base-level understanding of fungi. Fungal antiviral and antibacterial properties can also extend beyond humans — they have proven to be extremely effective in fighting colony collapse disorder in honeybee populations.

Perhaps the most exciting aspect of human–mushroom cooperation ties into the original purpose of nutrient recycling. Because of their impact on plant growth, pairing different crops with different fungi and exploring the full scope of mycorrhizal relationships allows farmers to change the flavor, consistency, and yield of their crops. Some mycorrhizal partnerships even aid in pest resilience, potentially decreasing the need for harmful pesticides. While the agricultural possibilities are promising, the truly thrilling advancements of mushroom technology relate to cleaning up existing pollution and beginning the daunting process of habitat restoration. Washington State conducted a study where Battelle Laboratories compared petroleum-polluted soil treated with mycelia, bacteria, or enzymes to an untreated, control pile. While the soil treated with enzymes and bacteria did not change, the soil treated with mycelia sprouted multiple mushrooms within five weeks. In eight weeks, the number of aromatic hydrocarbons dropped from 10,000 parts per million (ppm) to only 200 ppm. Shortly thereafter, the mushrooms released spores that attracted bugs, who attracted birds, who brought seeds. Within months, the pollution was not only cleared but the pile of oily dirt had been transformed into the beginning of a flourishing ecosystem.

As evidenced by breaking down and consuming petroleum, mushrooms are surprisingly adventurous with what they will eat. With minimal training, the mycelium of oyster mushrooms unlocked the genetic code for enzymes that allow them to break down used diapers and cigarette butts. A further benefit is that many sprouting, decomposing mushrooms are completely safe for animal consumption. Through these techniques, mushrooms have the power to transform harmful human waste into valuable and ethically-produced nutrition.

While mushrooms show great promise in cleaning up our environmental mess, our society cannot afford to only focus on recycling accumulated waste. Rather, we must dramatically decrease the production of non-biodegradable goods in order to leave behind a liveable planet for our descendants that is not drowning in polyethylene, the most common plastic pollutant. Emerging fungal technologies provide an opportunity to prevent pollution from entering the system altogether. Using commercial agricultural waste, such as husks and bean pods, engineers have molded fungi into corner blocks for furniture shipping, reducing the use of styrofoam, one of the least biodegradable substances ever made. These fungi blocks are just the beginning. A company called Ecovative has explored other mushroom-based packaging alternatives, vegan leather, and even beauty products. Replacing traditional coffins, one can now be buried in an eco-friendly fungi suit, enclosed by mushrooms that reincorporate a body's nutrients into our heavily depleted soils. There have also been preliminary studies examining how portobello mushrooms could replace current non-biodegradable casings of lithium-ion batteries.

Without fungi, life as we know it would not exist. If we reconnect with our roots (or mycelium in this case), we might just be able to save it. It is not a question of if fungi will be able to clean up our mess — it is just a question of if we will still be around to see it. • • •