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Entangled Life: How Fungi Make Our Worlds, Change Our Minds, and Shape Our Futures, (Vintage, UK)

Text Excerpt

A contribution to the socio-ecological (Re-)Gaining Ecological Futures: Mycopoetics festival at Floating ~~University~~, Berlin 22-25 June, 2023, curated by Berit Fischer

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To use the world well, to be able to stop wasting it and our time in it, we need to re-learn our being in it.

~ URSULA LE GUIN

I lay naked in a mound of decomposing wood chips and was buried up to my neck by the spadeful. It was hot, and the steam smelled of cedar and the fust of old books. I leaned back, sweating under the damp weight, and closed my eyes.

I was in California, visiting one of the only fermentation baths to be found outside Japan. The wood shavings had been moistened and piled into a heap. After two weeks of rotting they had been shovelled into a large wooden tub, and ripened for another week before I arrived. The bath was now cooking, heated by nothing more than the fierce energy of decomposition.

The intense heat made me drowsy, and I thought of the fungi decomposing the wood. How easy it is when one's not being stewed in a heap of rotting wood to take for granted that everything decays. We live and breathe in the space that decomposition leaves behind. I greedily sucked some cold water through a straw and tried to blink the sweat out of my eyes. If we could pause decomposition, starting now, the planet would pile up kilometres deep in bodies. We would think of it as a crisis, but from a fungal point of view it would be an enormous heap of opportunities.

My torpor deepened. It certainly wouldn't be the first time fungi have thrived through a period of dramatic global transformation. Fungi are veteran survivors of ecological disruption. Their ability to cling on – and often flourish – through periods of catastrophic change is one of their defining characteristics. They are inventive, flexible and collaborative. With much of life on Earth threatened by human activity, are there ways we can partner with fungi to help us adapt?

These may sound like the delirious musings of someone buried up to their neck in decomposing wood chips, but a growing number of radical mycologists think exactly this. Many symbioses have formed in times of crisis. The algal partner in a lichen can't make a living on bare rock without striking up a relationship with a fungus. Might it be that we can't adjust to life on a damaged planet without cultivating new fungal relationships?

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Many of the most dramatic events on Earth have been – and continue to be – a result of fungal activity. Plants only made it out of the water around 500 million years ago because of their collaboration with fungi, which served as their root systems for tens of million years until plants could evolve their own. Today, over 90 per cent of plants depend on mycorrhizal fungi – from the Greek words for fungus (*mykes*) and root (*rhiza*) – which can link trees in shared networks sometimes referred to as the 'Wood Wide Web'. This ancient association gave rise to all recognisable life on land, the future of which depends on the continued ability of plants and fungi to form healthy relationships.

To this day, new ecosystems on land are founded by fungi. When volcanic islands are made or glaciers retreat to reveal bare rock, lichens (pronounced LY-kens) – a union of fungi and algae or bacteria – are the first organisms to establish themselves, and to make the soil in which plants subsequently take root. In well-developed ecosystems soil would be rapidly sluiced off by rain were it not for the dense mesh of fungal tissue that holds it together. From deep sediments on the sea floor, to the surface of deserts, to frozen valleys in Antarctica, to our guts and orifices, there are few pockets of the globe where fungi can't be found. Tens to hundreds of species can exist in the leaves and stems of a single plant. These fungi weave themselves through the gaps between plant cells in an intimate brocade and help to defend plants against disease. No plant grown under natural conditions has been found without these fungi; they are as much a part of planthood as leaves or roots.

The ability of fungi to prosper in such a variety of habitats depends on their diverse metabolic abilities. Metabolism is the art of chemical transformation. Fungi are metabolic wizards and can explore, scavenge and salvage ingeniously, their abilities rivalled only by bacteria. Using cocktails of potent enzymes and acids, fungi can break down some of the most stubborn substances on the planet, from lignin, wood's toughest component, to rock, crude oil, polyurethane plastics and the explosive TNT. Few environments are too extreme. A species isolated from mining waste is one of the most radiation-resistant organisms ever discovered. The blasted nuclear reactor at Chernobyl is home to a large population of such fungi. A number of these radio-tolerant species even grow towards radioactive 'hot' particles, and appear to be able to harness radiation as a source of energy, as plants use the energy in sunlight.

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We all live and breathe fungi, thanks to the prolific abilities of fungal fruiting bodies to disperse spores. Some species discharge spores explosively, which accelerate 10,000 times faster than a Space Shuttle directly after launch, reaching speeds of up to a hundred kilometres per hour – some of the quickest movements achieved by any living organism. Other species of fungi create their own microclimates: spores are carried upwards by a current of wind generated by mushrooms as water evaporates from their gills. Fungi produce around fifty megatonnes of spores each year – equivalent to the weight of 500,000 blue whales – making them the largest source of living particles in the air. Spores are found in clouds and influence the weather by triggering the formation of the water droplets that form rain, and ice crystals that form snow, sleet and hail.

Some fungi, like the yeasts that ferment sugar into alcohol and cause bread to rise, consist of single cells that multiply by budding into two. However, most fungi form networks of many cells known as hyphae (pronounced HY-fee): fine tubular structures that branch, fuse and tangle into the anarchic filigree of mycelium. Mycelium describes the most common of fungal habits, better thought of not as a thing, but as a process – an exploratory, irregular tendency. Water and nutrients flow through ecosystems within mycelial networks. The mycelium of some fungal species is electrically excitable and conducts waves of electrical activity along hyphae, analogous to the electrical impulses in animal nerve cells.

Hyphae make mycelium, but they also make more specialised structures. Fruiting bodies, such as mushrooms, arise from the felting together of hyphal strands. These organs can perform many feats besides expelling spores. Some, like truffles, produce aromas that have made them among the most expensive foods in the world. Others, like shaggy ink cap mushrooms (*Coprinus comatus*), can push their way through asphalt and lift heavy paving stones, although they are not themselves a tough material. Pick an ink cap and you can fry it up and eat it. Leave it in a jar, and its bright white flesh will deliquesce into a pitch-black ink over the course of a few days.

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Radical fungal technologies can help us respond to some of the many problems that arise from ongoing environmental devastation. Antiviral compounds produced by fungal mycelium reduce colony collapse disorder in honeybees. Voracious fungal appetites can be deployed to break down pollutants such as crude oil from oil spills, in a process known as ‘mycoremediation’. In ‘mycofiltration’, contaminated water is passed through mats of mycelium which filter out heavy metals and break down toxins. In ‘mycofabrication’, building materials and textiles are grown out of mycelium and replace plastics and leather in many applications. Fungal melanins, the pigments produced by radio-tolerant fungi, are a promising new source of radiation-resistant biomaterials.

Human societies have always pivoted around prodigious fungal metabolisms. A full litany of the chemical accomplishments of fungi would take months to recite. Yet despite their promise, and central role in many ancient human fascinations, fungi have received a tiny fraction of the attention given to animals and plants. The best estimate suggests that there are between 2.2 and 3.8 million species of fungi in the world – six to ten times the estimated number of plant species – meaning that a mere 6 per cent of all fungal species have been described. We are only just beginning to understand the intricacies and sophistications of fungal lives.

Merlin Sheldrake is a biologist and author of *“Entangled Life: How Fungi Make Our Worlds, Change Our Minds, and Shape Our Futures”*, a New York Times and Sunday Times bestseller, and winner of the Royal Society Book Prize and Wainwright Prize. He is a research associate of the Vrije University Amsterdam, and works with the Society for the Protection of Underground Networks and the Fungi Foundation.