Ancient Tiri Part 9: Adventures in "Deep Time". The Fungi.

We have been travelling through "Deep Time" from the dawn of Earth's history when living things first appeared, some 4,000,000,000 years ago (4,000Mya or 4Ga).

A saprophytic fungus feeding on dead wood *J.S.*

It is thought the Fungi evolved about 410Mya just before the land had been colonized by plants. Today they form one of the most diverse kingdoms with varied ecologies, lifestyle strategies and morphologies (outward shapes). Their members include the single celled yeasts, filamentous fuzzy moulds and familiar mushrooms. Although once classified with the plants, they share more features (including genetics) with the Animal Kingdom. Part of our fascination with fungi is that they have a secret "hidden life" in the earth beneath our feet, emerging above ground only to disperse their spores into the air - popping up overnight as a wonderful variety of "fruiting" bodies. Some of these "mushrooms" are very poisonous to humans while others are delicious to eat! Yet other fungi raise our bread, brew our beer, flavour our soy sauce and cheese, and cure our ills (antibiotics and statins etc).

It is estimated that this hidden fungal horde with their vast subterranean network of feeding threads at least equals and perhaps exceeds the biomass of the more visible Plant Kingdom that lives above them in the world of light.

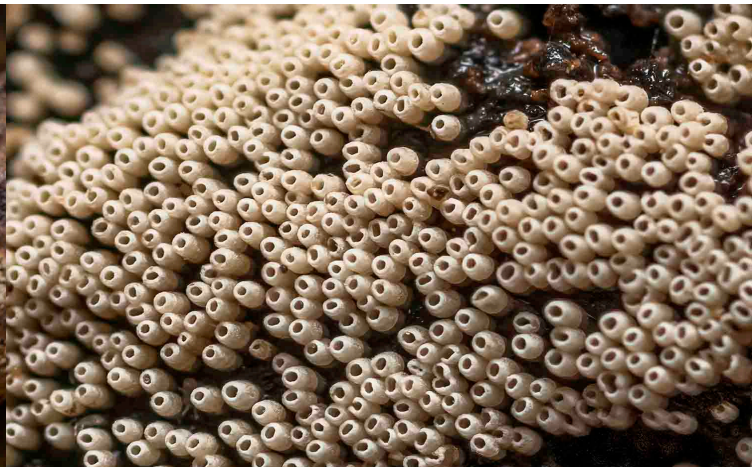
The only time you might notice this hidden world is if you disturb a moldering piece of branch on the forest floor when raking leaves off the track. The tufts of white threads (*hyphae* - collectively called a *mycelium)* visible where the branch touched the earth are a sure sign these rotters are at work!

Unlike plants their cell walls are composed of chitin (Pron. *Ky-tin*) used in arthropod exoskeletons and Mollusc "teeth". None are photosynthetic, instead feeding heterotrophically like animals. They do this by exuding digestive enzymes from their hyphae externally onto their food material and absorbing the digested products. When guiding, you might see a powdery rotted piece of tree branch on a Tiri track. You can explain to your visitors that it has been digested *from within* by the fungal threads that once permeated it! In this way the fungi perform the extremely important task of *recycling nutrients* in the forest ecosystem as *decomposers*.

Growth is their only method of movement, apart from microscopic *spores* which can be blown far and wide in global weather systems. For this reason, many native NZ fungi also have a worldwide distribution. Many fungi will invade *living* plant (and animal) tissue as *pathogens* (disease causing *parasites*).

Fungal hyphae forming a feeding mycelium on dead wood. *J.S.*

Pyenoporus coccineus. *J.S.*



Henningsomyces sp. *J.S.*

A parasitic spot fungus on flax. *J.S.*

Helper bacteria clustered round a fungal mycelium grown in vitro. *J.S.*

Shaggy cap mushroom, Coprinus sp. - a mycorrhyzal fungus on Mahoe. *J.S.*

Look for the telltale fungus infection spots on living mahoe, karo or karamu leaves where sap-sucking psyllid insects have injected spores from these parasitic fungi into their leaves. The plants strategy is to grow new leaves faster than the old ones can be destroyed by disease. Not all fungi are parasites though, many are *saprophytes* – living off *already dead* plant material, recycling it. A few are both – killing the host parasitically and then feeding off the corpse saprophytically!

Another vital role of many fungi is to help tree roots absorb water and minerals from the soil in exchange for sugars and proteins from the roots. The fungal threads do this by penetrating right through the root cell walls (but not entering the cell cytoplasm). This is close partnership is known as a *mycorrhizal association*, a relationship that has long been known to exist between fungi and conifers as well as orchids. Today it is thought that nearly all plants and trees have their own specific fungus partners performing this service. The fungi not only increase the surface area of the roots for enhanced nutrient absorption, but also exude chelating (or "capturing") chemicals which bind onto scarce soil nutrients making them more available to the plants.

Mycorrhizae are especially beneficial for the plant partner in nutrient-poor soils, such as those found near the top of the Wattle Track. Other recent studies have shown that these fungi target specific parts of different root systems for maximum gain, "trading" less abundant soil minerals for the best quality nutrients from the plants. In addition, several types of specific "helper" bacteria work closely with the fungi to enhance their ability to take up soil nutrients for the plants.

Sugars have also been shown to move *between different species* of tree via the mycorrhizal network, promoting the succession of tree species as ecosystems change over time. For a new seedling in the forest to thrive, it is important for them to acquire their own mycorrhizal partner as quickly as they can.
When both parties benefit from a relationship it is called *mutualistic*. Fossil evidence and DNA sequence analysis suggest that this mutualism appeared 400 – 600Mya, when the first plants were colonizing land.

Fungi also act as a food supply, forming a vital link in the food web of the forest. A wide range of invertebrates such as springtails, mites and fly larvae graze on them, and they in turn feed our birdlife on Tiri.
Without the Fungi life would be exceedingly dull for us humans – but imagine a forest ecosystem where no dead trees are broken down and recycled!

A springtail feeding on the Ear fungus *Auricularia cornea.* *J.S.*

In the next issue of Ancient Tiri we will look at how the fungi have partnered with the algae to form an association we know as the *lichens*.