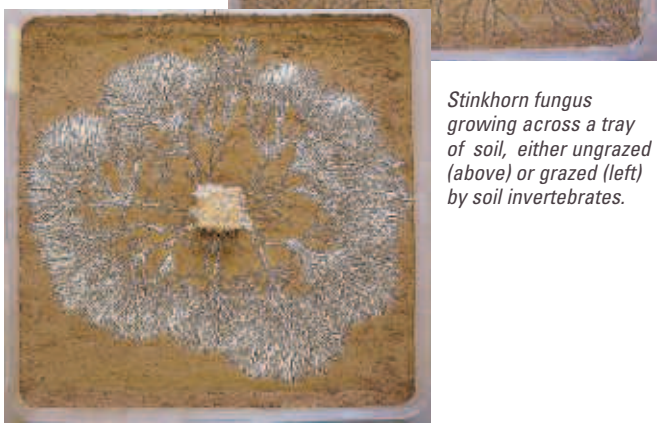
If you go down to the **woods** today . . .

. . . . you're sure of a big surprise. George Tordoff and colleagues describe a mighty battle beneath our feet, and it's the fungi that are fighting.



George Tordoff

Stinkhorn fungus growing across a tray of soil, either ungrazed (above) or grazed (left) by soil invertebrates.

You may fancy a woodland wander as the perfect antidote to the rat-race, but do you realise that underneath the tranquil leaf-covered surface of the forest lies an unforgiving and ferocious battlefield? This is the dark, mysterious and surprisingly violent world of fungi.

In woodlands, much of the soil's microbial biomass is made up of saprotrophic basidiomycetes. These fungi are the main decomposers of plant material, such as dead wood and leaf litter, on which they feed. As such they play a major role in nutrient dynamics in tropical, temperate and cold forest soil systems throughout the world. These fungi either stay put on the dead plant material they first grew on, or they spread out to find new material to digest. Those that go in search of new food supplies, often do so by sending out long filaments, called hyphae, that can grow into massive underground networks, called mycelia. They can cover up to many metres square, and live for up to hundreds of years. You may have noticed the filaments growing in a compost heap, or in piles of old bark chip in your garden. In Oregon USA, a fungus called *Armillaria ostoyae*, which is up to 8,500 years old and carpets nearly 10 square kilometres of forest floor, may be the largest living organism in the world.

When these long systems of filaments run into each other, they register the fact, both before contact has been made and/or following contact and fusion. This recognition goes on between filaments of the same fungal species and between different species. When the mycelia they come up against register as 'non-self', the result is fungal warfare. Unless they can mate with the fungus they meet, the filaments react antagonistically, changing their structure at the meeting point, and often elsewhere. They also produce enzymes, volatile and diffusible secondary metabolites, which show up as bright pigments, both in the mycelium and the surrounding soil. The outcome is often deadlock, with neither fungus gaining headway. But when the fight is between species, sometimes one will wrest territory from the other. In some cases, the fungi replace each other: one fungus gains some of the territory held by the other fungus and *vice versa.*

> When these filaments meet, the result is fungal warfare

Once the battle is underway, resources within the mycelium are mobilised. At first, nutrients are rapidly transported to the battlefront to produce the armoury for chemical warfare, but if the fungus appears to be losing the battle, then as many nutrients as possible are shunted as far away as possible.

The fungal filaments are rich in nutrients, which the fungus has released from plant material with its digestive enzymes. They make an attractive food source to soil invertebrates, such as springtails. They graze on the nutrient-rich filaments and may play an important part in stopping them spreading. Invertebrates are not only attracted to, but prefer to graze in fungal battle zones. We don't yet know why. No one has yet even identified what attracts them, but it is obvious that the ecology of both fungi and invertebrates is dramatically affected.

Our studies aim to understand the role of these battles between fungal species, and the interactions between invertebrates and fungi, within woodland ecosystems.

As well as providing fundamental information on how the interactions of fungi and springtails (collembolan) affect the structure and functioning of the mycelia, we also hope to provide crucial information on what role these interactions have on carbon sinks and sources, and mineral nutrient cycling in the soil.

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