Using Rainforest Research

Hidden forest gardens - microfungal communities thrive on the rainforest floor

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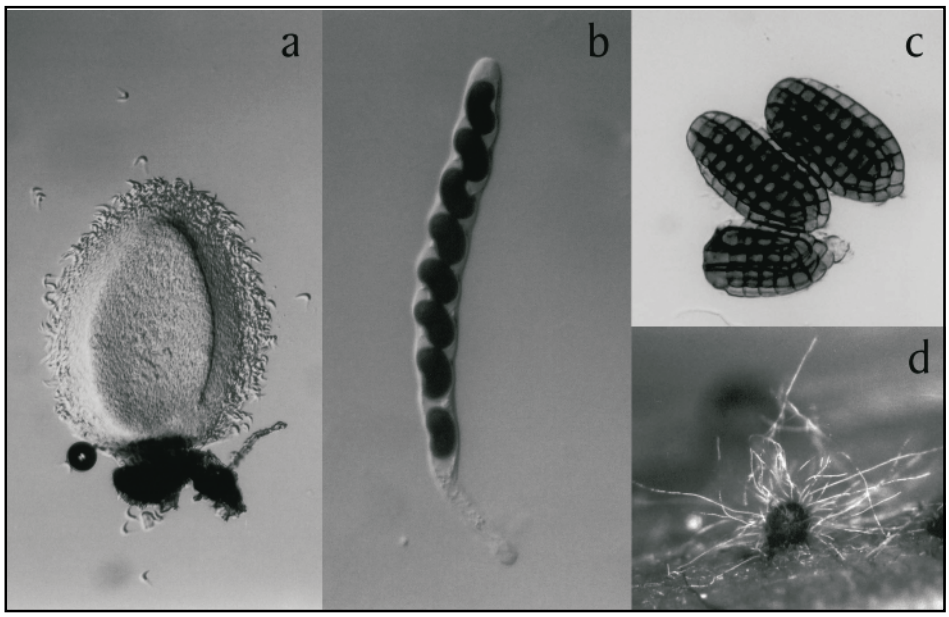
Take a walk through an Australian tropical rainforest and you will be struck by the array of trees, the cacophony of birds, the rustling of animals in the undergrowth, highways of busy ants and many other creatures that may cross your path. Most likely you will remain unaware of the thriving communities of minute decomposer fungi under your feet - a microcosm of humble workers that help to ensure the efficient recycling of cast-off leaves, wood and other organic matter that ends up on the forest floor. Breaking down the complex molecules contained in rainforest debris, they make available to seedlings and trees the simple nutrients that are required for growth, such as nitrogen, sulphur and phosphorous.



Examples of microfungi: new species of a) *Thozetella* and b) *Anthostomella*, c) *Dictyosporium novezealandia* and d) *Lanceispora amphibia*

The Culture of Fungi

Growing microfungi in the laboratory is a necessity if we want to study aspects of their biology. One traditional method places a substratum of leaves or wood in humid, enclosed chambers. After some days, minute fungal fruiting bodies begin to sprout on the surface. With a steady hand and a good microscope, these structures can be placed on a slide and fungal cultures isolated from single spores. Mycologists however, suspect that this method underestimates how many fungi are actually involved in the decay of a leaf or a piece of fallen wood and that many more fungi may grow inside the substratum without being visible on the leaf surface.

Particle filtration is a method that does not rely on observing fungal fruiting bodies. Leaves are minced in a blender and then washed through very fine sieves where tiny pieces of leaf collect in the finest sieve. These are then spread over the surface of a special medium in a petri dish where, if there are even miniscule fragments of a fungus in the leaf particle, they will begin to grow into a colony. Even though this method gives us a better understanding of the diversity of fungi in leaves, it is still not perfect as some fungi will not grow under artificial conditions.

A neglected field of research

Despite the important services fungi provide to ecosystems, they have not received nearly as much attention as plants or animals, especially in tropical regions. This is particularly true for those fungi that cannot be observed by the unaided human eye, commonly referred to as *microfungi*. It is estimated that microfungi outnumber visible fungi by thirty to one.

Before we can begin to understand microfungal decomposer communities, we need to look at which fungi are present and how the species composition changes over space and time. Rainforest CRC PhD student Barbara Paulus is currently using the two methods, shown in the box, to study microfungi in the decaying leaves of a number of rainforest tree species.

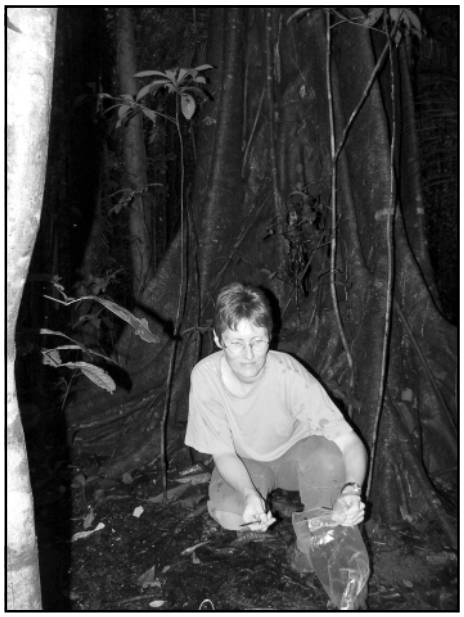
The Rainforest CRC is a research partnership involving the Commonwealth and Queensland State governments, the Wet Tropics Management Authority, the tourism industry, Aboriginal groups, CSIRO, James Cook University, Griffith University and The University of Queensland

How many fungi can be found on leaves?

Barbara's work has confirmed that the diversity of microfungi in leaves in Australian rainforest is far greater than was previously assumed. On average 30 different fungal species can be found on 5 grams of decaying leaves from the same tree when 100 cultures are isolated. It is likely that there are many more *rare* fungi that would be captured if more cultures were isolated. Many of the fungal species found during Barbara's project are new to science. A small number are very common and seem to cover a large area of the leaf but many more are less common and some were only present once among approximately 5000 cultures. This pattern appears to be universal on all leaves, however the species composition often differs even between two leaves of the same tree. This is called a patchy distribution.

Why is the distribution of fungal species so patchy?

To assess whether changes in the state of decay of the leaves contribute to the patchy distribution observed in leaves, Barbara collected freshly fallen leaves of the banana fig (*Ficus pleurocarpa*) and placed them on the forest floor under thin nylon nets. Over the next three months, she studied microfungi on about 120 leaves. Of the 104 fungal species found on the decaying leaves, the majority were observed only for a short period and were then replaced by other fungi. This process, referred to as *fungal succession* may partially explain the patchy distribution of fungi.



Barbara Paulus collecting leaf samples

Do the same fungi occur on different leaf types?

Mycologists working in the cooler climates have traditionally considered decomposer fungi as *generalists* that can grow on a wide range of substrata. This role has not been confirmed in a rainforest environment however, where trees often gain some protection from the ravages of leaf-feeding animals by producing chemicals like alkaloid and phenolic compounds. It would seem logical that some fungi may have evolved superior abilities to break down particular compounds and hence show a preference for certain leaf types.

To address this question, Barbara studied microfungi in the decaying leaves of four rainforest trees: the rusty laurel (*Cryptocarya mackinnoniana*), the blue quandong (*Elaeocarpus angustifolius*), the banana fig (*Ficus pleurocarpa*) and the blush silky oak (*Opisthiolepis heterophylla*).

Not surprisingly, the answer is not clear-cut. Some fungi seem to be able to grow on a range of leaf types and even habitats. For example *Lanceispora amphibia* was found on laurel and fig leaves and had been reported previously from the submerged leaves of a mangrove tree. However, other microfungi appear to be restricted to a certain leaf type or even to certain regions of the leaf. One example is a tiny cup fungus, new to science and so far found only on the juicy stalks and midribs of banana fig leaves.

No fungi, no future

More research is required to answer some pressing questions about the microfungi that support rainforest ecosystems. Is their efficiency in breaking down leaves and wood directly linked to their diversity? What effect does land clearing and global warming have on their diversity? How many species of fungi are there?

Associate Professor Dr Paul Gadek, James Cook University, and Associate Professor Dr Kevin Hyde, University of Hong Kong, are gratefully acknowledged for supervising this PhD project.

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