



Biology: uniformity and diversity

Where the fungi fits into the forest

Dr Lee Su See, Forest Research Institute of Malaysia

Well the dipterocarps are one of the most important family of timber trees in Malaysia and south East Asia. This family consists of a very large number of species. Many of which have very important value, as commercial timber trees.

Narrator

Behind every great dipterocarp, lies a team of tiny Funghi.

Prof Ian Alexander

The mycorrhizas are very active and competing for water and nutrients and providing benefits to the tree. In fact the trees on these poor tropical soils just wouldn't survive without them.

Narrator

So the tree taps the fungus for nutrients and water. By climbing to the top of the forest, Su See can get to the other side of the bargain.

Dr Lee Su See:

Up near the canopy the trees are photosynthesising. They're capturing the energy from the sunshine. And with the carbon dioxide up here, they're going to produce sugars, which are then transported down the tree.

Prof Ian Alexander

Down here on the forest floor, is where the trees have to capture their water and their nutrients. So a proportion of sugars which are made up there in the canopy. Come down here below ground to fuel the root system, to capture nutrients. And some of that sugar finds its way out into the mycorrhizal fungus.

Narrator

With a Geiger counter and the mycorrhizal seedling Jonathan can track the process.

Jonathan:

This shoot has received radioactive carbon dioxide in this box for just two hours. The shoot has photosynthesised and fixed some of that carbon. We'll check now and see where it is and where it's gone. You can hear that the large amount of carbon that's been fixed by the shoots and then that carbon also has been transferred on to the root system. And then from the roots, through the mycorrhizal roots it's on to the external mycorrhizal mycelium that you can see here.

Narrator

So carbon passes not only from the shoot to the roots. But out of the plant to a totally different organism. A more sophisticated technique reveals the fungal side of the bargain. The patch contains nutrient rich leaf litter. Within weeks the fungus will grow towards it, and start to take up phosphorus and other nutrients.

Jonathan

Phosphorus is one of the key nutrients in the forest eco systems that controls plant growth. And it's the one major nutrient that these mycorrhizal systems are very important in terms of acquiring from the soil.

Narrator

Adding radio actively labelled phosphorus reveals what happens next.

Jonathan

You can see straight away that we've got the radioactive phosphorus that we've added. Some of it's already moved up and this is where the plant is. Just outside of the imaging area. So it's moving up towards the plant. And if we look in at a bit more detail, we can see firstly that it's moved through the fungus. This is the fungus connecting up to the plant. And then secondly, you can see that there are root tips here, mycorrhizal root tips, which have already acquired quite high concentrations of the phosphorus.

This is the same system five days later. You can see the main pathways becoming even more evident now. And you can see that accumulation of phosphate particularly in the root tips. The large amounts accumulating there. And some of it being transferred then on throughout the root system of the plant. The other part that's very exciting here is you can see the distribution of the phosphate that's being transferred around by the fungus. And particularly to the growing tips, where the demand is greatest, as the fungus is growing.

Narrator

This all fits in to an intricate larger system. Trees and mycorrhizal Fungus create a natural network with far reaching connections.

Dr Lee Su See

Well as you can see the canopy consists of many layers of trees. And the light filters down. And the light intensity gets less and less. It gets darker as you get down to the forest floor. And when you have little seedlings down at the forest floor, most of them get very little light.

Narrator

Dipterocarp seedlings are often overshadowed by their parents. They're in very deep shade, where many kinds of tree wouldn't grow at all. In effect they're waiting for dead men's shoes. If an older tree dies or falls, a gap in the canopy suddenly appears. Light floods in to fuel growth. Eventually one of the seedlings will take the place of the dead tree in the canopy. But while they're waiting, the seedlings might be dependant on others.

Prof Ian Alexander

When they germinate, they're going to encounter a web, a woodwide web if you like or mycorrhizal Fungus.

Narrator:

As the seedlings root grows down into the soil, it releases a cocktail of chemicals. Sugars, amino acids and nutrients, an attractive meal for soil bacteria and fungus. The mycorrhizal fungus is just one of a crowd but the plant root also releases chemicals called flavonoids. They act as a signal and the microrrhizal fungus is more sensitive to its message than other organisms. Under the influence of flavonoids the fungus grows towards the root. A subtle molecular conversation starts to take place.

Closer in, a new chemical vocabulary comes into play. Cytocynins tells the fungus to branch. Now it's the turn of the fungus to release a chemical. It in turn communicates with the plant. In response the plant switches off its natural defences. And the root hairs now redundant disappear. The fungus has now been recognised. The stage is set for the formation of a fully-fledged mycorrhizal partnership.

In microcosm this is what happens in a forest. A baby plant joins a larger one, which already has a mycorrhizal network.

Jonathan Leake

This mycorrhizal network is being supported by the larger and established plant. And the seedling growing here will become part of that network when it becomes infected and will gain the benefits of being part of that network, in terms of the uptake of nutrients.

Prof Ian Alexander

That means that they have a ready-made system for capturing water and nutrients. And they may be getting that cheap. Because they're parents upstairs in the sunlight up there, are producing carbon to support this fungal web. And all these guys have to do is tap into it.

Narrator

It could be a case of parental care for a nursery full of seedlings.

Jonathan Leake

I think the big question outstanding is to what extent does this actually mean that plants no longer can compete with each other in the conventional sense. To what extent are individual plants supporting perhaps individuals of other species or even juveniles or seedlings of their own type, through this network.

Narrator

If this idea is true, the seedlings are subsidised by the mycorrhizal network. The network is supported by the canopy trees. Even more controversial, something may pass from parents to offspring via the fungal web.

Prof Ian Alexander

It's possibly that some of the carbon which comes from the over story trees, and out into the web of mycorrhizal Fungi. Some of that may in fact find its way into these seedlings. And that means that that gives them an extra chance of surviving down here in these low light conditions until such time as a gap in the canopy opens. And then off they go.