Wood decay fungi

The mystery of a competitive community

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One of nature's most spectacular displays comes from the fungi growing on trees and tree stumps. Fungal fruiting bodies (the mushroom bit) come in every shape, size and colour. Many have weird and wonderful names too – turkey tail fungus, razor strop, witch's butter and scarlet elf cup. Beautiful and strange they may be, but we know remarkably little about how these wood decaying fungal communities become established, or how the different fungi interact. Our focus at Swansea University is primarily on understanding which species colonise the wood (a difficult job as wood is made of lignocellulose and hard to break down) and when. How do the different fungi that we see interact with each other?

Scarlet elf cup on the forest floor

Turkey tail fungus can be found on lots of trees and stumps.

Pattern of decay

The community of fungi growing on dead wood changes over time. Traditionally it is described as a succession with each fungus being out-competed when a new and stronger competitor arrives. For example, primary colonisers are those fungi which are the first saprotrophs to start decaying dead wood. (The branch may die due to a variety of environmental conditions, and wood decay fungi do not wait for the branch to detach from the tree to begin the decay process.) Examples of these include bleeding oak crust (which can also invade other trees) and beech tar crust.

Secondary colonisers are fungi which can out-compete the primary colonisers and utilise more of the partially decayed wood. Turkey tail fungus is a secondary coloniser and has a formidable range of enzymes that can attack the complex structure of wood and break down the lignocellulose.

New approaches

Research being conducted at Swansea University is using pairs of fungal competitors to examine how these interactions occur, which competitors are the more aggressive and how each competition is being fought. Using techniques that look at differences in gene expression and protein production, our research hopes to shed light on why turkey tail fungus is so good at out-competing primary colonisers, and why it in turn is out-competed by competitors such as sulphur tuft fungus. While this laboratory-based work may help our understanding of how fungi interact, it is not the whole story. The reality of decaying wood is a great deal more complex.

A Xylariaceae fungus on a log

Saprotrophs are organisms which feed on dead and decaying things.

The photograph on pages 10-11 shows beechtar fungus and a shelf fungus fruiting on the same piece of branch.

Two different species of fungus growing on a single branch – but are they working together or fighting it out? Research at Swansea University aims to find out.

Catalyst

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A whole standing beech tree which has been colonised by bleeding oak crust (the white fungus) and dryad's saddle fungus (reddish)

Which fungus?

The assessment of which species are present has always been done visually, using the presence of fungal fruiting bodies. This is beginning to change as molecular techniques are brought into the field of microbial ecology. Anna Rawlings, a PhD student at Swansea University, is studying the colonisation of tree branches before they ever reach the forest floor. To try to determine the community structure and function of early colonisation and the role of the primary coloniser, she is using molecular methods such as DNA extraction and sequencing to determine which species are present, rather than relying on the presence of fruiting bodies.

The results so far suggest that far from mushrooms telling us everything, there can be many other species of fungi present in the wood which are not producing mushrooms. Indeed, it may be that far from one species dominating a section of wood, complex communities of different fungi are present from early on in the invasion process. As can be seen in the photo above, two fungi (bleeding oak crust and dryad's saddle) are present in a standing beech tree. Both fungi have already colonised the wood and begun the decay process. What we are interested in is whether that co-existence is a battle or whether there is a degree of tolerance.

Metabolites are small molecules produced during the chemical reactions carried out by living organisms.

A wood slice showing the interaction zones of different fungi

Witches butter on a standing beech tree

A slice of life

Looking at the slice taken through a beech branch, each of the wiggly lines delineates an area colonised by a different fungus (most of which will not produce fruiting bodies and therefore their presence would remain unknown by traditional methods). Clearly, there are many 'individuals' in close proximity. The lines are caused by the fungi putting up chemical barriers to prevent the neighbouring fungi from taking over.

Anna is using protein and metabolite analysis to try to understand the relationships between the different fungi early in the wood colonisation process, to see what the overall function of the community is and whether communities with different individual members perform in a similar way. It remains to be seen whether these community members are always competing or whether there is also some degree of co-operation. Lignocellulose is extremely tough to break down, and the possibility of co-ordinated degradation by co-operative fungi is certainly something to be considered.

All of the fungi pictured here are involved in wood decay, some as primary colonisers and some in the final stages on the forest floor. How and why they compete and/or co-operate remains something of a mystery.

Suzy Moody is a microbiologist at Swansea University