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The effects of co-occurring mycorrhizal functional types on the distribution of fungal functional groups in the soil profile

Research Highlights

- Across a gradient of trees associated with arbuscular mycorrhizal and ectomycorrhizal fungi, we looked at how the presence of an ericoid shrub (mountain laurel, *Kalmia latifolia*) influences the diversity and distribution of fungal communities at different soil depths.
- Overall, we found that the type of mycorrhizal association (ecto-, arbuscular-, or ericoid) was associated with large changes in fungal communities, in addition to soil depth and site differences.
- Ericoid shrubs reduce total fungal diversity and diversity of ectomycorrhizal and saprotrophic fungi in organic soils.
- Ericoid shrubs also decreased the relative abundance of ectomycorrhizal fungi in the surface mineral horizon.

Research Summary

Symbiotic relationships between plants and fungi are widespread, occurring in over 90% of all existing plant species. These relationships are classified based on the type of fungal structures that form (ectomycorrhizal fungi grow on the surface of roots, while arbuscular fungi form tree-like growths inside root cells) or the plant family involved in the partnership ("ericoid" refers to plants in the family Ericaceae). Ectomycorrhizal and arbuscular trees can have different effects on forest ecosystem processes, such as soil organic matter accumulation, decomposition rates, and nitrogen availability. Ericoid mycorrhizal fungi can slow decomposition rates and intensify nitrogen limitation, thereby shaping nutrient cycling in forest ecosystems. Despite this, how understory ericoid shrubs modify the influence of arbuscular versus ectomycorrhizal trees on fungal communities has been little researched.

Alex Polussa and Mackenzie Birkey identifying and measuring trees within plots to assess the relative proportion of ectomycorrhizal and arbuscular mycorrhizal associated trees. *Photo courtesy of Dr. Elisabeth Ward*

Research Summary cont.

In this project, we wanted to understand how the presence of ericoid shrubs, specifically mountain laurel (*Kalmia latifolia*) might modify the distribution of larger groups of fungi associated with dominant trees in the Yale-Myers Forest. Dr. Elisabeth Ward and I identified plots that were on the edge of ericoid shrub thickets in the understory and had canopy trees ranging in dominance from 100% arbuscular mychorrizal (predominantly sugar and red maple) to 100% ectomycorrhizal (predominantly red oak and black birch). Within these plots, we sampled soils in the organic horizon, the surface mineral horizon and a deeper mineral horizon under the ericoid shrubs and adjacent plots where they were absent. By sampling at these different depths, we aimed to characterize how the presence of these shrubs might modify the distribution of other mycorrhizal and free-living fungal communities in the forest.

To identify the fungi that make up the communities in these soils, we first extract the DNA in a soil. To identify which fungi are part of this whole community, we then amplify region of DNA, known generally as the ITS region, and reference it against a database of fungal species based on the unique sequences. These data detail the composition of the fungal community which we can group according to taxonomy or function.

We found that in the surface, organic horizon, the number of unique fungal species fell drastically in the presence of ericoid shrubs. We observed that the presence of ectomycorrhizal trees reduced overall fungal diversity while increasing ectomycorrhizal fungal diversity while the presence of ericoid shrubs was associated with a greater reduction in the richness of fungi across the whole community and within both ectomycorrhizal and saprotrophic groups. While studying the effect of ericoid shrubs on fungal communities, we were also interested in the ability to detect ericoid fungi belowground. They are not known to have an extensive network of mycelia like their ecto- and arbuscular counterparts and have also been observed to exist without their plant host. We found no difference in the relative abundance of ericoid fungi under the shrubs and without, but we found that the relative abundance of ericoid fungi decreased in the surface mineral horizon when transitioning from arbuscular tree dominating to ectomycorrhizal trees.

How understory ericoid shrubs are shaping nutrient cycling and interacting with mycorrhizae associated with dominant trees will help provide a more comprehensive view on plant effects on nutrient cycling and the buildup of carbon in forests.

Mountain laurel, *Kalmia latifolia*¸ in Yale-Myers Forest. *Photo courtesy of Dr. Elisabeth Ward.*

Organic layer of soil under mountain laurel can be very thick! *Photo courtesy of Dr. Elisabeth Ward*