Symbiotic niche mapping reveals nutrient specialization and functional complementarity among ectomycorrhizal fungi

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Project Goals: Despite strong geographic patterns in the dominant form of mycorrhizal symbiosis[1] and the associated ecosystem consequences, ecologists have a limited understanding of why these patterns emerge. Why and how do ectomycorrhizal host trees outcompete arbuscular mycorrhizal host trees in certain ecosystems? Does climate play a direct or indirect role in determining the success of ectomycorrhizal symbiosis? Given that ectomycorrhizal fungi are themselves highly diverse, do changes in the ectomycorrhizal community expand the range of climates a host tree can grow in? For this early career award (ECA) I am determining the mechanisms by which mycorrhizal symbiosis influences the distribution of tree species across North America.

Abstract text. Mutualisms are ubiquitous in natural systems, but research on ecological interactions has focused almost exclusively on antagonism and we know little about how these positive interactions influence species distributions. The niche concept is one useful approach for thinking about factors that control species distributions but has generally been considering without recognizing the growing importance of mutualisms. In particular, understanding how the nature of positive interactions between plants and mycorrhizal fungi change across large environmental gradients remains a significant research frontier. Here, we used a continuous niche mapping approach to examine how ectomycorrhizal fungi impact plant growth across a two-dimensional soil nitrogen (N) and phosphorus (P) gradient. We found that one ectomycorrhizal fungus, *Thelephora terrestris*, improved seedling growth most at high N:P ratios, suggesting that members of the Thelephoraceae may be P specialists. By contrast, the presence of a second ectomycorrhizal fungus (*Suillus pungens*) improved seedling growth most at the lowest nutrient levels and N:P ratios. Mycorrhizal colonization by *T. terrestris* increased plant niche volume (calculated as the volume of convex hulls comprising total plant biomass across N and P gradients) compared to non-mycorrhizal control plants and shows the positive effects of mutualisms on plant niche size. However, despite growth benefits at low nutrient conditions, the presence of both fungi decreased plant niche volume compared to *T. terrestris* alone, indicating the costs of maintaining multiple mycorrhizal symbioses exceed benefits in some environments. The niche mapping approach we present has the potential to answer fundamental questions about the dimensions of functional diversity in ectomycorrhizal fungi and the global distribution of mycorrhizal symbioses.

References

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