Spatiotemporal drivers of ectomycorrhizal diversity in Europe

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Ectomycorrhizal (ECM) fungi are symbiotic partners to the major tree species in Europe. They play a crucial role in tree nutrition and are increasingly recognised for their role in soil carbon sequestration. However, forests and ECM communities may be approaching a tipping point in response to nitrogen (N) pollution, leading to phosphorus deficiency in trees and cascading negative effects on forest health and the services that they provide. Therefore, it is urgent to quantify the responses of ECM fungal taxonomic, phylogenetic, and functional diversity to changes in climate, soil chemistry and the atmosphere.

With a large dataset of ECM communities collected in 137 Level II ICP Forests plots, we showed that ECM diversity and species composition are driven by host distribution, soil chemistry, climate, and atmospheric N deposition across Europe. New taxonomic and phylogenetic diversity analyses indicate both selection for competitive N-tolerant species and local species extinctions across different fungal clades. We also find tree host-specific climate influences, and selection of nutrient acquisition and C sequestration-related functional traits by N pollution. Moreover, using distance-decay models, multivariate analyses, and indicator species analyses we observed that biogeographic patterns in ECM communities are independent from climate and host tree distribution, and show adherence to ecoregions, unlike previously claimed by studies based on fruitbody occurrences. We are currently resampling a subset of beech and pine plots, to study temporal changes in community composition and diversity and to measure the effect of changes in climate and N pollution 10 years after the first collection.

Mycorrhizas are crucial to understand forest nutrient dynamics, resilience, and recovery from change; understanding them at the large-scale will inform forest management, conservation, and global change mitigation efforts.