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Rock-eating fungi: Ectomycorrhizal fungi are picky eaters

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Ectomycorrhizal fungi, which form mutualistic symbiosis with the roots of most temperate and boreal forest trees, play a key role in the provision of nitrogen and phosphorus to their plant symbionts; they have also been shown to provide potassium and magnesium. Ectomycorhizal hyphae colonize and take up mineral nutrients (including P, K, and Mg) from primary mineral surfaces in the soil. It is poorly understood whether mineral colonization and uptake of nutrients from minerals can increase in accordance with host plant demand for these nutrients, and this question has been difficult to address in field settings. Ectomycorrhizal fungal communities are diverse and niche separation according to nutrient uptake and transport to the host is commonly considered one of the major factors maintaining diversity and shaping ectomycorrhizal community composition.We investigated ectomycorrhizal growth, community composition, and mineral colonization in a series of connected Norway spruce forests in the Czech republic. These forests have similar aspect, climate and stand history, but are underlain by different parent materials and are, as a result, limited by different nutrients. The productivity of forests overlying a high amount of serpentinite rock are co-limited by K and P, those growing on primarily granitic rock are limited by Mg, while those on amphibolite are N limited. We assessed the fungal community in both soil and in-growth mesh bags measuring biomarkers, using in-growth assays and performing community analysis with 454 sequencing of the ITS region. In-growth mesh bags were filled with quartz sand and incubated for two growing seasons in the soil. These mesh bags select for ectomycorrhizal hyphae and were either pure quartz sand or amended with ground apatite (Ca and P source), hornblende (Mg source) or biotite (K source).

Ectomycorrhizal growth and community composition were most strongly affected by parent material. The phosphorus-limited site had the lowest tree growth but the highest ectomycorrhizal growth. Apatite amendment (a phosphorus source) increased fungal in-growth in the serpentinite sites, but had no effect on the other (not P-limited) sites, while hornblende and biotite had no effect on fungal in-growth on any sites. Mineral amendments in the mesh bags had a small but significant effect on fungal community composition; this effect was strongest in apatite-amended bags and on serpentinite sites. Fungal species-specific responses to different mineral amendments were also observed. These results indicate that the parent material from which a soil is formed has a major effect on the soil fungal community, and that ectomycorrhizal communities may respond to the phosphorus limitation of their host trees by increased colonization of phosphorus-containing minerals. In contrast, this response to nutrient limitation does not appear to exist for potassium or magnesium limitation.