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Using isotopic patterns of ectomycorrhizal and saprotrophic fungi to elucidate fungal sources of carbon and nitrogen in a Norway spruce stand

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To predict effects of global change on fungal community structure and the consequential effects on carbon (C) and nitrogen (N) cycling, we first need to understand different fungal sources of C and N. We determined sources of C and N by measuring δ15N and δ13C of an extensive collection of ectomycorrhizal and saprotrophic sporocarps and their potential substrates from Norway spruce (Picea abies) stands in southern Finland. The substrates included organic soil, roots in organic soil, mineral soil, roots in mineral soil, moss, needles, needles in litter, branches, twigs in litter, wood and decay wood from stages I-V. Notably, δ15N and δ13C analysis of wood in decay stages I-V was a novel measurement, as were our associations between wood decay fungi and the decay stage of trees. Decay stage of wood significantly correlated with the δ15N and δ13C of associated saprotrophic wood decay fungi species. Fungi were lower in δ15N by 0.3-0.7‰ when associated with decay wood in stages II and III compared to I and IV and higher in δ13C by 0.9-1.2‰ when associated with decay stage I compared to decay stages II-IV. The ectomycorrhizal fungi, Piloderma fallax, was significantly correlated with 15N enrichment of decay wood upon its introduction in decay stages III and IV that continued to the later decay stage V, with δ15N of decay stage V 1.5‰ higher than decay stage IV. These results indicate that wood decay fungi rely on C and N from various wood decay stages and influence C and N pools of wood as well. Litter decay fungi were lower in δ13C than wood decay fungi by 1.9‰ and higher in δ15N by 3‰ and isotopically tracked their C and N sources. Calocera viscosa, Gymnopus acervatus, and Leotia lubrica were highly 15N-enriched compared to other saprotrophic fungi and they had δ15N values similar to fungi with hydrophobic ectomycorrhizae indicating function more similar to ectomycorrhizal fungi or N sources similar to this functional group. Similar to other studies, ectomycorrhizal fungi were 15N-enriched relative to saprotrophic fungi and fungi with hydrophobic ectomycorrhizae were 15N-enriched compared to fungi with hydrophilic ectomycorrhizae by 3.6‰δ15N and δ13C values indicate that ectomycorrhizal fungi derive C from plant sugars similar to woody substrate, and acquire N from older sources within the litter layer and deeper in organic and mineral soils, with hydrophobic ectomycorrhizae using older sources of N than hydrophilic ectomycorrhizae. Interestingly, Entoloma cetratum with hydrophilic ectomycorrhizae and Hydnum repandum with hydrophobic ectomycorrhizae both had abnormally high δ15N values that suggest an irregular 15N-enriched source of N, likely from a higher 15N-enriched trophic level.