Roots and mycorrhizal fungi differentially impact microbial processes

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Project Summary. Plant roots, their associated mycorrhizal community, and the free-living microbial community interact to regulate the movement of carbon from soil to the atmosphere, one of the most important and least understood fluxes of terrestrial carbon. Our understanding of how plant-microbial interactions alter soil carbon decomposition is lacking, leading to poor model predictions of terrestrial carbon feedbacks to the atmosphere. I tested how roots, mycorrhizal fungi, and the free-living microbial community alter soil carbon decomposition and predicted roots and mycorrhizal fungi would additively increase microbial activity. I manipulated the access of roots and mycorrhizal fungi to bulk soils *in situ* in a temperate mixed deciduous forest. I added ^{13}C-labelled substrate to trace carbon through respiration and measured microbial extracellular enzyme activity.

Cellobiohydrolase activity was equally high when the free-living microbial community was degrading soil carbon alone as when microbes were in the presence of both roots and mycorrhizal fungi. Cellobiohydrolase activity was lowest when mycorrhizal fungi were present with the free-living community, but roots were excluded. I found that microbial biomass was negatively correlated with peroxidase activity and mycorrhizal biomass was positively correlated with phenol oxidase activities. My results indicate soil carbon decomposition rates were contingent upon root-mycorrhizal-microbial interactions and, when excluded from roots, mycorrhizal fungi reduced microbial decomposition of soil carbon. Some of the heterogeneity in soil decomposition rates observed in nature may be explained by shifting interactions among roots, mycorrhizal fungi, and the free-living soil community. Understanding heterogeneity of plant-mycorrhizal-microbial interactions can improve predictive abilities of decomposition models.

Student Contribution. This DOE-funded project is central to my dissertation research program, which asks how plant-microbe interactions influence soil carbon dynamics. I helped conceive the project objectives and experimental design. I designed, constructed, and installed root and mycorrhizal exclusion PVC mesocosms at four field sites over two years. I added ^{13}C substrates to soil and collected necessary gas and soil samples. I trained three undergraduate students, a post-doc, and our lab technician to aid me in procedures such as chloroform fumigation for measurement of microbial biomass, soil enzyme assays, and isolation of soil carbon fractions. I managed data collected at each of four field sites and analyzed it after discussing appropriate analyses with the project team. I presented results from this project at the Ecological Society of America 2014 meeting and submitted a first-authored manuscript on these data to *Journal of Ecology*.