20. Influence of shallow soil strata and chronic N deposition on the fungal community in pine and maple forests

Cedar Hesse[1], Rebecca Mueller[1], Blaire Steven[1], La Verne Gallegos-Graves[1], Chris Yeager[1], John Dunbar[1], Carolyn Weber[1,3], Donald R. Zak[2], and **Cheryl R. Kuske[1*]**(kuske@lanl.gov)

[1] Los Alamos National Laboratory, Los Alamos, NM, [2] University of Michigan, Ann Arbor, [3] Idaho State University, Pocatello

Project Goals: Anthropogenic N deposition is a chronic and increasing condition in temperate regions that may strongly influence C cycling dynamics. One major theme of our Science Focus Area is to determine the influence of chronic N deposition on microbial C cycling processes in two major biomes of Earth's temperate regions, forests and arid grass/shrublands. In both biomes fungal and bacterial biomass is concentrated in shallow surface soil strata where C/N cycling is a major process. The goals of this project are to (a) correlate the resident fungal and bacterial communities, enzyme activities, and local geochemistry across shallow strata of strongly stratified forest soils and biocrust dominated soils of arid grass/shrub lands, (b) determine the impacts of chronic N amendment across multiple forest and arid grass/shrubland biomes using a suite of long-term field experiments, and (c) compare the ability of phylogenetic rRNA gene surveys, soil enzyme assays, and metatranscriptome surveys to detect shifts in community structure and concomitant changes in C cycling processes in response to altered N conditions.

This poster describes highlights from our studies of soil fungal communities in two forest types, loblolly pine in central NC (Duke forest FACE site) and hardwood forest dominated by maple in MI, USA. Studies at the long-term maple N deposition field site are led by Donald R. Zak (University of Michigan) and are supported by both the NSF and the DOE. We measured soil/litter chemistry, relative abundance of fungal rRNA genes (qPCR), and community richness and composition (454 sequencing of the fungal LSU gene).

In the pine forest, the fungal community was dominated by Basidiomycota taxa that are often ectomycorrhizal associates with pine (1). Soil chemistry and resident fungal communities were significantly different across the forest floor, O horizon (0-2 cm depth) and A horizon (2-5 cm and 5-10 cm depths) under ambient conditions. After 5 years of N amendment (11.2 g N/m^{-2} annually as ammonium nitrate), the soil chemical conditions were significantly altered, especially in the forest floor and O horizon. Relative abundance of fungi in each horizon was not affected by N amendment, but composition of the resident fungal communities were significantly different in N amended conditions, and the response of the fungal community to N amendment differed across the strata. Fungal taxa found to be responsive to N differed with soil stratum.

The impact of 16 years of N amendment (3 g N/m^{-2} annually as sodium nitrate) on fungal relative abundance and community composition was surveyed in the forest floor, in four maple forests across a 10 km latitudinal transect. In contrast to the pine forest, the forest floor fungal community was dominated by taxa in the Ascomycota, however our survey primers did not efficiently detect members of the Glomeromycota that may be arbuscular mycorrhizal associates of the maple. The concentration of N amendment is lower at the four maple sites than in the pine forest experiment, thus differences in forest floor soil chemistry with N amendment were slight. Fungal relative abundance in the forest floor was not significantly impacted by N amendment at any of the four sites. Comparison of fungal community composition across the four sites showed highly significant differences with site, illustrating that the resident fungal community differed across the latitudinal transect even where the major plants and soil

conditions were similar. N amendment had a lesser, but significant, impact on fungal community structure in the forest floor and this effect differed among sites. The number and taxonomic assignment of responsive taxa to N deposition differed among the sites within this study.

Although the two forest field experiments are different in design and implementation, it is clear that chronic N deposition impacts the geochemistry and resident fungal community in both the pine and maple forest. Fungal community composition was affected by N deposition in site- specific ways. Soil metatranscriptomes have been generated from these soils, and soil enzyme assays are in progress (pine site). Together with the taxonomic information, these gene expression and enzyme activity surveys will identify shifts in C cycling patterns that are mediated by both fungal and bacterial communities.

(1) Weber CF, R Vilgalys, CR Kuske (2013) *Changes in fungal community composition in response to elevated atmospheric CO_2 and nitrogen fertilization varies with soil horizon*. Frontiers Terrest Microbiol. doi: 10.3389/fmicb.2013.00078

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