Impact of Atmospheric Nitrogen Deposition on Carbon Storage Pathways along a Nitrogen Deposition Gradient in Coastal Sage Scrub Soils

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Introduction

Recent studies suggest that nitrogen can have significant effects on microbial activity and carbon storage by causing shifts in fungal:bacterial activity such that bacterial degradation pathways become dominant under high nitrogen conditions. If true, changes in fungal:bacterial (F:B) ratios could have a major impact on carbon storage in urban pollution affected soils that receive high amounts of nitrogen from atmospheric deposition. To address this question, this research will take advantage of previously established research sites that have been used to examine the impact of nitrogen deposition on coastal sage scrub (CSS) plant communities in southern California

Hypotheses:

Microbial activity, measured as soil respiration, is predominately associated with the fungal biomass in CSS vegetation in low nitrogen soils. Fungal:bacterial activity ratios will decrease with increasing nitrogen deposition.

Fungal dominated decomposition results in higher carbon storage than in soils where decomposition occurs through bacterial decomposition pathways. F:B activity ratios will be positively correlated with carbon storage along a nitrogen deposition gradient..

Methods:

Replicate intact soil cores were taken from five sites along the N deposition gradient and were transported to the lab, where the cores were brought to field capacity and allowed to equilibrate for 10 days. One set of cores from each site was subjected to substrate induced respiration assays with selective inhibitors as described by Bailey et al. 2002. Each SIR assay included 4 treatments: no inhibitor, bacterial antibiotic (streptomycin), fungal antibiotic (cyclohexamide), and a combination of both inhibitors. Additional cores from each site were subjected to PLFA analysis, organic matter analysis, and nitrogen analysis. PLFA was run using standard procedures involving fatty acid extraction, separation of phospholipids fatty acids by column chromatography, and derivitization for GC analysis.

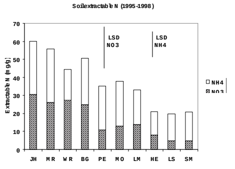

Figure 1. Nitrate and ammonia nitrogen concentrations at 10 different locations along a nitrogen deposition gradient Coastal Sage Scrubland in Riverside County. Key: JH, Jurupa Hills; MR, Motte Reserve; WR, Waterman Rd; BG, UCR Botanic Garden; PH, Pedley Hills; MO, Mockingbird Reservoir; LM, Lake Mathews; HE, Hemet; LS, Lake Skinner; SM, Santa Margarita.

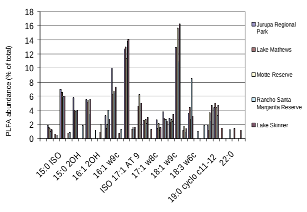

Fig. 2. PLFA abundance (% of total) in soils across a nitrogen deposition gradient.

Results showed that the microbial community composition is highly similar at all of the locations that were sampled. Among the PLFA that were detected, there were marker PLFA present for bacteria, actinomycetes, and fungi that can be used to obtain a rough estimate of the relative biomass of each of these groups in the different soils.

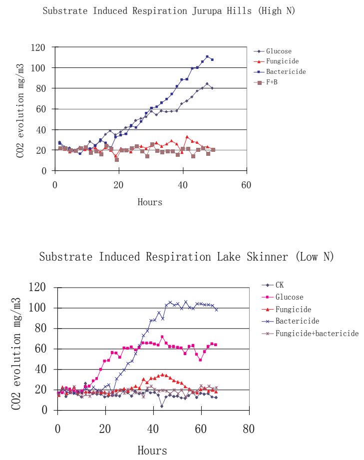

Fig. 3. Substrate induced respiration assays

Results showed that approximately 90% of the carbon dioxide that was released was due to fungal metabolic activity. This suggest that even though fungi comprise only 30 to 35% of the soil biomass, they were responsible for the majority of the soil respiration, and that the bacterial biomass was relatively inactive.

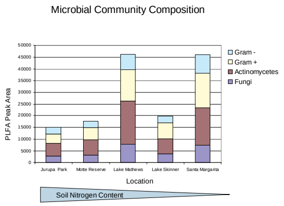

Fig. 4. Relative abundances of bacteria, actinomycetes, and fungi in soil collected along the nitrogen deposition gradient. Total peak heights reflect total biomass.

Bacterial:fungal biomass ratios varied from 1.9 to 2.4 across the different locations, and showed no correlation with nitrogen content.

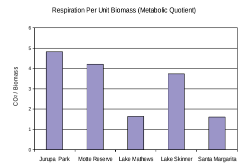

Figure 5. Measurements of the respiration per unit biomass, also known as the metabolic quotient (Q), showed that there was a general tendency for the soils containing high nitrogen to have a high metabolic quotient. This is an indication that carbon is being lost from these soils at a higher rate than in the low nitrogen soils.

Summary

The microbial communities in the soils that were examined were highly similar in composition of fungi, bacteria, and actinomycetes. Although fungi comprised only about a third of the soil biomass, they were responsible for the majority of the respiration activity. Soils containing high nitrogen appear to have higher respiration rates per unit biomass, which suggest that they will not accumulate carbon at the same rates as the soils with low nitrogen.

Further studies are needed to examine seasonal dynamics of the respiration and biomass patterns, and to further characterize the active microflora that contribute to soil respiration and carbon storage.

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