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Resource limitation of microbial decomposition of soil organic matter

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While it is consensus that nutrient availability is a major control of net primary production, the effect of resource availability on decomposition of soil organic matter is less clear. We here report on field experiments in which girdling of beech trees and fertilization with ammonium nitrate were used to alter carbon and nitrogen availability for decomposer communities. Additionally, we analyzed the effect of seasonal variation in soil nutrients on decomposition. Both, tree girdling and fertilization significantly affected inorganic N pools compared to controls. Fertilization roughly doubled nitrate concentrations, while girdling led to a 5- to 10-fold increase over two vegetation periods, most likely due to reduced plant nitrate uptake. Dissolved organic carbon concentrations were only affected in the girdling treatment (significant decrease during the growing season). These alterations in resource availability translated into changes microbial community structure. Analysis of phospholipid fatty acids showed significant differences in microbial community composition of girdled and control treatment during the vegetation period and in early winter (litterfall), mainly due to differences in fungi and gram positive bacteria. No treatment effects were found in the late winter. Similarly, analysis of selected bacterial and archaeal taxa by 16S rRNA gene-based quantitative PCR exhibited significant treatment effects. These changes in

microbial community composition were correlated with changes in extracellular enzyme activities. During the vegetation period hydrolytic enzymes (i.e., cellulases and chitinases) were decreased in the girdling treatment compared to controls, while phenoloxidase and peroxidase activities were increased during all seasons in the soil of girdled plots. These differences are, however, unlikely to have been caused solely by the higher N availability, as the fertilization treatment showed an opposite response, but are likely to have been caused by differences in microbial community composition between the treatments. Furthermore, microbial community composition and associated extracellular enzyme activities affected ecosystem scale processes, such as gross N mineralization and heterotrophic respiration. We conclude that (1) resource availability controls, at least in part, the microbial community composition in a temperate forest ecosystem, that (2) changes in community composition affect microbial decomposition mainly by effects on depolymerizing enzymes and that (3) this translated into changes in processes at the ecosystem scale.