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The diversity-stability relationship in soil microbial community investigated by a diversity-manipulation experiment

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How biodiversity influences the stability of ecosystem processes is the central question in environmental science, but empirical investigations on the biodiversity-stability relationship in soil microbial community is still limited. To investigate the diversity-stability relationship in soil microbial community, microbial community composition was manipulated using taxon-specific biocides, and changes of community functions (i.e., soil decomposition activities) against changes in external environmental factors (i.e., plant materials to be decomposed) imposed to the soil microbial communities were investigated in a microcosm experiment.

Distilled water, bactericide (oxytetracycline) and fungicide (cycloheximide) were added to forest soils to create communities that are intact (i.e. fungi and bacteria are coexisting), fungi dominated and bacteria dominated, respectively. For decomposition substrates, fresh leaves of eastern hemlock and sugar maple were collected from the same location as the soil collection. The leaves, whose chemical qualities differ from each other, were dried, powdered, then mixed to fixed proportions to produce the substrate quality variations. The substrates were then added to each microbial community, and soil decomposition activity (soil respiration rate and activities of acid phosphatase, N-acetyl-glucosamidase, β-D-glucosidase and cellbiohydrase) was measured after the substrate addition.

Soil respiration rates of the bacterial and fungal communities showed highly significant change along the substrate quality variation, but those of the coexisting community changed less significantly. Dependence of the enzyme activity on the substrate quality in the coexisting community was the weakest in general. These results indicated that the decomposition activity of the coexisting community was generally more stable than those of the less-diverse communities. In addition, microbial community compositions, which were estimated by soil lipid profile, changed more flexibly along the substrate quality variation for the coexisting community. These results can be interpreted as that, for the coexisting community, substrate quality influenced the microbial composition, and in turn, the shift in the microbial composition buffered the influences of the changes of substrate quality. The results could indicate that belowground microbial diversity as well as aboveground plant biodiversity is essential for the stability of terrestrial ecosystem processes, which are driven by the interaction of production and decomposition.

Great cautions should be taken because the specificity of the taxon-specific biocides used in this study was not perfect. For example, there must be many bacteria species that could not be inactivated by the addition of the bactericide. In order to understand the diversity-stability, or diversity-function, relationship in microbial community, more sophisticated methodology to manipulate microbial community composition is required. Limitations of current methodologies as well as possible techniques for the better manipulation of microbial community composition will be discussed in this presentation.

Keywords: biocides, enzyme activity, diversity, soil microbial community, soil respiration rate, stability