The effect of plant-derived C flow on the microbial community structure and enzymatic activities in boreal forest

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Introduction

- The boreal forest soils are globally significant reservoirs of carbon (C), and the humic compounds form the most stable C pool.
- In boreal forest soils, nitrogen (N) is often the growth limiting factor, and it is tightly incorporated into soil organic matter (SOM).
- The increase in plant photosynthesis rate and the C flow to the soil enhances the decomposition of the older and more slowly degradable SOM, i.e. humus, through the priming effect [1],[2].
- It has been suggested that the availability of N has an important impact on the rate of priming [1],[2].
- In addition, ectomycorrhizal fungi have been shown to be involved in the SOM decomposition and priming.

The aim, experimental setup and methods

- The aim was to study the effect of plant-derived C on the structure and enzymatic activities of the microbial community in boreal forest humus.
- A three-year field experiment, where below-ground C fluxes were controlled, was set up at the Hyytiälä forestry station in southern Finland in 2013.
- Mesh bags (N=24) with three different mesh sizes, filled with sieved humus were buried between organic and mineral soil horizons.
- The different mesh sizes prevent the entrance of plant-derived C into the bags (1 µm mesh size), exclude root-derived C from the bags but allow fungal hyphae to penetrate (50 µm mesh size), or allow penetration of both fungal hyphae and fine roots (1 mm mesh size, control).
- The organic material modifying enzyme activities were measured using fluorometric assays for acid phosphatase, N-acetylglucosaminidase, cellobiohydrolase, β-glucosidase, β-glucuronidase, β-xylosidase and leucine amino peptidase, and colorimetric assay for laccase.
- The changes of the microbial community structure were observed with the phospholipid fatty-acid analysis (PLFA).
- The C and N contents and the mass losses of the humus bags were analyzed.

Results and Conclusions

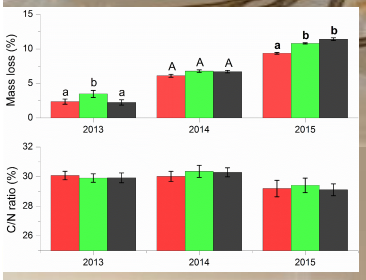

Figure 1. The mass losses and the C and N contents of the humus bags in years 2013,2014 and 2015. *

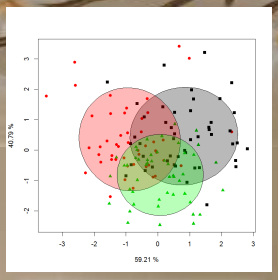

Figure 2. The structures of microbial communities in the mesh bags in years 2013 and 2014. *,X

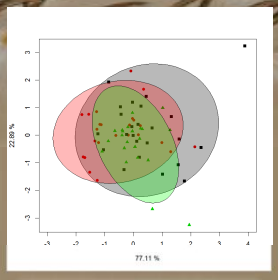

Figure 3. The enzyme activity profiles of the mesh bags in year 2013. *,X

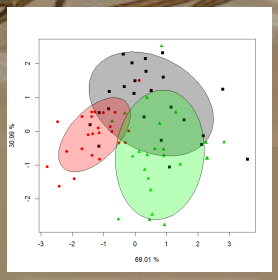

Figure 4. The enzyme activity profiles of the mesh bags in year 2014. *,X

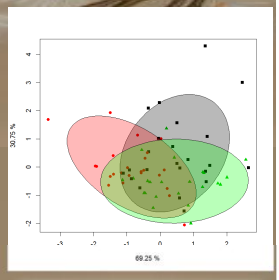

Figure 5. The enzyme activity profiles of the mesh bags in year 2015. *,X

*) The mesh sizes 1 µm, 50 µm and 1 mm are marked with red, green and black, respectively.
X)The circles represent the general trends of the data with a confidence intervals of 70 %.

- Positive correlation between the mass losses of the mesh bags and accessibility of plant-derived C was observed.
  - The mass loss was larger in those humus bags where the below-ground fluxes were not restricted.
- The sampling year had a significant effect both on the structures and enzymatic activities of the microbial community of the humus mesh bags.
- Within the years, a treatment specific shift to enzyme activity profiles of the microbial communities was detected.
- The results indicate that SOM decomposition is enhanced by plant-derived C.

References:
[1] Kuzyakov et al.2000. Soil Biology and Biochemistry 32:1485–1498.
[2] Fontaine et al. 2007. Nature 450:277–280.

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