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How mycorrhizal plant-soil interactions affect formation and degradation of soil organic matter in boreal forest

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Forest soil organic matter (SOM) contains more carbon (C) than all the flora and atmosphere combined and that is why C release as CO_2 from SOM may have drastic consequences for climate globally. SOM is enormous C sink which has the potential to become C source (IPCC 2013). To predict long-term soil C storage and climate feedbacks we need profound understanding of dynamics and drivers of SOM decomposition.

Ecosystem processes associated with C cycle are constrained by C and N interactions. At the level of ecosystem boreal forest is N-limited, as most of soil N is stored in recalcitrant organic form bound or complexed with soil compounds such as polyphenols. To improve N uptake, also from less available pools, plant species form symbioses with mycorrhizal fungi able to degrade recalcitrant N and sharing it with plants. As a feedback, plants provide to fungal symbiont assimilated C. Climate change through elevated CO_2 level led to increases in photosynthesis which enhance the C flow belowground accelerating N uptake by plants also from more recalcitrant N pools. Increased SOM decomposition would possibly result also in increase of CO_2 production from soil.

Our field experiment was conducted at Hyytiälä forestry field station (SMEAR II, University of Helsinki) located in southern Finland (61°84'N, 24°26'E). In this 3-year long experiment, we discriminated SOM decomposition with different mesh bags filled with humus. These mesh bags allowed for the entrance of mycorrhiza and fine roots (1mm mesh size), or only mycorrhiza (50μm), or both were excluded (1μm). We followed changes in SOM content, N pools and enzymatic activity. The results suggests that plant-mycorrhiza interactions increase recalcitrant pool of organic N in SOM due to root-derived tannins, but mycorrhizal plants have still access to this N. Although mycorrhizal plant-soil interaction seems to strongly affect the formation of recalcitrant SOM, the net decomposition is not hindered by these chemical changes. This study underline that plant-soil feedbacks and especially soil chemistry behind this interaction are decisive factors for estimating changes in SOM decomposition rate.