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Long-term stabilization of labile carbon in microbial biomass and its residues – A question of microbial N demand?

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It was assumed for a long time that soil organic carbon (SOC) storage is mainly regulated by non-biological environmental conditions and by selective preservation of recalcitrant compounds. Yet, a new paradigm in SOC research points to a more active role of microorganisms in regulating and building C storage. In this context, even labile C may persist in soil for a long time due to microbial transformation into compounds that become stabilized in soil. However, little is known about the cycling of labile C through the microbial biomass and the turnover time of its residues. Unraveling the mechanisms, regulating factors, and involved microbial groups would be critical for understanding C storage in soil.

We assume that the path of labile C through the microbial biomass and its residues is mainly driven by microbial nutrient demand. Specifically, we hypothesize that (1) high nutrient demand forces microbes to decompose N-rich substances, such as amino sugars, leading to a rapid turnover of C from microbial residues, and that (2) labile C is stabilized in microbial residues when N demand is met.

To investigate these hypotheses, we study the fate of trace amounts of 13C labeled glucose in a greenhouse pot experiment including four treatments: (1) bare soil, (2) bare soil+N, (3) tree, and (4) tree+N. The soil is a sandy and nutrient poor forest soil from southern Finland. Trees are 1 m high pines (Pinus Sylvestris), which are supposed to induce microbial N deficiency by exuding easily degradable C compounds and by competing with microbes for mineral N. Each treatment is replicated 4 times with 13C-glucose and 4 times with 12C-glucose, the latter is used as a control to account for natural variations in 13C. We sample the soil 1 day, 3 days, 8 days, 1 month, 3 months, 6 months, and 1 year after glucose addition and measure the 13C recovery in bulk soil, microbial biomass, PLFA, amino sugars, and DNA. This will allow exploring the role of N demand in cycling and stabilization of labile C in soil through the microbial biomass. The experiment is in progress and we will present results of the first 3 months.