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Drivers of the microbial-derived soil organic matter turnover in Europe

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Soil organic matter (SOM) represents one of the largest carbon and nitrogen reservoirs on Earth, which is sensitive to changes in climate and local land management. SOM decomposition is regulated by the complex interaction between many factors, such as soil temperature and moisture, molecular structure, soil texture and physicochemical properties, nutrient concentrations and stoichiometry, and microbial community structure. Soil microorganisms not only affect SOM decomposition by secreting extracellular hydrolases and oxidases, but themselves - as necromass - are also major components of SOM. Specifically, fungal cell walls are composed of chitin (a polymer of N-acetyl-glucosamine), while bacterial cell walls consist of peptidoglycan which is a polymer of N-acetyl-amino sugar chains interlinked by stem peptides of D- and L-amino acids. However, previous studies of decomposition of microbial-derived SOM were mostly based on the natural differences in the isotopic signatures (δ^{13}C) of SOM deriving from C3 and C4 plants after vegetation shifts, while in situ measurements of microbial cell wall decomposition are rare.

In this study, we applied a novel ^{15}N isotope pool dilution assay (the target compound pool is labeled with ^{15}N labeled tracers and subsequently the dilution of the tracers is measured) of microbial-derived organic monomers and oligomers (N-acetyl-glucosamine and chitobiose deriving from chitin; N-acetyl-glucosamine, muropeptides and D-amino acids deriving from peptidoglycan; and L-amino acids deriving from protein) to measure the in situ decomposition rates of microbial-derived SOM. The experiment was performed at 96 sites across a European continental transect, ranging from southern Spain to northern Norway, including soils from three land use types, i.e. croplands, pastures, and forests, to investigate the potential drivers of the microbial-derived SOM decomposition process.

In a previous study on Austrian soils, the microbial cell wall decomposition process was more related to soil pH, soil texture, and nutrient availability rather than to potential extracellular enzyme activities, indicating that the availability and accessibility of microbial necromass rather than enzyme production control its decomposition. We will further show how climate, vegetation, geology, and land-use through effects on soil physicochemistry, microbial necromass composition and microbial community structure influences the microbial-derived SOM decomposition process across this large-scale transect. This approach will greatly deepen our understanding of SOM turnover and its driving factors.