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Environmental controls of gross protein depolymerization and microbial amino acid uptake in soils across a European climate transect.

Lisa Noll, Shasha Zhang, Qing Zheng, Yuntao Hu, and Wolfgang Wanek
Terrestrial Ecosystem Research, Department of Microbiology and Ecosystem Science, University of Vienna, Vienna, Austria

The cleavage of macromolecular organic N by extracellular enzymes maintains an ongoing flow of new bioavailable organic N into biotic systems and is considered to be the bottle neck of terrestrial N cycling in litter and soils. As proteins are cleaved by extracellular enzymes, depolymerization is not under direct metabolic control of microorganisms. However, major environmental factors controlling gross protein depolymerization and free amino acid uptake by microbes are largely unknown.

We here report gross protein depolymerization and microbial amino acid immobilization rates from 96 mineral and 14 organic top soils representing the climate and soil variability across Europe. In total we sampled soils from 28 vegetation zones from the Mediterranean to the Subarctic and if available from three different land-use types (forests, pastures and croplands). Gross protein depolymerization and gross microbial amino acid uptake rates were assessed by an isotope pool dilution assay with 15N labeled amino acids.
Our results showed that in mineral soils gross rates of protein depolymerization and amino acid uptake increased significantly with latitude and mean annual precipitation and decreased with potential evapotranspiration and mean annual temperature. Considering soil characteristics dissolved organic P and free amino acid concentrations were significantly positively related to gross organic N cycling rates. Soil pH was negatively related to depolymerization and amino acid immobilization rates. We found no significant differences in gross rates for the three studied land use types. However, gross rates in pasture and forest soils were positively correlated with soil total N and dissolved organic N. In mineral soils gross depolymerization and amino acid uptake were tightly correlated suggesting co-regulation of both processes. In organic soils gross depolymerization and amino acid uptake rates exceeded those of underlying mineral soils significantly.
Since depolymerization rates were not related to potential peptidase activity but positively to soil total N, we assume that extracellular protein cleavage in soils is mainly substrate limited and less by proteolytic enzyme activity. Furthermore, the positive relationship of gross depolymerization and dissolved organic P and total P might reflect microbial N mining, to meet the enhanced N demand at high P availabilities and keep stoichiometric N:P homeostasis. Overall, the study implies increasing gross organic N cycling rates towards higher latitudes and higher annual precipitation across a European transect due to changes in protein availability and sorption capacity of the soil matrix.