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Temperature or substrate: what is responsible for carbon decomposition in mountain soils?

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Decomposition of organic substrates in soil is enzymes mediated process. Activity of enzymes is substrate dependent and mostly increases with temperature up to an optimum. Quantity of the substrate is the main limiting factor for enzymatic or microbial heterotrophic activity in mountain soils. It remains unclear whether the lack of available substrate can counterbalance the temperature induced acceleration of mineralization of soil organic carbon caused by global warming. Different mechanisms of enzymes response to temperature suggested for low and high substrate availability were never proved for real soil conditions. The ecological importance of temperature acclimation of enzyme activity also remains to be tested.

To estimate the possible "temperature acclimation" of enzyme activity we compared the responses of enzymes-catalyzed reactions using the natural climatic differences in soils located at 950, 2010, 2435, 2780 and 3020 m altitudes of Mt. Kilimanjaro. Basing on Michaelis-Menten kinetics we determined the enzymes affinity to substrate (Km) and mineralization potential of heterotrophic microorganisms (Vmax) 1) for three hydrolytic enzymes: -1,4-glucosidase, N-acetyl- –D-glucosaminidase and phosphatase by the application of fluorogenically labeled substrates and 2) for mineralization of 14C-labeled glucose by substrate-dependent respiratory response.

Here we show that the amount of available substrate is responsible for temperature sensitivity of hydrolysis of polymers in soil, whereas monomers oxidation to CO2 does not depend on substrate amount and is mainly temperature governed. We also found different response of Km to warming for the processes of depolymerisation and monomers oxidation. So, the enzymes responsible for hydrolysis of polymers and for monomers oxidation have different temperature sensitivity. Both substrate affinity and heterotrophic potential showed the weaker response to increasing temperature at high versus low altitudes. This demonstrates the greater potential to "temperature acclimation" for soil microbial communities at higher altitudes.