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Revisiting the theory of 'enzymic latch' on carbon in peatlands

Tomáš Hájek and Zuzana Urbanová

Faculty of Science, University of South Bohemia in České Budějovice, Branišovská 1760, České Budějovice 370 05, Czech Republic

Peatlands are long-term sinks of atmospheric carbon, to a large extent due to water-saturated soil conditions, decay-resistant plant litter and other factors such as the presence of biochemical inhibitors of decomposition. In the frame of 'enzymic latch' theory, soluble phenolics are traditionally considered to be key inhibitors by immobilizing microbial extracellular enzymes. The theory also assumes that phenolics accumulate in peat water due to anoxy, which limits the activity of oxidative enzymes degrading phenolics. However, recent studies do not unambiguously support this theory.

We aimed to verify the effect of soluble phenolic compounds at different concentrations on the activity of oxidative and hydrolytic enzymes in plant litter and peat. Separate experiments tested the effects of (1) anoxy and phenolics (2) concentration and (3) molecular weight on the activity of oxidative and hydrolytic enzymes and on microbial respiration rate. The phenolics were used in the form of humic compounds extracted from bog water collected below Sphagnum carpet and separated into two molecular weights. Phenolics were added either to Sphagnum litter with natural microbial inoculum or to peat slurry and incubated under aerobic and anaerobic conditions.

Potential activities of oxidative enzymes (phenol oxidases and peroxidases) did not decline after up to 2 months in anaerobic incubations, having thus no oxygen requirement. Potential activities of hydrolytic enzymes were generally higher under aerobic than anaerobic conditions, reflecting the microbial activity. No negative relationship between hydrolytic enzymes activities and phenolics concentration was observed. On the contrary, the addition of soluble phenolics (up to 1000 (!) mg of tannic acid standard per L) supported the activity of both, enzymes and microbial respiration indicating the phenolics (or another constituent of the humic compounds) were utilized by microbes as a source of carbon and mineral nutrients.

In summary, our results do not support the enzymic latch theory at all. Peatland microbes seems to be well adapted to reduced and nutrient-poor conditions and seem to utilize phenolics for their growth. Critical re-examination of mechanisms leading to accumulation of organic matter in peatlands is needed.