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Acceleration of cellulose and organic matter decomposition as a result of earthworms effect on soil microbial community

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The biotic activity of earthworms alters soil carbon turnover 1) indirectly by the disturbance of soil structure which increases the availability of organic matter; or 2) directly changing the structure of soil microbial community which is mainly in the dormant state in undisturbed soil. The activation of soil microorganisms by earthworms can strongly change the turnover of native soil organic matter (SOM), i.e. cause priming effects (PE). The effects of earthworms on mineralization of SOM and plant residues during PE induced by the input of available organic substances remains unclear. Our study aimed to evaluate how the microbial community modified by earthworms alters the decomposition of SOM and 14C-cellulose added to soil. Two-factorial experiment to assess the interactive effect of 1) earthworms Aporrectodea caliginosa and of 2) 14C-uniformly labeled cellulose on soil organic matter mineralization was carried out during 30 days incubation. The following variables were determined: 1) dynamics of CO2 evolution; 2) 14CO2 originated from the added cellulose; 3) microbial biomass C and 14C by fumigation-extraction; 4) specific growth rates of microorganisms by the kinetics of substrate induced respiration and 5) activities of extracellular enzymes (β-glucosidase, chitinase, cellobiogidrolase and xylanase) with fluorogenically labeled substrates. The experimental design allowed us to distinguish the contribution of different microbial communities to priming-effects, i.e. soil microbial community activated by cellulose; earthworms and their own microbial community; soil microbial community changed by earthworms.
Maximal intensity of CO2 and 14CO2 efflux as well as of enzyme activities was observed between 5th and 15th days after cellulose application. Contribution of earthworms to total soil respiration (calculated as difference between CO2 efflux from soil with and without earthworms) amounted up to 60%. Earthworms accelerated SOM decomposition for 50% while cellulose mineralization was accelerated by A. caliginosa for 15.8 % as compared to soil without earthworms. Increased activity of enzymes which release monomer units from polymeric chains (β-glucosidase for 32 % and chitinase for 19 %) was observed in the presence of earthworms in soil. However, strong decrease in activity of cellulolytic enzymes: xylanase (for 25 %) and especially of cellobiogidrolase (for 87 %) was caused by A. caliginosa in 15 days after cellulose addition. The maximal specific growth rates of soil microorganisms were 20 - 30 % lower in soil with application of earthworms as compared with worms-free soil. No significant effect of earthworms on total microbial biomass C was observed. However, the changes in microbial growth kinetics as well as in enzyme activities prove the shift in microbial community structure to domination of slow growing K-strategists caused by earthworms. We conclude that earthworms strongly affect soil microbial populations resulting in accelerated decomposition of both SOM and plant residues.