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Carbon turnover in topsoil and subsoil: The microbial response to root litter additions and different environmental conditions in a reciprocal soil translocation experiment

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At the global scale, soil organic carbon (SOC) represents the largest active terrestrial organic carbon (OC) pool. Carbon dynamics in subsoil, however, vary from those in topsoil with much lower C concentrations in subsoil than in topsoil horizons, although more than 50 % of SOC is stored in subsoils below 30 cm soil depth. In addition, microorganisms in subsoil are less abundant, more heterogeneously distributed and the microbial communities have a lower diversity than those in topsoil. Especially in deeper soil, the impact of changes in habitat conditions on microorganisms involved in carbon cycling are largely unexplored and consequently the understanding of microbial functioning is limited.

A reciprocal translocation experiment allowed us to investigate the complex interaction effects of altered environmental and substrate conditions on microbial decomposer communities in both topsoil and subsoil habitats under *in situ* conditions. We conducted this experiment with topsoil (5 cm soil depth) and subsoil (110 cm) samples of an acid and sandy Dystric Cambisol from a European beech (*Fagus sylvatica* L.) forest in Lower Saxony, Germany. In total 144 samples were buried into three depths (5 cm, 45 cm and 110 cm) and ^{13}C-labelled root litter was added to expose the samples to different environmental conditions and to increase the substrate availability, respectively. Samples were taken in three month intervals up to a maximum exposure time of one year to follow the temporal development over the experimental period. Analyses included $^{13}C_{mic}$ and ^{13}C PLFA measurements to investigate the response of microbial abundance, community structure and ^{13}C-root decomposition activity under the different treatments. Environmental conditions in the respective soil depths such as soil temperature and water content were recorded throughout the experimental period.

All microbial groups (gram$^+$ and gram$^-$ bacteria, fungi) showed highest relative ^{13}C incorporation in 110 cm depth and samples with root addition had generally higher microbial abundances than those with no root addition. Here, especially fungi benefited from the additional carbon source with highly increased abundances in all incorporation depths. Also the altered environmental conditions in the different incorporation depths significantly influenced the different microbial groups. The steepest decrease with depth was detected in fungal abundance, while bacteria were less affected and increased in relative abundance in soil samples incorporated into subsoil layers. The highest seasonal variability in microbial abundance, however, was determined in 5 cm incorporation depth demonstrating the higher amplitude in micro-climatic and micro-environmental conditions in this near-surface soil habitat.

In summary, this experiment demonstrated that carbon quality and quantity are the main factors restricting fungal abundance in deeper soil layers, while bacterial decomposer communities are adapted to a wider range of habitat conditions.