The use of plant litter and soil fauna traits in a mechanistic assessment of litter decomposition under global change

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Summary

Plant litter decomposition is a key process in the global biosphere-atmosphere carbon cycle and sustains life on earth. This crucial ecosystem process is closely coupled to climate, as they feedback to each other. Due to ongoing and further increasing climate change, a better understanding of the controls over plant litter decomposition is needed both at a local- and global-scale in order to improve the predictions of climate change and its effects on ecosystem functioning.

Decomposer organisms determine plant litter decomposition as the process is run by their activity. Decomposers are soil organisms that spread out to several trophic levels. Unlike the responses of vegetation to climate change, the responses of soil organisms are unclear due to lack of studies and problems in generalizing the results of widely varying experiments. Chapter II shows that adopting a trait-approach allows generalizations in the responses of soil organisms to climate change. The soil Collembola community shows an expected general decrease and a shift in its composition. The Collembola community composition shifts from hydrophilic and deeper-dwelling species to their counterparts, xeroresistant and surface-dwelling species, as a response to increased drought in dry subarctic birch forest. Both the decrease in abundance and the shift in the community composition are expected to influence several soil processes, as micro-arthropods are an important part of soil fauna and decomposer community, especially in the subarctic.

The need to unravel the links between above- and belowground biodiversity and ecosystem functioning is highlighted by the ongoing global loss of biodiversity. Decomposers are strongly controlled by plant litter quality, i.e., their food resource and a co-determinant of their microclimate, that strongly varies among plant litter species. No direct link between plant litter richness and richness, diversity and density of decomposers was found in Chapter III. In contrast, the micro-arthropod community inhabiting plant litter of varying litter richness relates to the litter quality and shows some degree of niche partitioning, which is one mechanism leading to synergism in decomposition rates of litter mixtures. Furthermore, Chapter IV demonstrates that litter mixing effects (synergistic or antagonistic), which obscure the predictability of plant litter decomposition rates, are also controlled by the physical traits of plant litter. The inclusion of litter physical traits into the decomposition assessments improves the characterization of litter quality aspects with regards to the functioning of decomposers. Therefore, this largely neglected aspect of plant litter quality should be brought back to the soil ecological studies.

In order to enhance the understanding of global controls over decomposition process and thus aid the modeling of carbon fluxes and climate change, global patterns in decomposition rates were assessed in Chapter V. A small specific set of chemical and physical litter traits explains species specific variation in decomposition along a large spatial gradient. Nevertheless, macro-decomposers determine the absolute level of decomposition rates in at least some biomes.

In conclusion, this thesis shows that a trait-based approach improves the mechanistic understanding of communities of both decomposers and plant litter, and thus plant litter decomposition in forest ecosystems. Furthermore, this thesis contributes to resolving several uncertainties in soil ecology such as the role of biodiversity in plant litter decomposition, the responses of soil fauna to climate change and the importance of soil meso-and macrofauna in global plant litter decomposition. Therefore, a better understanding of the effects of global climate change and loss of biodiversity in soils is provided by this thesis.