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Editorial

The Effects of Environmental Change on Decomposition

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Litter decomposition processes are regulated by three driving variables: physico-chemical climate, litter quality and decomposer organisms. The fact that these three variables are intrinsically linked, has consequences for the interpretation and thereby understanding of global environmental changes on litter decomposition. This Special Issue, entitled "Biodiversity-mediated effects of environmental change on decomposition", aims to document recent studies in which the interlinkage between climate, litter quality and decomposer organisms is shown in the effect they have on the decomposition process.

In the article by Zhou et al. [1] the global change factors studied are increased nitrogen (N) deposition and altered precipitation regimes. In a two-year field litterbag experiment in a natural evergreen broad-leaved forest in the central area of Western China, they studied the effects of these environmental changes on the dynamics of nutrients released during litter decomposition. The authors have chosen calcium, magnesium and manganese as important mineral nutrients due to the vital role they play in regulating decomposer and enzyme activities. Ca stimulates directly earthworm activity, Mg supports microbial activity and Mn is a key component in lignine-degrading enzymes.

The results of this study suggest that N deposition affects Ca accumulation, while N deposition combined with throughfall reduction affect Mg and Mn releases. The authors state that further investigation on the interlinkage between environmental changes (N deposition and drought), mineral nutrient dynamics and functioning and biodiversity of soil decomposers in its effect on the soil key process litter decomposition, is necessary.

In a subtropical evergreen broadleaved forest, Tie et al. [2] studied the responses of the litter decomposition and the release of C, N, and P to the global change factors N deposition and S deposition separately and in combination. They found that the addition of N and S synergistically decreases the degradation of lignin and cellulose and the release of C and N and increases the litter N/P ratio, suggesting that N and S deposition slows down the release of C and N from litter and exacerbates litter P limitation during the soil key process litter decomposition. Reduced microbial biomass and reduced activities of soil C-cycle enzymes are considered to be crucial.

Temperature increase, as an important environmental factor, has been studied by Fan et al. [3] at the highest plateau in the world (the Qinghai-Tibetan Plateau). Because of its height, this plateau is sensitive to climate change. They studied the dynamics of soil enzyme activities and microbial diversities as good indicators of alpine biochemical processes during increasing temperatures.

They sampled topsoil and subsoil along an altitudinal gradient with changes in soil microclimate, soil physical properties, nutrient availability, microbial biomass and vegetation types. The authors found significant changes in the relative abundances of the dominant microbial taxa along the altitudinal gradient, but the richness and diversity of the soil microbial communities did not significantly change with altitude. They point to previous studies showing that global microbial communities share a common diversity structure, with high environmental resilience. Along the gradient, enzyme activities were closely linked with the changes in soil nutrient availability. Both were higher in the topsoil but in the subsoil, soil nutrients, enzyme activity and the microbial community were more significantly correlated.

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Chen et al. [4] have performed a litter input control experiment at three subalpine forest types: coniferous forest, mixed forest and broadleaved forest. This region is sensitive to climate change due to its unique microclimatic characteristics, such as seasonal snow cover, frequent freeze–thaw cycles, and long-term freezing cold in winter. These climatic factors may directly or indirectly regulate soil organic carbon (SOC) fraction dynamics, but the knowledge gap between SOC fractions and plant litter input is, according to the authors, inconsistent. Especially in winter, intense leaching and frequent freeze–thaw cycles stimulate litter cellulose/lignin degradation and influence the community structure and activity of soil microbes. This study focuses on litter input as a key controller affecting SOC cycles in different forest types in cold biomes. Litter quality was different for the 3 forest types and so was the effect of litter input on SOC. Microbial biomass C declined under litter input and its variation was strongly controlled by soil temperature and freeze–thaw events. As a consequence, climate change might have a major effect on SOC dynamics in these subalpine forests.

The contribution of leaf and root litter to soil organic carbon (SOC) is considered to be significant, but not fully understood. For that reason, Altmann et al. [5] have studied the decomposition of fine root and leaf material of six temperate tree species in a 1-year incubation experiment using distinctive molecules, called biomarkers, as indicators to trace back the origin of soil organic matter. General biomarkers for all tree species were hard to find: only one molecule could be validated as a general leaf-specific biomarker for the six tree species, and for roots no general root biomarker could be found. It is concluded that the validity of leaf- and root-derived ester-bound lipids as biomarkers is highly tree species dependent. The authors suggest that general assumptions about litter input to forest soils solely based on biomarker analysis have to be considered carefully.

The effects of environmental change on decomposition (the title of this special volume) is discussed in the Commentary by Verhoef [6]. If we want to understand the effects of environmental change on decomposition, we should have a clear idea of the dominant controls on this process. The fundamental controls are indicated to be physico-chemical environment, litter traits and decomposer organisms. Regional-scale decomposition studies emphasize the importance of climate, whereas studies at broad spatial scales mention litter quality as the dominant control factor. These paradigms assume that the activities of decomposer organisms are regulated by climate and litter quality, denying any independent control on decomposition rates. However, recent meta-analysis using litterbags shows negative effects of soil fauna exclusion on litter decomposition rates at global and biome scales. In another meta-analysis of 69 independent studies on the impact of global environmental change on decomposer diversity and litter decomposition, it was shown that declines in the diversity and abundance of decomposers explained reduced litter decomposition. Underlying changes in keystone species, functional and vertical diversity as well as dominance patterns are supposed to cause these changes in decomposition. The importance of future synthesis work addressing the effects of shifts in functional diversity is stressed. It is concluded that the effects of environmental changes on ecosystem functions, such as decomposition, can be better understood if we have more knowledge on the selective effect of these changes on specific facets of soil biodiversity, such as functional diversity.

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