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Damen und Herren
habilitierte und promovierte Angehörige
sowie
Mitglieder des Rates
des Fachbereiches VI

06.04.2021

Promotionsverfahren zur Erlangung des akademischen Grades Doktor der Naturwissenschaften (Dr. rer. nat.) von Herrn Marcel Lorenz

Sehr geehrte Damen und Herren,

die Dissertation von **Herrn Marcel Lorenz** mit dem Titel

„Soil organic matter status in forest ecosystems depends on the microbial transformation of tree species-specific inputs."

sowie die Berichte liegen gemäß § 8 S. 2 PromO vom 27. Juli 2016 in der Zeit

vom 19.04.2021 bis zum 03.05.2021

im Dekanat (Zi. F 126) zur Einsichtnahme aus. Die Zeit der Auslagefrist entspricht den Regelungen der PromoO des FB VI vom 27.7.2016.

Aufgrund der aktuellen Auflagen der Corona-Bekämpfungsverordnung, ist eine Einsichtnahme nur nach vorheriger Terminvereinbarung mit dem Dekanat möglich.

Vorbehaltlich einer einspruchslosen Auslage ist als Termin für die Disputation vorgesehen:

Dienstag, 04.05.2021, 14:00 Uhr, via Zoom

Weitere Informationen zur Durchführung der Disputation finden Sie auf der Homepage der Universität Trier unter: Fachbereich VI > Der Fachbereich > Aktuelles > Disputationen am FB VI

Mit freundlichen Grüßen

Univ.-Prof. Dr. Thomas Udelhoven
Dekan

Soil organic matter status in forest ecosystems depends on the microbial transformation of tree species-specific inputs

Soils in forest ecosystems bear a high potential as carbon (C) sinks in the mitigation of climate change. The amount and characteristics of soil organic matter (SOM) are driven by inputs, transformation, degradation and stabilization of organic substances. While tree species fuel the C cycle by producing aboveground and belowground litter, soil microorganisms are crucial for litter degradation as well as the formation and stabilization of SOM. The investigation of tree species effects on SOM is challenging because in long-established forest ecosystems the spatial distribution of tree species is a result of the interplay of environmental factors including climate, geomorphology and soil chemistry. Moreover, tree distribution can further vary with forest successional stage and silvicultural management. Since these factors also directly affect the soil C-status, it is difficult to identify a pure "tree species effect" on the SOM status at regular forested sites. It therefore remains unclear in how far tree species-specific litter with different quality influences the microbial driven turnover and formation of SOM.

Tree species effects on SOM and related soil microbial properties were investigated by examining soil profiles (comprising organic forest floor horizons and mineral soil layers) in different forest stands at the recultivated spoil heap 'Sophienhöhe' located at the lignite open-cast mine Hambach near Jülich, Germany. The afforested sites comprised monocultural stands of Douglas fir (*Pseudotsuga menziesii*), black pine (*Pinus nigra*), European beech (*Fagus sylvatica*) and red oak (*Quercus rubra*) as well as a mixed deciduous stand site planted mainly with hornbeam (*Carpinus betulus*), lime (*Tilia cordata*) and common oak (*Quercus robur*) that were grown for 35 years under identical soil and geomorphological conditions. Because the parent material used for site recultivation was free from organic matter or coal material, the SOM accumulation is entirely the result of in situ soil development due to the impact of tree species.

The first study revealed that tree species had a significant effect on soil organic carbon (SOC) stocks, stoichiometric patterns of C, nitrogen (N), sulfur (S), hydrogen (H) and oxygen (O) as well as the microbial biomass carbon (MBC) content in the forest floor and the top mineral soil layers (0-5 cm, 5-10 cm, 10-30 cm). In general, forest floor SOC stocks were significantly higher at coniferous forest stands compared to deciduous tree species, whereas in mineral soil layers the differences were smaller. By investigating the linkage of the natural abundance of ^{13}C and ^{15}N in the soil depth gradients with C:N and O:C stoichiometry, the second study showed that differences in SOC stocks and SOM quality resulted from a tree species-dependent turnover of SOM. Significantly higher turnover of organic matter in soils under deciduous tree species depended to 46 % on the quality of litterfall and root inputs (N content, C:N, O:C ratio), and on the initial isotopic signatures of litterfall. Hence, SOM composition and turnover also depends on additional – presumably microbially driven – factors. The subsequent results of the third study revealed that differences in SOM composition and related soil microbial properties were linked to different microbial communities. Phospholipid fatty acid (PLFA) patterns in the soil profiles indicated that the supply and availability of C and nutrient-rich substrates drive the distribution of fungi, Gram-positive (G_+) bacteria and Gram-negative (G_-) bacteria between tree species and along the soil depth gradients. The fourth study investigated the molecular composition of extractable soil microbial biomass (SMB) derived and SOM derived compounds by electrospray ionization Fourier transformation ion cyclotron resonance mass spectrometry (ESI-FT-ICR-MS). This was complemented by the analysis of nine monosaccharides representing microbial or plant origin. Microbially derived compounds substantially contributed to SOM and the contribution increased with soil depth. The supply of tree species-specific substrates resulted in different chemical composition of SMB with largest differences between deciduous and coniferous stands. At the same time, microorganisms contributed to SOM resulting in a strong similarity in the composition of SOM and SMB.

Overall, the complex interplay of tree species-specific litter inputs and the ability, activity and efficiency of the associated soil fauna and microbial community in metabolizing the organic substrates leads to significant differences in the amount, distribution, quality and consequently, the stability of SOM. These findings are useful for a targeted cultivation of tree species to optimize soil C sequestration and other forest ecosystems services.