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Long-term changes in litter quantity and quality alters soil organic matter composition and dynamics in a temperate forest

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Forest soils store vast amounts of carbon (C), but the stability depends on the relative proportion of above- and belowground C inputs and is impacted by global environmental change. The importance of the quality and quantity of litter sources to soil organic matter (SOM) composition was assessed through a 30-year detrital input and removal treatment experiment at the Bousson Forest in Pennsylvania. Chronic litter additions and exclusions of litter and/or roots were compared to plots receiving ambient litter and root inputs (control). Elemental analysis, targeted compound analysis, solid-state ^{13}C nuclear magnetic resonance (NMR) spectroscopy, and assessments of microbial biomass and community composition were employed to characterize soil samples. Interestingly, soil C concentrations decreased for the Double Litter treatment, even after 30 years of added litter. The exclusion treatments (No Litter, No Roots, and No Inputs) also exhibited lower soil C concentrations in the mineral soils compared to the control. The relative stage of SOM decomposition was assessed by comparing specific NMR resonance regions, which showed that the exclusion treatments had higher stages of SOM decomposition. Additionally, microbial biomass decreased in the root exclusion treatments, likely due to the lack of fresh inputs. Lower soil C in the exclusion treatments, coupled with lower microbial biomass, and higher stages of SOM decomposition, suggest that preferred microbial substrates have been reduced, and the relative proportion of more complex and degraded forms of SOM are increasing. Conversely, microbial biomass increased for the Double Litter treatment in response to the added litter. Furthermore, differences in substrate availability likely altered the microbial community composition, with shifts towards a relative dominance in Gram-positive bacteria for all treatments. This analysis after 30 years of treatments provides insight into the importance of inputs and the stability of SOM in forests, and highlights responses of microbial communities and SOM composition to alterations in litter and root inputs.