Forest litter under altered freeze-thaw events drive differentiation of microbial community structure and functions in the litter horizon across mixed forest ecotone

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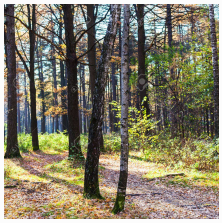
Abstract

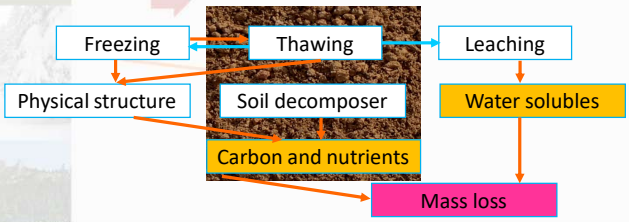
The decomposition of plant litter involves a complex set of processes that include chemical, physical, and biological agents acting upon a wide variety of organic substrates. Mass loss and nutrient release of forest litter during the freeze–thaw season could play an essential role in C and nutrient cycling. Soil microbial communities play an important role in soil carbon functioning, particularly in forest ecosystems. Their variation in response to climate change may affect soil carbon processes, highlighting the importance of understanding how environmental factors affect microbial communities. Cellulose and lignin are the main polymeric components of the forest litter horizon. We monitored microbial community composition using phospholipid fatty acid (PLFA) analysis and investigated the ligninolytic and cellulolytic enzyme activities of the litter horizon across an alpine treeline ecotone. This study aimed to determine to what extent an increase in the quantity of fresh litter may affect heterotrophic mineralization of organic carbon and bacterial community structure in soil and litter. A litter manipulation experiment was performed in situ in a temperate deciduous forest. The quantity of fresh litter seemed to affect soil and litter bacterial community structure and to interact with soil temperature and moisture to determine the temporal variation in the bacterial community on a month to season scale. In addition, this study highlighted the large temporal variability in soil and litter bacterial community structure and that this variability may affect our ability to relate bacterial community structure to respiration processes. In addition, the loss of mass, lignin, cellulose and component bio-elements during the freeze–thaw season correlated closely with the initial substrate type and the levels of the individual bio-elements.

Background:

Leaching contributes a considerable percentage of mass loss and carbon and nutrient release in early stage of decomposition, but the magnitudes are different between species levels depending on the chemical traits

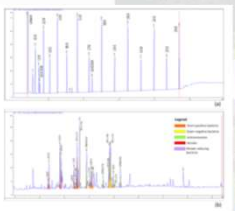
Frequent freezing and thawing events could positively influence decomposition rate in cold biomes but also hamper soil decomposer and there is no general and predictable pattern has been emerged.





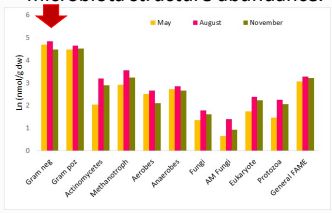
Analytical approach:

GC-FID PLFA analysis of soil microbiota structure and abundance.

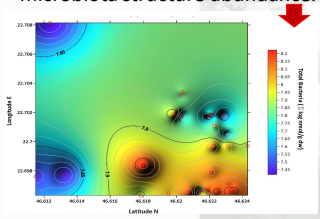


Results:

Seasonal variation of soil microbiota structure abundance.

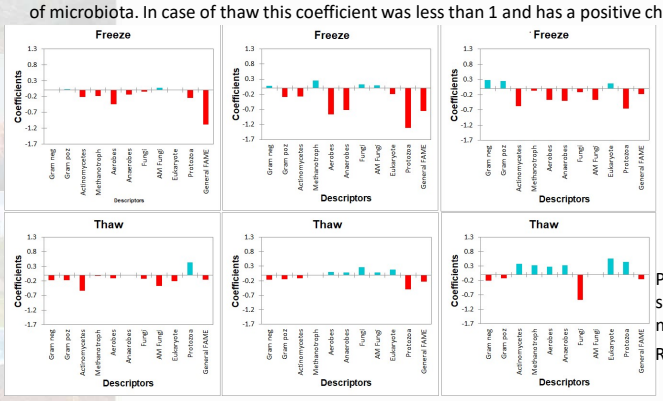


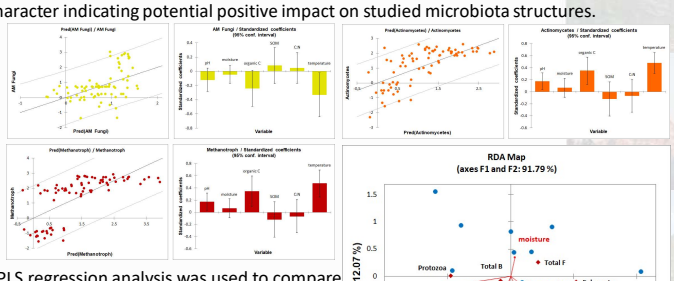
Spatial distribution of soil microbiota structure abundance.



Discussions:

According with sensitivity analysis that in case of freeze the sensitivity coefficient is generally higher than 1 indicating significant influence on structure and abundance of microbiota. In case of thaw this coefficient was less than 1 and has a positive character indicating potential positive impact on studied microbiota structures.





PLS regression analysis was used to compare soil physicochemical properties with soil microbiota structure and abundance.

RDA analysis showed that the first canonical axes isolate completely protozoa and bacteria.

Conclusions:

The quantity of fresh litter seemed to affect soil and litter bacterial community structure. In addition, the loss of mass, lignin, cellulose and component bio-elements during the freeze–thaw season correlated closely with the initial substrate type and the levels of the individual bio-elements.

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