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Temperature Impact on Soil Bacterial Diversity During Early Decomposition Stage of Aspen Litter

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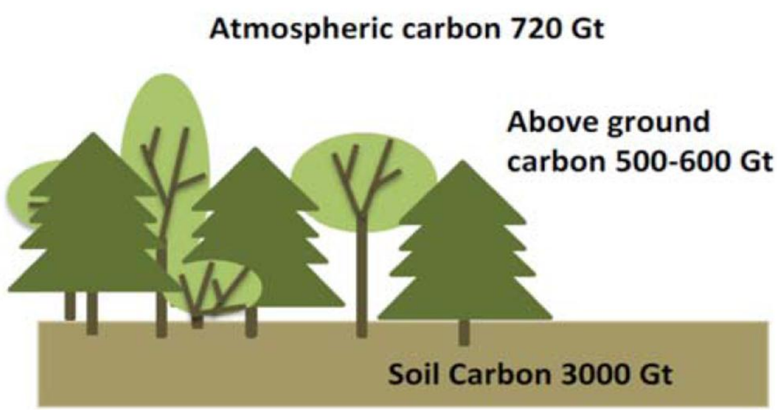
INTRODUCTION & AIM



Litter decomposition in terrestrial ecosystems has a major role in the biogeochemical cycling of biogenic elements but initial stages of this process in temperate forest ecosystems remain poorly understood. Soil organic matter in forest ecosystems is highly sensitive to temperature rise, which makes it the most vulnerable under global warming.

Temperature is considered as a prime factor in determining the rates of microbial litter decomposition. The effect of temperature is due to its influence on the growth and activity of soil organisms, as well as on the saturation of the soil with oxygen and soluble nutrients.

It was hypothesized that the temperature change is the main driver of microbial activity and differentiation of microbial communities at the initial stage of transformation of tree litter. **We aimed** to estimate how aspen litter (leaves and twigs) affects the activity and quantitative traits of soil microbial communities under climate change-modeling circumstances.

METHOD

To investigate the combined impacts of temperature and plant residues on the mineralization capacity of soil organic matter and taxonomic composition and activity of the soil microbiome, a 28-day experiment with gray forest soil was carried out in a controlled laboratory conditions. Three substrate management, control (C), augmented with fragments of aspen leaves (L) and branches (B) (0.5% by weight), and three temperature settings: 5°C (model of the average temperature for spring and autumn months in the southern Moscow region), 15°C (model of average temperature in summer) and 25°C (model of global temperature rise).

Microbial respiration (CO_2 production) was used as a proxy for the rate of decomposition of organic amendments and formation of active organic matter in soil. Taxonomic analysis of the bacterial community was conducted by Illumina 16S rRNA sequencing using universal by primers 341F and 805R.

FUTURE WORK

The results gained can be utilized in predictive models of plant litter decomposition processes and soil organic matter dynamics in Eurasian forest biocenoses under climate change, improving our understanding of soil carbon dynamics.

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RESULTS & DISCUSSION

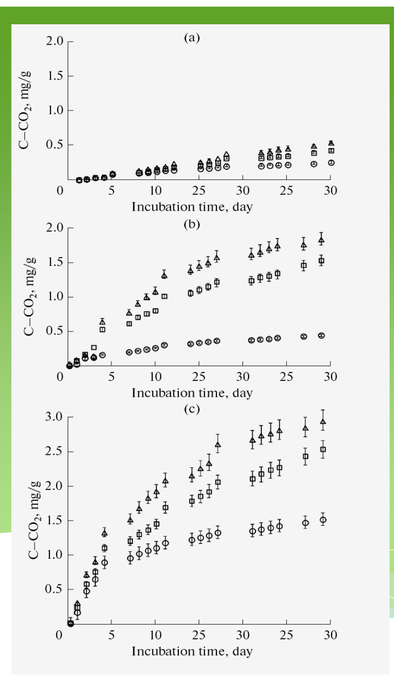

Figure 1. The curves of the integral accumulation of CO_2 during the incubation experiments at different temperatures: 5°C (a), 15°C (b), 25°C (c). Abbreviations: circles (control), squares (branches) and triangles (leaves).

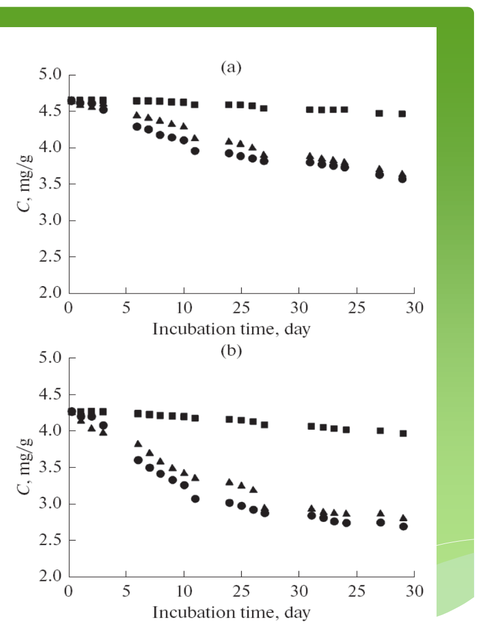

Figure 2. The dynamics of the carbon residue of the added leaves (a) and branches (b) in soil samples, incubated at different temperatures: squares (5°C), circles (15°C), and triangles (25°C).

The ideal temperature for the plant litter's breakdown was determined to be 15°C, and both decreases and increases resulted in a less severe litter degradation process. When plant wastes were applied, the temperature sensitivity of the soil respiration process increased significantly in the 5–15°C temperature range, and the temperature coefficient Q10 rose from 1.75 to 3.44–3.54. Incorporating plant leftovers promoted the breakdown of soil organic matter at elevated temperatures.

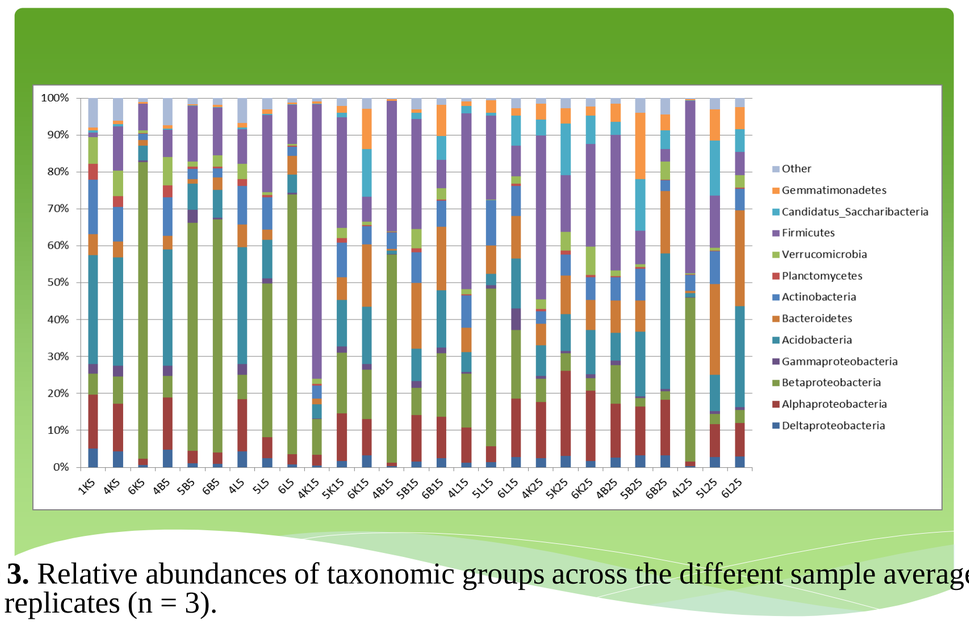

Figure 3. Relative abundances of taxonomic groups across the different sample averaged across replicates (n = 3).

The bacterial succession was investigated using a MiSeq sequencing technique using ribosomal markers in order to gain a thorough understanding of the initial phases of aspen litter decomposition. *Bettaproteobacteria*, *Bacteroidete*s, *Firmicutes*, and *Acidobacteri*a were among the fast-cycling microorganisms that were present during the early phases of decomposition. This succession was probably caused by a decline in readily degradable carbohydrates.

CONCLUSION

It was found that temperature rise increased the content of active organic carbon, and the bacterial community structure was highly dependent on temperature, which further supports the importance of microorganisms in soil C mineralization during the warming.