Soil Warming Reshapes Microbial Communities Along Vertical and Thermal Gradients in a Subarctic Forest

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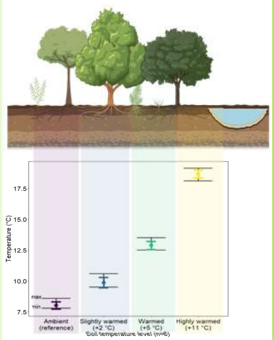
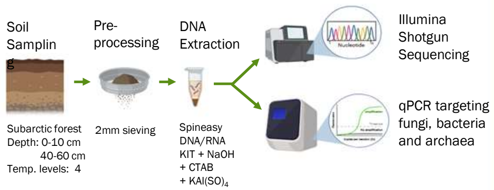
Background



Rising global temperatures are transforming soil environments, yet long-term impacts on microbial communities, remain poorly understood. Subarctic regions are particularly sensitive to warming, but most studies have been short-term and limited in scope.

Here, we leverage a century-long natural soil warming gradient in a subarctic forest near Takhini Hot Springs, Yukon, Canada, to explore how sustained temperature increases influence microbial community composition across soil depths.

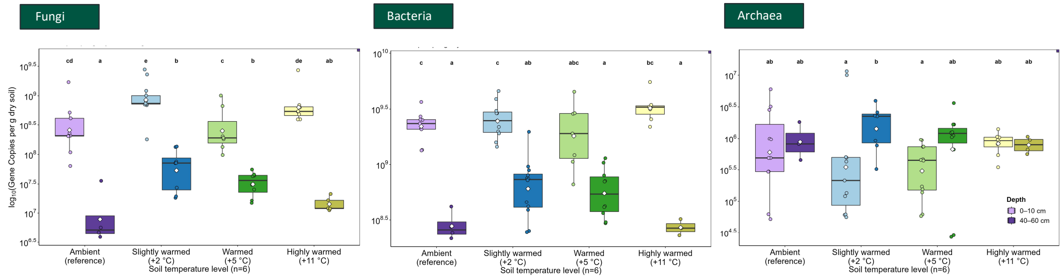
Methods



Hypotheses

- **Microbial populations decrease** when subjected to long-term warming
- **Long-term warming will shift microbial community composition** towards stress-tolerant taxa associated with oligotrophic life strategies

Results

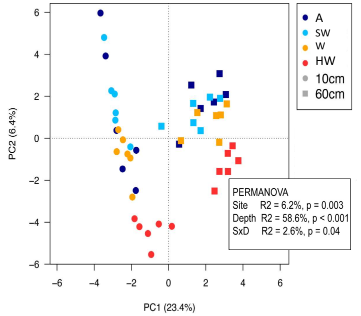


Long-term soil warming significantly affected microbial gene abundances across warming and depth gradients.

Fungi: Significant effects of depth ($p < 0.001$) and warming ($p < 0.001$). Effect of warming dependent on soil layer ($p < 0.001$).

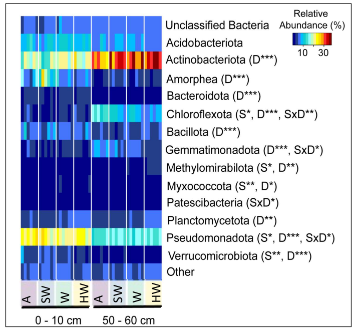
Bacteria: More abundant in topsoils ($p < 0.001$). Effect of warming ($p = 0.008$) varied with depth ($p = 0.006$).

Archaea: Affected by warming ($p = 0.012$), not by depth or interaction.



Principal Component Analysis (PCA) of phylum-level community composition showed clear separation by both soil depth and warming treatment. Surface (0–10 cm) and subsoil (40–60 cm) samples clustered distinctly, with warmer plots driving divergence along PC1.

This highlights strong **depth stratification** and **temperature-driven shifts** in microbial community structure.



Microbial composition varied with depth and warming:

Actinobacteriota increased in warm, deep soils.

Planctomycetota and **Chloroflexi** declined with warming.

Amorphea most abundant at surface.

Results suggest warming restructures dominant phyla in a depth-dependent manner.

Conclusion

- Major **microbial groups respond differently** to long-term warming
- **Actinobacteriota increase** with warming and depth
- **Planctomycetota** and **Chloroflexi decline** under warming
- Future work will assess impacts on **soil organic matter processing**

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