Unraveling differences in temperature sensitivity of soil organic matter decomposition under various oxygen conditions

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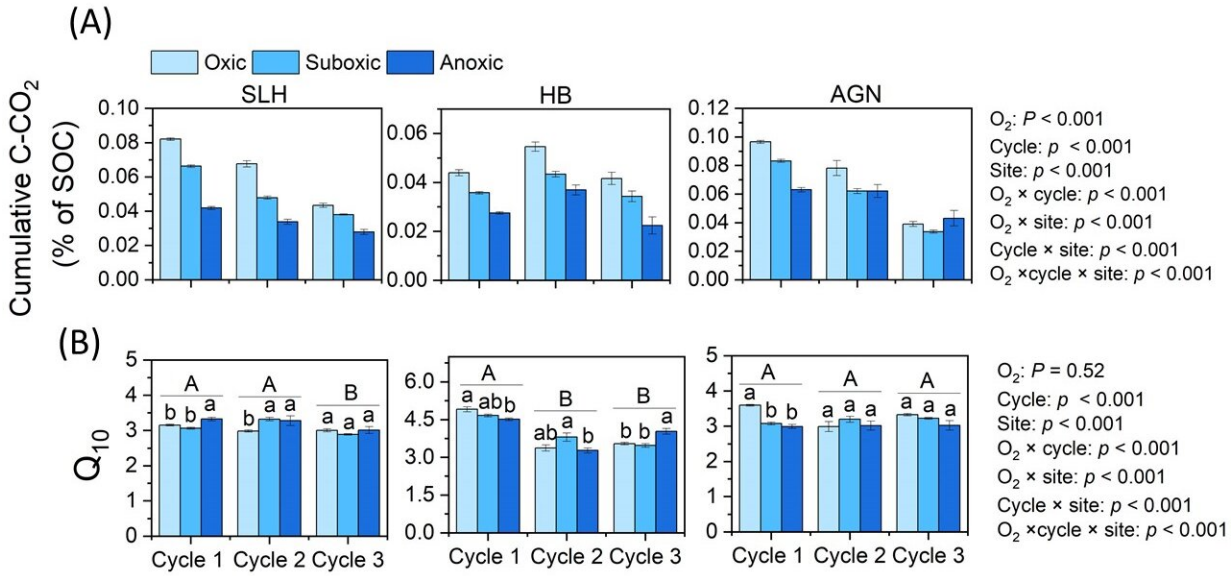


(A) Soil cumulative C-CO_2 emission and (B) Q_{10} in Experiment 1. Uppercase and lowercase letters indicate different levels among three temperature cycles and three O_2 levels, respectively. Credit: *Soil Ecology Letters* (2024). DOI: 10.1007/s42832-023-0189-z

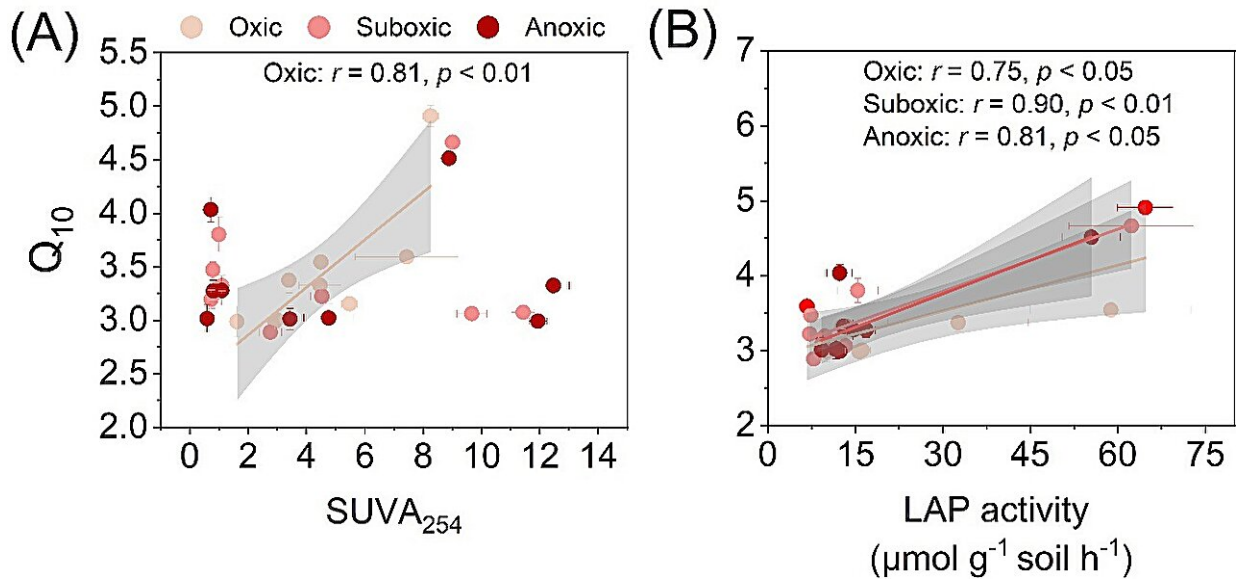
Soil organic matter (SOM) decomposition is a key process that affects soil carbon storage and greenhouse gas emissions. Investigating the

temperature sensitivity (Q_{10}) of SOM decomposition and its regulating mechanisms is important for improving predictions of SOM stability and carbon fluxes under future warming.

Most studies on $Q_{10}$are based on aerobic conditions, but little is known about how Q_{10} varies in soils under oxygen limitation. A new study compares Q_{10} under oxic, suboxic, and anoxic conditions in three grassland soils and reveals the different roles of substrate carbon quality and nitrogen limitation in regulating Q_{10}. The findings were published in *Soil Ecology Letters*.

Xiaojuan Feng's team at the Institute of Botany, Chinese Academy of Sciences, conducted soil microcosm incubation experiments to test how Q_{10} varies in three grassland soils at different oxygen levels. They used three oxygen concentrations of 21%, 1% and 0% to simulate oxic, suboxic and anoxic conditions, respectively.

They found that Q_{10} did not show consistent patterns under different oxygen conditions, suggesting that other factors may override the effect of oxygen on Q_{10}. To delve deeper into these findings, they analyzed the soil properties by conducting a supplementary experiment and found that substrate carbon quality was a strong predictor of Q_{10} in oxic soils, while nitrogen limitation was more important in suboxic and anoxic soils.



Relationship between (A) Q_{10} and specific ultraviolet absorbance at 254 nm (SUVA254), and (B) Q_{10} and L-leucine aminopeptidase (LAP) activity under three O_2 levels. The SUVA254 was positively related to Q_{10} in oxic soils. The activity of LAP, an important N-targeting enzyme involved in releasing N from SOM, showed stronger correlation with Q_{10} in suboxic and anoxic soils than in oxic soil based on a partial analysis. These results suggest that substrate quality had a strong influence on Q_{10} in oxic soils, and N limitation likely influenced Q_{10} variations in the suboxic and anoxic soils. Credit: *Soil Ecology Letters* (2024). DOI: 10.1007/s42832-023-0189-z

Professor Xiaojuan Feng, the corresponding author of the study, said, "We used incubated soils at varying temperatures to calculate Q_{10}. This method is increasingly popular in estimating Q_{10}, as it eliminates potential complications introduced by varying depletion rates of substrates at different, constant temperatures, which may affect soil C concentrations and microbial biomass in 'equal-time' incubations."

"Our study shows that substrate carbon quality and nitrogen limitation may play roles of varying importance in determining Q_{10} under various

oxygen conditions. This implies that the response of SOM decomposition to warming may differ among soil types and moisture regimes due to differences in substrate availability and quality as well as nitrogen status."

The study also highlights the importance of considering oxygen availability and its interactions with other factors when predicting soil carbon dynamics under climate change. Oxygen-deprived soils are widespread in wetlands and upland microsites, which contain a large proportion of global soil carbon stock.

Understanding how Q_{10} varies under different oxygen conditions will help improve the accuracy and reliability of soil carbon models and better inform management practices for soil carbon sequestration.

More information: Zhenhui Jiang et al, Comparing the temperature sensitivity of organic matter decomposition in oxic and oxygen-deprived soils, *Soil Ecology Letters* (2024). DOI: 10.1007/s42832-023-0189-z

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