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Development and resilience of microbial CH4 oxidizers in rewetted fens

Peatlands cover only ~3% of Earth's land area yet store nearly a third of global soil carbon. When drained, they release vast amounts of CO_2, but rewetting—an increasingly used restoration strategy—often increases CH_4 emissions. Methane-oxidizing microorganisms (methanotrophs) can mitigate these emissions by acting as a biological CH_4 filter, yet their post-rewetting development, resilience to disturbance, and functional role in regulating CH_4 fluxes remain poorly understood. This PhD project (Project A5 in WETSCAPES 2.0 —a DFG TRANSREGIO collaborative research center on peatland rewetting and its ecological, hydrological, and biogeochemical consequences) takes a holistic approach to soil methanotrophy, linking spatiotemporal microbial dynamics with biogeochemistry and ecosystem CH_4 fluxes. Three complementary approaches are combined: a spatial screening across ~100 rewetted sites to test how hydrology, vegetation, and peat type shape methanotroph diversity and resilience; high-resolution temporal monitoring at the Zarnekow fen, a core site of the TERENO observatory Northeast coupling DNA/RNA-based community analyses with CH_4 flux and porewater data; and mesocosm experiments to probe community vulnerability and recovery after controlled stress events. Special focus is placed on the role of anaerobic methane oxidation (AOM), mediated by poorly constrained taxa such as *Candidatus* Methanoperedens, which may use alternative electron acceptors and significantly alter CH_4 balances under anoxic conditions. Together, these studies aim to disentangle the drivers of methanotrophic community assembly, clarify the contributions of both aerobic and anaerobic methane oxidizers, and achieve a predictive understanding of methanotroph dynamics in the heterogeneous landscapes of rewetted fens.

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