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Anaerobic methanotrophy in tidal wetland: Effects of electron acceptors

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Wetlands have been considered to represent the largest natural source of methane emission, contributing substantially to intensify greenhouse effect. Despite in situ methanogenesis fueled by organic degradation, methanotrophy also plays a vital role in controlling the exact quantity of methane release across the air-sediment interface. As wetlands constantly experience various disturbances of anthropogenic activities, biological burrowing, tidal inundation, and plant development, rapid elemental turnover would enable various electron acceptors available for anaerobic methanotrophy. The effects of electron acceptors on stimulating anaerobic methanotrophy and the population compositions involved in carbon transformation in wetland sediments are poorly explored. In this study, sediments recovered from tidally influenced, mangrove covered wetland in northern Taiwan were incubated under the static conditions to investigate whether anaerobic methanotrophy could be stimulated by the presence of individual electron acceptors. Our results demonstrated that anaerobic methanotrophy was clearly stimulated in incubations amended with no electron acceptor, sulfate, or Fe-oxyhydroxide. No apparent methane consumption was observed in incubations with nitrate, citrate, fumarate or Mn-oxides. Anaerobic methanotrophy in incubations with no exogenous electron acceptor appears to proceed at the greatest rates, being sequentially followed by incubations with sulfate and Fe-oxyhydroxide. The presence of basal salt solution stimulated methane oxidation by a factor of 2 to 3. In addition to the direct impact of electron acceptor and basal salts, incubations with sediments retrieved from low tide period yielded a lower rate of methane oxidation than from high tide period. Overall, this study demonstrates that anaerobic methanotrophy in wetland sediments could proceed under various treatments of electron acceptors. Low sulfate content is not a critical factor in inhibiting methane consumption, suggesting that unlike the consensus derived from marine sediments, anaerobic methanotrophy might not be necessarily coupled with sulfate reduction. The regeneration of Fe-oxyhydroxide during cyclic tidal recession provides an alternative pathway to maintain methanotrophic activity. The ultimate control on methane oxidation and emission is, however, complicated by the interplay between oxygen penetration, organotrophic sulfate reduction, methanogenesis, methanotrophy, and anaerobic sulfate production modulated by tidal influence.