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Methane oxidation associated to submerged brown-mosses buffers methane emissions from Siberian polygonal peatlands

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Circumpolar peatlands store roughly 18 % of the globally stored carbon in soils [based on 1, 2]. Also, northern wetlands and tundra are a net source of methane (CH_4), an effective greenhouse gas (GHG), with an estimated annual CH_4 release of 7.2% [3] or 8.1% [4] of the global total CH_4 emission. Although it is definite that Arctic tundra significantly contributes to the global methane emissions in general, regional variations in GHG fluxes are enormous. CH_4 fluxes of polygonal tundra within the Siberian Lena Delta, for example, were reported to be low [5, 6], particularly at open water polygonal ponds and small lakes [7] which make up around 10 % of the delta's surface. Low methane emissions from polygonal ponds oppose that Arctic permafrost thaw ponds are generally known to emit large amounts of CH_4 [8].

Combining tools of biogeochemistry and molecular microbiology, we identified sinks of CH_4 in polygonal ponds from the Lena Delta that were not considered so far in GHG studies from Arctic wetlands. Pore water CH_4 profiling in polygonal ponds on Samoylov, a small island in the central part of the Lena Delta, revealed a pronounced zone of CH_4 oxidation near the vegetation surface in submerged layers of brown-mosses. Here, potential CH_4 oxidation was an order of magnitude higher than in non-submerged mosses and in adjacent bulk soil. We could additionally show that this moss associated methane oxidation (MAMO) is hampered when exposure of light is prevented. Shading of plots with submerged *Scorpidium scorpioides* inhibited MAMO leading to higher CH_4 concentrations and an increase in CH_4 fluxes by a factor of $\sim$13. Compared to non-submerged mosses, the submerged mosses also showed significantly lower $\delta^{13}C$ values indicating that they use carbon dioxide derived from methane oxidation for photosynthesis. Applying stable isotope probing of DNA, type II methanotrophs were identified to be responsible for the oxidation of CH_4 in the submerged *Scorpidium scorpioides*.

Our study gives first evidence for MAMO in submerged brown-mosses and in the oligotrophic polygonal peatlands of the Lena Delta. It shows that MAMO might effectively reduce methane fluxes to the atmosphere also in Arctic GHG emission hot spots.

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