Water column dynamics control nitrite-dependent anaerobic methane oxidation by Candidatus "Methylomirabilis" in stratified lake basins

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We investigated microbial methane oxidation in the water column of two connected but hydrodynamically contrasting basins of Lake Lugano, Switzerland. Both basins accumulate large amounts of methane in the water column below their chemoclines, but methane oxidation efficiently prevents methane from reaching surface waters. Here we show that in the meromictic North Basin water column, a substantial fraction of methane was eliminated through anaerobic methane oxidation (AOM) coupled to nitrite reduction by Candidatus Methylomirabilis. Incubations with (CH4)-C-14 and concentrated biomass from this basin showed enhanced AOM rates with nitrate (+62%) and nitrite (+43%). In the more dynamic South Basin, however, aerobic methanotrophs prevailed, Ca. Methylomirabilis was absent in the anoxic water column, and no evidence was found for nitrite-dependent AOM. Here, the duration of seasonal stratification and anoxia seems to be too short, relative to the slow growth rate of Ca. Methylomirabilis, to allow for the establishment of anaerobic methanotrophs, in spite of favorable hydrochemical conditions. Using 16 S rRNA gene sequence data covering nearly ten years of community dynamics, we show that Ca. Methylomirabilis was a permanent element of the pelagic methane filter in the North Basin, which proliferated during periods of stable water column conditions and became the dominant methanotroph in the system. Conversely, more dynamic water column conditions led to a decline of Ca. Methylomirabilis and induced blooms of the faster-growing aerobic methanotrophs Methylobacter and Crenothrix. Our data highlight that physical (mixing) processes and ecosystem stability are key drivers controlling the community composition of aerobic and anaerobic methanotrophs.
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