Discovery of microbial pathway that may help combat methane emissions

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The stalactites-like biofilms hanging over cave ceiling (A) and the star-shaped cell residing in the wall biofilm (B). Credit: Beijing Zhongke Journal Publising Co. Ltd.

Methane is a powerful greenhouse gas, contributing more than 20% of global warming since preindustrial times. Anaerobic oxidation of methane (AOM) is an important methane sink, reducing methane emission from various environments to the atmosphere. Methylomirabilota bacterium (Methylomirabilis oxyfera) that can use nitrite as the electron acceptor to drive AOM has been recently reported.

Intriguingly, although M. oxyfera is an anaerobe, it employs the aerobic pathway for methane oxidation, using its own intracellularly formed oxygen via "oxygenic denitrification." Currently, our understanding

towards the ecophysiology and ecology of Methylomirabilota methanotrophs is limited.

In the study led by Dr. Baoli Zhu (Institute of Subtropical Agriculture, Chinese Academy of Sciences) and Dr. Tillmann Lueders (University of Bayreuth, Germany), an iodine-rich spring cave, whose atmosphere was microoxic and contained high-level thermogenic methane (~3000 ppm) has been investigated. Massive biofilms were discovered covering the cavern walls and ceilings, forming spectacular stalactites-like views.

16S rRNA amplicon sequencing revealed that aerobic methanotrophs and methylotrophs were present in all biofilms, but Methylomirabilota bacteria were exceptionally abundant in the submersed wall biofilm. Additionally, star-shaped cells resembling the morphology of M. oxyfera were directly observed under electron microscope, suggesting its presence in the submersed biofilm.

From the metagenome of the submersed biofilm, the authors assembled a MAG (metagenome-assembled genome) of a novel Methylomirabilota bacterium, which they named Candidatus Methylomirabilis iodofontis. In the metagenome, M. iodofontis 16S rRNA reads accounted up to 14.3% of the total 16S rRNA reads, suggesting its high abundance in the biofilm. A complete M. iodofontis 16S rRNA sequence was built from these reads, and it showed high similarity to that of M. limnetica. However, M. iodofontis MAG only had low identity to M. iodofontis genome (AAI, 85.8%，ANI, 91.3%), suggesting it may have a different ecophysiology from M. limnetica.

Although there was high concentration of methane in the cave atmosphere, nitrite was undetectable in the spring water, and nitrate concentration was low (