Photoferrotrophy and Fe-cycling in a freshwater column

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Emerging insight shows that ferruginous (anoxic and iron-rich) conditions dominated ocean chemistry throughout the first 3.5 billion years of Earth evolution. Modern ferruginous water masses are rare, but detailed examination of these oddities, especially of photoferrotrophs and their Fe-reducing respiratory counterparts, could yield important insights into the early evolution of life on Earth and its impact on global element cycles.

Here, we describe an abundant microbial community of pelagic photoferrotrophic and Fe-reducing microbes in a freshwater basin in East Africa (Kabuno Bay, DR Congo), recently discovered to be ferruginous. The application of culture–dependent and –independent techniques allowed the identification of active photoferrotrophs genetically similar to laboratory cultures of *Chlorobium ferrooxidans*, the only member of the *Chlorobi* previously known to conduct photoferrotrophy. The Kabuno Bay photoferrotrophic Green Sulfur Bacteria (GSB) community ranged between the 16.2% and 38.3% of the entire bacterial community retrieved by 454 pyrotag analyses of the euphotic Fe-rich chemocline of Kabuno bay. The GSB maximum coincided with high rates of ferrous Fe oxidation and bacterial production. Up to 60% of total depth integrated BP is carried out at the depths where photoferrotrophic GSB dominate. Main bacterial groups involved in methanogenesis were also recovered from the upper oxic-anoxic transition zone, but in contrast to the GSB community, other microorganisms typically implicated in the sulfur cycle were only present at low relative abundances. DAPI counts revealed a high microbial biomass in the water column of Kabuno bay, which we speculate supports large populations of pelagic iron-reducers. Reactive iron oxides, however, are exhausted within the chemocline and excess organic matter is thus channelled through mineralization by methanogenesis directly in the water column.

Our study documents for the first time that photoferrotrophs are suited to pelagic lifestyles and putatively possess a low-light adapted light harvesting apparatus. That pelagic carbon mineralization is channelled through methanogenesis even under ferruginous conditions impling that gaseous reduced equivalents can escape to the atmosphere, allowing excess ferric iron to be exported to sediments such as Banded Iron Formations. In this way, photoferrotrophs could contribute to the overall oxidation of the Earth's surface prior to the oxygenation of the atmosphere.

Target Session: 13. Phototrophic plankton as the movers and shakers in aquatic ecosystems. (Oral Presentation)