Metagenomes reveal the common presence of phototrophic Gemmatimonadota in freshwater lakes.

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Phototrophic organisms transform solar radiation into metabolic energy, which fuels most of the world's ecosystem. While majority of photosynthesis on Earth is performed by oxygenic phototrophs, plants, algae and Cyanobacteria, there also exists a great variety of prokaryotic organisms performing anoxygenic photosynthesis. The existence of anoxygenic phototrophic species containing bacteriochlorophyll has so far been reported from several bacterial phyla. One of them is a cosmopolitan phylum Gemmatimonadetes. Until now, it contains only five cultured species; however, Gemmatimonadetes are present in many different environments. In soils, they represent one of the top 10 most abundant bacterial phyla. However, much less information exists about their distribution, species diversity and ecological role in freshwaters.

In 2014, a new phototrophic organism *Gemmatimonas phototrophica*, member of phylum Gemmatimonadetes, was isolated from a freshwater lake in Inner Mongolia. This indicated that phototrophic Gemmatimonadetes might be also present in other freshwater habitats. Therefore, we analyzed the presence of Gemmatimonadetes species in metagenome assembled genomes (MAGs) from different depths of five freshwater lakes in Czech Republic and Switzerland, Europe. Our results confirmed presence of three groups of phototrophic Gemmatimonadetes in epilimnia and hypolimnia of the studied lakes. In addition, we developed a specific FISH probes to identify Gemmatimonadetes using epifluorescence microscopy. We found that both heterotrophic and phototrophic Gemmatimonadetes persist in the water column. They represent 0.2-1% of planktonic bacteria during the all seasons. Using microscopy we found that Gemmatimonadetes live both as single celled species as well as in association with diatoms (*Fragelaria sp.*) or Cyanobacteria (*Microcystis sp.*), which suggests their closer association with phytoplankton.