Role of aerobic anoxygenic photoheterotrophic bacteria in a freshwater carbon cycle

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Carbon is the most actively cycled element in the biosphere. Unfortunately, the natural carbon cycle has been imbalanced by anthropogenic activities, resulting in the climate change, and affecting not only wild life, but also human health and well-being. Freshwater lakes are a significant component of the global carbon cycle: they cover only about 3% of Earth's surface, but they bury annually more organic carbon in their sediments than oceans. Thus, understating the carbon cycle in lakes is crucial for understanding the global carbon cycle.

Microbes are the key component of the carbon cycle. Eukaryotic algae and cyanobacteria fix CO_2 during photosynthesis, and so produced organic matter is recycled back to CO_2, mainly due to microbial respiration. Rates of microbial heterotrophic activities are considered to be independent of light, and consequently, they are measured in the dark. However, discovery that photoheterotrophic bacteria are abundant in the aquatic environments questioned the assumption that *in situ* microbial heterotrophic activities occurs at the same rates in the light and dark. Two groups of photoheterotrophic bacteria thrive in aquatic environments: rhodopsin containing bacteria (RBs), and aerobic anoxygenic phototrophic bacteria (AAPs). RBs include most abundant but little active and slowly growing small freshwater taxa. In contrast, AAPs exhibit fast growth rates, larger than average bacteria cell size and higher than average activity, thus their contribution to the carbon cycling is believed to be higher that it could be deduced from their numbers. Experiments with pure cultures showed that AAPs grown in the light:dark cycle decrease their respiration by 75%, and increase production by 50% compared to the growth in the dark. However, *in situ* benefits of light harvesting by AAPs is still not understood.

Despite the fact that the potential importance of photoheterotrophy has been realized almost two decades ago, rates of bacterial respiration and production are still typically measured in the dark. This can substantially bias the estimates of bacterial activity in times of elevated abundance of photoheterotrophs, especially of highly active AAPs. In this project, I used a novel approach to address the question of contribution of photoheterotrophy to the freshwater carbon cycle. I compared *in situ* rates of microbial activity: respiration and production, measured in the dark and in the infrared light (λ>750 nm). Infrared is absorbed only by bacteriochlorophyll-containing AAPs, therefore our measurements were unaffected by photosynthetic algal activity. I showed that measuring bacterial activity only in the dark may overestimate bacterial respiration by 120%, and underestimate bacterial production by 24-160%. These results emphasize the key importance of photoheterotrophic metabolism in the carbon cycle.