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Variability and regulation of the planktonic respiratory quotient in a eutrophic lake (Lake Vombsjön) in summer 2016

Freshwater ecosystems are an important part of the global carbon cycle, releasing as much carbon dioxide to the atmosphere as is absorbed by the oceans during the same time. Carbon in lakes is cycled via primary production, i.e. the fixation of inorganic carbon by autotrophs, and respiration, i.e. the remineralisation of organic carbon by the lake community. Bacterial respiration is often determined by measuring O_2 concentrations and converting them into CO_2 concentrations by using a respiratory quotient (RQ). The RQ is described as the ratio of O_2 consumed to CO_2 produced and is usually assumed to be 1. Recent studies have shown, however, that RQs can vary a lot in different aquatic ecosystems (0.5-5), which may lead to an under- or overestimation of respiration.

In this study, we conducted in-situ measurements of O_2 and CO_2 fluxes in a eutrophic lake (Lake Vombsjön) in Southern Sweden. We used those measurements to assess the magnitude and variability of the RQ as well as the bacterial growth efficiency in summer 2016. The RQ was mostly below 1 and increased with increasing water depth. The BGE was high (0.2 – 0.5) and showed no pattern similar to the RQ. Both trends could partly be attributed to the preferential use of autochthonous organic matter by bacterioplankton. However, the majority of our observed RQs was lower than any reported values (0.2 – 0.5) and we found no single explaining factor for this. Instead, a combination of different processes may be responsible for the low RQs: bacterioplankton use abundant algal organic matter from primary production, which yields a theoretical RQ of 0.7 – 0.8. Nitrification, the stepwise oxidation of NH_4^+ to NO_3^-, removes O_2 from the water column without producing CO_2, thus lowering the RQ we measured. Methane oxidation, having a theoretical RQ of 0.5, may also occur and lower the overall RQ.

Our findings indicate that using a theoretical RQ of 1 may lead to an overestimation of bacterial respiration in eutrophic ecosystems. Since many temperate lakes are eutrophic, their role in the global carbon cycle as sources of atmospheric carbon may be wrongly represented on a global scale. It is thus necessary to gain deeper knowledge about the size and variability of RQs in those lakes and take other metabolic processes (nitrification, denitrification, methane oxidation) into consideration when studying respiration on an ecosystem level.

Keywords: Physical geography and ecosystem analysis, biogeochemistry, bacterioplankton respiration, eutrophic lake, carbon cycling

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