Maximum photosynthetic efficiency of size-fractionated phytoplankton assessed by 14C uptake and fast repetition rate fluorometry

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ABSTRACT: Under high nutrient concentrations and sufficient light conditions, large phytoplankton may display higher photosynthetic efficiency than smaller cells. This is unexpected since smaller phytoplankton, because of their higher surface to volume ratio, possess a greater ability to take up nutrients and absorb light. In order to investigate the causes of the increased photosynthetic efficiency in larger phytoplankton, we assessed the maximum photosynthetic efficiency of coastal assemblages in three size classes (<5, 5-20, and >20 mm) by concurrently conducting ^{14}C-based photosynthesis-irradiance experiments and fast repetition rate fluorescence measurements. The light-saturated, chlorophyll-specific photosynthesis (P^b_{max}) and the maximum photosystem II (PSII) photochemical efficiency (F_v/F_m) of each size class were determined during winter mixing (March 2003) and summer stratification (June 2003). During winter mixing, size-fractionated P^b_{max} and F_v/F_m were similar in all size classes. In contrast, during summer stratification, size-fractionated P^b_{max} and F_v/F_m were significantly higher in the >20-mm size class. In the entire data set, size-fractionated P^b_{max} and F_v/F_m were not significantly correlated. However, a significant relationship was found between size-fractionated P^b_{max} and F_v/F_m for phytoplankton assemblages acclimated to low light conditions. Under high light, an excess PSII capacity may be responsible for the discrepancy between size-fractionated P^b_{max} and F_v/F_m measurements, whereas under low light conditions, photosynthetic electron transport chain and components downstream of PSII become more balanced, which results in a tight covariation between both variables. Higher maximum photosynthetic efficiencies of large-sized phytoplankton might be associated with a higher PSII photochemical efficiency characteristic of certain taxonomic groups such as diatoms.

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