Flow induces higher rates of photosynthesis in marine organisms by preventing oxygen inhibition of RubisCO

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Why does the flow have such a profound effect on primary production in corals, algae and sea grasses? Numerous studies in the past 3-4 decades have shown that exposure to strong flow strikingly augments primary production in many benthic autotrophs (Dennison & Barnes 1988, Patterson et al. 1991, Patterson 1992, Koch 1993, Atkinson et al. 1994, Koch 1994, Lesser et al. 1994, Bruno & Edmunds 1998, Enriquez & Rodriguez-Roman 2006, Finelli et al. 2006). The mechanism responsible for such augmentation, however, remains elusive. Traditional explanations include more efficient supply or removal of metabolic gases, such as, the uptake of C (Wheelerw 1980, Koehl & Alberte 1988) and NH_4^+ (Parker 1982), increased supply and efficiency of particle capture, and better elimination of waste products (Patterson 1993). Jokiel (1978) suggested that increased water motion may enhance exchange of CO_2 and O_2 between corals and their environment. Lesser et al. (1994) proposed that increased flow is the mechanism that may limit the supply of dissolved inorganic carbon (DIC) through the increased translocation of carbon rich photosynthate.

The objective of my study is to reveal the mechanism responsible for the augmentation of primary production by flow. My hypothesis is that in low-flow conditions photosynthesis organisms’ switch from photosynthesis to photorespiration, which is metabolically very costly and potentially detrimental to health (Dykens 1984, Dykens & Shick 1984, Lesser).

A combined O_2 microelectrode and Dual PAM was used to conduct simultaneous measurements of O_2 concentration and PSII fluorescence yield (maximum quantum yield in the dark, effective quantum yield in the light) in side the tissue of coral, sea grass and macro algae under steady-state conditions as a function of increasing flow.

In order to quantify the various O_2 uptake reactions *in vivo* under different flow condition we used mass spectrometric measurements of $^{16}O_2$ evolution from water and $^{18}O_2$ uptake from the O_2 pool in the medium (Canvin et al. 1980).

My study has revealed, for the first time, the mechanism by which flow enhances primary production in benthic organisms. I demonstrate that the photosynthetic efficiency is modulated by oxygen concentration in the different species tissue, which is in turn modulated by flow. This result has wide ranging implications for understanding photosynthesis organisms' physiology in general.

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