A mechanistic model of the photoinhibited P–I curve

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Primary production in the northern Gulf of Elat, Red Sea: a case study for open-sea coral-reef interactions

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Temporal and spatial patterns in the primary production of phytoplankton in the Gulf of Elat were determined during 1989–1991. Water was sampled monthly in a cross-section at 600 m, 150 m, and 50 m bottom depth. Duplicate 330 ml pyrex BOD bottles were spiked with 5 μCi 14C and incubated in situ. The dark and time-zero controls were in the range of instrumental background, while the light incubations were at least one order of magnitude higher. Rates of primary production for the upper photic zone (0–50 m) ranged between 0.5 and 1.5 μgC l−1 h−1 and are similar to those reported previously for the same region (Levanon-Spanier et al., 1979). Depth-integrated and time-averaged rates yield primary production of 80 to 120 gC m−2 y−1. Oxygen consumption rates below the seasonal thermocline yielded minimum values for new production which are around 160 gC m−2 y−1. In an effort to resolve for this discrepancy we tested for some of the commonly cited methodological pitfalls involved in primary productivity measurements: bottle size effect, plastic vs. glass bottles, trace-metal contamination in the radiotracer and the length of incubation. None of these factors seem to have a significant effect on our measurements. It is possible that the high oxygen consumption rates are caused by oxidation of sedimentary organic matter transported down slope from the adjacent coastal fringing coral reefs. During the oligotrophic summer period we observed a sharp increase in phytoplankton primary production towards the coastal fringing coral reefs. This observation is in good agreement with a similar productivity gradient reported by Levanon-Spanier et al. (1979). These gradients are associated with distinct (although much sharper) gradients of nitrate and occasionally DON and phosphate, showing decreasing concentrations towards the open sea. Stable carbon isotopes and plankton distribution studies suggest that the reef obtains the bulk of its nutrients from feeding and digestion of pelagic plankton. The excess nutrients are transported back to the open sea and support the elevated photosynthetic rates of phytoplankton. During the winter period (Jan–Mar) the thermocline is destroyed and complete vertical mixing brings nutrients to the photic zone. Under these conditions the nutrient and productivity gradients reverse their direction because benthic primary producers in the reef take up dissolved inorganic nutrients from water and the phytoplankton responds with lower productivity.

Reference

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