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Carbon fluxes in the pelagic ecosystem of the Gulf of Trieste (Northern Adriatic Sea)

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ABSTRACT

By measuring a broad suite of physical, chemical, and biological parameters coupled with experiments on grazing efficiency of mesozoo-, microzoo- and heteronano-plankton we were able to depict the seasonal trophic status of the pelagic system in the Gulf of Trieste over a period of 8 years from 1998 to 2005. In winter and spring, primary production exceeded respiration, the autotrophic fraction biomass was higher than the heterotrophic biomass. Moreover, predation on microphytoplankton and autotrophic nanoplankton largely structured the ecosystem and bacterial carbon production accounted for <50% of primary production. The ratio of primary production/respiration was higher than 1 in winter and spring suggesting that pelagic ecosystem was autotrophic whereas in summer and in autumn the ratio was lower than 1 suggesting a shift towards net heterotrophic status. Carbon export was possible in winter and in autumn, and the few data from the sediment trap supported the theoretical rates. Thus since spring most of the C fixed by photosynthesis remained segregated in the surface layer and possibly it was exported to the bottom through grazer fecal pellets. In summer the system was dominated by heterotrophic picoplankton, which showed the highest production rate. In this scenario we hypothesize that the DOC produced during the winter-spring period can sustain a high and active bacterial biomass that is the primary energy source for the whole system. Picoplankton communities were heavily grazed by microzooplankton and heteronano-plankton, moreover predation rates of mesozooplankton on microzooplankton were particularly high in summer. Despite the high variability typical of the coastal areas, the pelagic ecosystem during these 8 years has shifted seasonally from a nutrient-excited state (winter–spring) to a background state (summer–autumn) as it has been observed from open-ocean ecosystem. Understanding the dynamic and the magnitude of this variability-shift is rather compelling in order to give guidance in managing the Gulf area in the context of CO_2 sequestration mitigation programs (carbon export downward flux) as well as for fishery economy.

1. Introduction

Oceanic and coastal carbon fluxes depend on the efficiency of primary production and on the bacterial mediated biogeochemical processes within the photic zone, as well as on the structure of the pelagic food webs.

Primary production may be respired within the euphotic layer (microbial loop: primary production – POC-DOC ⇒ bacteria ⇒ viruses or grazers), exported into the ocean interior by downward fluxes of sinking materials or channelled through the biomass of larger consumers in to the classical grazing food web (phytoplankton ⇒ zooplankton ⇒ fish).

Planktonic communities can shift from the prevalence of the microbial loop to the dominance of the grazing "classic" food web over short-medium periods of time depending on nutrient availability and grazing pressure (bottom-up and top-down control). Classical grazing food webs develop in shallow turbulent environments where nutrient availability is pulsed or episodic. In this scenario, large size phytoplankton blooms in the spring, following episodic pulses of nutrients when the predation pressure is low; this will increase the downward fluxes of phytoplankton detritus. On the opposite, microbial food web is typical of low energy environments, where nutrient availability depends on regeneration processes (Kiorbe, 1996). As a consequence, the fate of fixed carbon can change over time in the same environment as a function of the

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