WHAT HAPPENS TO PLANKTON FOOD WEB AFTER RESUSPENSION OF SEDIMENT IN COASTAL WATERS

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Abstract

Two trophic network models were developed to characterize the structure and the functioning of plankton food web in natural marine water and after addition of sediment elutriate in the Bizerte Lagoon (SW Mediterranean). Elutriate was obtained by resuspension of contaminated sediment with the release of nutrients, dissolved organic matter and chemical contaminants. Modeling showed that the trophic network control water was multivorous pathways in wish herbivorous and microbial activities coexist together. After elutriate addition, the food web switched to a microbial pathway, where microzooplankton exerted sever grazing pressure on bacterial and algal production.

Keywords: Models, Inverse methods, Food webs, Mediterranean Sea

Introduction

Coastal waters receive various types of contaminants, which are mainly concentrated in the sediment. However during mixing event, contaminants and nutrients can be released from sediment into water column. Sediment resuspension can thus result in pulsed exposures of complex mixtures of contaminants and nutrients which can impact planktonic organisms. Effectively, several studies have reported significant effects of resuspension of contaminated and nutrient-rich sediments on the biomass and structure of plankton communities [1]. However, the ecological consequences of resuspension of coastal sediment on the structure and functioning of the plankton food web stay until now unclear.The aim of the study was modeling the pelagic food webs of the lagoon of Bizerte by applying the Monte Carlo Markov chain Linear Inverse Modeling (LIM-MCMC) and to compare the food pathways in natural conditions and after exposure to a contaminant-nutrient mixture.

Materials and Methods

Sampling was carried in the lagoon at different depths (0.5, 2.5, 5/6 and 8/16 m) during spring 2012. The Sediment elutriates were prepared from sediment and water collected from the sampling station following the method described in [1]. Samples were used for determination of dissolved and particular organic carbon concentrations (DOC and POC), and carbon stocks of three size classes of phytoplankton (picophytoplankton: < 2 µm, nanophytoplankton: 2 – 10 µm, microphytoplankton: 10 – 200 µm), bacteria and microzooplankton. Two nets (200 µm and 700 µm) were towed vertically to determine carbon biomass of mesozooplankton and to estimate their grazing impact on phytoplankton by the method of gut pigment content [2]. Vertical fluxes of carbon particles were measured with sediment traps. Production rates of phytoplankton as well as consumption rates of bacteria and microzooplankton were estimated from dilution method [3]. Nutrients and contaminants (trace metals, HAPs, PCBs and organotins) were analysed in the elutriate. Field data were used to construct plankton food web model that quantitatively illustrate carbon pathway in study site. Since the unknown flows outnumbered the known flows, the linear inverse method Monte Carlo Markov chain method "LIM-MCMC" [4], derived from the LIM of Vezina and Platt [5] , was adopted to reconstruct food carbon flows through the pelagic food web.

Results and Discussion

In the Lagoon, the main carbon input was supported by the primary production (PP = 1234.24 mg C m^{-2} d^{-1}) and was mainly performed by microalgae (70% of total PP). Microzooplankton, composed mainly of heterotrophic dinoflagellates and ciliates, removed daily half of the total PP. These micrograzers consumed the pico- and the nanophytoplankton as well as the microalgae. Grazing on bacteria was equivalent to 35% of their production. Mesozooplankton grazed only on micro/nanophytoplankton and removed 8% of their production. This trophic pathway corresponds to a multivorous food web in wish microbivorous and herbivorous grazers can act together in channelling the biogenic carbon. After addition of sediment elutriates, which were rich in N-nutrients (especially NH_4^+, 40 µM) and in trace metals (especially Zn, As, Cu, Ni and Pb: 1 - 17 ug l^{-1}), the growth and the production of picophytoplankton noticeably increased and these picoalgae became the main C producers, representing 64% of total PP. The biogenic carbon entered to a plancktonic foodweb mainly by the microzooplankton grazing on picophytoplankton (half of its PP was grazed) and on bacteria (82% of their production were consumed). The micrograzers removed also an important fraction of nano- and microphytoplankton. Despite the mesozooplankton grazed 28% of the nano/microalgal production, it contributed only weakly in the channel of C, since the > 2 phytoplankton had low contribution to PP. This new C pathway, in which micrograzers play the significant role in channeling the biogenic C *via* their high microbivory, corresponded to the microbial food web. These results revealed that during mixing event in shallow water ecosystems, trophic interactions among plankton components can be strongly affected by sediment resuspension. The modelling exercise showing theses change provoked severe consequences in the structure and the functioning of plankton foodweb of the Bizerte Lagoon.

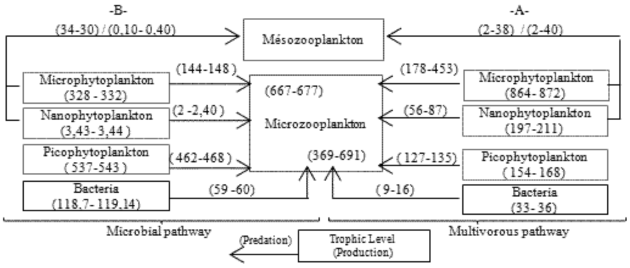

Fig. 1. Interval of possible values (Production and Predation: mgC m^{-2} d^{-1}) derived from the inverse analysis solution for the lagoon. A: Food web in natural water , B: Food web after elutriate addition.

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