PHYTOPLANKTON-ZOOPLANKTON TROPHIC INTERACTIONS ALONG THE SALINITY GRADIENT (GULF OF TRIESTE)

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Abstract

The response of phytoplankton to nutrient inputs of the Soca River and its interactions with zooplankton were studied monthly from 1993 to 1995 and during short-time field experiments in June 1995. The major influence of riverine discharges on phytoplankton biomass was observed after autumn freshets, especially in October 1993 and October-December 1994. In these periods, when diatoms dominated the phytoplankton community, the highest grazing rates of the copepod Acartia clausi were measured (5.31 and 2.49 ng Chla ind.$^{-1}$). An increase of phytoplankton biomass was observed after a freshwater discharge in June 1995. Despite the high phytoplankton standing stock in the Soca River plume, grazing rates of *A. clausi* were lower in comparison to less-diluted areas.

Key-words: plankton, trophic relations, river input, Adriatic Sea

Introduction

Direct inputs from land-based sources and atmospheric deposition are the main sources of plant nutrients in estuarine and coastal waters. In such areas increasing nutrient and organic matter inputs have been paralleled with marine eutrophication for some decades (1, 2). This is the case with the northern Adriatic (3) and its shallowest part, the Gulf of Trieste with the Soca River as the largest freshwater source. Development of phytoplankton blooms and changes in phytoplankton community usually follow seasonal and interannual fluctuations in freshwater discharges in the Gulf of Trieste (4, 5). Coastal waters and estuaries are also suitable sites for studying interactions between phytoplankton and zooplankton due to increased phytoplankton standing stock after external nutrient enrichment of the waters (6). The question that arises is what is the zooplankton response to phytoplankton fluctuations (in time and space)? This can consequently provide useful information about the fate of phytoplankton biomass.

The aim of this work was to assess the influence of freshwater inputs on the phytoplankton community, and subsequently the response of the zooplankton community to favorable nutritional conditions. Phytoplankton-zooplankton trophic interactions were followed on an annual basis and during short-term field experiments with Soca River discharges as the main nutrient inputs.

Material and methods

The Gulf of Trieste is a shallow, semi-enclosed gulf with a maximum depth of ca. 25 m in the central part. It is characterized by large temperature variations (6-26°C in the surface layer and 6-20°C above the bottom) and, following the seasonal freshets, surface salinity oscillations (<30 to 38.5). From mid-April through September typical thermal stratification develops, while in other seasons the water column is mixed. Most of freshwater enters the Gulf with the Soca River inflow on the northwestern side (annual average of 150 m^{3}s^{-1}; 7).

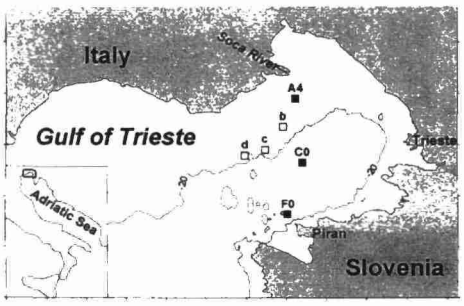

Fig. 1: Locations of sampling stations during the September 1993 - June 1995 period (station F0) and during short-term experiments in June 1995 in the Gulf of Trieste; (■) stations along the salinity gradient (June 13 and 19 1995), (□) stations along drifter trajectory (June 15, 16 and 21 1995).

Sampling was carried out from September 1993 to June 1995 on station F0 (21 m depth) in the southeastern part of the Gulf (Fig. 1). Samples for phytoplankton biomass and abundance were collected monthly at five depths (0, 5, 10, 15 and 21 m). Samples for grazing measurements in terms of gut pigment content were collected separately in approximately week intervals.

Additionally, five short-term experiments near the Soca River plume were conducted in June 1995 (8). Two 24-hours experiments (June 13 and 19) were performed at three stations along the salinity gradient (A4, C0 and F0). The station A4 is directly influenced by freshwater inputs, station F0 is under marine water influence and station C0 is influenced by water of both origins. The other three experiments (June 15, 16 and 21 1995) were set up as drifting experiments. A surface drifter was released at station A4 and tracked to station d within 12 hours. The trajectory A4-d represents the transport of the water mass of the Soca River plume during its movement to the mid-gulf area. Sampling protocol for gut pigment content and chlorophyll a biomass is described in detail in Lipej *et al.* (9).

Phytoplankton biomass, expressed as chlorophyll *a* concentration, was determined fluorometrically (10). Phytoplankton was identified in formaldehyde fixed samples (800 ml) and counted on the inverted microscope at 200x magnification (11). Chlorophyll a concentrations from discrete depths were integrated over the whole water column.

The live mesozooplankton samples were obtained by vertical net tows and transported to the laboratory within 15 minutes. During field experiments in June 1995, samples were immediately stored in liquid nitrogen after capture. Comparison of the effect of two handling procedures on the gut pigment content showed no statistical differences between them (ANOVA, P<0.31; 12). *Acartia clausi* was chosen as the most representative copepod, which often dominates the mesozooplankton community of the Gulf of Trieste (13). The gut fluorescence method was used to assess grazing (14, 15). Twenty to thirty freshly caught adults of *A. clausi* were picked out from the container using a stereomicroscope and placed in tubes with 90% acetone and stored in a dark refrigerator overnight. Chlorophylla and phaeopigment content were determined fluorometrically (10), and their concentrations were computed using the equation of Dagg & Wyman (16). Most gut content analyses were carried out in 3-6 replicates. Gut pigment content was expressed as ng Chl *a* • individual^{-1}. Data of daily river flows were provided by Hydrometeorological Survey of Slovenia.

Results and discussion

Seasonal variations (September 1993 - June 1995). Most of Soca River freshwater is generally density-driven out of the Gulf along the northern coastline. Only after autumn freshets does the low-salinity surface water of the Soca River plume reach the southeastern part of the Gulf after a few days' interval (8). This situation was observed also during our study.

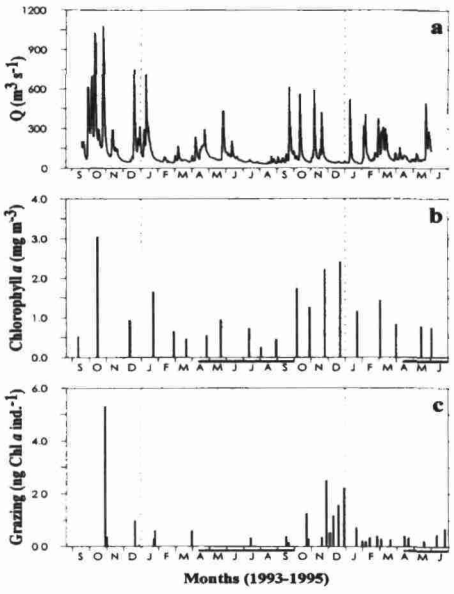

Fig. 2: (a) Daily flow of the Soca River, (b) depth integrated concentrations of chlorophyll *a*, and (c) gut pigment content of *A. clausi* at the station F0 in the period September 1993 - June 1995. Bold lines below the X axis denote the periods of stratified water column.