SEASONAL DISTRIBUTION OF HYDROGRAPHIC CHARACTERISTICS AND PHYTOPLANKTON IN THE KARSTIC ZRMANJA ESTUARY (EASTERN ADRIATIC SEA)

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Abstract

The abundance of phytoplankton and concentrations of nutrients were analyzed in relation to thermohaline conditions in the lower reach of the karstic Zrmanja River estuary, eastern Adriatic coast, Croatia, in the period from June 1998 to October 2000. The Zrmanja Estuary is highly stratified, shallow, oligotrophic estuary, dominated by marine phytoplankton. It is characterized by extremely low ortophosphate concentratios, and the distinctive summer minimum of inorganic nitrogen, as a result of exhaustion of the water column after the spring phytoplankton development, and a negligible anthropogenic influence.

Key-words: Estuary, phytoplankton, nutrients, Adriatic Sea

The increased primary production in estuaries is influenced by nutrients brought by the river discharge. The karstic rivers that discharge into the eastern Adriatic Sea and have been investigated to date (1) are extremely oligotrophic. The small karstic river Zrmanja discharges into the sea (fig.1) forming highly stratified estuary (2). High stratification is maintained, due to the relatively high volume of river discharge and low tides (3). The Zrmanja river is 69 km long with the annual mean outflow of 38 m s-1, but may be as high as 456 and low as 0.09 m s^{-1}. The surrounding area is scarcely inhabited. In the upper reach of the estuary there is only a settlment Obrovac with 1200 inhabitants.

Materials and methods

Water samples for the analyses of phytoplankton were collected at station Z2 (Fig. 1), in monthly intervals, in the period June 1998 to October 2000. We devided the water column in two layers: above (0-1 m) and below (2-4 m) the halocline.

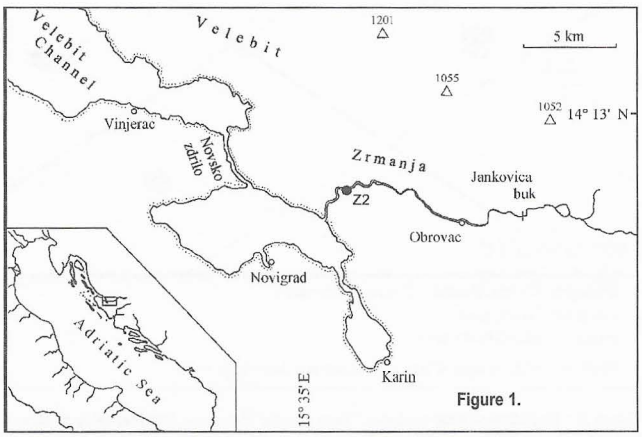

Figure 1.

Phytoplankton was sampled using 5-liter Niskin bottles at one-meter intervals of the water column. Samples were preserved in a 2 per cent (final concentration) neutralized formaldehyde solution. The cell counts were obtained by the inverted microscope method (4). Thermohaline properties were determined using a conductivity, temperature and depth profiler (SEA Bird Electronics Inc. USA), and by the argentometric titration. Nutrient concentrations were measured using standard method (5).

Results and discussion

The seasonal distribution of salinity values (Fig. 2) shows high stratification, during most of the year, especially during rainy period (November to May). The reduced river discharge in summer (June to September) resulted in the higher salinity (up to 22.4) above the halocline. The salinity of the marine layer varied between 13.4 and 34.1. The temperature ranged between 7.6°C in February and 24.5°C in August (at the surface). The extremely low ortophosphate concentratios varied between 0.01and 0.13 μmol l^{-1}. The concentrations of total inorganic nitrogen provided distinctive summer minimum, as a result of the exhoustion of the water column after the spring phytoplankton development, and the negligible anthropogenic influence. In comparison to nitrogen concentrations, phosphates were determined to be limiting growth factor for the phytoplankton growth in the estuary.

Silicate concentrations were mostly bellow 10 μmol l^{-1} in the marine layer. The higher concentrations vere detected above the halocline (maximum 35.9 μmol l^{-1} in October 1998) during the rainy season.

The phytoplankton in the estuary was represented mostly by marine species. The increased abundances of marine diatoms were registered (bellow the halocline) in spring. Sporadic spring maxima could be determined

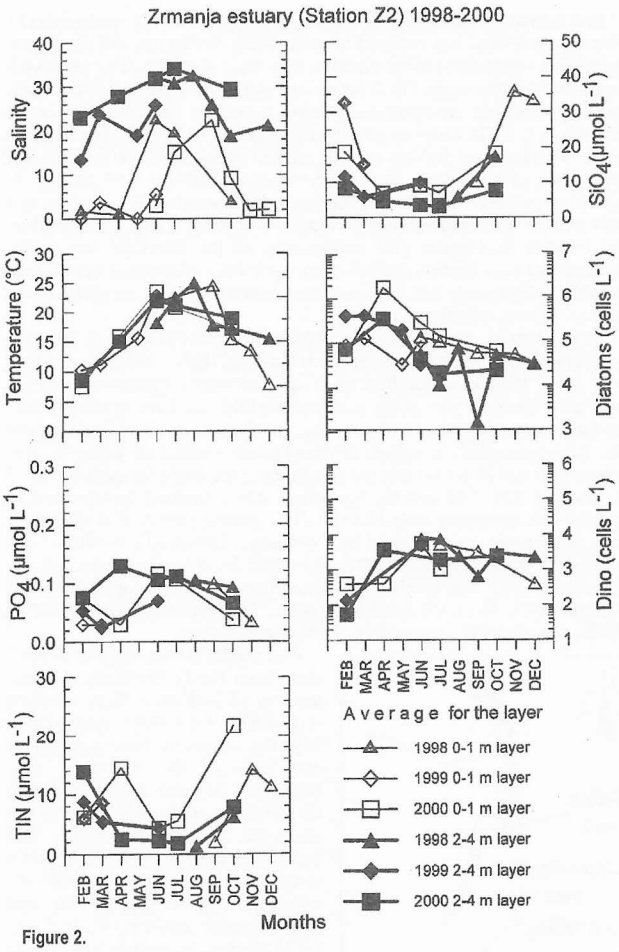

Figure 2.

above the halocline (April 2000). The maximum abundance of diatoms reached not more than 1.8 10^6 st. l^{-1} (April 2000), probably as a consequence of poore enrichement of seawater with nutrients. Dinoflagellates usually dominate after the peak development of diatoms (due to the mixotrophic potential of dinoflagellates).

Low concentrations of nutrients and relatively low abundance of phytoplankton indicate ecological stability (without serious anthropogenic influence) in the oligotrophic waters of the Zrmanja Estuary.

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