ENVIRONMENTAL GRADIENTS OF NUTRIENTS AND PHYSICAL-CHEMICAL PARAMETERS IN A MEDITERRANEAN COASTAL EMBAYMENT

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Abstract

Temperature, salinity, pH, dissolved oxygen, Secchi depth, phosphates, ammonia and chlorophyll-a were studied for one year in Vistonis, a shallow, turbid, partially mixed coastal embayment in N. Greece. In summer, a salinity wedge of 4.5 ‰ reached the head of the estuary. pH values remained above 8.00 and the Secchi depth was below 1 m. In summer and late fall, anoxia was observed near the bottom. Phosphates remained below 20 mg/m^3 but, in the fall, bottom-derived phosphates resulted in a mean water concentration of about 100 mg/m^3. Ammonia remained below 360 mg/m^3, while in July it reached 1300 mg/m^3. The annual maximum of Chl-a (86 mg/m^3) in August was two orders of magnitude higher than the annual minimum (0.6 mg/m^3 in January).

Key-words: brackish water, salinity, nutrients, stratification, Aegean Sea

Introduction

Information on general patterns of nutrient cycles and phytoplankton dynamics in estuaries is relatively limited mainly because of the great diversity of estuarine types (ranging from large deep fjords to shallow tidal creeks) and of the extreme complexity of estuaries that have unique circulation, complex bathymetry and large horizontal and vertical gradients of properties [1]. Vistonis Estuary protected by the Ramsar International Convention on Wetlands of International Importance is part of a wetland system extending over the coast of Thrace (N.E. part of Greece). With the exception of one preliminary study [2] and some subsequent publications by the author [3-7], no other publications exist which describe the physical factors and nutrient status of this estuary. In this work, the general framework dealing with the physical factors, nutrients and chlorophyll-a and their complex environmental gradients is presented in order to understand this type of aquatic ecosystem in the Mediterranean region.

The Environmental setting

Vistonis is a bar-built, shallow (3 to 4 m maximum depth) estuary with a surface area of 45 Km^2. The only outlet to the sea is about 60 m wide and 4 m deep (Fig.1). The catchment area covers about 1355 Km^2; the mountain zone encompasses about 75% of the total drainage basin, the remaining 25% being low hills or plains. The mean annual rainwater reaching Vistonis, mainly in its northern and eastern regions, is about 403x106 m^3, 97% of which originates in the mountain area. The Kompsatos river contributes more than half of the total inflow, while the Kossynthos river and other smaller creeks contribute about 40%. The estuary has a total water volume of about 75x106 m^3, and the mean annual hydraulic residence time is about 38 days in winter and 467 days in summer.

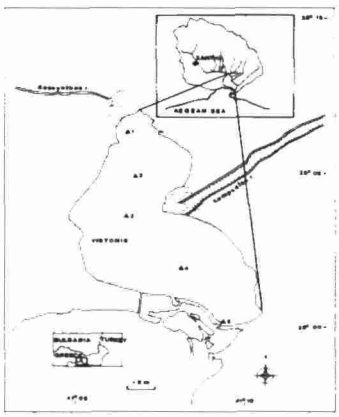

Figure 1: Vistonis estuary and catchment area. Triangle: sampling stations.

Materials and methods

During a one year period, samples were collected monthly from five sampling stations, with a Ruttner 0.5 l capacity sampler at 1 m intervals in the water column. Their distance from the mouth (Station 5) was 2.53 Km for St 4, 5.41 Km for St 3, 7.00 Km for St 2 and 8.76 Km for St 1 (Fig. 1). Temperature, salinity, dissolved oxygen, pH profiles and the Secchi depth were measured *in situ* with a YSI oxygen meter, a Hydrobios temperature-salinity bridge and a Consort pH meter. Samples were filtered through Millipore GF/F filters (nominal pore size μm) and the filters were immediately processed for Chlorophyll-a spectrophotometric determination [8]. The filtrates were transported in an ice chest to the laboratory where ammonia and phosphates were immediately determined [8, 9, 10].

Results

Mean monthly temperature ranged from 5.5°C in December to 26.1 °C in July. Vertical stratification of temperature was of minor importance. However, strong vertical, spatial and seasonal salinity differences were recorded due to a strong salinity gradient created by the intrusion of sea water (Figure 2). In January, a salinity wedge of over 2.0 ‰, almost reached the head at about 1 m depth creating over it a slight salinity gradient. In April, at the end of the wet season, almost holomictic conditions prevailed, while a well-mixed layer of only 0.9 ‰ remained near the mouth. In August, in the middle of the dry season, a salinity wedge of about 4.5 ‰ reached the head. However, vertical salinity differences away from the mouth were relatively small, since the shallow depth favored mixing of the layers. In October, salinity at the head reached the annual maximum (about 7 ‰). In October, the surface-to-bottom salinity differences from head to mouth were 0, 7.4, 8.2, 10.5, and 24.8 ‰, while the longitudinal salinity gradient at 3 m depth was 0.88 Km^{-1}.

In winter and spring the water column was well oxygenated down to the bottom (Fig. 3). In summer and late fall, however, the paucity of oxygen at the bottom created strong vertical gradients. In October, at the bottom of Stations 2 and 3, zero values of dissolved oxygen were recorded. Less than one mg/l oxygen values were also recorded at the bottom of station 3 in July, August and September.

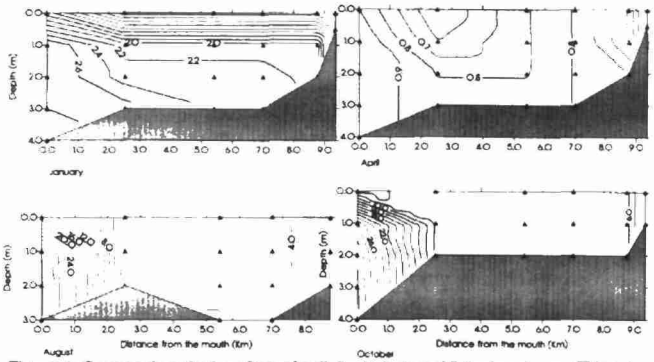

Figure 2: Seasonal vertical profiles of salinity (‰) along Vistonis estuary. (Triangle: Recorded values).

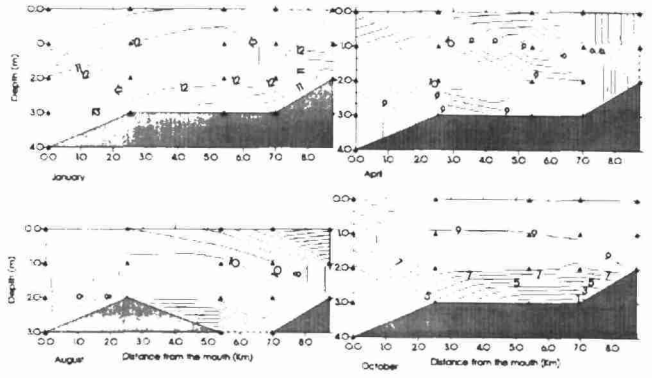

Figure 3: Seasonal vertical profiles of dissolved oxygen (mg/l) along Vistonis estuary. (Triangle: Recorded values).