LONG TERM CHANGES OF NUTRIENTS ENRICHMENT IN A GREEK ANOXIC MARINE BAY

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Abstract

This paper concerns the nutrient status and the oxygen conditions between two different periods, 1973-1976 and 1993-1996, in the Elefsis Bay, which is an anoxic basin in the Saronic Gulf. The development of a thermohaline circulation has significant implication for nutrient cycles and oxygen distribution in the bay. The relation between the long-term accumulation of nutrients and denintification for the periods 1973-1976, 1993-1996, are discussed.

Keywords: Nutrients, eutrophication, Greek anoxic bay.

Introduction

The Gulf of Elefsis (Fig. 1) is an almost enclosed body of water which is situated in the northern Saronikos Gulf. It is a small (67 km^2), shallow area (max. depth 33 m) joined to the rest of the Saronikos Gulf by two sills, 8 m minimum depth at the western end and 12 m minimum depth at the eastern end. It differs from the rest of the Saronikos Gulf not only in its morphology, but also in the extent to which it is polluted. Most of this pollution arises form the industrial complexes on its shores. It is also polluted by sewage from the main outfall through the east channel. The present study deals with long term nutrients enrichment over a long period of time (1973-1996).

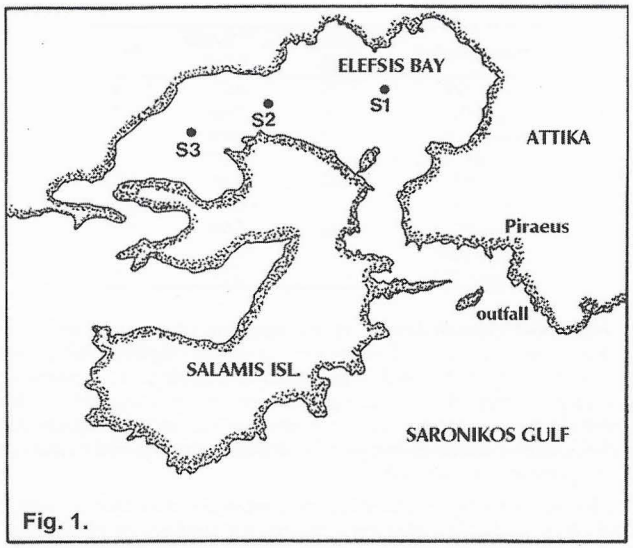

Fig. 1.

Materials and methods

The topographical setting and typical station locations are shown in Fig. 1. The sampling was performed seasonally during 1993-1996. Measurements of temperature, salinity dissolved oxygen and inorganic nutrients were performed by methods quoted by Friligos(1).

Results and discussion

Analysis of the data revealed that there was one general cycling of temperature over the year. Cooling of the upper layers reached a minimum in February-April, with temperatures of about 12-14 °C. Then water mass began warming up to maximum values of about 25 °C in August. The salinity range was 38-39 psu. The density lay within the range 26-29 σ_t and the pycnocline was related to the thermocline. During the winter the water in the Gulf was well mixed while, from May onwards, the gradual development of a thermocline led to the stratification of the water column and, in late September, there was a breakdown of the thermocline and vertical mixing of the water column.

In summer, temperature differences of 10 °C between sea surface and bottom resulted in the development of a strong stratification, which persisted for about 4 months and caused anoxic conditions below 20 m. High salinities develop in the summer as a result of evaporation and low temperatures occur during the winter as a result of the shallow maxium depth, 33 m.

The period of stratification was accompanied by deoxygenation of the water column below 20 m. The values of oxygen ranged between 1 and 7 ml/l in the water column at 0-20 m and 0.5 and 5 ml/l below 20 m. Anoxic conditions occurred below 20 m during the summer.

The values of silicate fluctuated from 1 to 10 μM down to 20 m. Below 20 m, the values were 1-45 μM. Silicate maxima occurred at the bottom of the water column at times of stratification and deoxygenation. The values of phosphate, down to a depth of 20 m, ranged from 0.1 to 0.5 μM. Below 20 m, the values were 0.30 – 3.00 μM. The highest values up to 3 μM occurred during anoxic conditions.

Increased values of nitrate of 0.5 – 2.5 μM were observed in the winter. Owing to the denitrification during the period July – October, the nitrate value fell below 0.5 μM. The values of nitrite were between 0.1 – 0.5 μM above 20 m and 0.5 – 1.0 μM below 20 m. The corresponding values of ammonia were 1 – 5 μM and 5 – 10 μM. It should be noticed that in summer with the occurrence of denitrification, nitrite exceeded nitrate. Higher ammonia values, as in the case of silicate and phosphate, occurred during anoxic conditions. The formation of ammonia and its subsequent oxidation to nitrate via nitrite proceeds throughout the winter. Also we found during this study (1993-1996), the tendency of the water of the Elefsis Bay to accumulate nutrients above the background level. The Elefsis Bay contained about three times more inorganic nitrogen than the background; this was mainly due to the ammonia, which was about five times more than the background value. Nitrate and nitrite also were two times, more than the background. Moreover, phosphate and silicate were respectively about five and four times more than the background.

Friligos(1) reported that the Elefsis Bay during the period 1973-1976 contained nine times more inorganic nitrogen than the background; this was mainly due to the ammonia which was about fifteen times more than the background value. Nitrates and nitrites also were respectively, seven and three times more than the background. However, the enrichment of phosphates and silicates were similar to the period 1993-1996.

Thus the denitrification was greater for the period 1993-1996 and the Elefsis bay worked as reductant biological treatment plant for the case of nitrogen.

References

1 - Friligos N., 1989. Nutrient and oxygen conditions in the Elefsis Bay, and intermittently anoxic Mediterranean basin. *Toxicol. and Environm. Chemistry*, 19:179-186.