Eutrophication and dystrophy in a coastal lagoon (Sacca di Goro, Po River Delta): role of macroalgae, organic detritus and sediment in nutrient cycling and oxygen budget

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The Po River Delta forms a number of naturally eutrophic embayments, where in recent years, increasingly serious summer dystrophic events have been occurring. Dystrophy appears to depend mainly on decomposition of large biomass of macroalgae, which in the last few years have had remarkable development in these embayments as well as in other coastal lagoons of the Northern Adriatic Sea.

This paper summarizes the main results of investigations carried out from 1989 to 1991 on some aspects of nitrogen and phosphorus cycles in the Sacca di Goro, a large eutrophic subtidal lagoon located in the southern part of the Po Delta. Three main goals were pursued:

1.- determination of hydrological and hydrochemical parameters;

2.- analysis of the seasonal succession of macroalgae and studies on production and respiration of both macroalgae and plankton community;

3.- determination of sediment oxygen demand, water-sediment nitrate reduction, and regeneration of ammonium and soluble reactive phosphorus from sediment cores.

The Sacca di Goro has an area of about 26 Km2 and an average depth of 1.5 m. The bottom is flat and the sediment is composed of typical alluvial mud with a high clay and silt content in the northern and central zones. Sand is more abundant near the southern shore-line, while sandy-mud prevails in the eastern area.

In the western and central areas a planktonic grazing-controlled food chain tends to prevail, but, on the whole, the seasonal evolution of the lagoon trophic state depends primarily upon presence and succession of the benthic nitrophilous macroalgae *Ulva rigida* and *Gracilaria verrucosa*.

Seasonal variations of nutrient concentration have shown marked potentially N-limiting conditions, chiefly during spring, and summer. Dissolved inorganic nitrogen (DIN) has shown wide seasonal fluctuations with high winter concentrations and extended summer depletion. DIN concentrations have been also found to be closely related to the nitrogen content in the *Ulva* thalli.

This situation seems to favour metabolic pathways that lead the system to conditions in which nitrogen-limitation plays an increasingly important role because of the appearance of nitrogen-accumulating algae (HOWARTH, 1988). In fact, *Ulva* and *Gracilaria* seem to be able to store available nitrogen and use it to support their growth when DIN depletes (FUJITA *et al.*, 1989). Competition for DIN seems to be the main mechanism causing phytoplankton depression, since macroalgae show high affinity for nitrogen. Furthermore, shallowness of water and the high amounts of organic matter determine time-space alternation of anaerobic and aerobic conditions due to intense primary production and decomposition processes and turbulence induced by wind or tide currents. Fluctuations in redox conditions appear to favour nitrogen transformation and loss through sequential nitrification-denitrification processes. This seems to contribute to summer nitrogen depletion, enhancing the role of nitrogen as limiting factor.

Oxygen budget data evidence a spring period characterized by oxygen overproduction due to the macroalgal growth. During the summer oxygen consumption prevails causing an accentuated deficit and a widespread anoxic crisis.

The spring phase of massive accumulation of organic detritus followed by a rapid phase involving decomposition and release of inorganic nutrients determines the breakdown of nutrient cycles. Under these conditions the cycling of materials is controlled by an extremely shortened trophic network comprising macroalgae and the associated microbiota.

The processes taking place in the top sediment layer play a central role. On one hand there is a notable release of inorganic nutrients (ammonium nitrogen, orthophosphate phosphorus). Yet, anaerobic microbial processes become more significant, bringing about considerable nitrate losses due to nitrate reduction and denitrification.

The system migth be described with good approximation by a model including a spring phase dominated by assimilation processes, and a summer phase dominated by decomposition, dissimilation and nutrient release.

The succession of such phases tends to strengthen the importance of nitrogen as a limiting factor and the metabolic role of nitrophilous algal communities and the microbial loop associated with them. This dynamics could constitute a self-enhancing loop for the system.

Consequently the lagoon becomes increasingly more unstable and episodes of collapse of its trophic equilibrium could become increasingly harsh.

REFERENCES

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