LONG-TERM INVESTIGATIONS IN MEROMICTIC SEAWATER LAKE (ROGOZNICA LAKE, EASTERN ADRIATIC COAST)

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Abstract

Since 1994 seasonal variations of temperature, salinity and vertical distribution of dissolved oxygen, nutrients, dissolved organic carbon, surface-active substances, reduced sulfur species, phyto- and zooplankton have been investigated in water column of the Rogoznica Lake. During the thermohaline stratification (spring, summer) the surface water is well-oxygenated while anoxia is occurring in the bottom layer. As a result of autumn or winter mixing, bottom water enriched with nutrients is coming to the surface supporting new phytoplankton and oxygen productions. Turnover of Lake water layers in September 1997 occurred so quickly that it resulted in the appearance of total anoxia and sulfide presence throughout the water column. The aerobic flora and fauna died and added to the oxygen demand and production of nutrients. Special conditions leading to and following after the disastrous anoxia are illustrated and discussed.

Keywords: seawater lake, eutrophication, anoxia, reduced sulfur species, nutrients

Lakes are natural laboratories in which biogeochemical processes can be effectively studied. They are much quicker to respond to environmental pressures than ocean basins, and because of their smaller size of the reservoirs, the biogeochemical signals of such perturbations are amplified. In many lakes due to their topographic and hydrographic conditions anoxia could exist in the bottom layer seasonaly or permanently (1). Oxygen or the lack thereof is the driving force for many processes in lakes. It governs aqueous chemistry via oxidation and reduction processes, and it contributes to biological diversity and abundance by creating different habitats. Many lakes with anoxic hypolimnia are eutrophic.

Besides stratification in temperature and salinity many lakes with anoxic deep waters are chemically stratified. Meromixis is a condition of persistent chemical stratification with incomplete mixing over the course of a year: it usually results in anoxia and the accumulation of nutrients in permanently stagnant layer and reduced vertical mixing (2).

Rogoznica Lake is a typical example of meromictic saline lake. The lake is a small (15 m deep), naturally intensely eutrophicated and intermittently anoxic, karstic, seawater lake situated on the eastern coast of the Adriatic Sea, Croatia (43°32'N 15°58'E) (3, 4). During the thermohaline stratification the surface water is well oxygenated (oxygen saturation up to 300%), while hypoxia/anoxia occurs in the bottom layer (5, 6). Anoxic deep water (below 10 m) is characterized by high concentrations of reduced sulfur compounds (6), iodine species (5) and nutrients (7), as well as dissolved organic carbon (8) indicating the pronounced remineralization of organic matter in this water layer. The oxic-anoxic water layer boundary in Rogoznica Lake is characterized by a strong chemocline where usually up to 50 cm thick, pinky coloured water layer due to the presence of very dense populations of purple sulphur bacteria exist.

In September 1997 total anoxia occurred in the Rogoznica Lake, with hydrogen sulfide present in the entire water column, followed by massive death of planktonic and benthic organisms (7). Due to the decomposition of dead organisms, concentrations of nutritious salts tremendously increased along the entire water column and were maintained in the lake several months after disastrous anoxia, which points out to very complex and slow lake regeneration processes. Due to the extreme ecological conditions which prevail in this lake, phyto- and zooplankton populations are represented by a relatively small number of species, some of them, however in denser population from the surrounding sea. After the period of total anoxia, the number of species and their abundance were significantly reduced in comparison with the pre-anoxia values.

Since 1994 seasonal variations of temperature, salinity as well as vertical distribution of dissolved oxygen, nutrients, dissolved organic carbon, surface-active substances, reduced sulfur species, phytoplankton and zoo-plankton have been investigated in water column of the Rogoznica Lake. The aim of this paper is to present the importance of long-term investigations in studying eutrophication processes in the Rogoznica Lake. Special attention was paid to the conditions leading to and following after the disastrous anoxia.

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