Long-term monitoring of organic matter in an eutrophic marine lake that fluctuates between stratified and holomictic euxinic conditions

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The karstic, stratified marine lake (Lake Rogoznica, RL) on the eastern Adriatic coast (43°32'N, 15°58'E) is a unique environment. It oscillates between a stratified water column with euxinic conditions below the chemocline and a holomictic euxinic water column under certain physicochemical conditions (1). Given the specific physicochemical, microbiological, and biochemical properties of the water column, the lake proves to be an ideal test site to track environmental changes indicative of climate change. Climate change will further increase water column temperature and enhance deoxygenation in the epilimnion while promoting the accumulation of toxic sulphide, ammonium in the hypolimnion, and organic matter (OM) throughout the water column (2). Since the early 1990s, when exploration of the lake began, the volume of the anoxic water has increased several times. The stronger stratification has led to an enrichment of dissolved organic matter (DOC) in the euxinic hypolimnion due to the anoxic conditions, while the concentration of DOC in the oxic epilimnion (0-8 m depth) decreases. At the same time, the concentration of the most reactive DOC fraction (surface active substances- SAS) (3) increases in the upper layer, while a decreasing trend in SAS is observed below 8 m depth. In addition, there is evidence of accumulation of particulate organic matter (POC) in the water column and an increase in the fraction of POC in total organic carbon (TOC).

In RL, vertical mixing events occur in early fall that can end with holomictic conditions that affect lake biogeochemistry (4), including organic matter properties and dynamics. Over the past 30 years, these events are becoming more frequent and intense. Each holomictic event is associated with a subsequent high production of POC and a change in composition DOC. On a long-term scale (1992-2021), this study presents a unique time series of organic matter content (DOC, POC, SAS) showing a noticeable change in its quantity and quality within the RL water column as an indication of the pronounced eutrophication escalated by global change.

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