BIOGEOCHEMICAL CYCLING AND MULTILAYER PRODUCTION IN THE BLACK SEA

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Abstract
In the present study, the photo- and chemoautotrophic organic carbon productions have been determined in the Black Sea multilayer system for 1998-2001 period. Relative importance of NO_3, NO_2 and NH_4 uptakes on the new production were estimated using ^{15}N isotope technique. Carbon and nitrogen natural isotopic ratios ($\delta^{15}N$, $\delta^{13}C$) of suspended particulate organic matter (SPOM) were determined to trace the productivity in the euphotic zone, bacterial decomposition in the oxycline, chemoauto- and heterotrophic activities in the suboxic and anoxic layers.
Keywords : Black Sea, Primary Production, Geochemistry.

The Black Sea is a unique marine environment representing the largest land-locked/semi-enclosed and deep anoxic basin in the world. The coastal waters of the Black Sea are principally fed by the rivers and by the lateral/vertical nutrient transport mechanisms including sediment coupling. In the open ecosystem, which is dominated by the cyclonic eddies, primary production is mainly sustained by the influx of nutrients from the oxic/suboxic lower layers mainly by vertical mixing processes. However, the input from the anoxic layer is limited due to the presence of a permanent pycnocline in the Black Sea which coincides with the oxic-anoxic transition zone. Intense denitrification, redox-dependent processes within this zone also limit nitrogen and phosphorus input to the productive layer (Fig. 1).

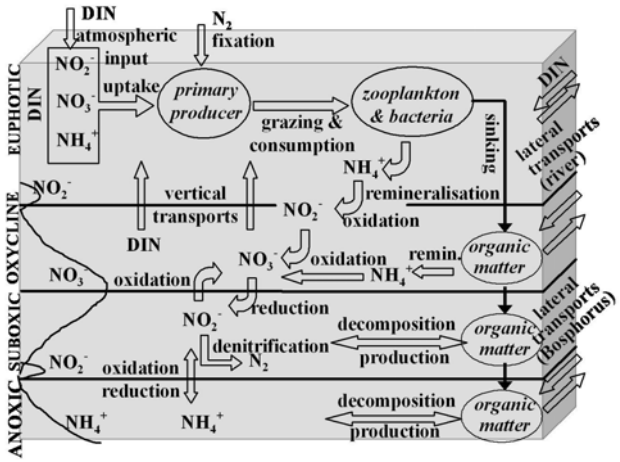

Fig. 1. Conceptional model of the biogeochemistry in Black Sea multilayer system.

Integrated photoautotrophic production rates ranged from 112 and 640 mg C $m^{-2}d^{-1}$ in the study period.The lowest values were determined in the central gyre and the highest values were found at the shelf break station near the Bosporus, the NW shelf/shelf break area. Bioassay experiments showed that under optimum light conditions, photoautotrophic production was nitrogen limited [1, 2]. Planktonic nitrogen productivity and relative importance of NO_3, NO_2 and NH_4 on productivity in the Black Sea were estimated using ^{15}N isotopic technique. Though the main nitrogen source utilised by phytoplankton was NH_4, annual f-ratio was estimated as high as 0.3-0.5.

Multilayer systems having anoxia support multiple layers of biological production. In addition to photosynthetic production at the surface layer, microbial communities at the oxic-anoxic interface live on the residual chemical energy originate from anoxic waters. Present data showed that, chemo-autotrophic production at O_2-H_2S interface is relatively high in the Black Sea and it is potential mid-water source of sedimentary biogenic particles for the basin related to the microbial activities and red-ox processes. Chemoautotrophic production increased in the redox transition zone and coincided with the lower boundary of the fine particle layer. The maximum values were shallower (at 16.25 Sigma-theta) in the central gyre and deeper (at 16.5 Sigma-theta) in the shelf break region near Sakarya Canyon. Integrated chemoautotrophic production rates were 63 and 1930 mg C $m^{-2}d^{-1}$ which were equivalent to 30 and 89 % of the overall water column production for the central gyre and Sakarya Canyon regions, respectively. Lateral transport of Mediterranean origin oxygenated waters from the continental slope possibly enhanced the chemoautotrphic production in the canyon region. Indeed, the organic carbon produced at midwater depths exceeded the surface photo-autotrophic production and this made quantitative contribution to sinking particles [2].

Carbon and nitrogen natural isotopic ratios ($\delta^{15}N$ and $\delta^{13}C$) of suspended particulate organic matter (SPOM) produced in the water column of the Black Sea were also determined in the Black Sea. The results revealed important vertical and regional variations in terms of isotopic composition while the seasonality was less remarkable. SPOM of each layer possessed distinct isotopic composition associated with microbial decomposition and formation of organic matter [3]. C and N isotopic composition of Black Sea SPOM collected revealed that planktonic production and rapid recycling in the nutrient-poor surface layers. Old and partially decomposed fragments of SPOM are dominated in the oxycline. Intense microbial activity was observed in the suboxic/anoxic transition layer of especially coastal regions where there is partial aeration by Mediterranean waters (Fig. 1).

References

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