ECOLOGICAL MONITORING IN THE MONTENEGRIN COASTAL SEA

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Abstract

Investigations of the sea-water quality and the level of eutrophication in the Montenegrin coastal sea have been continued in 1999-2002 period. The increasing values of some parameters (indicators of eutrophication) as oxygen saturation at the surface and the microphytoplankton density have been established. The highest eutrophication was found in the inner and middle parts of the Boka Kotorska Bay, and in the Bojana river mouth. Sanitary quality of the sea was satisfying, yet. About 20% of the beaches in the Bay, and about 52% outside the Bay were the first category – up to 500 TC/100 ml of the sea-water.

Keywords: sea-water eutrophication, sanitary quality

Having in mind the importance of the Montenegrin coastal sea for tourism and all activities connected with it, the control of the marine environment and plankton community has been continued after 1998 (1) throughout next four years period. The main intentions were: to estimate the possible changes caused by eutrophication and to follow the sanitary quality of the sea. So, the material was taken at same 28 localities in the inner (Kotor Bay), middle (Tivat Bay) and outer part (Herceg Novi Bay) of the Boka Kotorska Bay, 26 outside the Bay and one at the Bojana river mouth. Standard methodology was used as before.

Although about 20 physical, chemical and biological characteristics have been investigated, only some of them would be presented here, owing to their importance for classification of the eutrophic level or sanitary quality of the sea water.

From physical characteristics, only transparency and sea-water color will be described here.

Transparency varied significantly in comparison with the previous results. It decreased along (near) the coast very often, at about 30% of the beaches in the Bay and at about 18% of the positions outside the Bay – including the Bojana river mouth. Such decreasing was caused by anthropogenic eutrophication as the consequence of yet unsolved system of waste- waters discharges and their direct impact to the shallowest coastal sea (2).

Sea-water color was changed in Kotor and Tivat Bays predominantly, to yellowish (XI-XII, XIII-XIV, XV-XVI) or even brownish (XVII-XVIII, XIX-XX, XXI) according to Forell- Uhle scale. So, the recent results affirmed that the color of the sea-water was changed occasionally, or usually at some positions in the Boka Kotorska Bay. Outside the Bay, changes were found rarely , because of direct exposition of this area to stronger influence of unpolluted oligotrophic waters of the open South Adriatic. The exception was locality at the Bojana river mouth, as freshwater impact and a lot of organic matter caused changed color to yellowish and brownish very often (3).

From chemical characteristics, oxygen saturation was measured between all others. At the whole area of the Montenegrin coastal sea, values increased at the surface, related to the higher phytoplankton production. So, mean values from the recent investigations (149-155.4%), were similar to the maximum values from 1995-1998 period. Such high values are characteristic of eutrophic and extremely eutrophic areas. (4).

Eutrophication was visible even more clearly throughout some biological parameters: composition and biomass of microphytoplankton, and heterotrophic bacteria. So, in the preceding period, microphytoplankton biomass increased to maximum values of 4.4 x 10^6 cells dm^{-3} and even 10^7 cells dm^{-3} or more, in the Kotor Bay (throughout summer, especially). Outside the Bay, up to 10^5 cells dm^{-3} were found, with the exception of the Bojana river mouth, where 8 x 10^5 cells dm^{-3} were established. Maximum values were always presented during summer everywhere, although usual spring and autumn maxima have been existed, yet (5). Dominant species were: *Chaetoceros affinis*, *Sceletonema costatum*, *Nitzschia seriata*, *Nitzschia delicatissima*, *Leptocylindrus danicus*, and eleven other species, indicator of eutrophic coastal sea. Their number was the highest in the Boka Kotorska Bay, and decreased outside the Bay to seven or eight species. Sometimes (in summer, too) *Sceletonema costatum* appeared in the Kotor Bay with maximum percentage of 55.5% among all other microphytoplankton species, while *Nitzschia delicatissima* was presented with 25.5% of the whole microphytoplankton density, simultaneously (6). In the area outside the Bay the percentage of above mentioned species decreased as their density, too. Nevertheless, throughout summer 2001, even in this part of the Montenegrin coastal sea microphytoplankton density was high enough to overtake values of eutrophic regions.

The density of heterotrophic bacteria varied in four years period to maximum values of 10^4/ml of the sea-water in the Boka Kotorska Bay, and 2.1 x 10^4/ml in the Bojana river mouth. In the area outside the Bay, values were between 10^2 and 1.9 x 10^3/ml of the sea-water. All these values are typical for eutrophic areas.

The recent investigations of the sanitary quality (bacterial pollution) of the coastal sea have been performed at the same well known beaches of the Montenegrin coast as before. From 28 localities in the Boka Kotorska Bay, the first category of the sea-water quality (up to 500 total coliforms/100 ml of the sea and up to 100 faecal coliforms/100 ml of the sea) was found at 20% of them (7). Second category (up to 10000 total coliforms/100 ml of the sea and up to 2000 faecal coliforms/100 ml of the sea) was found at about 72% of investigated positions. From time to time 8% of them exceeded allowed criteria. Some parts of the Bay (Kotor and Risan Bays in the inner area) were polluted more (7) and control would be continue with special attention to this fact. Outside the Bay, at about 52% of the beaches the first category was found, at 42% of them the second category was presented, and 6% of them exceeded mentioned criteria.

Conclusion

So, we can conclude that progressive eutrophication was found in the Montenegrin coastal sea throughout 1999-2002 period. Sanitary quality of the sea was satisfying, yet.

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