Bulgarian Journal of Agricultural Science, 21 (Supplement 1) 2015, 86–89
Agricultural Academy

EUTROPHICATION OF VARNA BAY AND COASTAL WATERS

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Abstract

KLISAROVA, D. and D. GERDZHIKOV, 2015. Eutrophication of Varna Bay and coastal waters. *Bulg. J. Agric. Sci.,* Supplement 1, 21: 86–89

The aim of the article is a study of the current state and growth of phytoplankton in the Bulgarian coastal waters and in the so-called „hot spots" (Varna Bay) (2008–2010). The established average phytoplankton biomass in the coastal waters was 1.20 g/m^3. Declining trend of average annual biomass and numbers from 2008 to 2010 was registered. Spring and autumn peaks typical for the post-eutrophication period were observed during the study.

Key words: Black Sea coast, post-eutrophication period, phytoplankton, numbers, biomass

Introduction

Phytoplankton constitutes an elementary component in aquatic ecosystems. Representing the base of the pyramid of productivity, the understanding and modeling of the aquatic ecosystem is not possible without knowledge of productivity and biomass of phytoplankton (Olenina et al., 2006).

The main aim of the study is to establish the influence of the anthropogenic factors on the current state and growth of phytoplankton in the Bulgarian coastal waters.

Materials and Methods

The study was carried out within the period 2008 – 2010 in the Bulgarian coastal aquatory. The scientific expeditions were conducted on board the R/V Prof. Al. Valkanov. 389 phytoplankton samples were collected from 71 stations at standard horizons (0, 10, 25, 50, 75 and 100 m) by bathometers type Niskin-5L or in shallow water (up to 15 m depth) at surface – bottom horizons. The samples were fixed onboard the ship in 2% formalin solution and concentrated by the sedimentary method (Morozova-Vodyanitskaya, 1954). The qualitative and quantitative analyses of the samples were performed with a light microscope Nikon E400 in counting cells *Sedgewick Rafter* – 1 ml and *Palmer – Maloney* – 0.05 ml, using standard methods (Moncheva and Parr, 2010). The cell volume was calculated by geometric formulas (Edler, 1979). Software Phytomar 2.0 (IFR – Varna 2008) and Excel 12 (Microsoft Office 2007) were used for calculations and graphs.

Results and Discussion

The analysis of the obtained in coastal waters (2008–2010) phytoplankton quantitative data (abundance and biomass) and parameters (index of Shannon-Weaver and transparency of water body) showed that the annual growth of phytoplankton was subjected to the influence of natural abiotic environmental factors .

During that period were exhibited the typical for the physico-chemical conditions of the temperate latitudes (Bulgarian coast) spring (May) and autumn (October, November) maxima in phytoplankton development (Angelov, 1971; Petrova – Karadjova, 1973; Raymont, 1980; Moncheva, 1991; Uzunov and Kovachev, 2002; Owen, 2014) (Figures 1 and 2).

In past years in the Bulgarian coastal waters was observed annual phytoplankton growth with high summer or

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autumn maxima caused by the impact of the anthropogenic pressure. High values were registered in summer and autumn in the Bay of Sozopol (2004–2005) (Mavrodieva, 2012). For the water area of Varna Bay summer maxima were often reported in the 90s (Petrova et al., 2006).

The observed relatively high values of biomass in July indicated a possible impact of anthropogenic factors (Sukhanova, et al., 1988; Moncheva, and Krastev, 1997; Velikova et al., 1999). The high concentrations of peridines are assumed as an indicator of an active process of eutrophication. In this study the summer development of large diatoms (*Proboscia alata* up to 98%) can not be accepted as an unequivocal sign of eutrophication or developmental disorders (Black Sea, 1978, Petrova – Karadzhova, 1984; Velikova et al., 1999; Stelmakh et al., 2009).

The average values of the index of Shannon-Weaver characterizing the structural organization of phytoplankton community demonstrated limits from "very good" to "good" ecological status (according to the criteria developed in Uzunov et al., 2005), mainly seen as "very good" condition (Figure 1).

The average values of water transparency (measured with white disc after Sekki, m) varied from „very poor" to „very good" ecological status (in SG. 22, 2013). A positive feature was the definition of „very good" ecological status according to that parameter in 7 out of 10 months of the hydrobiological year (Figure 1).

The average monthly values of water transparency and measured quantities of phytoplankton were in reciprocal correlative dependence, well expressed in May and November (Figure 1).

In 2009 a deviation was registered from the normal annual cycle of phytoplankton growth and the presence of another summer maximum in the development of phytoplankton biomass (in July 2009) and development of a late-summer, not autumn maximum of abundance (September 2009) (Figure 2). The summer peak was caused by the massive development of large diatom species *Proboscia alata*, a phenomenon observed also during the reference period (1954–1970) (Petrova, 1965; Petrova – Karadzhova, 1973).

The main trend for the period 2008–2010 was reducion of the phytoplankton quantitative values, better expressed in the number (Figure 2). In the transparency of water that

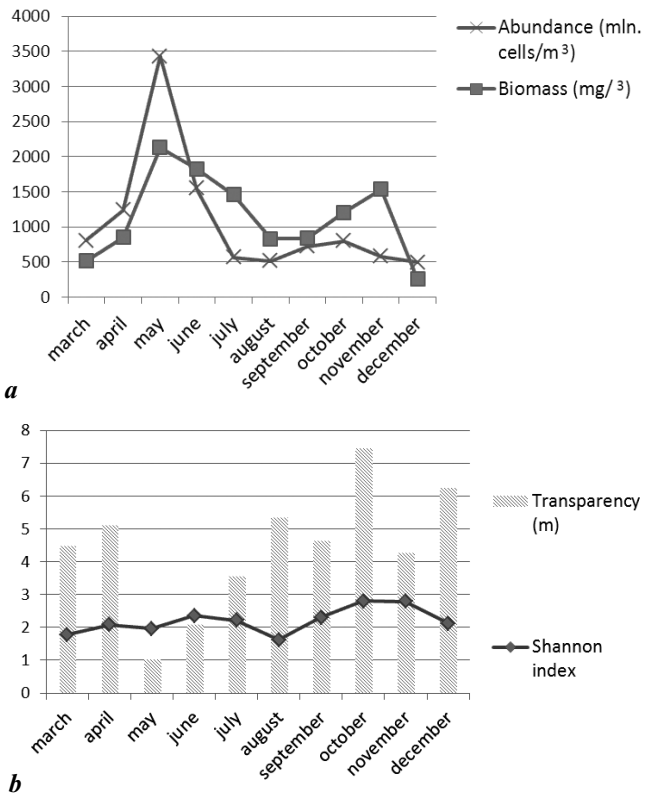

Fig. 1. Summarized for the period studied average monthly values of *a*) phytoplankton number (x10^6 cells/m^3) and biomass (mg/m^3); *b*) index of Shannon-Weaver and transparency (m) in the Bulgarian coastal waters (2008–2010)

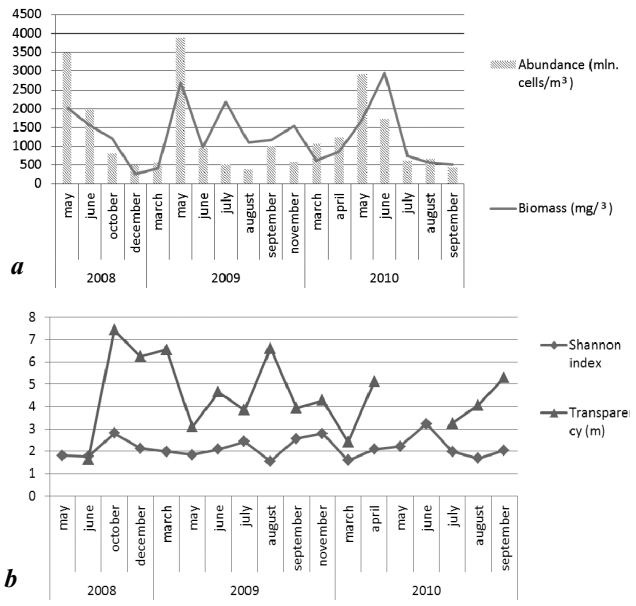

Fig. 2. Chronological monthly dynamics of established values of *a*) phytoplankton number (x10^6 cells/m^3/m^3) and biomass (mg/m^3); *b*) index of Shannon-Weaver and transparency (m) in the Bulgarian coastal waters during the period 2008–2010

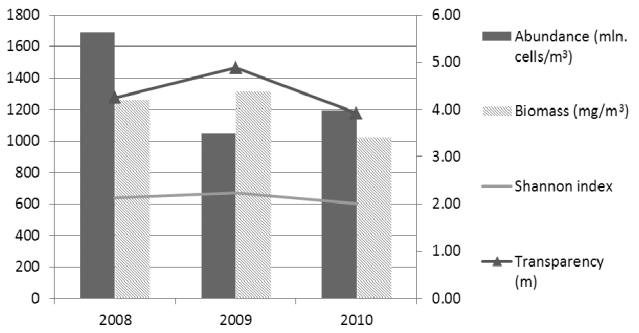

Fig. 3. Dynamics of phytoplankton number (x10^6 cells/m^3), biomass (mg/m^3), index of Shannon-Weaver and transparency (m) in the Bulgarian coastal waters (2008–2010)

is dependent on the amount of dissolved substances in water and suspended particles and organisms (Uzunov and Kovatchev, 2002), tends to decrease from 2008 to 2010 were also registered.

The index of Shannon-Weaver, characterizing the stability of the phytoplankton community showed a positive trend (Figure 2). As regularity in its annual dynamics (2008–2010) were the higher values in autumn and lower values during winter-spring period when blooms occurred.

The average number of phytoplankton in the period 2008 – 2010 was 1310.39 x 10^6 cells/m^3. A tendency for its reduction was registered: (1688.11 (08‘) – 1048.42 (09‘) – 1194.63 (10‘) x10^6 cells/m^3) (Figure 3).

The average phytoplankton biomass for the period 2008 – 2010 was 1196.72 mg/m^3. The value was close and even lower than the observed biomass of phytoplankton during the “reference” period of the development of the Black Sea ecosystem (Petrova, 1965; Petrova-Karadzhova, 1973).

Phytoplankton biomasses decreased from 2008 toward 2010: (1258.20 (08‘) – 1312.41 (09‘) – 1019.55 (10‘) mg/m^3) (Figure 3). A continuing trend was established for reduction of phytoplankton biomasses in the Bulgarian coastal waters compared to the period 2003–2007 (1260 mg/m^3) (Petrova and Gerdzhikov, 2008).

Conclusions

During the period 2008-2010 in the Bulgarian coastal waters were observed typical of temperate latitudes spring and autumn peaks in the quantitative dynamics of phytoplankton communities.

The average values of the index of Shannon-Weaver ranged from “very good” to “good” ecological status. The trend in this index was to increase from 2008 toward 2010.

A downward trend was registered in the average annual phytoplankton biomasses and numbers from 2008 toward 2010. The established values were close to ones found in the “reference” period of development of the Black Sea ecosystem (50s and 60s of the 20thh century).

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