Plankton structure in Musura Bay (Danube – Black Sea system) in the conditions of year 2005

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Keywords: plankton, diversity, density, biomass, destruction

Introduction

Located at the confluence of Kylia and Sulina branches with the Black Sea, Musura Bay is characterized by a very rapid evolution. In the middle of 19th century, it presented a wide opening towards the sea (13 km) and depths more than 12 m, providing to the aquatic biocenoses the same abiotic conditions as in the maritime area (BURGHELE, 1946). The rapid progression of the secondary delta of Kylia branch at the northern part of the bay and the channel built at the mouth of Sulina branch (9 km length) determined the decrease of the opening size with more than 5 km, while the depths decreased below 2 m (in 2005). Besides this, the maritime sandbank formed in the last decades at the bay's mouth contributed to the transformation of the bay in a lagoon. The shallow water and the progressive decrease of salinity favored the shift of maritime biocenoses to the freshwater type (ENACEANU, 1955, BACESCU & DUMITRESCU, 1958, TEODORESCU & ZINEVICI, 1995). The dynamics of this process was even more obvious in the conditions of 2005 year when, due to the significant increase of Danube flow, the salinity decreased below 0.2 g/l, value comparable with the ones of Danube Delta freshwater lakes.

The aim of this study was to compare the actual status of the ecological evolution of Musura Bay with the previous investigations and to study the shift of the aquatic communities towards the freshwater type.

Material and methods

The researches undertaken in 2005 represent the initial phase of a 3 years project which will investigate the structure and functions of main types of aquatic organisms as well as the physico-chemical factors with an essential role in their dynamics. This paper presents the data regarding the plankton communities and water chemical characteristics in the specific conditions of the year 2005.

The samples have been taken from 5 stations, in May, July and October 2005, on water column, as follows: the water and phytoplankton samples with a Patalas-Schindler device; 50 l of water were filtered through a plankton net (60 μm mesh size) for zooplankton samples; 100 ml of fresh water were filtered through a 0.2 μm cellulose nitrate filter for microbial biomass. The plankton samples were preserved with formaldehyde to 4% final concentration.

Depth, transparency, temperature, pH, total dissolved solids (TDS), conductivity were measured in the field. Dissolved oxygen analyses were performed according to Winkler's method. Samples for chemical analyses were frozen for further analyses in the laboratory. Nutrients were determined spectrophotometrically: NH_4^+- as yellow compound with Nessler reagent, NO_2^-- as red compound with sulphanilic acid and α-napthylamine, NO_3^-- as yellow compound with sodium salycilate (TARTARI & MOSELLO, 1997), total reactive phosphorus (TRP) - as blue phosphomolibdate, reduced by ascorbic acid, TP – by oxidation with potassium peroxodisulphate (TARTARI & MOSELLO, 1997); the organic matter content was estimated from the chemical oxygen demand determined by oxidation with $K_2Cr_2O_7$ (GOLTERMAN, 1969).

The phytoplankton samples were analysed in the laboratory, using a Zeiss microscope. The quantitative analysis of phytoplankton was accomplished according to UTERMÖHL (1958): after the sedimentation of plankton and removal of supernatant water, the cells were counted in a Kolkwitz-chamber. Phytoplankton biomass was calculated by multiplying the mean volume of each species with the number of cells for that species, on different size classes.

The zooplankton samples were analysed in the lab, using an inverted microscope and a binocular. The determination of species composition and density was made by direct counting; for biomass calculation, organisms dry weight was considered according to DUMONT (1975) and ODERMATT (1970). The results were expressed in milligrams wet weight according to the WINBERG (1971) ratio (dry wt. represents 10% of wet wt.).

For microbial biomass estimation, the phosphate from phospholipids was determined (WHITE, 1979); the microbial oxygen consumption was determined for estimation of aerobic decomposing rate (NICOLESCU, 1991).

Results and discussion

In the specific conditions of 2005, the salinity (measured as TDS) was very low, the average value ranging around 0.18 g/l, characteristic for freshwater ecosystems. The transparency index (T/D) was characterized by low values as a consequence of the high Danube flow and the increased amount of fine sediments carried by the river (Table 1).

Table 1 Water physico – chemical characteristics of Musura Bay in 2005 year

Parameter	May	July	October	Xa
Depth (m)	1.64	1.56	1.66	1.62
Transparency (m)	0.74	0.38	0.36	0.49
Index of transparency (T/D)	0.47	0.25	0.23	0.32
Temperature [°C]	25.2	27.1	20.5	24.3
pH	7.92	8.38	7.92	8.07
Conductivity [$\mu S\ cm^{-2}$]	350	350	410	370
Total dissolved solids TDS (g/l)	0.18	0.17	0.2	0.18
[O_2] [$mg\ L^{-1}$]	8.19	8.36	7.88	8.14
[O_2] [%]	92.7	104.3	88.3	95.1
Total organic matter [$mg\ C\ L^{-1}$]	16.1	6	9	10.37
Dissolved inorganic nitrogen DIN [$mg\ L^{-1}$]	1.69	0.70	0.693	1.030
Total reactive phosphorus TRP[$\mu g\ L^{-1}$]	51.4	99.4	82.8	77.9
DIN/TRP	32.9	7	8.37	13.2

The annual average values of mineral nitrogen content (1.03 mgN/l) and total phosphorus (78 µgP/l) placed the bay in the category of mesotroph – eutrophic type of aquatic ecosystems; the average value of DIN/TRP ratio shows P as a potential limiting nutrient of primary producers growth (Table 1). Though in summer and autumn, it might shift towards a nitrogen limitation (the ratio was decreasing below 10). The organic matter amount in the water column was also low due to the diluting effect of high Danube water input.

The phytoplankton diversity shows higher values (152 species) than the ones recorded for some of the Danube Delta freshwater lakes (e.g. for Erenciuc and Gorgostel lakes there were recorded 83 – 143 species between 2002 –2003). The main difference appeared in species spectra: while for most of the lakes, due to the more advanced trophic state, the dominant group is *Cyanobacteria*, here the dominant groups were *Bacillariophyceae* (42%) and *Chlorophyceae* (23%) (Table 2).

In an inverse relationship with the specific diversity, phytoplankton abundance and biomass were rather low (Table 2). The annual average of abundance (758,000 ind/l) was 2-6 lower than the one recorded for Erenciuc lake; though in summer phytoplankton blooms occurred, the annual average of biomass was below the “blooming level” (OLTEAN, 1985) of 5mg/l,

characteristic for mesotrophic ecosystems. The *Bacillariophyceae* group recorded the highest abundance (53%) (the dominant species being *Anabaena spiroides, Chlamydomonas vulgaris, Cocconeis chaetocerus*), while from biomass viewpoint, the dominant groups were *Bacillariophyceae* and *Cyanobacteria* (with 31 % each; dominant species: *Anabaena spiroides*, *Pandorina morum*, *Phacus acuminatus*).

Table 2: Taxonomical structure (%), numerical density (%) and biomass (%) of the phytoplankton community of Musura Bay in 2005 year
Xa=annual average

Taxonomical group	May	July	October	Xa
Species				
Cyanobacteria	7.32	18.00	10.60	15.80
Euglenophyceae	8.54	16.20	10.60	13.20
Pyrrhophyceae	2.44	4.50	5.32	3.95
Chrysophyceae	1.22	1.80	1.06	1.32
Xanthophyceae	1.22	1.80	2.13	1.32
Bacillariophyceae	54.90	33.30	50.00	42.10
Chlorophyceae	24.40	24.30	20.20	22.40
Total (species number)	82	111	94	152
Numerical density				
Cyanobacteria	9.06	18.6	8.29	14.9
Euglenophyceae	3.02	11.1	5.8	8.44
Pyrrhophyceae	4.72	1.23	2.76	2.24
Chrysophyceae	1.51	0.29	4.42	0.92
Xanthophyceae	0.38	0.43	8.01	1.58
Bacillariophyceae	53.8	52.7	54.4	53.4
Chlorophyceae	27.6	15.6	16.30	18.50
Total (10^3 ind/l)	530	1384	362	758
Biomass				
Cyanobacteria	13.90	39.80	8.30	31.50
Euglenophyceae	10.9	19.80	11.20	17.40
Pyrrhophyceae	4.42	0.71	2.25	1.37
Chrysophyceae	0.92	0.02	1.07	0.31
Xanthophyceae	1.17	0.79	18.00	3.84
Bacillariophyceae	50.60	22.90	54.00	31.30
Chlorophyceae	18.11	16.00	5.08	14.30
Total (mg w.w/l)	1.198	8.329	2.047	3.858

The zooplankton diversity is rather low (82 species), as well as annual averages of abundance (172 ind/l) and biomass (979 μg w.w/l) (Table 3). These values are lower than the one recorded previously for freshwater lakes (e.g. in 2002, in Gorgostel lake, the diversity was 1.6 times higher, while the abundance and biomass were 6.5, respectively 4.9 higher). For the primary consumers, the specific diversity and the abundance show the dominance of rotifers (60.8%, respectively 68.24%), while the biomass is dominated by cladocerans (75.38%). Dominant species from abundance viewpoint were *Synchaeta oblonga, Dreissens polymorpha* larvae and *Brachinus calyciflorus amuraeriformis*, while biomass was dominanted by *Synchaeta oblonga, Moina micrura* and *Diaphanosoma orghidani.*

For the secondary consumers, copepods are dominant for specific diversity (62.5%), rotifers for abundance (68.75%) and cladocerans for biomass (40.9%) (Table 3). Dominant species were *Acanthocyclops vernalis, Asplanchna priodonta* and copepodits IV-V of Cyclopidae g.sp., both as abundance and as biomass.

Table 3: Taxonomical structure (%), numerical density (%) and biomass (%) of the zooplankton community of Musura Bay in 2005 year
Xa=annual average

Taxonomical group	May	July	October	Xa
Species number				
Primary consumers:				
Ciliata	14.29	3.57	9.52	8.12
Testacea	8.57	14.28	16.67	13.51
Lamellibranchia	2.86	1.79	2.38	1.35
Rotatoria	57.14	62.51	52.38	60.80
Gastrotricha	2.86	-	-	1.35
Cladocera	5.71	7.14	14.29	9.46
Copepoda	8.57	10.71	4.76	6.41
Secondary consumers:				
Ciliata	-	16.67	-	12.50
Rotatoria	50.00	16.67	20.00	12.50
Cladocera	-	16.66	-	12.50
Copepoda	50.00	50.00	80.00	62.50
Total zooplankton (species number)	37	62	47	82
Numerical density				
Primary consumers:				
Ciliata	1.20	0.05	0.37	0.47
Testacea	0.95	3.12	2.99	2.36
Lamellibranchia	33.57	0.70	0.92	11.65
Rotatoria	56.25	79.19	46.08	68.24
Gastrotricha	0.06	-	-	0.02
Cladocera	0.36	12.75	0.96	7.39
Copepoda	7.01	4.19	48.68	9.87
Secondary consumers:				
Ciliata	-	12.5	-	9.37
Rotatoria	20.00	77.50	8.20	68.75
Cladocera	-	6.25	-	6.25
Copepoda	80.00	3.75	91.80	15.63
Total zooplankton (ind/l)	169	293	55	172
Biomass				
Primary consumers:				
Ciliata 0.05	0	-	-	-
Testacea	0.84	0.27	0.93	0.34
Lamellibranchia	23.63	0.05	0.28	1.43
Rotatoria	38.47	12.88	12.28	14.34
Gastrotricha	0.03	-	-	0.003
Cladocera	7.33	82.74	18.93	75.38
Copepoda	29.55	4.06	67.57	8.50
Secondary consumers:				
Ciliata	-	2.32	-	1.96
Rotatoria	7.96	43.49	3.55	36.75
Cladocera	-	49.52	-	40.90
Copepoda	92.04	4.67	96.45	20.39
Total zooplankton (μg w.w/l)	167	2612	158	979

Due to the shift of abiotic conditions from marine to the freshwater type, the ecological spectra of phyto and zooplankton, in the specific conditions of 2005 year, shows the presence of freshwater or brackish species; the marine species are completely absent. Also, the structure and functions of bacterioplankton are similar with the one recorded for freshwater lakes of Danube Delta (e.g. the bacterioplankton biomass annual average in Musura Bay, as well as the rate of respiration in the water column are similar with the values recorded for Gorgostel – Erenciuc lakes between 2003 – 2005 (Fig.1).

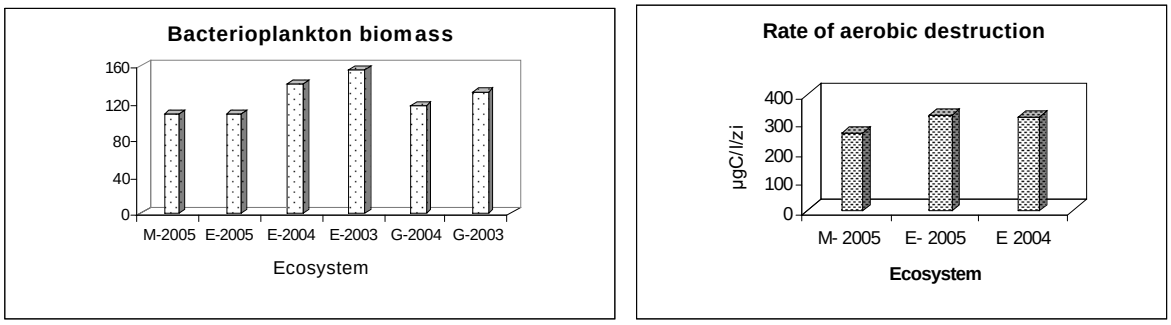

Fig.1 Bacterioplankton biomass and rate of aerobic destruction in Musura bay and some lakes of Danube Delta
Legend: M- Musura Bay, E – Erenciuc Lake, G – Gorgostel Lake

Summary

The progressive transformation of Musura Bay in a lagoon with a restraint connection with the sea and thus, the increased freshwater input of the Danube River determined the shift of abiotic conditions from the marine to the freshwater characteristics. The structure and functions of plankton communities were also influenced, recording the same shift towards the freshwater type. The high flow of Danube River in 2005 accelerates the dynamics of this process.

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