PRELIMINARY STUDIES ON THE STRUCTURE AND DYNAMICS OF THE PHYTOPLANKTON IN LAKE GOLEŞTI (2006 – 2009)

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Abstract. The hydrographic basin Argeş-Vedea represents one of the most important one in Romania owing to its development appliance towards producing electricity and providing water for various categories of customers (in industrial and agricultural branches or for domestic use). It has a large number of reservoirs including Goleşti reservoir, which is the second biggest one after Vidraru. It is situated between Udeni and Catanele villages, downstream Piteşti Dam. Its surface is 680 ha; it is 7 km long and 16.5 meters deep and it was built to produce hydropower, to reduce flooding, for irrigation and water supplying. The study of the spatial-temporal variability of the total density of the phytoplankton communities in lake Goleşti revealed that the phytoplankton density increased from the entrance of lake toward the dam, as the physical-chemical conditions of the water improve.

Keywords: phytoplankton, the quality of the water, the Argeş river, Romania.

Rezumat. Studii preliminare asupra structurii și dinamicii fitoplanctonului din lacul Goleşti (2006 - 2009). Bazinul hidrografic Argeş-Vedea reprezintă unul dintre cele mai importante bazine hidrografice din România, datorită amenajării sale dezvoltate în scopul producerii de energie electrică, dar şi de a alimenta cu apă diverse categorii de utilizatori (din ramuri industriale, agricole, sau populaţia umană). Prezintă un număr mare de lacuri de acumulare printre care şi lacul de acumulare Goleşti, care reprezintă ca mărime, a doua acumulare de baraj pe râul Argeş, după lacul Vidraru. Este situat între localităţile Udeni şi Catanele, aval de barajul Piteşti. Are o suprafaţă de 680 ha, lungimea de 7 km, şi adâncimea de 16,5 m, construit în scopul producerii de hidroenergie, pentru atenuarea inundaţiilor, irigare şi alimentare cu apă. Studiul variabilităţii spaţio-temporale a densităţii totale a comunităţilor fitoplanctonice din lacul Goleşti a relevat că densitatea fitoplanctonului a crescut de la intrarea în lac spre baraj, odată cu îmbunătăţirea condiţiilor fizico-chimice ale apei.

Cuvinte cheie: fitoplancton, calitatea apei, râul Argeş, România.

INTRODUCTION

The wastewater treatment plant in Piteşti is situated on the right bank of the Argeş River and ejects the purified effluent into lake Goleşti (Fig. 1). Knowing the effect of the purified water on the ecosystem of lake Goleşti represents a necessity for the evaluation of its state of health and its trophic level for setting decisions and management plans and for its further conservation and exploitation.

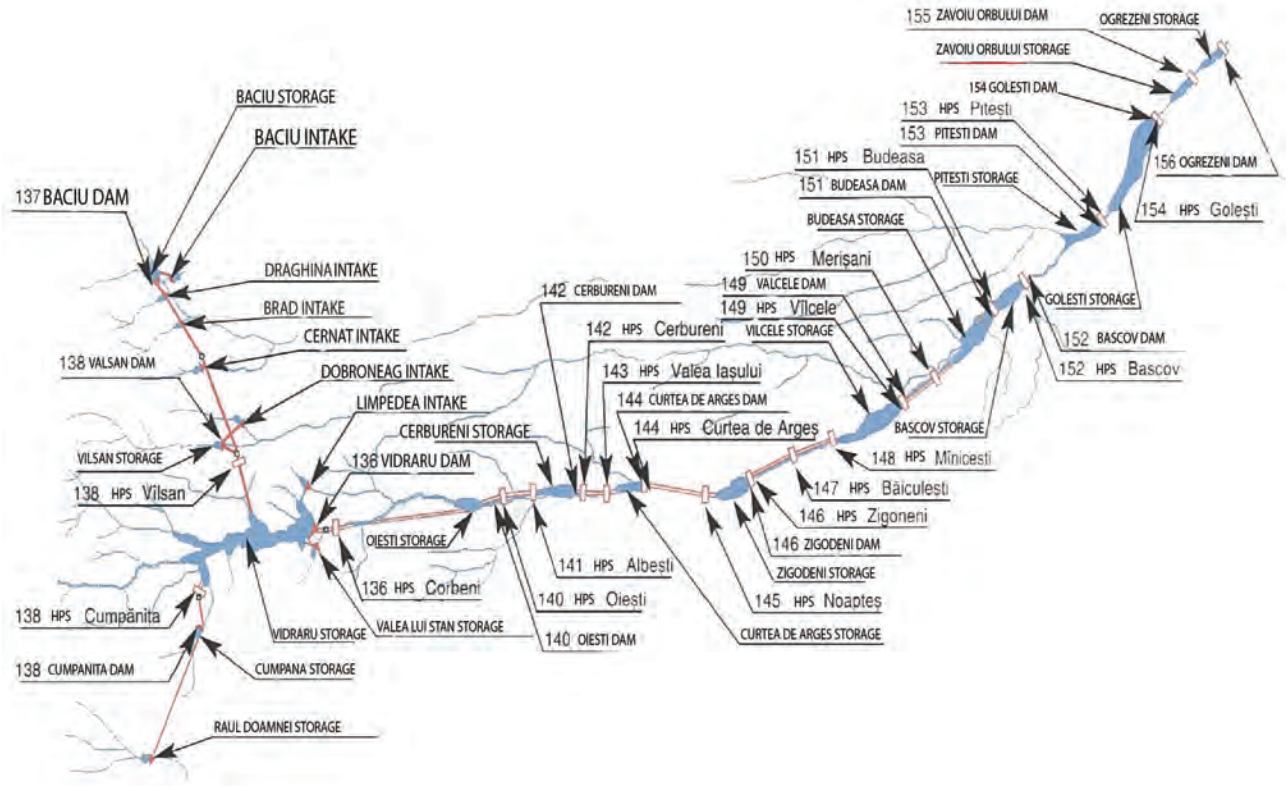

Figure 1. Arrangement scheme of the Argeş river (Hydroelectric power construction). (Source:http://barajulvidraru.ro/wp-content/uploads/2011/07/schema-amenajarii-raului-arges.jpg).

The classical determination of the quality of rivers is based upon the chemical analysis of water samples. In recent years, it has been shown that the analysis of the community structure of plants and animals in creeks, rivers and lakes reflects more accurately their health. So, it was considered that the biological methods allow detecting and assessment of intensity and expansion of water pollution regardless of its nature and the typology of the receiver (ALLAN, 1995; BREZEANU et al., 2011).

MATERIAL AND METHOD

Sampling and sample collection were performed according to the standards in effect. Phytoplankton samples were collected monthly between January and September 2006-2009. Thus, phytoplankton study covered three quarters of the year in which the development and seasonal variations within this biotic compartment are significant. Plankton samples were directly analysed under a microscope without being preserved in advance.

So, research stations were provided for a better monitoring:

- at the upstream end (at the treatment plant of the lake in Piteşti (A),
- at the outlet of the treatment plant – Piteşti (I, E),
- at the actual portion of entry in the lake Goleşti, and in the terminal portion of the lake in the proximity of the dam Goleşti, about 7.5 km far from the treatment plant evacuation (G0, G3, G10) for the vertical research of the dynamic structure of the phytoplankton in lake Goleşti (on depth profiles). Here samples were taken from the water surface (0 m deep), 3 m and 10 m deep as well (Fig. 2).

RESULTS AND DISCUSSION

The qualitative analysis of phytoplankton studied at lake Goleşti between 2006 and 2009 revealed the following taxonomic richness of six main groups of organisms: Cyanobacteria, Cryptophyceae, Dinophyceae, Bacillariophyceae, Chlorophyceae and Euglenophyceae.

The analysis of the dynamics of the numerical densities achieved by all six taxonomic groups identified in the structure of the phytoplankton in Lake Goleşti in all control sections and for the entire study period was achieved through a graphical representation of this parameter of quarterly averages (Figs. 3; 4).

Figure 2. Location of the research stations A-upstream the treatment plant-Piteşti I, E-the treatment plant Piteşti (influent – I-and effluent – E-waters were studied) – G-entrance in Lake Goleşti and G0, G3, G10 - station in close proximity to the dam Goleşti, where measurements and samplings were accomplished on the depth of the water main (at the surface - 0 m, respectively at 3 m and 10 m deep) - (Source: Google earth).

Cyanobacteria

During the period of study 2006-2009, their density increased progressively from the first quarter of the year (T1 with the maximum 275 Ind/L in March 2007 in G0) till the third quarter (T3, 3541 Ind./L, in July 2008).

Numerous quarterly values (of all three analysed quarters) revealed, in the case of cyanobacteria, higher numerical densities in the lake entrance section (G), downstream the treatment plant, compared to the upstream section (A) or to the farthest section in the proximity of dam Goleşti (G0). In the terminal section, but in the depth of the water main, Cyanobacteria was present only to a depth of 3m., and only in quarters 2 and 3 of the year, with densities much lower than those determined (max. 265 Ind./L in June 2008) in the superficial layer of water.

They grow very well in the warm period of the year. Therefore toward the end of spring, in summer and in the first part of autumn, if it is warm enough, the highest densities are reached (PÂRVU, 1999).

Criptophyceae

In lake Goleşti their quarterly densities varied in different aspects like cyanobacteria dynamics. Criptophyceae are spread in almost all water basins, mainly in those rich in organic substances (IONESCU & PETERFI, 1981).

Dinophyceae

In this group, the highest numerical densities were also registered from April till September in the section of dam Goleşti in the superficial layer of water. The variation area of the Dinophyceae density of phytoplankton structure in time and space in lake Goleşti was situated between 24 Ind./L (G10 in April 2010) and 2110 Ind./L (G0 in June 2008).

The development and persistence of the populations of dinophyceae in lake Goleşti can be supported by their ability to assimilate nitrates during the night or by the distribution of the highest concentration of nutrients in the superficial layer of water. The excessive multiplication of this group of algae becomes a limiting factor for the development of invertebrate and fish community, because it releases toxins in water (IONESCU & PETERFI, 1981).

Bacillariophyceae

In the period 2006-2008, they had the highest values of the numerical density of the represented phytoplankton groups: it was found that their high density at G0 was 442,447 Ind./L, in T1, and the lowest one 871 Ind./L, in T3; the lowest densities were generally between 0 and 10,000 Ind./L in all control sections of the study area, the highest are also observed at G0.

In the third quarter of the research period, the densities of bacillariophyceae grew again, reaching the maximum values at G0 in the proximity of the dam (e.g.: 31,231 Ind./L in September 2009)

The flowering of the algae in the group of bacillariophyceae (diatomee) is seldom followed by the degradation of the aquatic animals, which are specific for the summer flowering of phytoplankton, in conditions of high temperature (IONESCU & PETERFI, 1981). Bacillariophyceae show good conditions for development in early spring and autumn, when they become very numerous.

Chlorophyceae

In the warm periods of the year, in lakes with nutrient resources, green algae develop very well. In lake Goleşti, these algae presented the highest densities in the exit area of lake, at the dam. The highs were reached in the second quarter of the year (G0: between 21,450 in April 2007 and 256,410 Ind./L, in June 2008) and in T1 the densities of the chlorophyceae were lower (G0: 1,504 Ind./L in January 2009 and 8,745 in March 2007). The lowest densities of the chlorophyceae were recorded in T3 (G0: between 789 Ind./L, in September 2008 and 3,102 Ind./L, in July 2006), in some cases with higher densities in the 3m deep layer (G3). The development and abundance of the chlorophyceae are subject to their wintering, in the form of cysts and spores that turn slower into vegetative stages and to the amount of nitrogen compounds in the water mass.

Euglenophyceae

In the first two quarters during the study period, the numerical densities of this group of phytoplankton increased horizontally in lake Goleşti, in the upstream section towards its terminal portion of the dam; they decreased vertically along with the increase of depth. Euglenophyceae reached maximum values of density in T2 (18,562 Ind./L in A, in June 2008 and 13,569, in G0, in June 2008), and the lowest in T3 (in sections G and G0).

The massive proliferation of Euglenophyceae has a special importance for the life of aquatic biocoenosis, contributing to the production of oxygen and therefore to the biological self-purification of waters rich in organic substances (PETERFI & IONESCU, 1981).

The identified structural dissimilarities among them (qualitative and quantitative in time and space) could be attributed to the dynamics of natural control of phytoplankton (the intensity of light, temperature, the depth of water, the oxygen and trophic regime of the lake, the singularity of the hydrological regime, the water basin morphology, etc.) but also to some artificial ones like the retention time of the water in the lake, cases of accidental spills or leakage of polluted water.

Through NMDS-the biotic data set was analysed, making possible to determine the degree of similarity between samples (RADU, 2011). The comparative multivariate analysis of the structure of the phytoplankton in the three sections of control monitored in the period 2006-2012, in lake Goleşti (A, G and the dam G0, G3 and G10) revealed that there are no major differences between the ways of assembly of their phytoplankton communities (GAVRILESCU, 2006; VARDUCA, 2000; VĂDINEANU, 2004).

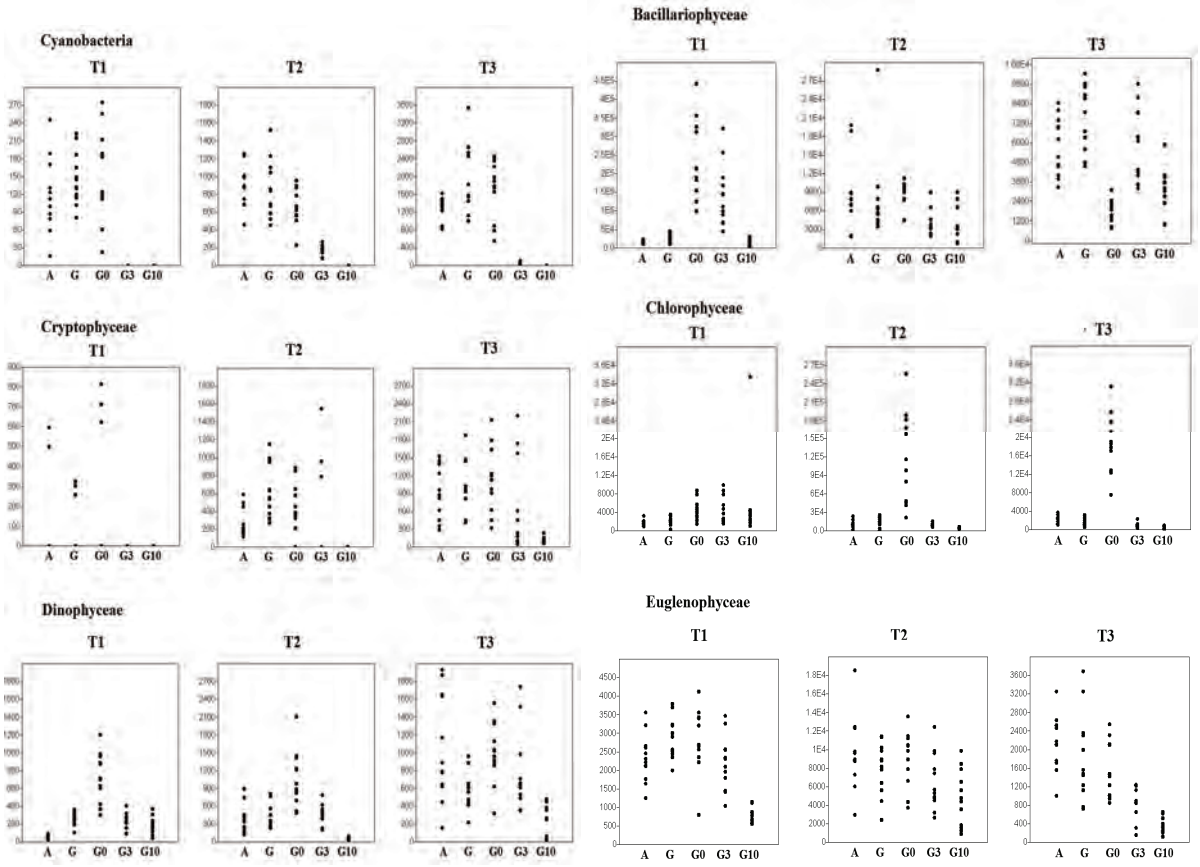

Figure 3. The dynamics of the numerical densities of the taxonomic groups identified in the structure of the phytoplankton in lake Goleşti, in the upstream section-A, at the entrance of lake Goleşti –G, and in close proximity to the dam of lake Goleşti, vertically- G0, G3 and G10- for the period 2006-2009 (T1=First quarter -with the months 1,2 3; T2=second quarter with the months 4, 5 and 6 and T3=third quarter with the months 7, 8 and 9. E4=10,000 Ind./L. E5=100,000 Ind./L).

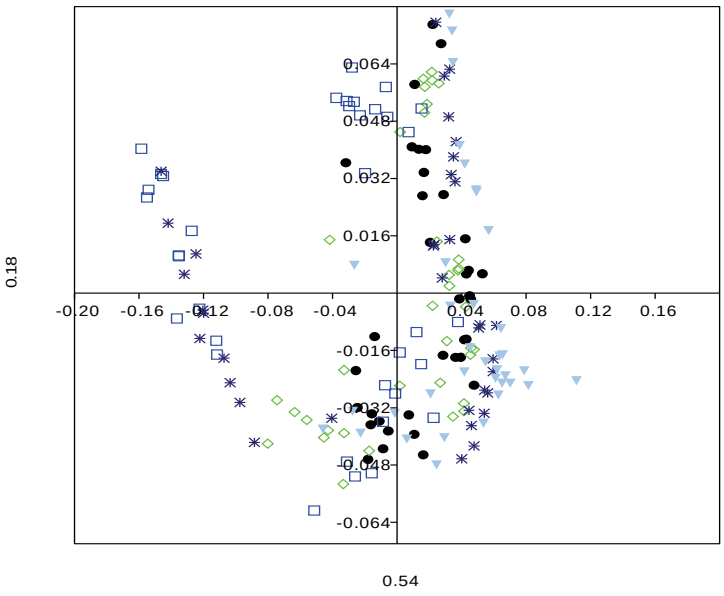

Figure 4. Comparative analysis of the structure of the phytoplankton communities in upstream section (A), the entrance section in lake Goleşti and in close proximity to the dam of lake Goleşti (vertically, G0, G3 and G10) in the period January - September, 2006 – 2009, NMDS, 3D (stress: 0.1488, Bray-Curtis).
(Caption: Upstream station – A = black dots, the entrance station to lake Goleşti – G = light green diamonds, and the station close to dam Goleşti – Go = blue empty squares, G3 = navy blue stars and G10 = blue triangles).

CONCLUSIONS

We can say that Goleşti dam lake is a stable aquatic system, that retrieves its physical-chemical water quality by natural self-purification processes and on which the purified water discharged from the treatment plant Piteşti (by their flow and physical-chemical characteristics) has a minor impact. These assertions are sustained by the results of the analysis on the composition and spatial-temporal dynamics of the phytoplankton structures in this lake. The trophodynamic mode of primary producers response to the changes of the water quality is direct and fast. Thus, the treated wastewaters from the treatment plant of Piteşti caused little impact in the catchment during 2006 – 2009; therefore, they could not cause significant changes in the composition of phytoplankton in the lower section of the Argeş river.

The study of the spatial-temporal variability of the total density of the phytoplankton communities in lake Goleşti revealed that the phytoplankton density increased from the entrance of lake Goleşti to the dam, as the physical-chemical conditions of the lake water improved.

REFERENCES

ALLAN D. J. 1995**.** *Stream Ecology. Structure and function of running waters*. Chapman & Hall. London. 388 pp.

BREZEANU GH., CIOBOIU OLIVIA, ARDELEAN A. 2011. *Ecologie acvatică*. Edit. Vasile Goldiş University Press. Arad. 406 pp.

GAVRILESCU ELENA. 2006. *Poluarea mediului acvatic*. Edit. Sitech. Craiova. 274 pp.

IONESCU A. & PETERFI S. 1981. *Tratat de algologie*. Edit. Academiei R. S. R. Bucureşti. **4**. 168 pp.

PÂRVU C. 1999. *Ecologie generală*. Edit. Tehnică. Bucureşti. 445 pp.

RADU EMILIA. 2011. *Compoziţia şi distribuţia faunei fitofile în sistemul de Zone Umede al Dunării Inferioare*. Teza de Doctorat. Universitatea din Bucureşti. 320 pp.

VARDUCA A. 2000. *Protecţia calităţii apelor*. Edit. H*G*A*. Bucureşti. 368 pp.

VĂDINEANU A. 2004. *Managementul dezvoltării o abordare ecosistemică*. Edit. Ars Docendi. Bucureşti. 394 pp.

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