THE STRUCTURE AND THE IMPORTANCE OF THE CYANOPHYTA ALGAE COMMUNITIES IN THE MAIN AQUATIC ECOSYSTEMS OF THE REPUBLIC OF MOLDOVA

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Summary. *In this work there are presented the results of the investigations of Cyanophyta algae that have been carried out within the period of 1990-2007 within the main aquatic ecosystems of the Republic of Moldova: the Dniester River, the Prut River, the water accumulation reservoirs Dubasari and Costeşti-Stânca. The obtained results have been compared with the results of previous studies from 1950-1989. It has been revealed that the development of the Cyanophyta algae in aquatic ecosystems is influenced by various factors among the most important are the next: solar radiation, the transparency, thermal regimen, chemical composition of water and hydrologic conditions. There has been registered a reduction of the Cyanophyta diversity during last years. In river ecosystems there have been found 28-30 species of Cyanophyta algae, but in lacustrine ecosystems 22-24 species. In the composition of Cyanophyta algae from the main aquatic ecosystems of the Republic of Moldova there have been identified only representatives of 2 classes Chroococcophyceae and Hormogoniophyceae. The specific composition of Cyanophyta in river ecosystems Dniester and Prut are similar (the affinity coefficient Sörensen K_s= 0.73), but the dominant species differ both in various sectors of the rivers and different seasons. There have been recorded high variations of the quantitative parameters of the Cyanophyta algae within the vegetation period and in multiannual aspect.*

Keywords: *phytoplankton, Cyanophyta, number, biomass, diversity.*

Rezumat. Structura şi importanţa comunităţilor algelor cianofite în ecosistemele acvatice principale ale Republicii Moldova. *În lucrare sunt prezentate rezultatele cercetărilor algelor cianofite, efectuate în perioada anilor 1990-2007 în ecosistemele acvatice principale ale Republicii Moldova: fluviul Nistru, râul Prut, lacurile de acumulare Dubăsari şi Costeşti-Stânca. Rezultatele obţinute sunt comparate cu rezultatele cercetărilor anterioare 1950-1989. S-a stabilit că dezvoltarea algelor cianofite în ecosistemele acvatice este influenţată de o gamă vastă de factori, printre care importanţă deosebită are nivelul radiaţiei solare, transparenţa, regimul termic, componenţa chimică a apei şi condiţiile hidrologice. În ecosistemele investigate a fost înregistrată reducerea diversităţii algelor cianofite în ultimii ani. În ecosistemele fluviale au fost semnalate 28-30 specii de alge cianofite, iar în cele lacustre 22-24 specii. În componenţa cianofitelor ecosistemelor acvatice principale ale Republicii Moldova pe parcursul a mai multor decenii au fost identificaţi reprezentanţi doar a 2 clase Chroococcophyceae şi Hormogoniophyceae. Componenţa specifică a cianofitelor în ecosistemele fluviale Nistru şi Prut este asemănătoare (coeficientul de afinitate Sörensen K_s= 0,73), însă speciile dominante sunt diferite atât în diferite sectoare ale râurilor cât şi în diferite anotimpuri. Au fost relevate variaţii în limite mari ale parametrilor cantitativi ai algelor cianofite în decursul perioadei de vegetaţie cât şi în aspect multianual.*

Cuvinte cheie: *fitoplancton, cianofite, efectiv, biomasă, diversitate.*

INTRODUCTION

Cyanophyta algae have a significant importance in the productivity of the aquatic ecosystems, being one of the main sources of organic substances. Thanks to their capacity to accumulate nitrogen from the environment a lot of species develop under conditions unfavorable for the eukaryotes. Growing in high quantities, they often lead to the "water bloom". Within this phenomenon could be mentioned such the dominant species as: *Microcystis aeruginosa Kutz.f. aeruginosa, Microcystis aeruginosa f. flos-aquae, Anabaena flos-aquae (Wittr.) Elenc., Anabaena spiroides Kleb. f. spiroides, Aphanizomenon flos-aquae (L.) Ralfs f. flos-aquae, Oscillatoria agardhii Gom.f. agardhii*, etc. The biomass formed by the planctonic Cyanophyta in the period of their intense development „the bloom" of water can constitute 80-90% of the phytoplankton biomass. As the result of the vital activity the chemistry of the water noticeably changes, the fact that influences the functionality of the aquatic ecosystem. The investigations of the phytoplaknton of the main aquatic ecosystems of the Republic of Moldova have been carried out during many decades starting from the 50's, and the obtained results have been reflected in the works of algologists researchers (ŞALARU, 1971, 1984; ŞALARU & UNGUREANU, 1995; TODERAŞ et al., 2002; UNGUREANU, 2000, 2002, 2003).

MATERIALS AND METHODS

The phytoplankton samples have been collected seasonally within the 1990-2007 period in the main aquatic ecosystems of the Republic of Moldova: the Dniester River, the Prut River, the water accumulation reservoirs Dubasari and Costeşti-Stânca. 840 samples of phytoplankton have been collected and processed. The collection and the processing of the phytoplankton were made according to the unified methods of collecting and processing of the field and experimental hydrobiological samples. The identification of the species has been done using the effective determiners. The obtained results have been compared with the data obtained in 1950-1989.

RESULTS AND DISCUSSIONS

The development of the Cyanophyta algae in aquatic ecosystems is influenced by various factors, among the most important are the next: solar radiation, the transparency, thermal regime, chemical composition of water and hydrologic conditions. The influence of environmental factors is complex, different, and thus a quantitative expression of that is quite difficult. The temperature has an influence not only on the processes inside of the algal cells, but also on the hydrochemical regimen of the ecosystem and on its hydrological properties. The influence of the temperature on the algal development through the modifications of the chemical composition of water is more pronounced than its direct influence on algal cells. The seasonal successions of the phytoplankton from aquatic ecosystems is influenced more by the hydrochemical conditions than by the thermal conditions and are determined by their capacity to maintain themselves in a suspended state according to the turbidity level of the water swift. The biomass of Cyanophyta algae is in direct ratio to solar radiation and temperature.

The speed of the water swift contributes to the repartition of the planktonic algae within different types of aquatic ecosystems, serves as a way to provide nutrients, remove the metabolites, and at the same time it has a mechanical influence on algal cells and a direct influence on the hydrochemical and thermal regime, upon the water turbidity and transparency. Along with the decrease of the water swift speed increases the number of Cyanophyta algae.

Cyanophyta algae refer to hydrobionts with a fast reaction to the changes in the hydrochemical regime of the water. The necessity of Cyanophyta in mineral nutrition is not very different from the necessity of other taxonomic groups, the main nutrients being the mineral nitrogen, phosphorous and microelements. The mineral nitrogen is of a great importance to planktonic Cyanophyta, but this group of algae can also use the organic compounds of nitrogen. The phosphorus, which is present in the aquatic ecosystems not only in mineral form, but also as soluble and insoluble organic compounds, is considered as one of the basic elements that influences the development of algae as well as their seasonal and multiannual successions. The phosphorous activity changes in accordance with the pH level in the aquatic environment and the composition of organic substances, but at the same time not only the concentration of phosphorous is important but the value of the N:P ratio.

The Cyanophyta Phylum comprises 3 classes: Chroococcophyceae, Chamaesiphonophyceae and Hormogoniophyceae [Водоросли, 1989]. Representatives of only 2 classes Chroococcophyceae and Hormogoniophyceae have been identified in the main aquatic ecosystems of the Republic of Moldova (the Dniester River, the Prut River, the water accumulation reservoirs Dubasari and Costești-Stânca) during several decades. The number of taxa from the Hormogoniophyceae class has been much higher during all the research periods (tab. 1.).

Table 1. The taxon spectrum of the phytoplankton from the aquatic ecosystems situated in the hydrographic basin of the Dniester and the Prut Rivers.
Tabel 1. Spectrul taxonomic al fitoplanctonului ecositemelor acvatice situateîn bazinul hidrografic al fluviului Nistru și râului Prut.

Taxa Name	Nistru River		Dubăsari Lake		Prut River		Costești-Stânca Lake	
	1*	2**	1	2	1	2	1	2
CLASS CHROOCOCCOPHYCEAE	**16**	**6**	**16**	**6**	**13**	**7**	**8**	**6**
Order Chroococcales	**16**	**6**	**16**	**6**	**13**	**7**	**8**	**6**
Family Coccobactreaceae	**5**	**2**	**5**	**1**	**3**	**1**	**2**	**2**
Genus *Synechocystis*	1	1	1	1	0	0	1	1
Genus *Dactylococcopsis*	4	1	4	0	3	1	1	1
Family Merismopediaceae	**2**	**2**	**3**	**2**	**3**	**2**	**2**	**2**
Genus *Merismopedia*	2	2	3	2	3	2	2	2
Genus *Pseudoholopedia*	0	0	0	0	1	0	0	0
Family Microcystidaceae	**2**	**1**	**2**	**1**	**2**	**1**	**3**	**2**
Genus *Microcystis*	2	1	2	1	2	1	3	2
Family Gloeocapsaceae	**4**	**0**	**4**	**1**	**3**	**2**	**0**	**0**
Genus *Gloeocapsa*	4	0	4	1	3	2	0	0
Family Coelospaeriaceae	**2**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
Genus *Coelosphaerium*	2	0	1	0	0	0	0	0
Family Gomphoshaeriaceae	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**0**
Genus *Gomphosphaeria*	1	1	1	1	2	1	1	0
CLASS HORMOGONIOPHYCEAE	**30**	**22**	**33**	**18**	**36**	**23**	**23**	**18**
Order Oscillatoriales	**21**	**16**	**24**	**12**	**26**	**16**	**15**	**12**
Family Pseudonostocaceae	**5**	**2**	**5**	**1**	**3**	**2**	**2**	**2**
Genus *Pseudanabaena*	5	2	5	1	3	2	2	2
Family Oscillatoriaceae	**16**	**14**	**19**	**11**	**23**	**14**	**13**	**10**
Genus *Oscillatoria*	14	12	16	10	15	11	10	8
Genus *Spirulina*	1	1	1	0	3	1	1	1
Genus *Romeria*	1	1	1	1	2	1	1	1
Genus *Phormidium*	0	0	0	0	2	0	1	0
Genus *Lyngbya*	0	0	1	0	1	1	0	0
Order Nostocales	**9**	**6**	**9**	**6**	**10**	**7**	**8**	**6**
Family Anabenaceae	**7**	**5**	**7**	**5**	**8**	**6**	**7**	**5**
Genus *Anabaena*	5	4	5	4	6	5	5	4
Genus *Anabaenopsis*	2	1	2	1	2	1	2	1
Family Aphanizomenonaceae	**2**	**1**	**2**	**1**	**2**	**1**	**1**	**1**
Genus *Aphanizomenon*	2	1	2	1	2	1	1	1
Total species and varieties	**46**	**28**	**49**	**22**	**49**	**30**	**31**	**24**

1* – the period of years 1950-1989, the data belong to algologists researchers V. ŞALARU, N. IALOVIŢCAIA, I. PANFILE, I. UNGUREANU, and have been selected from the database.

2 ** – the period of years 1990-2007 – personal data.

In the phytoplankton composition of the Dniester River during 1990-2007 the Cyanophyta has been represented by 28 species and algae varieties, its number considerably decreasing compared to previous research periods (46 taxa). There haven't been identified species from the genera *Coelosphaerium*, *Gloeocapsa* in the composition of phytoplankton communities of the Dniester River during last years. The number of species from the *Dactylococcopsis*, *Pseudanabaena* genera has decreased. In the medial sector of the Dniester River more frequent have been the *Synecocystis aquatilis* SANV., *Microcystis aeruginosa Kutz. f. aeruginosa*, *Oscillatoria planctonica* WOLOSZ. species, which number has been evaluated as 1,2-9,1 mln cel./l. Because of its intense development within the vegetation period, the average annual number of Cyanophyta has registered higher values in the years 1991, 2001 and in the period of years 2004-2007. At the same time their biomass wasn't exceeding the value of 0,27 g/m^3 (Fig. 1.).

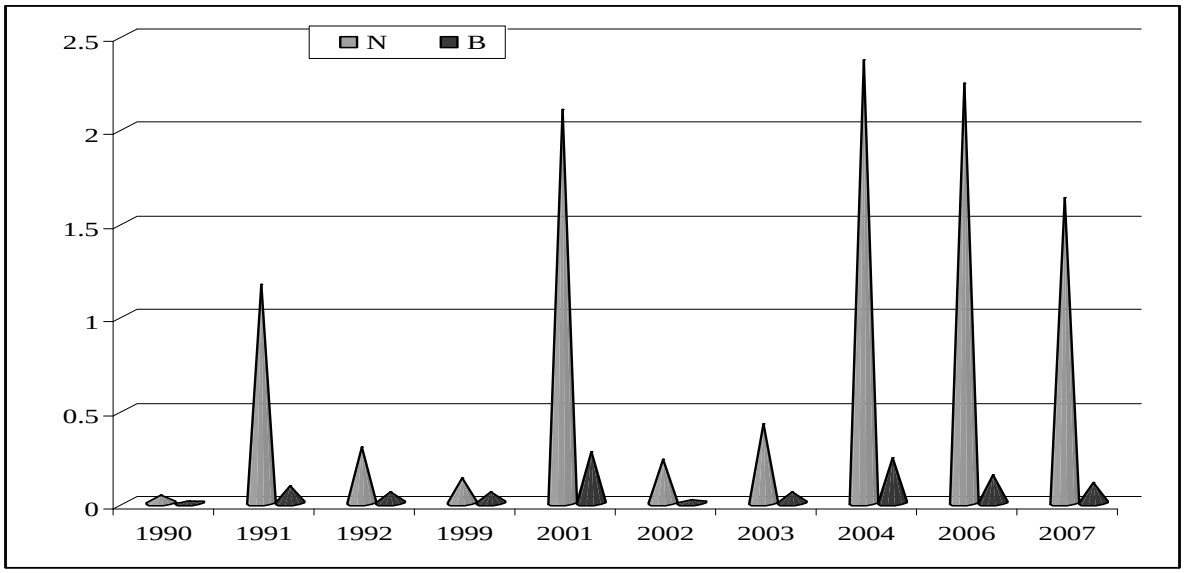

Fig. 1. The dynamics of the effective number (N- mln cel./l) and biomass (g/m^3) of the Cyanophyta algae in the medial sector of the Dniester River.

Fig. 1. Dinamica efectivului numeric (N- mln cel./l) şi a biomasei (g/m^3) algelor cianofite în sectorul medial al fl. Nistru.

In the lower sector more frequent were the *Merismopedia glauca* (EHR.) *Nag f. glauca*, *Merismopedia tenuissima* LEMM., *Aphanizomenon flos-aquae* (L.) *Ralfs f. flos-aquae* species, and their number was evaluated as 1,2-3,9 mln cel./l during autumn period. The average annual values of the number and biomass of Cyanophyta in the lower sector of the Dniester River were higher than in 1990, 1991 and 2003 years (Fig. 2).

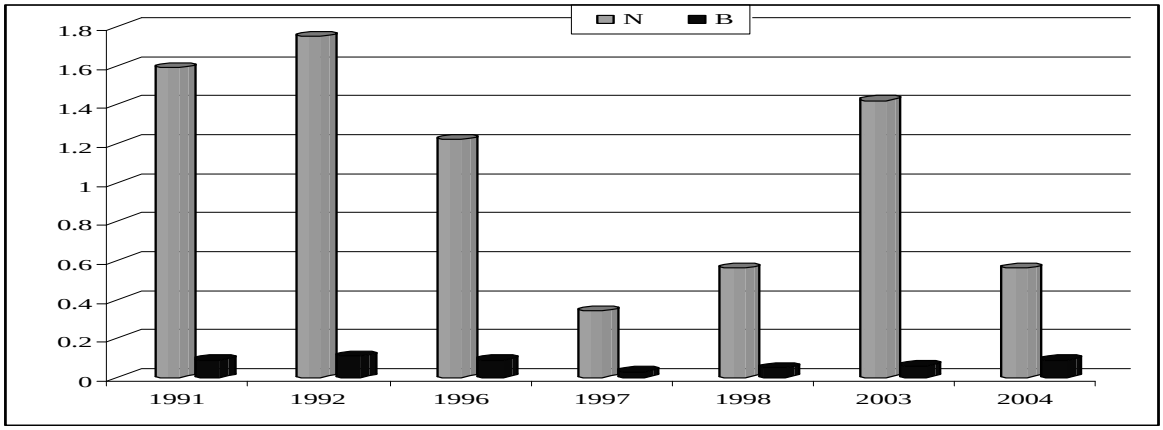

Fig. 2. The dynamics of the effective number (N- mln cel./l) and of biomass (g/m^3) of the Cyanophyta algae in the lower sector of the Dniester River.

Fig. 2. Dinamica efectivului (N- mln cel./l) şi a biomasei (g/m^3)) algelor cianofite în sectorul inferior al fl. Nistru.

In the phytoplankton composition of the Prut River during the 1993-2005 period the Cyanophyta have been represented by 30 species and algae varieties, its number being 49 in the 1962-1983 period (Tab. 1). The number of species from the genera *Dactylococcopsis, Oscillatoria, Spirulina*, has decreased in the Prut River during the last few years, but the representatives of the *Pseudoholopedia* and *Phormidium* genera haven't been identified. In the medial sector of the Prut River the number of Cyanophyta was increasing from 1994 (1,03 mln cel./l) to 1998 (2,56 mln cel./l). In 2001 there has been noticed a decrease of quantitative parameters of Cyanophyta (0,07 mln cel./l; 0,005 g/m^3), that starting from 2002 have been increasing (Fig. 3). The species *Aphanizomenon flos-aquae* (L.) *Ralfs f. flos-aquae, Microcystis aeruginosa* KUTZ. *f. aeruginosa, Oscillatoria simplicissima* GOM have been more numerous.

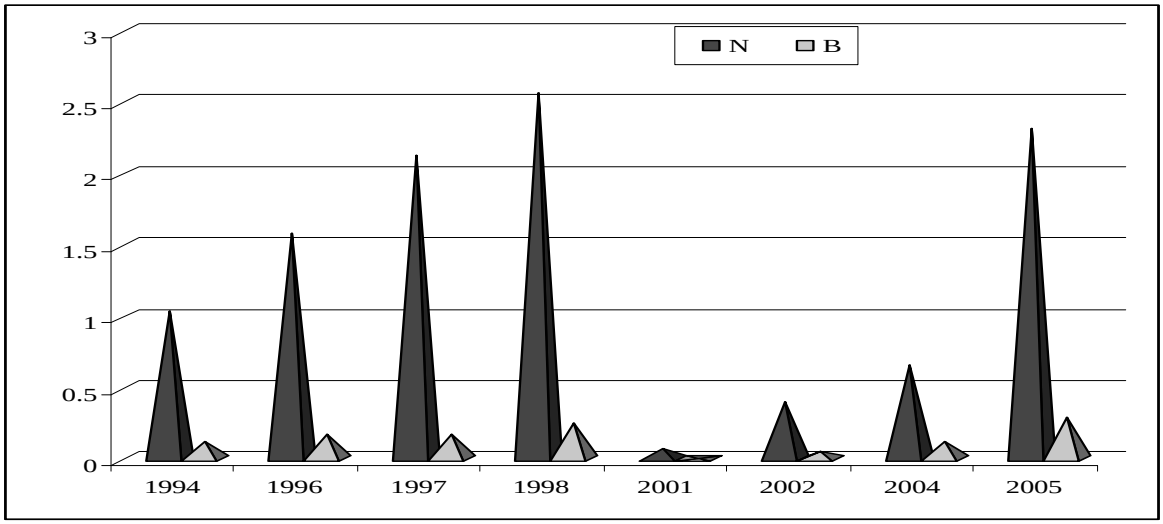

Fig. 3. The dynamics of the effective number (N- mln cel./l) and of biomass (g/m^3) of the Cyanophyta algae in the medial sector of Prut River.
Fig. 3. Dinamica efectivului numeric (N- mln cel./l) şi a biomasei (g/m^3)) algelor cianofite în sectorul medial al r. Prut.

In the lower sector of the Prut River the Cyanophyta have been more diverse, but the annual average values of their quantitative parameters have been lower. Maximal values of their number has been registered in 1993 (1,35 mln cel./l), 1994 (3,11 mln cel./l) and in 2003 (2,17 mln cel./l) (Fig. 4). The *Aphanizomenon flos- aquae* (L.) *Ralfs f. flos-aquae, Merismopedia tenuissima* LEMM., *Oscillatoria planctonica* WOLOSZ species had a considerable development during these years.

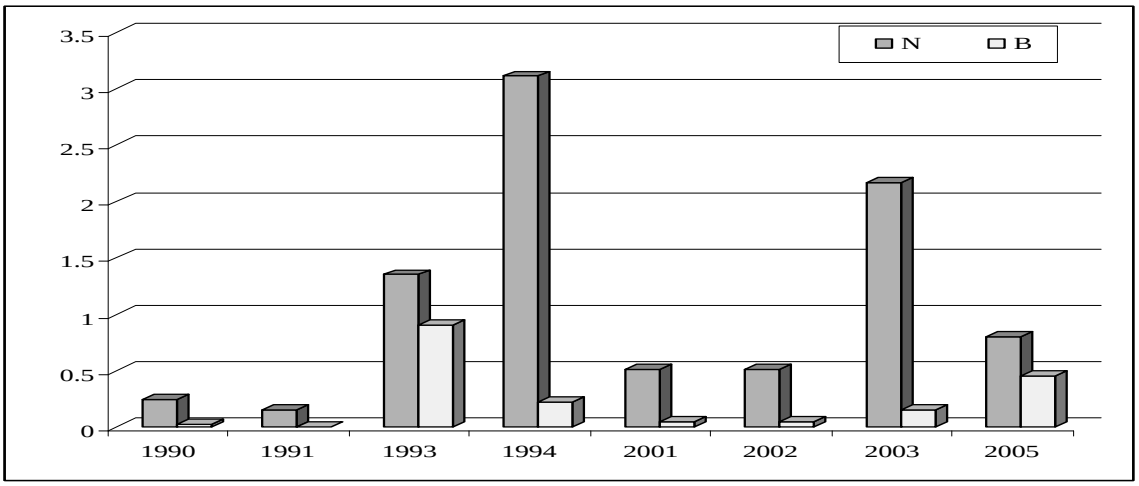

Fig. 4. The dynamics of the effective number (N-mln cel./l) and of biomass (g/m^3) of the Cyanophyta algae in the lower sector of the Prut River.
Fig. 4. Dinamica efectivului numeric (N-mln cel./l) şi a biomasei (g/m^3) algelor cianofite în sctorul inferior al r. Prut.

The specific composition of the Cyanophyta in the river ecosystems of Dniester and Prut are similar (the affinity coefficient Sörensen K_s= 0,73), but the dominant species are different both in various sectors of the rivers and in different seasons.

In the period of years 1990-2007 in the composition of phytoplakton from the water accumulation reservoir Dubasari, situated in the medial sector of the Dniester river, Cyanophyta have been represented by 22 species and algae varieties, their number decreasing approximately by half compared to the period of 1956-1989 on the basis of

Pseudanabaena, Dactylococcopsis, Gloeocapsa, Spirulina, Lyngbia genera. In higher quantities there were developing the following species: *Aphanizomenon flos-aquae* (L.) *Ralfs f. flos-aquae*, *Oscillatoria subtilissima* KUTZ., *Anabaena variabilis f. rotundospora* HOLLERB., *Synecocystis aquatilis* SANV.

The annual average values of the Cyanophyta number in the water accumulation reservoir Dubasari were rather low, but in recent years (2006-2007) because of the intense growth of the *Synecocystis aquatilis* species in the autumn, especially in the lower sector of the lake, the number of Cyanophyta considerably increased being evaluated as 2,87-3,71 mln cel./l. The average values of biomass have been kept in the 0,01-0,27 g/m^3 limits (Fig. 5).

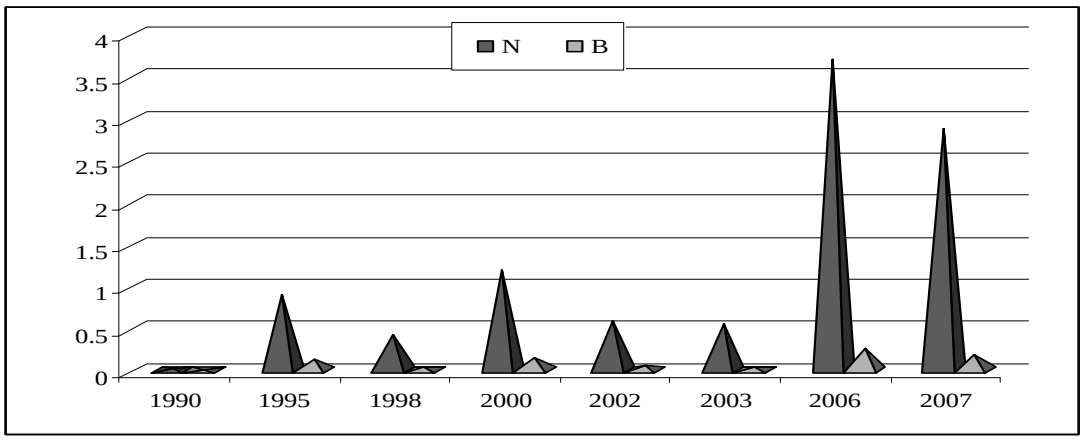

Fig. 5. The dynamics of the effective number (N- mln cel./l) and of biomass (g/m^3) of the Cyanophyta algae in the Water Accumulation Reservoir Dubasari.
Fig. 5. Dinamica efectivului numeric (N- mln cel./l) şi a biomasei (g/m^3) algelor cianofite în lacul de acumulare Dubăsari.

In the water accumulation reservoir Costeşti –Stânca the Cyanophyta algae have been represented by 24 species and varieties, diminishing compared to the period 1980-1983 by 7 species (Tab.1). The *Aphanizomenon flos-aquae (L.) Ralfs f. flos-aquae, Oscillatoria planctonica, Anabaena spiroides* KLEB. *f. spiroides* species have shown a higher growth in the lake.

The average annual values of the number of Cyanophyta algae have varied during 1996-2005 in the limits 2,19-4,47 mln. cel./l, but those of biomass between 0,26-0,34 g/m^3 (Fig.6) .

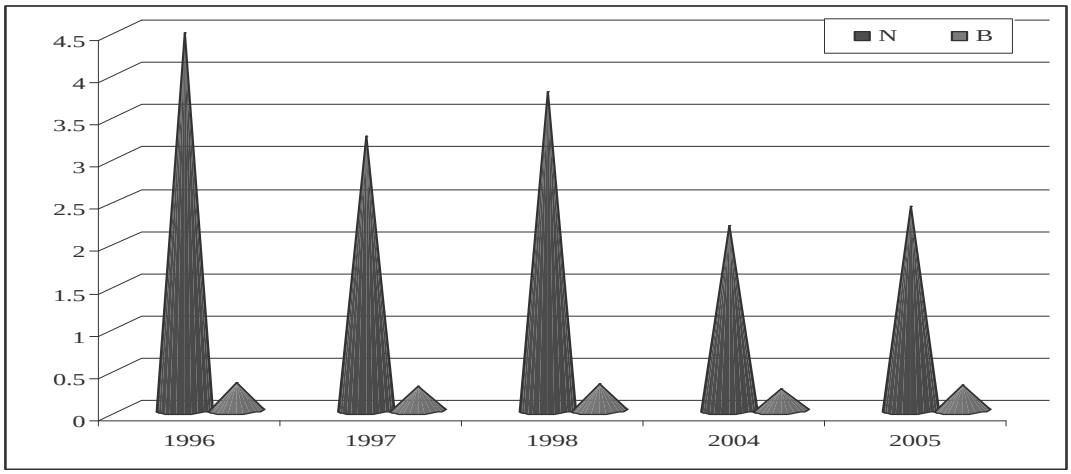

Fig. 6. The dynamics of the effective number (N- mln cel./l) and of biomass (g/m^3) of the Cyanophyta algae in the Water Accumulation Reservoir Costeşti-Stânca.
Fig. 6. Dinamica efectivului numeric (N- mln cel./l) şi a biomasei (g/m^3) algelor cianofite în lacul de acumulare Costeşti-Stânca.

CONCLUSIONS

During the last 2 decades there has been registered a reduction of the Cyanophyta algae diversity in the ecosystems of the Dniester and Prut Rivers. 28-30 species of Cyanophyta algae have been registered in river ecosystems, and 22-24 species were registered in lake ecosystems. The development of the Cyanophyta algae in aquatic ecosystems is influenced by various factors among the most important are the next: solar radiation, the transparency, thermal regime, chemical composition of water and hydrologic conditions. Representatives of 2 classes Chroococcophyceae and Hormogoniophyceae have been identified in the main aquatic ecosystems of the Republic of Moldova within several decades. The specific composition of the Cyanophyta in river ecosystems of the Dniester and

Prut are similar (the affinity coefficient Sörensen K_s=0.73), but the dominant species are different both in various sectors of the rivers and in different seasons. High variations of quantitative parameters of Cyanophyta algae have been revealed during the vegetation period and in multiannual aspect.

REFERENCES

TODERASH I., VLADIMIROV M., LAURENȚIA UNGUREANU, VICOL M., ŞUBERNEȚKI I., USATÎI M., CLIMENCO V. et all. 2002. *Biodiversity of the aquatic ecosystems from the Republic of Moldova (problems, Realizations and Perspectives).* Analele ştiinţifice ale Universităţii "Al. I. Cuza" din Iaşi. Lucrările sesiunii ştiinţifice "Viaţa în apă şi pe pământ în mileniul III" (19-20 oct. 2001). Edit. Univ. "Alexandru Ion Cuza" Iaşi: 126-135.

UNGUREANU LAURENȚIA. 2000. *Structura comunităților fitoplanctonice din lacul de baraj Costeşti-Stânca.* Rezumatele comunicărilor Conferinței corpului didactico-ştiinţific "Bilanţul activităţii ştiinţifice a USM pe anii 1998/ 99" Ştiinţe chimico-biologice. Chişinău: 135-136.

UNGUREANU LAURENȚIA. 2002. *Peculiarities of the Phytoplankton development in the Prut River*. Limnological reports. **34**. IAD. Proceedings of the 34th Conferince Tulcea, Romania: 189-193.

UNGUREANU LAURENȚIA. 2003. *Researches on the Prut river phytoplankton.* Analele ştiinţifice ale USM. Seria «Ştiinţe chimico-biologice» Chişinău: 298-301.

ŞALARU V. & LAURENȚIA UNGUREANU. 1995. *Diversitatea taxonomică a fitoplanctonului râurilor Nistru şi Prut şi succesiunile multianuale.* Conf. Intern. şt.-pract.» Anul 1995 European de conservare a naturii în RM: probleme realizări şi perspective» Chişinău: 15 pp.

ШАЛАРЬ В. М. 1984. Фитопланктон рек Молдавии.- Кишинев. Штиинца: 216 с.

ШАЛАРЬ В. М. 1971. Фитопланктон водохранилищ Молдавии.- Кишинев: Штиинца: 204 с.

Водоросли. Справочник / Вассер С.П., Кондратьева Н.В., Масюк Н.П. и др. - Киев: Наук. думка, 1989: 608 с.

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