DIVERSITY AND QUALITATIVE STRUCTURE OF GREEN ALGAE IN THE MAIN AQUATIC ECOSYSTEMS OF THE REPUBLIC OF MOLDOVA

UNGUREANU Laurenţia, TUMANOVA Daria, MELNICIUC Cristina, UNGUREANU Grigore

Abstract. The paper includes the results of green algae investigations, made during 1989-2011 in the major aquatic ecosystems of Moldova: the Dniester river, the Prut river, Cuciurgan, Dubasari and Costeşti-Stanca reservoirs. The obtained results are compared with data from previous studies (1956-1988). During the period of 1956-2011, there were identified 308 species and intraspecific taxa of Chlorophyta phylum. Green algae among flora spectrum of algal communities constitute 31-64%. It was reported the reduction of green algae diversity in the past 20 years, influenced by changes in hydrological and hydrochemical regimes of ecosystems due to hydraulic structures on rivers, wastewater discharges and intake of nutrients and toxic substances from water basins adjacent territories. Green algae quantitative parameters from the investigated ecosystems are characterized by large amplitude of space-time oscillations of number and biomass values, that stands out when comparing their values over time (seasonal and multiannual dynamics) and space (distribution of algal communities in different sectors of aquatic ecosystems).

Keywords: chlorophyta, algae, diversity, phytoplankton, biomass.

Rezumat. Diversitatea şi structura cantitativă a algelor clorofite în ecosistemele acvatice principale ale Republicii Moldova. Lucrarea include rezultatele investigaţiilor algelor verzi, efectuate în perioada anilor 1989-2011 în ecosistemele acvatice principale ale Republicii Moldova: fluviul Nistru, râul Prut, lacurile de acumulare Dubăsari, Cuciurgan şi Costeşti-Stânca. Rezultatele obţinute sunt comparate cu datele cercetărilor anterioare (1956-1988). În perioada anilor 1956-2011 au fost identificate 308 specii şi taxoni intraspecifici din filumul Chlorophyta, ponderea algelor verzi în spectrul floristic al comunităţilor algale constituie 31-64%. A fost semnalată reducerea diversităţii algelor verzi în ultimii 20 de ani, influenţată de modificările regimului hidrologic şi hidrochimic al ecosistemelor investigate datorate construcţiilor hidrotehnice pe râuri, deversărilor de ape reziduale şi aportului scurgerilor de substanţe nutritive şi toxice de pe teritoriile adiacente bazinelor de apă. Parametrii cantitativi ai algelor verzi din ecosistemele investigate se caracterizează printr-o amplitudine vastă a oscilaţiilor spaţial-temporale ale valorilor efectivului şi biomasei, care se evidenţiază la compararea valorilor acestora în timp (dinamica sezonieră şi multianuală) şi spaţiu (distribuţia comunităţilor algale în diferite sectoare ale ecosistemelor acvatice).

Cuvinte cheie: alge, clorofite, diversitate, fitoplancton, biomasă.

INTRODUCTION

The study of aquatic ecosystems functioning legalities, their productivity and water quality are of particular importance in terms of eutrophication and continuous pollution. The interpretation of ecological processes and developing a prediction of aquatic ecosystem changes are impossible without ecological-physiological multilateral investigations of forming and restructuring mechanisms of planktonic algae community - main producers of organic substance and important factors in the formation of natural water quality (ELIZAROVA, 1999).

Establishing the formation and functioning legalities of phytoplankton communities and revealing environmental factors influence upon this process under human pressure contributes to the development of biological productivity theory, of operation and management methods for sustainable use of aquatic ecosystems.

Currently the regional algo-floristic studies are of major importance and contribute to the process of establishing the species diversity of the Republic of Moldova flora. The generalization and analysis of obtained results allow revealing the peculiarities of ecology and spreading of some groups of algae species, establishing their development in different aquatic ecosystems (UNGUREANU, 2003a, b; 2006; UNGUREANU et al., 2011; ZUBCOV et al., 2005, 2008, 2009). Algo-floristic studies also occupy an important role in regional environmental monitoring, as within the water ecosystems each component part is in a permanent dynamic interrelation with other parts and continually changes not only its structure, but also its properties.

MATERIAL AND METHODS

Phytoplankton samples were collected seasonally during 1989-2011 in representative biotopes of the Dniester and the Prut rivers, and also Dubasari, Cuciurgan and Costeşti-Stanca reservoirs within the researches of Hydrobiology and Ecotoxicology Laboratory of the Institute of Zoology of the Academy of Science of Moldova. During these studies, the materials were collected from 34 points (8 on the Dniester river, 8 on the Prut river, 6 on Dubasari, 6 on Cuciurgan and 6 on Costeşti-Stanca reservoirs). A number of 952 phytoplankton samples were investigated by microscopy. Collecting and processing of phytoplankton samples was performed according to the unified methods for field and experimental hydrobiological material (ABAKUMOV, 1983; KUZIMIN, 1975). Species identification of algae was performed using microscopes ("Jenaval" and Lomo "Микмед 2") and identification keys (VASSER et al., 1989).

Phytoplankton number was estimated by counting cells of algae in "Goreaev" chamber (0.9 cm^3). The cell was considered as unit of counting and assessing phytoplankton composition, the results were expressed in million cell/l. During the microscopic analysis of the samples, the necessary parameter dimensions were measured for assessing algal cell volume and estimate individual mass. In each analysed sample the algae species were determined and their cells were counted at least in 3 counting chambers.

Phytoplankton biomass was calculated by the method of biomass summation of identified algae species in samples. Their volume was calculated by the likeness of figures or combinations of geometric figures according to known formulas in geometry based on linear dimensions of algae cells.

Relative density of freshwater algae is considered equal to 1.0 – 1.05 (VASSER et al., 1989). Biomass was calculated for each species and then summed to obtain the total biomass of phytoplankton in the given sample expressed in mg/l or g/m^3, with accuracy of 0.01.

To establish the accuracy of the data, mathematical and statistical analysis methods were used by using applications of Biostat, Statistica 7 for Windows, Excel 2007. The results of the investigations were compared with data reported for 1956-1988.

RESULTS AND DISCUSSIONS

Following - multiannual investigations of phytoplankton from aquatic ecosystems located in the Dniester and the Prut river basins, there were identified 881 species, varieties and forms of algae, which refers to 161 genera, 54 families, 23 orders, 11 classes and 8 phyla. The basis of floristic diversity of the investigated aquatic ecosystems consists of 3 phyla, Chlorophyta, Bacillariophyta and Cyanophyta, which recorded the highest number of taxa at level of families, genera, species and varieties of algae.

During the period 1956-2011, there were identified 308 species and intraspecific taxa of the phylum Chlorophyta, belonging to the classes Chlorophyceae and Conjugophyceae (OBUH, 1995; SHALARI, 1971, 1984; UNGUREANU 1998, 2003a, b, 2006; UNGUREANU et al., 2011). Green algal flora proportion constitutes 31-64% from algal communities.

During 1989-2011 in **the Dniester river**, the phylum Chlorophyta - was represented by a total number of 78 species and varieties of algae from 2 classes, 5 orders, 15 families and 34 de genera, and their diversity decreased twice in comparison to 1956-1988 period. The number reduction was registered in all the genera of this phylum, while the representatives of the genera *Staurastrum, Cosmoastrum, Cosmarium, Binuclearia, Elakatothrix, Chlorolobion, Nephrocytium* and others disappeared from the phytoplankton composition of the river. In the last years, the species *Polyedriopsis spinulosa* SCHMIDLE*, Desmatractum indutum* (GEITL.) PASCH., *Characium falcatum* SCHROED., *Diacanthos belenophorus* KORSCH., *Closterium lanceolatum* KUTZ.*,* which were registered only in the Dniester river, were not recorded in the last years.

At the same time, in some sectors of the studied ecosystems, there appeared several species that have not been recorded previously - *Characium sieboldii* A. BR., *Korschikoffiella limnetica* (LEMM.) SILVA, *Ankyra ancora* f. *spinosa* (KORSCH.) FOTT, *Tetraedron caudatum* var. *incisum* LAGERH., *Closteriopsis longissima* (LEMM.), *Dictyochlorella globosa* KORSCH. and *Monoraphidium griffithii* (BERK.).

In middle sector of the Dniester river in the period 1956-1988 the dominant complex was formed by the species *Actinastrum hantzschii* LAGERH. var. *hantzschii, Monoraphidium griffithii, Dictyosphaerium pulchellum* WOOD*., Coelastrum microporum* NAGELI*, Oocystis borgei* CHNOW. var. *borgei, Scenedesmus acuminatus* LAGERH. var. *acuminatus* etc., which developed intensely in the periods with low water level in summer and autumn (OBUH, 1995; SHALARI, 1971; SHALARI, 1984).

In the middle sector of the Dniester, the phytoplankton composition is highly variable, with a significant contribution to phytobenthos characteristic species. In 1982-1988, there were registered 149 species and varieties of Clorococoficeae algae with the dominance of species from the families Scenedesmaceae - 37.6%, Selenastraceae - 17.5% and Oocystaceae - 11.4% (OBUH, 1995). During this period, the sector algoflora is significantly enriched on the account of algae penetration from Dnestrovsk reservoir.

In the period of our studies, among the dominant complex, there were the species *Scenedesmus quadricauda* Turp. var. *quadricauda, Coelastrum microporum*, *Crucigenia tetrapedia* (KIRCHN.) W. et G. S. WEST and *Tetrastrum triangulare* CHOD.

In the middle sector of the Dniester, the Chlorophyta number ranged from 0.06 to 2.4 million cell/l, and the biomass from 0.03 to 0.72 g/m^3, recording higher values in 1991, 1992, 2003 and 2009 (Fig. 1). In 1991 summer, there was an abundant development of all identified species of Chlorophyta, which conditioned increased values of their number and biomass.

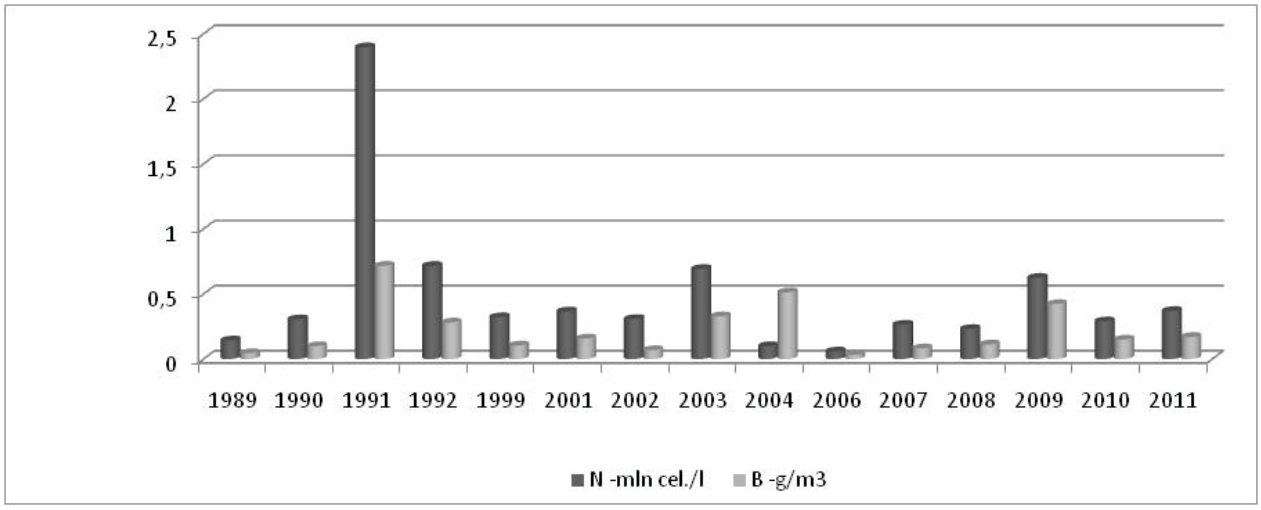

Figure 1. Dynamics of number (N - mln cell/l) and biomass (B – g/m^3) of Chlorophyta algae in the middle sector of the Dniester river in the period 1989-2011.

In general, the middle sector of the Dniester River, which, due to the impact from hydrotechnical constructions from Dnestrovsk, is characterized by low temperatures of water even in the summer, does not present favourable conditions for the growth of Chlorophyta algae, most of which are thermophilous. Therefore, both diversity and quantitative development of these algae are relatively low.

In the Lower Dniester sector, the Chlorophyta algae quantitative parameters were higher especially in 1991, 1992, 1998 and 2003 (Fig. 2). High values of Chlorophyta population and biomass were recorded downstream of Dubasari reservoir up to Vadul-lui-Voda station and correspond to their more abundant development in the reservoir.

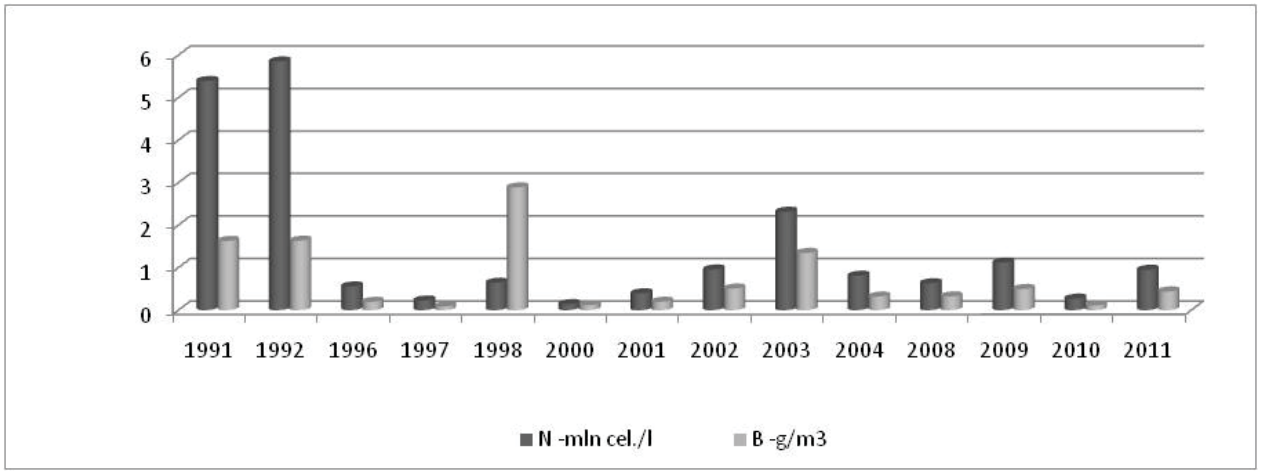

Figure 2. Dynamics of number (N – mln cell/l) and biomass (B – g/m^3) of Chlorophyta algae in the lower sector of the Dniester river in 1989-2011.

Thus, the contribution of Dubasari reservoir to the formation of phytoplankton communities in the lower Dniester river, situated downstream of it is obvious. The floristic diversity and its quantitative development level increase. The limnophylous algae-complex suffers essential changes under the conditions of limnophylous lower sector of the river. Despite this, the limnophylous features of phytoplankton maintain on the whole lower course, as the distance is insufficient for the total transformation of the limnophylous complex in potamophylous one.

In the lower river sector, the Chlorophyta algae number ranged from 0.14 to 5.85 mln cell/l and biomass from 0.09 to 2.89 g/m^3, whereas in previous research periods their number did not overpass the value of 1.32 mln cell/l and the biomass was in most cases lower than 0.5 g/m^3.

Among the dominant algae complex of this sector, there are the species *Micractinium pusillum*, *Tetrastrum triangulare*, *Scenedesmus quadricauda, Crucigenia tetrapedia*, *Scenedesmus acuminatus,* which are also characteristic for the middle sector of the river.

In **Dubasari reservoir,** the Chlorophyta algae were represented by a total of 87 species and varieties of algae belonging to 2 classes, 3 orders, 18 families and 39 genera; the genera *Monoraphidium* and *Scenedesmus* were more numerous. In 1956-1988, in Chlorophyta algae composition, there were registered 211 species and varieties of algae, of which 121 in the first years of the reservoir functioning – 1957-1959 (SHALARI, 1971). At that time Chlorophyta algae,

although they were diverse in terms of identified taxa number, did not have any important role quantitatively. Their numbers and biomass grew in the lower sector of the lake with slower water flow. Before building the Dubasari dam, in this sector, there were identified 70 species and varieties of Chlorophyta algae with dominance of the representatives from families Scenedesmaceae, Selenastraceae and Oocystaceae (SHALARI, 1971).

During our investigations (1989-2011), many species that were characteristic exclusively for Dubasari reservoir have not been found - *Chlamydomonas korschikaffii* PASCH., *Ch. denticulata, Eudorina cylindrica* KORSCH., *Characium pluricoccum* KORSCH., *Ch. acuminatum* A. BR., *Paradoxa multiseta* SWIR., *Ankyra judayi* (G.-M.SMITH.) FOTT, *Heleochloris pallida* KORSCH., *Pediastrum borianum* var. *perforatum* RACIB., *Tetraedron pentaedricum* W. et W., *Franceia elongata* KORSH. and *Fusola viridis*.

Chlorophyta algae quantitative parameters in Dubasari reservoir suffered significant changes over the years of its existence, registering periodic increases and decreases in number and biomass values. During our research, planktonic Chlorophyta algae number ranged within 0.11-4.45 mln cell/l and biomass within 0.1-2.33 g/m^3 (Fig. 3).

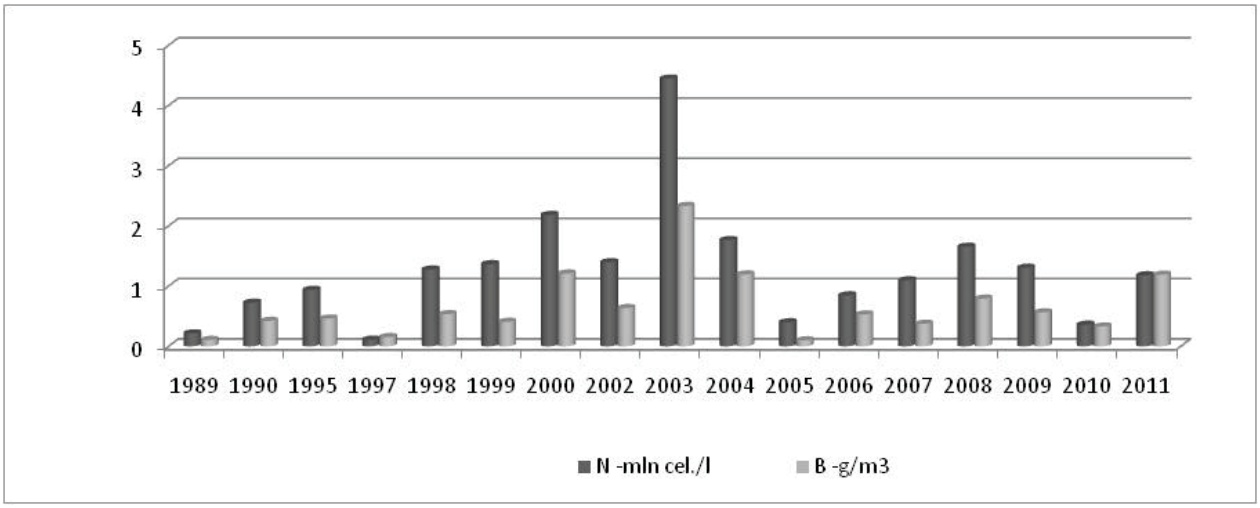

Figure 3. Dynamics of number (N – mln cell/l) and biomass (B – g/m^3) of Chlorophyta algae in Dubasari reservoir in 1989-2011.

Relatively higher values were recorded in 2000 and 2003, when in phytoplankton composition developed in great quantities the species *Coelastrum microporum*, *Crucigeniella apiculata* LEMM., *Pediastrum duplex* MEYEN. var. *duplex, Scenedesmus quadricauda, Monoraphidium contortum* THUR. and *Pediastrum boryanum* (TURP.) MENEGH. var. *boryanum.* It was determined a gradual increase of Chlorophyta algae quantitative parameters, then a significant decrease in their values with a certain periodicity.

In comparison with the period 1956-1988 the Chlorophyta algae quantitative parameters did not change substantially, their values varying practically between the same limits 0.17-5.96 mln cell/l and 0,08-1,17 g/m^3.

In **Cuciurgan reservoir**, in the composition of Chlorophyta algae, there were identified 109 species and varieties of planktonic algae which refers to 2 classes, 5 orders, 17 families and 37 genera. More diverse were the genera *Scenedesmus* (11 species), *Monoraphidium* (6 species), *Oocystis* (8 species), *Chlamydomonas* (7 species). In the last years, there have not been found the species of the genera *Staurastrum, Cosmoastrum, Franceia, Pyrobotrys, Pteromonas, Phacotus, Scherffelia* and *Lobomonas*, which in 1965-1988 were represented by 1-2 species and did not play an important role in algal biomass formation of the lake, because they met sporadically in phytoplankton composition. Thus, compared with previous research periods, when there have been reported 175 species and varieties of Chlorophyta algae, their diversity decreased about 1.5 times.

In 1989-2011 in the lake, there appeared new species that were not identified during previous research, such as *Ankyra ancora* F. *issajevii* (KISSEL), *Fernandinella alpina* CHOD. et KORSCH., *Pediastrum duplex* var. *reticulatum* LAGERH., *Chlorella vulgaris* BEIER., *Oocystis eliptica* W.- WEST., *O. pelagica* LEMM., *O. solitaria* WITTR., *O. parva* W.et W., *Tetraedron minutissimum* KORSCH., *Kirchneriella obesa* (W. WEST.) SCHMIDLE, *Kirchneriella irregularis* SMITH. KORSCH., *Ankistrodesmus fusiformis* CORDA ex KORSCHIKOFF, *Selenastrum bibraianus* REINSCH., etc. The species that entered the first in the lake have failed to grow in large quantities, playing a small role in the formation of phytoplankton biomass.

The analysis of the multi-annual average values of Chlorophyta algae population and biomass in the lake reveals higher values in the period of 1990-1994 (2.11-4.05 mln cell/l) and 2002-2011 (1.88-4.63 mln cell/l) (Fig. 4.). During these periods, it was documented the abundant development of Volvocophyceae *Carteria globosa* KORSCH., *C. pallida* KORSCH., *Pandorina morum* (MULL.) BORY, *P. charkoviensis* KORSCH. and Clorococcophyceae *Monoraphidium arcuatum*, *Scenedesmus quadricauda, Tetrastrum triangulare*.

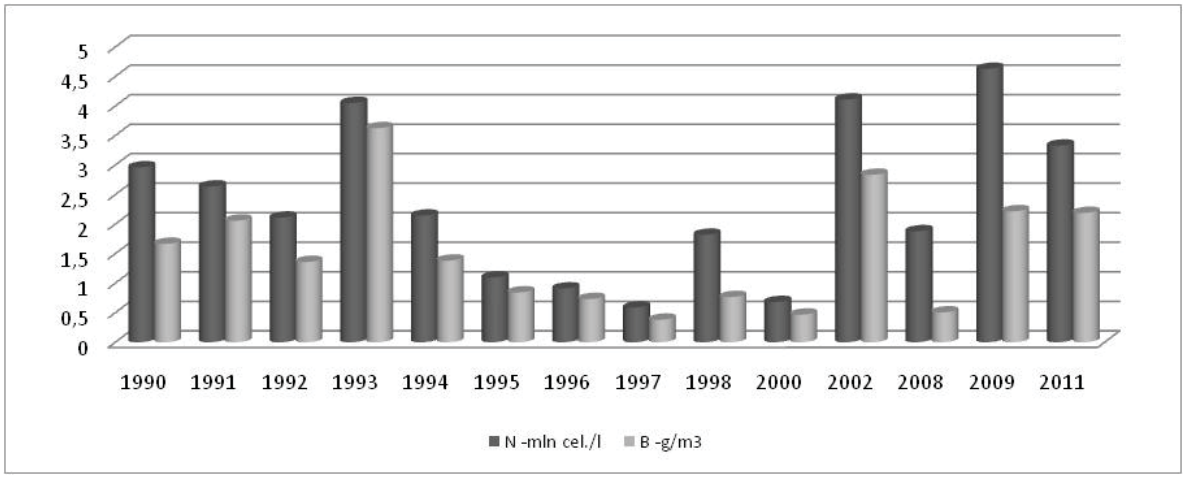

Figure 4. Dynamics of number (N – mln cell/l) and biomass (B – g/m^3) of Chlorophyta algae in Cuciurgan reservoir in 1990-2011 period.

Chlorophyta algae development in 1995-2000 was insignificant, having values ranging between 0.59 and 1.82 mln cell/l and biomass between 0.38 and 0.84 g/m^3, because the phytoplankton was dominated by bacillariophyta, cyanophyta and dinophyta algae, which were their trophic competitors. The same situation was observed in the earlier periods of study (1965-1988), when the number of Chlorophyta algae varied within 0.15-1.68 mln cell/l and biomass between 0.05 and 1.48 g/m^3 (SHALARI et al., 1988).

In the middle and lower sectors of the **Prut river** 79 species and varieties of Chlorophyta algae were identified, belonging to 2 classes, 3 orders, 14 families and 33 genera. A greater number of species belongs to the genera *Scenedesmus, Monoraphidium, Tetraedron, Dictyosphaerium, Pediastrum* and *Schroederia*, and the other genera were represented by 1-3 species each. In the last years, the species number for the genera *Closterium, Oocystis, Lagerheimia* and *Chlamydomonas* has reduced considerably, while the species of the genera *Phacotus, Gonium, Volvox, Treubaria, Golenkiniopsis, Dicellula, Botryococcus, Coenochloris, Didymocystis* and *Cosmarium* were not registered at all. From phytoplankton composition, it disappeared the species *Chlamydomonas atactogama* KORSCH. and *Carteria multifillis* (FRES.) DILL., which were met exclusively in the Prut river. Thus, the diversity of Chlorophyta algae in the Prut River decreased from 126 species recorded in the period 1962-1983, up to 79 species during 1990-2011.

Nevertheless, we have to mention the recording of new species in the river - *Carteria pallida* KORSCH., *Schroederia nitzschioides* (WEST.) KORSCH., *Ankyra ocellata* (KORSCH.) FOTT, *Fernandinella alpina* CHOD. et KORSCH., *Pediastrum duplex* var. *cornutum* RACIB., *Chlorella vulgaris* BEIER., *Ankistrodesmus fusiformis* CORDA ex KORSCHIKOFF, *Selenastrum gracile* REINSCH., *Dictyosphaerium pulchellum* var. *ovatum* KORSCH., *Coelastrum cubicum* NAG., *Scenedesmus acutiformis* SCHROED., *Staurastrum gracile* RALFS var. *gracile* and *Staurastrum crenulatum* (NAG.) DELP., that in previous research periods were reported only for the Dniester River basin ecosystems.

Concerning the Chlorophyta algae quantitative development in the middle sector of the Prut, there were registered two very similar maximum values corresponding to the years 1993 and 2005 (Fig. 5). In 1993, the maximum development was conditioned by the species *Coelastrum microporum, Tetrastrum triangulare*, *Monoraphidium irregulare* (G.M. SMITH.), *Closteriopsis longissima* LEMM., while in 2005 by the species *Chlorella vulgaris*, *Scenedesmus quadricauda, Tetrastrum triangulare*.

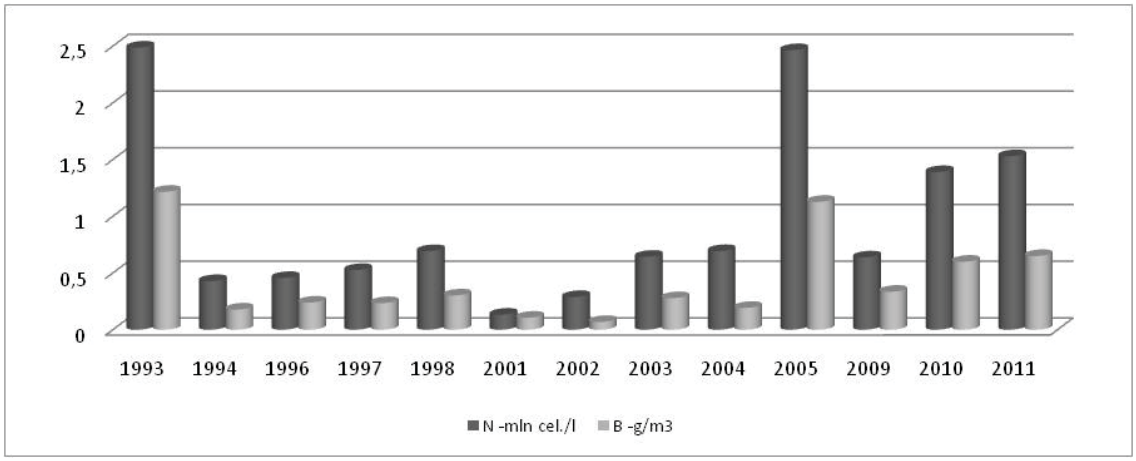

Figure 5. Dynamics of number (N - mln cell/l) and biomass (B - g/m^3) of Chlorophyta algae in the middle sector of the Prut river in 1990-2011 period.

In 1994-2004, Chlorophyta algae quantitative parameters were very low (number 0.13-0.69 mln cell/l, biomass 0.07-0.3 g/m^3), because of the high amount of suspension in the river and low transparency during summer. In fact, low quantitative parameters of Chlorophyta algae are characteristic for the middle Prut, being certified for the period 1962-1983 (SHALARI, 1984; OBUH, 1995). A significant contribution to creating unfavourable conditions for phytoplankton development in this sector is bringing by untreated wastewater discharged to the river from Ungheni city. During our research Chlorophyta planktonic algae number varied in the middle Prut within 0.13-2.49 mln cell/l and biomass 0.07-1.22 g/m^3 (Fig. 5).

In the Lower Prut River sector, the number and biomass values of Chlorophyta algae were higher compared to the values recorded in the middle sector and recorded several peaks corresponding to the years 1990, 1993, 1994 and 2009 (Fig. 6). In 1993-1994, in summer period, the species *Actinastrum hantzschii, Tetrastrum triangulare*, *Scenedesmus quadricauda, Pandorina morum*, *Monoraphidium irregulare* (SMITH.), *Coelastrum microporum* developed intensively, which contributed to the average annual increase of Chlorophyta algae to 15.03 mln cell/l and biomass up to 5.95 g/m^3. In 2001, their quantitative values were much lower and then recorded a steady increase until 2009.

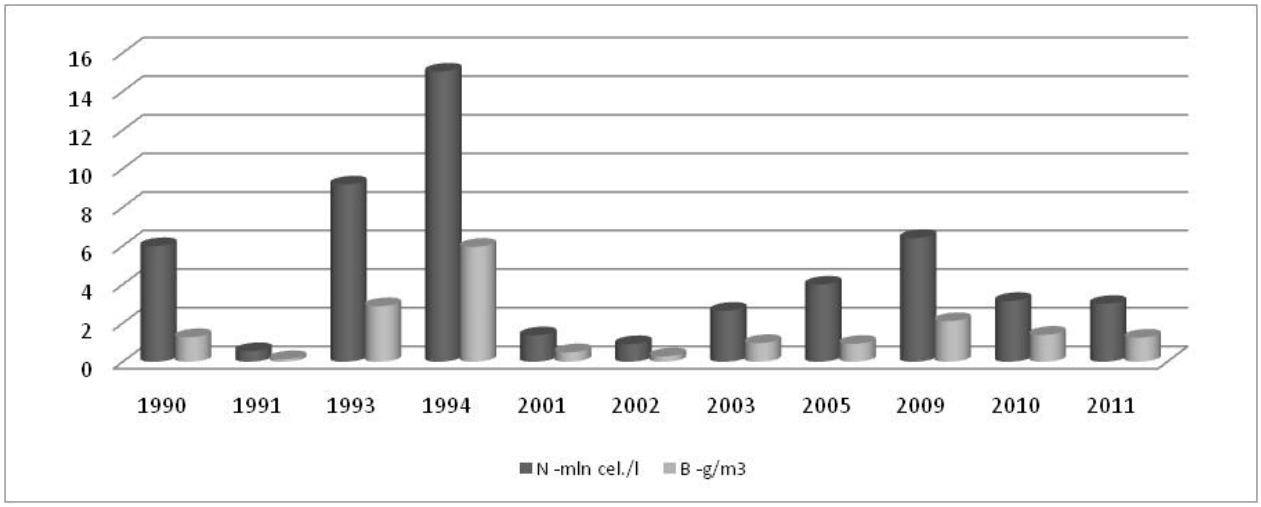

Figure 6. Dynamics of number (N – mln cell/l) and biomass (B – g/m^3) of Chlorophyta algae in the lower sector of the Prut river in 1990-2011.

In **Costeşti-Stanca** Lake 80 species and varieties of Chlorophyta algae were registered, divided into 2 classes, 4 orders, 18 families and 36 genera. The diversity of Chlorophyta algae increased compared to the first years of the reservoir functioning, when 73 species and varieties were found in quantitative samples. Many species that inhabited the lake in the '80s have disappeared from phytoplankton composition (*Chlamydomonas perty* GROSCH., *Ch. angulosa* DILL., *Carteria radiosa* KORSCH., *Eudorina elegans* EHR., *Volvox aureus* EHR., *Sphaerocystis planctonica* (KORSCH.) BOURR, *Tetraedron caudatum* var. *incisum* LAGERH., *Franceia tenuispina* KORSCH., *Lagerheimia ciliata* (LAEGERH.) CHOD., *Oocystis gigas* ARCHER. var. *gigas, Nephrocytium obesum* WEST var. *obesum*, etc.), and new species were recorded, such as *Carteria globosa* KORSCH., *Gonium pectorale* MULL, *Pleodorina californica* SHAW, *Micractinium pusillum* FRES., *Treubaria setigera (Archer)* G. M. SMITH., *Fernandinella alpina* CHOD. et KORSCH., *Lagerheimia wratislaviensis* SCHROED., *Oocystis eliptica* W. WEST., etc., which somehow compensate the algae extinction.

In the quantitative development of Chlorophyta algae, there were emphasized increased number values from 1996 to 2004, then their decreasing in 2005 (Fig. 7). High values of quantitative parameters in 1998 is due to the development of the species *Pandorina morum*, *Scenedesmus quadricauda, Crucigenia tetrapedia*, which together with Chlorophyta and Bacillariophyta algae formed a relatively high biomass in the lake. In 2004, the species *Chlorella vulgaris* BEIER. appeared again in the lake and grew in large quantities in the middle and lower sector although, in 1980, it was registered in small amounts only in lower sector.

In 2005, its abundance decreased considerably, being registered only in the lower sector, accompanied by the species *Coenococcus planctonicus* KORSCH., *Coenococcus polycoccus* (KORSCH.) HIND., *Crucigenia tetrapedia*, *Scenedesmus obtusus* MEYEN and *Monoraphidium griffithii*.

Thus, during the investigation it was concluded that the first years of Costesti-Stanca dam building until 2005 both diversity and quantitative structure of Chlorophyta algae have suffered significant changes, which are confirmed by the disappearance of some species, appearance of others, seasonal and multiannual fluctuations of their quantitative parameters, conditioned by abundant development of certain species.

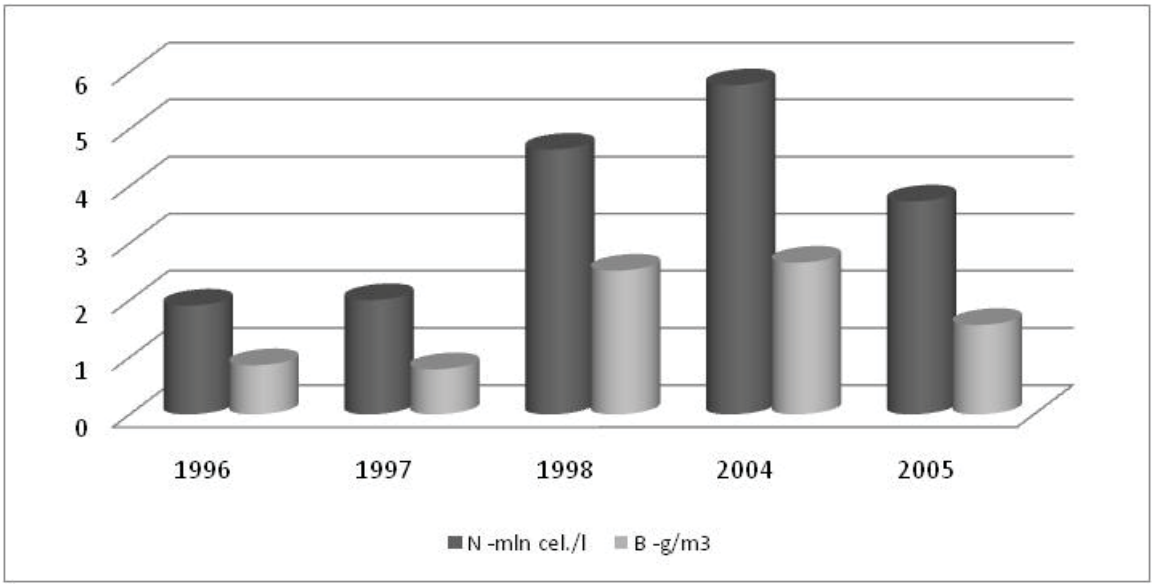

Figure 7. Dynamics of number (N – mln cell/l) and biomass (B – g/m^3) of Chlorophyta algae in Costesti-Stanca reservoir in 1996-2005 period.

CONCLUSIONS

Following phytoplankton multiannual (1956-2011) and complex study from the ecosystems located in the Dniester river basin (the Dniester River within Moldova, Cuciurgan and Dubasari reservoirs) and the Prut river basin (the Prut river within Moldova and Costeşti-Stanca reservoir), there were identified 308 species and intraspecific taxa of phylum Chlorophyta, belonging to Chlorophyceae and Conjugophyceae classes. Green algae flora proportion range within 31-64% from all algae communities.

It was recorded the diversity reduction of green algae in the past 20 years, influenced by changes in hydrological and hydrochemical regimes of the investigated ecosystems due to hydraulic structures in rivers, wastewater discharges and intake of nutrients and toxic substances from water basins adjacent territories.

Green algae quantitative parameters from the investigated ecosystems are characterized by large amplitude of space-time oscillations of number and biomass values that stands out when comparing values over time (seasonal and multiannual dynamics) and space (distribution of algal communities in different sectors of the aquatic ecosystems). It was determined a gradual increase of Chlorophyta algae quantitative parameters, then a significant decrease in their values with a certain periodicity.

ACKNOWLEDGEMENTS

We would like to extend our appreciation to the Supreme Council for Sciences and Technological Development of the Academy of Sciences of Moldova for providing funding for this study (projects 06.411.012F and 11.817.08.15A).

REFERENCES

ABAKUMOV V. A. 1983. *Methods of hydrobiological analysis of surface waters and bottom sediments.* Leningrad: Gidrometeoizdat: 78-87. [In Russian].

ELIZAROVA V. A. 1999. *The ecology and biology of algae of main systematic groups and mass species.* The ecology of phytoplankton of Rybinsk reservoir. Edit. Samara Scientific Centre of Russian Academy of Sciences. Togliatti: 51-88.

KUZIMIN G. V. 1975. *Methodology of biocenosis of internal water basin study*. Moscow: 73-87. [In Russian].

OBUH P. 1995. *Chlorococcophyceae (Class Chlorococcophyceae, Chlorophyta) fron Nistru-Prut interfluve.* Abstract of Dr. hab. of biologie thesis. Edit. Typography of State University of Moldova. Chişinău. 54 pp.

SHALARI V. M. 1971. *Phytoplankton of Modova water reservoirs*. Edit. Ştiinţa. Cishinev. 204 pp. [In Russian].

SHALARI V. M. 1984. *Phytoplankton of Moldova rivers*. Edit. Ştiinţa. Chishinev: 114-144. [In Russian].

SHALARI V. M., PANFILE I. M., GRABCO NADEJDA. 1988. *Phytoplankton*. In: Bioproduction processes in cooling reservoirs of TES. Edit. Ştiinţa. Cishinev: 22-39. [In Russian].

UNGUREANU LAURENŢIA. 1998. *Taxonomic diversity of phytoplankton from Dubăsari reservoir and its multiannual successions*. In: Materials of International Conference "Problems of biodiversity conservation in middle and lower courses of Dniester river". Typography of ASM. Chişinău: 172-174. [In Romanian].

UNGUREANU LAURENȚIA. 2003a. *Study of diversity and evaluation of quantitrative parameters of phytoplankton from lake ecosystems of Republic of Moldova*. Journal of Academy of Sciences of Moldova. Life sciences. Typography of ASM. Chişinău. **2**(291): 74-77. [In Romanian].

UNGUREANU LAURENȚIA. 2003b. *Researches on the Prut river phytoplankton*. Scientific annals of Satet University of Moldova. Series "Chemical and Biological Sciences". Typography of State University of Moldova. Chişinău: 298-301.

UNGUREANU LAURENȚIA. 2006. *Primary production and phytoplankton structure of Costeşti-Stânca reservoir*. Oltenia Journal for Studies in Natural Sciences. Craiova. **22**: 64-67.

UNGUREANU LAURENȚIA, TUMANOVA DARIA, UNGUREANU G. 2011. *Trophic status and saprobiological condition of the Dubăsari and Cuciurgan reservoirs according to the quantitative phytoplankton parameters.* Journal of Academy of Sciences of Moldova. Life sciences. Typography of ASM. Chişinău. **3** (315): 93-99. [In Romanian].

VASSER S. P., CONDRATIEVA N. V., MASIUC N. P., PALAMARI-MORDVINTEVA G. M., VETROVA Z. I., KORDIUM E. L., MOSHCOVA N. A., PRIHODIKOVA L. P., KOVALENCO O. V., STUPINA V. V., TARENCO P. M., IUNGHER V. P., RADCENCO M. I., VINOGRADOVA O. N., BUHTIAROVA L. N., RAZUMNA L. F. (1989). *Algae. Guid*. Edit. Nauk. Dumka. Kiev. 608 pp. [In Russian].

ZUBCOV E., UNGUREANU L., MUNJIU O. 2005. *The influence of abiotic factors on development of the phytoplankton in ecosystems of Prut river*. Journal of Academy of Sciences of Moldova. Life sciences. Typography of ASM. Chişinău. **2**(297): 87-94. [In Romanian].

ZUBCOV E., UNGUREANU L., ZUBCOV N., SHUBERNETKI I., MUNJIU O. 2008. *The influence of some abiotic factors on phytoplankton development and biotic processes in Prut river ecosystems.* Proceedings of 37th IAD Conference The Danube River basin in a changing World. Chişinău. Moldova: 82-86.

ZUBCOV E., UNGUREANU L., ENE A., BAGRIN N., BORODIN N. 2009. *Influence of nutrient substances on phytoplankton from Prut River.* Annals of the University Dunărea de Jos of Galați. Fascicle II - Mathematics hysics, Theoretical Mechanics. Year I(32): 68-72.

Ungureanu Laurenția
The Institute of Zoology of Academy of Sciences of Moldova, Chişinău.
MD 2028, Academiei street 1, Tel (373 22) 241623, Fax (373 22) 739809
E-mail: ungur02laura@yahoo.com

Received: March 15, 2013
Accepted: May 12, 2013