THE DEVELOPMENT OF *Dinophyta* ALGAE IN THE DUBOSSARY RESERVOIR

UNGUREANU Laurenția, TUMANOVA Daria, UNGUREANU Grigore

Abstract. The article presents the results of the investigations on the diversity and quantitative structure of *Dinophita* algae in the Dubossary Reservoir within the Republic of Moldova during 1956-2022. The ecological peculiarities, distribution and role in nature of dinophytes are insufficiently studied. Most species of the *Dinophyta* phylum do not grow in polluted waters. The potential growth of these phytoplankton species can lead to algal blooms. Following our investigations, it was established that the biomass of *Dinopyta* species during their intense development can account for about 20-80% of the phytoplankton biomass.

Keywords: diversity, *Dinopyta* algae, cantitative parameters.

Rezumat. Dezvoltarea algelor *Dinopyta* în lacul de acumulare Dubăsari. Articolul prezintă rezultatele investigațiilor privind diversitatea și structura cantitativă a algelor *Dinopyta* din Lacul Dubăsari din Republica Moldova în perioada 1956-2022. Particularitățile ecologice, distribuția și rolul în natură al dinofiților sunt insuficient studiate. Majoritatea speciilor din filumul *Dinophyta* nu cresc în apele poluate. Creșterea potențială a acestor specii de fitoplancton poate duce la înflorirea algelor. În urma investigațiilor noastre, s-a stabilit că biomasa speciilor *Dinopyta* în timpul dezvoltării lor intense poate reprezenta aproximativ 20-80% din biomasa totală a fitoplanctonului.

Cuvinte cheie: diversitatea, algele *Dinopyta*, parametrii cantitativi.

INTRODUCTION

Dinopyta algae play a significant role in the life of aquatic ecosystems – in the oxygen, phosphorus and nitrogen cycle, in the synthesis of organic matter from minerals, in the feeding of fish larvae, and as food for zooplankton species. Temperature and light factors play an important role in the distribution of dinophyte species. The maximum development of the species is associated with the summer period. *Dinophyta* are very sensitive to water pollution with organic substances and they are largely oligo-saprobic species; their development in significant numbers in the reservoir can serve as an indicator of water purity.

The Dubossary Reservoir is located along the middle course of the Dniester river and was formed as a result of the construction of the dam in the city of Dubăsari in 1954. A more detailed description of the phytoplankton of the lake during the years 1951-1970 was presented in the works of Şalaru V. (1984), and from 1980 to our days by Ungureanu L. and Tumanova D., who describe the composition of the species, as well as the seasonal dynamics of phytoplankton abundance and biomass (TUMANOVA, 2013; TUMANOVA & UNGUREANU, 2018).

The development of phytoplankton in the Dubossary Reservoir largely depends on the content of nutrients and the amount of mineral nutrients introduced on the adjacent fields, which enter the lake with rainwater or from the middle sector of the Dniester river.

MATERIAL AND METHODS

Hydrobiological samples from Dubossary Reservoir were collected seasonally during the years 1956-2022, within the research of the Laboratory of Hydrobiology and Ecotoxicology of the Institute of Zoology of USM. Phytoplankton samples were collected on the left bank of the Dubossary Reservoir from the Republic of Moldova in the following collection points: upper (Hirjău), middle (Goian) and lower sector (Cocieri).

The sample processing was performed according to unified methods for the collection and processing of hydrobiological samples in field and experimental (UNGUREANU & TUMANOVA, 2015). Algae species identification was performed using the microscope MIKMED-2 (LOMO) and identifying keys. The multiannual diversity and quantitative parameters of the *Dinophyta* phylum were obtained using the database compiled in Microsoft Excells The obtained data were compared with previous research data to evaluate the seasonal and multiannual successions of the taxonomic structure and quantitative parameters of *Dinophyta* algae (SHALARI, 1971; UNGUREANU et al., 2011; 2020).

RESULTS AND DISCUSSIONS

The *Dinophyta* phylum consists of two classes: *Desmophyceae* and *Dinophyceae* (VASSER, 1989). The ecological peculiarities, distribution and role in nature of dinophytes are insufficiently studied. Most species of the phylum *Dinophyta* do not grow in polluted waters. Such species as *Ceratium hirundinella* (O. F. M.) Bergh and *Gymnodinium aeruginosum* Stein et. Debl are indicator species of water pollution, with a preference for the oligo saprobic zone.

Algae *Dinophyta* identified in the aquatic ecosystems of the Republic of Moldova belong to the class *Dinophyceae,* with two orders – *Gymnodiniales şi Peridiniales* and two families – *Gymnodiniaceae* and *Peridiniaceae* (Table 1). Being divided into 4 genera, they are represented by a total number of 7 species and varieties, which have been identified in the last 30 years in the Dubossary Reservoir (1989-2022).

Table 1. The classification of Dinophyta algae in the Dubossary Reservoir.

Name of the taxa	1956-1988	1989-2009	2010-2015	2016-2022
CLASS DINOPHYCEAE	11	6	2	5
Order Gymnodiniales	1	1	0	0
Family Gymnodiniaceae	1	1	0	0
Genus *Gymnodinium*	1	1	0	0
Order Peridiniales	10	5	2	5
Family Peridiniaceae	10	5	2	5
Genus *Peridinium*	4	1	0	2
Genus *Glenodinium*	5	4	1	2
Genus *Ceratium*	1	0	1	1

Thus, 7 species belonging to the *Dinophyta* phylum were identified in the Dubossary Reservoir (*Gymnodinium aeruginosum* Stein et. Debl., *Glenodinium berolinense* (Lemm.) Lind. var. *berolinense, G. quadridens* (Stein.) Schiller., *G. gymnodinium* Penard., *Peridinium cinctum* (O. F. M.) Ehr. var. *cinctum, Peridinium bipes* Stein., *Ceratium hirundinella* (O. F. M.) Bergh (Photo 1), and their number decreased by about 2 times compared to the previous research period.

Photo 1. *Ceratium hirundinella* (O. F M.) Bergh. (photo by Tumanova D.*(15x40)*).

The *Dinophyta* algae in the composition of the phytoplankton of the Dubossary Reservoir were present even from the first years of its existence, but they did not develop in large quantities (0,003-0,91 g/m^3), thus they played a reduced role in the formation of the lake's productivity. Higher values of the number of species and biomass in 1987 with 0.041 million cells/l and 0.15 g/m^3 and in 1988 with 0.07 million cells/l and 0.9 g/m3 respectively, were attested (Fig. 1). Between the years 1975-1986, species from the *Dinophyta* phylum were not attested.

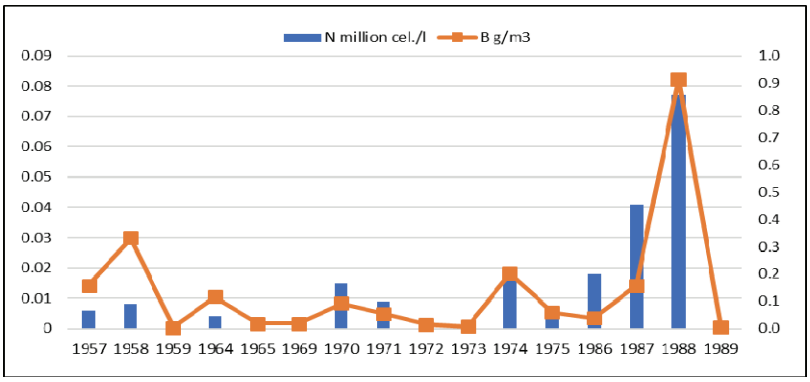

Figure 1. The dynamics of the number of species (N – million cells/l) and the biomass (B – g/m^3) of Dinophyta algae in the Dubossary Reservoir during the years 1957-1989.

Between the years 1990-2014, the values of the number of dinophyte species varied within the limits of 0.001-0.12 million cells/l, and of the biomass between 0.005-4 g/m^3 (Fig. 3). The maximum value of the biomass was attested in 2003, when the following species developed in the middle and lower sector of the lake during the summer and autumn: *Glenodinium berolinense* (Lemm.) Lind. var. *berolinense, G. gymnodinium* Penard., *Gymnodinium aeruginosum* Stein et. Debl. Then, starting from 2006, the quantitative parameters of dinophytes decreased until 2008,

and in 2009-2010 they were no longer identified in the reservoir. In 2012, high numbers of species and biomass with the share of species were attested *Glenodinium gymnodinium* Penard. (0.22 million cells/l and 3.03 g/m^3) and *Ceratium hirundinella* (O. F. M.) Bergh. (0.09 million cells/l and 4.3 g/m^3). The intensity of the development of the mentioned species reaches its maximum in the summer 2012 in the middle sector of the Dubossary Reservoir.

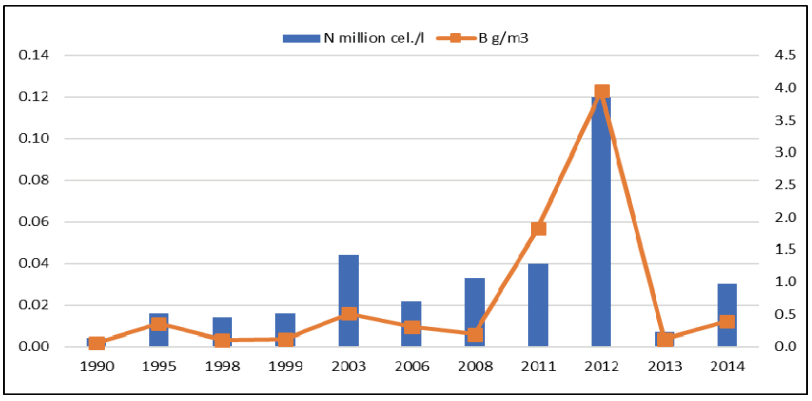

Figure 2. The dynamics of the number of species (N – million cells/l) and the biomass (B – g/m3) of Dinophyta algae in the Dubossary Reservoir during the years 1990-2014.

The average values of the number and biomass of *Dinopyta* algae were within the limits of 0.01-0.07 million cells/l and 0.11-1.28 g/m^3 in the years 2015-2018 and 2020-2021, with higher values in 2019 and 2022 (Fig. 3). The population of dinophyta algae increased due to the intensive development of algae in the years 2019 and 2022, with the species *Glenodinium guadridens* (Stein) Schiller (0.89 million cells/l) and *Glenodinium guadridens* (Stein) Schiller (0.56 million cells/l). The biomass was higher in the summer and autumn of 2019 in the middle sector caused by the development of algae from the *Dinopyta* group (20.4 g/m^3 and 13.4 g/m^3 respectively). The high values of biomass were recorded in the autumn 2022 and it increased along the entire course of the Dubossary Reservoir from 0.5 g/m^3 to 24.4 g/m^3, with the share of the species *Glenodinium gymnodinium* Penard, *Glenodinium guadridens* (Stein) Schiller, *Peridinium cinctum* (O. F. M.) Ehr, *Ceratium hirundinella* (O. F. M.) Bergh.

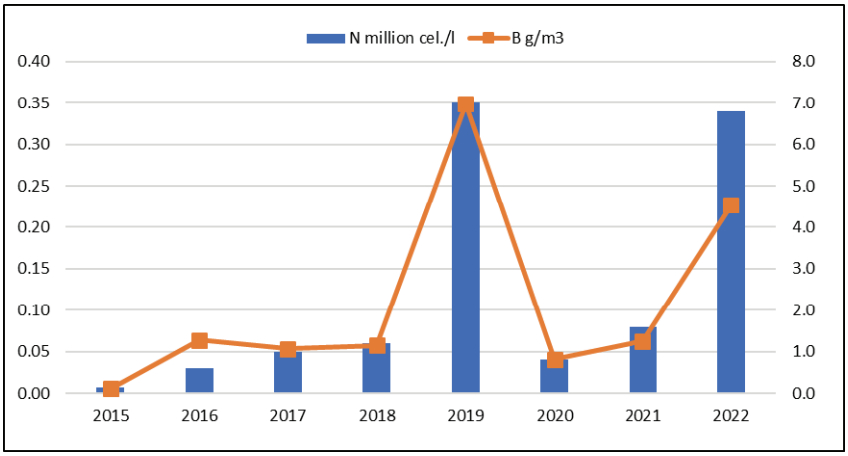

Figure 3. The dynamics of the number of species (N – million cells/l) and the biomass (B – g/m3) of Dinophyta algae in the Dubossary Reservoir during the years 2015-2022.

In recent studies, a comparison between the abundance and biomass of the planktonic algal group and the Dinophyta group in the Dubossary Reservoir was made for the years 2015-2022. It was established that the number of species of the planktonic algae of the reservoir consisted in most cases of Cyanophyta algae 10-95%, with higher values in the upper sector of the lake during the autumn period throughout the years. The number of species of Bacillariophyta algae ranged from 3 to 99%, being higher in spring in the upper sector in 2015, 2016 and 2019, 2022; the same situation was seen in the middle sector in 2017. The number of species of Chlorophyta algae was within the limits of 2-55%, corresponding to the weight of this group of algae in the summer period throughout the years 2015-2022. The share of green algae was also confirmed in the summer of 2019 in the middle and lower sectors. Other algae groups developed insignificantly: Euglenophyta-5%, ***Dinophyta***-2-10% and Chrysophyta-2%. The algae representing a significant number of species were: *Anabaena flos-aquae* (Lyng.) Breb., *Oscillatoria lacustris* (Kleb.) Geitl., *Oscillatoria planctonica* Wolosz., *Synechocistis aquatilis* Sauv.

The biomass formed mostly by algae from the Bacillariophyta group 62-100%, being higher in the spring period throughout the studied period. The lowest share of diatom algae was attested in the autumn period of 2019 (5%) due to the intense development of species from the ***Dinophyta*** group 20-80% in the middle and lower sector of the lake. The algae biomass of the Cyanophyta group ranged from 1 to 35%, being higher in the autumn period of 2015-2016. Chlorophyta algae 2-45% were attested with higher biomass in summer period. The proportion of Euglenophyta algae in the phytoplankton biomass ranged from 1 to 20%, being higher in the lower sector in the summer and autumn of 2015. Chrysophyta algae constituted only 1%, being attested only in the middle sector of the lake in the spring of 2015 and 2019, and in the lower sector in the summer of 2018. The share of ***Dinophyta*** algae was attested in the middle and lower sectors of the lake in the summer and autumn of 2019 and the autumn of 2022 with a percentage of 60-80%. The algae that contributed to the formation of higher biomass in the last ten years in the Dubossary Reservoir were: *Amphora ovalis* Kutz., *Cymatopleura solea* (Breb.) W.Sm., *Nitzschia sigmoidea* Her.W.Sm., *Gyrosigma acuminatum* (Kutz) Rabenh, *Stauroneis anceps* Ehr., *Ceratium hirundinella* (O. F. M.) Bergh, *Glenodinium gymnodinium* Penard.

CONCLUSIONS

During the investigations, it was established that algae from the *Dinophyta* phylum, with a rather low specific diversity (7 species and varieties), populate the Dubossary Reservoir in summer time. They play a reduced role in the formation of phytoplankton productivity, but the species *Gymnodinium aeruginosum* Stein et. Debl causes the phenomenon of water "blooming" in the lake from time to time. In the last ten years, the following species: *Glenodinium gymnodinium* Penard and *Ceratium hirundinella* (O. F. M.) Bergh participate in the formation of biomass in the lake. Following our investigations, it has been established that the biomass of *Dinophyta* species during their intensive development can represent approximately 20-80% of the total biomass of phytoplankton.

ACKNOWLEDGMENT

The research was carried out in the framework of the AQUABIO project (2020 - 2023) from the State Program "Environment and Climate Change", implemented by the Laboratory of Hydrobiology and Ecotoxicology, using the equipment and material base of the Institute of Zoology (Chisinau, Republic of Moldova) for field and laboratory investigations.

REFERENCES

UNGUREANU LAURENȚIA & TUMANOVA DARIA. 2015. Sampling of fitoplankton. Hydrochemical and hydrobiological sampling guidance. *Progr. Operaţional Comun România-Ucraina-Republic of Moldova 2007-2013*. Chișinău: 12-14.

UNGUREANU LAURENȚIA, TUMANOVA DARIA, UNGUREANU G. 2011. The trophic and saprobiological state of the Dubăsari and Cuciurgan reservoirs according to the quantitative parameters of the phytoplankton. In: *Buletin ASM. Ştiinţele vieţii*. Institute of Zoology Publishing. Chișinău. **3**(315): 93-99 [in Romanian].

UNGUREANU LAURENȚIA, TUMANOVA DARIA, UNGUREANU G. 2020. Phytoplankton. Primary prodaction of phytoplankton and destruction of organic matter. In: *Guidance on the Monitoring of Water Quality and Assessment of the Ecological Status of Aquatic Ecosystems*. Institute of Zoology Publishing. Chișinău. **5**: 49-52.

TUMANOVA DARIA. 2013. Phytoplankton development and production as an indicator of water qality of Dubăsari Reservoir. *International Conference Eco-Tiras 20-21 sept. 2013*. Chișinău: 424-428.

TUMANOVA DARIA & UNGUREANU LAURENȚIA. 2018. Diversitatea fitoplanctonului şi calitatea apei lacului de acumulare Dubăsari. În: *Conf. naţională consacrată jubileului de 90 ani de la ziua naşterii lui Boris Melnic, 12 februarie 2018*. CEP USM. Chișinău: 303-306.

SHALARI V. 1971. *Phytoplankton of reservoirs in Moldova*. Edit. "Știința". Chișinău. 204 pp. [in Russian].

VASSER S. 1989. *Algae*. Directory. Kyiv: Naukova Dumka. 60 pp. [in Russian].

***. Regulation on quality requirements for surface waters. GD RM No 890 of 12.11.2013. Chișinău: Monitor Official no. 262 - 267, 22 November 2013. [in Romanian].

Ungureanu Laurenția, Tumanova Daria, Ungureanu Grigore
Moldova State University, Institute of Zoology, 1, Academiei Str., Chișinău, , Republic of Moldova.
E-mails: ungur02laura@yahoo.com; dariatumanova@gmail.com

Received: April 15, 2023
Accepted: August 31, 2023