ECOLOGICAL STATUS OF THE DUBĂSARI RESERVOIR ASSESSED ACCORDING TO THE DIVERSITY, QUANTITATIVE AND FUNCTIONAL PARAMETERS OF PHYTOPLANKTON

UNGUREANU Laurenția, TUMANOVA Daria, UNGUREANU Grigore

Abstract. The article presents the results of the investigations on diversity, quantitative parameters, primary production of phytoplankton and destruction of organic matter in the Dubăsari reservoir in the period 2020-2024. Evaluation of multiannual phytoplankton successions has revealed that species from the *Cyanobacteria, Bacillariophyta, Dinophyta, Chlorophyta* and *Euglenophyta* groups predominated in the reservoir. Intensity of production and destruction processes has demonstrated considerable variations throughout the vegetation season and in different areas of the Dubăsari reservoir. According to the values of planktonic algae biomass and those of primary production in the photic zone of the water column, the reservoir can be fitted into the category of eutrophic ecosystems, periodically hypertrophic. According to the mean values of self-purification index (A/R), the water quality in the Dubasari reservoir correspond to classes IV and V (polluted to very polluted). Investigations have put in evidence that destruction processes predominated over the production ones.

Keywords: phytoplankton, primary production, destruction of organic substances, trophicity, water quality.

Rezumat. Starea ecologică a lacului de acumulare Dubăsari evaluată conform diversității, parametrilor cantitativi și funcționali ai fitoplanctonului. Articolul prezintă rezultatele investigațiilor privind diversitatea, parametrii cantitativi, productivitatea fitoplanctonului și destrucția materiei organice în lacul de acumulare Dubăsari în perioada anilor 2020-2024. În urma evaluării succesiunilor multianuale ale fitoplanctonului constatăm că în lacul de acumulare au predominat speciile de fitoplancton din grupele: *Cyanobacteria, Bacillariophyta, Dinophyta, Chlorophyta* și *Euglenophyta*. Analiza intensității proceselor de producție și destrucție în lacul de acumulare Dubăsari a relevat variații considerabile ale producției primare și ale destrucției de-a lungul sezonului de vegetație și în diferite zone ale lacului. Conform valorilor biomasei algelor planctonice și valorilor producției primare a acestora în stratul fotic, în coloana de apă, apele lacului pot fi încadrate în categoria ecosistemelor eutrofe periodic hipertrofe. După valorile medii ale indicelui A/R calitatea apei în lacul de acumulare Dubăsari corespunde claselor a IV-a și a V-a (poluată – foarte poluată). În urma investigațiilor procesele destrucționale prevalează asupra proceselor producționale.

Cuvinte cheie: fitoplancton, producția primară, destrucție, troficitate, calitatea apei.

INTRODUCTION

Over approximately 65 years of exploitation, the Dubăsari Reservoir has suffered significant hydrological, hydrochemical and hydrobiological transformations as a result of anthropogenic factors such as the intensive development of industry, agriculture, animal husbandry, etc**.** The presence of chemicals in the water accelerates the eutrophication process and causes rapid changes in the physico-chemical composition of the aquatic environment. These contaminants influence aquatic organisms, affecting in particular the diversity, structure and productivity of phytoplankton. With their high sensitivity to environmental changes, algae have been recognised as effective biological indicators.

Investigations of the algoflora of the Dubăsari Reservoir began in 1956 and continue to the present day. In different periods the algological researchers Vasile Salaru, Nelea Ialovitkaia, Ilarion Panfile, Laurenția Ungureanu and Daria Tumanova have carried out complex investigations and characterised the taxonomic structure of phytoplankton, dynamics of algal abundance and biomass, also production- destruction processes. The phytoplankton of the Dubăsari reservoir is quite varied in terms of species diversity. The lake's panktonic algal species successions were found annually, with differences, usually quantitative, being the result of the varying capacity of algal populations to grow or changes in environmental conditions. The values of primary production and phytoplankton quantitative parameters are relevant indices of water quality and eutrophication of the lake ecosystem.

The analysis of primary production contributes to the assessment of the biological capacity of ecosystems, the establishment of methods for forecasting and control of fishery resources, the evaluation of the sanitary-ecological quality of surface waters and the classification of ecosystems according to the trophicity level. The impact of anthropogenic activities and climate change makes it necessary to monitor the ecological status and analyse the processes of functioning of aquatic ecosystems of the Republic of Moldova.

MATERIAL AND METHODS

The hydrobiological samples from the Dubăsari Reservoir were seasonally collected in the period of 2020-2024, within the framework of the researches of the Hydrobiology and Ecotoxicology Laboratory of the Institute of Zoology of the MSU. The phytoplankton samples were collected in the upper, middle and lower sectors of the Dubăsari reservoir in the Republic of Moldova (Fig. 1).

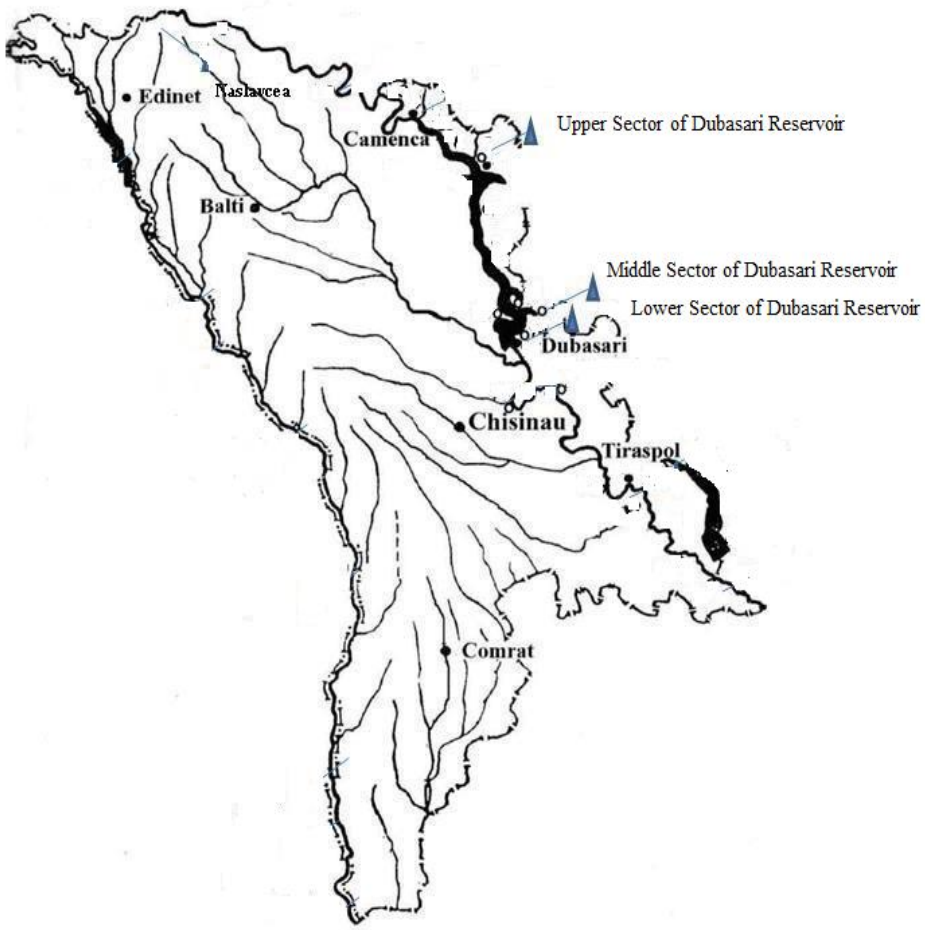

Figure 1. Map with locattion of the Dubăsari Reservoir and phytoplankton sampling points (original).

The processing of samples was carried out according to unified methods for the collection and processing of hydrobiological samples in the field (UNGUREANU & TUMANOVA, 2015). Algal species identification was carried out using the MIKMED-2 (LOMO) microscope and identification keys. Primary production and destruction of organic substances was estimated by the method of exposed bottles in oxygen modification. This technique enables the determination of both primary production (in light bottles) and respiration or oxygen consumption (in dark bottles), allowing for the calculation of both gross and net production. Dissolved oxygen concentrations are measured using the Winkler titration method in accordance with ISO 5813:1983. (UNGUREANU et al., 2014; 2021).

The integral phytoplankton production ∑A under m^2 of water surface was calculated according to the obtained experimental values, taking into account the transparency and depth of the euphotic layer, respectively, and the integral destruction ∑R - by multiplying its mean value R by the ecosystem depth. The value of primary production is determined by constructing a curve representing the vertical distribution of primary production. From this curve, the area beneath it is calculated, which corresponds to the production within 1 m^3 of the water column. The ratio between the total area under the curve and that of a 1 m^3 section is then determined. By multiplying the primary production per 1 m^3 of water by this ratio, the total production per square meter of water surface is obtained.

Primary production (A) is calculated using the following formula: $A = K_1A_1 + K_2A_2 + ... + K_nA_n$ where: A_1, A_2, ..., A_n are the primary production values (in mg O_2/m^3) measured at various depth horizons (1, 2, ..., n); K_1, K_2, ..., K_n are coefficients that depend solely on the depth intervals between the selected horizons.

These coefficients (K) are determined by dividing the area under the production-depth curve into a series of trapezoids. The area of each trapezoid is calculated using the formula: $A = (a + b) \times h / 2$, where: a and b are the lengths of the trapezoid bases (i.e., the production values at two consecutive depths), h is the height of the trapezoid (i.e., the vertical distance in meters between these depths). The sum of the areas of all trapezoids gives the total primary production (∑A) per square meter of water surface. If the primary production is known in mg O_2/L/hour or per m^2 of surface area, and the length of the daylight period in the study area is known, daily primary production can be estimated using the formula: A (mg O_2/day) = A (mg O_2/L/hour) × (T − 2) where: T − 2 accounts for the effective daylight duration, excluding one hour after sunrise and one hour before sunset, during which the low solar angle significantly reduces the intensity of photosynthesis. The primary production under 1 m2 of water surface serves as a characteristic of theproductivity of the water column in the researched area of the water body. The destruction of organic substances in 1 m^3 of the water column

(mgO2/L · hour) is obtained by calculating the arithmetic mean of the values obtained at different horizons. The value of the destruction (∑R) of organic substances for 24 hours can be calculated as follows: R (mg O 2 /L)/24 hours = A mg O 2 /L/hour x 24 hours. (UNGUREANU et al., 2020a).

Seasonal and multi-annual values of biomass and primary production of phytoplankton were used to estimate the trophic dynamics of the Dubăsari Reservoir according to the criteria of the classification and trophic categories of continental aquatic ecosystems.

RESULTS AND DISCUSSIONS

As a result of the evaluation of phytoplankton multi-annual succession in the period of 2020-2024, we found that in the Dubăsari Reservoir the following groups of phytoplankton species predominated: *Cyanophyta (Cyanobacteria), Bacillariophyta, Dinophyta, Chlorophyta* and *Euglenophyta*. During investigations were identified 95 species which belong to 6 taxonomic groups: *Cyanophyta (Cyanobacteria)*-8, *Bacillariophyta*-41, *Dinophyta*-5, *Chrysophyta*-1, *Euglenophyta*-11 and *Chlorophyta*-29 (UNGUREANU et al., 2024). It was established that the highest diversity (41 species) belongs to the Bacillariophyta group, ranging from 5 to 21 species at all collection points, being higher in the spring of 2023 and 2024, with the highest proportion of species *Cocconeis placentula* Ehr., *Diatoma vulgare* Bory, *Navicula cryptocephala* Kutz., and *Nitzschia sigmoidea* (Nitzsch) W.Smith. At the beginning of summer, as temperatures rises, species from the *Chlorophyta* group (29 species) begin to develop more intensely, from 1 to 11 species in most collection points, with maximum development in 2021 and 2022 in the middle sector and in 2024 in the middle and lower sectors. The most common species in this group were: *Coelastrum microporum* Nägeli, *Monoraphidium contortum* (Thur.) Komárk.-Legn, *Scenedesmus quadricauda* Turp. and *Pediastrum boryanum* (Reinsch) Hansgirg. The species of the *Cyanophyta (Cyanobacteria)* group were represented by a total of 8 species and were recorded at collection points from 1 to 4 species during the period 2020-2024, with higher values in the summer of 2024 in the lower sector, the most widespread being: *Oscillatoria lacustris* Kleb., *Oscillatoria planctonica* Wolocz. and *Synechocistys aquatilis* Sanv. Species from the *Euglenophyta* group, represented by a total of 11 species, were frequently recorded at 1-3 species per station during summer and autumn in the middle and lower sectors in 2022 and 2024. The most common species in this group were: *Euglena polymorpha* P.A.Dang., *Trachelomonas hispida* (Perty) F.Stein, and *Monomorphina pyrum* Ehr. A total of five *Dinophyta* algae species were recorded, ranging from one to three species periodically founded in collectioned points, with the highest diversity in the summer of 2020 and the autumn of 2021 and 2022 in the lower sector of the lake, with the following species proportions: *Ceratium hirundinella* Dujardin, *Glenodinium gymnodinium* Penard, and *Peridinium cinctum* Ehr. The *Chrysophyta* group was represented by a single species, *Dinobryon sertularia* Ehr., recorded in the summer of 2021 in the middle sector of the lake (Fig. 2). When the hydrological and hydrochemical conditions were favourable, in the Dubasari Reservoir, species of the Cyanophyta (Cyanobacteria) phylum such as *Aphanizomenon flos-aquae* (L.) Ralfs, *Microcystis aeruginosa* Kutz. and sometimes *Anabaena spiroides* Kleb. developed in large quantities and caused the water "blooms". Thus, it has been established that the high species diversity of phytoplankton largely depends on the degree of illumination of the water column and the favorable content of nutrients (UNGUREANU et al., 2024).

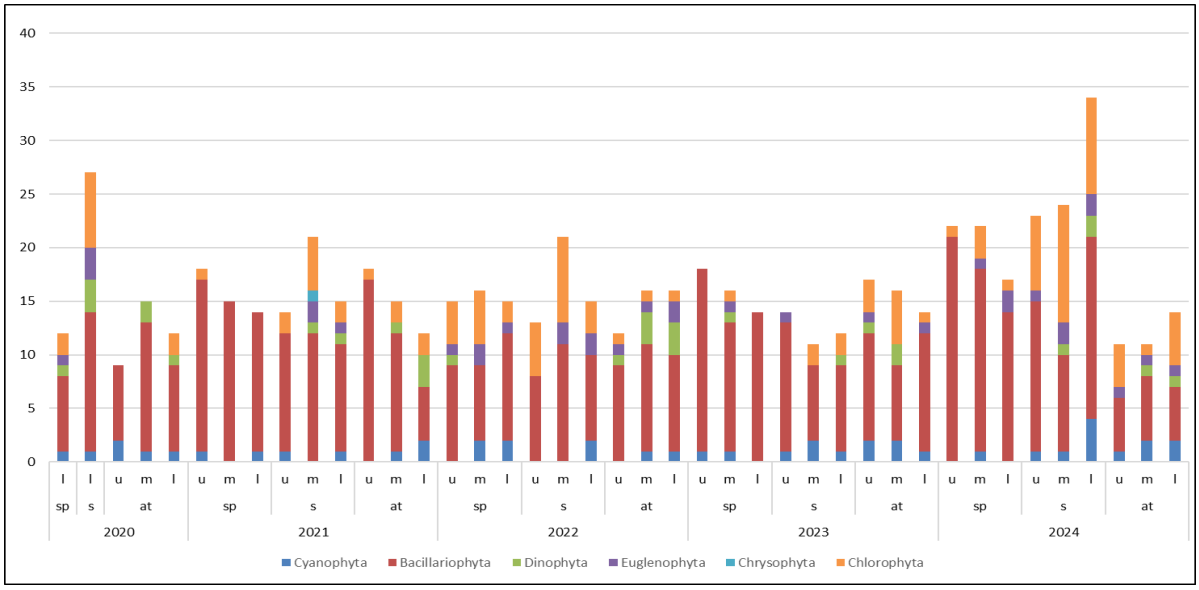

Figure 2. Seasonal dynamics of the diversity of phytoplankton groups in different sectors of the Dubăsari Reservoir (u-upper, m-middle, l-lower) in 2020-2024 (sp-spring, s-summer, at-autumn).

The seasonal dynamics of the phytoplankton of the Dubăsari reservoir is divided into four main phases, which by hydrological conditions correspond to the periods of water circulation in spring, autumn and stagnation of water masses in summer and winter. In the phytoplankton composition of the lake, the most common species were: *Aphanizomenon*

flos-aquae (L.) Ralfs, *Oscillatoria lacustris* (Kleb.) Geitl., *Synechocystis aquatilis* Sanv., *Cyclotella Kuetzingiana* Thw., *Cymatopleura solea* (Breb.)W.Sm., *Navicula cryptocephala* Kutz., *Nitzschia acicularis* W.Sm., *Nitzschia sigmoidea* (Ehr.) W.Sm., *Synedra acus Kutz.*, *Ceratium hirundinella* (O. F. M.) Bergh., *Euglena polymorpha* Dang., *Trachelomonas hispida* (Perty) *Stein.*, *Monoraphidium contortum* Thur., and *Scenedesmus quadricauda* Turp.

Changes in phytoplankton diversity in the reservoir were influenced by the water level in the Dniester River, as well as the seasons. The phytoplankton was more diverse in summer, when all algal groups increased their diversity with the exception of bacillariophytes. During the investigations, the numbers of species varied between 0.96-11.44 million cells/L in spring, 3.78-18.82 million cells/L in summer and between 1.59-8.28 million cells/L in autumn, with higher values in the lower part of the lake. The high abundance recorded during the summer was partly due to the contribution of cyanophyta algae, including *Synechocystis aquatilis* Sanv. and *Merismopedia tenuissima* Lemm. Biomass values in the period of 2020-2024 ranged between 2.07-12.98 g/m^3 in spring, 2.39-13.3 g/m^3 in summer and between 0.98-27.5 g/m^3 in autumn (Fig. 3). A decrease in numbers and a significant increase in the biomass of planktonic algae was observed, due to the development of high individual mass species of the *Bacillariophyta*, *Euglenophyta* and *Dinopyta* groups. During the investigations, the biomass values in the vernal and autumn periods fell within the limits of the trophicity category 'eutrophic', sometimes 'mesotrophic'. Higher biomass values have been attested in autumn 2022 in the lower section of the reservoir and in summer 2024 in the middle section, which are within the limits of the trophicity category 'hypertrophic'.

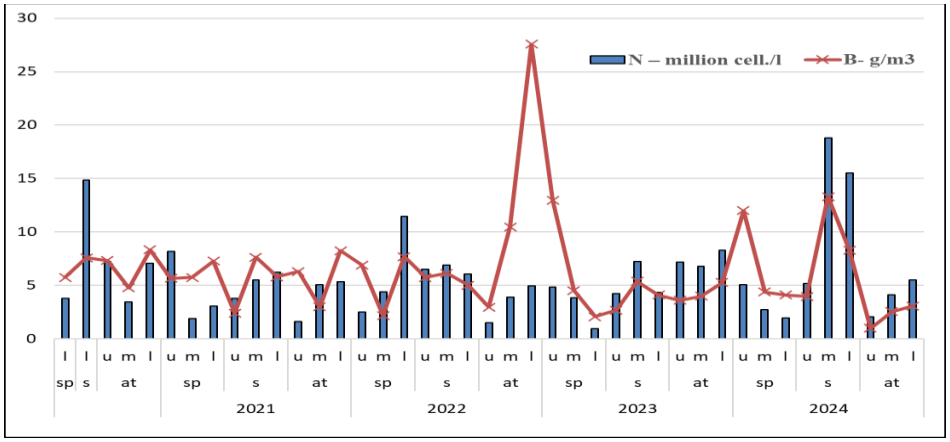

Figure 3. Seasonal dynamics of the number of algae (N – million cell./l) and the biomass (B – g/m^3) in different sectors of the Dubăsari Reservoir (u-upper, m-middle, l-lower) in 2020-2024 (sp-spring, s-summer, at-autumn).

Seasonal and spatial changes in primary production in the reservoir were accompanied by variations in phytoplankton biomass, modifications in the structure of planktonic algal communities, changes in nutrient concentrations, and fluctuations in water transparency, which depended on the amount of suspended substances. In the Dubasari reservoir, the primary production of phytoplankton and the destruction of organic substances are considerably influenced by the hydrochemical and hydrobiological parameters of the water from the middle section of the Dniester River (UNGUREANU et al., 2020b). In the multiannual analysis, lower values of primary production in the period of 2006-2009 and 2020-2024 in the spring period were attested , values varying within the range of 1.82-1.69 $gO_2/m^{-2}\cdot$ 24 hours in the spring period, 2.32 $gO_2/m^{-2}\cdot$24 hours in the summer period and values ranging within the limits of 0.28-1.4 $gO_2/m^{-2}\cdot$ 24 hours in the autumn period. During multiannual investigations of the Dubăsari Reservoir, the highest values of primary production (2.32–4.96 g $O_2/m^{-2}\cdot$ 24 h) were recorded in summer, wich is due to the longer duration of daylight hours and higher temperatures (Table 1).

Table 1. Long term succession of phytoplankton gross primary production ($gO_2/m^{-2}\cdot$ 24 hours) in the Dubăsari Reservoir.

Period	Spring	Summer	Autumn	Average value for the growing season
1986-1990*	2,63	4,03	1,07	2,78
1995	4,37	3,43	0,92	2,98
2006-2009	1,82	2,32	0,28	1,59
2010-2014	1,46	4,96	0,82	2,77
2015-2019	2,71	2,83	2,31	2,64
2020-2024	1,69	2.32	1.40	1.87

* The primary production values for the period of 1981-1995 were estimated by the scientific researcher Borș Zaharia of the Hydrobiology Laboratory of the Institute of Zoology of the ASM, and were selected from the primary data and reports of the laboratory and some publications (SHALAR, 1971).

Significant differences between the values of phytoplankton primary production and organic substances destruction during the growing season and in different areas of the lake were observed during the years 2020-2024. Primary production values in the spring period were in the range of 0.5-3.9 $gO_2/m^{-2}\cdot$ 24 h, with higher values in the lower part of the lake in 2020 ($gO_2/m^{-2}\cdot$ 24 h) and 2024 ($gO_2/m^{-2}\cdot$ 24 h), and lower values in the upper sector in 2023. The biomass values have reached the value of 12.9 g/m^3, caused by the intensive growth of algae from the *Bacillariophyta* and *Dinopyta* groups which, although large in size, did not contributed substantially to the formation of primary production.

The highest intensity of production processes was reached in the summer season, varying within the limits 0,54-4,31 g O_2/m^{-2} 24h. Higher values were recorded for the upper sector in 2022 (3.64 g $O_2/m^{-2}\cdot$24h), the middle sector in 2024 (4.31 g $O_2/m^{-2}\cdot$24h) and the lower sector (3.7 g $O_2/m^{-2}\cdot$24h), with the biomass being respectively 11.29 g/m^3, 5.79 g/m^3 and 14.35 g/m^3, with the share of species from the groups *Dinopyta*: *Glenodinium gymnodinium* Penard., *Glenodinium guadridens* (Stein) Schiller, *Peridinium cinctum* (O.F.Mull.) Ehr. and *Bacillariophyta: Cyclotella ocellata* Pant., *Cymatopleura solea* (Breb.) W. Smith., *Diatoma vulgare* Bory, *Nitzschia sigmoidea* (Nitzsc.) W. Smith. The lowest values of phytoplankton primary production were recorded in spring 2022 in the middle sector of the lake (0.54 g $O_2/m^{-2}\cdot$24h) with the biomass value of 2.17 g/m^3, being the lowest in this season (Figs. 4; 5).

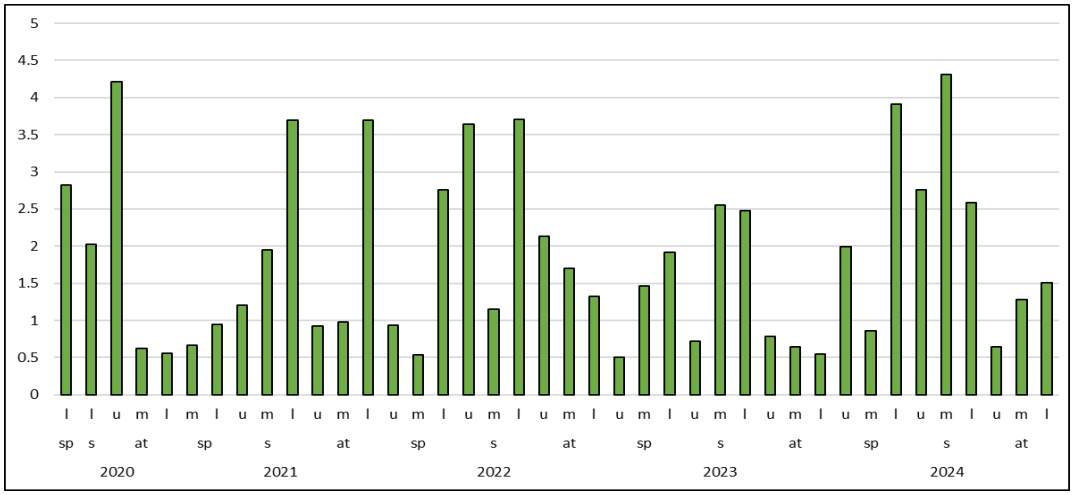

Figure 4. Seasonal dynamics (sp-spring, s-summer, at-autumn) of the phytoplankton primary production ($gO_2/m^{-2}\cdot$ 24 hours) in different sectors of the Dubăsari Reservoir (u-upper, m-middle, l-lower) in 2020-2024.

In spring and autumn the phytoplankton primary production was lower in all sectors of the lake. In the autumn period the values of primary production in the upper sector of the lake were in the range of 0.65-4.2 g $O_2/m^{-2}\cdot$24h, in the middle sector between 0.62-1.92 g $O_2/m^{-2}\cdot$24h and in the lower sector between 0.55-3.7 g $O_2/m^{-2}\cdot$24h, being lower in the lower sector of the reservoir in 2020 with the biomass of 8.34 g $O_2/m^{-2}\cdot$24h and the prevalence of diatom algae in this period. The lowest values of primary production were attested in 2022 in the middle -1.7 g $O_2/m^{-2}\cdot$24h and lower sectors-1.32 g $O_2/m^{-2}\cdot$24h with the highest biomass values 10.48 g/m^3 and 27.6 g/m^3, respectively. These high biomass indices were caused by the intensive growth of algae of the *Dinopyta* and *Bacillariophyta* groups with high individual mass. The highest values of primary production were recorded in 2020 in the upper sector, where the presence of cyanophyta algae *Oscillatoria amphibia* Ag., *Oscillatoria lacustris* (Kleb.) Geitl. and also green algae *Scenedesmus quadricauda* Turp., *Monoraphidium contortum* Thur., *Tetrastrum triangulare* (Chodat) Komárek was also recorded, which plays an active role in primary production. According to the values of the primary production of phytoplankton, in the euphotic layer, which ranged from 0.5-4.21 g $O_2/m^{-2}\cdot$24h, the Dubăsari Reservoir can be attributed to the category of eutrophic ecosystems periodically hypertrophic (Fig. 4).

The values of destruction of organic substances (R) exceeded by far the values of primary production (A) in all seasons and in all sectors of the reservoir, varying from 10.2-57.1 g $O_2/m^{-2}\cdot$24h in spring, 6.9-44.8 g $O_2/m^{-2}\cdot$24h in summer and 2.16-69.36 g $O_2/m^{-2}\cdot$24h in autumn. The lowest values of destruction of organic substances are attested in the autumn of 2020 in the middle section and in the upper section of the reservoir in the autumn of 2022. The highest values of destruction of organic substances (56.5 g $O_2/m^{-2}\cdot$24h) were recorded in spring 2021 in the upper part of the reservoir, in the lower part in spring 2023 (57.12 g $O_2/m^{-2}\cdot$24h) and in autumn 2024 (69.36 g $O_2/m^{-2}\cdot$24h). However, we also noted the considerable increase of destruction of organic substances in the lower part of the Dubasari reservoir in recent years, which indicates the presence of intense processes of decomposition of organic substances and unfavourable ecological conditions for the development of hydrobionts (Fig. 5).

The self-purification index (A/R) in the Dubăsari Reservoir varied in spring within the range of 0.03–0.27, with higher values recorded in the lower sector. In summer, it ranged between 0.02–0.23, with higher values observed in the upper sector of the reservoir, while in autumn it varied between 0.02–0.47. The higher values of the A/R ratio were recorded in autumn 2020-2021 in all sectors of the Dubasari Reservoir (Table 2).

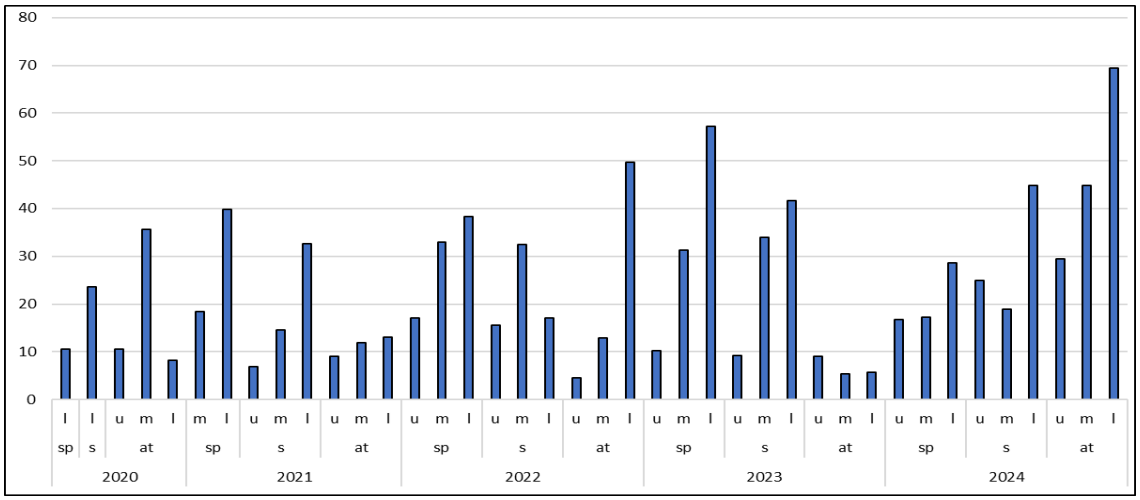

Figure 5. Seasonal dynamics (sp-spring, s-summer, at-autumn) of destruction of organic substances (gO_2/m-2· 24 hours) in different sectors of the Dubăsari Reservoir (u-upper, m-middle, l-lower) in 2020-2024.

Table 2. Variations of A/R ratio values in the Dubăsari Reservoir in the period 2020-2024.

Sector	Spring	Summer	Autumn
upper	0,03-0,12 0,07±0,03	0,05-0,23 0,13±0,06	0,02-0,47 0,19±0,17
middle	0,04-0,05 0,04±0,01	0,02-0,23 0,10±0,07	0,02-0,45 0,21±0,23
lower	0,02-0,27 0,12±0,09	0,06-0,22 0,11±0,05	0,02-0,28 0,09±0,07

During spring period of 2020-2024 the values of A/R self- purification index are mostly attributed to classes VI-V (polluted-very polluted), and the lowest values were attested in the lower part of the reservoir in 2021. The A/R self-purification index values in the summer season were within Class V (highly polluted), with lower values in the middle sector in 2022-2023. In autumn, the values of the self-purification index were higher in most cases within the limits of classes IV and V (polluted-very polluted), with lower values in 2022 and 2024 in the lower sector of the Dubasari reservoir. The A/R ratio values were less than 1 in most cases and indicate the prevalence of destructive processes over productive ones (Fig. 6).

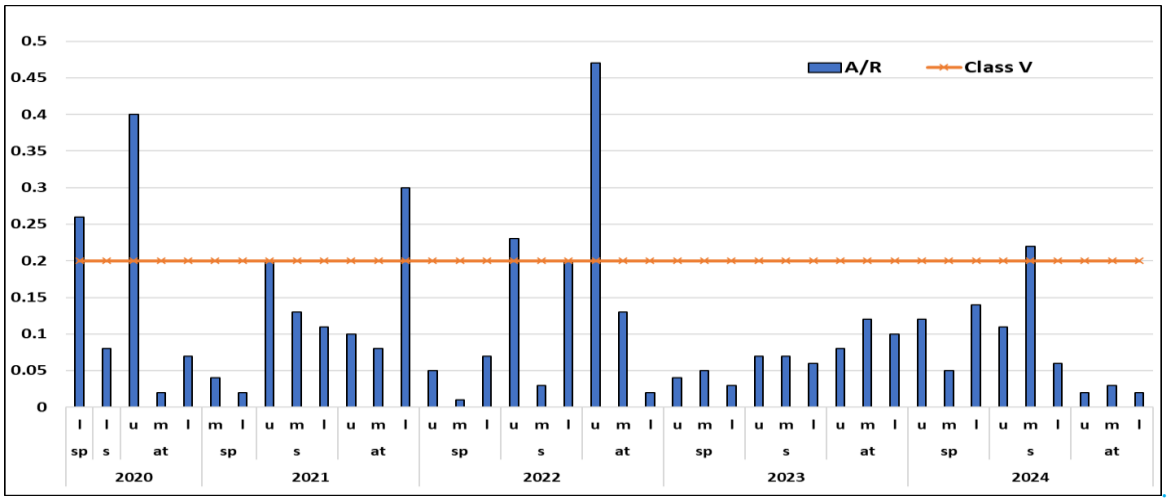

Figure 5. Variations of A/R ratio values in the Dubăsari reservoir (u-upper, m-middle, l-lower; sp-spring, s-summer, at-autumn) in 2020-2024.

CONCLUSIONS

Investigations of the intensity of production- destruction processes in the Dubăsari reservoir showed considerable differences between the values of primary production and destruction of organic substance during the vegetation period and in different sectors of the reservoir. Thus, the highest values of primary production and destruction of organic substances were recorded in most cases in the lower sector of the lake across all seasons. The primary production of phytoplankton and the destructin of organic substances in the Dubăsari Reservoir are largely determined by the hydrochemical and hydrobiological characteristics of the Dniester River's middle sector. According to the values of planktonic algal biomass and their primary production in the photic layer, in the water column, the lake waters can be assigned to the category of eutrophic ecosystems periodically hypertrophic . According to the average values of the A/R index, the water quality in the Dubasari reservoir refers to classes IV and V (polluted - very polluted) in most cases, with destructive processes prevailing over the productive processes.

ACKNOWLEDGMENT

The research was carried out in the framework of the research national projects Eutrophication processes of the Dubasari reservoir under climate change conditions. 23.70105.7007.09T, "Determination of changes in the aquatic environment, assessment of migration and the impact of pollutants, establishment of the legitimacy of the functioning of hydrobiocenoses and prevention of harmful consequences on ecosystems" 20.80009.7007.06, and Evaluation of the structure and functioning of the animal world and aquatic ecosystems under the influence of biotic and abiotic factors in the context of ensuring ecological security and the well-being of the population 010701 funded by *Ministry of Education and Research*, implemented by the Laboratory of Hydrobiology and Ecotoxicology, using the equipment and material base of the Moldova State University, Institute of Zoology (Chisinau, Republic of Moldova) for the field and laboratory investigations.

REFERENCES

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

SHALAR V. 1971. *Phytoplankton of reservoirs in Moldova*. Știința Press. Chișinău. 204 pp. [in Russian].

TUMANOVA DARIA. 2013. Phytoplankton development and production as an indicator of water qality of Dubăsari Reservoir. *Internationale Conference Eco-Tiras*. Chișinău: 424-428 [in Romanian].

TUMANOVA DARIA & UNGUREANU LAURENȚIA. 2018. Phytoplankton diversity and water quality of the Dubăsari reservoir. In: nat. conf. *Consec. jub. 90th anniversary of Boris Melnic*. CEP USM Press. Chișinău: 303-306 [in Romanian].

TUMANOVA DARIA & UNGUREANU LAURENȚIA. 2024. Structura taxonomică și cantitativă a fitoplanctonului – indicatori ai troficității și calității apei lacului de acumulare Dubăsari. In: *Starea ecosistemelor acvatice transfrontaliere ale Republicii Moldova*. Centrul Editorial-Poligrafic al Universităţii de Stat din Moldova. **1**: 95-100.

TUMANOVA DARIA, UNGUREANU LAURENȚIA, UNGUREANU GR. 2024. Trophic state of Dubăsari reservoir according to phytoplankton parameters. In: *The scientific symposium biology and sustainable development the 22 edition, November 21-22.* Bacău: 42

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

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

UNGUREANU LURENȚIA, TODERAS I., TUMANOVA DARIA, UNGUREANU GR. 2014. Diversity and funcioning of phytoplankton in the Dubasari water accumulation reservoir. In: *V International Conference „Actual broblems in modern phycology".* ASM Press. Chișinău: 118-126.

UNGUREANU LAURENȚIA, TUMANOVA DARIA, UNGUREANU GR. 2020a. Capitol V: Phytoplankton. Primary production of phytoplankton and destruction of organic substances. In: *Guidance on the Monitoring of Water Quality and Assessment of the Ecological Status of Aquatic Ecosystems*. Chișinău: 49-52.

UNGUREANU LAURENȚIA, GRANDOVA M., KOVALYSHYNA S., TUMANOVA DARIA, UNGUREANU GR. 2021. Chapter 3 Monitoring of phytoplankton and identification of its role in the functioning of aquatic ecosystems. In: *Methodological guide for monitoring the hydropower impact on transboundary river ecosystems* / BSB165-HydroEcoNex, Joint Operational Program Black Sea Basin. Chișinău: 28-31.

UNGUREANU LAURENȚIA, TUMANOVA DARIA, UNGUREANU GR. 2020b. Productivity of phytoplankton of the Dniester River and Dubăsari Reservoir under the impact of natural and anthropogenic factors. In materials of the symposium: *Functional modifications of aquatic ecosystems in the context of anthropogenic impacts and climate change.* Chișinău: 33-36 [in Romanian].

ISO 5813:1983 Water quality – Determination of dissolved oxygen – Iodometric method. http://www.iso.org/iso/catalogue_detail.htm?csnumber=11959

***. 2007. Aquatic resources of the Republic of Moldova. Vol. I. Surface waters. Chișinău: 66-203[in Romanian].
***. 2013. Regulation on quality requirements for surface waters. GD RM No 890 of 12.11.2013. Chisinau: Monitor Official no. 262 - 267, 22 November 2013. [in Romanian].

Ungureanu Laurenția, **Tumanova Daria, Ungureanu Grigore**
Moldava State University, Institute of Zoology, Academiei str. 1, MD-2028, office 326, Chișinău, Republic of Moldova.
E-mails: ungur02laura@yahoo.com; dariatumanova@gmail.com; ungureanu62igor@gmail.com

Received: April 14, 2025
Accepted: August 03, 2025