Journal of Experimental Biology and Agricultural Sciences, December - 2020; Volume – 8(Spl-2- AABAS) page S272 – S279

Journal of Experimental Biology and Agricultural Sciences

http://www.jebas.org

ISSN No. 2320 – 8694

FEATURES OF THE SEASONAL DYNAMICS OF PHYTOPLANKTON AT THE LEFT BANK OF THE VOLGA REACH OF KUIBYSHEV RESERVOIR (REPUBLIC OF TATARSTAN, RF)

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Received – September 25, 2020; Revision – November 12, 2020; Accepted – December 15, 2020
Available Online December 15, 2020

DOI: http://dx.doi.org/ 10.18006/2020.8(Spl-2-AABAS).S272.S279

KEYWORDS

Algocenosis

Phytoplankton

Algae

River Volga

Kuibyshev Reservoir

ABSTRACT

Biocenosis of shallow waters of lowland reservoirs lives in various habitat regimes and are characterized by a special structural and functional organization. To fully elucidate these features, it is necessary to research several hydrologically different areas simultaneously. This study was conducted to evaluate the effect of seasonal dynamics on the phytoplankton community of the Volga reach of the Kuibyshev reservoir near the left bank. During the observation period, 112 taxa were found in the phytoplankton of the studied site. The greatest number of taxa were identified from the groups of diatoms (44%) and green (28%) algae. Some other less diverse groups are blue-green (16%), Chrysophyta (6%), cryptophyta and dinophyta (3%), etc. Cosmopolitan and planktonic species of algae prevail in terms of environmentally-geographical characteristics. Concerning halobility, most species are indifferent, and in terms of pH, the most common are the indifferent alkaliphile + alkalibiontic algae. The total abundance and biomass of planktonic algae range 8.49-1661.09 mln.cl./l and 10.28 -114.11 mg/l respectively. Some important dominant species are blue-green algae *Microcystis aeruginosa f. flos-aquae*, *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, *Anabaena scheremetievi*, *Aulacoseira italica*, *Navicula* sp., *Carteria globosa*, *Chlamydomonas* sp., *Pandorina morum*, *Scenedesmus guadricauda*. Seasonal dynamics of phytoplankton have two peaks of abundance and biomass which are at the end of the first decade of July and in the second decade of August. Both maxima are due to the massive development of blue-green algae, which causes water to "bloom". The phytoplankton of the investigated section of the Kuibyshev reservoir is dominated by β-mesosaprobic organisms.

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Peer review under responsibility of Journal of Experimental Biology and Agricultural Sciences.

Production and Hosting by Horizon Publisher India [HPI] (http://www.horizonpublisherindia.in/).

1 Introduction

Kuibyshev reservoir is the sixth step of the Volga cascade, that was filled in 1955-1957 after damming out the river Volga near the Zhiguli Mountains (Russia, Republic of Tatarstan) (Kuibyshev reservoir, 2008; Kuibyshev reservoir phytoplankton ecology, 1989). Among all the reservoirs created on the river valleys, this reservoir ranked first in Europe and second in the world. The right and left banks of the Kuibyshev reservoir are different, among these two, the left bank is mostly flat and low while the right bank is high and steep. As we know, in the northern hemisphere, the right bank of the rivers is always higher and steeper, prone to collapse, and the left bank is flat and low-lying, prone to flooding during floods. This rule is known as "Baer's Law", is also valid for the rivers of the Northern Hemisphere, flowing from north to south (Stasenko, 1997). Rivers wash away their right bank, leaving sand and sediment on the left. You can see that the same law is opposite for the rivers of the southern hemisphere - a steep left bank and a flat right bank. The law was formulated in 1857 by K.M. Baer and is explained by the joint action of the Coriolis force and the friction force, which creates a rotational motion of the masses of water around the axis of the channel, which causes the transfer of matter between the banks. As a result of this circumstance, the conditions for the existence of aquatic organisms vary greatly (Korneva, 2009; Khaliullina et al., 2009). This is primarily because most of the left bank of the Volga River and the Kuibyshev reservoir have a shallow water. The distribution of phytoplankton with this aspect remains poorly understood in the Kuibyshev reservoir. The objective of this study was to identify the features of the seasonal dynamics of phytoplankton in the Volga reach of the Kuibyshev reservoir near the left bank.

2 Materials and Methods

From June to September 2015, a weekly sampling of phytoplankton was carried out at the Kuibyshev reservoir (the Volga river) in an open water area. The layout of the study area is shown in Figure 1. Phytoplankton samples were collected from a depth of 0.5-1.5 m. During the study period, a total of 26 quantitative and qualitative samples were collected.

The selection and processing of the collected phytoplankton samples were carried out according to standard methods (Algae, 1989; Krammer, 1991a; Krammer, 1991b; AlgaBase, 2000; Sadchikov, 2003; Pröschold&Leliaert, 2007; Cantonati, 2017). For this, all quantitative samples of 0.5L were fixed with 40% formalin solution. The fixed samples were concentrated to 7-10 ml by sedimentary method for qualitative and quantitative measurement of phytoplankton. Also, to thicken phytoplankton, a vacuum filter (PVF-35/NB) was used for hydrobiological studies in water. To

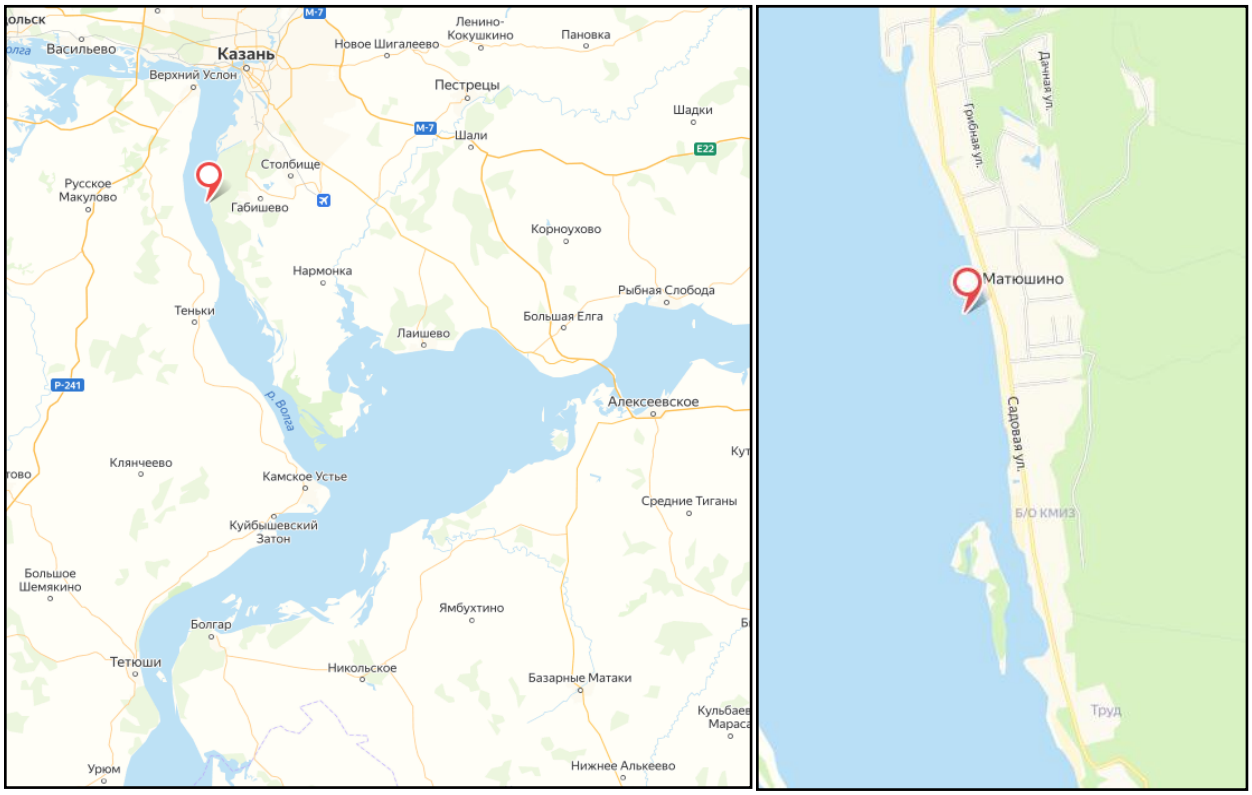

Figure 1 Location map of the phytoplankton study area of the Volga reach of the Kuibyshev Reservoir (Borovoe Matyushino, 2015).

concentrate the phytoplankton, Vladipor membrane filters (MFAS – OS – 2 and MFAS – OS – 3 type) with pore sizes of 0.45 and 0.8 μm were used. The organisms were counted according to the generally accepted method in the Goryaev chamber. The volumetric method was used to determine biomass. During the entire research period, meteorological conditions and hydrological features of the sampling area (water level, transparency, etc.) were also recorded.

3 Results and Discussion

3.1 Composition and ecologically floristic characteristic of algae

During the study, 112 taxa of planktonic algae were identified. The greatest diversity was found of ochrophytic algae (Table 1, Figure 2) and each sample contains 6 to 15 species in large quantities (Figure 3). Most often, the samples contained species of blue-green, diatoms, green and dinophytic algae. Ecologically and geographically, most of the identified algae are cosmopolitan planktonic species and are indifferent with halobility; alkaliphilic + alkalibiontic species are most often indifferent with pH. In terms of saprobity, β-mesosaprobic organisms predominate (Table 2).

3.2 Seasonal changes in planktonic algae

The total abundance and biomass of planktonic algae ranged 8.5-1661.1 mln.cl./l and 10.3-114.1 mg/l respectively (Figure 4-8). Some common quantitatively dominating phytoplankton blue-green algae are *Microcystis aeruginosa f. flos-aquae* (Wittr.) Elenk., *Aphanizomenon flos-aquae* (L.) Ralfs., *Anabaena flos-aquae* Breb., *Anabaena scheremetievi* Elenc., *Aulacoseira italica* (Ehr.) Kiitz., *Naviculas*p. sp., *Carteria globosa* Korschik., *Chlamydomonas* sp., *Pandorina morum* (Mill.) Bory., *Scenedesmus guadricauda* (Turp.) Breb.

The seasonal dynamics of phytoplankton involved two peaks of abundance and biomass. Among these, the first peak fell on the border of the first and second decades of July (a week earlier than in the upstream areas) which might be due to the shallowness of this area, which warms up faster and has a slower flow. The second peak in time coincided with the "bloom" of water with blue-green algae throughout the reservoir and fell in the second decade of August. Both maxima are due to the massive development of blue-green algae, which cause water bloom. The phytoplankton of the investigated section of the Kuibyshev reservoir is dominated by β-mesosaprobic organisms.

The objective of this study was to investigate the phytoplankton population in the water column, which was mainly represented by metaphyton. In the initial period of littoral community formation, dominating species were algae with a wide environmental range, capable to live within the plankton and benthos. These are mainly the species of filamentous centric and pennate diatoms, and

Table 1 Main systematic phytoplankton algal groups of the Volga reach of the Kuibyshev Reservoir (Borovoe Matyushino, 2015)

Phylum	Class	Order
Cyanophyta	*Cyanophyceae*	*Chroococcales*
		Oscillatoriales
		Nostocales
Cryptophyta	*Cryptophyceae*	*Cryptomonadales*
Dinophyta	*Dinophyceae*	*Peridiniales*
Ochrophyta	*Chrysophyceae*	*Chromulinales*
	Bacillariophyceae	*Thalassiosirales*
		Melosirales
		Aulacosirales
		Fragilariales
		Naviculales
		Achnanthales
		Cymbellales
		Surirellales
Chlorophyta	*Chlorophyceae*	*Chlamydomonadales*
		Volvocales
		Sphaeropleales

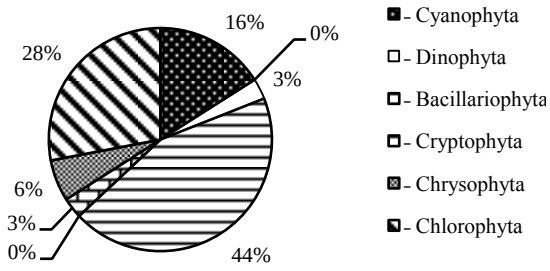

Figure 2 Distribution of the phytoplankton taxa at the Volga reach of the Kuibyshev Reservoir (Borovoe Matyushino, 2015)

chlorococcales. However, at the beginning of the water warming the macrophytes are joined by epipelon and epiphytic algae (large species having heteropolar structure of cells or colonies, often able to mobility). These are types of diatoms and blue-green algae, scraps of green filamentous and desmidia algae. During the observation period, 112 phytoplankton taxa were found at the study site. The greatest number of taxa were identified from the groups of diatoms (43.75%) and green (28.13%) algae. Some other less diverse groups are blue-green (15.63%), Chrysophyta (6.25%), cryptophyta, and dinophyta (3.13%) each. Cosmopolitan and planktonic species of algae prevail in terms of environmental and

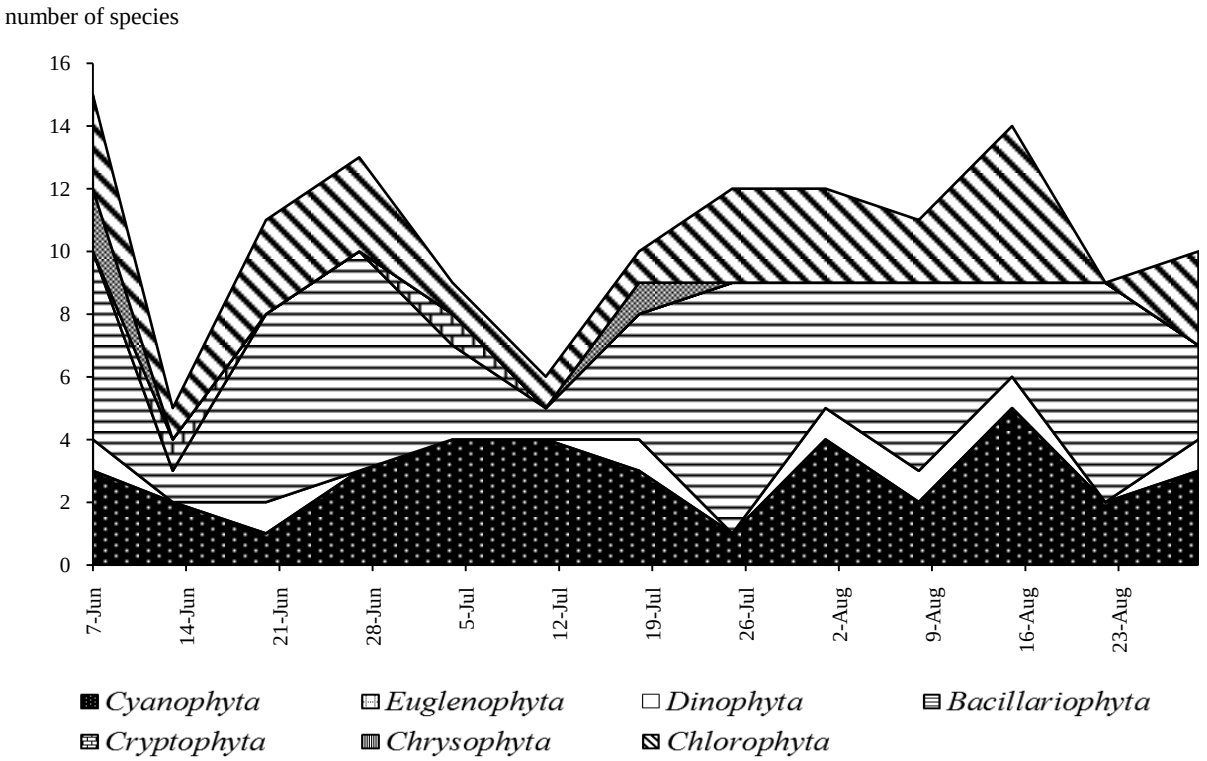

Figure 3 Distribution of the phytoplankton taxa at the Volga reach of the Kuibyshev Reservoir (Borovoe Matyushino, 2015)

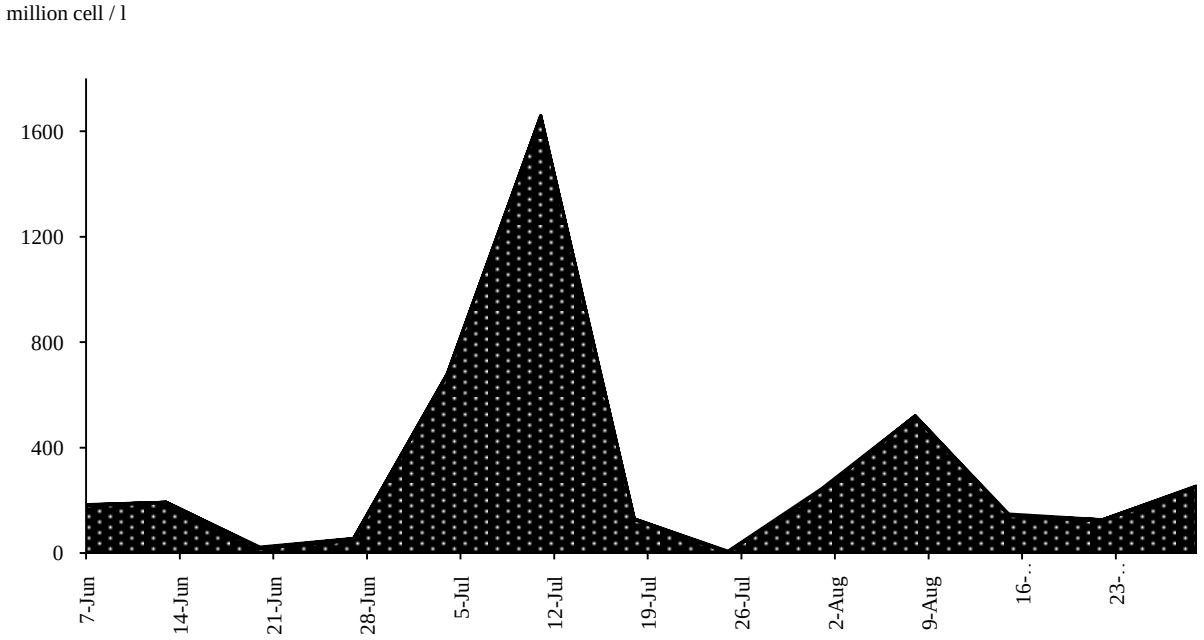

Figure 4 Seasonal dynamics of the abundance of blue-green planktonic algae (million cells/l) at the Volga reach of the Kuibyshev reservoir (Borovoe Matyushino, 2015)

Table 2 Ecologically and geographical characteristics of common species of phytoplankton of the Volga reach of the Kuibyshev Reservoir (BorovoeMatyushino, 2015)

Groups	Number of species
Habitats	
Planktonic	13
Littoral	1
Benthic-planktonic	1
Fouling inhabitant	1
Plankton-benthic fouling inhabitant	3
Plankton fouling inhabitant	5
Plankton-benthic-epibiontic	–
Plankton-epibiontic fouling inhabitant	1
Plankton-littoral	–
Geographical distribution	
Cosmopolite	24
Subtropical	1
Biographically poorly studied species	–
Boreal	–
Halobity categories	
Indifferent	21
Oligohalobe	3
Halophile	–
Halophobe	–
PH indicator categories	
Alkaliphile + alkalibiont	11
Indifferent	9
Acidophile + acidobiont	–
Saprobity	
Oligo-betamesosaprobe	5
Beta-mesosaprobe	14
Beta-alfamesosaprobe	2
Oligosaprobe	1
Mesosaprobe	1
Alfa-mesosaprobe	2
Polysaprobe	–
Alfa-polysaprobe	1

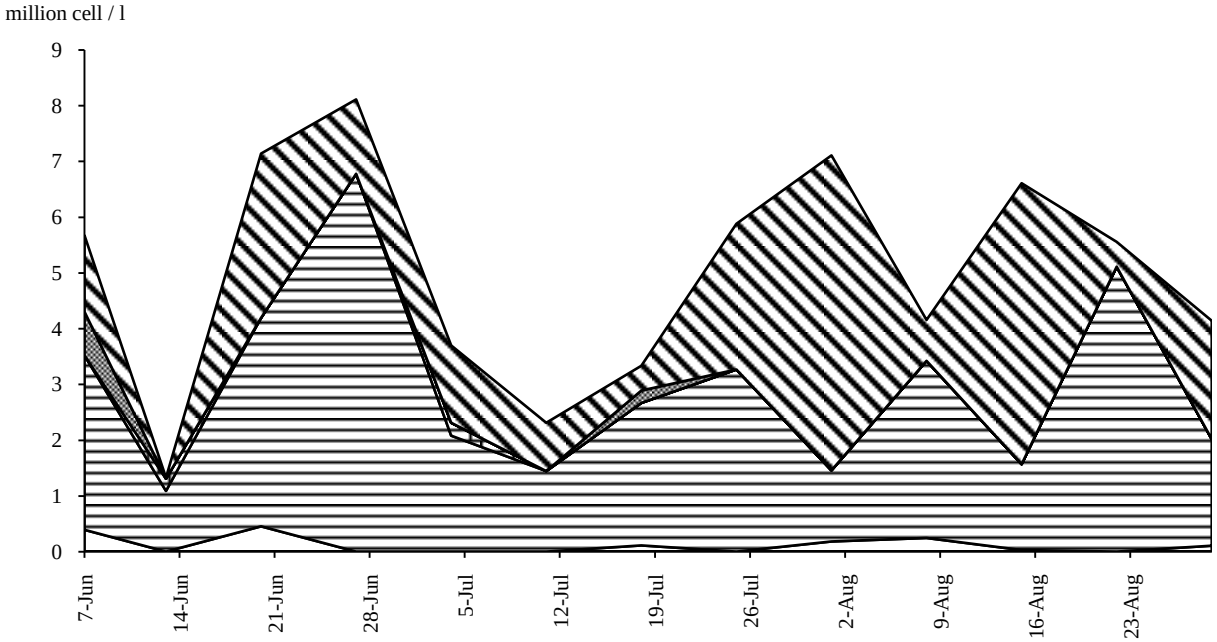

Figure 5 Seasonal dynamics of the abundance of dominanting planktonic species of algae (excluding blue-green algae) (million cells/l) at the Volga reach of the Kuibyshev reservoir (Borovoe Matyushino, 2015)

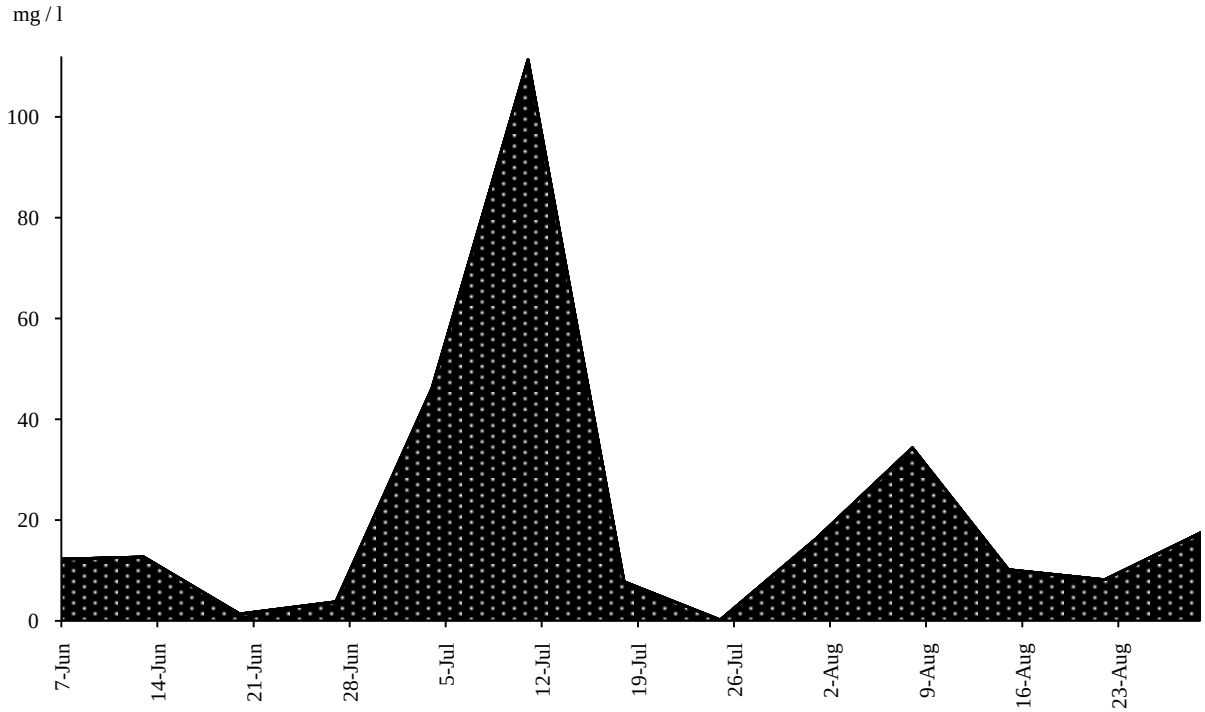

Figure 6 Seasonal dynamics of biomass (mg/l) of blue-green planktonic algae at the Volga reach of the Kuibyshev reservoir (Borovoe Matyushino, 2015)

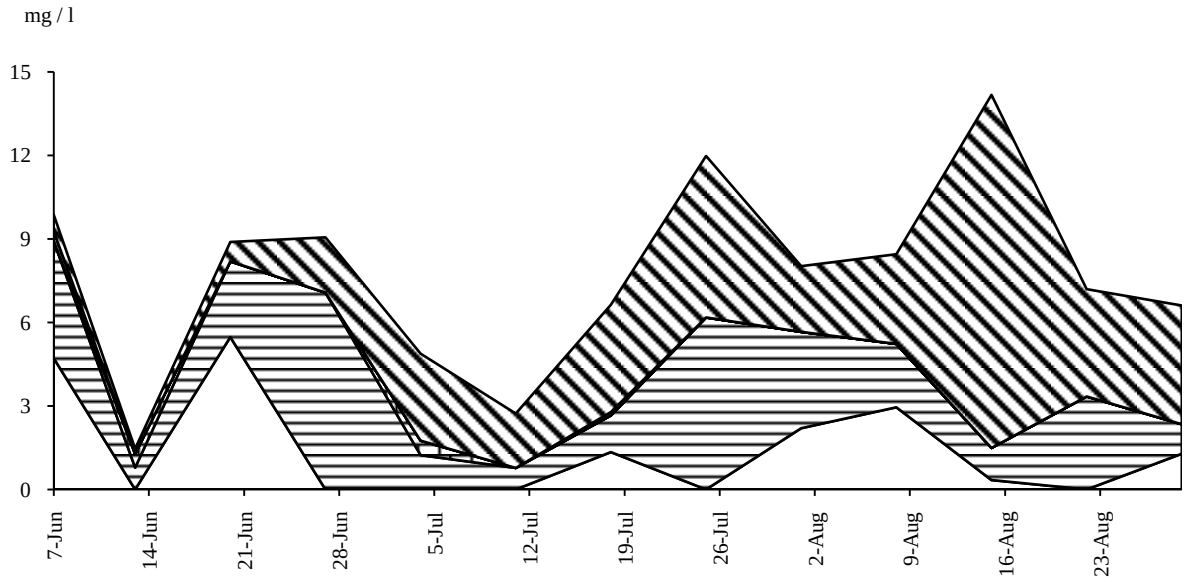

Figure 7 Seasonal dynamics of biomass (mg/l) of the dominant species of planktonic algae (excluding blue-green algae) at the Volga reach of the Kuibyshev reservoir (Borovoe Matyushino, 2015)

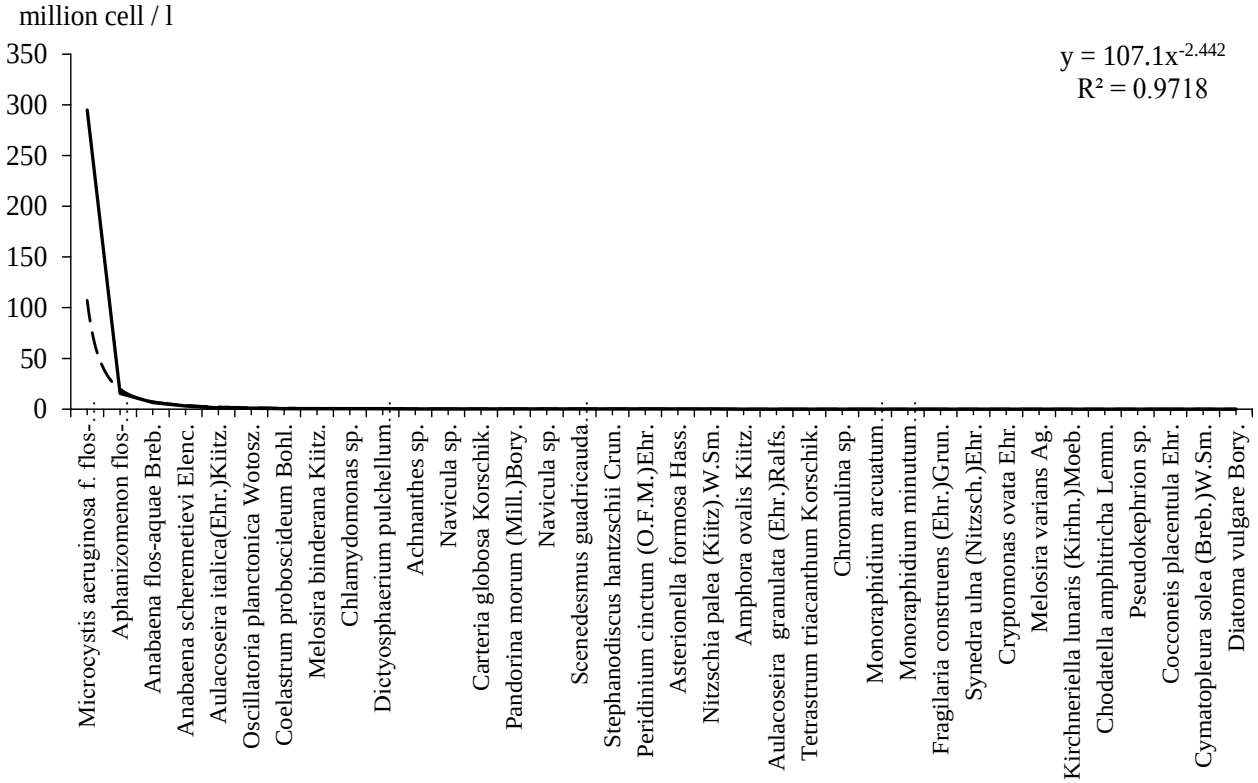

Figure 8 Distribution of the average abundance (million cells/l) of dominant species of planktonic algae (excluding blue-green algae) of the Volga reach of the Kuibyshev reservoir (Borovoe Matyushino, 2015)

geographical characteristics. With halobility, most species are indifferent, and in terms of pH, the most common species are the indifferent and alkaliphile + alkalibiontic algae.

Conclusions

Biocenosis of shallow waters live increased variability of habitat regimes and are characterized by a special structural and functional organization. To fully elucidate these features, it is necessary to research the Kuibyshev reservoir simultaneously in several hydrologically different areas. A comparison and analysis of the data will provide more reliable statistics. This article presents the results of studies of the Volga reach of the Kuibyshev reservoir near the left bank. The future works will present a comparative analysis of the phytoplankton structure of the left and right banks, as well as other areas of the middle part of the reservoir. This study was performed under the State Program of Competitive Growth of the Russian Federation at Kazan Federal University.

Acknowledgments

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

Conflict Of Interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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