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Research Article

Planktonic Algae of the Stepnoy Zay River

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ABSTRACT:
The article presents the results of phytoplankton investigations of the StepnoyZay River (left tributary of the Kama River, the Republic of Tatarstan). 59 taxa of plankton algae were identifiedduring the research. The maximum quantitative indicators (total abundance and biomass) are characteristic for river areas with thethickets of macrophytes. Bacillariophyta,Chlorophyta and Euglenophytaspecies dominate in the phytoplankton. The greatest species diversity is characteristic for open water area with banks, without thickets of macrophytes. Waters of the investigated area of the StepnoyZay River refer to β-mezasaprobic type and moderately-polluted zone. The trophic status of water among macrophyte thickets mostly corresponds to eutrophic type, in open water area –to meso- and eutrophic types.

KEYWORDS: algocenosis, phytoplankton, algae, the StepnoyZay River.

INTRODUCTION.

The StepnoyZay River (the left tributary of the Kama River) flows from the southeast to the northwest through the territory of the Republic of Tatarstan, within the Bugulma-Belebey Upland and is a regional monument of nature. In this region there is an intensive development of the oil-producing, gas and energy industries, and related branches. 276 settlements, including 4 large cities (Bugulma, Almetyevsk, Zainsk, Leninogorsk)are located in the catchment area of the StepnoyZay River. In the river basin there are 137 industrial and agricultural enterprises, using waters of the river. At 71 km from the mouth,the StepnoyZay River is regulated by Zainsky reservoir. It was created in 1965 as a reservoir-cooler for Zainskaya GRES. All these factors have a huge impact on the water quality of this river [Information bulletin on the state of surface water bodies, 2007; Nikanorov A.A., Zakharov S.D., Bryzgalo V.A., Zhdanova G.N. 2010].

To date, there is little published information on the algocoenosesof the StepnoyZay River. There are only episodic and non-systematic data on materials, collected in 2008-2009 by Federal State Budgetary Institution "Administration for Hydrometeorology and Environmental Monitoring of the Republic of Tatarstan" (in the section of the monograph "Rivers of Russia" of Nikanorov, Zakharov, 2010) .Also, the shortcoming of monitoring system, used for this river, as well as for most other water bodies, is an inadequate study of the seasonal dynamics of phytoplankton.

MATERIALS AND METHODS.

This article analyses the results of studies of the plankton algae in the StepnoyZay River. Studies were conducted near the settlement SvetloeOzeroduring August 2013 in the thickets of macrophytes (narrow-leaved catoptric - Typhaangustifolia L.), and in the

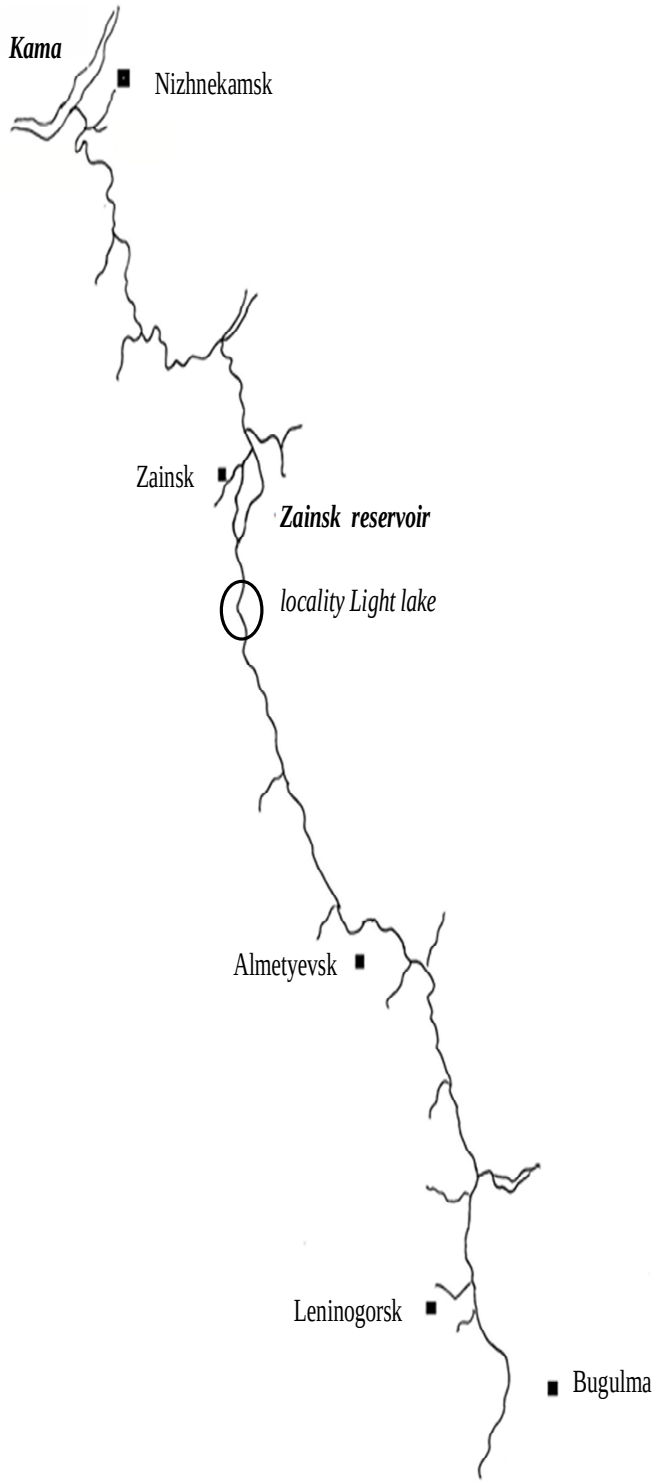
open water area without macrophytethickets. Selection of integrated phytoplankton samples was carried out at two permanent stations, which were located on the middle reaches of the river, above the Zainsk reservoir (Figure 1). There are 4 large citiesupstream.

Sampling and laboratory investigation of phytoplankton samples were carried out according to the generally accepted methods [The methodology of studying the biogeocenoses of inland water bodies. 1975;Algae. 1989]. The samples of phytoplankton were taken using the Molchanov bathometer.All quantitative samples, having the volume 0.5 litre, were fixed with 4% formalin solution. Fixed samples were concentrated in 2 stages, using settling method, to 10-20 ml. Qualitative water samples were concentrated by direct filtration through membrane filters in two stages - with a pore diameter of 3-5 μm and 1.2-1.5 μm, and they were studied being alive.Also during the study period, weather conditions and air temperature were recorded. It the process of sampling, the water temperature and transparency (according to Secchi disk) were measured.

In total, 30 quantitative and qualitative samples were collected. The period of research began with cloudy weather, but in final weeks it was sunny, without precipitation.

Species composition, abundance and biomass were used to characterize algae communities. The index of trophicity, using the Milius block: Ib = 44.87 + 23.22*logB [Andronikova I.N. 1993], and theindex of saprobityof Pantle and Buck in the modification of Sladechekfor plankton communities were calculated for each sample [Sadchikov A.P. 2003.]. In order to characterize the structural indices of phytoplankton communities, the dynamics of general and relative species richness were studied. Dominant species had the abundance or biomass more than or equal to 10% of the overall indices for the community; subdominant species - 5-10%. Dominant complexes were distinguished on the basis of rank distribution, according to the number and biomass of species.

Figure 1. Location map ofphytoplankton sampling stations on the StepnoyZay River in 2013



The basin of the StepnoyZay River is located on the northern slope of the Bugulma Upland. The river heads on the south-west from Bugulmacity, at altitudes of about 300 m, and flows in the north-west direction. The river basin in the east and south shares its borders with the Ik River basin, in the west - with the

basin of the SheshmaRiver. The forest cover of the territory is about 15%. There are swamps in the floodplain of the river and in the estuary. The length of the StepnoyZay River from the source is 219 km. The length from the source of the right-bank tributary the BugulminskyZay Riveris 257 km. The catchment area is 5.02 thousand km^2. The river has a well-defined valley with a width up to 2 km in the upper and up to 4 km - in the lower reaches. The valley is asymmetric: the right bank is precipitous, the left is more gentle. The floodplain begins to allocate from Leninogorsk. It stretches along the river in the form of a broad band, sometimes disappearing and expanding to the mouth. The prevailing width of the floodplain in the upper reaches is 0.2-0.5 km, in the middle reaches - 1.0-1.5 km. The floodplain in certain areas is cut by channels and dead stream branches. The width of the river bed in the upper reaches is 2-10 m, in the middle reaches - 20-50 m, in the lower reaches - 50-100 m. A large number of tributaries (68) form a dense river network (0.35-0.44 km/km^2). Seven tributaries have a length from 20 to 61 km. The largest tributaries are the rivers BugulminskyZay, Zay-Karatay, Ursala, Shumishka, LesnoyZay, Zycha.

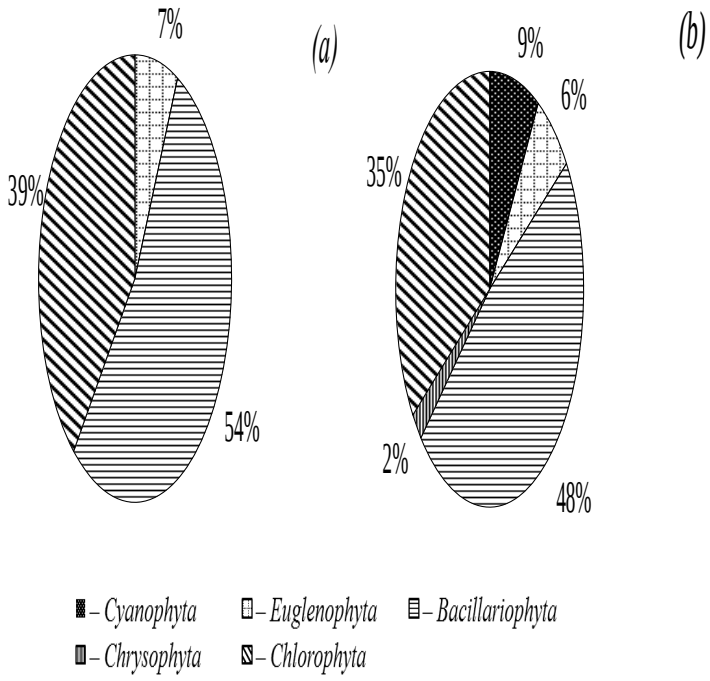
The long-term annual average low flow at the mouth of the river is 6.15 m^3/s. The hydrological regime of the river is characterized by high floods and low long-term dry-weather period, and medium water content. The nourishment of river is mixed, mostly snow (62%). Before the development of oil fields, the water in the river belonged to hydrocarbonate-sulphate-calcium type, with increased mineralization (300-600 mg/l). At present, the qualitative composition of water varies from hydrocarbonate-sulphate-calcium (sources) to chloride-hydrocarbonate-sodium (estuary). On small areas near the city Almetyevsk, the type of water is sulfate-chloride-sodium, and after the confluence of the Zycha River it is hydrocarbonate-chloride-magnesium. Mineralization isincreased; sometimes it is very high (more than 2000 mg/l).The hardness of water is very high in spring (9-12 meq/l) and in dry-weather period (9-20 meq/l).

RESEARCH RESULTS.

59 species of plankton algae were identified during the study. The species diversity is not very rich, since the object of these studies was mainly the phytoplankton of water column, which was represented mainly by metaphyton.Also, the studies were carried out in a short period of time, and on a small water area of the river. In the water samples, taken at the shore with tickets of macrophytes, 41 species of algae have been identified, of which 3 Euglenophyta, 22 Bacillariophyta, and 16 Chlorophyta.

In the water samples, taken at the station with open water, 46 taxa were found, 4 of which belonged to Cyanophyta, 3 to Euglenophyta, 22 to Bacillariophyta, 1 to Chrysophytaand 16 to Chlorophyta. The data on the taxonomic structure of algae as a percentage are shown in Figure. 2.

Figure 2. Number of taxa (%) in certain groups of phytoplankton of the StepnoyZay River, collected in August 2013: a – in the thickets of macrophytes, b – in open water area.



During the period of observations, the abundance of phytoplankton of the StepnoyZay River varied within the range of 0.95-7.20

million cells/litre.The biomass variedfrom 1.69 to 9.54 mg/l (Table 1). The average abundance and biomass of algae in the thickets of macrophytes was 3.27 million cells/litre and 6.5 mg/l. In the area with open water the average values were 2.32 million cells/litre and 3.4 mg/l.

The highest values of quantitative indicators of phytoplankton were noted at the stations with macrophyte thickets. In general, the number of phytoplankton was characterized by an increase in the open areas by the end of August.And, on the contrary, there was a decrease in abundance in the area with macrophytethickets.

Table 1. Quantitative indicators of phytoplankton of the StepnoyZay Riverin August 2013

Date	Number of species in the sample	Abundance (million cells/ litre)	Biomass (mg/l)
Thickets of macrophytes			
03.08.2013	21	5.10	9.54
07.08.2013	22	1.80	5.38
11.08.2013	18	4.88	8.02
15.08.2013	19	2.56	5.83
19.08.2013	18	2.01	3.69
Open water area			
03.08.2013	25	1.89	2.25
07.08.2013	23	2.84	4.75
11.08.2013	15	9.46	3.16
15.08.2013	23	3.61	3.23
19.08.2013	16	7.20	1.69

DISCUSSION OF THE RESULTS.

Chlorophyta and Bacillariophyta form the basis of plankton algocenoses in the investigated areas. They accounted for 60-91% of the total abundance and biomass. Euglenophytaspecies are also numerous.In quantitative terms, the same species of algae predominate in all samples, but the relation between them varies (Figure 3). The dominant algae complex on the investigated area of the river is represented by BacillariophytaCocconeisplacentulaEhr.,

Amphora ovalisKiitz., Navicula sp. sp., Pinnularia sp. sp., StephanodiscushantzschiiCrun., Gomphonemaolivaceum (Lyngb.) Kiitz., Synedra ulna (Nitzsch.) Ehr., Aulacoseira italic (Ehr.) Kiitz., ChlorophytaChlamydomonas sp. sp., CarteriaglobosaKorschik.In the samples from all sites, EuglenophytaPhacus are also widespread. These species of algae grow in mass in both areas.

Despite the similar composition of the main dominants, there are some differences in the algalocenosis of the studied biotopes. As researches show, the total quantitative indices of phytoplankton (abundance and biomass) are much higher near the shore with the tickets of macrophytes, than in the area with open water.

Figures 4-5 shows the dynamics of variability of algae biomass and abundance during the research, conducted on the StepnoyZay River in 2013. Most of the algae, occurringin the macrophyte thickets, are periphyticdiatoms with large cells.

Figure 3. The average biomass of the predominant algae species of the StepnoyZay River, collected in August 2013 (the biomass of species is ranked in descending order): a – in the tickets of macrophytes, b – in the open water area.

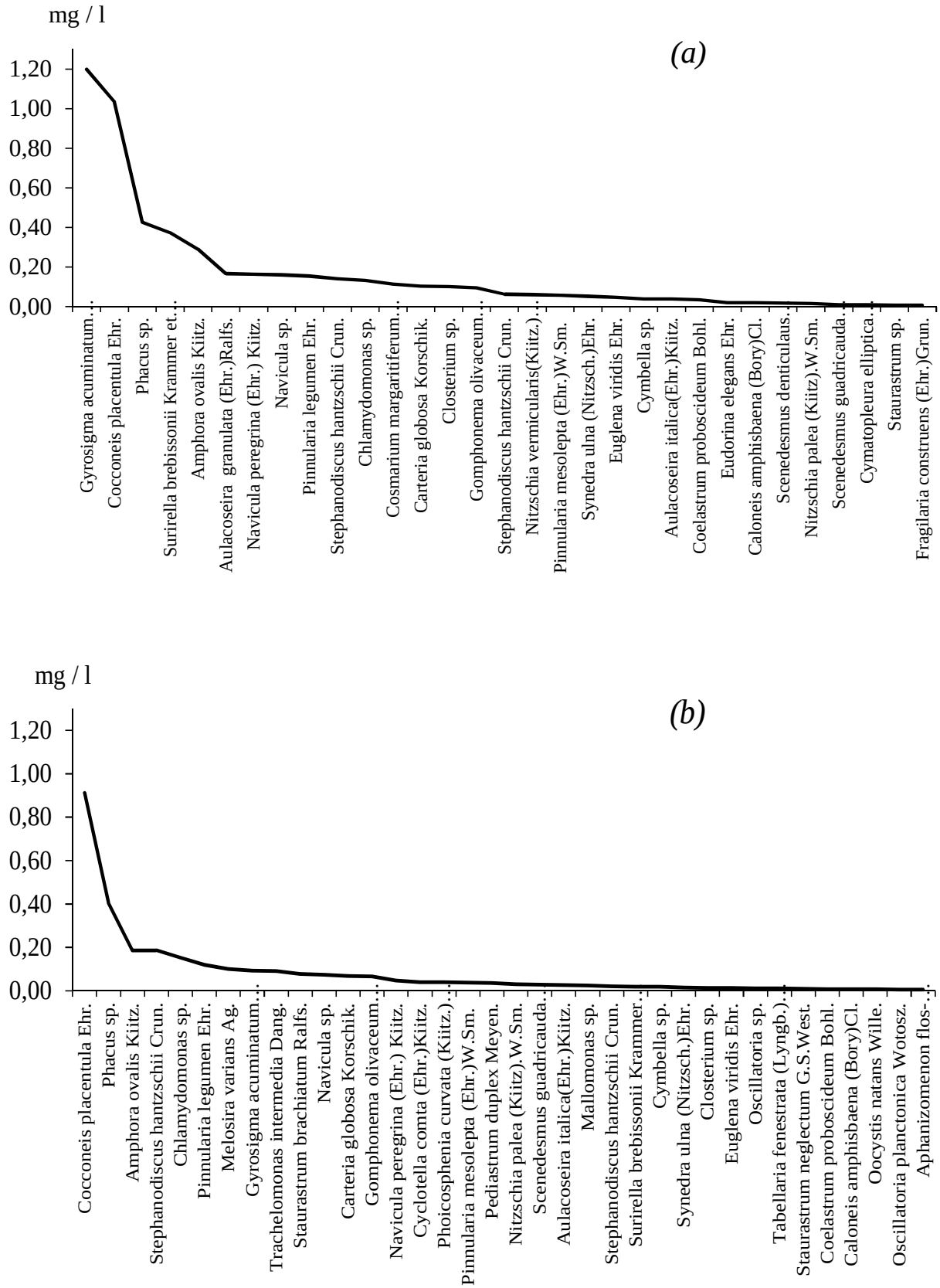


Figure 4. Dynamics of algae abundance (mln. cells/l) in the StepnoyZay River in August 2013: a – in the tickets of macrophytes, b – in the open water area.

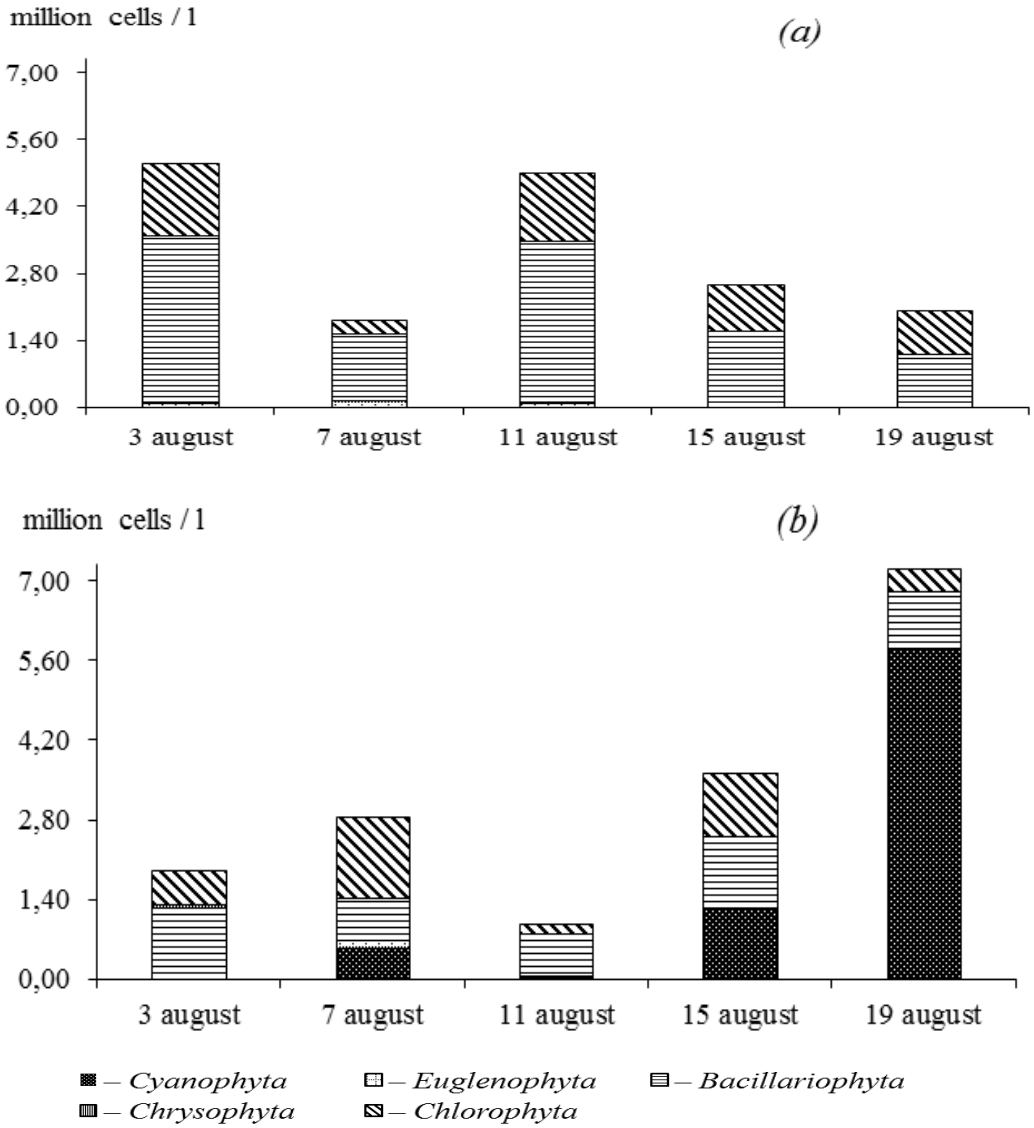
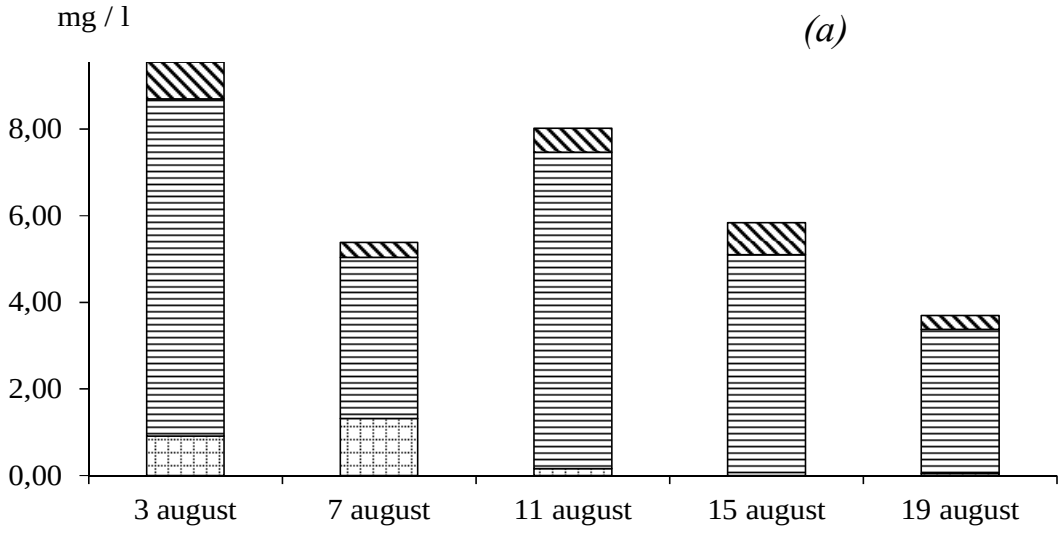
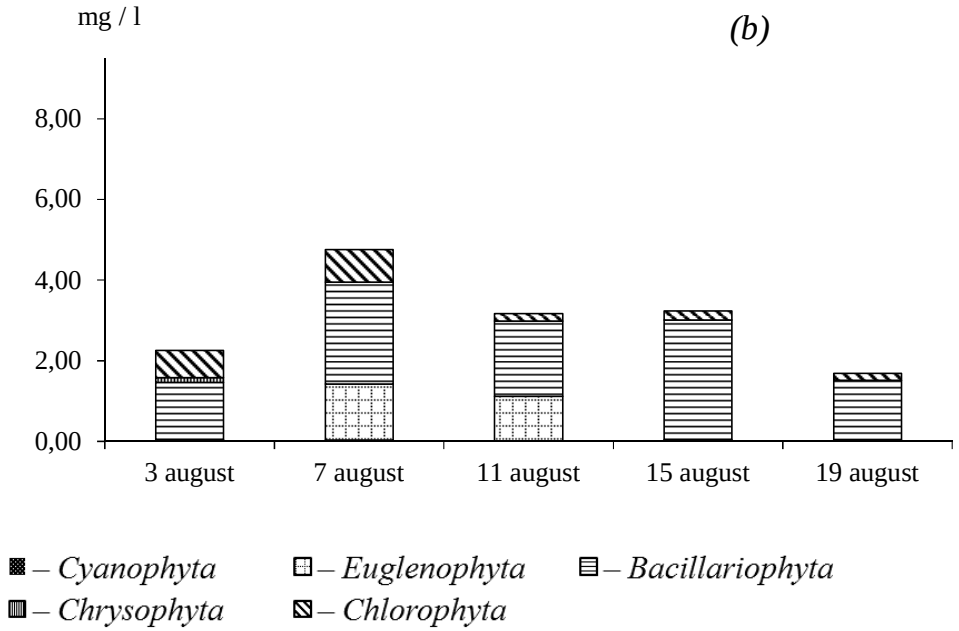


Figure 5. Dynamics of algae biomass (mg/l) in the StepnoyZay River in August 2013: a – in the tickets of macrophytes, b – in the open water area.





Pennate diatoms Navicula sp. sp., Nitzschiavermicularis (Kiitz.) Grun., Synedra ulna (Nitzsch.) Ehr., CocconeisplacentulaEhr.and other algae, which don't develop massively in the areas with open water and rapid current, are predominant in abundancein the tickets of macrophytes. The major part of biomass is formed by large diatoms Gyrosigma acuminatum (Kiitz.) Rabenh., CocconeisplacentulaEhr., Navicula sp., Synedra ulna (Nitzsch.) Ehr., Amphora ovalisKiitz. SurirellabrebissoniiKrammer et Lange-Bertalot., Cymbella sp. Also, a large contribution to the biomass and abundance is made by Chlorophyta, such as Coelastrumproboscideum Bohl., Cosmariummargaritiferum Menegh., Chlamydomonas sp. sp., Eudorinaelegans Ehr., Closterium species. EuglenophytaPhacus and Euglena viridis Ehr. occur quite often in this area.

During the period of observations, the total abundance and biomassin the open water area were lower, than those near the shore with the tickets of macrophytes. Rheophilic algae, which prefer plankton mode of living, are most often developedin this area. It is facilitated by the hydrological features of the site, and the current of river. More than a half of all algae species,found in this biotope, is Bacillariophyta. Centric diatoms are dominated in terms of biomass and abundance:StephanodiscushantzschiiCrun., Melosiravarians Ag., Cyclotellacomta (Ehr.) Kiitz., Aulacoseira italic (Ehr.) Kiitz., etc. Among the pennate algae, the most significant part of abundance and biomass are constituted by the species Nitzschiapalea (Kiitz).W.Sm., Amphora ovalisKiitz., PinnularialegumenEhr., Navicula sp. sp., Gomphonemaolivaceum (Lyngb.) Kiitz., Phoicospheniacurvata (Kiitz.) Grun. Coccoid plankers have quantitative advantage among the green algae: Pediastrum duplex Meyen., Scenedesmusguadricauda (Turp.) Breb., however, many monadic algae Chlamydomonas sp. and CarteriaglobosaKorschik. There are many species of EuglenophytaPhacus sp. and Trachelomonas intermedia Dang. Also ChrysophytaMallomonas sp.from time to time appeared on this site in early August.

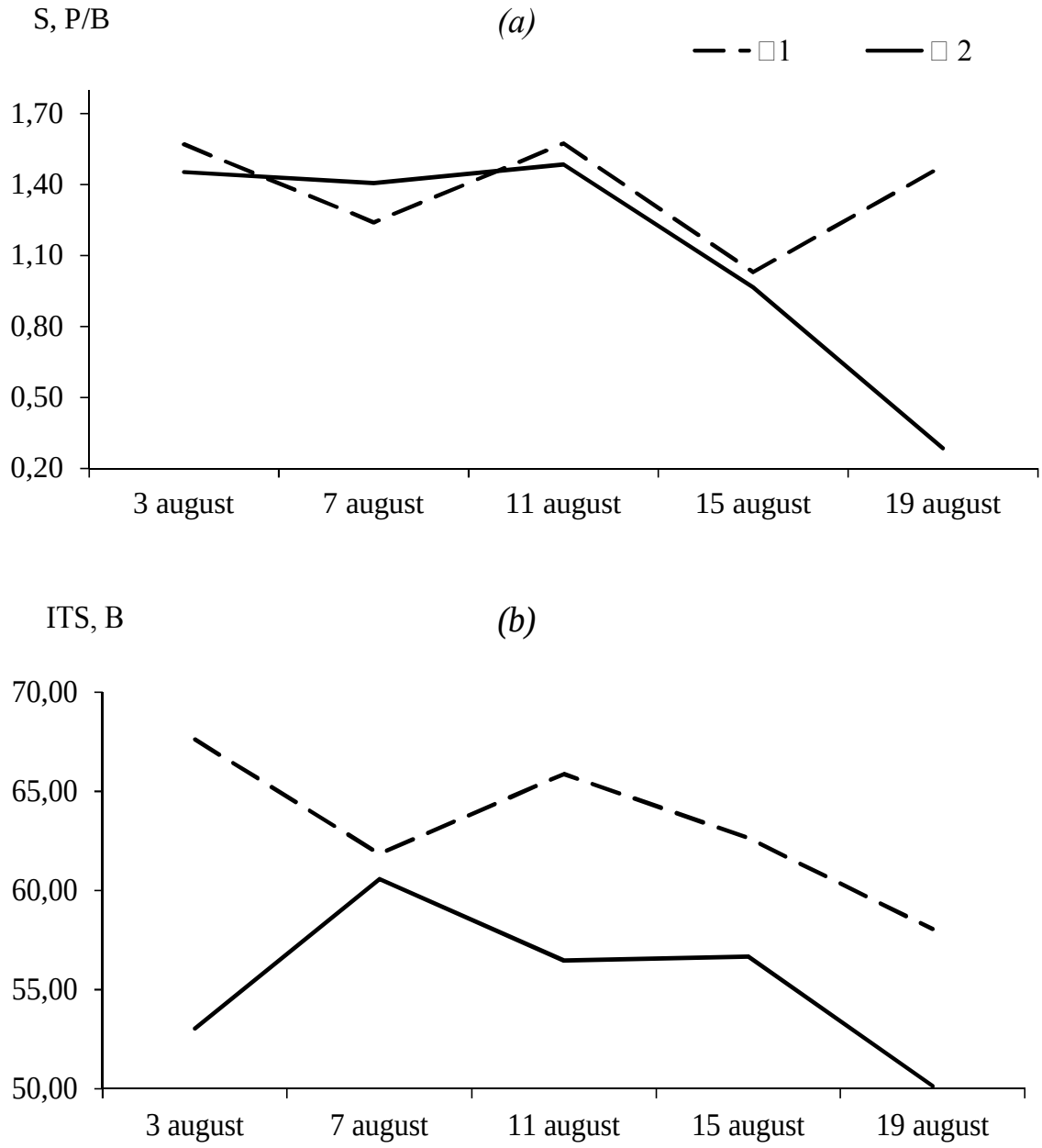
With a decline in quantitative indicators of phytoplankton, higher species diversity is observed in the open area of the river and the occurrence of certain algae species increases. The species diversity of phytoplankton ranges from 15 to 25 species per sample over the entire period of study.

At the end of August, "blooming" of water, caused by Cyanophyta Oscillatoriaplanctonica Wotoss, Aphanizomenonflos-aquae (l.) Ralfs was observed in the open water area. There were no aggregations of Cyanophytaamong the thickets of macrophytesduring the period of research.

According to the ecological and geographical characteristics, the phytoplankton of the river is mainly represented by a complex of algal species, which are widespread and indifferent to the mineralization and pH of water.

Indices of quantitative development of phytoplankton are widely used to characterize the condition and trophic status of water bodies. In the course of the work, the index of trophicity, using the Milius block, and the index of saprobity of Pantle and Buck in the modification of Sladechek were calculated for each sample (Figure 6). According to the results obtained, the water of the investigated section of the river corresponded to the β-mezasaprobic type and the moderately polluted zone (1.5-2.5). Trophic status of the StepnoyZay River in the thickets of macrophytes mostly corresponded to eutrophic, and in open water area – to the meso- and eutrophic types. According to our observations, the silts in the composition of bottom sediments of the investigated areas are yellow, and contain considerable amount of detritus, that indicates the intensity of oxidative processes [Ivanov D.V., Shagidullin R.R., Ziganshin I.I., Osmelkin E.V. 2011].

Figure 6. Dynamics of the indices of saprobity (S, P/B) and trophicity (ITS, B) in the biomass of phytoplankton of the StepnoyZay River in August 2013: 1 – in the thickets of macrophytes, 2 – in the open water area



During the study, the active use of the river by agriculture facilities was noted. Upstream of the research area, there is a duck and goose breeding enterprise. It could also affect the indicators of saprobity. The StepnoyZay River is located in the zone of oil industry that also has a considerable influence on the degree of water pollution.

SUMMARY .

Phytoplankton of the investigated areas of the StepnoyZay River is formed by Chlorophyta, Bacillariophytaand Euglenophyta. The highest values of quantitative indices of phytoplankton are characteristic for macrophyte thickets. The phytoplankton content increases in the open areas by the end of summer, and, on the contrary, decreases in the thickets of macrophytes. Waters of the StepnoyZay River in the area under consideration are prone to "blooming", caused by Cyanophyta. Macrophyte thickets prevent the massive development of Cyanophyta. And during the period of research, the aggregations of these algae in the thickets were not observed. Analysing the dynamics of saprobity and trophicity indices, it can be concluded that there are few unstable organic substances in the waters of this section of the river, and there is rather intensive mineralization.

CONCLUSION.

Multiple seasonal studies with repeated analyses are needed to reveal a complete list of species composition,and features of the algal flora structure of the StepnoyZay River. Nevertheless, the data obtained can be applied in multi-year monitoring and forecasting studies of biodiversity, and the state of water bodies of the Russian Federation. The study of biology and the structure of phytoplankton communities in aquatic ecosystems is the basis for monitoring and managing the quality of natural waters.

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