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Analysis of phytoplankton of a small water body in the zone of influence of a large industrial center by the example of the Lake Vos'merka (Samara Region, Russia)

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The analysis of the changes of the general species composition of phytoplankton and of the complex of dominant algae species has been performed for a small urbanized water body under the influence of anthropogenic load by the example of the Lake Vos'merka (Togliatti city, Samara Oblast, Russia) from 1991 through 2015. The species composition of the algae of the lake was characterized as green algae-diatom-cyanobacteria and was taxonomically stable over the study period. Low intra-rank saturation degree and a small percentage of polytypic genera indicated harsh conditions in the studied ecosystem. The species composition of the complex of dominant algae species has changed significantly. By 2013, anthropogenic transformation promoted the transition of the Lake Vos'merka to the *Planktothrix*-type and developing there the *Oscillatoria*-induced disease.

Keywords: phytoplankton, urbanized water body, floristic analysis, ecological-geographical analysis, dominant species.

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Introduction

The pollution of aquatic and terrestrial ecosystems due to human activities is a recognized global problem nowadays. The influence of various pollutants of anthropogenic origin negatively affects the state of aquatic ecosystems. In particular, the supply of nutrients, primarily phosphorus and nitrogen, promotes eutrophication, which is often accompanied by the blow-up development of algae (water "blooming") and the deterioration of the sanitary, hygienic, and recreational properties of water bodies (Birch and McCaskie, 1999; Kleeberg, 2003; Kopylov and Kosolapov, 2011; Korneva, 2015). In contrast, heavy metals and toxic organic substances lead to reduced productivity and death of organisms. Easily degradable organic substances promote both the dominance of heterotrophic metabolism in the aquatic ecosystems (in hydrobiological practice, it is customary to refer to the increase of saprobity index) and a decrease in oxygen concentration, ending up to the development of anaerobic conditions in some cases. Anthropogenic impact may also lead to a change in the hydrological and hydrochemical properties of the water and thereby cause anthropogenic succession both of the key groups of hydrobionts and the entire aquatic ecosystem (Krivina and Tarasova, 2017a, 2017b; Ostvald, 1987; Trifonova, 1990).

Large industrial centers represent a number of the point sources of pollution, which vary in power characteristics, toxicity, type of exposure, and intensity. In addition, such centers are also a source of diffuse pollution as a result of recreational and cultural activities of the local population and the activity of secondary pollution sources. Aquatic ecosystems located in such areas are under significant adverse effects. The transformation of these ecosystems is complex and multidirectional in most cases.

A number of studies analyze the ecosystems of urbanized water bodies both in Russia (Babanazarova et al., 2011; Mingazova et al., 2014; Okhapkin et al., 2003; Protisty..., 2009) and overseas (Anneville, 2002; Barinova et al., 2006; Birch and McCaskie, 1999; Kleeberg, 2003; Reynolds et al., 2002). However, despite the large amount of information available, the data on the current state and changes in the ecosystems of small water bodies of the urbanized landscape, especially in the zone of influence of large industrial centers, are still relevant.

The Vasilievskie Ozera lake system is located in Togliatti city, the Samara Region, Russia. The environmental state of these water bodies is influenced by emissions and wastes of industrial enterprises, transport, agricultural and recreational activities of residents living in the Vasilievka settlement, horticultural cooperatives and cottages.

The study aims to analyze the floristic composition and taxonomic structure of the phytoplankton of a small urbanized water body affected by a large industrial center by the example of the Lake Vos'merka (Togliatti city, Samara Region, Russia).

Materials and methods

The Lake Vos'merka is a small urbanized pond located in the southern part of the Vasilievskie Ozera lake system (N 53°49'88'', E 49°49'97''). The lake of natural origin, it was formed in the middle of the XX century as a result of filling the natural relief depressions with groundwater after the construction of the Kuibyshev Reservoir. It has an irregular, oblong shape, its length is about 700 m. According to the outline of the water area, it may be attributed to type IV, oval (Litinsky, 1960). According to the main morphological indicators, the lake belongs to the class of small and very small lakes (Kitaev, 1989): its volume is 395 000 m^3, reservoir area, 12.88 ha, maximum depth, 8.0 m, average depth, 3.1 m.

The phytoplankton samples were taken from the surface of the Lake Vos'merka. Sampling was performed according to standard hydrobiological methods every 10 days from June through October 1991 and from May through October 1992. Monthly sampling was performed from June through October 2013 and from May through October 2001 and 2014–2015.

The main abiotic environmental parameters of the Lake Vos'merka during the study period are presented in Table 1.

During the study, in late spring and summer, temperature and oxygen stratification was well pronounced along the water column in the studied lake. The thermocline was located at a depth of 3–4 m. The oxycline was narrower, but most often located within the boundaries of the thermocline. In October–November, during the period of autumn homothermy, the entire water column of the lake was saturated with oxygen. As a rule, pH changed from slightly alkaline in the epilimnion zone to almost neutral near the bottom (Gorbunov et al., 2014).

Regard must be paid to a change in the hydrochemical class of water in Lake Vos'merka under the influence of anthropogenic load from 1991 to 2015. In 1991–1992, the waters of the lake corresponded to the hydrocarbonate class of calcium group, but in 2013–2015, to the sulfate class of sodium group. Probably, these changes were associated with the processes of water income from the technogenic Lake Otstoynik located nearby (Gorbunov et al., 2014; Protisty..., 2009).

The material was obtained using the Ruttner bathometer, the samples were fixed with a 40% formaldehyde solution and concentrated by direct filtration method. The study of the phytoplankton of the lake was carried out according to standard hydrobiological methods. Cell counting was carried out in the Uchinskaya counting chamber (0.01-mL volume), the phytoplankton biomass was calculated by the method of reduced geometric figures (Metodika..., 1975).

The floristic list of species, varieties and forms of algae found in Lake Vos'merka are presented in accordance to the algae classification recommended by algologists of Papanin Institute of Biology of Inland Waters, Russian Academy of Sciences (Borok, Russia), summarized in the work of L.G. Korneva (2015), and the system presented in (Vasser et al., 1989), which is a transformed system of M.M. Hollerbakh (1977), where Cryptophyta, Dinophyta, and Raphidophyta are considered as independent phyla. The diatom species are given according to the accepted classification (Diatoms of the USSR, 1988), considering later publications on this taxon (Krammer and Lange-Bertalot, 1986, 1988, 1991a, b); Dinophyta, by J. Popovsky and L. Pfister (Popovsky and Pfiester, 1990); Chlorococcales order, according to P.M. Tsarenko (1990); green phytoflagellates, according to N.A. Moshkova and M.M. Hollerbakh (1986). The work took into account systematic revisions in floristic reports on cyanobacteria (Komárek and Anagnostidis, 1999, 2005).

The degree of similarity in the species composition of various algae species was determined using the Sørensen index (Shmidt, 1980, 1984).

Results and discussion

In total, the planktonic algae of 298 taxa of a species and sub-species rank were registered in the Lake Vos'merka, belonging to 10 phyla, 11 classes, 23 orders, 52 families, and 112 genera (Table 2).

Table 1. Main physico-chemical characteristics of the surface water layer of the Lake Vos'merka at different study periods. The data are given according to literary sources (Gorbunov et al., 2014; Materialy otsenki vozdeystviya..., 2012; Ogurechnikova and Pimenov, 2012, 2015 with alterations; Protisty..., 2009). Values above the line are the average, below the line, limits of variation

Year	Period, months	Secchi disk depth, m	T, °C	pH	O_2, mg/l
1991	VI–X	1.17 / 0.8–1.6	20.8 / 13.0–24.1	8.99 / 8.60–9.33	11.75 / 8.29–16.97
1992	V–X	1.20 / 0.75–1.6	19.5 / 10.2–23.6	8.94 / 8.3–9.28	10.47 / 8.67–12.83
2001	V–X	1.04 / 0.75–1.35	19.7 / 5.9–24.3	8.82 / 8.42–9.18	10.03 / 8.33–12.06
2013	VI–X	0.51 / 0.35–0.8	19 / 8.2–24.3	8.82 / 7.38–9.58	9.15 / 6.15–12.86
2014	V–X	0.45 / 0.35–0.77	16.2 / 3.2–21.0	9.14 / 9.05–9.98	11.08 / 8.17–15.18
2015	V–X	0.48 / 0.36–0.77	17.4 / 4.7–23.0	9.02 / 8.85–9.67	10.98 / 8.07–15.38

The taxonomic structure of the phytoplankton community of the Lake Vos'merka was stable at the level of large taxonomic ranks (phyla) (Table 3). At each study period, it could be characterized as green algae-diatom-cyanobacteria. It should be noted that the predominance of phyla Chlorophyta and Bacillariophyta in regard to the species richness is a characteristic of water bodies and streams of the temperate climatic zone and is widely observed in reservoirs of both protected areas and anthropogenically transformed landscape (Balashova and Nikitin, 1989; Ekologicheskiye problemy ..., 2001; Fitoplankton..., 2003; Gerasimova, 1996; Mingazova et al., 2014; Okhapkin, 1994). Phylum Cyanoprokariota occupies the third place in terms of the algae species richness. The same ranking of phyla by the richness of species, varieties and forms of algae, is observed in the Kuibyshev Reservoir, and the Lake Vos'merka has formed as a result of its development (Ekologicheskiye problemy..., 2001; Fitoplankton..., 2003; Protisty..., 2009). However, this ratio is not necessarily observed in all urbanized water bodies. For example, in the lakes of the cultural landscape of Nizhny Novgorod and Samara cities, the algoflora of plankton is characterized as green algae-diatom-Euglenidae (Okhapkin et al., 2003; Protisty..., 2009).

The most taxonomically significant orders through the entire study were Chlorococcales, Raphales, Euglenales, Chroococcales, Desmidiales, Oscillatoriales, Nostocales, Araphales, Chlamydomonadales and Cryptomonadales, which accounted for more than 80% of species and varieties of algae.

The dominating families representing the algoflora appearance and reflecting the taxa at the developmental optimum were Euglenaceae, Scenedesmaceae, Naviculaceae, Chlorellaceae, Desmidiaceae, Nitzschiaceae, Cryptomonadaceae, Pseudanabaenaceae, Oaceystaceae, Chlamydomonadaceae, Fragilariaceae, and Anabaenaceae. These families comprised over 60% of taxa of subgenus rank in regard to the total species richness.

Floristically significant genera were *Navicula, Scenedesmus, Euglena, Cosmarium, Nitzschia, Trachelomonas, Fragilaria, Cryptomonas, Phacus, Anabaena, Chlamydomonas, Monoraphidium,* and *Closterium*, which comprised in total 40% of the total number of taxa of a sub-genus rank. As a rule, high floristic importance of the genera *Navicula* and *Scenedesmus* is noted in many reservoirs with a high concentration of nutrients (Ekologicheskiye problemy..., 2001; Fitoplankton..., 2003; Protisty..., 2009).

The ratio of the various taxonomic ranks of the Lake Vos'merka planktonic algoflora evidenced that the main floristic coefficients (species-, genus-, family-, and order-related saturation) were low at each stage of the study and did not change significantly over time. A weak trend of increasing of species-, genus-, and family-related saturation index reflected probably the adaptation of the algocenosis of the reservoir to a change in the hydrochemical properties and justified the increase of the trophic status of ecosystem. However, this needs to be clarified and requires further research.

The saturation coefficients of taxa of various ranks in the Lake Vos'merka (Table 4) were approximately similar to those in other small reservoirs of central Russia, belonging to the cultural and anthropogenically transformed landscape and affected by

Table 2. Species composition of algae of the Lake Vos'merka during different study periods. List of designations here and in Table 5: characteristics by habitat: B – benthic, E – epibiont, L – littoral, F – fouling, F-P – fouling-planktonic, P – planktonic, P-B – planktonic-benthic, P-F – planktonic- fouling, P-L – planktonic- littoral; by geographical distribution: b – boreal, sb − subboreal, c – cosmopolitan, n-a – north-alpine, st – subtropical; by halobility: Hb – halophobic, Hph – halophilic, Ind – indifferent, Mh – mesohalobiont, Ohb – oligohalobiont; in regard to the environmental pH: Al – alkaliphilic + alkalibiont, Ind – indifferent, Ac – acidophilic + acidobiont; "?" – no data.

		Typical habitat	Distribution	Halobility	pH preference	Species occurrence 1991–1992	2001	2013–2015
PHYLUM CYANOPROKARYOTA	**Class CHROOCOCCEAE**							
	Order CHROOCOCCALES							
	Family SYNECHOCOCCACEAE							
	Aphanothece clathrata W. et G.S. West	P	c	Ind	?	–	+	+
	Cyanothece aeruginosa (Näg.) Komarék	L	c	Ind	?	+	+	+
	Dactylococcopsis rupestris Hangs.	E	c	?	?	+	–	–
	Rhabdogloea elenkinii (Roll.) Komárek et Hindak	P	c	?	?	+	+	+
	R. planctonica (Teiling) Kom.	P	c	?	?	+	–	–
	R. smithii (R. et F. Chodat) Komárek	P	c	?	?	+	–	–
	Family MERISMOPEDIACEAE							
	Aphanocapsa incerta (Lemm.) Croberg et Krámer	P	c	Ind	?	+	+	+
	Marssoniella elegans Lemm.	P	c	Ind	?	–	+	+
	Merismopedia minima G. Beck	F-P	c	Hph	Al	+	+	+
	M. punctata Meyen	P	c	Ind	Ind	+	+	+
	M. tenuissima Lemm.	P	c	Ind	?	+	+	+
	Snowella lacustris (Chodat) Komárek et Hindak	P	c	Ind	?	+	+	+
	Family MICROCYSTACEAE							
	Microcystis aeruginosa (Kütz.) Kütz.	P	c	Ind	Al	+	+	+
	M. pulverea (Wood) Forti emend. Elenk.	P	c	Ind	Al	+	+	+
	M. wesenbergii Komarék	P	c	Ind	Al	+	+	+
	Family CHROOCOCCACEAE							
	Chroococcus dispersus (Keissl.) Lemm.	P	?	Hph	?	+	–	–
	C. minutus (Kütz.) Näg.	P	c	Hph	?	+	+	+
	*C. turgidus (*Kütz.) Näg.	L	c	Hph	?	+	+	+
	Class HORMOGONIOPHYCEAE							
	Order OSCILLATORIALES							
	Family PSEUDANABAENACEAE							
	Geitlerinema amphibium (Ag. ex Gom.) Anag.	P-B	c	Hph	?	+	+	+
	Jaaginema gracile (Boch.) Anag. et Kom.	P-B	c	Ind	?	+	+	+
	J. gemincensis (Menegh. ex Gom.) Anag. et Kom.	P-B	c	?	Ind	+	+	+
	Leptolyngbya foveolara (Rab. ex Gom.) Anag. et Kom.	B	c	?	?	–	+	+

						Species occurrence		
		Typical habitat	Distribution	Halobility	PH preference	1991–1992	2001	2013–2015
PHYLUM CYANOPROKARYOTA	*L. fragilis* (Gom.) Anag. et. Kom.	B	c	?	?	+	+	+
	L. mucicola (Lemm.) Anag. et Kom.	?	?	?	?	+	–	+
	Limnotrix planctonica (Wolosz.) Meff.	P	c	Ind	?	+	+	+
	L. redekei (Van Goor) Meff.	B	?	Hph	?	+	+	+
	Planktolyngbya limnetica (Lemm.) Kom.-Legn.et Gronb.	P	c	Ind	Ind	+	+	+
	Pseudoanabaena mucicola (Hub.) Anag. et Komárek	P	c	Ind	?	+	+	+
	P. limnetica (Lemm.) Kom.	P-B	c	?	?	+	+	+
	R. gracilis (Koczw.) Koszw.	L	c	Ind	?	+	+	+
	S. magnifica (Capeland) Anag.	P	?	?	?	+	+	+
	Family PHORMIDIACEAE							
	Phormidium ambiguum Gom.	B	c	Ind	Ind	–	+	+
	P. molle (Kütz.) Gom.	L	c	Ind	?	+	+	+
	Planktothrix agardhii (Gomont) Anagn. et Kom.	P	c	Ind	?	+	+	+
	Family OSCILLATORIACEAE							
	Oscillatoria limosa Ag. ex. Gom.	P	c	Hph	Al	+	+	–
	O. tenuis Ag.	P	c	Ind	?	+	+	+
	Order NOSTOCALES							
	Family ANABAENACEAE							
	Anabaena circinalis (Kütz.) Hansg.	P	c	Ind	?	+	–	+
	A. flos-aquae (Lyngb.) Breb.	P	c	Ind	?	+	+	+
	A. planctonica Brunnth.	P	?	Hph	?	+	+	+
	A. sigmoidea Nyg.	P	?	?	?	–	+	+
	A. variabilis Kütz. var. *variabilis*	B	c	Ind	?	+	+	+
	Anabaenopsis arnoldii Apt.	P-B	?	?	?	+	+	+
	A. elenkinii Mill.	P-B	?	Hph	?	–	–	+
	A. raciborskia Wolosz.	P	st	?	?	–	+	+
	Family APHANIZOMENONACEAE							
	Aphanozomenon flos-aquae (L.) Ralfs.	P	c	Ind	?	+	+	+
	A. gracile (Lemm.) Lemm.	P	?	?	?	+	+	–
	A. issatschenkoi (Ussatsch.) Pr.-Lavr.	P	c	Ind	?	+	+	+
	A.klebahnii (Elenk.) Pechar et Kalina	P	?	?	?	+	+	+
	A. ovalisporum Forti	P	c	?	?	+	–	+

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence 1991–1992	2001	2013–2015
	Class CHRYSOPHYCEAE							
	Order CHROMYLINADALES							
	Family CHRYSOCOCCACEAE							
PHYLUM CHRYSOPHYTA	*Kephyrion moniliferum* (Schmid) Bourrelly	P	b	Ohb	?	–	–	+
	K. rubric-claustri Conrad	B	b	Ind	?	+	+	+
	K. schmidtii (Schmidt) Bourrelly	?	?	?	?	–	+	+
	Order OCHROMONADALES							
	Family DINOBRYONACEAE							
	Dinobryon divergens Imhof	P	c	Ind	Ind	–	–	+
	D. sertularia Ehr.	P	?	?	?	–	+	+
	D. sociale Ehr.	P	c	Ind	?	–	+	+
	Pseudokephyrion schilleri (Schiller) Conrad	P	c	Ohb	?	+	+	+
	Family SYNURACEAE							
	Synura uvella Ehr.	P	c	Ind	Ac	–	+	+
	Class CENTROPHYCEAE							
	Order THALASSIOSIRALES							
	Family THALASSIOSIRACEAE							
PHYLUM BACILLARIOPHYTA	*Skeletonema subsalsum* (Cl.-Euler) Bethge	P	c	Hph	?	+	+	+
	Family STEPHANODISCACEAE							
	Cyclostephanos dubius (Fricke) Round	P	b	Ind	Al	–	+	–
	Cyclotella atomus Hust.	P-B	c	Hph	Al	+	+	+
	C. meneghingiana Kütz.	P	c	Hph	Al	+	+	+
	C. radiosa (Grun.) Lemm.	P	c	Ind	Al	+	+	+
	C. pseudostelligera Hust.	P	c	?	?	+	+	+
	C. stelligera Cl. et. Grun.	P	c	Ind	Al	+	+	+
	Stephanodiscus hantzschii Grun.	P	c	Ind	Al	+	+	+
	S. makarovae Genkal	P	?	?	?	+	–	+
	Order MELOSIRALES							
	Family MELOSIRACEAE							
	Melosira varians Ag.	P	c	Hph	Al	+	+	+
	Family AULACOSIRACEAE							
	Aulacoseira granulata (Ehr.) Sim.	P	c	Ind	Al	+	+	+
	A. islandica (O. Müll) Sim.	P-B	c	Ind	Al	+	+	+
	Order COSCINODISCALES							
	Family HEMIDISCACEAE							
	Actinocyclus normanii (Gregory) Hustedt	P	?	Hph	Al	–	+	+

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence 1991–1992	2001	2013–2015
	Class PENNATOPHYCEAE							
	Order ARAPHALES							
	Family TABELLARIACEAE							
PHYLUM BACILLARIOPHYTA	*Tabellaria fenestrata* (Lyngb.) Kütz.	P-B	c	Hb	?	+	+	–
	T. tabulata (C.A. Agardh) Snoeijs	B	c	Mh	Ind	+	+	+
	T. ventricosa Kütz.	P-B	c	Hb	Ac	+	–	–
	Family FRAGILARIACEAE							
	Fragilaria atomus Hust.	B	?	Ind	?	+	+	+
	F. capucina var. *rumpens* Desmaz.	B	c	Ind	Al	+	+	+
	F. capucina Desmaz. var. *vaucheriae* (Kütz.) Lange-Bertalot	L	c	Ind	Al	+	–	+
	F. crotonensis Kitt.	P	c	Hph	Al	–	+	+
	F. ulna (Nitzsch) Lange-Bertalot var. *ulna*	L	c	Ind	Ind	+	+	+
	F. ulna var. *acus* Sippen	P	c	Ind	Al	+	+	+
	F. ulna var. *angustissima* Sippen	P	c	Ind	Al	+	+	+
	F. virescens Ralfs	L	b	Ind	Ind	+	+	+
	Synedra tabulata (C. Ag.) Kütz.	B	c	Mh	Ind	+	+	+
	Family DIATOMACEAE							
	Diatoma tenuis Ag.	P	b	Hph	Al	+	+	+
	Order RAPHALES							
	Family NAVICULACEAE							
	Navicula capitata var. hungarica (Grun.) Ross.	L	c	Ind	Al	–	+	+
	N. cincta (Ehr.) Ralfs	B	c	Hph	Al	–	+	+
	N. cryptocephala Kütz.	P-B	c	Ind	Ind	+	+	+
	N. clementis Grun.	B	c	Ind	Al	+	+	+
	N. halophila (Grun.) Cleve	B	c	Ind	Al	+	+	+
	N. trivialis Lange-Bertalot	B	c	Ind	Al	+	+	+
	N. laterostrata Hust.	B	b	Ind	Al	+	+	+
	N. longirostris Hust	B	c	Hph	Al	+	–	–
	N. minuscula Grun.	B	c	Ind	Al	+	–	+
	N. peregrina (Ehrb.) Kütz. var. *peregrina*	B	c	Mh	Al	+	+	–
	N. peregrina var. *minuta* Skv.	B	?	?	?	+	–	–
	N. placentula (Ehr.) Grun. var. *placentula*	B	c	Ind	Al	+	+	+
	N. placentula var. *rostrata* A. Mayer	P	b	Ind	Ac	+	–	–
	N. pupula Kütz. var. *pupula*	B	c	Hph	Ind	+	+	–
	N. pupula Kütz. var. *elliptica*	B	c	Hph	Ind	+	–	–

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence		
						1991–1992	2001	2013–2015
PHYLUM BACILLARIOPHYTA	*N. pseudoanglica* Lange-Bertalot	?	?	?	?	–	+	+
	N. semen Ehr. emend Donk.	B	b	Ind	Ind	+	–	–
	N. seminulum Grun.	P-B	c	Ind	Ind	+	–	–
	N. tripunctata (O.F. Mull) Bory	B	c	Ind	Al	+	+	+
	N. tuscula (Ehr.) Grun.	P-B	c	Ind	Al	+	–	–
	N. veneta Kütz.	B	c	Hph	Al	–	+	–
	Neidium productum (W. Sm.) Cl.	B	c	Ind	Ac	+	–	–
	Family ACHNANTHACEAE							
	Achnanthes exigua Grun.	B	c	Ind	Al	+	+	+
	A. exilis Kütz.	B	c	Ind	Al	+	–	–
	A. lanceolata (Bréb.) Grun. var. *lanceolata*	F	c	Ind	Al	+	–	+
	A. minutissima Kütz. var. *minutissima*	B	c	Ind	?	+	–	–
	A. minutissima var. *affinis* (Grun.) Lange-Bertalot in Lange-Bertalot & Krammer	F	c	Hph	Ind	–	+	+
	Cocconeis placentula Ehr.	F	c	Ohb	Ind	+	+	+
	C. thumensis A. Mayer	B	?	?	Ind	–	–	–
	Family EUNOTIACEAE							
	Eunotia bilunaris (Ehrb.) Mills	B	c	Hb	Ac	–	–	+
	E. zebra (Kütz.) Bréb.	B	c	Ind	Al	–	–	+
	Family CYMBELLACEAE							
	Amphora delicatissima Krasske	B	c	Mh	?	+	+	+
	A. ovalis (Kütz.) Kütz.	B	c	Ohb	Al	–	–	–
	A. veneta Kütz.	L	c	Ind	?	+	+	+
	Cymbella affinis Kütz.	B	c	Ind	Al	–	+	+
	C. cistula (Ehrb.) Kirchn.	B	c	Ind	Al	+	+	–
	C. silesiaca Bleich.	F	c	Ind	Ind	–	–	–
	C. tumidula Grun. in A. Schmidt	B	?	Ind	Al	+	–	–
	Family GOMPHONEMACEAE							
	Gomphonema acuminatum Ehr. var. *acuminatum*	P-B	c	Ind	Al	–	+	+
	G. constrictum Ehr.	F	c	Ind	Al	+	–	–
	G. olivaceum (Horn.) Bréb.	B	c	Ind	Al	+	+	+
	G. parvulum Kütz. var. *parvulum*	F	c	Ind	Ind	–	+	+
	G. parvulum var. subelliptica Cl.	B	c	Ind	Ind	–	–	+
	Family NITZSCHIACEAE							
	Hantzschia amphioxys (Ehr.) Grun.	L	c	Ind	Ind	–	–	+
	Nitzschia acicularis (Kütz.) W. Sm.	B	c	Ind	Al	+	+	+

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence		
						1991–1992	2001	2013–2015
PHYLUM BACILLARIOPHYTA	*N. closterium* (Ehr.) W. Sm.	P	c	Hph	?	+	–	+
	N. communis Rabenh.	B	b	Ind	?	+	+	–
	N. palea var. *tenuirostris Sippen*	L	c	Ind	Ind	+	+	+
	N. linearis (Ag.) W. Sm.	B	c	Ind	Al	–	+	–
	N. palea (Kütz.) W. Sm. var. *palea*	L	c	Ind	?	+	+	+
	N. paleacea Grun.	P	c	Ind	?	+	+	+
	N. pusilla Grun.	L	c	Ohb	Ind	–	+	+
	N. subtilis Grun.	B	c	Ind	Ind	+	+	+
	Family SURIRELLACEAE							
	Cymatopleura solea (Bréb.) W. Sm.	L	c	Ind	Al	+	–	–
PHYLUM XANTHOPHYTA	**Class HETEROCOCCOPHYCEAE**							
	Order HETEROCOCCALES							
	Family PLEUROCHLIRIDACEAE							
	Goniochloris fallax Fott	P	c	?	?	+	+	+
	G. spinosa Pasch.	L	?	Hb	Ac	+	–	–
	G. torta Pasch.	L	?	Hb	Ac	+	+	+
	Tetraedriella regularis (Kütz.) *(= Tetraedriella gigas* (Pasch.) Ded.-Stscheg.)	L	c	Hb	Ac	–	+	–
PHYLUM CRYPTOPHYTA	**Класс CRYPTOMONADOPHYCEAE**							
	Order CRYPTOMONADALES							
	Family CRYPTOMONADACEAE							
	Chroomonas acuta Uterm.	P	c	Ind	?	+	+	+
	C. minima Czosn.	L	?	?	Ac	+	+	+
	Cryptomonas borealis Skuja	P	c	Ind	Ac	+	+	+
	C. curvata Ehr.	P	?	?	?	+	+	+
	C. erosa Ehr.	P	c	?	?	+	+	+
	C. gracilis Skuja	P	c	Ohb	Ac	+	+	+
	C. lucens Skuja	L	?	?	?	+	+	+
	C. marssonii Skuja	P	c	Ind	Ind	+	+	+
	C. ovata Ehr.	P-B	c	Ind	Ind	+	+	+
	C. reflexa Skuja	P	c	Hph	?	+	+	+
	C. rufescens Skuja	B	?	Hph	?	+	–	+
	Rhodomonas lens Pasch. et Ruttn.	P	n-a	Ind	Ind	–	+	

Phylum	Taxon	Typical habitat	Distribution	Halobility	PH preference	Species occurrence 1991–1992	2001	2013–2015
PHYLUM DINOPHYTA	**Class DINOPHYCEAE**							
	Order GYMNODINILES							
	Family GYMNODINIACEAE							
	Gymnodinium lacustre Schill. in Rabenh.	P	?	?	?	+	+	+
	G. paradoxum A.J. Schill	P	?	?	?	+	–	+
	Order GONYAULACALES							
	Family CERATIACEAE							
	Ceratium hirundinella (O.F. Müll.) Bergh	P	c	Ind	?	+	+	+
	Order PERIDINIALES							
	Family GLENODINIOPSIDACEAE							
	Sphaerodinium cinctum (Her.) Wolosz.	P	c	Ind	Ind	+	+	+
	Family PERIDINIACEAE							
	Durinskia occulata (F. Stein) G. Hansen et Flaim (*P. oculatum* (Stein) Bourrelly)	P	c	Ind	Ind	+	+	–
	Glochidinium penardiforme (Er. Lindem.) Boltovskoy (*P. penardiiforme*)	P	c	Ind	Ind	+	+	+
	Peridiniopsis quadridens (Stein) Bourrelly	P	c	Ohb	Al	+	+	+
	P. penardii (Lemm.) Bourrelly	P	c	Ind	Ind	+	–	+
	Peridinium aciculiferum Lemm.	P	?	?	?	–	+	–
	P. umbonatum Stein	P	c	Ind	?	+	+	+
PHYLUM RAPHYDOPHYTA	**Class RAPHYDOPHYCEAE**							
	Order RAPHYDALES							
	Family RAPHYDACEAE							
	Vacuolaria virescens Cink.	P	c	?	Ac	–	+	+
PHYLUM EUGLENOPHYTA	**Class EUGLENOPHYCEAE**							
	Order EUGLENALES							
	Family EUGLENACEAE							
	Astasia inflata Duj. f. *fusiforme* (Skuja) Popova	P	?	?	?	–	+	–
	A. parva E.G. Pringsh.	P	c	Ind	?	+	–	+
	Euglena acus Ehr.	L	c	Ind	Ind	–	+	+
	E. clara Skuja	L	b	Mh	?	–	–	+
	E. minima France	L	?	?	?	+	+	+
	E. limnophyla Lemm.	L	c	?	Ind	–	+	+
	E. limnophyla var. *swirenkoi* (Arnold.) Popova	L	c	Ind	?	–	+	+

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence 1991–1992	2001	2013–2015
PHYLUM EUGLENOPHYTA	*E. pasheri* Swir.	P-B	sb	?	Ind	+	+	+
	E. texta (Duj.) Hubner	L	c	Hph	Ind	+	+	+
	E. variabilis Klebs	L	c	Ind	Ind	+	+	+
	Lepocinclis fusiformis (Carter) Lemm. var. *fusifmisor*	L	c	Hph	?	–	+	–
	L. ovum (Ehr.) Lemm.	P	c	Ind	Ind	+	+	+
	Phacus inflexus (Kiss.) Poch.	?	?	?	Ind	–	+	+
	P. pleuronectes var. *prunoides* (Roll) Popova	L	c	Ind	Ind	–	+	+
	P. pseudonordstedtii Pochm.	P-B	?	?	?	–	+	+
	T. cylindrica Ehr. sec. Playf.	?	?	?	?	+	+	+
	T. hispida (Perty) emend. Defl. var. *hispida*	P	c	Ind	Ind	–	+	+
	T. hispida var. *coronata* Lemm.	P	c	Ind	?	–	–	+
	T. hispida var. *granulate* Playf.	L	c	Ind	Ind	–	+	+
	T. planctonica Swir. var. *planctonica*	P	c	Ind	?	+	+	+
	T. oblonga Lemm.	P	c	Ind	?	–	+	+
	T. rotunda Swir. emend. Defl.	P	?	?	Ind	+	+	–
	T. volvocina Ehr.	P	c	Hph	Ind	+	+	+
PHYLUM CHLOROPHYTA	**Class PRASINOPHYCEAE**							
	Order TETRASELMIDALES							
	Family TETRASELMIDACEAE							
	Tetraselmis arnoldii (Pr.-Lavr.) Norris et al.	P	c	Hph	?	+	+	+
	T. tetrathele (G.S. West) Butcher	P	?	?	?	–	+	+
	Class CHLOROPHYCEAE							
	Order CHLOROCOCCALES							
	Family CHARACIACEAE							
	Characium ornithocephalum A. Br.	E	c	Ind	?	–	+	+
	Schroederia setigera (Schrod.) Lemm.	P	c	Ind	?	+	+	+
	S. spiralis (Printz) Korsch.	?	?	?	?	+	+	+
	Family GOLENKINIACEAE							
	Golenkinia radiata Chod.	P	c	Ind	?	+	+	+
	Family HYDRODICTYACEAE							
	Pediastrum boryanum (Turp.) Menegh.	P	c	Hph	?	+	+	+
	P. duplex Meyen var. *duplex*	P	c	Ind	Ind	+	+	+
	Family MICRACTINIACEAE							
	Golenkiniopsis solitaria (Korsch.) Korsch.	P	c	Ind	?	+	–	–
	Micractinium pusillum Fres.	P	c	Ohb	?	+	+	+

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence 1991–1992	2001	2013–2015
PHYLUM CHLOROPHYTA	**Family BOTRYOCOCCACEAE**							
	Dictyosphaerium anomalum Korsch.	P	c	Ind	?	+	+	–
	D. pulchellum Wood	P-B	c	Ind	Ind	+	+	+
	D. subsolitarium von Goor	P	c	Ind	?	+	+	+
	Quadricoccus ellipticus Hortob	P	c	Ind	?	–	–	+
	Family RADIOCOCCACEAE							
	Coenochloris korshikovii (Korsch.) Hind.	B	c	Ind	?	–	–	+
	C. pyrenoidosa Korsch.	P-B	?	?	?	+	–	–
	Eutetramorus planctonicus (Korsch.) Bourrelly	B	c	Ind	Ind	+	+	+
	E. polycoccus (Korsch.) Kom.	P	c	Ind	?	–	–	+
	Family OOCYSTACEAE							
	Lagerheimia ciliata (Lagerh.) Chod.	P-B	c	?	?	–	+	–
	L. genevensis (Chod.) Chod.	P	c	Ind	?	+	+	+
	L. longiseta (Lemm.) Wille	P	c	Ind	?	–	–	+
	L. marssonii Lemm.	P	c	?	?	+	–	–
	Nephrochlamys allanthoidea Korsch.	P-B	b	?	?	+	–	–
	N. rotunda Korsch.	P	c	Ind	?	+	+	+
	N. subsolitaria (G.S. West) Korsch.	P	c	Ind	?	+	+	+
	Oocystis borgei Snow	P	c	Ind	?	+	+	+
	O. lacustris Chod.	P-B	c	Hph	?	+	–	+
	O. submarina Lagerh.	P	c	Hph	?	+	+	+
	Family CHLORELLACEAE							
	Ankistrodesmus falcatus (Corda) Ralfs	L	c	Ind	?	–	+	+
	A. fusiformis Corda	P	c	Ind	?	–	+	–
	A. gracile (Reinsch) Korsch.	P-B	?	?	?	+	+	+
	Chlorella vulgaris Beijer.	P	c	Ohb	Ind	+	+	+
	Hyaloraphidium contortum Pasch. et Korsch	P-B	c	Ind	?	+	+	+
	Kirhneriella danubiana Hind.	P	?	?	?	–	–	+
	Monoraphidium arcuatum (Korsch.) Hind.	P-B	c	?	?	+	+	+
	M. contortum (Thurn.) Kom.-Legn.	P	c	Ind	?	+	+	+
	M. griffithii (Berk.) Kom.-Legn.	P	c	Ind	?	+	+	+
	M. irregulare (G.M. Sm.) Kom.-Legn.	P	c	Ind	Ind	+	+	+
	M. minutum (Näg.) Kom.-Legn.	P-B	c	Ohb	?	+	+	+
	M. tortile (W. et G.S. West) Kom.-Legn.	P	?	?	?	+	+	+
	Raphidocelis sigmoidae Hind.	P	c	Ind	?	+	+	+

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence 1991–1992	2001	2013–2015
PHYLUM CHLOROPHYTA	*R. subcapitata* (Korsch.) Nyg. et al.	P	c	Ind	?	–	+	–
	Selenastrum gracile Reinsch	P-F	c	Ind	Ind	–	+	+
	Siderocelis ornata (Fott) Fott	L	c	Ind	Ind	–	+	+
	Tetraedron caudatum (Corda) Hansg.	P	c	Ind	Ind	–	–	+
	T. incus (Teil.) G.M. Sm.	P	c	Ind	Al	+	+	+
	T. minimum (A. Br.) Hansg.	P-L	c	Ind	?	+	+	+
	T. triangulare Korsch.	P	c	Ind	?	+	+	+
	Family COELASTRACEAE							
	Actinastrum hantzschii Lagerh.	P	c	Ind	?	+	+	+
	Coelastrum astroideum de Not	P	c	?	?	+	+	+
	C. microporum Näg. in A. Br	P	c	Ind	Ind	+	+	+
	Family SCENEDESMACEAE							
	Crucigenia fenestrata (Schmidle) Schmidle	P	c	Ind	?	+	–	–
	C. tetrapedia (Kirchn.) W. et G.S. West	P	c	Ind	Ind	+	+	+
	Crucigeniella apiculata (Lemm.) Kom.	P	c	Ind	?	+	+	+
	Didymocystis inermis (Fott) Fott					+	+	+
	D. planctonica Korsch.	P	c	Ind	?	+	+	+
	Scenedesmus acuminatus (Lagerh.) Chod.	P	c	Ind	?	+	+	+
	S. acutus Meyen	P-B	c	Ind	?	–	+	–
	S. bicaudatus Deduss.	P	?	?	?	+	–	–
	S. caudato-aculeolatus Chod.	P	c	?	?	–	+	+
	S. communis (Hegew.) Hegew.	P-B	c	?	?	–	+	+
	S. ellipticus Corda	P-B	c	?	?	–	+	+
	S. falcatus Chod.	P	c	Ohb	Al	+	+	+
	S. gutwinskii Chod.	P	c	Ind	?	+	+	–
	S. intermedius (R. Chod.) Hegew	P-B	c	?	?	+	+	+
	S. magnus Meyen	P	c	?	?	+	–	+
	S. microspina Chod.	P-B	?	?	?	+	+	+
	S. obliquus (Turp.) Kütz.	P-B	c	?	?	–	–	+
	S. obtusus Meyen	P-B	?		?	–	+	+
	S. opoliensis P. Richt.	P	c	Ohb	Ind	+	+	+
	S. protuberans Fritsch	P	c	Ind	Ind	+	+	+
	S. quadricauda (Turp.) Bréb.	P	c	Ohb	Ind	+	+	+
	S. sempervirens Chod.	P	c	Ind	Ind	+	–	–
	S. spinosus (R. Chod.) Hegew.	P-B	?	?	?	–	–	+

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence 1991–1992	2001	2013–2015
PHYLUM CHLOROPHYTA	*Tetrastrum glabrum* (Roll) Ahlstr. et Tiff.	P	c	Ind	Ind	+	–	–
	T. heteracanthum (Nordst.) Chod.	P	c	Ind	?	+	–	–
	T. staurogeniaeforme (Schröd.) Lemm.	P-B	c	Ind	?	+	+	+
	T. triacanthum Korsch.	P	?	?	?	–	+	–
	Westella botryoides (W. West.) de Wild	P	c	Ind	?	+	+	+
	Class CHLAMYDOPHYCEAE							
	Order CHLAMYDOMONADALES							
	Family CHLAMYDOMONADACEAE							
	Carteria globosa Korsch.	P	c	Ind	?	+	+	+
	C. klebsii (Dang.) Francé	P	c	Ind	?	+	+	+
	C. multifilis (Fres.) Dill.	P	c	Ind	?	+	+	+
	Chlamydomonas asymmetrica Korsch.	P	?	Ind	?	–	–	+
	C. debaryana var. *atactogama* (Korsch.) Gerloff.	P	c	Ind	?	–	+	–
	C. globosa Snow.	P	c	Ohb	?	+	+	+
	C. incerta Pasch.	L	c	?	?	–	–	+
	C. monadina Stein	P	c	Ind	?	–	+	–
	C. reinhardtii Dang.	P-B	c	?	?	+	+	+
	C. simplex Passh.	P	c	Ind	?	+	+	+
	C. snowiae Printz.	P	c	Ind	?	+	+	+
	Gloeomonas mucosa (Korsch.) Ettl.	P	c	Hb	?	+	–	+
	Family PHACOTACEAE							
	Phacotus coccifer Korsch.	P	?	Ind	Ind	–	+	–
	Pteromonas aculeata Lemm.	P	c	Ind	?	+	–	–
	P. torta Korsch.	P	c	Ind	?	+	+	+
	Order VOLVOCALES							
	Family VOLVOCACEAE							
	Pandorina morum (Müll.) Bory	P	c	Ind	?	+	+	+
	Class ULOTRICHOPHYCEAE							
	Order ULOTRICHALES							
	Family ULOTROCHACEAE							
	Elakatotrix biplex (Nyg.) Hind.	P	?	?	?	+	+	+
	E. gelatinosa Wille	P	c	Ind	?	+	+	+
	Gemnellopsis fragile Korsch.	?	?	?	?	+	+	–
	Koliella longiseta (Vischer) Hind.	P	c	Ind	?	+	+	+

		Typical habitat	Distribution	Halobility	PH preference	Species occurrence		
						1991–1992	2001	2013–2015
	Class CONJUGATOPHYCEAE							
	Order DESMIDIALES							
	Family CLOSTERIACEAE							
PHYLUM STREPTOPHYTA	*Closterium acutum* (Lyngb.) Bréb.	P	c	Ind	?	+	+	+
	C. acutum var. *variabile* (Lemm.) Krieg.	B	?	?	?	+	+	+
	C. ceratium Perty	?	?	?	?	+	–	–
	C. gracile Bréb.	?	?	?	?	–	–	+
	C. selenastroides Roll	P	c	?	?	+	+	–
	Jn DESMIDIACEAE							
	Cosmarium abbreviatum W. et G.S. West	P	c	?	?	+	+	+
	C. bipunctatum Borg.	P	?	?	?	–	–	+
	C. cruatum Borg.	P-B	?	?	?	–	–	+
	C. formosulum Hoffm.	?	?	?	?	+	+	–
	C. margaritiferum Menegh.	B	c	Ind	?	+	+	+
	C. pygmeaum Arch.	L	c	?	?	+	–	+
	C. rectangulare Grun.	L	c	?	?	–	–	+
	C. subcostatum Nordst.	L	?	?	?	–	+	+
	C. undulatum Corda	P	c	Ind	?	+	–	–
	C. vensutum (Bréb.) Archer in Pritchard	P-B	?	?	Ac	–	+	–
	Staurastrum chaetoceros (Schrod.) G.M. Smith	?	?	?	?	+	+	+
	S. gracile Ralfs	P	?	?	Ac	+	+	+
	S. tetracerum Ralfs	P	c	Ind	?	+	+	+

a strong anthropogenic load (Korneva, 2015; Krivina and Tarasova, 2017a, b; Okhapkin et al., 2003; Protisty..., 2009). The degree of intra-rank saturation allowed to characterize the environmental conditions of the Lake Vos'merka and other cited reservoirs as harsh, with pronounced processes of anthropogenic eutrophication and the absence of nutrient limitation (Barinova, 2011; Protisty..., 2009; Trifonova, 1990).

Ecological and geographical analysis of the planktonic algae of Lake Vos'merka did not reveal significant differences at different study periods (Table 5). Depending on the habitat, planktonic forms prevailed in the reservoir at each observation period, they comprised 56–60% of the total number of intragenera taxa with a known habitat. The Lake Vos'merka is a small and relatively shallow water body, therefore, it is logical that the share of benthic (13–17%), plankton-benthic (12–13%), and littoral forms (8–13%) are also noticeable here. In regard to the geographic distribution, 95% of the species are cosmopolitan. Species with wide salinity range tolerance predominate (74–77%), as well as the species with wide pH range (45–50%) and alkaliphilic forms (42–46%).

Generally, the algae species composition of the Lake Vos'merka did not change much from 1991 to 2015. Sørensen similarity index exceeded 80%, indicating a high degree of similarity of algal communities. However, the species composition of planktonic algae, dominating by abundance and biomass, has changed significantly (Table 6).

At the beginning of the study, in 1991–1992, the dominant phytoplankton complex was presented by the most widespread representatives of M-type

Table 3. The species richness of various planktonic algae phyla of the Lake Vos'merka during different study periods. The values left to slash indicate the number of species and intraspecific taxa of algae, right to slash, % of the total species richness.

Phylum	1991–1992	2001	2013–2015
Cyanoprokaryota	41/19	41/18	43/18
Chrysophyta	2/1	5/2	8/3
Bacillariophyta	53/25	54/23	54/23
Xanthophyta	3/1	3/1	2/1
Cryptophyta	11/5	11/5	11/5
Dinophyta	10/5	8/3	8/3
Raphydophyta	0/0	1/< 1	1/< 1
Euglenophyta	10/5	20/9	20/8
Chlorophyta	74/34	76/33	78/33
Streptophyta	12/5	11/5	13/5
Total	**219**	**230**	**238**

Table 4. Saturation coefficients of various ranks of planktonic algoflora in the water bodies of different types.

Water body	Number of families / number of orders	Number of genera / number of families	Number of species / number of genera	Number of intraspecific taxa / number of species
Lake Vos'merka, 1991–1992	2.33	1.94	2.25	0.02
Lake Vos'merka, 2013–2015	2.17	2.02	2.29	0.03
Lake Bol'shoe Vasilievskoe, 1991–1992 (Krivina, 2019)	2.22	2.14	2.52	0.09
Lake Bol'shoe Vasilievskoe, 2013–2015 (Krivina, 2019)	2.32	2.25	2.59	0.06
"Technogenic" reservoirs of the Vasilievskie Ozera lake system of the Samara Region (Krivina, Tarasova, 2017b)	1.93–2.17	1.79–1.82	1.80–1.92	0.02–0.04
Water bodies of cultural landscape in Nizhny Novgorod (Okhapkin et al., 2003)	1.85–2.50	1.72–2.62	2.00–3.74	0.05–0.16

(*Microcystis*) and H_1-type (*Anabaena, Aphonizomen*) cyanobacteria (Reynolds et al., 2002). Centric diatoms, cryptophytes, and dinophytes dominated by biomass. As the trophic status of the water body has increased since 2001, the role of filamentous S_1-type cyanobacteria (genera *Planktothrix, Limnotrix, Oscillatoria,* and *Planktolyngbya*) increased also; these cyanobacteria were represented mostly by highly toxic species that could cause *Oscillatoria*-induced disease (Birch and McCaskie, 1999; Kleeberg, 2003; Kopylov and Kosolapov, 2011; Korneva, 2015). In 2013–2015, these species almost absolutely dominated by abundance, but their share in terms of biomass was insignificant. Firstly, the cells of these algae are extremely small in size; secondly, large-cell mixotrophic algae, such as dinophyte *Ceratium hirundinella* and centric diatom *Stephanodiscus hantzschii,* most adapted to a high content of organic substances, develop actively as the process of eutrophication intensifies in the water body.

According to Sørensen index, the degree of similarity of the dominant complex (in terms of abundance) at the initial and final stages of the study was extremely low, accounting for 25% only

Table 5. Ecological and geographical analysis of planktonic algae of the Lake Vos'merka at different periods of the study. Notation conventions are similar to Table 2.

	1991–1992	2001	2013–2015
Habitat			
B	35	31	30
L	17	25	30
F	3	3	4
F-P	1	1	1
P	124	127	128
P-B	26	28	29
P-L	1	1	1
P-F	0	1	1
E	1	1	1
Total	**208**	**218**	**225**
Distribution			
b	8	6	6
c	173	178	185
n-a	0	1	0
sb	1	1	1
st	0	1	1
Total	**182**	**187**	**193**
Water salinity preference			
Hb	3	1	1
Hph	25	25	25
Ind	124	129	132
Mh	3	3	3
Ohb	11	10	13
Total	**166**	**168**	**174**
pH preference			
Al	39	39	39
Ind	38	46	46
Ac	7	7	6
Total	**84**	**92**	**91**

Table 6. Planktonic algae species dominating by abundance and biomass in the Lake Vos'merka at different study periods. % – share from total phytoplankton abundance/biomass.

Period	Dominant species, by abundance	%	Dominant species, by biomass	%
		1991–1992		
5/V	*Spirulina magnifica*	10	*Stephanodiscus hantzschii*	33
			Cryptomonas ovata	10
11/VI–14/VI	*Microcystis pulverea*	20	*Cryptomonas reflexa*	13
	Dictyosphaerium subsolitarium	13	*Stephanodiscus hantzschii*	10
	Microcystis aeruginosa	10		
9/VII–13/VII	*Planktothrix agardhii*	13	*Cyclotella radiosa*	20
	Dictyosphaerium subsolitarium	12	*Ceratium hirundinella*	20
	Microcystis pulverea	12		
29/VII–30/VII	*Microcystis aeruginosa*	31	*Ceratium hirundinella*	17
	Planktothrix agardhii	11	*Cyclotella radiosa*	14
			Microcystis aeruginosa	10
13/VIII	*Microcystis aeruginosa*	32	*Melosira varians*	23
			Cyclotella radiosa	15
			Ceratium hirundinella	10
25/VIII–31/VIII	*Microcystis aeruginosa*	32	*Cyclotella radiosa*	26
			Melosira varians	16
			Ceratium hirundinella	14
10/IX–12/IX	*Microcystis aeruginosa*	30	*Stephanodiscus hantzschii*	18
	Leptolyngbya fragilis	10	*Cyclotella radiosa*	15
20/IX	*Microcystis aeruginosa*	23	*Stephanodiscus hantzschii*	18
	Leptolyngbya fragilis	18	*Cyclotella radiosa*	12
	Planktolyngbya limnetica	18	*Microcystis aeruginosa*	11
	Planktothrix agardhii	16	*Leptolyngbya fragilis*	10
			Cyclotella meneghingiana	10
		2001		
12/V	*Planktolyngbya limnetica*	24	*Stephanodiscus hantzschii*	24
	Limnotrix redekei	11		
8/VI	*Planktolyngbya limnetica*	14	*Stephanodiscus hantzschii*	16
	Monoraphidium contortum	12	*Chlamydomonas simplex*	13
			Cyclotella radiosa	11
24/VI	*Planktolyngbya limnetica*	15	*Ceratium hirundinella*	15
	Planktothrix agardhii	11		

Period	Dominant species, by abundance	%	Dominant species, by biomass	%
7/VII	*Planktolyngbya limnetica*	20	*Ceratium hirundinella*	20
	Planktothrix agardhii	12		
	Aphanozomenon flos-aquae	11		
20/VII	*Planktolyngbya limnetica*	23	*Ceratium hirundinella*	24
	Planktothrix agardhii	16	*Cyclotella radiosa*	10
	Microcystis aeruginosa	15		
	Aphanozomenon flos-aquae	14		
25/VIII	*Aphanozomenon flos-aquae*	22	*Ceratium hirundinella*	43
	Microcystis aeruginosa	21	*Cyclotella radiosa*	14
	Planktothrix agardhii	20	*Microcystis aeruginosa*	10
	Planktolyngbya limnetica	13		
7/IX	*Planktothrix agardhii*	30	*Ceratium hirundinella*	49
	Planktolyngbya limnetica	20		
	Aphanozomenon flos-aquae	16		
	Microcystis aeruginosa	16		
17/IX	*Planktothrix agardhii*	35	*Ceratium hirundinella*	29
	Planktolyngbya limnetica	27	*Peridinium umbonatum*	10
	Aphanozomenon flos-aquae	12		
24/X	*Planktothrix agardhii*	38	*Stephanodiscus hantzschii*	13
	Planktolyngbya limnetica	28	*Cyclotella radiosa*	10
	Limnotrix redekei	10	*Peridinium umbonatum*	10
		2013–2015		
20/V–25/V	*Limnotrix planctonica*	48	*Stephanodiscus hantzschii*	32
	Planktolyngbya limnetica	12	*Anabaena flos-aquae*	13
			A. planctonica	10
17/VI–25/VI	*Planktolyngbya limnetica*	18	*Cyclotella radiosa*	17
	Limnotrix redekei	16	*Ceratium hirundinella*	12
24/VII–27/VII	*Planktothrix agardhii*	24	*Ceratium hirundinella*	25
	Planktolyngbya limnetica	15	*Cryptomonas ovata*	12
	Aphanozomenon flos-aquae	14		
3/IX–14/IX	*Planktothrix agardhii*	28	*Ceratium hirundinella*	63
	Planktolyngbya limnetica	25		
	Aphanozomenon flos-aquae	14		
17/X–20/X	*Planktothrix agardhii*	53	*Stephanodiscus hantzschii*	15
	Oscillatoria tenuis	11	*Cryptomonas curvata*	13

Table 7. Similarity of the species composition of algae, dominating by abundance and biomass in the phytoplankton community, at different study periods

Year	Abundance, %			Biomass, %		
	1991–1992	2001	2013–2015	1991–1992	2001	2013–2015
1991–1992	100	46	25	100	54	52
2001	46	100	53	54	100	40
2013–2015	25	53	100	52	40	100

(Table 7). The degree of similarity in terms of biomass for the dominant complex was slightly higher (52%) and was estimated as median. Nevertheless, it can be said with confidence that the transformation of the algal community of the Lake Vos'merka under the influence of anthropogenic pressure went along the *Planktothrix*-type over time (Reynolds et al., 2002).

Conclusion

The Lake Vos'merka is a classic example of a small pond located in the urban landscape. The studies of the phytoplankton of this water body in 1991–1992, 2001, and 2013–2015 made it possible to characterize its algoflora as green algae-diatom-cyanobacteria by the species composition and as taxonomically stable within the study period. The species composition, floristic, and ecological-geographical characteristics of the planktonic algoflora of the Lake Vos'merka are typical for the water bodies of the anthropogenically transformed landscape of central Russia. Low intra-rank saturation index and a small percentage of polytypic genera indicate harsh environmental conditions in the system. The species composition of the dominant algae complex has changed significantly under the influence of anthropogenic load both in terms of abundance and biomass in contrast to the general species composition of phytoplankton. By 2013, anthropogenic transformation brought the Lake Vos'merka to the *Planktothrix*-type and promoted developing here the *Oscillatoria*-induced disease.

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