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ZOOPLANKTON, ZOOBENTHOS, ZOOPERIPHYTON

Composition and Structure of Zooplankton Community in Lake Pleshcheyevo, Russia

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Abstract—The composition and abundance of zooplankton were studied in 2012–2016 in the deepwater stratified mesotrophic Lake Pleshcheyevo, Yaroslavl oblast (Russia). During the study period, 130 species of rotifers and crustaceans were recorded in the lake. The plankton abundance and biomass during the study period were lower or close to the values indicated for 1979–1996. The open littoral of the lake was more often characterized by the low abundance of zooplankton compared to deeper areas (depths exceeding 4 m). Interannual variations in the total abundance and biomass of zooplankton in different seasons of the year were observed, caused by the climatic features of different years and different times of sampling. The composition of the dominant species of rotifers and crustaceans in 2012–2016 was close to that indicated earlier in 1979–1996. *Synchaeta lakowitziana*, *S. kitina*, *Diaphanosoma mongolianum*, and *Thermocyclops oithonoides* were noted for the first time as dominant zooplankton species in the lake.

Keywords: zooplankton, species composition, abundance and biomass dynamics

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INTRODUCTION

The long-term study of the structure and abundance of components of aquatic ecosystems is one important issue in hydrobiological research. It allows to track changes occurring in water bodies and identify their reasons.

Long-term observations of zooplankton were carried out at Lake Glubokoe in Moscow oblast (Korovchinsky and Boykova, 2009; Korovchinsky et al., 2017) and Lake Krasnoe in Leningrad oblast (*Mnogoletniye* ..., 2008; Trifonova and Makartseva, 2006). Using the example of Lake Krasnoye, it has been found that the state of the biological communities of this water body is largely determined by fluctuations in the water level and temperature conditions with a relatively stable nutrient load (*Mnogoletniye* ..., 2008).

Studies of the zooplankton of Lake Pleshcheyevo have a long history, and it has been described in sufficient detail (Stolbunova, 2006). The first information about the planktonic animals of the lake appeared in the 1930s. It was faunistic information describing mainly the littoral (Borisov, 1924; Kastal'skaya-Karzinkina, 1934; Korde, 1928; Lastochkin, 1930; Pervukhin, 1927). The next period of study (1960s–early 1970s) was characterized by the sporadic collection of materials in the lake (Makoveeva et al., 1964; Stolbunova, 2006). Full-scale studies of zooplankton were carried out from 1979 to 1996 by the staff of the Institute for Biology of Inland Waters of the Russian Academy of Sciences (IBIW RAS) (Stolbunova, 2006). In the late 1980s–early 1990s, employees at Yaroslavl State University joined the IBIW RAS in studying the lake (Medyantseva, 1996; Medyantseva and Semernoy, 1997). More recent publications include the work of I.K. Rivier (2012), focusing on the biology of the large planktonic crustacean *Bythotrephes brevimanus* Lilljeborg and listing the species (with their relative abundance) found in the deep part of the lake in August 2008.

This study aims to characterize the composition, structure, and abundance of zooplankton in Lake Pleshcheyevo according to the data obtained in 2012–2016.

MATERIALS AND METHODS

Study area. Lake Pleshcheyevo (56°43′–56°48′ N, 38°43′–38°50′ E) is of glacial origin; it has a regular oval shape (51.5 km^2). The littoral zone (depths of 0–3 m) makes up 21.2% of the total area of the lake; the greatest depth was 24 m. The lake belongs to typical dimictic water bodies with spring and autumn homothermy, well-pronounced summer stratification of the water column, and reverse winter stratification of the water mass (*Ekosistema* ..., 1989).

Collection and processing of samples. Zooplankton studies were carried out in 2012–2016 in different parts of the lake (Pryanichnikova and Tsvetkov, 2018; Sabitova and Tsvetkov, 2017); the number of samples and collection dates are presented in Table 1. Planktonic animals were collected in the pelagial (14–24 m depth) and sublittoral (4–8 m depth) using 5-L Dyachenko–Kozhevnikov samplers (in 2012–2013) and 4.2-L Van Dorn samplers (in 2014–2016); the plankton was sampled in duplicates every meter through the water column at stations with depths of 3–4 m or every 2 m (at stations with depths exceeding 4 m); then the sample was gently filtered onto a plankton sieve (mesh size of 64 μm). The samples obtained at one station were pooled into one bottle and fixed.

Such an integrated sample was considered an average for the entire water column at a given station. During the period of summer stagnation in the pelagial of the lake, zooplankton was collected every 2 m (duplicates); the samples from epilimnion, metalimnion, and hypolimnion were fixed in three (two) separate bottles. At one station in the deepwater zone, collections were carried out with a sampler every 2–4 m (duplicates); the samples were fixed in separate bottles for the layers of 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, and 22 m. In this work, averaged data per water column were used. At the stations located in the littoral (1-m depth), zooplankton was collected with a measuring bucket by filtering 50 L of water through a plankton sieve (mesh size of 64 μm). The samples were fixed with 4% formalin. The laboratory processing of samples was performed according to the method generally accepted in hydrobiology (Metodicheskiye rekomendatsii, 1984). Species of planktonic animals were identified by taxonomic keys (Kutikova, 1970; *Opredelitel'*..., 2010). The nomenclature was given in accordance with Rotifera (Segers, 2007), Cladocera (Kotov et al., 2013), and Copepoda (*Opredelitel'*..., 2010)). Zooplankton biomass was calculated based on the equations of size-weight dependence (Balushkina and Vinberg, 1979; Ruttner-Kolisko, 1977). The copepod abundance was estimated taking into account copepodites and nauplii, which were assigned to a certain species in accordance with the abundance of adult crustaceans. Species with a relative abundance exceeding 10% of the abundance of rotifers or crustaceans were considered dominant (Lazareva, 2010). Morphotypes of genus *Bosmina* (*Eubosmina*) were taken into account when calculating the total number of species, species richness, and dominant species as separate species.

Dissolved oxygen concentration, electrical conductivity, and water temperature were measured with a portable conductometer YSI-85 (YSI Inc., United States).

Mathematical analysis. In order to compare the quantitative indicators of zooplankton in different parts of the lake and in different periods, the nonparametric Mann–Whitney test was applied.

RESULTS AND DISCUSSION

Climatic features of the growing seasons of 2014–2016. In 2014–2016, spring started early, but frosts were repeatedly noted. Positive temperatures were established the earliest in 2016 (at April 8–12), later in 2015 (at April 10–14), and the latest in 2014 (at April 13–17). The spring of 2014 was the warmest for the entire observation period. In April 2014, the sum of active temperatures above 4°C was 611.4°C day, in 2015 528.3°C day, and in 2016 608°C day.

The ice rims on the lake appeared in the last decade of March 2014; ice shifts and floods began on April 1. Since April 5, there has been sparse floating ice; by mid-April, the lake was completely ice-free. In the first decade of April 2015, the lake was frozen; in the second decade, rims, ice shifts, and leads appeared until April 18. Since April 26, the lake has been freed from ice. In 2016, at the beginning of April, ice formation was still observed on the lake. From April 3, rims appeared, then ice shifts. From April 8, rare floating ice was observed; it persisted until the middle of the third decade of April. May of 2014 was abnormally warm. Until May 20, 2015, the weather in the European part of Russia was colder than usual, and May of 2015 was not very warm. In May 2016, the average monthly temperature was above the norm.

The summer of 2014 was one of the hottest in the Northern Hemisphere during the observation period. June 2014 was characterized by hot weather in the first decade. In the second and third decades, the heat was replaced by cold (down to 4.4°C). July was characterized by abnormally hot and dry weather. In August, the heat persisted on most of the European part of Russia. June 2015 was abnormally warm; the average monthly temperature was above the norm. July was rainy, and almost two monthly norms of precipitation were registered. August was cool. The main heat was observed at the end of the first decade and beginning of the second decade, with a gradual temperature decrease by autumn. Precipitation was almost normal. The beginning of the summer of 2016 resembled prolonged spring. The air began to warm up by mid-June. July of 2016 was the hottest month in the history of meteorological observations in Russia. August was also characterized by abnormally warm weather. Summer 2016 was the hottest of the three studied seasons: the sum of effective temperatures above 10°C in 2016 was 1653°C day; in 2014 1571°C day, and in 2015 1501°C day.

September of 2014 was close to normal in terms of temperature. In October, the weather was abnormally cold. The average monthly temperature in November was within the normal range, but this month was the driest November for the last 50 years. Ice began to appear on the lake on October 18, firstly along the shores. By October 25, the lake was completely covered with ice. September of 2015 was characterized by exceptionally warm weather in European part of

Table 1. Water temperatures (°C) and the number of samples of zooplankton collected at different sites of Lake Pleshcheyevo in 2012–2016

Date	Open litoral		Sublitoral		Pelagial			
					Epilimnion	Metalimnion	Hypolimnion	*n*
	T	*n*	*T*	*n*	*T*			
July 25, 2012	–	–	–	–	20.0 19.2–21.1	12.0 7.5–18.0	6.4 6.1–7.5	2
June 6, 2013	18.7 15.2–21.6	3	15.7 6.6–21.2	2	19.1 18.5–20.0	8.6 6.1–15.1	4.0 3.8–4.9	4
August 3, 2013	19.0 18.6–19.5	3	17.7 9.6–19.1	3	19.1 17.6–21.1	8.3 5.4–15.1	5.0 4.3–5.0	3
May 3, 2014	7.2 5.5–10.5	2	6.6 5.5–10.5	4	6.7 5.3–7.2			6
June 7, 2014	22.8 18–26	3	15.7 10.4–19.6	3	18.7 16.2–21.5	11.1 7.9–15.3	7.2 7.1–7.6	2
July 18, 2014	21.2 18.4–22.8	3	17.9 15.9–21	6	18.6 16–22.3	10.9 7.9–14.7	7.4 7.3–7.6	7
September 5, 2014	17.1 14.6–18.6	3	16.7 16.4–17.0	4	16.7 16.6–16.9	11.4 8.3–16.3	7.8 7.7–7.9	7
October 8, 2014	10.2 7.98–10.8	3	10.1 9.2–10.5	1	10.0 8–10.3			2
May 6, 2015	8.1 6.2–12.9	5	6.2 5.1–7.1	6	5.6 4.7–6.3			7
June 4, 2015	18.2 14.9–20.8	3	15.9 11.7–19.2	1	17.6 15.6–19.5	9.2 7.6–11.4	6.6 6.4–7.2	2
July 4, 2015	18.6 16.9–20	3	18.0 17.5–18.5	4	18.8 18.3–19	11.9 8.2–17.1	7.2 7–7.6	3
September 22, 2015	15.9 14.2–17	3	15.7 15.2–16.1	1	15.8 15.3–16.9	10.9 8.5–14	7.8 7.6–8.1	3
October 22, 2015	6.5 3.1–8.0	3	7.4 7–8.1	1	8.2 8.1–8.2			2
April 22, 2016	3.7 2.1–11.4	3	2.5 2–4.4	1	2.2 1.9–2.3			
July 27, 2016	25.1 23.2–27.6	3	22.1 19.4–23.5	1	23.2 20.5–25.8	12.3 8.2–17.6	7.3 7–7.9	3
September 15, 2016	14.2 9.4–15.3		14.9 13.2–15.3		15.0 14.9–15	9.8 8.7–10.5	7.8 7.5–8.3	3
November 3, 2016	4.1 3.6–4.5	2	4.2 4.1–4.3	1	4.7 4.7–4.8			2

Values above the line is average, below the line, the minimum and maximum values; *n* is the number of zooplankton samples; and a dash indicates no data obtained.

Russia. October was cold and dry. November was warmer than normal. On the lake, the ice along the shores began to appear in the third decade of November, and incomplete freezing formed at the very end of December. Autumn 2016 was the coldest of all three observed periods. After a cool September, warm weather settled in October in the European part of Russia. November was quite cold. Ice started to form on the lake at November 4; incomplete freeze-up was recorded from November 29. The fall of 2015 was the warmest of the 3-year observation period. The sum of temperatures above 4°C was 492.8°C × day in autumn 2015, 456.0°C × day in 2014, and 384.3°C × day in 2016.

According to the average annual value, the lowest water level was recorded in 2015 (137.51 m Baltic System (BS)); the highest was in 2016 (137.65 m BS). In 2014, it was intermediate, 137.56 m BS (*Avtomatizirovannaya* ..., electronic resource). The difference between the lowest and highest absolute level of the lake during the observation period was 66 cm.

Taxonomic composition of zooplankton. In 2012–2016, 130 species of planktonic animals were recorded in the lake (Table 2). Rotifers were represented by 73 species, cladocerans by 41, and copepods by 16 species. Rotifers were characterized by the largest number of species; among them, the families Brachionidae and Synchaetidae were the richest (11 species each).

The list of planktonic animals found in 2012–2016 had a smaller number of taxa compared to 1979–1996, which was due to the lack of zooplankton studies in winter and random studies of the fauna in the overgrown littoral of the lake. In 2012–2016, 23 species new to the lake were noted — among them 17 species of rotifers and five species of cladocerans. Rotifers *Synchaeta lakowitziana, S. kitina*, and cladoceran *Diaphanosoma mongolianum* were among the dominant zooplankton species and were widely distributed throughout the lake in certain seasons. *Synchaeta lakowitziana* and *S. kitina* were numerous in spring and early summer. Previously, *S. oblonga* was recorded in winter and spring zooplankton, forming up to 12% of the total abundance of zooplankton (Stolbunova, 2006). Unfortunately, the lack of archive samples for the previous observation period did not make it possible to clarify the exact species taxonomy of representatives of the genus *Synchaeta*. Currently, there is also the problem of their identification and quantitative ratio (Obertegger et al., 2006), which requires additional detailed studies of the already available material. Crustacean *Diaphanosoma mongolianum* was represented in zooplankton in summer (Zhdanova, 2018). Other species, first described for Lake Pleshcheyevo, belonged mainly to thicket-inhabiting and benthic forms.

The zooplankton of the lake was characterized by the stability of the core of the species composition of planktonic animals. In 2012–2016, 30 species of planktonic animals were recorded from year to year. Most of these species were also encountered every year in 1979–1996 (Stolbunova, 2006), except for copepods of the genus *Thermocyclops*, which were previously recorded much less frequently. The composition of zooplankton species of Lake Pleshcheyevo was close to the fauna of Lake Glubokoe, which was similar in morphometry, geographical location, and trophic status, but the main differences were associated with a large number of species of copepods in the water body we studied (Zhdanova and Lazareva, 2009; Korovchinsky and Boikova, 2009; Korovchinsky et al., 2017).

Quantitative development of zooplankton in different parts of the lake. Open littoral. In the studied areas of the littoral, the species richness of zooplankton varied from 8 to 27 species per sample; the highest values were more often observed in the second half of summer (Table 3). The total abundance of planktonic animals varied widely from 6.1 to 461.3 thous. ind./m^3. The maximum values were typical for the first half of summer (Table 3). By autumn, the abundance of planktonic animals decreased. The total zooplankton biomass ranged from 0.02 to 3.26 g/m^3; the highest values were recorded in the second half of summer.

In spring and in the first half of summer, rotifers dominated by abundance. In the second half of summer, a decrease in the relative role of rotifers and an increase in the share of copepods were noted. In autumn, copepods dominated by abundance. They also prevailed in terms of biomass in spring and autumn. In the summer period of different years, the dominance of different taxonomic groups of planktonic animals was observed (Table 3).

Changes in the number of rotifers were unimodal, with a maximum in May (2015) or early June (2014). Cladocerans were characterized by one abundance peak in June (2014) or in June–early July (2015). The abundance of copepods was maximum at the beginning of summer (2015) or in its second half (2013 and 2014).

In spring, 2–3 species of rotifers and 2–3 species of crustaceans dominated in the littoral (Table 4). Rotifers *Filinia terminalis*, genus *Synchaeta* (*S. lakowitziana* and *S. kitina*), and copepods *Cyclops kolensis*, and *Mesocyclops leuckarti* were among the dominant species every year. In the first half of summer, the composition of dominants changed, and it was formed by 2–3 species of rotifers and 2–4 species of crustaceans. Every year (2013–2015), the dominant complex included the rotifers *Conochilus unicornis* and the copepod *Mesocyclops leuckarti* (Table 5). In the second half of summer, 2–3 species of rotifers and 1–3 species of crustaceans predominated. During this period, the dominant zooplankton complexes were the most variable from year to year (Table 6). In autumn, dominants were represented by 3–4 species of rotifers and 2–5 species of crustaceans (Table 7). The composition of dominant species of rotifers varied annually,

Table 2. Species composition of zooplankton in Lake Pleshcheyevo in different periods of observation

Taxon	Period			
	1919–1931*	1959–1974**	1979–1996***	2012–2016
Phylum Rotifera				
Class Eurotatoria				
Subclass Bdelloidea				
Family Philodinidae				
Dissotrocha macrostyla (Ehrenberg)	–	–	+	–
Dissotrocha aculeata (Ehrenberg)	–	–	+	–
Philodina roseola Ehrenberg	–	–	+	–
Philodina sp.	–	–	+	–
Rotaria rotaria Pallas	–	–	+	–
R. neptunia (Ehrenberg)	–	–	+	–
R. tardigrada (Ehrenberg)	–	–	+	–
Rotaria sp.	–	–	–	+
Bdelloidea gen. sp.	–	–	–	+
Subclass Bdelloidea				
Superorder Pseudotrocha				
Order Ploima				
Family Asplanchnidae				
Asplanchna priodonta Gosse	+	–	+	+
A. girodi De Geurne****	–	–	–	+
Asplanchnopus multiceps (Schrank)	–	–	+	–
Family Brachionidae				
Anuraeopsis fissa Gosse	–	–	+	–
Brachionus angularis Gosse	–	–	+	+
B. calyciflorus Pallas	–	–	+	+
B. diversicornis (Daday)	–	–	+	–
B. quadridentatus Hermann	–	–	+	+
B. leydigii Cohn	–	–	+	–
B. variabilis Hempel	–	–	+	–
Keratella cochlearis (Gosse)	+	+	+	+
syn. *Anuraea cochlearis* Gosse				
K. hiemalis Carlin	–	–	+	+
K. quadrata (Müller)	+	+	+	+
syn. *Anuraea aculeata* Ehrenberg				
Kellicottia longispina (Kellicott)	+	–	+	+
Notholca acuminata (Ehrenberg)	+	–	+	+
Notholca foliacea (Ehrenberg)	–	–	+	–
Notholca labis Gosse	–	–	+	–
N. squamula (Müller)	+	–	+	+
syn. *Notholca striata striata frigida* Rylov				
Platias quadricornis (Ehrenberg)	–	–	+	+
P. patulus (Müller)	–	–	+	+
Family Dicranophoridae				
Dicranophorus uncinatus (Milne)	+	–	–	–
Family Euchlanidae				
E. deflexa Gosse	–	–	+	+
Euchlanis dilatata (Ehrenberg)	+	–	+	+
E. incisa Carlin****	–	–	–	+
E. lyra Hudson	–	–	+	+
E. lucksiana Hauer	–	–	+	+
E. oropha Gosse	+	+	+	+
E. pyriformis Gosse****	–	–	–	+
E. triquetra Ehrenberg****	–	–	–	+
Family Gastropodidae				
Ascomorpha agilis Zacharias**	–	–	–	+
A. eucaudis Perty	–	–	+	+
A. minima Hofsten****	–	–	–	+
A. ovalis (Bergendal)	+	–	+	+
syn. *Chromogaster ovalis* (Bergendal)				

Table 2. (Contd.)

Taxon	Period			
	1919–1931*	1959–1974**	1979–1996***	2012–2016
A. saltans Bartsch****	–	–	–	+
Family Lecanidae				
L. bulla (Gosse)	–	–	+	+
L. closterocerca (Schmarda)	+	–	–	–
syn. *Monostyla closterocerca*				
L. cornuta (Müller)	–	–	+	–
L. flexilis (Gosse)	–	–	+	–
L. furcata (Murray)	–	–	+	–
syn. *Lecane tethis* (Harring and Myers)				
L. hamata (Stokes)****	–	–	–	+
L. luna (Müller)	–	–	+	+
L. lunaris (Ehrenberg)	–	–	+	+
L. quadridentata (Ehrenberg)	–	–	+	+
L. stenroosii (Meissner)****	–	–	–	+
L. ungulata (Gosse)****	–	–	–	+
Family Lepadellidae				
Colurella obtusa (Gosse)	–	–	+	+
C. colurus (Ehrenberg)	–	–	+	+
Lepadella ovalis (Müller)****	–	–	–	+
L. patella (Müller)	–	–	+	+
L. triptera (Ehrenberg)	–	–	+	–
Squatinella lamellaris (Müller)	+	–	–	–
syn. *Squatinella intermedia* Korde				
Family Mytilinidae				
Mytilina ventralis (Ehrenberg)	+	–	+	+
M. mucronata (Müller)	+	–	+	+
Lophocharis oxysternon (Gosse)	–	–	+	–
Family Notommatidae				
Cephalodella auricula (Müller)	–	–	+	–
C. catellina (Müller)	–	–	+	–
C. exigua (Gosse)	–	–	+	–
C. forficula (Ehrenberg)	–	–	+	–
C. gibba (Ehrenberg)	–	–	+	+
C. gracilis (Ehrenberg)	–	–	+	+
C. ventripes (Dixon-Nutall)	–	–	+	+
Cephalodella sp.	–	–	–	+
Monommata longiseta (Müller)	–	–	+	–
Notomatta copeus Ehrenberg	–	–	+	+
Pleurotrocha petromyzon (Ehrenberg)	+	–	+	–
Family Proalidae				
Proales sigmoidea (Skorikov)	–	–	+	–
Family Scaridiidae				
Scaridium longicaudum (Müller)	+	–	–	–
Family Synchaetidae				
Polyarthra dolichoptera Idelson	–	–	+	+
P. longiremis Carlin	–	–	+	+
P. luminosa Kutikova	–	–	+	+
P. major Burckhardt	–	–	–	+
P. minor Voigt	–	–	+	+
P. vulgaris Carlin	–	–	+	+
P. sp.	+	–	–	–
syn. *P. platiptera*				
Synchaeta grandis Zacharias	–	–	+	–
S. lakowitziana Lucks ****	–	–	–	+
S. kitina Rousselet ****	–	–	–	+
Synchaeta oblonga Ehrenberg	–	–	+	–
Synchaeta pectinata Ehrenberg	–	–	+	+
S. tremula (Müller)	–	–	+	+

Table 2. (Contd.)

Taxon	Period			
	1919–1931*	1959–1974**	1979–1996***	2012–2016
S. stylata Wierzejski	–	–	+	+
Family Trichocerciidae				
Ascomorphella volvocicola (Plate)****	–	–	–	+
Trichocerca capucina (Wierzejski and Zacharias)	–	–	+	–
T. cylindrica (Imhof)	–	–	+	–
T. elongata (Gosse)	–	–	+	+
T. longiseta (Schrank)	–	–	+	–
T. rattus (Müller)	–	–	+	+
T. tenuior (Gosse)	–	–	+	–
T. similis (Wierzejski)	+	–	+	+
syn. *Diurella stylata* Eyferth				
T. stylata (Gosse)	+	–	+	–
Family Trichotriidae				
Trichotria pocilum (Müller)	–	–	+	+
T. similis (Steneroos)	–	–	+	–
T. truncata (Whitelegge)	–	–	+	+
Superorder Pseudotrocha				
Order Flosculariaceae				
Family Conochilidae				
Conochilus coenobasis (Hudson)****	–	–	–	+
C. natans (Seligo)	–	–	+	+
C. unicornis Rousselet	+	–	+	+
Family Filinidae				
Filinia longiseta (Ehrenberg)	+	+	+	+
syn. *Triarthra longiseta* Ehrenberg				
F. terminalis (Plate)	–	–	+	+
syn. *F. maior* (Colditz)				
Family Hexarthridae				
Hexarthra mira (Hudson)	–	–	–	+
Family Testudinellidae				
Pompholyx complanata Gosse	+	–	+	–
P. sulcata Hudson	+	–	+	+
Testudinella bidentata (Ternetz)****	–	–	–	+
T. mucronata (Gosse)****	–	–	–	+
T. patina (Hermann)	–	–	+	+
Order Collothecaceae				
Family Collothecidae				
Collotheca campanulata (Dobie)	+	–	–	–
C. mutabilis (Hudson)	–	–	+	–
C. ornata (Ehrenberg)	+	–	+	–
C. pelagica (Rousselet)	–	–	+	–
Phylum Arthropoda				
Class Branchiopoda				
Superorder Cladocera				
Order Anomopoda				
Family Bosminidae				
Bosmina coregoni (Baird)	+	+	+	+
syn. *B. crassicornis* (Müller)	–	–	+	+
syn. *B. longispina* Leydig	–	–	+	+
B. longirosrtris (Müller)	+	+	+	+
Bosminopsis deitersi (Richard)	+	–	–	–
Family Chydoridae				
Acroperus angustatus (Sars)****	–	–	–	+
A. harpae (Baird)	+	–	+	+
A. elongatus (Sars)	–	–	+	–
Alona affinis (Leydig)	+	–	–	+
A. costata Sars	–	–	+	+
A. gutatta Sars	–	–	+	+

Table 2. (Contd.)

Taxon	Period			
	1919–1931*	1959–1974**	1979–1996***	2012–2016
A. quadrangularis (Müller)	–	–	+	+
Alonella excisa (Fischer)	+	–	+	–
A. exigua (Lilljeborg)	–	–	+	–
A. nana (Baird)****	–	–	–	+
Camptocercus lilljeborgi Schoedler	–	–	+	–
C. rectirostris Schoedler	–	–	+	+
Chydorus gibbus Sars	+	–	+	+
C. ovalis Kurz	–	–	+	+
C. sphaericus (Müller)	+	–	+	+
Coronatella rectangula (Sars) syn. *Alona rectangula* Sars	–	–	+	+
Disparalona rostrata (Koch)	–	–	+	+
Dunhevedia crassa King****	–	–	–	+
Graptoleberis testudinaria (Fischer)	–	–	+	+
Monospilus dispar Sars	+	–	+	+
Oxyurella tenuicaudis (Sars)	+	–	–	–
Picripleuroxus laevis (Sars)****	–	–	–	+
P. striatus (Schödler) syn. *Pleuroxus striatus* Schoedler	–	–	+	–
Pleuroxus aduncus (Jurine)	+	–	–	+
P. truncatus (Müller)	–	–	+	+
P. uncinatus Baird	+	–	+	+
Pseudochydorus globussus (Baird)	–	–	+	+
Rhynchotalona falcata (Sars)	–	–	+	–
Family Daphniidae				
Ceriodaphnia affinis Lilljeborg	+	–	–	–
C. laticaudata Müller	+	–	–	–
C. megalops Sars	–	–	+	–
C. quadrangula (Müller)	+	–	+	+
C. pulchella (Müller)	+	–	+	+
C. reticulata (Jurine)	+	–	+	–
C. rotunda Sars	+	–	–	–
Daphnia cucullata Sars	+	+	+	+
D. cristata Sars	+	–	+	+
D. galeata Sars	–	–	+	+
D. hyalina (Leydig)	+	+	–	–
D. longispina (Müller)	+	–	+	+
D. pulex Leydig	+	–	–	–
Scapholeberis aurita (Fischer)	+	–	–	–
S. mucronata (Müller)	+	–	+	+
Simocephalus exspinosus (Koch)	+	–	+	–
S. vetulus (Müller)	+	–	+	+
Family Eurycercidae				
Eurycercus lamellatus (Müller)	+	–	+	+
Family Ilyocryptidae				
Ilyocryptus sp.	+	–	–	+
Family Macrothricidae				
Macrothrix laticornis (Jurine)	+	–	+	–
Lathonura rectirostris (Müller)	+	–	+	–
Streblocerus serricaudatus (Fischer)	+	–	–	–
Order Ctenopoda				
Family Sididae				
Diaphanosoma brachyurum (Lievin)	+	+	+	+
D. mongolianum Uéno ****	–	–	–	+
Sida crystallina (Müller)	+	–	+	+
Order Haplopoda				
Family Leptodoridae				
Leptodora kindtii (Focke)	+	+	+	+

Table 2. (Contd.)

Taxon	Period			
	1919–1931*	1959–1974**	1979–1996***	2012–2016
Order Onychopoda				
Family Cercopagidae				
Bythotrephes brevimanus (Lilljeborg)	–	–	–	+
B. longimanus Leydig	+	–	+	–
Family Polyphemidae				
Polyphemus pediculus (Linnaeus)	+	–	+	+
Class Hexanauplia				
Subclass Copepoda				
Order Calanoida				
Family Diaptomidae				
Eudiaptomus graciloides (Lilljeborg)	+	+	+	+
syn. *Diaptomus graciloides*				
Family Temoridae				
Eurytemora lacustris (Poppe)	–	–	+	–
Eurytemora sp.	–	–	–	+
Order Cyclopoida				
Family Cyclopidae				
Acanthocyclops vernalis (Fischer)	+	–	+	–
Cyclops kolensis Lilljeborg	–	+	+	+
C. strenuus Fischer	+	–	–	+
C. vicinus Uljanin	–	+	+	+
Diacyclops bicuspidatus (Claus)	+	–	–	–
D. bisetosus (Rehberg)	–	–	+	–
Eucyclops macruroides (Lilljeborg)	+	–	+	+
E. macrurus (Sars)	+	–	+	+
syn. *Cyclops macrurus*				
E. serrulatus (Fischer)	+	–	+	+
syn. *Cyclops serrulatus*				
Macrocyclops albidus (Jurine)	+	–	+	+
syn. *Cyclops albidus*				
M. fuscus (Jurine)	+	–	+	–
syn. *Cyclops fuscus*				
Megacyclops viridis (Jurine)	+	–	+	+
syn. *Cyclops viridis*				
Mesocyclops leuckarti (Claus)	+	–	+	+
syn. *Cyclops leuckarti*				
Microcyclops varicans (Sars)	+	–	+	+
M.bicolor (Sars)	+	–	+	–
syn. *Cyclops bicolor*				
Paracyclops affinis (Sars)	+	–	+	–
Paracyclops fimbriatus (Fischer)	+	–	+	–
syn. *Cyclops fimbriatus*				
Paracyclops sp.	–	–	–	+
Thermocyclops crassus (Fisher)	+	–	+	+
syn. *Cyclops crassus*				
T. oithonoides (Sars)	–	–	+	+
T. dybowskii (Landé)	+	–	–	–
syn. *Cyclops dybowskii*				
Order Harpacticoida	–	–	–	–
Family Ameridae	–	–	–	–
Nitocrella hibernica (Brady)	–	–	+	–
Harpacticoida gen. sp.	–	–	+	+

*The species has been included in the list according to (Borisov, 1924; Kastal'skaya-Karzinkina, 1934; Korde, 1928; Lastochkin, 1930; Pervukhin, 1927);

**according to (Makoveeva et al., 1964; Stolbunova, 2006);

***according to (Stolbunova, 2006);

****first noted for the lake in the present study.

Table 3. Species richness of zooplankton (*S*) and abundance (*N*) and biomass (*B*) of the main zooplankton groups in the open littoral of Lake Pleshcheyevo in 2013–2016

Date	*S*, number of species per a sample				*N*, thous. ind./m^3 and *B*, g/m^3				
	Rotifera	Cladocera	Copepoda	Sum	Rotifera	Cladocera	Copepoda	Veliger	Sum
June 6, 2013	9 ± 1	1 ± 0	6 ± 1	16 ± 0	68 ± 47 / 0.4 ± 0.3	<1 / <0.1	12 ± 7 / <0.1	<1 / <0.1	80 ± 55 / 0.5 ± 0.3
August 3, 2013	8 ± 2	7 ± 1	3 ± 1	17 ± 3	7 ± 3 / 0.9 ± 0.5	16 ± 14 / 0.4 ± 0.4	39 ± 11 / 0.3 ± 0.2	3 ± 2 / <0.1	65 ± 16 / 1.6 ± 0.9
May 3, 2014	11 ± 1	2 ± 1	5 ± 1	17 ± 1	5 ± 1 / <0.1	<1 / <0.1	3 ± 1 / <0.1	0	8 ± 1 / <0.1
June 7, 2014	9 ± 0	8 ± 1	3 ± 1	20 ± 1	129 ± 18 / <0.1	19 ± 7 / 0.2 ± 0.1	49 ± 4 / 0.1 ± 0.0	7 ± 2 / <0.1	204 ± 24 / 0.3 ± 0.1
July 18, 2014	8 ± 2	10 ± 1	4 ± 0	23 ± 2	35 ± 10 / 0.6 ± 0.4	8 ± 2 / <0.1	76 ± 25 / 0.1	12 ± 5 / <0.1	131 ± 30 / 0.8 ± 0.5
September 5, 2014	10 ± 0	4 ± 1	4 ± 1	17 ± 2	11 ± 3 / <0.1	2 ± 1 / <0.1	43 ± 31 / 0.2 ± 0.1	1 ± 0 / <0.1	57 ± 35 / 0.2 ± 0.1
October 8, 2014	9 ± 1	5 ± 1	3 ± 0	17 ± 1	10 ± 2 / <0.1	7 ± 4 / 0.1 ± 0.1	9 ± 7 / 0.1 ± 0.1	0	26 ± 9 / 0.2 ± 0.1
May 1, 2015	7 ± 1	3 ± 1	4 ± 1	13 ± 2	149 ± 42 / <0.1	1 ± 0.4 / <0.1	12 ± 5 / 0.1 ± 0.0	0	162 ± 40 / 0.2 ± 0.0
June 4, 2015	8 ± 1	5 ± 1	5 ± 0	18 ± 2	135 ± 66 / <0.1	6 ± 3 / <0.1	122 ± 61 / 0.5 ± 0.3	1 ± 0 / <0.1	263 ± 128 / 0.5 ± 0.3
July 4, 2015	8 ± 0	11 ± 1	3 ± 0	22 ± 1	46 ± 11 / 0.5 ± 0.1	5 ± 2 / 0.1 ± 0.0	31 ± 2 / 0.3 ± 0.0	0	82 ± 8 / 0.9 ± 0.1
September 22, 2015	7 ± 2	4 ± 1	3 ± 0	14 ± 2	9 ± 5 / 0.1 ± 0.1	1 ± 0.2 / <0.1	15 ± 6 / 0.1 ± 0.1	<1 / <0.1	25 ± 4 / 0.2 ± 0.1
October 22, 2015	8 ± 3	4 ± 1	4 ± 1	16 ± 5	6 ± 4 / <0.1	2 ± 1 / <0.1	11 ± 5 / 0.2 ± 0.1	0	18 ± 3 / 0.2 ± 0.1
April 22, 2015	9 ± 1	2 ± 0	3 ± 1	14 ± 2	13 ± 2 / <0.1	<1 / <0.1	5 ± 1 / <0.1	0	17 ± 3 / <0.1
July 27, 2016	8 ± 2	10 ± 1	4 ± 1	22 ± 3	10 ± 4 / <0.1	4 ± 3 / 0.1 ± 0.1	16 ± 7 / 0.1 ± 0.1	7 ± 5 / <0.1	36 ± 19 / 0.2 ± 0.1
November 3, 2016	6 ± 1	4 ± 1	3 ± 0	14 ± 2	1 ± 0 / <0.1	4 ± 0 / <0.1	7 ± 1 / 0.2 ± 0.0	0	11 ± 1 / 0.3 ± 0.0

Values above the line are abundance and, below the line, biomass. The mean and standard error are given.

Keratella cochlearis and *Synchaeta pectinata* dominated most often. *Eudiaptomus graciloides, Mesocyclops leuckarti*, and *Bosmina coregoni* dominated among crustaceans almost every year.

Sublittoral. In the sublittoral, the number of species in the sample varied from 12 to 24; the highest values were typical for the summer period (Table 8). The total abundance of zooplankton varied from 10.9 to 992.7 thous. ind./m^3; the maximum values were recorded in the first half of summer. The total zooplankton biomass varied from 0.03 to 3.47 g/m^3. High values of this indicator were typical for the beginning of summer (2014) or its second half (2015).

In spring, rotifers dominated by abundance in plankton community (Table 4). In the first half of summer, rotifers were also numerous; in some years the share of cladocerans was high (2015). In the second half of summer, copepods prevailed more often; in

Table 4. Abundance (N, thous. ind./m^3) of zooplankton dominant species zooplankton and their share (%) to total abundance of rotifers and crustaceans in of Lake Pleshcheyevo in the spring of 2014–2016

Taxon	Open litoral			Sublitoral			Pelagial		
	2014	2015	2016	2014	2015	2016	2014	2015	2016
Rotifera									
Polyarthra dolichoptera	1 ± 0 / 13 ± 6	0	0	5 ± 1 / 32 ± 5	0	0	8 ± 2 / 29 ± 5	0	0
Filinia terminalis	1 ± 0 / 18 ± 9	82 ± 35 / 45 ± 12	6 ± 1 / 13 ± 2	5 ± 1 / 33 ± 5	160 ± 34 / 61 ± 6	1 / 22	7 ± 1 / 30 ± 5	107 ± 18 / 65 ± 4	3 ± 1 / 17 ± 4
Conochiloides natas	<1 / 5 ± 5	25 ± 5 / 20 ± 3	2 ± 0 / 13 ± 2	0	46 ± 2 / 21 ± 4	1 / 17	1 ± 0 / 5 ± 2	31 ± 6 / 18 ± 3	2 ± 1 / 15 ± 1
Synchaeta (*S. lakowitziana* + *S. kitina*)	2 ± 1 / 37 ± 23	30 ± 6 / 26 ± 8	9 ± 1 / 59 ± 11	2 ± 1 / 13 ± 7	25 ± 3 / 11 ± 1	4 / 55	3 ± 1 / 13 ± 5	13 ± 7 / 10 ± 2	9 ± 1 / 60 ± 5
Crustacea									
Cyclops kolensis	<1 / 21 ± 1	2 ± 1 / 18 ± 11	3 ± 1 / 63 ± 6	3 ± / 17 ± 17	5 ± 2 / 26 ± 8	3 / 69	3 ± 1 / 39 ± 11	7 ± 2 / 39 ± 11	3 ± 1 / 59 ± 15
Mesocyclops leuckarti	<1 / 21 ± 5	10 ± 5 / 65 ± 12	<1 / 10 ± 10	5 ± 2 / 36 ± 14	6 ± 2 / 41 ± 10	1 / 13	5 ± 1 / 46 ± 10	6 ± 1 / 35 ± 7	2 ± 1 / 37 ± 14
Megacyclops viridis	<1 / 19 ± 19	0	0	0	1 ± 1 / 11 ± 5	1 / 13	0	0	0

Values above the line are absolute abundance and, below the line, share of rotifers or crustaceans to total zooplankton abundance.

some years (2015) the abundance was evenly distributed among the taxonomic groups of zooplankton. Copepods were numerous in autumn.

In spring, copepods dominated by biomass. In the first half of summer, these were rotifers (2013, 2014) and crustaceans (2015). In the second half of summer, the share of copepods was large, in some years, that of rotifers was large (2015). In autumn, copepods formed the basis of the zooplankton biomass (Table 8).

Changes in the abundance of rotifers were unimodal, with a maximum in early May (2015) or early June (2014). For cladocerans, one peak of abundance was characteristic in June and, in some years, in the second half of summer (2013). The maximum abundance of copepods was recorded in June.

In spring, 3 species of rotifers and 2–3 species of crustaceans usually dominated in the sublittoral (Table 4), similarly to the littoral. At the beginning of summer, the dominant complex changed, formed by 1–3 species of rotifers and 2–3 species of crustaceans. Every year it included the rotifer *Conochilus unicornis*; *Mesocyclops leuckarti* and *Thermocyclops oithonoides* most often dominated in crustacean zooplankton. In the second half of summer, 2–3 species of rotifers and 1–3 species of crustaceans predominated. In different years of the study (2013–2016), the dominant complexes of rotifers varied (Table 8). Among crustaceans, *Thermocyclops oithonoides* prevailed most often. In autumn, the composition of dominants included 3–4 species of rotifers and 2–3 species of crustaceans (Table 7). *Synchaeta pectinata* and *Keratella cochlearis* prevailed most often among rotifers and *Eudiaptomus graciloides* and *Mesocyclops leuckarti* among crustaceans.

Pelagial. The species richness of zooplankton in the pelagial of the lake ranged from 12 to 30 species per sample; the maximum number of species was typical for the summer period (Table 9). The total abundance of zooplankton varied within a wide range of 17.8–719.3 thous. ind./m^3; high values were recorded in the first half of summer. The total zooplankton biomass varied from 0.03 to 2.71 g/m^3, with a maximum observed in June (2014) or in its second half (2015).

In spring and early summer, rotifers dominated by abundance. In the second half of summer, copepods more often dominated; in some years, these were rotifers (2015). Crustaceans were numerous in autumn (Table 9). Copepods prevailed by biomass in spring and autumn (Table 9). At the beginning of summer, rotifers (2013 and 2014) or copepods (2015) formed the basis of biomass. In the second half of summer, the role of cladocerans was great and, in some years, that of rotifers (2013).

Changes in the abundance of rotifers were unimodal with a peak in early June. For cladocerans, one abundance peak was typical in July. The abundance

Table 5. Abundance (*N*, thous. ind./m^3) of zooplankton dominant species zooplankton and their share (%) to total abundance of rotifers and crustaceans in of Lake Pleshcheyevo in the first half of summer of 2013–2015

Taxon	Open litoral			Sublitoral			Pelagial		
	2013	2014	2015	2013	2014	2015	2013	2014	2015
Rotifera									
Polyarthra dolichoptera	3 ± 0 / 9 ± 3	10 ± 4 / 9 ± 4	0	13 ± 5 / 4 ± 0	57 ± 26 / 9 ± 3	3 / 2	29 ± 12 / 10 ± 4	67 ± 19 / 14 ± 3	<1 / <1
Polyarthra luminosa	0	67 ± 24 / 49 ± 11	8 ± 5 / 5 ± 3	0	4 ± 2 / <1	8 / 7	0	1 ± 1 / <1	1 ± 1 / 1 ± 1
Asplanchna priodonta	9 ± 7 / 12 ± 2	<1 / <1	0	41 ± 16 / 12 ± 0	8 ± 5 / <1	0	8 ± 3 / 3 ± 1	8 ± 1 / 2	0
Conochilus unicornis	34 ± 33 / 24 ± 19	23 ± 10 / 19 ± 10	72 ± 37 / 36 ± 18	202 ± 110 / 56 ± 11	451 ± 73 / 78 ± 7	57 / 53	45 ± 26 / 16 ± 10	186 ± 24 / 43 ± 2	100 ± 43 / 48 ± 15
Synchaeta pectinata	5 ± 1 / 19 ± 9	1 ± 1 / 1	<1 / 1	19 ± 11 / 5 ± 1	2 ± 1 / 0	0	58 ± 22 / 41 ± 15	6 ± 2 / 1	<1 / <1
Filinia terminalis	<1 / <1	2 ± 2 / 1	<1 / 1	<1 / <1	10 ± 8 / <1	0	10 ± 4 / 4 ± 2	43 ± 13 / 10 ± 2	48 ± 5 / 24 ± 1
Keratella quadrata	10 ± 6 / 20 ± 4	6 ± 3 / 1	0	33 ± 15 / 13 ± 10	4 ± 2 / 5	0	17 ± 6 / 6 ± 2	2 ± 1 / 1	0
Synchaeta (*S. lakowitziana* + *S. kitina*)	0	<1 / <1	4 ± 2 / 28 ± 27	0	14 ± 14 / 2 ± 1	1 / 1	0	104 ± 14 / 24 ± 2	22 ± 12 / 12 ± 7
Kellicottia longispina	2 ± 2 / 2 ± 1	10 ± 2 / 7 ± 3	8 ± 3 / 7 ± 2	1 ± 1 / <1	10 ± 2 / 2 ± 1	12 / 11	2 ± 1 / 3 ± 2	5 ± 1 / 1	5 ± 2 / 3 ± 2
Crustacea									
Bosmina longirostris	<1 / 0	15 ± 6 / 20 ± 6	5 ± 2 / 6 ± 2	<1 / <1	9 ± 2 / 5 ± 1	284 / 75	<1 / <1	5 ± 1 / 9 ± 2	7 ± 1 / 33 ± 5
Bosmina coregoni	<1 / 1 ± 1	2 ± 1 / 2 ± 1	<1 / 1	6 ± 1 / 12 ± 0	23 ± 9 / 13 ± 5	3 / 1	1 ± 0 / 4 ± 1	12 ± 2 / 20 ± 2	3 ± 0 / 4 ± 0
Eudiaptomus gracilodes	2 ± 1 / 10 ± 3	11 ± 4 / 16 ± 4	<1 / 1	6 ± 3 / 11 ± 5	28 ± 3 / 17 ± 3	5 / 1	2 ± 0 / 7 ± 2	10 ± 2 / 17 ± 4	1 ± 0 / 1
Mesocyclops leuckarti	4 ± 3 / 28 ± 12	30 ± 4 / 47 ± 14	41 ± 27 / 21 ± 11	24 ± 4 / 51 ± 0	39 ± 11 / 21 ± 4	23 / 6	2 ± 1 / 9 ± 3	16 ± 3 / 25 ± 3	12 ± 6 / 15 ± 8
Thermocyclops oithonoides	0	8 ± 1 / 10 ± 5	44 ± 22 / 27 ± 15	0	58 ± 14 / 34 ± 7	58 / 15	0	12 ± 2 / 21 ± 4	28 ± 6 / 35 ± 6

Values above the line are absolute abundance and, below the line, share of rotifers or crustaceans to total zooplankton abundance.

peak of copepods occurred in July 2014. In 2015, the copepod abundance was approximately the same during the summer and early autumn.

In spring, three species of rotifers and two species of crustaceans prevailed in the pelagic zone (Table 4), similarly to the littoral and sublittoral zones. In the first half of summer, the composition of dominants changed; 3–4 species of rotifers and 1–4 species of crustaceans prevailed. Every year the dominant complex included *Conochilus unicornis* and *Mesocyclops leuckarti* (Table 5). Cold-water species *Filinia terminalis* and genus *Synchaeta* (*S. lakowitziana* and *S. kitina*) were also abundant during this period. In the second half of summer, 3–5 species of rotifers and 3–4 species of crustaceans prevailed. The dominant complex of rotifers varied from year to year; most often it included *Kellicottia longispina* (Table 5). *Daphnia cucullata* and *Thermocyclops oithonoides* predominated among crus-

Table 6. Abundance (N, thous. ind./m^3) of zooplankton dominant species zooplankton and their share (%) to total abundance of rotifers and crustaceans in of Lake Pleshcheyevo in the late summer of 2013–2016

Taxon	Open litoral				Sublitoral				Pelagial				
	2013	2014	2015	2016	2013	2014	2015	2016	2012	2013	2014	2015	2016
Rotifera													
Polyarthra dolichoptera	<1 / 2 ± 2	0	0	0	<1 / <1	0	1 ± 1 / 3 ± 3	<1 / 5	0	<1 / 1 ± 1	<1 / <1	<1 / <1	1 ± 0 / 10 ± 7
Polyarthra luminosa	<1 / 4 ± 1	9 ± 4 / 18 ± 7	16 ± 4 / 34 ± 3	3 ± 3 / 18 ± 18	<1 / 8 ± 4	16 ± 3 / 25 ± 3	5 ± 4 / 7 ± 6	0	<1 / 2 ± 1	2 ± 1 / 10 ± 6	5 ± 2 / 17 ± 5	12 ± 7 / 16 ± 8	0
Polyarthra vulgaris	<1 / 4 ± 4	0	0	1 ± 1 / 26 ± 13	0	0	2 ± 2 / 3 ± 2	1 / 37	<1 / 4 ± 3	<1 / 1 ± 1	<1 / 1 ± 1	0	1 ± 1 / 12 ± 4
Asplanchna priodonta	6 ± 3 / 59 ± 29	1 ± 1 / 4 ± 4	2 ± 0 / 4 ± 1	<1 / 2 ± 1	11 ± 6 / 52 ± 27	<1 / <1	1 ± 0 / 2 ± 0	2 / 47	<1 / 6	5 ± 1 / 22 ± 2	<1 / 1	<1 / 1 ± 0	<1 / 6 ± 3
Conochilus unicornis	<1 / <1	1 ± 1 / 2 ± 1	8 ± 2 / 18 ± 6	<1 / 17 ± 16	0	<1 / 1 ± 0	18 ± 10 / 30 ± 9	0	4 ± 0 / 31	1 ± 1 / 6 ± 4	3 ± 3 / 8 ± 6	37 ± 22 / 37 ± 8	4 ± 2 / 39 ± 13
Synchaeta pectinata	<1 / 19 ± 19	6 ± 4 / 12 ± 10	1 ± 0 / 6 ± 2	<1 / <1	11 ± 1 / 18 ± 15	2 ± 1 / 2 ± 2	3 ± 1 / 2 ± 2	0	<1 / 1	6 ± 5 / 22 ± 20	1 ± 0 / 3 ± 1	<1 / <1	<1 / 2 ± 1
Filinia terminalis	<1 / <1	0	<1 / 1 ± 0	0	2 ± 1 / 12 ± 4	0	<1 / 2 ± 1	0	1 ± 1 / 10 ± 8	8 ± 6 / 30 ± 19	< 1 / 2 ± 1	6 ± 5 / 4 ± 3	<1 / <1
Keratella cochlearis	<1 / <1	4 ± 2 / 8 ± 3	3 ± 1 / 4 ± 1	<1 / 1 ± 1	<1 / 3 ± 2	11 ± 3 / 21 ± 6	3 ± 1 / 5 ± 3	0	1 ± 0 / 11 ± 1	<1 / 3 ± 21	8 ± 2 / 32 ± 3	8 ± 4 / 9 ± 2	1 ± 0 / 13 ± 4
Kellicottia longispina	<1 / 2 ± 1	17 ± 8 / 46 ± 19	14 ± 4 / 30 ± 3	<1 / 3 ± 1	<1 / 2 ± 1	28 ± 8 / 41 ± 8	19 ± 4 / 38 ± 6	0	<1 / 2	<1 / <1	8 ± 2 / 31 ± 5	22 ± 8 / 29 ± 6	<1 / 10 ± 4
Crustacea													
Daphnia cucullata	8 ± 8 / 10 ± 10	2 ± 1 / 5 ± 3	3 ± 1 / 7 ± 3	<1 / <1	4 ± 2 / 6 ± 3	22 ± 7 / 17 ± 4	13 ± 5 / 16 ± 6	0	18 ± 10 / 22 ± 10	13 ± 5 / 15 ± 4	21 ± 6 / 20 ± 2	10 ± 3 / 12 ± 3	1 ± 0 / 1 ± 0
Daphnia cristata	0	0	<1 / <1	1 ± 1 / 4 ± 2	<1 / <1	<1 / <1	3 ± 3 / 3 ± 2	2 / 2	15 ± 3 / 19 ± 5	8 ± 3 / 9 ± 3	2 ± 1 / 2 ± 1	3 ± 1 / 2 ± 0	16 ± 4 / 20 ± 3
Bosmina coregoni	1 ± 1 / 2 ± 1	2 ± 1 / 3 ± 3	1 ± 1 / 9 ± 3	<1 / 1 ± 1	4 ± 1 / 6 ± 1	9 ± 4 / 7 ± 2	7 ± 3 / 2 ± 1	7 / 9	3 ± 0 / 4 ± 1	9 ± 3 / 10 ± 1	8 ± 2 / 7 ± 1	13 ± 3 / 16 ± 2	4 ± 1 / 5 ± 1
Eudiaptomus gracilodes	14 ± 6 / 24 ± 4	14 ± 9 / 13 ± 4	1 ± 0 / 3 ± 1	4 ± 1 / 19 ± 8	24 ± 7 / 32 ± 6	10 ± 2 / 9 ± 1	3 ± 1 / 3 ± 0	4 / 5	9 ± 2 / 12 ± 3	19 ± 1 / 22 ± 2	8 ± 3 / 8 ± 2	3 ± 0 / 4 ± 1	11 ± 4 / 14 ± 4
Mesocyclops leuckarti	9 ± 4 / 25 ± 14	32 ± 16 / 35 ± 19	2 ± 1 / 4 ± 3	1 ± 1 / 6 ± 4	40 ± 15 / 52 ± 15	25 ± 11 / 23 ± 12	<1 / <1	<1 / <1	34 ± 10 / 44 ± 17	53 ± 8 / 61 ± 11	23 ± 5 / 24 ± 4	1 ± 1 / 1 ± 1	2 ± 0 / 3 ± 0
Thermocyclops oithonoides	0	33 ± 15 / 40 ± 19	26 ± 5 / 72 ± 7	9 ± 3 / 51 ± 11	0	52 ± 11 / 44 ± 10	42 ± 3 / 57 ± 5	57 / 72	0	0	38 ± 12 / 35 ± 3	28 ± 4 / 36 ± 7	33 ± 33 / 43 ± 4

Values above the line is absolute abundance and, below the line, share of rotifers or crustaceans to total zooplankton abundance.

taceans. In autumn, the composition of dominants was formed by 1–4 species of rotifers and 2–4 species of crustaceans (Table 7). *Synchaeta pectinata, Keratella cochlearis*, and *Kellicottia longispina* prevailed among rotifers and *Eudiaptomus graciloides, Mesocyclops leuckarti*, and *Bosmina coregoni* among crustaceans.

The seasonal cycle of zooplankton development in the pelagic zone of Lake Pleshcheyevo was characterized by two peaks in abundance and biomass, in spring–summer and summer–autumn periods (Stolbunova, 2006). In the littoral of the lake, one or two peaks of quantitative indicators were noted (Medyantseva and Semernoy, 1997). During the study period of

Table 7. Abundance (N, thous. ind./m^3) of zooplankton dominant species zooplankton and their share (%) in the total abundance of rotifers and crustaceans in of Lake Pleshcheyevo in the autumn of 2014–2016

Taxon			Open litoral			Sublitoral					Pelagial				
	2014		2015		2016	2014		2015		2016	2014		2015		2016
	Sep	Oct	Sep	Oct	Nov	Sep	Oct	Sep	Oct	Nov	Sep	Oct	Sep	Oct	Nov
Rotifera															
Polyarthra dolichoptera	0	0	<1 / <1	<1 / <1	0	0	0	0	0	0	<1 / <1	<1 / 2 ± 1	<1 / <1	<1 / 3 ± 3	<1 / 1 ± 1
Polyarthra luminosa	1 ± 1 / 11 ± 10	0	3 ± 3 / 15 ± 15	0	0	1 ± 1 / 26 ± 14	0	2 / 16	0	0	1 ± 1 / 3 ± 2	<1 / 2 ± 2	5 ± 1 / 11 ± 7	0	<1 / <1
Polyarthra vulgaris	<1 / 1 ± 1	1 ± 1 / 8 ± 8	<1 / <1	<1 / 2 ± 2	<1 / 19 ± 3	0	1 / 14	0	1 / 14	<1 / 21	0	2 ± 2 / 8 ± 8	<1 / <1	1 ± 1 / 14 ± 14	<1 / 12 ± 5
Polyarthra maior	0	<1 / 4 ± 4	<1 / 1 ± 1	1 ± 1 / 13 ± 7	<1 / 12 ± 5	0	0	<1 / 4	1 / 14	<1 / 16	<1 / 1	<1 / 2 ± 2	2 ± 1 / 5 ± 1	2 ± 1 / 19 ± 7	<1 / 8 ± 3
Conochilus unicornis	4 ± 3 / 30 ± 17	0	<1 / 5 ± 3	<1 / 2 ± 1	0	6 ± 3 / 45 ± 25	0	<1 / 6	0	0	6 ± 1 / 43 ± 5	<0.1 / <1	3 ± 1 / 6 ± 2	<1 / 4 ± 2	0
Synchaeta pectinata	<0.1 / <1	2 ± 1 / 20 ± 6	2 ± 1 / 18 ± 5	<1 / 8 ± 4	<1 / 39 ± 10	<1 / <1	3 / 41	5 / 40	1 / 41	1 / 48	<1 / <1	4 ± 2 / 24 ± 3	2 ± 1 / 5 ± 1	3 ± 2 / 20 ± 12	2 ± 0 / 59 ± 16
Filinia terminalis	0	0	<1 / <1	<1 / <1	0	0	0	0	<1 / <1	0	<1 / <1	<0.1 / <1	<1 / <1	1 ± 1 / 10 ± 10	<1 / <1
Keratella cochlearis	1 ± 0 / 13 ± 3	1 ± 1 / 10 ± 10	2 ± 1 / 38 ± 7	2 ± 1 / 39 ± 4	<1 / 4 ± 4	1 ± 0 / 13 ± 1	2 / 21	4 / 31	1 / 27	<1 / 11	<1 / 3 ± 1	4 ± 3 / 19 ± 6	16 ± 6 / 48 ± 7	2 ± 1 / 21 ± 12	1 ± 1 / 11 ± 11
Kellicottia longispina	3 ± 0 / 28 ± 5	3 ± 2 / 31 ± 7	1 ± 0 / 8 ± 1	<1 / 2 ± 1	<1 / 4 ± 4	5 ± 2 / 49 ± 9	2 / 21	0	0	<1 / <1	3 ± 1 / 19 ± 3	6 ± 2 / 41 ± 7	5 ± 3 / 17 ± 7	<1 / 2 ± 0	<1 / 4 ± 3

Table 7. (Contd.)

Taxon			Open litoral			Sublitoral					Pelagial				
	2014		2015		2016	2014		2015		2016	2014		2015		2016
	Sep	Oct	Sep	Oct	Nov	Sep	Oct	Sep	Oct	Nov	Sep	Oct	Sep	Oct	Nov
Crustacea															
Daphnia galeata	<1/<1	<1/<1	0	<1/1 ± 1	1 ± 0/10 ± 1	<1/1 ± 1	<1/<1	0	<1/<1	5/34	<1/<1	<1/<1	<1/<1	1 ± 16/1 ± 1	9 ± 2/34 ± 0
Bosmina coregoni	0	5 ± 3/31 ± 20	<1/3 ± 2	2 ± 1/10 ± 5	2 ± 0/20 ± 2	<1/<1	11/39	<1/2	5/19	0	1 ± 0/2 ± 1	11 ± 0/26 ± 1	1 ± 1/2 ± 1	7 ± 1/17 ± 3	3 ± 0/12 ± 1
Eudiaptomus gracilodes	1 ± 1/5 ± 1	1 ± 1/14 ± 8	2 ± 25/13 ± 10	2 ± 0/20 ± 6	2 ± 0/20 ± 5	3 ± 1/5 ± 1	4/12	7/27	5/18	3/18	3 ± 1/6 ± 2	3 ± 0/7 ± 0	5 ± 1/12 ± 2	9 ± 3/22 ± 2	5 ± 2/20 ± 5
Cyclops kolensis	0	3 ± 3/13 ± 9	0	<1/3 ± 1	2 ± 1/22 ± 10	<1/<1	8/29	0	2/7	2/12	0	3 ± 2/7 ± 5	0	0	1 ± 1/7 ± 7
Megacyclops viridis	<1/1 ± 1	<1/12 ± 12	2 ± 1/19 ± 16	<1/<1	0	3 ± 2/12 ± 9	0	0	0	0	<1/<1	<1/<1	<1/<1	1 ± 1/2 ± 2	0
Mesocyclops leuck-arti	35 ± 24/77 ± 4	4 ± 4/36 ± 27	11 ± 6/55 ± 17	7 ± 5/43 ± 16	<1/4 ± 2	12 ± 3/23 ± 5	5/17	17/66	5/17	1/4	24 ± 9/40 ± 7	15 ± 11/36 ± 27	28 ± 12/65 ± 11	4 ± 3/9 ± 6	<1/<1
Thermocyclops oithonoides	7 ± 6/12 ± 5	0	<1/1 ± 1	1 ± 1/11 ± 7	0	41 ± 26/44 ± 11	0	0	0	2/12	23 ± 7/40 ± 5	0	4 ± 4/12 ± 11	7 ± 7/25 ± 25	1 ± 1/<1

Values above the line is absolute abundance and, below the line, share of rotifers or crustaceans to total zooplankton abundance.

Table 8. Species richness of zooplankton (S), abundance (N), and biomass (B) of the main zooplankton groups in the sublittoral of Lake Pleshcheyevo in 2013–2016

Date	S, number of species per a sample				N, thous. ind./m^3 and B, g/m^3				
	Rotifera	Cladocera	Copepoda	Sum	Rotifera	Cladocera	Copepoda	Veliger	Sum
June 6, 2013	11 ± 3	2 ± 0	6 ± 1	18 ± 3	337 ± 131 / 1.5 ± 0.5	6 ± 1 / <0.1	42 ± 8 / 1.0 ± 0.7	1 ± 1 / <0.1	386 ± 139 / 2.6 ± 0.2
August 3, 2013	7 ± 1	8 ± 1	4 ± 0	19 ± 3	15 ± 5 / 1.4 ± 0.7	19 ± 5 / 0.5 ± 0.1	54 ± 7 / 0.7 ± 0.1	17 ± 7 / <0.1	106 ± 14 / 2.5 ± 0.9
May 3, 2014	9 ± 1	3 ± 0	5 ± 1	17 ± 2	16 ± 2 / <0.1	<1 / <0.1	15 ± 2 / 0.4 ± 0.1	<1 / <0.1	31 ± 5 / 0.4 ± 0.1
June 7, 2014	9 ± 0	7 ± 1	5 ± 0	21 ± 1	589 ± 91 / 1.1 ± 0.5	40 ± 9 / 0.4 ± 0.2	136 ± 17 / 0.7 ± 0.1	11 ± 3 / <0.1	775 ± 102 / 2.2 ± 0.5
July 18, 2014	7 ± 0	8 ± 1	4 ± 0	18 ± 1	63 ± 9 / 0.2 ± 0.1	32 ± 11 / 0.6 ± 0.2	87 ± 4 / 0.4 ± 0.1	26 ± 8 / <0.1	208 ± 8 / 1.2 ± 0.3
September 5, 2014	5 ± 1	7 ± 1	5 ± 0	16 ± 1	10.0 ± 3.2 / <0.1	12 ± 7 / 0.1 ± 0.1	59 ± 29 / 0.2 ± 0.0	2 ± 1 / <0.1	83 ± 38 / 0.3 ± 0.1
October 8, 2014	6	6	3	15	7.3 / <0.1	12 / 0.2	17 / 0.2	0	36 / 0.5
May 1, 2015	7 ± 1	5 ± 1	5 ± 0	16 ± 1	246 ± 35 / 0.1 ± 0.0	1 ± 0.5 / <0.1	17 ± 5 / 0.2 ± 0.1	0	264 ± 34 / 0.3 ± 0.1
June 4, 2015	7	5	5	17	108 / <0.1	289 / 0.6	92 / 0.5	6 / <0.1	494.8 / 1.1
July 4, 2015	8 ± 1	8 ± 1	4 ± 0	20 ± 1	53 ± 16 / 0.2 ± 0.1	31 ± 8 / 0.5 ± 0.2	45 ± 3 / 0.6 ± 0.1	0	129 ± 8 / 1.3 ± 0.3
September 22, 2015	6	4	2	12	11 / 0.1	1 / <0.1	24 / 0.3	<1 / <0.1	38 / 0.4
October 22, 2015	6	4	3	13	47 / <0.1	5 / <0.1	21 / 0.5	0	30 / 0.6
April 22, 2016	6	1	5	12	6 / <0.1	<1 / <0.1	4 / <0.1	0	11 / <0.1
July 27, 2016	4	13	5	22	4 / 0.4	18 / 0.3	62 / 0.7	<1 / <0.1	84 / 1.3
November 3, 2016	5	4	4	13	2 / <0.1	6 / 0.1	10 / 0.2	0	17 / 0.4

Values above the line are abundance and, below the line, biomass. The mean and standard error are given.

2012–2016, a unimodal curve of changes in both abundance and biomass of planktonic animals was recorded. In the mesotrophic lakes of the Middle Volga region (Salakhutdinov, 2003), the maxima of zooplankton abundance were noted in February–March and June.

Spring zooplankton. The beginning of the hydrobiological spring is considered the period of intense warming of the water after the lake is freed from its ice cover. In Lake Pleshcheyevo, it is usually observed at the end of April. The water masses of the lake warmed up unevenly, in the littoral the water temperature was higher than in the sublittoral and pelagic (Table 1), and the minimum values were typical for 2016. In 2015 and 2016, the total abundance of zooplankton was similar in different parts of the lake. In 2014, the zooplankton abundance in the littoral was significantly lower (5 times) than in the sublittoral and pelagial due to a decrease in the abundance of all taxonomic groups (Tables 3, 8, and 9). This was noted in the spring of

Table 9. Species richness of zooplankton (S), abundance (N), and biomass (B) of the main zooplankton groups in the pelagial of Lake Pleshcheyevo in 2012–2016

Date	S, number of species per a sample				N, thous. ind./m^3 and B, g/m^3				
	Rotifera	Cladocera	Copepoda	Sum	Rotifera	Cladocera	Copepoda	Veliger	Sum
July 25, 2012	14 ± 2	8 ± 0	7 ± 1	29 ± 1	12 ± 1 / 1.0 ± 0.0	43 ± 11 / 0.9 ± 0.3	36 ± 3 / 0.4 ± 0.1	51 ± 1 / <0.1	143 ± 6 / 1.3 ± 0.3
June 6, 2013	12 ± 0	2 ± 0	7 ± 2	22 ± 1	291 ± 38 / 0.5 ± 0.1	18 ± 17 / <0.1	23 ± 3 / 0.3 ± 0.2	<1 / <0.1	332 ± 37 / 0.8 ± 0.2
August 3, 2013	9 ± 1	8 ± 0	5 ± 1	22 ± 1	24 ± 4 / 1.0 ± 0.2	41 ± 9 / 0.8 ± 0.0	48 ± 4 / 0.5 ± 0.0	12 ± 0 / <0.1	124 ± 9 / 2.4 ± 0.2
October 19, 2013	4 ± 0	4 ± 0	7 ± 0	15 ± 0	2 ± 0 / <0.1	13 ± 0 / 0.2 ± 0.0	4 ± 0 / 0.1 ± 0.0	0	18 ± 0 / 0.0 ± 0.0
May 3, 2014	11 ± 1	2 ± 0	4 ± 0	17 ± 1	26 ± 4 / <0.1	<1 / <0.1	9 ± 1 / 0.1 ± 0.0	0	35 ± 3 / 0.2 ± 0.0
June 7, 2014	11	6 ± 0	5 ± 0	22 ± 1	442 ± 64 / 1.3 ± 0.2	19 ± 2 / 0.2 ± 0.0	40 ± 3 / 0.3 ± 0.0	3 ± 1 / <0.1	504 ± 67 / 1.8 ± 0.2
July 18, 2014	9 ± 1	7 ± 0	4 ± 0	20 ± 1	27 ± 6 / 0.1 ± 0.1	33 ± 8 / 0.5 ± 0.1	70 ± 16 / 0.3 ± 0.1	5 ± 2 / <0.1	134 ± 29 / 0.9 ± 0.2
September 5, 2014	6 ± 1	7 ± 0	4 ± 0	16 ± 1	15 ± 2 / <0.1	7 ± 1 / 0.3 ± 0.1	51 ± 15 / 0.4 ± 0.1	2 ± 1 / <0.1	74 ± 17 / 0.7 ± 0.2
October 8, 2014	12 ± 4	4 ± 0	4 ± 1	19 ± 4	16 ± 8 / <0.1	12 ± 1 / 0.1 ± 0.0	32 ± 3 / 0.3 ± 0.1	0	60 ± 12 / 0.5 ± 0.1
May 1, 2015	7 ± 1	4 ± 0	5 ± 0	15 ± 1	166 ± 24 / 0.1 ± 0.0	<1 / <0.1	16 ± 2 / 0.2 ± 0.0	0	183 ± 23 / 0.3 ± 0.0
June 4, 2015	11 ± 0	5 ± 1	5 ± 0	21 ± 1	201 ± 27 / 0.1 ± 0.0	30 ± 5 / 0.1 ± 0.0	49 ± 2 / 0.2 ± 0.0	<1 / <0.1	281 ± 23 / 0.5 ± 0.0
July 4, 2015	9 ± 1	9 ± 0	4 ± 1	22 ± 1	88 ± 37 / 0.2 ± 0.1	50 ± 18 / 1.0 ± 0.2	36 ± 6 / 0.5 ± 0.1	<1 / <0.1	173 ± 59 / 1.6 ± 0.4
September 22, 2015	10 ± 1	6 ± 0	4 ± 1	19 ± 2	35 ± 13 / 0.3 ± 0.1	2 ± 0.4 / <0.1	42 ± 16 / 0.4 ± 0.1	1 ± 0 / <0.1	80 ± 26 / 0.8 ± 0.3
October 22, 2015	10 ± 1	6 ± 1	5 ± 1	20 ± 2	12 ± 2 / <0.1	8 ± 1 / 0.1 ± 0.0	31 ± 9 / 0.7 ± 0.2	<1 / <0.1	51 ± 8 / 0.8 ± 0.2
April 22, 2016	9 ± 1	3 ± 0	3 ± 1	16 ± 1	15 ± 2 / <0.1	<1 / <0.1	5 ± 1 / <0.1	0	21 ± 2 / <0.1
July 27, 2016	9 ± 2	8 ± 0	4 ± 0	20 ± 2	9 ± 2 / 0.2 ± 0.1	32 ± 3 / 1.1 ± 0.2	47 ± 4 / 0.7 ± 0.2	3 ± 1 / <0.1	91 ± 4 / 2.0 ± 0.2
November 3, 2016	9 ± 4	5 ± 1	4 ± 2	17 ± 3	4 ± 1 / <0.1	12 ± 2 / 0.2 ± 0.0	13 ± 3 / 0.3 ± 0.1	0	28 ± 6 / 0.6 ± 0.1

Values above the line are abundance and, below the line, biomass. The mean and standard error are given.

1984–1985, when the abundance of zooplankton in the littoral was 2–27 times lower than in the deepwater zone, due to the lower abundance of copepods in shallow water areas (Stolbunova, 2006).

The spring period was characterized by significant interannual differences in the zooplankton abundance. The minimum abundance values were noted in 2014, biomass in 2016, and maximum abundance and biomass in 2015. High abundance values observed in May 2015 were due to an increase in the concentration of all taxonomic groups of zooplankton, but this was especially pronounced for rotifers (*Filinia terminalis* and *Conochiloides natans*).

When comparing the data for the spring periods of 2014–2016 with materials obtained earlier (Stolbunova, 2006), the abundance in May 2015 fell in a range given for the spring period of 1979–1996, but was significantly less (2–10 times) in April 2016 and May 2014. In spring of 1979–1996, in the pelagic zone of the lake, both rotifers (1979, 1980, 1983, 1989, 1990, 1992, and 1996) and copepods (1984, 1985, 1988, and 1991) predominated (Stolbunova, 2006). In 2014–2016, only rotifers were dominants in the main water area of the lake.

Two spring groups of zooplankton species (early spring and late spring) were identified for the lakes of the Volga River basin (Lazareva, 2010) and Lake Pleshcheyevo (Stolbunova, 2006). In the springs of 1979–1996, cold-water rotifers *Keratella hiemalis, Polyarthra dolichoptera, Filinia terminalis, Conochloides natans*, and *Synchaeta oblonga* and eurybiont *Keratella quadrata, Kellicottia longispina*, and *Conochilus unicornis* were indicated as dominants (Stolbunova, 2006). In the springs of 2014–2016, the number of dominant rotifer species was lower: *Polyarthra dolichoptera, Filinia terminalis, Conochloides natans*, and genus *Synchaeta* (*S. lakowitziana* and *S. kitina*); eurybiont (=late spring) species were not numerous in April–May of 2014–2016, as was observed earlier (Stolbunova, 2006); among crustaceans, *Cyclops kolensis* and *Mesocyclops leuckarti* prevailed.

Interannual differences in the zooplankton abundance were probably due to climatic and trophic conditions of certain years. In April 2015, frequent and abrupt changes of hot and cold days were observed, and the sum of effective temperatures was minimal in 2014–2016, which contributed to the development of cold-water rotifers. During this period, favorable trophic conditions were also established for successful development of this group of zooplankton. At the beginning of May 2015, the peak of phytoplankton development was noted (Sakharova, 2019). For comparison, in Lake Krasnoe in 2015, a long-term pattern of seasonal dynamics was preserved, when the complex of copepods and rotifers dominated at low temperatures in May, and the quantitative development of zooplankton was minimal. Whereas in 2016, the earlier ice melting and, accordingly, earlier warming of the water contributed to the abundant development of rotifers by the first decade of May, this was the period of the zooplankton abundance peak (Trifonova et al., 2017). The timing of the beginning of the spring development of zooplankton may be determined by the oxygen content in lakes in winter. The more deadly phenomena expressed and the deeper the lake, the later zooplankton developed (Salakhutdinov, 2003).

Zooplankton in early summer. At the beginning of summer, further warming of the water column contributed to the development of zooplankton community (Table 1). During this period, the first peak of quantitative indicators was more often observed in the lake (Stolbunova, 2006). In June 2014, the abundance of zooplankton was 14.4–25.5 times higher than in May of the same year, while in June 2015 it was only 1.6–1.8 times higher. Biomass in early summer was 3.0–9.0 times higher than in spring in 2014 and 1.7–3.7 times in 2015 (Tables 3, 8, 9).

At the beginning of the summer of 2014, the abundance of zooplankton was significantly 1.5–1.8 times higher than in 2013 and 2015. Interannual variations in quantitative indicators of zooplankton in June 2014 and 2015 were due to the peculiarities of climatic conditions. May of 2014 was anomalously warm; by the beginning of June, the littoral and surface layers of pelagial warmed up much more compared to the same period in 2015 (Table 1). The zooplankton abundance recorded in June 2013–2015 fell in the range of values reported for June of 1979–1996 (Stolbunova, 2006).

The abundance of zooplankton varied in different parts of the lake; low values were typical for the open littoral and high values were typical for the sublittoral. In June 2014, in the open littoral, the zooplankton abundance was 2.5–3.8 times lower than in the sublittoral and pelagial (Tables 3, 8, 9).

In June of 2013–2015, rotifers prevailed by abundance in most parts of the lake; only in 2015 were cladocerans numerous in the sublittoral due to the mass development of *Bosmina longirostris*. Based on the data obtained in 1979–1996, at the beginning of summer, both rotifers (1979, 1981, 1985, 1990, and 1996) and copepods (1983, 1984) could form the basis of abundance (Stolbunova, 2006).

In Lake Pleshcheyevo, at the beginning of summer, cold-water species descended in the water column to the lower water layers in the summer period and warm-water species descended to the pelagial (Stolbunova, 2006). In the summer zooplankton community of lakes, two groups of dominants were identified: "early summer" and "late summer" (="true summer") (Lazareva, 2010). The early summer group was represented by a mixed complex of spring and summer plankton species. It was typical for June–early July (Lazareva, 2010). In early summer 2014–2015, the composition of dominant species in Lake Pleshcheyevo changed when compared to the spring period; it also varied from year to year. It included species both characteristic of spring (cold-water rotifers *Polyarthra dolichoptera*, genus *Synchaeta* (*S. lakowitziana* and *S. kitina*), *Synchaeta tremula*, and *Filinia terminalis*), as well as warm-water and eurybiont rotifers (*Asplanchna priodonta, Conochilus unicornis, Synchaeta pectinata, Keratella quadrata, Polyarthra luminosa, and Kellicottia longispina*) and crustaceans (*Eudiaptomus graciloides, Mesocyclops leuckarti, Bosmina longirostris,* and *B. coregoni*).

In the second half of summer, the abundance of zooplankton decreased 1.6–3.8 times relative to the beginning of June in different parts of the lake in all the study years. On the contrary, the zooplankton biomass of planktonic increased 1.8–2.6 times in the littoral zone (Table 3), while in the sublittoral zone it remained the same or decreased by 1.8 times (Table 8). In the pelagic zone in July 2014, the biomass decreased 2 times due to a decrease in the number of large rotifers *Asplanchna priodonta*; in 2015 increased 3.2 times relative to the beginning of June (Table 9) due to the mass development of representatives of the genus *Daphnia* (*D. cucullata* and *D. galeata*).

The lowest abundance was typical for July 2016 (Tables 3, 8, and 9); in other years, it did not differ significantly. Plankton abundance recorded in July–August of 2012–2016 in the central part of the lake was lower or close to the minimum values indicated for this period in 1979–1996. In 1979–1996, rotifers prevailed by abundance most often, but in some years (1984) these were crustaceans. In the second half of the summer of 2012–2016, copepods (2013, 2014, and 2016), rotifers (2015), or veligers of zebra mussels (2012) dominated by abundance.

In the littoral, the abundance of zooplankton was significantly lower by a factor of 1.5–10.0 than in the sublittoral and pelagial. In July and early August 1983, the zooplankton abundance in the deep-sea zone was higher than in the sublittoral zone, whereas in late August it was close to or even lower (Stolbunova, 2006). The zooplankton biomass in the open littoral was lower than in the deepwater zone (Stolbunova, 2006). In 2013–2016, the biomass did not differ in different parts of the lake; when comparing with other years of observation, the biomass of planktonic animals was the highest in August 2013 (Tables 3, 8, 9).

In the second half of summer, the dominant complexes of rotifers and crustaceans underwent some changes. In August 2013 and in the second decade of July 2014, *Conochilus unicornis* disappeared from the group of dominant rotifer species. In 2015, zooplankton samples were collected in the first decade of July and, accordingly, this species still retained a fairly high abundance (Table 6). In the dominant complex of crustaceans, the share of summer species of the genus *Daphnia* was increasing. In the long-term series of 1979–1996, rotifers dominated in summer (more than 10% of the total number of zooplankton), namely, *Keratella quadrata, K. cochlearis, Polyarthra vulgaris, P. luminosa, P. longiremis, Conochilus unicornis, Pompolyx sulcata, Asplanchna priodonta, Synchaeta oblonga, Filinia major*, and *Kellicottia longispina* (Stolbunova, 2006). The composition of dominant rotifer species in 2012–2016 was similar to that observed earlier. However, *Polyarthra longiremis, Pompolyx sulcata*, and *Synchaeta oblonga* were not noted as dominants, with that title being given to closely related species *Polyarthra dolichoptera* and *Synchaeta pectinata* were. During the summer period of 1979–1996, *Mesocyclops leuckarti, Eudiaptomus graciloides, Bosmina coregoni, Daphnia cucullata*, and *Diaphanosoma brachyurum* dominated in the group of crustaceans (Stolbunova, 2006). In addition to these species, *Thermocyclops oithonoides* and *Daphnia cristata* were dominants in 2012–2016.

At Lake Svetloyar (Novgorod oblast), favorable conditions developed for cold-water rotifers due to slow heating of the lake waters in June 2003, at the same time, the processes of hatching and growth of juvenile crustaceans slowed down and weakened (Kuznetsova et al.., 2017).

In autumn, the cooling of the water masses of the lake began (Table 1). The zooplankton parameters decreased relative to the summer period by 1.3–3.4 times (abundance) and by 1.3–6.5 times (biomass). The zooplankton indicators were higher in the pelagial than in the littoral, but similar to those in the sublittoral. Interannually, the abundance of planktonic animals did not differ significantly in the autumn period of different years. Population densities of planktonic animals recorded in September–November of 2013–2016 in the central part of the lake were lower or close to the minimum values indicated for the same season of 1979–1996.

When analyzing long-term dynamics, rotifers prevailed most often by abundance in the autumn of 1979–1996; crustaceans prevailed only in 1989, 1990, and 1991. However, crustaceans formed the basis of zooplankton abundance in autumn of 2013–2016.

The complex of dominant species of rotifers and crustaceans underwent changes in autumn. In September, some eurybiont and summer species still kept the leading position (*Kellicottia longispina, Thermocyclops oithonoides, and Mesocyclops leuckarti*). Species that were numerous in early summer formed a second (lower) abundance peak in autumn.

Based on data obtained in 1979–1996, rotifers *Keratella quadrata* and *K. cochlearis* and copepods *Mesocyclops leuckarti, Eudiaptomus graciloides*, and *Bosmina coregoni* dominated in September (Stolbunova, 2006). *Synchaeta tremula, S. pectinata, Asplanchna priodonta, Conochilus unicornis, Eudiaptomus graciloides*, and *Daphnia cucullata* dominated in October (Stolbunova, 2006 (Stolbunova, 2006)). The species indicated as dominants in 1979–1996 also occupied leading positions the autumn period of 2014–2016, supplemented by representatives of the genus *Polyar-*

thra and *Kellicottia longispina*. The dominant complex of crustaceans was represented by a large number of species; it also included *Cyclops kolensis, Thermocyclops oithonoides, Megacyclops viridis, Daphnia galeata*, and *D. cristata*.

CONCLUSIONS

During the study period, 130 species of rotifers and crustaceans were recorded in Lake Pleshcheyevo. The zooplankton abundance and biomass were lower than or close to the values indicated for 1979–1996. The open littoral of the lake was more often characterized by low quantitative indicators compared to deeper areas (depths exceeding 4 m). Total abundance and biomass of zooplankton varied greatly in different seasons of the year due to climatic features of certain years and differences in the time of sampling. The composition of the dominant species of rotifers and crustaceans in 2012–2016 was close to that indicated earlier for 1979–1996. *Synchaeta lakowitziana, S. kitina, Diaphanosoma mongolianum*, and *Thermocyclops oithonoides* were noted for the first time as dominating in the zooplankton community.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interest. The authors declare that they have no conflicts of interest.

Statement on the welfare of animals. All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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