NUMBER AND DYNAMICS OF ZOOPLANKTON TAXA IN THE DAUGAVA RIVER AND PĻAVIŅAS RESERVOIR

Aija Brakovska, Jana Paidere, Artūrs Škute

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In general 25 taxa of Rotifera and 2 taxa of Cladocera group were found in the Daugava River, and there were only Nauplii and Copepodite from Copepoda in 2014. It should be noted that the specimens of Copepoda group were identified in the samples collected in the Daugava River upstream of Pļaviņas Reservoir. On the other hand, 23 taxa of Rotifera group and 4 taxa of Cladocera were found in the Reservoir of Pļaviņas in 2014, but 34 taxa of Rotifera group, 18 taxa of Cladocera and 3 taxa of Copepoda were found in the reservoir of Pļaviņas in 2015. In the Daugava River upstream of the Pļaviņas Reservoir the highest percentage of Rotifera taxa were *Synchaeta* sp., *Keratella cochlearis*, *Brachionus calyciflorus* and Bdeloid, whereas in the Aiviekste estuary to the Daugava River the highest percentage of Rotifera taxa were *Conochilus* sp., *Synchaeta oblonga*, *Synchaeta* sp., *Keratella cochlearis*, *Brachionus quadridentatus* and Bdeloid which were typical species of the Daugava. Cladocera and Copepoda compared with Rotifera have very small percentage of representatives. Rotifera taxa of Pļaviņas Reservoir the highest percentage are *Synchaeta* sp., *Brachionus calyciflorus*, *Keratella cochlearis*, *Keratella quadrata*, *Polyarthra vulgaris*, *Polyarthra major* and *Asplanchna priodonta*. From Cladocera here were found typical of lake zooplankton taxa i.e *Bosmina coregoni*, *Chydorus ovalis*, *Diaphanosoma brachyurum*, *Bosmina longispina* and in some places also *Daphnia cucullata*, *Acroperus harpae* and *Ceriodaphnia quadrangula*.

In the studied stage of rivers and reservoir, variation among zooplankton quantity is smooth, but the right and left bank are much higher. The largest quantity were found in both zooplankton taxa from Rotifera, Cladocera and Copepoda group the pelagic and littoral zone without macrophyte stands, while in the middle of rivers and reservoirs, where there is a higher flow and no macrophyte, diversity significantly decreases.

Key words: Daugava River; Pļaviņas Reservoir, zooplankton groups, Rotifera, Cladocera, Copepoda, water physico-chemical measurements.

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INTRODUCTION

Daugava is one of the largest rivers in Eastern Europe. It starts in Russia, flows through the East-European Plain, crosses Belarus and Latvia. Daugava is 1005 km long with 87 900 km^2 large catchment area. It is one of the ten largest rivers in the Baltic Sea basin. It crosses three countries - Russia, Belarus and Latvia. Only a third part of the Daugava river catchment area is on the territory of Latvia (District Management Plan 2010 – 2015 of Daugava River Basin 2009). The Pļaviņu Reservoir is the largest reservoir in Latvia by volume, it is 509.5 million m^3. The area is 35 km^2, the average depth – 14.5 m, the maximum depth – 47 m. The length is 45 km, the maximal width about 2 km, whereas the minimal is 1 km (Tidriķis 1997). The Aiviekste is the largest tributary of the Daugava. It is the 14th longest river in Latvian, the length is 114 km, the basin area is 9160 km², the total fall 26.9 m (Rieksts 1994).

Zooplankton play a significant role in the ecosystem structure and functioning as a secondary trophic chain in aquatic ecosystems. Zooplankton are primary production consumers in waterbodies and one of indicators of waterbodies productivity as they serve as food for many fish, so the organisms are bioindicators, which show water quality (Chang & Hanazato 2004,Cimdiņš 2001, Hebert 1982, Malone & McQueen 1983, Pinel-Alloul 1995, Wetzel 2001). Many zooplankton species reduce the possibility of eutrophication by filtering feed, because they control the quantity of bacteria and algae and also they participate in water biological self-cleaning process. In general zooplankton is a dynamic system in which the composition of species may significantly change during the season. Numerous abiotic (eg temperature, salinity, stratification, pollution) and biotic factors (eg., food, predation, competition) affect temporal changes in the composition of zooplankton species of the temperate climate zones (Bengtsson 1986, Bertilsson et al. 1995, Bērziņš & Pejler 1987, 1989a, 1989b, Chang & Hanazato 2004, Cimdiņš 2001, Dagg 1977, Dodson, 1984, Dumont et al. 1973, Escribano & Hidalgo 2000, Fernandez-Rosado & Lucena 2001, Hanazato 1991, 1992, Harris et al. 2012, Hebert 1982, Horppila et al. 2000, Larsson & Dodson 1993, Locke & Sprules 2000, Malone & McQueen 1983, Pinel-Alloul 1995, Seda & Devetter 2000, Tallberg et al. 1999, Weider & Pijanowska 1993, Wetzel 2001, Лазарева 2010, Пидгайко 1984). It is really necessary to perform long-term systematic observations for receiving true structure of the ecosystem and for evaluating its natural variation scene ecosystem. The last serious zooplankton studies at Pļaviņas Reservoir in the Daugava River and in the Pļaviņas Reservoir were conducted in 1960 - 1970 (Шкуте 1976, Слока 1976). Recently, such studies have been unsystematic and not compiled together in a single long-term study. The exact and frequent plankton quantitative determination is a prerequisite for accurate evaluation of productivity in rivers and other waterbodies. It is therefore important to carry out such studies in order to check the current composition of zooplankton species at Pļaviņas Reservoir in the Daugava River and in Pļaviņas Reservoir. Qualitative and quantitative variations of zooplankton help to make conclusions about changes in environmental factors and their impact on living organisms. The obtained data and further long-term research are significant because the conditions of waterbodies which affect zooplankton are very diverse and changeable, as a result the data may vary significantly from year to year, so in order to make fundamental conclusions, long-term studies are required.

MATERIAL AND METHODS

Location of research and sampling

The study summarizes the data collected during the research in July 2014, in the Daugava River upstream of Pļaviņas Reservoir, in the area of Pļaviņas Reservoir and in the place where the Aiviekste River flows into the Daugava River. By contrast, in the Pļaviņas Reservoir area samples were collected in May, June and September 2015. At each sampling site the samples were collected on the left and on the right bank of the river, and in the middle of the river. The zooplankton samples were collected using Apstein type plankton net (65 μ), through which 100 liters of water were filtered from the water surface layer (0.5 -1m depth) (Fig. 1). In total, 7 zooplankton samples and 6 zooplankton samples were collected in the Daugava River and in the Pļaviņas Reservoir in 2014, however 19 zooplankton samples were collected in the Pļaviņas Reservoir in 2015. Sampling and data analysis were carried out in accordance with the standard methods (APHA 2005, Wetzel & Linkens 2000).

Physico-chemical measurements

Along with zooplankton sampling water physico-chemical parameters (water temperature (^{0}C), dissolved oxygen (mg^{-1}) and chlorophil α (μg^{-1}) were also carried out) which were determined at each site of waterbed using a *YSI Pro Plus Multi-Parameter Water Quality Meter* probe with 1 m interwal from the bottom towards water surface.

Analysis of zooplankton samples

Quantitative analysis of individuals and the number of organisms in a sample

The collection of zooplankton samples and their quantitative and qualitative analysis was performed in accordance with the American Public Health Association (APHA) Standard method procedures for the water and wastewater analysis (APHA 2005, Wetzel and Linkens 2000).

The samples of zooplankton were analysed by using Zeiss Primo Star upright light microscope (100- 400 x magnification). The samples of zooplankton were analysed repeatedly by Gridded Sedgewick Rafter counting chamber with the volume of 1 ml, in total 6 ml sample's subvolume examined (1 ml x 6) (Wetzel & Likens 2000). Having studied the samples in the light microscope the zooplankton organisms were then calculated and identified as species or families. We used the following zooplankton guides (Benzie 2005, Dagg 1977, Dumont & Negrea 2002, Dussart & Defaye 2001, Flössner 1972, Flössner 2000, Flössner 2002, Hudec 2010, Kotov 2006, Krauter & Streble 1988, Lieder 1996, Nogrady & Segers 2002, Paidere & Škute 2011, Pontin 1978, Radwan et al. 2004, Rivier 1998, Ruttner-Kolisko 1974, Scourfield & Harding 1994, Segers 1995, Segers 2007, Sloka 1981, Smirnov 1996, Кутикова 1970, Кутикова & Старобогатов 1977, Мануйлова 1964, Определитель зоопланктона

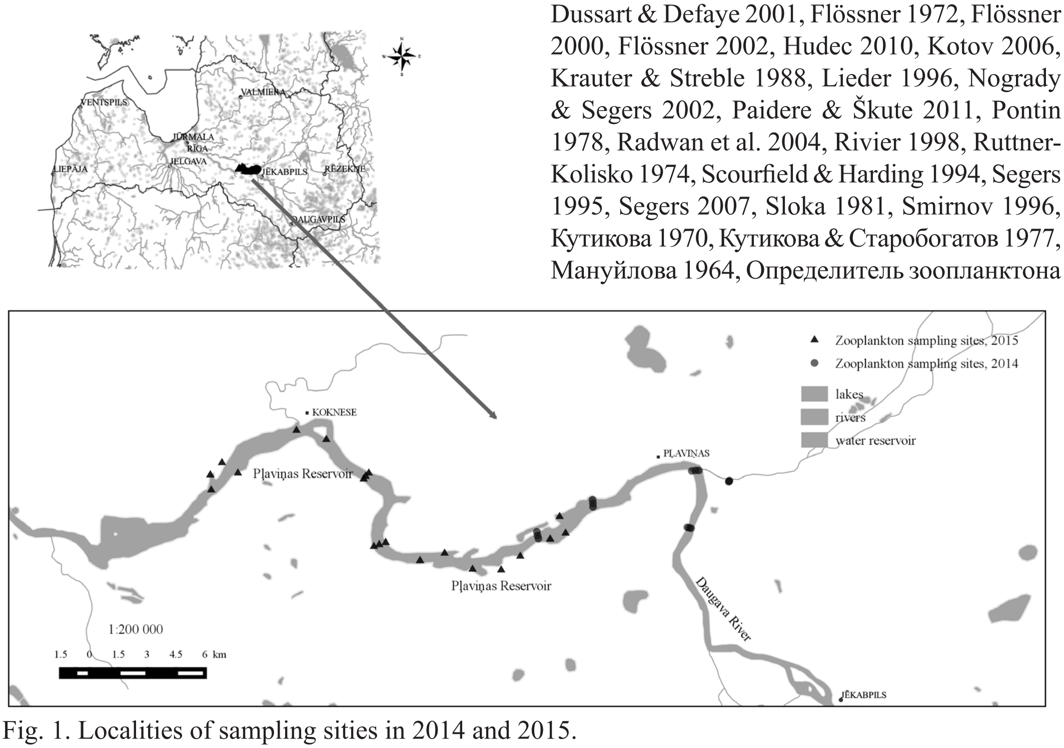

Fig. 1. Localities of sampling sities in 2014 and 2015.

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A zooplankton abundance changes analysis (median, quartiles and range) at all the sampling localities in Daugava River and Pļaviņas Reservoir were performed by the IBM SPSS Statistics 20 for Windows software package (Arhipova & Bāliņa 2003).

The following formula was used to calculate the number of organisms in a sample:

N= (a x b x 1000) / (c x d) /1000, where (1)

a - is a calculated number of organisms (average);
b - is a volume of concentrated sample;
c - is a sample volume;
d - is a volume of filtered water;
N - is a number of organisms per 1 l (litre).

Statistical analysis of zooplankton samples

The Shannon-Wiener function (H') was used to calculate as (Margalef 1958):

$$H' = -\sum_{i=1}^{S} (p_i)(\ln p_i) \quad (2)$$

H' - is the index of species diversity,
S - is the number of species, and
p_i - is a proportion of the total sample belonging to *i* th species.

Since the resulting equation is a measure of bits, we used the following equation to move from the bits unit to the species unit (Krebs 1999, MacArthur 1965):

$$N_1 = e^{H'}, \quad (3)$$

where *e* is equal to 2.71828 (base of natural logs),
H' - Shannon-Wiener function (calculated with base *e* logs), and
N_1 - the number of equally common species that would produce the same diversity as H'.

Sampling distributions for the Shannon-Wiener index (H') have been determined by Good (1953) and Basharin (1959). Shannon-Wiener index (H') is used for the quality control of the environment in accordance wich bioindication by principle (Krebs 1999, Margalef 1958, Лебедева et al. 2004, Терешенко et al. 1994). In this case it does not evaluate condition of the environment parameters, but the reaction of organisms, that is caused by the environment changes. This index is particularly suitable for population description of the water body (Liepa et al. 1991).

The software Microsoft® Excel 2010 was used to calculate the number of zooplanktons taxa and to analyse physical and chemical parameters (Arhipova & Bāliņa 2003).

RESULTS AND DISCUSSION

In general 25 Rotifera and 2 Cladocera taxa group were found in the Daugava River, and there were only subadult specimens - Nauplii and Copepodite from Copepoda (Table 1), however 19 Rotifera and 3 Cladocera taxa were found at the Aiviekste River estuarine in Daugava (Table 2). It has to be mentioned that the specimens of Copepoda group were not identified in the samples collected in the upstream of the Daugava River at Pļaviņas Reservoir. By contrast, 23 taxa of Rotifera group and 4 taxa of Cladocera group were found in the Reservoir of Pļaviņas in 2014 (Table 3), and 17 Rotifera and 5 Cladocera taxa were found in the reservoir of Pļaviņas in July 2015 (Table 4). The Copepoda group was represented by *Acanthocyclops* sp. *Cyclops* sp. and a large number of subadult specimens - Nauplii and Copepodite. 24 taxa of Rotifera and 17 taxa of Cladocera group were found in the samples collected in September (Table 4). The Copepoda group was represented by *Eudiaptomus graciloides*, *Cyclops* sp. and a large number of subadult specimens - Nauplii and Copepodite.

In the Daugava River upstream of the Pļaviņas Reservoirs the highest percentage of Rotifera taxa were *Synchaeta* sp.- 14.1%, *Keratella cochlearis*- 3.1%, *Brachionus calyciflorus*- 23.4% and *Bdeloid*- 4.7%, whereas in the Aiviekste estuary

Table 1. Diversity of zooplankton species in Daugava River in 2014

Species (taxon)	
ROTIFERA	**25**
Dicranophorus Nitzsch, 1827	
Bdeloid Ehrenberg, 1832	
Brachionus angularis Gosse, 1851	
Brachionus bennini Leissling, 1924	
Brachionus calyciflorus Pallas, 1766	
Brachionus quadridentatus Hermann, 1783	
Brachionus sp. Pallas, 1766	
Cephalodella catellina (Müller, 1786)	
Cephalodella sp. Bory de St.Vincent, 1826	
Conochilus (Conochilus) hippocrepis (Schrank, 1803)	
Conochilus sp. Ehrenberg, 1834	
Euchlanis sp. Ehrenberg, 1832	
*Filinia longiseta (*Ehrenberg, 1834)	
Keratella cochlearis (Gosse, 1851)	
Lecane luna (Müller, 1776)	
Lecane lunaris (Ehrenberg, 1832)	
Lepadella sp. Bory de St. Vincent, 1826	
Polyarthra major Burckhardt, 1900	
Polyarthra vulgaris Carlin, 1834	
Pompholyx sulcata Hudson, 1885	
Synchaeta oblonga Ehrenberg, 1832	
Synchaeta sp. Ehrenberg, 1832	
Testudinella patina (Hermann, 1783)	
Trichocerca pusilla (Jennings, 1903)	
Trichotria truncata (Whitelegge, 1889)	
CLADOCERA	**2**
Bosmina (Eubosmina) longispina Leydig, 1860	
Ceriodaphnia quadrangula (O.F.Müller, 1785)	
COPEPODA	
Copepodite cyclopoid	
Nauplii	
Number of species	**27**

Table 2. Diversity of zooplankton species in Aiviekste River in 2014

Species (taxon)	
ROTIFERA	**19**
Dicranophorus Nitzsch, 1827	
Cephalodella sp. Bory de St.Vincent, 1826	
Trichocerca pusilla (Jennings, 1903)	
Polyarthra sp. Ehrenberg, 1834	
*Polyarthra vulgaris*Carlin, 1943	
Synchaeta sp. Ehrenberg, 1832	
Asplanchna priodonta Gosse, 1850	
Lecane lunaris (Ehrenberg, 1832)	
Lepadella sp. Bory de St. Vincent, 1826	
Squatinella rostrum (Schmarda, 1846)	
Euchlanis sp. Ehrenberg, 1832	
*Brachionus urceolaris*Müller, 1773	
Brachionus calyciflorus Pallas, 1766	
Brachionus quadridentatus Hermann, 1783	
Keratella cochlearis (Gosse, 1851)	
Conochilus sp. Ehrenberg, 1834	
Testudinella patina (Hermann, 1783)	
Filinia longiseta (Ehrenberg, 1834)	
Bdeloid Ehrenberg, 1832	
CLADOCERA	**3**
Acroperus harpae (Baird, 1835)	
Alonella nana Baird, 1843	
Kurzia latissima Kurz, 1875	
COPEPODA	
Copepodite cyclopoid	
Nauplii	
Number of species	**22**

Table 3. Diversity of zooplankton species in Pļaviņas Reservoir in 2014

Species (taxon)	
ROTIFERA	**23**
Dicranophorus Nitzsch, 1827	
Asplanchna priodonta Gosse, 1850	
Bdeloid Ehrenberg, 1832	
Brachionus angularis Gosse, 1851	
Brachionus bennini Leissling, 1924	
Brachionus calyciflorus Pallas, 1766	
Brachionus quadridentatus Hermann, 1783	
Brachionus urceolaris Müller, 1773	
Cephalodella sp. Bory de St.Vincent, 1826	
Euchlanis sp. Ehrenberg, 1832	
Filinia longiseta (Ehrenberg, 1834)	
Keratella cochlearis (Gosse, 1851)	
Lecane lunaris (Ehrenberg, 1832)	
Lepadella sp. Bory de St. Vincent, 1826	
Polyarthra major Burckhardt, 1900	
Polyarthra sp. Ehrenberg, 1834	
Polyarthra vulgaris Carlin, 1943	
Synchaeta oblonga Ehrenberg, 1832	
Synchaeta sp. Ehrenberg, 1832	
Testudinella patina (Hermann, 1783)	
Trichocerca capucina (Wierzejski & Zacharias, 1893)	
Trichocerca pusilla (Jennings, 1903)	
Trichocerca sp. Lamarck, 1801	
CLADOCERA	**4**
*Bosmina (Bosmina) longirostris (*O. F. Müller, 1776)	
Bosmina (Eubosmina) longispina Leydig, 1860	
Chydorus ovalis (Kurz, 1875)	
Daphnia (Daphnia) cucullata Sars, 1862	
COPEPODA	
Copepodite cyclopoid	
Nauplii	
Number of species	**27**

Table 4. Diversity of zooplankton species in Pļaviņas Reservoir in 2015

Species (taxon)	May	July	September	Common species	Common species in 2015 and 2014
ROTIFERA	**25**	**15**	**23**	**34**	**16**
Dicranophorus Nitzsch, 1827	+			+	+
Asplanchna priodonta Gosse, 1850	+	+	+	+	+
Bdeloid Ehrenberg, 1832	+	+	+	+	+
Brachionus angularis Gosse, 1851		+		+	+
Brachionus calyciflorus Pallas, 1766	+		+	+	+
Brachionus quadridentatus Hermann, 1783	+			+	+
Cephalodella sp. Bory de St.Vincent, 1826	+	+	+	+	+
Conochilus sp. Ehrenberg, 1834	+				
Euchlanis dilatata Ehrenberg, 1832	+	+	+	+	
Filinia longiseta (Ehrenberg, 1834)	+	+	+	+	+
Gastropus stylifer (Imhof, 1891)			+	+	
Kellicottia longispina Kellicott, 1879	+	+	+	+	

Species (taxon)	May	July	September	Common species	Common species in 2015 and 2014
Keratella cochlearis (Gosse, 1851)	+	+	+	+	+
Keratella quadrata (Müller, 1786)	+	+	+	+	
Lecane luna (Müller, 1776)	+			+	
Lecane lunaris (Ehrenberg, 1832)	+		+	+	+
Lepadella (Lepadella) ovalis (Müller, 1786)			+	+	
Lepadella (Lepadella) patella (Müller, 1773)	+			+	
Lepadella sp. Bory de St. Vincent, 1826	+			+	+
Notholca acuminata (Ehrenberg, 1832)	+			+	
Polyarthra major Burckhardt, 1900	+	+	+	+	+
Polyarthra sp. Ehrenberg, 1834	+	+		+	+
Polyarthra vulgaris Carlin, 1834			+	+	+
Pompholyx sulcata Hudson, 1885			+	+	
Rotifera sp. (Pallas, 1766)	+	+	+	+	
Synchaeta sp. Ehrenberg, 1832	+	+	+	+	+
Testudinella patina (Hermann, 1783)		+	+	+	+
Trichocerca cylindrica (Imhof, 1891)			+	+	
Trichocerca pusilla (Jennings, 1903)		+	+	+	
Trichocerca rattus (Müller, 1776)			+	+	
Trichocerca similis (Wierzejski, 1893)	+		+	+	
Trichocerca sp. Lamarck, 1801	+			+	
Trichotria pocillum (Müller, 1776)	+			+	
Trichotria truncata (Whitelegge, 1889)	+		+	+	
CLADOCERA	**6**	**5**	**17**	**18**	**4**
Acroperus harpae (Baird, 1835)			+	+	
Alona affinis (Leydig, 1860)			+	+	
Alonella nana Baird, 1843	+		+	+	
Bosmina (Bosmina) longirostris (O. F. Müller, 1776)			+	+	+
Bosmina (Eubosmina) coregoni Baird, 1857		+	+	+	
Bosmina (Eubosmina) longispina Leydig, 1860	+	+	+	+	+
Ceriodaphnia quadrangula (O.F.Müller, 1785)	+			+	
Ceriodaphnia reticulata (Jurine, 1820)			+	+	
Ceriodaphnia sp. Dana, 1853		+	+	+	

Species (taxon)	May	July	September	Common species	Common species in 2015 and 2014
Chydorus ovalis (Kurz, 1875)	+	+	+	+	+
Chydorus sphaericus (O. F. Müller, 1776)			+	+	
Daphnia (Daphnia) cucullata Sars, 1862			+	+	+
Diaphanosoma brachyurum (Liévin, 1848)	+	+	+	+	
Eurycercus (Eurycercus) lamellatus (O. F. Müller, 1776)			+	+	
Kurzia latissima (Kurz, 1875)	+		+	+	
Macrothrix rosea (Jurine, 1820)			+	+	
Pleuroxus (Picripleuroxus) sp. Baird, 1843			+	+	
Simocephalus vetulus (O. F. Müller, 1776)			+	+	
COPEPODA	**2**	**2**	**1**	**3**	
Acanthocyclops sp. Kiefer, 1927	+	+		+	
Copepodite					
Cyclops sp. Müller, 1785	+	+		+	
Eudiaptomus sp. Kiefer, 1932			+	+	
Nauplii					
Number of species	**33**	**22**	**41**	**55**	**20**

to Daugava the highest percentage of Rotifera taxa were *Conochilus* sp.- 16.7%, *Synchaeta oblonga*- 12.1%, *Synchaeta* sp.- 14.8%, *Keratella cochlearis*- 13%, *Brachionus quadridentatus*- 11% and *Bdeloid*- 13% which were typical species of the Daugava. Cladocera and Copepoda compared with Rotifera had very small percentage of representatives. The Rotifera group of Pļaviņas Reservoir was mostly represented by *Synchaeta* sp.- 50.8%, *Brachionus calyciflorus*- 19.4%, *Keratella cochlearis*- 1.7%, *Polyarthra vulgaris*- 0.5%, *Polyarthra major*- 0.1% and *Asplanchna priodonta*- 10.3% in 2014. Cladocera and Copepoda groups were very little represented just like in the Daugava River upstream of the reservoir and at the Aiviekste estuary to the Daugava. Cladocera taxa found here were typical lake zooplankton taxa i.e *Daphnia cucullata*, *Bosmina longirostris*, *Bosmina longispina*, *Bosmina crassicornis.*

Water temperature in the upper layer of the Daugava River and of the Pļaviņas Reservoir in 2014 was 23.5 ^{0}C, the dissolved oxygen content 10.6 mg/l and chlorophyll α concentration 6 µg/l.

Rotifera group was mostly represented by *Synchaeta* sp.- 59%, *Keratella cochlearis*- 16.5%, *Keratella quadrata*- 6.9% and *Bdeloid*- 6.2%. Cladocera was relatively little represented- *Chydorus ovalis*- 3.8%, *Bosmina longispina*- 0.8% and *Alonella nana*- 0.1% in May 2015. By contrast, in the samples collected in July 2015 Rotifera was mostly represented by *Synchaeta* sp.- 56.4%, *Keratella cochlearis*- 4%, *Polyarthra vulgaris*- 2.3% and *Polyarthra major*- 4%. The most frequent representatives in Cladocera group were *Bosmina coregoni*- 13.7%, *Chydorus ovalis*- 0.3%, some places also *Daphnia cucullata*- 0.1%.

24 taxa of Rotifera group and 17 taxa of Cladocera were found in September 2015.

Eudiaptomus graciloides, *Cyclops* sp. and a large number subadult specimens - Nauplii and Copepodite were identified in Copepoda group. The highest percentage of Rotifera taxa were *Synchaeta* sp.- 17%, *Keratella cochlearis*- 28.1%, *Polyarthra vulgaris*- 7%, *Polyarthra major*- 11%, *Asplanchna priodonta*- 4.9% and *Keratella quadrata*- 15.6%. The highest percentage of Cladocera taxa were *Bosmina coregoni*- 0.9%, *Chydorus ovalis*- 1.5%, *Diaphanosoma brachyurum*- 0.9%, *Bosmina longispina*- 0.3% and in some places also *Daphnia cucullata*- 1.2%, *Acroperus harpae*- 2.6% and *Ceriodaphnia quadrangula*- 4.6%. When compared the composition of taxa differences both in July and in September, the Rotifera group did not differ substantially e.g. common number of taxa were 16. Cladocera taxa in the samples in September were more diverse, where 5 taxa were similar to the samples identified in July and 12 taxa were only found in the samples in September. Water temperature in the upper layer of the Pļaviņas Reservoir in July 2015 was 21 ^{0}C, the dissolved oxygen content was 12 mg/l and chlorophyll α concentration was 5 µg/l. On the other hand, water temperature in the upper layer in September 2015 was 19 ^{0}C, the dissolved oxygen content was 6 mg/l and chlorophyll α concentration was 1.3 µg/l.

Big zooplankton biodiversity in the Daugava River and in the Pļaviņas Reservoir is due to the Daugava large catchment area - 87,900 km^2 (Kavacs 1994), which includes tributaries and the water system. When water level in the river changes the exchange of plankton fauna takes place between these water bodies. In the 60-ies of 20^{th} century, Škute (1971) carried out a research of 28 Daugava River tributaries and noted that the upper reaches of the Daugava River tributaries have a significant effect on the Daugava zooplankton cenosis, zooplankton quantity even doubled in some of the tributaries of the river. Rotifera usually dominates in river plankton both qualitatively and quantitatively (Gbemisola 2003, Deksne 2011, Deksne et al. 2010, Lair 2006, Pace et al. 1992, Thorp et al. 2006, Thorp & Mantovani 2005, Pourriot et al. 1997, Шкуте 1973, Шкуте 1976). The results of our research show that the greatest diversity of zooplankton taxa is in Rotifera group both in the Daugava River and at the Pļaviņas Reservoir. The greatest diversity of zooplankton taxa was also established among Rotifera species that were found in the Daugava near Daugavpils (Deksne 2011, Deksne et al. 2010, Шкуте 1973, Шкуте 1976). However, these authors in their studies mentioned that sometimes during the summer and autumn Cladocera group is also widely represented. In our case, taxa of Rotifera group were observed at the Pļaviņas Reservoir in July, however in September the number of taxa rapidly decreased, while many of Cladocera group taxa- *Acroperus harpae, Diaphanosoma brachyurum* un *Ceriodaphnia quadrangula* taxa appeared in September (Table 4). However, taking into account that the weight of the majority of Cladocera and Copepoda representatives exceeds the weight of representatives of Rotifera group, it can be concluded in terms of biomass that all zooplankton groups in the Daugava are equally well represented. It should be noted that throughout all the stages of rivers and reservoir under research, the variation among

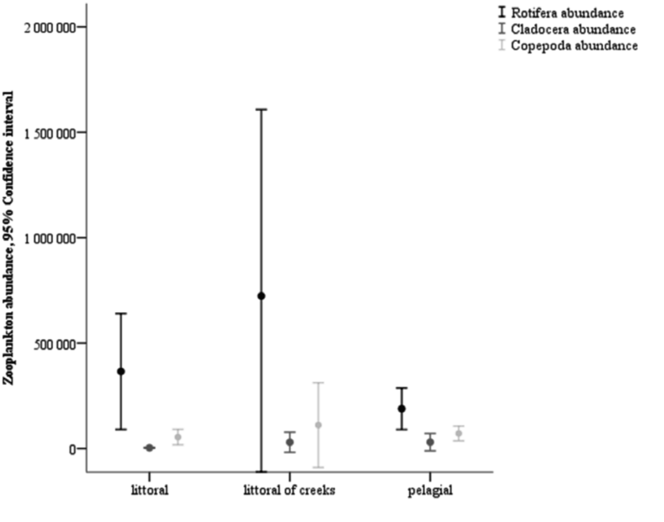

Fig. 2. Zooplankton groups distribution in water bodies pelagic, littoral / gulf area.

Table 5. Diversity of zooplankton groups (indiv./l) in Daugava/Aiviekste River in 2014

		Rotifera			Cladocera			Copepoda	
Daugava	**R**	**M**	**L**	**R**	**M**	**L**	**R**	**M**	**L**
		16,00			0,00			0,08	
	10,67			0,00			0,00		
			8,50			0,00			0,00
		9,00			0,00			0,00	
		0,25			0,00			0,00	
	107,67			0,33			2,33		
		9,87			0,00			0,33	
Aiviekste	13,83			0,00			0,33		
		4,00			0,00			0,00	
			73,00			0,67			3,83

*R-right bank of the river
M-middle of the river
L-left bank of the river

Table 6. Diversity of zooplankton groups (indiv./l) in Pļaviņas Reservoir in 2014 and 2015

		Rotifera			Cladocera			Copepoda	
	R	**M**	**L**	**R**	**M**	**L**	**R**	**M**	**L**
2014		1600,83			0,50			12,83	
	1707,67			0,50			3,83		
			1051,00			3,67			10,33
		89,00			0,17			0,50	
	164,83			0,17			1,67		
July 2015	96,50			2,00			104,33		
	178,83			1,17			84,00		
		110,83			6,83			12,17	
			18,17			0,50			20,17
	1719,83			1,50			22,00		
		106,50			113,83			118,67	
	75,83			3,83			23,00		
			391,17			3,00			33,17
		173,00			71,33			95,33	
September 2015			655,67			0,50			122,33
			603,50			35,50			51,50
	216,83			5,67			48,00		
			1831,00			119,17			503,83
	891,93			4,50			121,83		
			234,67			9,83			132,33

		Rotifera			**Cladocera**			**Copepoda**	
	R	**M**	**L**	**R**	**M**	**L**	**R**	**M**	**L**
	146,00			7,83			31,83		
		262,83			12,33			61,83	
	44,67			15,50			63,83		
			64,67			4,00			14,50

* R-right bank of the reservoir
M-middle of the reservoir
L-left bank of the reservoir

zooplankton quantity is similar, but the right bank and the left bank are different. Such variation is also determined by the influence of water body hydrological, hidrometreological factors, where the thermal water regime and water level fluctuations are of particular importance, as well as overgrowth of the water body and the pollution degree. When compared prevalence of zooplankton groups in pelagic and littoral area, the largest number of species can be observed in littoral and bays of reservoir (Fig. 2), in particular it could be observed in the samples which where collected in July. It could be explained that the stream is slower here, as well as the vegetation is richer, which is a very important factor for the development of certain zooplankton.

In particular, there are far more organisms on the left bank (Table 5, 6), which can be explained by the fact that the left bank was generally more overgrown with macrophytes. Zooplankton taxa in all groups, i.e. Rotifera, Cladocera and Copepoda, were found in macrophytes, compared to the pelagic and littoral waters without macrophytes (Fig. 3), while in the middle of the rivers and the reservoirs, where there was a faster flow and there was no macrophyte diversity, their number significantly decreased. The sections of the river where there are a lot of macrophyte in the coastal zone, macrophytes become the decisive factor for the formation of the river zooplankton (Lair 2006, Viroux 2002). When quantitative and qualitative parameters of taxa are compared (by Shannon-Wiener diversity) both in the Daugava before the Pļaviņas Reservoir, at the place where the Aiviekste River flows into the Daugava and in the Pļaviņas Reservoir (Fig. 4), it is evident that the greater diversity of taxa can be observed directly in the river. By contrast, there is no such a big diversity of taxa in the reservoir, but the dominance of certain taxa appears there, which is not typical of the river plankton. The number of the species does not only depend on the sampling time, habitat diversity, but also on the sampling frequency during the season and on the size of the water body (Лазарева 2010). Several authors in their researches (Czerniawski & Domagała 2010 a, b, Chang et al. 2008, Lair 2006, Крылов 2005) noted the influence of fish on zooplankton cenosis, but the influence of fish is significant only in small rivers. The main

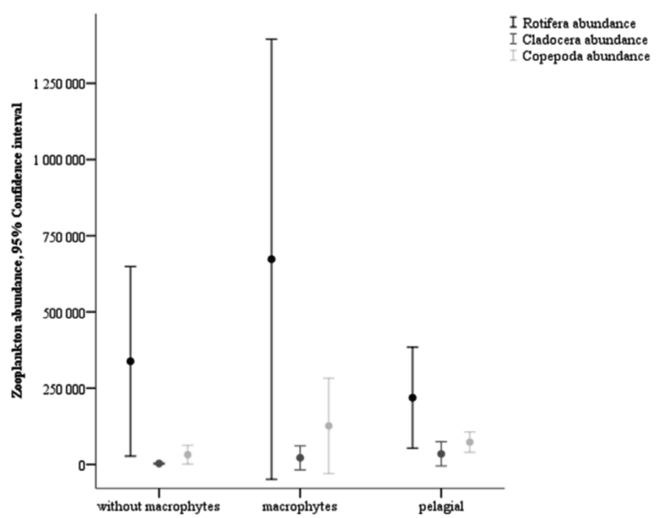

Fig. 3. Zooplankton groups distribution in different habitats.

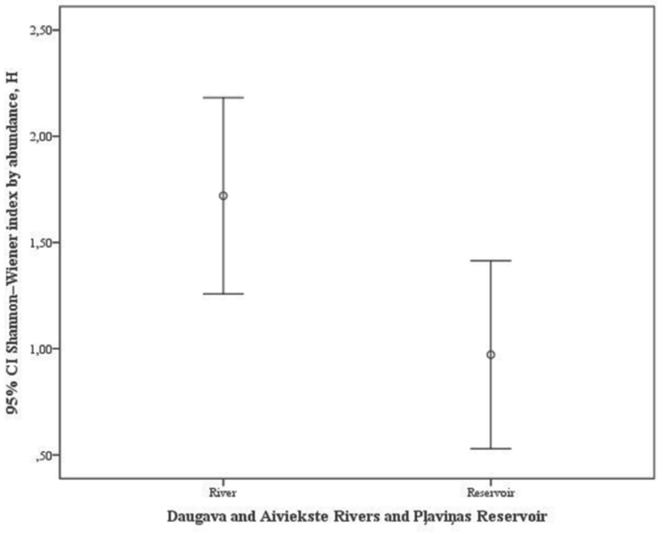

Fig. 4. Species abundance after Shannon-Wiener index.

influencing factors in large rivers that determine the number of zooplankton, in particular crustaceans, is the river hydrology and predators (Baranyi et al. 2002, Basu & Pick 1996, Chang et al. 2001, Lair 2006, Saunders & Lewis 1988, Thorp & Casper 2003, Thorp & Mantovani 2005, Viroux 2002).

CONCLUSIONS

As a result of the analysis of the obtained data, it can be concluded that there are variations in the number and diversity of species in the samples collected in the Daugava River before Reservoir Pļaviņas and in the Pļaviņas Reservoir. Zooplankton taxa in the Daugava River before the Reservoir are typical of moving water bodies, but zooplankton in the Pļaviņas reservoir is more characteristic for stagnant water masses. A large diversity of the Rotifera taxa was found in the Daugava River and in the Pļaviņas reservoir, but no taxa dominated in the River, however in the Pļaviņas Reservoir the dominance of certain taxa was identified. The diversity of Cladocera taxa in the Daugava River is very low, whereas, in the Pļaviņas Reservoir this diversity is much bigger. The dominance of individual taxa was also observed among the Cladocera group. Mainly subadult copepodite of Copepoda group were identified both in the Daugava River and in the Pļaviņas Reservoir. The identified differences could be due to the fact that zooplankton species are very sensitive to various changes in environmental factors, such as weather conditions, change in each specific place vegetation, overgrow, depth and physico-chemical parameters of the properties as well as with biological characteristics of each species, such as seasonality.

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