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DAPHNIA CUCULLATA SARS, 1862 (CRUSTACEA: CLADOCERA) DISTRIBUTION AND LOCATION IN COMPOSITION OF ZOOPLANKTON CENOSIS IN LAKE DRIDZIS

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Cladocera is a primarily-freshwater monophyletic group, an important component of the microcrustacean zooplankton, inhabiting pelagic, littoral, and benthic zones.

During the analysis of the samples, collected in the Lake Dridzis in 2010 and 2011, three zooplankton groups, i.e. Rotatoria, Cladocera and Copepoda groups, and 59 zooplankton taxa were identified in 2010, but 51 zooplankton taxa were identified in 2011. Rotatoria were the most dominant group consisting of 27 species in 2010 and 25 species in 2011, followed by Cladocera with 17 species in 2010 and 16 species in 2011. In its turn 15 species were identified in Copepoda group in 2010, and 10 species in 2011. The dominant species were *Polyarthra vulgaris*, *Keratella cochlearis*, *Kellicottia longispina*, *Conochilus hippocrepis*, *Diaphanosoma brachyurum*, *Daphnia cucullata*, *Daphnia cristata*, *Chydorus ovalis*, *Bosmina crassicornis*, *Bosmina longispina, Eudiaptomus gracilis*, *Eudiaptomus graciloides*, *Megacyclops viridis*, *Eurytemora lacustris*, *Thermocyclops oithonoides*, *Thermocyclops crassus* and *Mesocyclops leucarti.*

Having carried the analysis of the changes in zooplankton taxa vetrical structure *Daphnia cucullata* was identified in Dridzis at all depths in the spring, summer and autumn.

Daphnia cucullata has a positive correlation with *Daphnia cristata*, *Bosmina crassicornis*, *Bosmina longispina*, *Diaphanosoma brachyurum* (Cladocera), *Keratella cochlearis*, *Kellicottia longispina*, *Gastropus stylifer*, *Filinia longiseta*, *Conochilus unicornis* (Rotifera), *Megacyclops viridis*, *Cyclops* sp. and *Nauplii* (Copepoda). Negative correlation coefficient was obtained for *Asplanchna priodonta* (Rotifera) and *Eurytemora lacustris* (Copepoda), it is suggested that there is negative interaction among these species.

Key words: Zooplankton taxa, *Daphnia cucullata*, Lake Dridzis, Spearman's rank correlation, Shannon - Wiener species diversity index, redundancy analysis (RDA).

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INTRODUCTION

Zooplankton plays an important role in the structure and functioning of ecosystems as a secondary trophic chain of aquatic ecosystems. Zooplankton is an index of the productivity of a water body, because it is the food source for various planktophagous fish and juvenile fish. (Chang & Hanazato 2004, Cimdiņš 2001, Hebert 1982, Malone & McQueen 1983, Pinel-Alloul 1995, Wetzel 2001).

Zooplankton as a primary consumer of the production of water bodies (consuming phyto and bacterioplankton) plays an important role in ensuring the self-cleaning processes. The potential of zooplankton as a bioindicator is very high because its development and spread depends on many abiotic (e.g. temperature, dissolved oxygen, pH, transparency, wind, social aggregates, water turbulence, trophic gradient, salinity, stratification, pollution, etc.) (Bengtsson 1986, Bertilsson et al. 1995, Bērziņš & Pejler 1987, 1989a, 1989b, Dagg 1977, Dumont et al. 1973, Fernandez-Rosado & Lucena 2001, Hanazato 1991, 1992, Horppila et al. 2000, Locke & Sprules 2000, Malone & McQueen 1983, Pinel-Alloul 1995, Seda & Devetter 2000, Tallberg et al. 1999, Wetzel 2001, Пидгайко 1984) and biotic parameters (e.g. food, predation, competition) (Chang & Hanazato 2004, Cimdiņš 2001, Dodson 1984, Escribano & Hidalgo 2000, Harris et al. 2012, Hebert 1982, Larsson & Dodson 1993, Malone & McQueen 1983, Pinel-Alloul 1995, Weider & Pijanowska 1993, Wetzel 2001, Лазарева 2010). Carrying out the complex study of the zooplankton coenosis composition, researchers should never forget about the seasonality of zooplankton taxa i.e., if they want to obtain the most accurate information about the zooplankton species living there, their mutual interactions, the samples should be collected in spring, summer and autumn from different places of water bodies (Mergeay et al. 2005, Смирнов 1979).

Since the spatial and temporal apect of the composition of zooplankton species in Lake Dridzis has not been sufficiently studied recently, the aim of this research is to study the spatial distribution of the composition of zooplankton species in Lake Dridzis in the course of several years covering spring, summer and autumn seasons, so the author could get the fullest possible view of the current composition of zooplankton species in Lake Dridzis, their mutual interactions, interactions with different environmental factors, and place of one of the most common Cladocera species- *Daphnia cucullata* and its role in zooplankton species composition. Based on data of the past studies of zooplankton species diversity in deep Latvian lakes (Brakovska & Paidere 2012, Brakovska & Škute 2007, 2009, Brakovska et al. 2012, Brakovska et al. 2013, Jurevičs et al. 2012) it has been revealed that the Cladocera plays an important role between occurring zooplankton groups in terms of biomass and species number. *Daphnia cucullata* species can be considered as one of the leading species in this group, since they were found in the samples throughout the entire season. It forms also an important part of the vendace food (Sutela & Huusko 1997,Viljanen 1983). In addition, Cladocera genera (e.g. *Daphnia*) have frequently been used as model organisms for ecological genetic research (Colbourne & Hebert 1996, Harris et al. 2012) and also used in other scientific disciplines, including chemistry, physiology and freshwater ecology (Lampert 2006, Larsson & Weider 1995). Moreover, there have not been carried out any separate studies of prevalence and location of *Daphnia cucullata* in the zooplankton coenosis composition in Lake Dridzis so far.

MATERIAL AND METHODS

Location of reseach

Lake Dridzis is the deepest lake in Latvia. Moreover, it is the deepest lake in Baltia. The maximum depth of the lake is 65.1 m and the average 12.8 m. Lake Dridzis is situated in the Hillock of Dagda of the Latgale Highlands (705390.852/208462.077), in Skaista and Kombuļu Parishes, Kraslava Region. It is the area of Natura 2000 (Brakovska & Škute 2007, Brakovska et al. 2013, www.ezeri.lv database (accessed 30.06.2013)).

Physico-chemical measurements

Water physico-chemical parameters (water temperature (^{0}C), pH, conductivity (µS cm^{-1}), total dissolved solids (gl^{-1}), dissolved oxygen (mg^{-1}), oxygen saturation (%), oxidation-reduction potential-ORP (mV), chlorophil α (µg^{-1}), turbidity (NTU)) per one imagined line were determined using a HACH DS5 probe in the deepest locality of Lake Dridzis. During the study the sonde was lowered to the bottom of the water bodies. When the physical and chemical parameters became stabilize on the sonde display, they were saved to the sonde memory. Then the sonde was moved to one meter up. The activities were repeated until the sonde reached the water surface. The final measurements were taken at depths of one meter and half a meter (Brakovska & Škute 2007, Brakovska et al. 2012, Brakovska et al. 2013).

Collection and analyses of zooplankton samples

The collection of the zooplankton samples and their quantitative and qualitative analysis was performed using the APHA standard methods procedure for the water and wastewater analysis (APHA 2005, Wetzel & Likens 2000).

For the study of taxonomic classification of zooplankton and for the study of *Daphnia cucullata* location in composition of zooplankton cenosis the zooplankton samples were taken in the period from May to September in 2010 – 2011. Depth-integrated zooplankton samples were taken from the deepest site of the lake with a Hydro-bios Apstein type plankton net with an opening.closing mechanism (mesh size 64 µm), preserved with 37- 40% formaldehyde solution (4% final concentration), and stored in 0.33 L bottles (Brakovska et al. 2013).

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 и зообентоса... 2010, Определитель пресноводных ... 1995).

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

$N = (a \times b \times 1000) / (c \times d)$, 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 m^{-3}.

Dominance (*D*) frequency was calculated by the following formula:

(2)

$D = 100 \times (a / b)$, where

- *a*- is the number of individuals of a certain species;
- *b*- is the total number of all individuals in the sample.

If D value is > 10% it indicates the dominant species, but 5-10% indicate the subdominant species (Schwerdtfeger 1975).

Shannon - Wiener species diversity index (H ') was calculated by the following formula (Krebs 1999, Margalef 1958):

$$H' = -\sum_{i-1}^{S}(pi)(\ln pi), \quad (3)$$ where

H' – species diversity index;
S - total number of species;
pi –*i*-the number of individual species of total individual number of all species.

Since the values obtained are bits, in order to convert the bits to the generic unit, we used the following equation (Krebs 1999; MacArthur 1965):

$$N_1 = e^{H'}, \quad (4)$$ where

a- 2.71828 (base of natural logs);

H'- Shannon–Wiener function (calculated with base *e* logs);
N_1- the number of equally common species that produce the same diversity as H′

Statistical data analysis (Spearman's rank correlation) was conducted using *IBM SPSS Statistics 20*. Redundancy analysis (RDA) run in *CONOCO 4.5* (Gotelli & Ellison 2004; Lepš & Šmilauer 1999; Lepš & Šmilauer 2003; Quinn & Keough 2002) was used to analyse the covariance structure of interspecies and environmental variables. Zooplankton species were scored as presence/absence and abundance records from different depths of Lake Dridzis. Rare species were downweighted.

RESULTS AND DISCUSSION

During the research three zooplankton groups were identified in Lake Dridzis, i.e. Rotifera, Cladocera and Copepoda. In 2010 59 zooplankton taxa were identified: Rotifera- 27, Cladocera- 17 and Copepoda- 15 in 2010 (Table 1). The following Rotifera species were identified as dominant in Lake Dridzis depending on the season: *Polyarthra dolichoptera*, *Polyarthra vulgaris*, *Keratella cochlearis*, *Kellicottia longispina*, *Conochilus hippocrepis*, *Conochilus unicornis*, the dominant species in Copepoda group were as follows *Eudiaptomus gracilis*, *Eudiaptomus graciloides*, *Megacyclops viridis*, *Eurytemora lacustris*, *Cyclops scutifer*. In turn, 51 zooplankton taxa were identified in 2011, i.e.: Rotifera- 25 species, Cladocera- 16 species and Copepoda- 10 species (Table 2). The dominant species in Rotifera group were the following species: *Polyarthra vulgaris*, *Polyarthra major*, *Keratella cochlearis* and *Kellicottia longispina*, while in Copepoda group: *Thermocyclops oithonoides*, *Thermocyclops crassus*, *Mesocyclops leucarti*, *Eurytemora lacustris*, *Eudiaptomus gracilis*, *Eudiaptomus graciloides* and *Megacyclops viridis*. In turn, the following species in Cladocera group were dominant in both years (2010 and 2011), i.e. *Diaphanosoma brachyurum*, *Daphnia cucullata*, *Daphnia cristata*, *Chydorus ovalis*, *Bosmina crassicornis* and *Bosmina longispin*. The highest number of Rotifera taxa throughout the season 2010 was identified in mid-May and August. Cladocera taxa were mainly found from mid-June to September, but Copepoda taxa in June, August and mid-September samples (Table 1). In samples collected in 2011 the largest number of Rotifera taxa was found in May, June and August, Cladocera in early June, August and September. In turn, the largest number of Copepoda taxa was found in July and August (Table 2). Moreover, *Daphnia cucullata* in Dridzis was identified the samples collected in spring, summer and autumn at all depths.

Summarizing the data obtained during the research, it was revealed that the representatives of Cladocera group take an important place among the other zooplankton groups in Dridzis.

According to literature data (Līne 1966) there are some Rotifera species, such as *Keratella cochlearis*, *Kellicotia longispina*, *Polyarthra remata, Filinia longiseta*, which are found in the lake throughout the year. Most Rotifera, Cladocera and Copepoda species are characterized by a wide range of temperature tolerance (Bertilsson et al. 1995, Bērziņš & Pejler 1989a). Many studies have shown that the higher temperature variation over a specified period in lakes is, the greater is the species diversity (Beaver & Havens 1996, Gilbert 2011, Shurin et al. 2010).

Table 1. Presence of zooplankton species in Lake Dridzis in 2010

	Date of sampling									
Species (taxon)	**19.05.10.**	**04.06.10.**	**18.06.10.**	**05.07.10.**	**21.07.10.**	**01.08.10.**	**20.08.10.**	**05.09.10.**	**13.09.10.**	**Common species**
ROTIFERA	**15**	**12**	**13**	**13**	**13**	**15**	**16**	**13**	**13**	**27**
Ascomorpha ecaudis Perty, 1850	+					+	+		+	+
Ascomorpha ovalis (Bergendal, 1892)							+			+
Asplanchna priodonta Gosse, 1850	+	+	+	+	+	+	+	+	+	+
Brachionus angularis Gosse, 1851	+	+	+	+						+
Brachionus calyciflorus Pallas, 1766	+									+
Conochilus (Conochilus) hippocrepis (Schrank, 1803)							+	+	+	+
*Conochilus (Conochilus) unicornis*Rousselet, 1892	+	+	+	+	+	+				+
Conochilus sp.Ehrenberg, 1834								+		+
Filinia longiseta (Ehrenberg, 1834)	+	+	+	+	+	+	+	+	+	+
Gastropus stylifer (Imhof, 1891)	+	+	+	+	+	+	+			+
Kellicottia longispina Kellicott, 1879	+	+	+	+	+	+	+	+	+	+
Keratella cochlearis Gosse, 1851	+	+	+	+	+	+	+	+	+	+
Keratella quadrata Müller, 1786	+	+	+	+	+	+	+	+	+	+
Monommata longiseta (Müller, 1786)	+									+
Mytilina mucronata (Müller, 1773)						+				+
Ploesoma hudsoni (Imhof, 1891)								+		+
Polyarthra dolichoptera Idelson, 1925	+	+	+	+	+	+	+			+
Polyarthra major Burckhardt, 1900			+	+	+	+	+	+	+	+
Polyarthra sp. Ehrenberg, 1834								+	+	+

Species (taxon)	Date of sampling									
	19.05.10.	04.06.10.	18.06.10.	05.07.10.	21.07.10.	01.08.10.	20.08.10.	05.09.10.	13.09.10.	Common species
Polyarthra vulgaris Carlin, 1943	+	+	+	+	+	+	+		+	+
Pompholyx sulcata Hudson, 1885	+	+	+	+		+	+	+	+	+
Synchaeta pectinata Ehrenberg, 1832				+					+	+
Synchaeta sp. Ehrenberg, 1832	+	+	+		+	+				+
Trichocerca capucina (Wierzejski & Zacharias, 1893)							+	+	+	+
Trichocerca cylindrica (Imhof, 1891)									+	+
Trichocerca similis(Wierzejski, 1893)					+	+	+	+		+
Trichotria pocillum (Müller, 1776)					+	+	+			+
CLADOCERA	**7**	**9**	**11**	**12**	**11**	**10**	**8**	**11**	**12**	**17**
Bosmina (Bosmina) longirostris (O. F. Müller, 1776)	+	+	+	+	+				+	+
Bosmina (Eubosmina) coregoni Baird, 1857				+						+
Bosmina (Eubosmina) crassicornis Lilljeborg 1887	+	+	+	+	+	+	+	+	+	+
Bosmina (Eubosmina) longispina Leydig, 1860	+	+	+	+	+	+	+	+	+	+
Bosmina (Eubosmina) reflexa Seligo, 1907		+	+	+	+	+				+
Ceriodaphnia affinis Lilljeborg, 1900								+	+	+
Ceriodaphnia pulchella Sars, 1862	+						+		+	+
Ceriodaphnia reticulata (Jurine, 1820)						+	+	+	+	+
Chydorus ovalis (Kurz, 1875)	+	+	+	+	+	+	+	+	+	+
Chydorus sphaericus (O. F. Müller, 1776)	+		+	+	+	+	+	+	+	+
Daphnia (Daphnia) cristata Sars, 1862		+	+	+	+	+	+	+	+	+

Species (taxon)	Date of sampling									
	19.05.10.	**04.06.10.**	**18.06.10.**	**05.07.10.**	**21.07.10.**	**01.08.10.**	**20.08.10.**	**05.09.10.**	**13.09.10.**	**Common species**
Daphnia (Daphnia) cucullata Sars, 1862	+	+	+	+	+	+	+	+	+	+
Daphnia (Daphnia) longispina (O. F. Müller, 1776)	+		+					+		+
Daphnia (Daphnia) longispina hyalina (Leydig, 1860)					+					+
Diaphanosoma brachyurum (Liévin, 1848)	+	+	+	+	+	+	+	+	+	+
Leptodora kindtii (Focke, 1844)		+	+	+	+	+		+	+	+
Macrothrix laticornis (Jurine, 1820)				+						+
COPEPODA	**4**	**6**	**11**	**9**	**9**	**8**	**10**	**9**	**11**	**15**
Acanthocyclops sp. (Kiefer, 1927)			+	+						+
Cyclops scutifer G.O.Sars, 1863			+	+	+	+	+	+	+	+
Cyclops sp. Müller, 1785	+	+	+	+	+	+	+	+	+	+
Cyclops strenuus Fischer, 1851								+		+
Eucyclops sp. Claus, 1893			+							+
Eudiaptomus gracilis (G.O. Sars, 1863)	+	+	+	+	+	+	+	+	+	+
Eudiaptomus graciloides(G.O. Sars, 1863)	+	+	+	+	+	+	+	+	+	+
Eurytemora lacustris (Poppe, 1887)	+	+	+	+	+	+	+	+	+	+
Heterocope apendiculata G.O. Sars, 1863		+	+	+	+			+	+	+
Megacyclops sp. Kiefer, 1927			+	+	+	+			+	+
Megacyclops viridis (Jurine, 1820)		+	+	+	+	+	+	+	+	+
Mesocyclops leucarti (Claus, 1857)			+	+	+	+	+	+	+	+
Mesocyclops sp. Kiefer, 1927									+	+
Thermocyclops crassus (Fischer, 1853)							+		+	+

	Date of sampling									
Species (taxon)	**19.05.10.**	**04.06.10.**	**18.06.10.**	**05.07.10.**	**21.07.10.**	**01.08.10.**	**20.08.10.**	**05.09.10.**	**13.09.10.**	**Common species**
Thermocyclops oithonoides (G.O.Sars, 1863)							+		+	+
TOTAL	**26**	**27**	**35**	**34**	**33**	**33**	**34**	**33**	**36**	**59**

Table 2. Presence of zooplankton species in Lake Dridzis in 2011

	Date of sampling										
Species (taxon)	**12.05.11.**	**25.05.11.**	**08.06.11.**	**20.06.11.**	**08.07.11.**	**19.07.11.**	**01.08.11.**	**14.08.11.**	**30.08.11.**	**20.09.11.**	**Common species**
ROTIFERA	**14**	**15**	**15**	**13**	**13**	**13**	**14**	**17**	**16**	**13**	**25**
Ascomorpha ecaudis Perty, 1850		+	+			+	+	+			+
Ascomorpha ovalis (Bergendal, 1892)				+	+		+	+	+	+	+
Ascomorpha saltans saltans Bartsch, 1870	+										+
Asplanchna priodonta Gosse, 1850	+	+	+	+	+	+	+	+	+	+	+
Brachionus quadridentatus Hermann, 1783						+					+
Conochilus (Conochilus) hippocrepis (Schrank, 1803)		+	+	+	+						+
*Conochilus (Conochilus) unicornis*Rous-selet, 1892	+	+	+	+	+	+	+	+	+	+	+
Conochilus sp.Ehrenberg, 1834	+	+	+								+
Euchlanis dilatata Ehrenberg, 1832						+			+		+
Filinia longiseta (Ehrenberg, 1834)	+	+	+	+	+	+	+	+	+	+	+
Gastropus stylifer (Imhof, 1891)	+	+	+	+	+	+	+	+	+	+	+
Kellicottia longispina Kellicott, 1879	+	+	+	+	+	+	+	+	+	+	+
Keratella cochlearis Gosse, 1851	+	+	+	+	+	+	+	+	+	+	+
Keratella quadrata Müller, 1786	+	+	+	+	+	+	+	+	+	+	+
Lecane luna (Müller, 1776)						+		+			+

Species (taxon)	Date of sampling										
	12.05.11.	**25.05.11.**	**08.06.11.**	**20.06.11.**	**08.07.11.**	**19.07.11.**	**01.08.11.**	**14.08.11.**	**30.08.11.**	**20.09.11.**	**Common species**
Lecane lunaris (Ehrenberg, 1832)								+			+
Ploesoma hudsoni (Imhof, 1891)	+	+	+								+
Polyarthra dolichoptera Idelson, 1925	+	+	+	+	+						+
Polyarthra major Burckhardt, 1900	+	+	+	+	+	+	+	+	+	+	+
Polyarthra vulgaris Carlin, 1943	+	+	+	+	+	+	+	+	+	+	+
Pompholyx sulcata Hudson, 1885							+	+	+	+	+
Synchaeta sp. Ehrenberg, 1832	+	+	+	+	+	+		+	+		+
Trichocerca capucina (Wierzejski & Zacharias, 1893)						+	+	+	+	+	+
Trichocerca cylindrica (Imhof, 1891)									+	+	+
Trichocerca similis(Wierzejski, 1893)						+	+	+	+	+	+
CLADOCERA	**7**	**6**	**9**	**9**	**10**	**7**	**8**	**10**	**10**	**10**	**16**
Alonella nana (Baird, 1843)								+			+
Bosmina (Bosmina) longirostris (O. F. Müller, 1776)	+	+	+	+	+	+					+
Bosmina (Eubosmina) coregoni Baird, 1857		+	+	+	+				+		+
Bosmina (Eubosmina) crassicornis Lilljeborg 1887	+	+	+	+	+	+	+	+	+	+	+
Bosmina (Eubosmina) longispina Leydig, 1860	+	+	+	+	+	+	+	+	+	+	+
Bythotrephes longimanus (Leydig, 1860)							+		+		+
Ceriodaphnia pulchella Sars, 1862				+						+	+
Ceriodaphnia sp. Dana, 1855										+	+
Chydorus ovalis (Kurz, 1875)	+		+	+	+	+	+	+	+	+	+
Chydorus sphaericus (O. F. Müller, 1776)			+		+		+	+	+	+	+

	Date of sampling										
Species (taxon)	**12.05.11.**	**25.05.11.**	**08.06.11.**	**20.06.11.**	**08.07.11.**	**19.07.11.**	**01.08.11.**	**14.08.11.**	**30.08.11.**	**20.09.11.**	**Common species**
Daphnia (Daphnia) cristata Sars, 1862			+	+	+	+	+	+	+	+	+
Daphnia (Daphnia) cucullata Sars, 1862	+	+	+	+	+	+	+	+	+	+	+
Daphnia (Daphnia) longispina (O. F. Müller, 1776)	+										+
Diaphanosoma brachyurum (Liévin, 1848)		+	+	+	+	+	+	+	+	+	+
Leptodora kindtii (Focke, 1844)	+				+			+	+	+	+
Polyphemus pediculus (Linnaeus, 1758)								+			+
COPEPODA	**7**	**6**	**9**	**8**	**9**	**8**	**9**	**9**	**8**	**8**	**10**
Cyclops scutifer G.O.Sars, 1863					+	+	+	+			+
Cyclops sp. Müller, 1785	+	+	+	+	+	+	+	+	+	+	+
Eudiaptomus gracilis (G.O. Sars, 1863)	+	+	+	+	+		+	+	+	+	+
Eudiaptomus graciloides(G.O. Sars, 1863)	+		+	+	+	+	+	+	+	+	+
Eurytemora lacustris (Poppe, 1887)	+	+	+	+	+	+	+	+	+	+	+
Heterocope apendiculata G.O. Sars, 1863			+	+	+						+
Megacyclops viridis (Jurine, 1820)			+	+	+	+	+	+	+	+	+
Mesocyclops leucarti (Claus, 1857)	+	+	+	+	+	+	+	+	+	+	+
Thermocyclops crassus (Fischer, 1853)	+	+	+	+	+	+	+	+	+	+	+
Thermocyclops oithonoides (G.O.Sars, 1863)	+	+	+	+	+	+	+	+	+	+	+
TOTAL	**28**	**27**	**33**	**30**	**32**	**28**	**31**	**36**	**34**	**31**	**51**

It is accepted that due to the adaptations to certain environmental conditions, the same population of species is separated in different water layers and can be distinguished by their development cycles. Overall, Rotifera species have a wide temperature range (0 - 30 ^{0}C) at which the species can exist (Bērziņš & Pejler 1989a). By contrast, the optimum temperature for the existence of Cladocera and Copepoda is within 0- 24 ^{0}C (Bertilsson et al. 1995). However, the level of dissolved oxygen of Rotifera must be within the range 0 - 16 mg $^{-1}$ (Bērziņš & Pejler 1989b), but of Cladocera and Copepoda must be within the range 2 - 13 mg $^{-1}$ (Bertilsson et al. 1995).

The water temperature in the upper layer (0-5 m) of Lake Dridzis ranged from 17.5 ^{0}C to 26.8 ^{0}C in May and July 2010. The level of dissolved oxygen ranged from 7.3 mg $^{-1}$ in late August to 8.6 mg $^{-1}$ in mid-July, but chlorophyll-α ranged from 0.4 μg^{-1} in May to 1.55 μg^{-1} in early August. By contrast, water temperature on the surface of Lake Dridzis was from 14.3 ^{0}C to 25.6 ^{0}C in May and June in 2011. The level of dissolved oxygen ranged from 7.6 mg $^{-1}$ in July / September to 11 mg $^{-1}$ in May, but the chlorophyll-α ranged from 0.6 μg^{-1} in August to 4.6 μg^{-1} in September.

If I compare the literature data with the data received during our research in the corelation of Rotifera, Cladocera and Copepoda species with water temperature and dissolved oxygen (Bertilsson et al. 1995, Bērziņš & Pejler 1989a, Bērziņš & Pejler 1989b, Doulka & Kehayias 2011, Elliott 1977, Field & Prepas 1997, Kaya et.al. 2010, Kessler & Lampert 2004, Kizito & Nauwerck 1995, Taylor et. al. 1993), I can conclude that the species described in my research coincide with the optimal temperature and dissolved oxygen range specified in the literature. According to the samples of Rotifera species collected during my research such species as *Polyarthra major*, *Polyarthra vulgaris*, *Polyarthra dolichoptera*, *Asplanchna priodonta*, *Kallicottia longispina*, *Keratella cochlearis* have the highest range of dissolved oxygen i.e. 1-13 mg $^{-1}$ (Bērziņš & Pejler 1989b). By contrast, in according to the temperature data, such species as *Polyarthra dolichoptera, Keratella quadrata, Keratella cochlearis*, *Synchaeta pectinata* have the widest range for optimal existence, i.e 0-23 ^{0}C are (Bērziņš & Pejler 1989a). For certain Cladocera species e.g. *Diaphanosoma brachyurum*, *Daphnia cucullata*, *Daphnia cristata* and *Bosmina longispina* the temperature optimum is within 7- 23 ^{0}C, but for *Bosmina crassicornis*- 14- 15 ^{0}C (Bertilsson et al. 1995). The situation is similar to the Copepoda species. In turn, the optimal amount of dissolved oxygen both in Cladocera and Copepoda species is within the range 5- 11 mg $^{-1}$ (Bertilsson et al. 1995).

Summarizing the data obtained during the research, it was revealed that the representatives of Cladocera group take an important place among the other zooplankton groups in Dridzis. Spearmans rank correlation was used for the analysis of changes in zooplankton taxa vertical structure depending on the depth (Krebs 1999). The depth is a determinant for the following taxa in Lake Dridzis, i.e. *Ascomorpha ovalis*, *Trichocerca capucina*, *Polyarthra vulgaris*, *Polyarthra major*, *Conochilus unicornis*, *Diaphanosoma brachyurum*, *Daphnia cucullata*, *Daphnia cristata*, *Bosmina crassicornis*, *Eudiaptomus gracilis*, *Eudiaptomus graciloides*. Having analysed the interaction of *Daphnia cucullata* with other zooplankton species (according to the Spearmans correlation coefficient), a negative correlation coefficient was obtained for *Asplanchna priodonta* (Rotifera) r = -0.5 (0-5m depth) and *Eurytemora lacustris* (Copepoda) r = -0.89 (20 - 25m depth), it allows the author to suggest that there is negative interaction among these species. In turn, *Daphnia cucullata* has a positive correlation with *Daphnia cristata*, *Bosmina crassicornis*, *Bosmina longispina*, *Diaphanosoma brachyurum* (Cladocera), *Keratella cochlearis*, *Kellicottia longispina*, *Gastropus stylifer*, *Filinia longiseta*, *Conochilus unicornis* (Rotifera), *Megacyclops viridis*, *Cyclops* sp. and *Nauplii* (Copepoda). This could be explained by the fact that there is no competition between these species. The correlation coefficient (r) is different depending on the sampling depth.

Having performed the Redundancy data analysis (RDA), the results obtained over the years are different. In accordance with the RDA ordination analysis of the data in 2010, *Daphnia cucullata* has close interaction with *Daphnia cristata*, chlorophyll- α and sampling time (Fig. 1). The dissolved substances content and conductivity - with certain species of Copepoda group, but turbidity and temperature was identified closer interaction with *Diaphanosoma brachyurum* and *Polyarthra major* (Fig. 1). Oxygen saturation and pH affect the development of Copepoda (Bertilsson et al. 1995). The dissolved oxygen content and oxygen saturation interact with *Asplanchna priodonta*, *Polyarthra dolichoptera* and *Synchaeta* sp., but conductivity and total dissolved solids with *Megacyclops* sp., *Gastropus stylifer* and *Cyclops scutifer* (Fig. 1).

By contrast, in accordance with the RDA analysis of samples collected in 2011, different results were obtained. In this case, *Daphnia cucullata* is in close interaction with *Bosmina crassicornis*, *Gastropus stylifer,* total dissolved solids and conductivity (Fig. 2). Chlorophyll- α and pH affect *Polyarthra major* and *Eudiaptomus gracilis*, while Chlorophyll- α, the dissolved oxygen content and the oxygen saturation influence *Asplanchna priodonta*, *Polyarthra vulgaris*, *Keratella quadrata* and Copepodite. The turbidity and the oxidation reduction potential affect *Daphnia cristata, Diaphanosoma brachyurum, Eudiaptomus graciloides.* On the other hand, the depth and temperature affect *Keratella*

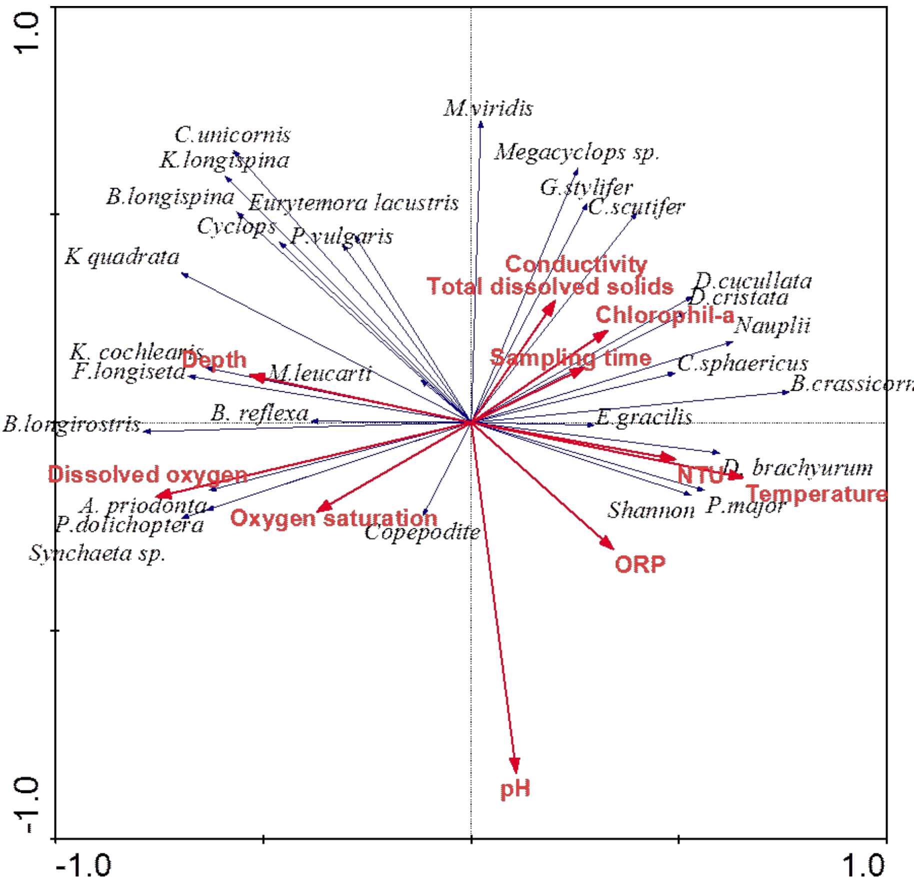

Fig. 1. Redundancy analysis (RDA) ordination plot for zooplankton abundance from Lake Dridzis during the sampling period of May to September 2010. Abbreviations: ORP- Oxidation-reduction potential; NTU- Turbidity.

cochlearis, *Conochilus unicornis*, *Bosmina longispina*, *Megacyclops viridis*, *Eurytemora lacustris* and *Cyclops* (Fig. 2). In accordance with the RDA data analysis performed in 2011 the species diversity (according to Shannon) was dependent on the turbidity and sampling time (Fig. 2).

The research results could be explained by the fact that the vertical structure of zooplankton population varies seasonally because specimens choose the most optimal ecological niche for themselves as a result of the variety of physiological and behavioral mechanisms. Water masses from deepwater pelagic lake are not homogeneous due to the influence of different abiotic and biotic factors, and it directly affects the structure of zooplankton community.

Differences in number and composition of species depend on a number of influencing factors, such as lake trophy, the depth from which the sample is taken, water temperature, pH, water transparency, dissolved oxygen, vegetation, season and so on (Beaver & Havens 1996, Bērziņš & Bertilsson 1990, Bērziņš & Pejler 1987, Bērziņš & Pejler 1989a, Bērziņš & Pejler 1989b, Doulka & Kehayias 2011, Elliott 1977, Field & Prepas 1997, Field & Prepas 1997, Hebert 1982, Jacobs 1977, Ka et.al 2006, Kaya et.al. 2010, Kessler & Lampert 2004, Kizito & Nauwerck 1995, Kubar et. al. 2005, Līne 1966, Paidere & Škute 2011,Taylor et. al. 1993). It is accepted that due to adaptations to certain environmental conditions, the same species of populations are separated in different water layers and can be distinguished by their development cycles.

It is considered that the variability of these factors is mainly subject to the seasonality, when many of thee influencing factors change, e.g. temperature, oxygen content, chlorophyll concentration, the presence of predators (both of vertebrates and invertebrates), as well as the competition among species. Beides the lake morphology and anthropogenic activities in the lake basin are also of great importance.

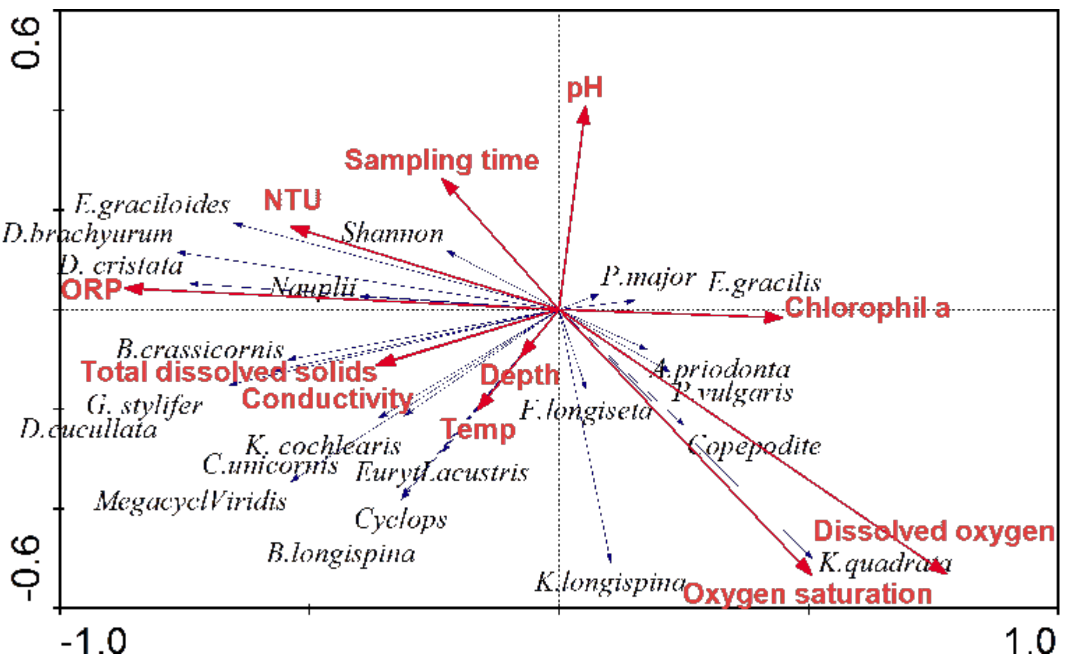

Fig. 2. Redundancy analysis (RDA) ordination plot for zooplankton abundance from Lake Dridzis during the sampling period of May to September 2011. Abbreviations: ORP- Oxidation-reduction potential; NTU- Turbidity.

CONCLUSIONS

1. During the research three zooplankton groups were identified in Lake Dridzis both in 2010 and 2011, i.e. Rotifera, Cladocera and Copepoda. In 2010 the total of 59 zooplankton taxa were identified, while 51 zooplankton taxa in 2011.

2. Both in 2010 and in 2011, Rotifera group was dominant (beased on zooplankton species), followed by Cladocera and Copepoda.

3. Depending on the season, *Diaphanosoma brachyurum*, *Daphnia cucullata*, *Daphnia cristata*, *Bosmina crassicornis* and *Bosmina longispina* were dominant species in Cladocera group both in 2010 and in 2011 in Lake Dridzis. In addition, *Daphnia cucullata* in Lake Dridzis was identified in spring in summer and in autumn season at all depths.

4. *Daphnia cucullata* has a positive correlation (based on Spearmans correlation coefficient) with *Daphnia cristata*, *Bosmina crassicornis*, *Bosmina longispina*, *Diaphanosoma brachyurum* (Cladocera), *Keratella cochlearis*, *Kellicottia longispina*, *Gastropus stylifer*, *Filinia longiseta*, *Conochilus unicornis* (Rotifera), *Megacyclops viridis*, *Cyclops* sp. and *Nauplii* (Copepoda).

5. *Daphnia cucullata* has a negative correlation (baed on Spearmans correlation coefficient) with *Asplanchna priodonta* (Rotifera) and *Eurytemora lacustris* (Copepoda).

6. Based on the RDA *Daphnia cucullata* was in a close interaction with *Daphnia cristata*, chlorophyll α and sampling time in 2010, while with *Bosmina crassicornis*, *Gastropus stylifer*, the dissolved substances and conductivity in 2011.

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