STUDIES ON THE DISTRIBUTION OF ZOOPLANKTONIC COMMUNITIES IN THE PRUT - DANUBE ECOSYSTEMS

LEBEDENCO Liubovi

Abstract. The goal of this paper was to study the distribution of zooplankton communities in the Lower Prut, a tributary of the Danube river. In this paper, data from the period of 2014-2015 were analysed, for both Prut and Danube rivers ecosystems. The complex expeditions were carried out on the Lower Prut ecosystems (Goteşti - Giurgiuleşti) and the Lower Danube area (Galați - Vilcovo). The value of the similarity coefficient of the zooplankton communities in Prut and Danube rivers was 0.40 (2014) and 0.33 (2015), the taxonomic difference being related to the different hydrological conditions. Although more than 85% of the identified taxa were recorded relatively rarely, considering their role in ecosystems, the Prut river deserves an important attention for the maintenance of zooplankton communities.

Keywords: zooplanktonic communities, Lower Prut, Danube river, biodiversity.

Rezumat. Studii privind distribuția comunităților zooplanctonice în ecosistemele Prut – Dunăre. Scopul acestei lucrări a fost studierea distribuției comunităților zooplanctonice din Prutul de Jos al Dunării, ca afluent al fluviului Dunărea. În această lucrare s-au analizat datele din perioada anilor 2014-2015, in același timp din ecosistemele Prut și Dunăre. Expedițiile complexe s-au desfăşurat pe sectorul Prutului Inferior (Goteşti - Giurgiuleşti) și în zona Dunării de Jos (Galați - Vilcovo). Valoarea coeficientului de similaritate al comunităților zooplanctonice din râurile Prut și Dunăre a fost 0,40 (2014) și 0,33 (2015), diferența taxonomică fiind legată de diferitele condiții hidrologice. Cu toate că 85% din taxonii identificați s-au întâlnit relativ rar, având în vedere rolul acestora in ecosistem, râul Prut necesită o atenție sporită pentru menținerea comunităților zooplanctonice.

Cuvinte cheie: comunitățile zooplanctonice, Prutul Inferior, fluviul Dunărea, biodiversitate.

INTRODUCTION

The zooplankton, with its structure and functions, is an important component of aquatic biodiversity. This group of aquatic organisms has a non-uniform distribution mainly due to the phenomena of active aggregation and migration of planktonic species and also under the influence of biotic and abiotic factors. In aquatic ecosystems, the horizontal distribution of zooplankton is influenced by many factors such as the morphological and hydrological characteristics of the ecosystem or the structure of the tributary network.

In recent years, a considerable attention has been paid to the Danube basin, which has a regional importance, for the purpose of the protection and sustainable use of water resources (ANON, 2009). Prut is the second river according to its length and importance on the territory of the Republic of Moldova. It springs from the Oriental Carpathians, from the North-Eastern slope of Mount Goverla. Prut is the last major tributary of the Danube river, flowing to the southwest of the village Giurgiulești.

The goal of this paper was to study the distribution of zooplankton communities in the Lower Prut as the tributary of the Danube river. The paper was elaborated on the basis of data obtained under MIS ETC 1676 "Cross-border Interdisciplinary Cooperation for the Prevention of Natural Disasters and the Mitigation of Environmental Pollution in the Lower Danube Euroregion".

MATERIALS AND METHODS

In the current paper the data on the structural and quantitative parameters of the zooplancton communities are presented during the vegetation period of 2014 – 2015 in the Lower Danube Basin within the boundaries of Moldova, Ukraine and Romania. Sample collection was carried out in accordance to unified methods for hydrobiological sample collection and processing (DEREVENSKAIA, 2015; JURMINSKAIA et al., 2015; LEBEDENCO & JURMINSKAIA, 2015). A total number of 50 zooplankton samples were collected and analysed. The complex expeditions were carried out on the Lower Prut ecosystems (Goteşti - Giurgiuleşti) and the Lower Danube area (Galați - Vilcovo). The samples were collected using the Apstein zooplankton net (№ 55) by filtering a quantity of 100 l of water. The collected zooplankton material was fixed immediately in the field with formalin solution (40 %). The quantitative counting of zooplankton was carried out using Bogorov counting chamber and the binocular stereo zoom Discovery V8 ZEISS, using three replications. The density (N – ind/m^3) of the organisms was reported to cubic meter. Identification of the main zooplankton groups (Rotatoria, Copepoda, Cladocera) was carried out up to the highest possible level, with the use of the microscope Axio Imager A.2 (Zeiss). The determination of the taxonomic structure of the zooplankton groups was carried out with the use of identification guides (KUTIKOVA, 1970; NEGREA, 1983; NABEREJNII, 1984; ALEXEEV & TALOLICHIN, 2010). In order to determine the contribution of the Lower Prut biodiversity to the Danube river the taxonomic complex was analyzed in the Danube, and the Jaccard similarity coefficient was calculated to compare the diversity between the two communities of organisms of the Prut and Danube river, this being expressed in the following equation : $Qs = 2 c / a + b$.

REZULTS AND DISCUSSION

In the taxonomic complex of the Lower Prut, 24 (2014) and 18 (2015) taxa were registered (Table 1), composed mainly of rotifers, which constituted 38% and 67%, respectively. In the Danube sector, the major contribution of the taxonomic complex of zooplankton belonged to copepods, and constituted 21 (52%) in 2014 and 12 taxa (67%) in 2015.

Table 1. The taxonomic complex in the Lower Prut and the Lower Danube ecosystems during 2014 – 2015 period.

Taxon	**2014**		**2015**	
	Lower Prut	**Lower Danube**	**Lower Prut**	**Lower Danube**
Rotatoria				
Asplanchna priodonta Gosse, 1850	+			
Asplanchna herricki Guerne, 1888			+	
Asplanchna sp. Gosse, 1850	+			
Brachionus bidentata Anderson, 1889			+	
Brachionus budapestinensis Daday, 1885		+		
Brachionus calyciflorus Pallas, 1776	+		+	
Brachionus quadridentatus, Hermann, 1783	+		+	+
Brachionus sp. Pallas, 1766			+	
Cephalodella gibba (Ehrenberg, 1832)			+	
Cephalodella eva (Gosse, 1887)		+		
Cephalodella sp. Bory de St. Vincent			+	
Euchlanis dilatata Ehrenberg, 1832	+	+		
Epiphanes senta (Műller, 1773)			+	
Epiphanes sp. Ehrenberg, 1832			+	
Filinia longiseta (Ehrenberg, 1834)	+		+	
Keratella quadrata (Műller, 1786)		+	+	
Lecane (Monostyla) sp. Ehrenberg, 1832	+			
Notommata sp. Ehrenberg, 1830		+		
Platyias patulus (Műller, 1786)		+		
Polyarthra luminosa Kutikova, 1962	+			
Polyarthra vulgaris Carlin,1943	+			
Rotatoria gen. sp.		+	+	+
Copepoda				
Acanthocyclops vernalis (Fischer, 1853)	+	+		
Copepodit Copepoda		+		
Copepodit Cyclopoida	+	+	+	+
Copepodit Harpacticoida			+	
Cyclopoida gen. sp.	+	+		+
Eurytemora lacustris (Poppe, 1887)				+
Eurytemora velox (Lilljerborg, 1853)		+		
Harpacticoida gen. sp.	+	+	+	
Mesocyclops asiaticus Kierfer, 1835		+		
Mesocyclops leuckarti (Claus, 1857)	+		+	
Mesocyclops sp. Sars, 1913				+
Microcyclops gracilis (Lilljeborg)		+		
Nauplii Copepoda	+	+	+	+
Nauplii Cyclopoida	+	+	+	+
Thermocyclops dybowskii (Lande, 1890)				+
Thermocyclops crassus (Fischer, 1953)	+	+		+
Thermocyclops oithonoides (Sars, 1863)	+			
Cladocera				
Alona rectangula Sars, 1862	+			
Bosmina longirostris (O. F. Műller, 1785)		+		+
Chydorus gibbus Sars,1891	+			
Chydorus sphaericus (O. F. Műller, 1785)	+			
Chydorus sp. Leach,1816				+
Daphnia longispina O. F. Műller, 1785	+	+		
Daphnia sp. O. F. Műller, 1785		+		
Scapholeberis mucronata (O. F. Műller, 1776)	+			
Sida crystallina (O. F. Műller, 1776)	+			
Total	24	21	18	12

An important feature of the Prut river basin is its mountainous hydrologic origin, which contributes to a relatively large variety of taxonomic composition of the ecosystem, including zooplankton species, which on its side adds to the Danube biodiversity, especially in the confluence area (ZUBCOV et al., 2014; LEBEDENCO et al., 2017). Although more than 85% of the identified taxa were recorded relatively rarely, this ecosystem deserve an important attention for the maintenance of its biodiversity.

The common complex of taxa recorded in the analysed ecosystems was smaller in 2015, constituting only 5 (Table 2) taxonomic units: *B. quadridentatus*, *Rotatoria* gen. sp., - rotifers, Copepodit *Cyclopoida*, *Nauplii*, *Copepoda*, *Nauplii Cyclopoida* - copepodele. For the period of 2014 the complex taxonomic unit was represented by rotifers – *E. dilatata*, copepode – *A. vernalis*, *Copepodit Cyclopoida*, *Cyclopoida* gen. sp., *Harpacticoida* gen. sp., *T. crassus*, Nauplii *Copepoda*, Nauplii *Cyclopoida*, and cladocera – *D. longispina*, constituting 9 units. The value (tab. 2) of the similarity coefficient of the zooplankton communities in Prut and Danube rivers was 0.40 and 0.33, the taxonomic difference being related to the different hydrological conditions.

Table 2. The dynamics of the similarity coefficient (Jaccard) of the taxonomic diversity complex of zooplankton in the lowland Prut and Danube ecosystems.

Ecosystem sector	2014	2015
Inferior Prut	24	18
Danube (inferior sector)	21	12
The number of common taxa	9	5
Similarity coefficient, Q_s	**0,40**	**0,33**

In the Lower Danube, downstream of the delta, the abundance of all zooplankton groups was low due to the backwater effect, which is confirmed in earlier studies (LEBEDENCO et al., 2016). The number of rotifers was very small, the development of the copepode group was the highest, especially of adult individuals, when the development stage of copepodites predominates in the Lower Prut. This was also conditioned by the climatic conditions in Lower Danube. Cladocers do not make a significant contribution to the zooplankton taxonomic complex formation in investigated ecosystems, with low values (14-20%) or even absence (Lower Prut 2015). At the same time, *B. longirostris* in the Danube was the dominant species with a range of 60 (St. Reni) to 360 ind/m^3 (St. Chilia). The zooplankton diversity of the Lower Prut and Lower Danube is described in figure 1.

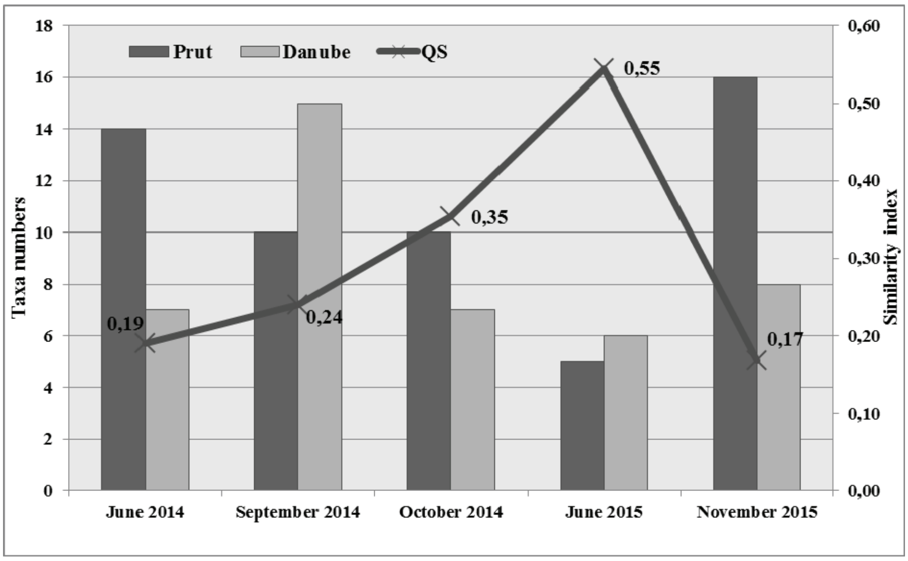

Figure 1. The number of taxonomic units in the ecosystems of Lower Prut and Lower Danube with changes over time and similarity coefficient.

The highest similarity index of the zooplankton communities between the Danube and Prut rivers with a value of 0.55 was recorded in June 2015, when the number of taxa in the given ecosystems has the lowest values. It has been noticed that the taxonomic diversity of the investigated ecosystems is largely high, while the similarity coefficient has low values (0.17 - 0.24). This demonstrates the low generality of these ecosystems and the existence of different habitats for the development of the zooplankton communities, caused by various factors such as the Giurgiulești port, the frequent floods in this area or other factors. The Shanon-Wiener diversity index in the studied ecosystems differs insignificantly and is 2.40 - in the Lower Prut and 2.43 - in the Lower Danube. The trophic level based on the diversity of zooplankton of the studied ecosystems is mesotrophic. The parameters of the zooplankton density in this area varied considerably, so that in the Lower Prut had values of 1.32 thousand ind/ m3 (June 2015) - 55.11 thousand in m3 / m3 (June 2014) and 1.25 in the Lower Danube 1.25 thousand ind / m^3 (November 2015) - 17,30 thousand ind /m^3 (September 2014). The fluctuations of the zooplankton biomass depend on taxonomic structure, when there is a direct dependence on the dominant complex and main groups included in its composition, therefore the biomass of zooplankton formed during the investigated period was considerable higher in the Danube sector than in the Prut river. For a saprobiological assessment of the monitored ecosystem, the species richness was analysed as a function of saprobity. In these communities the most indicators are representatives of β- mezasoprobe and o-β- mezasoprobe areas.

CONCLUSIONS

At the level of systematic groups, the zooplankton structure of the Lower Prut in 2014 includes: rotifers - 33 %, copepods – 52 %, cladocerans – 14 % and in 2015 year rotifers 67 %, copepods – 33 % and cladocerans - was absence. For the Lower Danube, the percent ratio of the taxa number is: rotifers - 38 %, copepods - 37 %, cladocerans – 25 % in 2014, and in 2015 year is: rotifers – 17 %, copepods – 67 % and cladocerans 16 %.

The value of the similarity coefficient of the zooplankton communities in Prut and Danube rivers was 0.40 and 0.33, the taxonomic difference being related to the different hydrological conditions. The common complex of taxa recorded in the analysed ecosystems was smaller in 2015, constituting only 5 units, while 9 were registered in 2014.

Despite the fact that the taxonomic diversity of the investigated ecosystems is very high, the similarity coefficient has low values (0.17 - 0.24). Analysing all the results of the investigated parameters, it can be concluded that the distribution of zooplankton communities of Lower Prut does not have a direct influence on the formation of biodiversity of Lower Danube. These two rivers present different habitats for zooplankton development. This demonstrates the low generality of these ecosystems and the existence of different habitats for the development of the zooplanktonic communities, caused by various factors such as the Giurgiulești port, the frequent floods in this area or other factors.

ACKNOLEDGEMENTS

Investigations were carried out within the project MIS ETC 1676 "Cross-border interdisciplinary cooperation for the prevention of natural disasters and mitigation of environmental pollution in the Lower Danube Euroregion".

REFERENCES

ALEXEEV V. & TALOLICHIN S. 2010. *Identification guide of zooplankton and zoobenthos of freshwater of European Russia*, *Zooplankton*. M-KMK Publisher. Moskow-Petersburg. **1**. 495 pp. [In Russian].

ANON P. 2009. Zooplankton. *Joint Danube Survey*. International Comission for the Protection of the Danube River Press. Vienna. **4**(6): 82-86.

DEREVENSKAIA O. 2015. *Methods of water quality assessment according to hydrobiological indicators*. *Methodical manual*. KFU Publisher. Kazan. 44 pp. [In Russian].

JURMINSKAIA OLGA., SUBERNETKII I., LEBEDENCO LIUBOVI. 2015. Sampling of zooplankton. In: Toderaș I., Zubcov E., Biletski L. (editor) *Hydrochemical and hydrobiological sampling guidance*. Elan poligraf. Chișinău: 14-18.

KUTIKOVA L. 1970. *Rotifers of the fauna of SSSR.* (Byhovski, editor). Nauka Press. Leningrad. 744 pp. [In Russian].

LEBEDENCO LIUBOVI & JURMINSKAIA OLGA. 2015. Zooplankton. In: Toderaș I., Zubcov Elena, Bilețchi Lucia (editor) *Monitoring of the quality of water and evaluation of the ecological state of aquatic ecosystems: Methodological guide*. Academy of Science of Moldova Puublisher. Chișinău. **7**: 51-56.

LEBEDENCO LIUBOVI, JURMINSKAIA OLGA, ZUBCOV ELENA. 2016. Dynamics of zooplankton in ecosystems of the Lower Danube. *Annals of the University Dunărea de Jos of Galați, Fascicle II - Mathematics, Physics, Theoretical Mechanics*. Universitaria Press. Galați. **39**(1): 92-100.

LEBEDENCO LIUBOVI, JURMINSKAIA OLGA, SHUBERNETSKII I. 2017. Diversity of zooplankton communities in the Prut River. *International symposium dedicated to the 100th anniversary from the birth of academician Alexei Spassky 13 october 2017 "Actual problems of zoology and parasitology: achievements and prospects"*. Academy of Science of Moldova Puublisher. Chișinău: 458-466.

NABEREJNII A. 1984. *Rotifers of aquatic ecosystem of Moldova.* Edit. Știința. Chișinău. 326 pp.

NEGREA ȘT. 1983. *Fauna R. S. România. Crustacea*. *Cladocera*. Edit. Academiei R.S.R. Bucuresti. **4**(12). 399 pp.

ZUBCOV ELENA, UNGUREANU LAURENȚIA, TODERAȘ I., BILEȚCHI LUCIA, BAGRIN NINA. 2014. *Hydrobiocenosis State of Prut River in the Sculeni-Giurgiulești Sector*. *Management of Water Quality in Moldova*. Springer International Publishing Switzerland. Berna. **7**: 22-32.

Lebedenco Liubovi
Institute of Zoology, Ministry of Education, Culture and Research of the Republic of Moldova,
Academiei street 1, Chișinău, Republic of Moldova.
E-mail: lebedenco.asm@mail.ru

Received: March 31, 2018
Accepted: July 3, 2018