ACTA ZOOLOGICA BULGARICA
Acta zool. bulg., Suppl. 7, 2014: 91-95

Composition of Zooplankton Species Diversity in the Hungarian and Bulgarian Sections of the Danube River

Stefan Kazakov[1], Károly Schöll[2], Roumen Kalchev[1], Luchezar Pehlivanov[1], Anita Kiss[2]

[1] Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences, Gagarin Str., 1113 Sofia, Bugaria; Email: Stefan.Kazakov@mail.iber.bas.bg
[2] Danube Research Institute, Centre for Ecological Research, Hungarian Academy of Sciences, Alkotmány u. 2-4, H-2163 Vácrátót/Hungary

Abstract: Zooplankton communities in the main arm of the Middle and the Lower Danube River and in 15 adjacent wetlands were compared. Different kinds of wetlands were included in the study. The investigated sites belong to the Bulgarian and Hungarian stretches of the Danube River. Most of the wetlands in the Middle Danube River section are situated in the active floodplain representing braided side arms that pass through different stages of hydrological connection. Most of the wetlands in the Lower Danube River floodplain are more or less isolated from the main channel through river embankment and are influenced by the hydrological regime of the Danube River mainly through underground infiltration and sluice regulation facilities. Cluster analysis based on the species composition was used to demonstrate the similarities between the investigated zones. Detrended Correspondence Analysis revealed a separation along the Danube River sections and depending on the connectivity pattern. Frequency of species occurrence was compared in the different types of wetlands. Over 202 species were identified and their spatial distributions were compared. The richest species composition was found in the Nyéki-oxbow and Rezéti-Danube on the Hungarian floodplain, and in the wetlands Orsoya and Kalimok-Brashlen on the Bulgarian floodplain. The crustaceans *Chydorus sphaericus* (Cladocera) and *Eucyclops serrulatus* (Copepoda) occurred in all the studied wetlands and also in the main Danube channel. The most frequent species of Rotifera were *Brachionus diversicornis, Brachionus quadridentatus, Euchlanis dilatata* and *Keratella quadrata*.

Keywords: Zooplankton, species composition, Middle and Lower Danube River, wetlands, floodplain

Introduction

The wetlands play an important role in the social and economic life of the people. Naturally the wetlands, as habitats, maintain the highest biodiversity on Earth. They belong to both terrestrial and aquatic environments. In particular they play an important role as breeding places for fish during the river floods. Moreover, the zooplankton in the wetlands is a main link in the grazing food chain and, therefore, plays an essential role for the survival of the fish larvae in the wetlands. The Danube River wetlands are highly dependent on the flood pulses of the river. Currently the hydrological regime has been severely modified, most of the naturally flooded areas are embanked and the natural hydrological surface connection is extremely limited.

This study compares the species diversity of zooplankton communities originating from wetlands belonging to the Middle and the Lower Danube River. The studied wetlands differ in their morphology, and in the duration and intensity of connectivity to the river. The investigated sites are located in floodplains of the Hungarian (HU) and Bulgarian

(BG) Danube River sections. Previous studies on the hydrological connectivity of the Hungarian section concerned mostly the Gemenc floodplain (Guti 2001, Schöll *et al*. 2008) and its zooplankton assemblages (Schöll 2004, 2006, Schöll, Kiss 2008), demonstrating that significant differences between the composition of isolated water bodies and those with temporal or permanent connection to the main arm existed (Kiss 2006). The studies on zooplankton communities from the Bulgarian Danube River wetlands (Naidenow 1984) mostly concerned Srebarna Lake (Pehlivanov *et al.* 2004, 2012) and the lake of Malak Preslavets (Tsavkova 2005). The development of the community structure according to the degree of connectivity between the main channel of the river and the adjacent lentic ecosystems were investigated by Pehlivanov *et al*. (2006) and Pehlivanov (2007).

Material and Methods

The Hungarian wetlands - Vén-Danube, Rezéti-Danube, Grébeci-Danube, Nyéki-oxbow Lake and Danube main arm at rkm 1489, are located in the floodplain of Gemenc. Gemenc floodplain is situated on the right bank of the Middle Danube River section, between rkm 1498 and rkm 1469 (Fig. 1). It is 5-10 km wide and about 30 km long, and covers a territory of about 18000 hectares. Riha Oxbow is positioned on the left side of the Danube River, 30 km downstream in a side that is protected from flooding events. Mocskos-Danube and Külső-Béda oxbows are located in the Béda-Karapancsa floodplain which is situated few kilometers downstream, in the Duna-Drava national park. Most of the investigated Bulgarian wetlands are situated between rkm 773 and rkm 393 (Fig. 1), on the right side of the Lower Danube River section. Exceptions are the island of Kozloduy and the island of Belene. All of the wetlands except the island of Kozloduy are embanked and the surface hydrological connectivity with the river is hampered and/or regulated.

Four types of wetlands were defined according to the system of Roux (1982) based on their spatial and temporal connectivity to the main channel of the river. Each wetland consisted of one or more different water bodies. As a result the potamon type (Table 1) was determined by the dominating connectivity type of the investigated stations during the study. Plesiopotamon type predominated in all wetlands from the Lower Danube River. Characteristic of the plesiopotamon wetlands was that the surface water connection in most of the cases was very short and completely regulated by sluice facilities.

Zooplankton samples were collected by filtering 50 L of water through plankton net and the filtrate was preserved in 4% solution of formaldehyde or 70% ethanol. In the Hungarian section the mesh size of the used plankton net was 45 μm for the Rotifera and 60 μm for Cladocera and Copepoda. For the Bulgarian section a 90 μm mesh size net was used. In the Hungarian wetlands sampling was performed from 2002 to 2004, from 2007 to 2009 and from 2012 to 2013, while in the Bulgarian wetlands sampling was conducted from 2009 to 2012.

ArcGIS 9.3.1 was used for the wetlands mapping. Zooplankton data were processed using Primer-E software (Clarke, Gorley 2006), with Soerensen algorithm being used for calculating the similarity resemblance matrix. Complete linkage mode and presence-absence data transformation of the samples were used for the Cluster analysis. In addition CANOCO 4.5 software (Ter Braak, Љmilauer 2002) was used for Detrended Correspondence Analysis based on all of species, with downweighting of rare species.

Frequency of occurrence of the zooplankton species was represented by four main classes: common species - occurring in more than 75% of the investigated wetlands; frequent species – occurring in 51-75%; rare species – occurring in 26-50% and very rare species – occurring in <25%. As "unique" are summarised the number of species found in only one wetland (5.88%) and nowhere else.

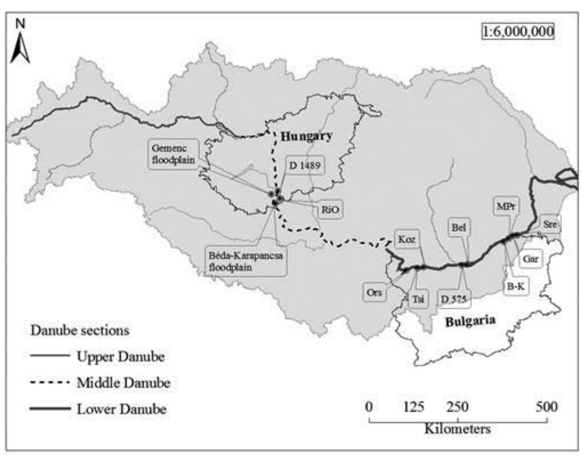

Fig. 1. Map of the studied Hungarian and Bulgarian wetlands

Results and Discussion

Two hundred and two species were identified and their spatial distributions were compared. The number of species from the genus *Asplanchna* from Gemenc floodplain was merged and included in the species lists as at least one species, owing to the fact that they were not identified to species level in the Bulgarian wetlands. The same procedure was followed with the species from the genus *Synchaeta*. In total one hundred and seven Rotifera (BG-85, HU-67), 29 Copepoda (BG-19, HU-26) and 66 Cladocera species (BG-48, HU-54) were identified.

The similarities between the investigated wetlands were explored through cluster analysis based on the species composition (Fig. 2). The highest similarity was found between the wetlands of Gemenc floodplain – Grébeci-Duna, Rezéti-Duna and Vén-Duna, and the more isolated Mocskos-Danube and Nyéki-oxbow lakes. However, according to the cluster analysis results the Hungarian Külső-Béda oxbow and Riha oxbow lakes, as well as two other Bulgarian wetlands, (Tsibar and Garvan) seemed to be equally remote from the remaining Hungarian and Bulgarian wetlands. The latter four wetlands belonged to the paleopotamon type (Table 1). Nevertheless, the dissimilarity between the Bulgarian and the Hungarian wetlands was obvious.

Differences in the species composition resulted from the large number of rare species for each of the Danube River sections (Table 1). Fifty species (22 Rotifera, ten Copepoda and 18 Cladocera) that occurred in the Hungarian wetlands were not found in the Bulgarian ones and vice versa: 55 species (40 Rotifera, three Copepoda and 12 Cladocera), from the Lower Danube River section were not found in the Middle one.

Detrended Correspondence Analysis (Fig. 3) based on all species, with downweighting of rare species, showed separation along the first axis between the Middle and Lower Danube River, as well as along the second axis according to the connectivity pattern. Paleopotamon was mostly occurring in the Lower Danube River section, while plesiopotamon predominated in the Middle section of the river.

Frequency of species occurrence was compared for the different habitats (Table 1). Fifty-six unique species were encountered in all wetlands: 26 in the Bulgarian (21 Rotifera and five Cladocera) and 30 species in the Hungarian wetlands (12 Cladocera, eight Copepoda and ten Rotifera) (Table 1). The highest numbers of unique species were found in the plesiopotamon wetlands: twelve species in Nyéki-oxbow of the Middle Danube River section

Table 1. Potamon type of the wetlands and number of species in terms of their frequency of occurrence

Danube section	Name of the wetland	Code	Unique	Very rare	Rare	Frequent	Common	Potamon type
HU	Danube m.a. 1489 rkm	D 1489	2	10	18	14	15	eupotamon
HU	Vén-Danube	VDU	4	16	29	14	18	parapotamon
HU	Grébeci-Danube	GDU	1	11	28	15	18	plesiopotamon
HU	Rezéti-Danube	RDU	6	19	30	15	18	parapotamon
HU	Nyéki-Oxbow	NYHD	12	30	35	14	18	plesiopotamon
HU	Mocskos-Danube	MDU	4	9	26	14	16	plesiopotamon
HU	Külső-Béda Oxbow	KBO	0	3	6	4	8	plesiopotamon
HU	Riha Oxbow Lake	RiO	1	1	3	7	7	paleopotamon
BG	Belene	Bel	4	19	19	14	11	plesiopotamon
BG	Brashlen-Kalimok	B-K	5	26	26	13	14	paleopotamon
BG	Danube s.a. 575 rkm	D 575	0	11	10	13	10	eupotamon
BG	Garvan	Gar	0	5	9	12	3	paleopotamon
BG	Tsibar	Tsi	1	3	3	9	4	paleopotamon
BG	Kozloduy	Koz	0	4	5	14	11	parapotamon
BG	Malak Preslavets	MPr	5	13	16	15	16	paleopotamon
BG	Orsoya	Ors	4	23	29	15	16	plesiopotamon
BG	Srebarna	Sre	7	23	19	15	20	plesiopotamon

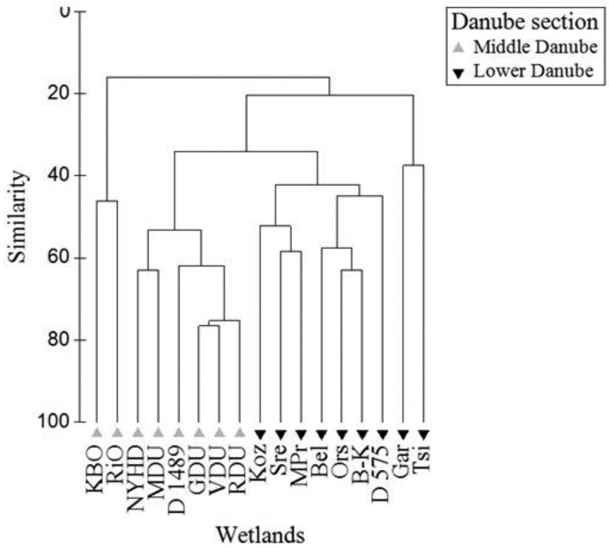

Fig. 2. Hierarchical cluster analysis, demonstrating the between-wetlands similarity. The calculations were performed using complete linkage, Soerensen algorithm and presence-absence data transformation. For the applied sampling site abbreviations see Table 1

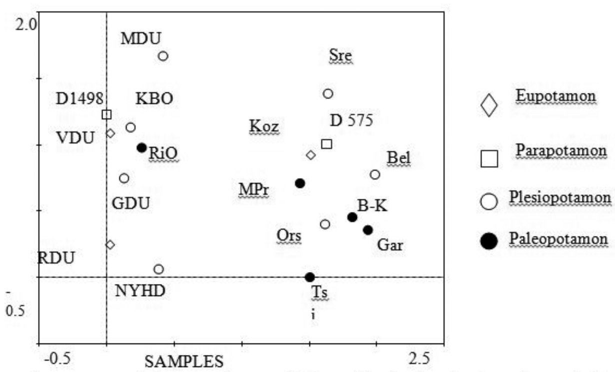

Fig. 3. Detrended Corespondence Analysis. Explained variance by the first and second axes: 14.2%; Total inertia – 1.78. Eigenvalues for the first axis: 0.323 and for the second: 0.133. Total cumulative percentage of variances: 25.5%. For sampling site abbreviations see Table 1

and seven species in Srebarna Lake from the Lower Danube River (Table 1). The most common rotifer species occurring in over 75% of the investigated zones were *Brachionus calyciflorus* Pallas, 1776, *Brachionus diversicornis* (Daday, 1883), *Brachionus quadridentatus* Hermann, 1783, *Euchlanis dilatata* Ehrenberg, 1832, *Keratella quadrata* (O. F. Müller, 1786), *Asplanchna* spp. and *Synchaeta* spp. The common Copepoda were *Eucyclops serrulatus* (Fischer, 1851), *Mesocyclops leuckarti* (Claus, 1857) and *Thermocyclops crassus* (Fischer, 1853). Five cladoceran species, *i.e. Bosmina longirostris* (O. F. Müller, 1776), *Chydorus sphaericus* (O. F. Müller, 1776), *Daphnia longispina* (O. F. Müller, 1776), *Pleuroxus aduncus* (Jurine, 1820) and *Simocephalus vetulus* (O. F. Müller, 1776) occurred commonly.

Conclusions

Significant differences between the zooplankton species diversity of the Middle and Lower Danube River zones were found. Their similarity is based on 97 common species. Frequency of species occurrence showed that the different Danube River sections consist of a considerable number of rare and very rare species. Significant differences between the different potamon types, based on a qualitative analysis of the zooplankton communities, were not found. A more precise definition based on the potamon type classification of the Bulgarian wetlands is needed.

Acknowledgments: The study was supported by the joint project "Comparison between wetland-Danube River systems of Hungary and Bulgaria related to their biodiversity, functioning, services, management and nature conservation". The sampling of the zooplankton in the wetlands along the Bulgarian Danube River section was carried out under the project DO 02-352/2008 funded by the Bulgarian NSF, and along the Hungarian Danube section by the Deutsche Bundesstiftung Umwelt (DBU) AZ 24050 project.

References

Clarke K. R., R. N. Gorley 2006. PRIMER v6: User Manual/ Tutorial. PRIMER-E, Plymouth.

Guti G. 2001. Water bodies in the Gemenc floodplain of the Danube, Hungary. (A theoretical basis for their typology). - *Opuscula Zooogica Budapest*, **33**: 49-60.

Kiss A. 2006. Cladocera, Ostracoda and Copepoda assemblages in different side arms of the Danube in Gemenc floodplain (Danube-Dráva National Park, Hungary). - In: Proceedings 36th International Conference of IAD. Austrian Committee Danube Research, IAD, Vienna: 250-254.

Naidenow W. 1984. Composition and ecology of the zooplankton of the Danube River and the inland water basins in Bulgaria. Doctor of Science Thesis, Sofia, Bulgarian Academy of Sciences, Inst. of Zoology: 503 p. (In Bulgarian).

Pehlivanov L., V. Tzavkova and W. Naidenow 2004. The Metazoan plankton of the Biosphere Reserve Srebarna Lake (North-Eastern Bulgaria). – *Lauterbornia*, **49**: 99-105.

Pehlivanov L., V. Tzavkova and V. Vasilev 2006. Development of the zooplankton community in the Srebarna Lake (North-Eastern Bulgaria) along the process of ecosystem rehabilitation. - In: Proceedings 36th International Conference of IAD. Austrian Committee Danube Research/IAD, Vienna: 280-284.

Pehlivanov L. 2007. Models of connectivity between adjacent lotic and lentic ecosystems along processes of the aquatic communities recovery and development in wetlands on the Lower Danube terrace. Final report on Contract No B-1307/2003. Central Laboratory of General Ecology – BAS, National Scientific Fund, 42 p.

Pehlivanov L., V. Tsavkova, M. Pavlova and S. Kazakov 2012. Zooplankton. - In: Uzunov Y., B. B. Georgiev, E. Varadinoiva, N. Ivanova, I. Pehlivanov and V. Vasilev (eds.), Ecosystems of the Biosphere Reserve Srebarna Lake. Prof. Marin Drinov Acad. Publ. House, Sofia: 77-92.

Roux A. 1982. Cartographie polythématique appliqué a la gestion écologique des eaux. - CNRS, Lyon: 1-113.

Schöll K. 2004. Planctonic rotifer communities in the side arms of the Danube at Gemenc (Danube-Dráva National Park, Hungary). - *IAD Limnological Reports*, **35**: 555-562.

Schöll K. 2006. Changes in rotifer communities regarding to the water-level fluctuations in the floodplain Gemenc, Danube, Hungary. - *Opuscula Zooogica Budapest*, **35**: 77-81.

Schöll K., M. Dinka and A. Kiss 2008. Water regime indicated hydrobiological differences between two side arms in the Gemenc floodplain (Danube/Hungary). Proceedings of the 37th IAD Conference, Moldova: 168-173.

Schöll K., A. Kiss 2008. Spatial and temporal distribution patterns of zooplankton assemblages (Rotifera, Cladocera, Copepoda) in the water bodies of the Gemenc Floodplain (Duna-Dráva National Park, Hungary) - *Opuscula Zooogica Budapest*, 2008, **39**: 65-76.

Ter Braak C. J. F., P. Smilauer 2002. Canoco Reference Manual and CanoDraw for Windows, User's Guide, Biometris, Wageningen and České Budějovice 499 p.

Tsavkova V. 2005. The zooplankton of the protected area "Malak Preslavets" as an indicator of water quality assessment. In: *Scientific Works of the University of Rousse "Angel Kanchev*.", Series 7.1.May scientific readings. Ruse, Ruse University "Angel Kanchev," 2005, **44:** 172-183. (In Bulgarian)