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Soil rotifers new to Hungary from the Gemenc floodplain (Duna-Dráva National Park, Hungary)

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Abstract: In summer and autumn 2010, we collected soil samples from the Gemenc floodplain of the Danube (Duna-Dráva National Park) from places with different flood regimes and vegetation cover and examined them for rotifers. We found a total of 31 species; 14 of them are new to the Hungarian fauna. The Hungarian occurrence of 8 further species is confirmed based on their first detailed data from the country. The genus *Wierzejskiella* Wiszniewski, 1934 is also new for Hungary. This study provides additional support to the conclusion that floodplains of large rivers have a diverse and sensitive biota.

Key words: Bdelloidea, diversity, the Danube

1. Introduction

Rotifera is an ecologically important phylum comprising about 2000 species of minute, unsegmented, bilaterally symmetrical pseudocoelomates living in aquatic and semiaquatic habitats (Wallace et al., 2006). Many species, especially of the subclass Bdelloidea (approximately 400 species), inhabit the interstitial water of soils; here they play an important role in nutrient cycling (Sohlenius, 1982). Knowledge of the Hungarian soil rotifer fauna is due in large part to the pioneering studies of Lajos Varga, who in the middle of the 20th century made extensive investigations of the soil rotifer community. In his monograph, the occurrences of several species are mentioned, but sometimes without any sampling data provided (Varga, 1966). Unfortunately, research of soil rotifers in Hungary then ceased. At present, the Hungarian rotifer fauna stands at about 600 species, with some 80 belonging to subclass Bdelloidea.

Floodplains have one of the most diverse fauna in the temperate region (Shiel et al., 1998). They represent ecotones with frequently high biodiversity regulated by shifts between aquatic and terrestrial stages. Soil rotifers represent an important part of the terrestrial rotifer fauna (Pourriot, 1979); their communities have important but only partially known ecological functions in the biota of temperate floodplains. To rectify this deficiency, we conducted a survey on the Gemenc floodplain of the Danube, a section of the Duna-Dráva National Park in Hungary. The Danube, the second largest river in Europe, is encountering increasing human interference (e.g., water regulation, over-abstraction, and pollution). Moreover, river–floodplain systems along the Danube are highly endangered; therefore, the recognition of the biota of existing natural floodplains is a pressing need. The Gemenc floodplain is one of the largest in Europe with an 18,000-ha area (Natura, 2000), and it is the only notable active floodplain of the Middle Danube (Berczik and Buzetzky, 2006).

Besides the faunal characterisation of soil rotifers of the Gemenc floodplain, the aims of our study included comparing the soil-inhabiting rotifers of natural forests and hybrid poplar plantations which are parallel to each other but with an altitude gradient, which means different flooding frequency and duration on the given sampling station. In this paper, the faunistic results of our studies are presented.

2. Materials and methods

2.1. Sampling area

The Gemenc floodplain is located in Hungary on the right bank of the Danube, between river kilometres 1503 and 1469 (Figure). It covers 18,000 ha, making it the only notable floodplain of the Middle Danube in the Carpathian basin. It is also one of the largest floodplains in Europe, with unique natural value (Zinke, 1996). Because the floodplain is not separated from the river by any dykes, the hydrological processes characteristic of river floodplain systems still occur here unperturbed. The 30-km-long and

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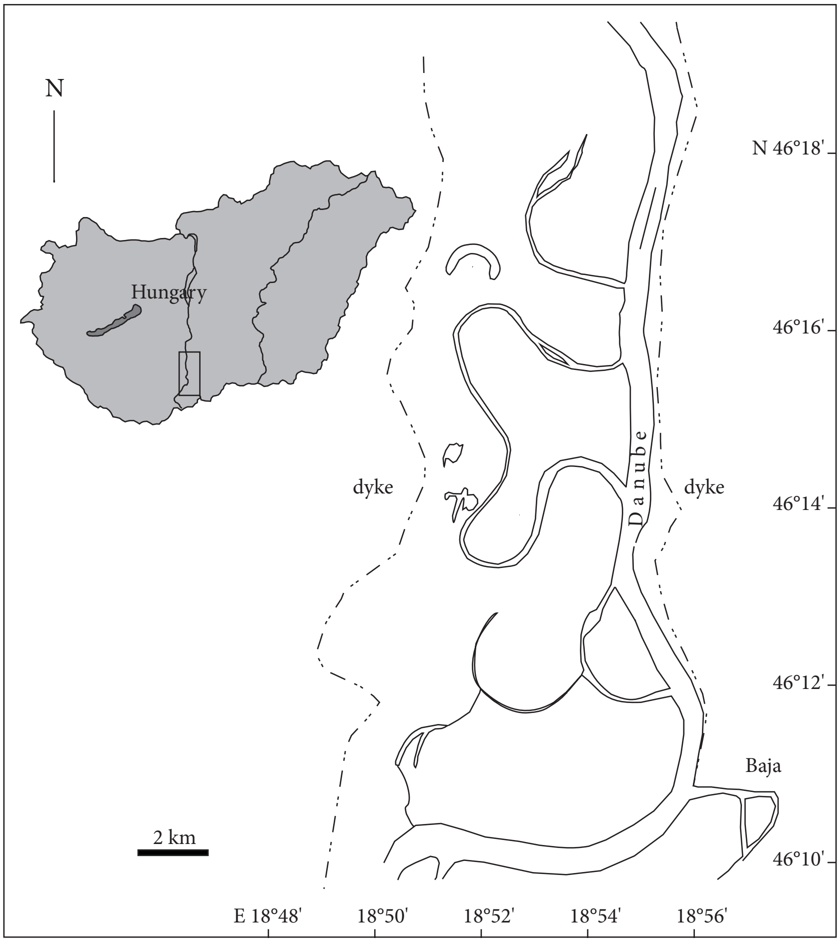

Figure. The Gemenc floodplain. See text for further explanation.

5–10-km wide area lies completely within the dyke system on the river. The mean annual discharge of the Danube is 2400 $m^3 s^{-1}$, with a minimum of 618 $m^3 s^{-1}$ and a maximum of 7940 $m^3 s^{-1}$ (Marosi and Somogyi, 1990). The stream gradient is about 5 cm km^{-1} in the main arm, with a flow velocity of 0.8–1.2 m s^{-1} at mean discharge.

Sampling was carried out on 02.06.2010, 04.06.2010, and 19.10.2010. Two parallel gradients with 4 plots each were sampled in 2 types of lowland forests, near natural and hybrid poplar plantations (Table 1). In each sampling plot, 3 random replicates were taken with a 10-cm^2 cylindrical soil corer down to a depth of 10 cm. These were placed in separate plastic bags, stored in a refrigerator at approximately 8 °C, and processed as soon as possible to reduce changes in the rotifer community. The contents of each bag were homogenised in the laboratory, and about 10–20 g of the sediment was extracted using the L-C extraction method (Devetter, 2010). Living specimens were identified and their numbers counted using a counting chamber. The keys of Bartoš (1959) and Donner (1965) and the nomenclature of Segers (2007) were used for species identification. Species richness (S) values were calculated to compare the α-diversity of the samples.

3. Results

We found 31 rotifer species in the soil samples from Gemenc. In the following text, we report the species present in our samples and comment on previous reports of their occurrence in Hungary, as well as their presence in the 8 large biogeographical regions as described by Segers (2007) (Table 2).

Class Eurotatoria

Subclass Bdelloidea

Fam. Adinetidae

Adineta gracilis Janson, 1893

Previous occurrences in Hungary: Tihany (Varga, 1941); Lesenceistvánd (Varga, 1933); Pécsely-brook: Vászoly, Pécsely, Örvényes (Varga, 1954a); Diósjenő – meadow (Varga, 1954b); Kelemér (Varga, 1956); Bátorliget (Varga, 1953).

Occurrences in Gemenc: 02.06.2010: 1Na, 2Na, 3Na, 1Aa, 2Aa.

Table 1. Locations and types of sampling sites.

Poplar plantation			Natural forest		
1Aa	46°17.681′N	18°53.131′E	1Na	46°11.600′N	18°50.621′E
1Ab	46°17.376′N	18°52.930′E	1Nb	46°11.592′N	18°50.640′E
2Aa	46°11.730′N	18°53.040′E	2Na	46°11.557′N	18°50.903′E
2Ab	46°16.456′N	18°54.104′E	2Nb	46°17.679′N	18°53.186′E
3Aa	46°11.960′N	18°53.048′E	3Na	46°12.278′N	18°52.937′E
3Ab	46°16.784′N	18°53.514′E	3Nb	46°17.054′N	18°52.876′E
4Aa	46°16.617′N	18°53.582′E	4Na	46°11.615′N	18°50.704′E
4Ab	46°16.765′N	18°53.536′E	4Nb	46°11.575′N	18°50.726′E

Adineta steineri Bartoš, 1951

Previous occurrences in Hungary: Present in forests near Sopron, among leaf litter, without statements of the dates and specific sampling sites (Varga, 1966).

Occurrences in Gemenc: 02.06.2010: 2Na, 3Na, 1Aa, 2Aa, 3Aa; 04.06.2010: 4Ab.

Adineta vaga (Davis, 1873)

Previous occurrences in Hungary: Aszófő (Varga, 1939); Tihany (Varga, 1941); Balatonszőlős, Aszófő (Varga, 1957); Lesenceistvánd (Varga, 1933); Pécsely-brook: Vászoly, Pécsely, Örvényes (Varga, 1954a); Diósjenő (Varga, 1955); Kelemér, Pálháza (Varga, 1956); Bátorliget (Varga, 1953).

Occurrences in Gemenc: 02.06.2010: 1Na, 2Na, 3Na, 2Aa, 3Aa; 04.06.2010: 1Nb, 2Nb, 3Nb, 3Ab, 4Ab; 19.10.2010: 1Nb, 2Nb, 1Aa, 3Ab.

Fam. Habrotrochidae

Habrotrocha constricta (Dujardin, 1841)

Previous occurrences in Hungary: Tihany (in a rain gutter) (Varga, 1960); Kelemér (Varga, 1956). Varga (1966) noted that this species was very frequent in forests (leaf litter).

Occurrences in Gemenc: 02.06.2010: 1Aa; 04.06.2010: 1Nb, 2Nb, 3Nb.

Habrotrocha pulchra (Murray, 1905)

This species is new to Hungary.

Occurrence in Gemenc: 04.06.2010: 1Ab.

Habrotrocha rosa Donner, 1949

Previous occurrences in Hungary: Varga (1966) noted this species to be very frequent in forests (leaf litter), but without giving information on its occurrence or any collecting data.

Occurrences in Gemenc: 02.06.2010: 3Na, 4Na; 19.10.2010: 1Ab.

Habrotrocha tranquilla Milne, 1916

This species is new to Hungary.

Occurrence in Gemenc: 04.06.2010: 2Nb.

Scepanotrocha semitecta Donner, 1951

This species is new to Hungary.

Occurrence in Gemenc: 19.10.2010: 2Nb.

Scepanotrocha simplex De Koning, 1947

This species is new to Hungary.

Occurrence in Gemenc: 04.06.2010: 2Ab.

Fam. Philodinidae

Ceratotrocha cornigera (Bryce, 1893)

Previous occurrences in Hungary: Varga (1966) found it in the Budai mountains, the Mecsek mountains, the surroundings of Sopron, and the Tisza floodplain forest, but did not provide information about the collection dates or exact sampling sites.

Occurrences in Gemenc: 02.06.2010: 1Aa; 04.06.2010: 2Nb, 1Ab, 2Ab; 19.10.2010: 4Nb, 4Aa, 1Ab, 2Ab, 3Ab, 4Ab.

Macrotrachela aculeata Milne, 1886

Previous occurrences in Hungary: Pécsely-brook: Vászoly, Pécsely, Örvényes (Varga 1954a). Varga (1966) found it in floodplain forests (Óhalom at the Tisza River), Nagybajom village, and the Bükk, Mecsek, and Soproni mountains, without statements of the collection dates or specific sampling sites.

Occurrence in Gemenc: 19.10.2010: 3Ab.

Macrotrachela habita (Bryce, 1894)

Previous occurrences in Hungary: Varga (1966) recorded occurrences in the Bükk, Mecsek, Vértes, and Soproni mountains, and the Somogyi hills, from leaf litter, but without statements of the collection dates or specific sampling sites.

Occurrences in Gemenc: 02.06.2010: 4Na; 04.06.2010: 3Nb; 19.10.2010: 1Nb.

Macrotrachela insolita De Koning, 1947

Previous occurrences in Hungary: Lake Fertő (Donner, 1979). Varga (1966) recorded this species from the Bükk, Mecsek, and Soproni mountains, and from Bugac (*Juniper* forest), but without statements of the collection dates or specific sampling sites (Varga, 1966).

Occurrences in Gemenc: 04.06.2010: 2Nb; 19.10.2010: 4Ab.

Macrotrachela nana (Bryce, 1912)

Previous occurrences in Hungary: Varga (1966) found

Table 2. Occurrences in the 8 large biogeographical regions after Segers (2007). Abbreviations: AFR - Afrotropical region; ANT - Antarctic region; AUS - Australian region; NEA - Nearctic region; NEO - Neotropical region; ORI - Oriental region; PAC - Pacific region; PAL - Palearctic region.

Species	Biogeographical regions
Subclass Bdelloidea	
Adineta gracilis Janson, 1893	AFR, ANT, AUS, NEA, ORI, PAL
Adineta steineri Bartoš, 1951	ANT, AUS, NEA, NEO, PAL
Adineta vaga (Davis, 1873)	AFR, ANT, AUS, NEA, NEO, ORI, PAL
Habrotrocha constricta (Dujardin, 1841)	AFR, ANT, AUS, NEA, NEO, PAC, PAL
Habrotrocha pulchra (Murray, 1905)	AFR, ANT, AUS, NEA, NEO, PAL
Habrotrocha rosa Donner, 1949	AFR, AUS, NEA, NEO, PAL
Habrotrocha tranquilla Milne, 1916	AFR, AUS, PAL
Scepanotrocha semitecta Donner, 1951	NEO, PAL
Scepanotrocha simplex De Koning, 1947	AUS, NEO, PAL
Ceratotrocha cornigera (Bryce, 1893)	ANT, AUS, NEA, NEO, PAL
Macrotrachela aculeata Milne, 1886	AFR, AUS, NEA, NEO, PAL
Macrotrachela habita (Bryce, 1894)	AFR, ANT, AUS, NEA, NEO, ORI, PAL
Macrotrachela insolita De Koning, 1947	ANT, AUS, NEA, NEO, PAL
Macrotrachela nana (Bryce, 1912)	AFR, AUS, NEA, NEO, PAL
Macrotrachela oblita Donner, 1949	PAL
Macrotrachela quadricornifera Milne, 1886	AFR, ANT, NEO, ORI, PAL
Macrotrachela vesicularis (Murray, 1906)	AUS, PAL
Mniobia bredensis De Koning, 1947	AUS, NEA, PAL
Mniobia lenta Donner, 1951	PAL
Mniobia tentans Donner, 1949	NEO, PAL
Philodina acuticornis Murray, 1902	AFR, AUS, NEA, NEO, PAL
Philodina plena (Bryce, 1894)	AFR, ANT, AUS, NEA, NEO, PAL
Philodina rapida (Milne, 1916)	AFR, NEO, PAL
Rotaria sordida (Western, 1893)	AFR, AUS, NEA, NEO, ORI, PAL
Subclass Monogononta	
Colurella geophila Donner, 1951	NEA, NEO, ORI, PAL
Encentrum arvicola Wulfert, 1936	PAL
Encentrum longipes Wulfert, 1936	ORI, PAL
Encentrum lutra Wulfert, 1936	NEA, PAL
Encentrum martes Wulfert, 1939	PAL
Wierzejskiella vagneri Koniar, 1955	PAL
Bryceella stylata (Milne, 1886)	NEA, PAC, PAL

this species in Pécsbányatelep and Szőce from moss and leaf litter, but did not provide statements about the dates of collection or the sampling sites.

Occurrences in Gemenc: 02.06.2010: 1Na, 2Na, 3Na, 1Aa, 3Aa; 04.06.2010: 1Nb, 2Nb; 19.10.2010: 2Aa, 3Ab.

Macrotrachela oblita Donner, 1949

This species is new to Hungary.

Occurrence in Gemenc: 04.06.2010: 2Nb.

Macrotrachela quadricornifera Milne, 1886

Previous occurrences in Hungary: Balatonszőlős, Aszófő (Varga, 1957); Pécsely-brook: Vászoly, Pécsely, Örvényes (Varga, 1954a); Diósjenő (Varga, 1955); Budapest: from pools in the underground tunnel (Berczik, 1960).

Occurrences in Gemenc: 02.06.2010: 1Na; 19.10.2010: 4Na, 1Aa.

Macrotrachela vesicularis (Murray, 1906)

Previous occurrences in Hungary: Varga (1966) found it in several places, without giving information on the collection dates: Jenőmajor, Óhalom (floodplain forest), Pusztavacs (Canadian poplar forest), Mecsek mountains, Soproni mountains, and Pécsbányatelep, between Cák and Velem villages.

Occurrences in Gemenc: 02.06.2010: 3Na, 1Aa.

Mniobia bredensis De Koning, 1947

This species is new to Hungary.

Occurrences in Gemenc: 04.06.2010: 1Nb; 19.10.2010: 3Aa, 1Ab.

Mniobia lenta Donner, 1951

This species is new to Hungary.

Occurrences in Gemenc: 04.06.2010: 1Ab; 19.10.2010: 2Aa.

Mniobia tentans Donner, 1949

Previous occurrences in Hungary: Varga (1966) reported it from the Vértes mountains and Soproni mountains, but did not give precise collecting data.

Occurrences in Gemenc: 19.10.2010: 3Na, 1Ab.

Philodina acuticornis Murray, 1902

Previous occurrence in Hungary: Lake Fertő (Donner, 1979).

Occurrence in Gemenc: 19.10.2010: 3Aa.

Philodina plena (Bryce, 1894)

Previous occurrences in Hungary: Varga (1966) found it in the Bükk, Mecsek, and Soproni mountains (from moss and dead leaves), but did not provide statements of the collection dates or specific sampling sites (Varga, 1966).

Occurrences in Gemenc: 04.06.2010: 2Ab; 19.10.2010: 2Na, 2Nb, 4Aa, 1Ab, 3Ab.

Philodina rapida (Milne, 1916)

This species is new to Hungary.

Occurrences in Gemenc: 19.10.2010: 1Aa, 3Aa, 4Aa, 1Ab, 4Ab.

Rotaria sordida (Western, 1893)

Previous occurrences in Hungary: Balatonszőlős (Varga, 1957); Pécsely-brook: Örvényes (Varga, 1954a); Tihany (Varga, 1937).

Occurrences in Gemenc: 02.06.2010: 1Na; 19.10.2010: 1Nb.

Subclass Monogononta

Order Ploima

Fam. Colurellidae

Colurella geophila Donner, 1951

This species is new to Hungary.

Occurrence in Gemenc: 19.10.2010: 4Nb.

Fam. Dicranophoridae

Encentrum arvicola Wulfert, 1936

This species is new to Hungary.

Occurrences in Gemenc: 02.06.2010: 3Na, 4Na, 1Aa, 2Aa, 3Aa, 4Aa; 04.06.2010: 3Nb; 19.10.2010: 1Na, 2Na, 3Na, 1Nb, 2Nb, 1Aa, 2Aa, 3Aa, 4Aa, 1Ab, 3Ab.

Encentrum longipes Wulfert, 1936

This species is new to Hungary.

Occurrences in Gemenc: 02.06.2010: 1Na, 2Na; 04.06.2010: 1Ab; 19.10.2010: 3Nb, 3Aa, 4Aa.

Encentrum lutra Wulfert, 1936

This species is new to Hungary.

Occurrences in Gemenc: 02.06.2010: 1Na, 3Na, 1Aa, 2Aa; 04.06.2010: 3Nb, 1Ab, 2Ab; 19.10.2010: 1Na, 2Na, 3Na, 3Nb, 1Aa.

Encentrum martes Wulfert, 1939

This species is new to Hungary.

Occurrence in Gemenc: 19.10.2010: 4Nb.

Wierzejskiella vagneri Koniar, 1955

This genus is new to Hungary.

Occurrence in Gemenc: 19.10.2010: 1Na.

Fam. Proalidae

Bryceella stylata (Milne, 1886)

Previous occurrence in Hungary: Pálháza: Kemencepataki marsh (Varga, 1956).

Occurrence in Gemenc: 19.10.2010: 1Na.

The mean value of species richness (S) was about 4; the values ranged between 0 and 8. The S of natural forest and that of poplar plantation were similar. There was a slight decrease of S values in autumn, but the difference was not significant (Table 3).

4. Discussion

Altogether, 48% of the species that we found are new to Hungary. For an additional 8 species (26%), which were mentioned in Varga's (1966) key without any collecting data, we report detailed data about their occurrence in Hungary. The genus *Wierzejskiella* is also new to Hungary. In the cases of some other taxa, the number of known species from Hungary is notably increased by our study. For example, the number of *Encentrum* species increases from 12 to 16. We also report the first occurrences of

Table 3. Species richness (S) in different forest types and sampling dates (mean values and standard deviations in brackets).

		Sampling date		
Forest type		2–4.06.2010	19.10.2010	Mean
	Natural	4.88 (2.53)	3.00 (1.07)	3.94 (2.11)
	Plantation	3.75 (2.38)	4.38 (1.92)	4.06 (2.11)
	Mean	4.31 (2.44)	3.69 (1.66)	

Scepanotrocha species, amending 2 new species to the 3 that were mentioned in Varga's key without supporting data. Most of the species (n = 24) belong to the subclass Bdelloidea (fam. Philodinidae 15, fam. Habrotrochidae 6, fam. Adinetidae 3 species), while 7 belong to the subclass Monogononta (order Ploima) (fam. Dicranophoridae 5, fam. Colurellidae 1, fam. Proalidae 1 species). The local diversity of bdelloids was surprisingly high: subclass Bdelloidea contains 461 known species, and so during this brief survey we found more than 5% of the global diversity (Fontaneto et al., 2006; Segers, 2007). The majority (79%) of bdelloids occurring here are known from more than 3 large biogeographical regions (Table 2), underlying the "everything is everywhere" theory about the biodiversity patterns of microscopic organisms (Finlay, 2002; Fenchel and Finlay, 2004). On the other hand, we do not yet have sufficient global faunistic data to contradict the generalised cosmopolitanism and demonstrate endemisms of such microscopic organisms (Fontaneto et al., 2007). The local diversity of bdelloids still seems to be dependent on the frequency of taxonomic and faunistic works in the given area (Ricci and Fontaneto, 2007).

The difference among the species composition of samples (β-diversity) was high: only 4 species occurred in more than 10 samples (*Adineta vaga*, *Ceratotrocha cornigera*, *Encentrum arvicola*, *E. lutra*), while 35% of the occurring species were singletons (*Bryceella stylata*, *Colurella geophila*, *Encentrum martes*, *Habrotrocha pulchra*, *H. tranquilla*, *Macrotrachela aculeata*, *M. oblita*, *Philodina acuticornis*, *Scepanotrocha semitecta*, *S. simplex*, *Wierzejskiella vagneri*). Similarly heterogeneous species distributions and high ratios of singletons occurred in other works about distribution of bdelloids, which could suggest habitat preferences (Fontaneto and Ricci, 2006; Kaya et al., 2009). Bdelloids share relatively similar basic ecological patterns and processes with macroscopic animals (Fontaneto et al., 2011). Due to their specific features (high dispersal ability, short lifecycle, anhydrobiosis), the temporal scale of influencing synecological processes is of another order of magnitude, resulting in different local/global diversity patterns from those of macroscopic species.

The local species richness values in the natural forest and poplar plantation were similarly low (3.94 and 4.06, respectively) as according to other observations (Fontaneto et al., 2006). The forest type had no significant direct effect on the α-diversity of soil rotifers. The seasonal differences were also low and the S values decreased slightly, but not significantly, in autumn (Table 3). However, the seasonal turnover of species can be seen.

These new additions to the Hungarian fauna suggest a diverse rotifer assemblage in floodplains of the temperate zone, yet much is still unknown about these habitats and all their biota. We aver the need of restoring and protecting of river–floodplain systems and call for additional studies about these communities and their ecological function.

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