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SPREAD OF INVASIVE MYSIDS (CRUSTACEA: MYSIDA) IN THE RIVER DANUBE WATER SYSTEM: RÁCKEVE–SOROKSÁRI DANUBE ARM, CANAL NETWORK OF THE KISKUNSÁG

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INVÁZIÓS HASADTLÁBÚ RÁKOK (CRUSTACEA: MYSIDA) TERJESZKEDÉSE A DUNA VÍZRENDSZERÉBEN: RÁCKEVE–SOROKSÁRI-DUNA-ÁG, KISKUNSÁGI CSATORNARENDSZER

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ABSTRACT: Focused samplings in the autumn of 2008 revealed *Katamysis warpachowskyi* and *Hemimysis anomala* to be present in the Ráckeve–Soroksári Danube arm and in the canal network of the Kiskunság. The latter species was found in natural habitats – among reed – at a few sites of the Kiskunsági-főcsatorna. This information may modify our concepts about the habitats invasible by this species. There are some fish farms in the area that gain water supply from the waters examined. The question whether these farms can contribute to the further spread of the species due to fish deployments has to be addressed by future investigations.

Key words: Mysida, *Katamysis warpachowskyi*, *Hemimysis anomala*, Hungary, spread

KIVONAT: 2008 őszi célzott mintavételek során kimutattuk, hogy a *Katamysis warpachowskyi* és a *Hemimysis anomala* megjelent a Ráckeve–Soroksári-Duna-ágban és a kiskunsági csatornarendszerben. Az utóbbi fajt természetes élőhelyeken, nádasokban is megtaláltuk a Kiskunsági-főcsatorna több helyszínén. Ez az információ módosíthatja a faj által meghódítható élőhelyekről alkotott képet. A meghódított területen halgazdaságok találhatók, melyek vizüket a vizsgált víztestekből nyerik. Jövőbeli vizsgálatok feladata annak kiderítése, hogy ezek hozzájárulhatnak-e a fajok további terjedéséhez haltelepítések révén.

Kulcsszavak: Mysida, *Katamysis warpachowskyi*, *Hemimysis anomala*, Magyarország, terjeszkedés

Introduction

At present, mysids are represented by three species in Hungary. *Limnomysis benedeni* Czerniavsky 1882 has been present for more than fifty years, it is known to occur all along the River Danube and its connected waters, in the River Tisza and some of its adjacent oxbows, and it was purposefully transplanted into the Lake Balaton as well (WOYNÁROVICH 1954, JUHÁSZ et al. 2006, BORZA 2007b). Two additional species were discovered in Hungary in the new millennium: *Katamysis warpachowskyi* G. O. Sars 1893 and *Hemimysis anomala* G. O. Sars 1907 (WITTMANN 2002, 2007, BORZA 2008). Previous to the present research they were recorded in Hungary only in the main arm of the Danube and in the Szigetköz (WITTMANN 2002, 2007, BORZA 2007a, 2007b).

Mysids are supposed to be unable to disperse against currents characteristic of the Middle–Danube; therefore, upstream, long-distance migrations are to be explained by human assistance (transport in ships' ballast water, cooling water filters, and other mechanisms; discussed e.g. by WITTMANN 2007, WITTMANN and ARIANI 2009). Downstream dispersion, on the other hand, encounters no obstacles. The Ráckeve–Soroksári Danube arm is separated from the main arm only by a lock-gate, and the canal network of the Kiskunság is in direct connection with this sidearm. *L. benedeni* was already known from the sidearm; moreover, it was so abundant that it was transported into the Lake Balaton from there (WOYNÁROVICH 1954). It was anticipated that the recently arrived mysid species can enter these water systems, too. The question remained, however, whether the biotic and abiotic conditions of these waters are tolerable for them.

In this paper we present the first faunistic records of the new invasive mysid species in these waters and discuss the insights these records bring on their habitat affinity. We also analyse the consequences this range expansion can have on their further spread.

Material and methods

Study area

The 57 km long (1642.5-1586 rkm) Ráckeve–Soroksári Danube arm is the longest sidearm of the Hungarian Danube stretch, situated downstream of Budapest. Its water level is regulated by two lock-gates at the beginning and the end of it (Kvassay and Tassi lock-gates, respectively). Water flow is seasonal, depending on the water level of the main Danube–arm. At sufficiently high levels the lock-gates are open to allow an influx of water mitigating the considerable ill-effects of wastewaters, which often cause water quality problems especially in the upper section. The higher loads of nutrients in this section induce rapid siltation, which results in a gradient of water depth and sediment material along the Danube arm. The latter is mud in the upper, and usually zebra mussel (*Dreissena polymorpha* Pallas, 1771) shells in the lower parts. The banks are naturally girdled by reed, but a large proportion of the bank is kept devoid of vegetation for recreational purposes. In spite of the occasional problems of water quality this is a very popular fishing area, with hundreds of tons of fish deployed every year.

The Kiskunság is a part of the great Hungarian lowland, characterised by sandy soil, which has low water retaining capacity. The soil water level has fallen considerably due to the regulation of the Danube, increasing the semi-arid character

of the area; therefore, irrigation channels were constructed to allow an intensive agriculture. The channel network emanates at three different points of the Ráckeve–Soroksári Danube arm and discharges into the main Danube arm. The different sections of the system have various width (usually between 20-40 m), and current velocity; water depth is around 1.5 meters. The bottom is mud in the slower parts, and clay in the sections of higher current velocity. The banks are usually followed by a reed belt, and dense submerged macrovegetation is also common.

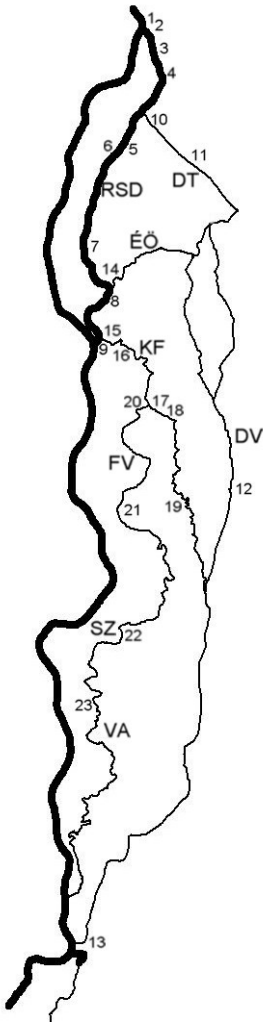

Figure 1. The sampling sites. Number codes as in Table 1. Abbreviations: RSD – Ráckeve–Soroksári Danube arm, DT – Duna–Tisza-csatorna, ÉÖ – Északi-övcsatorna, KF – Kiskunsági-főcsatorna, DV – Duna-völgyi-főcsatorna, FV – Fűzvölgyi-csatorna, SZ – Szeliditó, VA – Vajas-csatorna.

Sampling

Qualitative samples focused on mysids were taken at 23 sites of the above-mentioned waters between 9 September and 10 December 2008 using a hand net (aperture 40 cm, mesh size 450 µm). The samples were preserved in 70% ethanol immediately after catching. All except one sample were taken during the night (indicated in Table 1) to make possible the catching of the nocturnally active *H. anomala*. The specimens caught were identified on the field (the size of individuals

in this season is relatively large). Owing to this, it was possible to adjust the sampling effort according to the success of the catch. For example, if the first net haul contained obviously all of the three species, the sampling was usually ceased; if not, larger effort was made (additional hauls were taken, different depths and habitat types were examined). The identification was later supervised in the laboratory using stereomicroscope.

Results

The results are summarized in Table 1.

Table 1. The records of mysids and the details of the sampling sites in the waters examined in the autumn of 2008.

Code	Locality	Latitude N	Longitude E	Date	Habitat description	L. benedeni	K. warpachowskyi	H. anomala
	Ráckeve-Soroksári Danube arm							
1	Budapest, Kvassay lock-gate	47°27'40.55"	19° 4'15.13"	2008.12.10	concrete wall, stones	x		x
2	Budapest, Csepeli bridge	47°27'39.25"	19° 4'21.18"	2008.09.09	gravel	x	x	
				2008.12.10	gravel, stones	x	x	x
3	Budapest, Vízisporttelep	47°25'45.86"	19° 5'29.45"	2008.10.13	macrophytes, BY DAY	x		
4	Budapest, Soroksár (Tusa utca)	47°23'30.97"	19° 6'33.37"	2008.11.11	mud, reed	x		
5	Szigethalom, bridge	47°18'42.45"	19° 2'6.71"	2008.12.10	rip-rap	x	x	
6	Szigethalom, jetty	47°18'31.14"	19° 1'52.40"	2008.11.11	concrete wall, stones	x	x	x
7	Ráckeve, bridge	47° 9'44.00"	18°56'59.07"	2008.11.11	rip-rap	x	x	
				2008.12.02	rip-rap	x	x	x
8	Dömsöd, beach	47° 5'50.38"	18°59'57.26"	2008.11.11	gravel	x	x	
					reed	x		
9	Tass, above the lock-gate	47° 2'5.07"	18°58'45.22"	2008.09.23	rip-rap with macrophytes	x	x	x
	Duna-Tisza-csatorna							
10	Dunaharaszti, bridge of road 510	47°20'34.91"	19° 4'28.10"	2008.10.21	mud, macrophytes	x		
11	Road between Bugyi and Ócsa	47°15'8.96"	19°12'34.45"	2008.12.10	macrophytes,reed	x		
	Duna-völgyi-főcsatorna							
12	Hármaspuszta, bridge of road 52	46°50'4.20"	19°14'46.11"	2008.10.21	rip-rap	x	x	x
13	Baja, bridge	46°11'35.89"	18°56'1.18"	2008.10.08	rip-rap			x
	Északi-övcsatorna							
14	Dömsöd, under the lock-gate	47° 6'17.27"	19° 0'9.82"	2008.11.11	rip-rap	x	x	
	Kiskunsági-főcsatorna							
15	Tass, under the lock-gate	47° 1'59.39"	18°59'11.78"	2008.09.23	shells and reed	x	x	x
16	Tass, bridge of road 51	47° 1'56.94"	19° 1'26.73"	2008.10.08	clay, shells, macrophytes		x	
17	Homokpuszta 1	46°55'56.34"	19° 5'43.94"	2008.10.21	macrophytes	x		
18	Homokpuszta 2	46°55'57.27"	19° 5'42.45"	2008.11.11	reed	x		x
19	Kígyósi csárda, bridge of road 52	46°48'24.64"	19° 9'33.35"	2008.10.21	reed, clay with shells	x		x
	Fűzvölgyi-csatorna							
20	zsilip alatt (Vakvágány)	46°56'29.25"	19° 4'42.84"	2008.10.21	concrete wall,stones	x	x	x
21	Solt, bridge of road 52	46°48'3.90"	19° 1'6.26"	2008.10.21	rip-rap, reed	x		x
	Szelidi-tó							
22	Szeliditópart	46°37'20.69"	19° 2'28.95"	2008.10.08	reed	x		
	Vajas-csatorna							
23	Kalocsa	46°31'8.94"	18°58'30.63"	2008.10.08	macrophytes	x		

Discussion

L. benedeni has been found at almost every site sampled. It occurred among macrophytes (both reed and submerged vegetation), as well as on rip-raps and shell accumulations. The high abundance of macrophytes makes these waters a preferable habitat for this species, whose affinity to aquatic vegetation is widely

reported in the literature (e.g. BĂCESCU 1954, WOYNÁROVICH 1954, WITTMANN 2007, GERGS et al. 2008).

K. warpachowskyi has been recorded at most – but not all – sites examined in the Ráckeve–Soroksári Danube arm ranging along the whole course of it. It has been found in most of the major canals; Északi-övcsatorna, Kiskunsági-főcsatorna, Fűzvölgyi-csatorna, Duna-völgyi-főcsatorna (only one specimen), too, but not in the Duna–Tisza-csatorna. The absence of this species in the latter channel can be attributed most probably to the unfavourable environment (muddy bottom, dense vegetation); however, the species was not found in some places where it was anticipated according to the experience of previous records (downstream parts of the Kiskunsági-főcsatorna, Fűzvölgyi-csatorna, and Duna-völgyi-főcsatorna). It cannot be excluded that the species has not spread all over the channel network yet. This is not improbable if we consider that the species – owing to its high substrate affinity – has a lower chance of being swept away by the current than other mysids; cf. it is usually absent in drift net samples (WITTMANN 2002). The habitats where *K. warpachowskyi* occurred are mostly artificial (rip-raps under and near bridges and lock-gates, artificial gravel beaches), but include natural habitats (shell accumulations), as well. These findings are in accordance with our former observations on the habitat utilisation of the species, i.e. it is dependent on hard substrates (BORZA 2007a, 2007b). WITTMANN (2007) reports this species to occur among vegetation; in our samples, however, this was not unequivocally observable.

H. anomala has been recorded at five sites of the Ráckeve–Soroksári Danube arm, but these – as in the case of *K. warpachowskyi* – range along the whole course of the sidearm. It has been found in all major channels sampled except for the Duna–Tisza-csatorna and the Északi-övcsatorna. Its absence in the former is attributable possibly to the unfavourable environment, but in the latter canal the habitat sampled was a rip-rap with high densities of *L. benedeni* and *K. warpachowskyi* just under the lock-gate which separates it from the sidearm. In this case we can assume that the species has not entered this channel yet. The habitats occupied by this species were mostly rip-raps, but at some sites of the Kiskunsági-főcsatorna it was found among reed, too. These sites had moderate current and depth of 1-1.5 m. The animals were found on the front of the reed belt facing the open water. The habitat-preference of *H. anomala* can be explained by its behaviour of seeking daytime shelter. In the invaded inland waters it has been reported to inhabit almost exclusively anthropogenic habitats (rip-raps, concrete structures of harbours) (e.g. WITTMANN 2007, BORZA 2008, STUBBINGTON 2008), although in marine environments it is observed to live among algae, too (BĂCESCU 1954, SALEMAA and HIETALAHTI 1993). WITTMANN (2007) also reports this species to occur occasionally on algal covers of hard substrata and among submerged macrophytes. Our results show that reed with sufficiently deep and aerated water can also provide suitable shelter for this species. This observation of its ability to survive in natural habitats makes us revise our concepts about the waters potentially invasible by *H. anomala*.

The channel network of the Kiskunság does not have access to other drainage basins, but the fact that the newcomer species have established in this system can potentially have consequences on their further spread. There are some fish farms in this area that gain their water from the Ráckeve–Soroksári Danube arm and from these channels. If the species can survive at least temporarily in their ponds, they can be transported potentially to any waters supplied with fish from these fish farms. This is only conjecture at present time, assessing the actual chance of this means of transport is a task of the future investigations.

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