FISH DIVERSITY OF THE LOWLAND STRETCHES OF MORAVA AND VÁH RIVERS (DANUBE DRAINAGE, SLOVAKIA)

HALKÖZÖSSÉGEK DIVERZITÁSA A MORAVA ÉS A VÁG ALFÖLDI SZAKASZÁN

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Abstract

Lowland river ecosystems are considered as the most endangered worldwide, however the fish fauna of Slovakian lowland rivers is not sufficiently documented. We have investigated fish assemblages occurring in lower stretches of the Morava River (river km 20) and the Váh River (river km 25). Small beach seine net (2x5 m; 6 mm mesh size) was used to sample the shallow riparian zones in summer (June, July and August) every two hours over the daily period (24 hours). Additionally, samples from the Morava river obtained in 2006 by beach seining (river km 14-45) and electrofishing (river km 14-70) were included. Altogether 31 fish species were recorded in the Morava River and 26 fish species were recorded in the Váh River respectively. Abundance as well as the species composition varied considerably during the diel cycle. The most dominant nocturnal species were *Abramis bjoerkna*, *Chondrostoma nasus* and *Romanogobio vladykovi* and the most dominant diurnal species were *Alburnus alburnus*, *Rutilus rutilus* and *Aspius aspius*.

Kivonat

Az alföldi folyóvízi ökoszisztémákat világszerte a leginkább veszélyeztetetteknek tartják, a szlovákiai alföldi folyók halfaunája azonban nem kellően dokumentált. A Morava (20 fkm) és a Vág (25 fkm) alsó szakaszának halközösségeit vizsgáltuk. Kisméretű (2 x 5 m, 6 mm-es szembőségű) parti kerítőhálót használtunk a mintavételezéshez a sekély parti zónában a nyári időszakban (június, július, augusztus), minden kétórában a napi cikluson (24 óra) belül. Ezenkívül figyelembe vettük a Moraván 2006-ban parti kerítőhalászattal (14-45 fkm), illetve elektromos halászattal (14-70 fkm) gyűjtött mintákat. Összesen a Moravában 31, a Vágban 26 halfajt jegyeztünk fel. A napi cikluson belül a gyakoriság és a faj szerinti összetétel egyaránt jelentősen változott. A leginkább domináns éjjeli fajok az *Abramis bjoerkna*, a *Chondrostoma nasus* és a *Romanogobio vladykovi*, míg a leginkább domináns nappaliak az *Alburnus alburnus*, a *Rutilus rutilus* és az *Aspius aspius* voltak.

Introduction

Majority of European lowland rivers are strongly influenced by human activities and thus represent significantly threatened ecosystems. Such river sections are mostly characterized by higher water depth and low to moderate water current. The nature of lowland rivers impedes the feasibility and representativeness of fish sampling by standard ichthyological methods and gears. As a result, fish diversity of these river sections isn't sufficiently documented.

In the Western part of Slovakia, lowland rivers are represented by the Danube River (and its side arm Malý Dunaj) and its large tributaries the Morava River and the Váh River. The Morava River was monitored several years ago for the purposes of restoration/rehabilitation projects (Lisický 1995, 1996, 2005, Spindler et al. 1992), but all data were sampled only by electrofishing. Fish assemblages of downstream stretches of the Váh River or close Malý Dunaj side arm were investigated only sporadically (Kux & Weisz 1962, Nagy & Černý 1992, Mužík et al. 2008, Sedlár 1960). Therefore, we decided to contribute to the knowledge on the fish species occurring in the lower stretches of Váh and Morava rivers.

Material and methods

Two shallow riparian areas (beaches) of two Danube tributaries, Morava and Váh rivers (*Fig.1*), were selected to asses fish species assemblage. Sample site on Morava river main channel was situated near Vysoká pri Morave about 20 km upstream the mouth to the Danube River. Study site was dominated by sandy-gravel bottom substrate continuing to rip-rap river banks downstream and upstream. Sample site on Váh river was situated near Kolárovo about 25 km upstream the mouth to the Danube River. Study site was dominated by sandy beach transiting to vertical clay river banks downstream and upstream.

Fishes were sampled three consequent years in 2009-2011 (July-August). Small beach seine net (2x5m, 6 mm of mesh size) was used for fish sampling. The net was operated by the assistance of two people on the distance of 100 m downstream the river every 2 hours over the daily period (24 hour). Additional unpublished data sampled in Morava River in 2006 were added to obtain more representative results. Data were obtained by beach seining on four sites along the river (river km 14-45) and data from electrofishing in the rip-rap area on six sites along the river (river km 14-70).

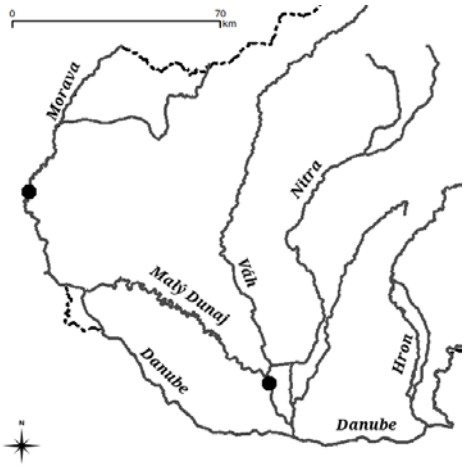

Fig. 1. Map of Western Slovakian main rivers with position of sampling points (black spots)
1. ábra. Nyugat-Szlovákia főbb folyóinak térképe a mintavételi helyekkel (fekete pontok)

Sampled fish individuals were determined and returned to the water downstream the sampled area. Data from each seining (years 2009-2011) per site and sampling occasion were pooled to one dataset and results were expressed as species relative density. Data from the year 2006 were pooled to one dataset respectively in the case of beach seining and in the case of electrofishing. All available published data were processed in the same way. Species dominance was evaluated according to Losos et al. (1984), the qualitative status of fish diversity was characterized by Shannon's index of diversity (H´), equitability index according to Lloyd & Ghellardi (1964). Species conservation status was evaluated according to Koščo & Holčík (2007) and non-native species were identified according to Koščo et al. (2010).

Results and discussion

Species assemblage of the Morava River documented in the years 2006 and 2009-2011 includes 31 fish species (*Table 1*). According to the conservation status of native fish species (Koščo & Holčík 2007) and the list of non-native fish species (Koščo et al. 2010), one species is considered as endangered, four species as vulnerable, seven species as near threatened, fifteen species as least concern and while six as non-native species (five of them invasive). Nine species were not recorded comparing with the past (Table 1), but the occurrence of *Zingel zingel*, *Sander volgense* and *Cyprinus carpio* is expected there. Other unrecorded species usually occur in isolated backwaters and only occasionally are recorded in the main channel. The occurrence of five new species was confirmed in the Morava River and two of them, *Rutilus virgo* and *Chondrostoma nasus* were probably overlooked in the past and three invasive species could have reached the Morava River only recently (Lusk et al. 2008).

*Table 1. Fish species recorded in lowermost section of the Morava River (*sampled in 2004, EF-electrofishing. SE-seining)*
*1. táblázat. A Morava legalsó szakaszán feljegyzett halfajok (*2004-es mintavétel, EF – elektromos halászat, SE – kerítőhálózás)*

species / data source	Spindler et al. 1992	Lisický 1995	Lisický 1996	Lisický 2005*	Lisický 2005	our data 2006 (EF)	our data 2006 (SE)	our data 2009	our data 2010	our data 2011
Abramis ballerus	7.84	-	-	-	-	-	1.04	-	-	-
Abramis brama	23.64	0.80	0.76	3.36	6.82	0.81	2.48	0.28	0.07	0.12
Abramis sapa	0.91	-	-	-	-	-	-	0.28	0.07	-
A. brama x *A.bjoerkna*	-	-	-	-	0.45	-	-	-	-	-
Abramis bjoerkna	20.85	15.10	2.50	11.34	18.18	1.22	25.48	22.69	64.67	47.78
Abramis sp.	-	-	-	-	-	-	-	-	2.29	-
Alburnus alburnus	14.43	35.60	-	31.93	5.00	0.41	33.27	17.37	7.86	45.07
Anguilla anguilla	-	-	-	-	1.36	-	-	-	-	-
Aspius aspius	0.34	0.50	0.43	0.42	0.45	-	0.88	5.88	0.07	-
Barbatula barbatula	-	-	0.11	-	-	-	-	-	-	-
Barbus barbus	0.28	3.80	-	2.52	10.00	1.22	0.13	0.56	-	-
Carassius carassius	0.11	0.30	-	-	-	-	-	-	-	-
Carassius gibelio	7.16	1.00	-	13.45	5.00	-	-	-	0.07	-
Ctenopharyngodon idella	-	-	-	-	0.45	-	-	-	-	-
Cyprinus carpio	0.23	-	-	0.84	10.45	-	-	-	-	-
Chondrostoma nasus	-	-	-	-	-	-	-	1.96	0.21	0.37
Cobitis elongatoides	0.23	5.10	1.41	-	-	2.03	0.20	1.12	0.21	-
Esox lucius	0.34	1.60	0.33	0.84	4.09	2.03	0.29	0.28	0.21	-
Gymnocephalus baloni	-	0.30	0.33	-	-	1.22	-	0.28	0.70	-
Gymnocephalus cernuus	10.34	-	-	0.42	-	-	4.43	1.12	3.27	-
Gymnocephalus schraetser	0.57	-	-	-	-	-	0.03	0.56	0.07	-
Lepomis gibosus	-	-	-	-	-	-	0.20	0.28	-	-
Leucaspius delineatus	0.06	-	-	-	-	-	0.16	-	-	-
Leuciscus leuciscus	-	6.60	0.33	12.61	-	6.10	1.14	4.48	0.35	0.12
Leuciscus cephalus	0.11	3.10	0.54	-	20.00	8.54	0.78	0.56	-	0.25
Leuciscus idus	0.17	6.10	77.39	2.10	2.73	9.76	4.46	3.36	1.11	0.74
Lota lota	-	0.30	3.15	0.84	1.36	9.35	-	0.28	-	-
Neogobius melanostomus	-	-	-	-	-	31.30	0.10	3.36	0.28	0.62
Neogobius kessleri	-	-	-	-	-	1.63	-	1.12	-	0.49
Perca fluviatilis	0.57	6.70	7.72	7.56	2.27	6.10	2.28	1.96	3.89	-
Proterorhinus semilunaris	-	6.10	0.87	-	0.45	12.20	0.03	-	-	-
Pseudorasbora parva	0.06	-	0.11	1.26	-	-	-	-	-	-
Rhodeus amarus	0.11	1.80	0.11	0.42	-	0.41	0.39	0.28	-	-
Romanogobio vladykovi	2.61	0.30	-	-	-	-	0.46	22.41	10.43	1.60
Rutilus rutilus	6.99	2.30	3.59	2.10	4.09	3.25	20.66	3.92	2.09	-
Rutilus pigus	-	-	-	-	-	-	-	-	0.14	-
Scardinius erythrophthalmus	0.57	1.00	0.22	-	-	0.41	0.33	-	0.21	-
Sander lucioperca	0.80	-	-	2.10	1.36	-	0.75	5.32	1.39	2.83
Sander volgensis	0.23	-	-	-	-	-	-	-	-	-
Silurus glanis	0.06	1.60	0.11	5.88	4.55	2.03	-	-	0.14	-
Tinca Tinca	0.28	-	-	-	-	-	-	-	-	-
Vimba vimba	0.11	-	-	-	-	-	0.03	0.28	0.21	-
Zingel zingel	-	-	-	-	0.91	-	-	-	-	-
no. of species	28	21	18	18	19	19	24	25	23	11
no. of individuals	1760	391	920	238	220	246	3069	357	1438	812
diversity index H´	2.19	2.25	1.01	2.20	2.40	2.30	1.85	2.32	1.33	1.03
eqitability	0.66	0.73	0.35	0.761	0.83	0.78	0.58	0.72	0.46	0.427

Species recorded at each sampling occasions can be considered as typical main channel species. *Abramis bjoerkna* and *Alburnus alburnus* were found at stable high densities and these species were recorded in similar frequencies and densities in the past. *Abramis brama*,

Aspius aspius, *Esox lucius*, *Leuciscus cephalus*, *Leuciscus idus*, *Perca fluviatilis*, *Rutilus rutilus*, *Sander lucioperca* occurred in low but stable densities in our samples and their occurrence is also comparable with the past. Other species, *Ch. nasus*, *Cobitis elongatoides*, *Gymnocephalus cernuus*, *Gymnocephalus schraetser*, *Leuciscus leuciscus*, *Neogobius melanostomus*, *Romanogobio vladykovi* and *Vimba vimba* recorded in stable frequencies are also typical for the main channel. Species richness seems to be stable (except for the year 2011) compared to the past, but species occurrence in sample depends on the methods used (electrofishing, beach seining).

Species assemblage of the Váh River documented in the years 2009-2011 includes 26 fish species (*Table 2*).

Table 2. Fish species recorded in lowermost section of the Váh River
2. táblázat. A Vág legalsó szakaszán feljegyzett halfajok

species/data source	Kux & Weisz (1962)	Mužík (2008)	our data 2009	our data 2010	our data 2011
Abramis brama	-	-	0.26	0.14	-
Abramis sapa	-	-	-	0.97	1.36
Abramis bjoerkna	1.67	-	0.69	13.02	4.08
Alburnoides bipunctatus	0.19	-	-	-	-
Alburnus alburnus	16.48	24.74	10.32	44.74	72.11
Ameiurus nebulosus	0.19	-	-	-	-
Aspius aspius	-	14.43	5.12	7.06	9.52
Barbus barbus	0.56	-	-	-	-
Carassius gibelio	-	0.52	0.30	-	0.34
Chondrostoma nasus	0.19	-	3.31	4.71	0.68
Cyprinus carpio	0.19	2.58	0.04	-	-
Gobio gobio	1.48	-	-	-	-
Gymnocephalus cernuus	17.59	-	0.09	-	-
Gymnocephalus schraetser	-	-	-	1.52	-
Lepomis gibosus	2.59	1.55	-	-	-
Leuciscus leuciscus	0.19	-	5.12	4.71	0.68
Leuciscus cephalus	3.52	0.52	-	0.28	-
Leuciscus idus	0.37	4.64	0.26	0.42	-
Lota lota	0.56	7.73	-	-	-
Neogobius fluviatilis	-	1.55	2.80	1.80	2.38
Neogobius melanostomus	-	27.84	-	-	-
Neogobius kessleri	-	5.67	1.25	-	-
Perca fluviatilis	0.74	1.55	0.47	-	-
Proterorhinus semilunaris	1.85	0.52	3.18	-	-
Rhodeus amarus	48.70	1.03	51.31	-	-
Romanogobio vladykovi	0.19	3.61	0.73	13.99	4.08
Rutilus rutilus	1.85	0.52	8.17	2.35	1.70
Rutilus pigus	-	-	-	0.42	0.68
Sabanejewia balcanica	0.37	-	-	-	-
Scardinius erythrophthalmus	-	-	-	0.28	-
Sander lucioperca	-	0.52	0.69	2.91	2.38
Sander volgensis	-	-	4.34	0.28	-
Silurus glanis	0.56	-	-	-	-
Tinca tinca	-	-	0.09	-	-
Vimba vimba	-	-	1.46	0.42	-
Zingel zingel	-	0.52	-	-	-
no. of species	19	18	21	18	12
no. of individual	540	194	2325	722	294
diversity index H´	1.61	2.10	1.86	1.87	1.15
eqitability index	0.55	0.73	0.61	0.65	0.46

According to the conservation status of native fish species (Koščo & Holčík 2007) and the list of non-native fish species (Koščo et al. 2010), three species are considered as endangered, seven species as near threatened, eleven species as least concern, while five species are classified as non-native (four of them invasive). Four species were not recorded compared with the past (*Table 2*), but these species are expected to occur there. The occurrence of twelve new species was confirmed there, but many of these species were expected to occur there in the past, although not recorded.

Species recorded at each sampling occasions can be considered as typical main channel species. *A. alburnus* and *A. aspius* occur there in stable high densities. Three other species, *Neogobius fluviatilis*, *R. vladykovi* and *S. lucioperca* occur in low, but stable densities and can be considered typical as well. *A. bjoerkna*, *Ch. nasus* and *L. leuciscus* that were found in each our sample can also be considered as typical main channel species. Species richness seems to be stable except for the year 2011, but species composition sampled by two methods is different.

Altogether, 41 fish species were recorded in the Slovak-Austrian section of Morava River compared to 30 species in the lower-most section of Vah River. Though the sampling probability of some rare species has to be taken into account, different species richness could be caused by different habitat conditions. Moreover, Váh River is influenced by water level fluctuations caused by dam and hydro-power plant upstream. On the other hand, lower species richness in both rivers in 2011 can indicate similar causes - dry season and low discharges.

Nonetheless, fish species occurring in both rivers are influenced by the connection to Danube river. Species recorded in both rivers cover the majority of all expected species that can be found in main channel except of salmonids and *Cottus gobio* that are adapted to more oxygen saturated waters of Danube River (Holčík 2003). However, *C. gobio* disappeared from the Slovak/Hungarian Danube section recently (Černý 2006). We can also expect the occurrence of *Pelecus cultratus*, that was repeatedly recorded in Malý Dunaj side arm (Hajdú & Pekárik, unpublished data) or *Zingel streber* that was recorded in lower-most section of Hron River (Pekárik, unpublished data) or upstream the Morava River (Lusk et al. 2004).

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