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Ichthyocenosis of Krupinica River (Ipeľ River basin, Slovakia)

A Krupinica folyó halközösségei (Ipoly-vízgyűjtő, Szlovákia)

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Keywords: protected species, rheophilic species, longitudinal profile, fish diversity

Abstract

Ichthyological investigations were performed at 11 sampling sites in the Krupinica stream basin in the period of 2020 and 2021. In total, 22 fish species of 6 families (Balitoridae, Cobitidae, Cyprinidae, Gobiidae, Lotidae, Salmonidae) were recorded in the study area. The ichthyocenosis composition varied in the longitudinal profile from source to mouth. Upper sections of the watercourses were dominated by typical rhithral species, such as Eurasian minnow (*Phoxinus phoxinus*), stone loach (*Barbatula barbatula*) and brown trout (*Salmo trutta m. fario*). The fish community is to some extent influeneced by human activity (stocking of indigenous fish species, water reservoir). In the middle section rheophilic fish species were in dominant position and the share of rhithral species decreased. The lower section near the mouth to Ipeľ proved to be important for the occurrence of several protected species of European importance, such as Sabanejewia bulgarica and Kessler's gudgeon (*Romanogobio kesslerii*). This part of the river also plays a significant role as a nursery habitat of the 0+ rheophilic species such as common nase (*Chondrostoma nasus*), barbel (*Barbus barbus*), ide (*Leuciscus idus*) and asp (*Leuciscus aspius*).

Kivonat

A 2020 és 2021-es évben tizenegy mintavételi szakaszon vizsgáltuk a Krupinica folyó vízgyüjtőjének halközösségeit. A vizsgált területen hat család (Balitoridae, Cobitidae, Cyprinidae, Gobiidae, Lotidae, Salmonidae) 22 halfaját regisztráltuk. A halközösségek összetétele változó volt a vízfolyás hosszanti profilján belül, forrástól egészen a torkolatig. A vízfolyások felső szakaszait a tipikus ritrális fajok uralták, mint a fürge cselle (*Phoxinus phoxinus*), kövicsík (*Barbatula barbatula*) és a sebes pisztráng (*Salmo trutta m. fario*). Az utóbbi faj előfordulása a halászati és horgászati célú rendszeres telepítéssel függ össze. A sujtásos küsz (Alburnoides bipunctatus) – a megfelelő élőhelyek ellenére – hiányzott a Krupinica folyó felső szakaszáról, feltehetően a vándorlást megakadályozó barrierek hatásának következtében. A folyó középső szakaszán a ritrális fajok előfordulása csökkent, amíg a reofil fajoké növekedett. Az Ipolyhoz közeledve a Krupinica alsó szakaszán több európai jelentőségű védett faj előfordulását regisztráltuk, mint például a bolgár csík (*Sabanejewia bulgarica*) és homoki küllő (*Romanogobio kesslerii*). E szakasz jelentőségét tovább növeli, hogy halbölcsőként szolgál a 0+ reofil fajok számára, mint például a paduc (*Chondrostoma nasus*), márna (*Barbus barbus*), jászkeszeg (*Leuciscus idus*) és balin (*Leuciscus aspius*).

Introduction

Due to a lack of current data on the ichthyofauna of the Krupinica river basin, we performed an ichthyological investigation of selected localities, in order to determine the current state and diversity of the fish communities. Krupinica springs in the Javorie Mountains at an altitude of 735 m.a.s.l. and is a significant right-hand tributary of the Ipeľ (Ipoly) river. The total length of the stream is 65.4 km and the catchment area is 551 km^2. The average flow near the village Plášťovce reaches 2.2 m^3/s. An important left tributary of the Krupinica is Litava stream with a total length of 48 rkm. It springs in Krupinská planina at an altitude of about 650 m.a.s.l. Near the village of Cerovo, it flows through a canyon-like

territory. It flows into Krupinica near the village of Plášťovce. Several sections of Krupinica and Litava streams belong to Natura2000 protected areas. Above the town of Krupina, Krupinica crosses the site of community interest (SCI) Mäsiarsky bok (SKUEV0260). Above the village of Medovarce, the stream borders with the SCI Medovarské dubiny (SKUEV0889). The Litava river flows in its upper section through the Čabraď Nature Reserve and the SCI Litava (SKUEV0036). Knowledge on the current composition of the ichthyofauna is an important basis for setting up proper nature conservation management of protected areas in the concerned catchment areas.

Material and methods

The ichthyological investigation was performed at 11 localities in the Krupinica stream basin by means of electrofishing (generator type: BMA PLUS, Honda GX 160: 2 KW, 300-600V). The length of the examined sections and the sampling time was variable, depending on the environmental conditions of the localities (*Table 1*). At each site, we recorded the length, average width and depth of the stream (*Table 1*).

Table 1. Basic data on the sampling sites. Explanations: DSU - length of the examined section in meters, DL - sampling time (minutes), H - average water depth (cm), L - average stream width (m).

Code	Site	GPS coordinates	Date	DSU	DL	H	L
Kr1	Krupinica (Bzovská Lehôtka)	48.4190439N, 19.1245961E	19.8.2021	100	20	20	2
Kr2	Krupinica (Babiná)	48.4161236N, 19.0910642E	19.8.2021	60	15	30	5
Kr3	Krupinica (Masiarsky bok)	48.3940619N, 19.0886289E	19.8.2021	100	20	15	4
Kr4	Krupinica (upstream Krupina)	**48.371043N, 19.065129E**	2.6.2020	330	30	20	4
Kr5	Krupinica (upstream Medovarce 1)	48.247419N, 19.011297E	1.7.2021	100	20	30	10
Kr6	Krupinica (upstream Medovarce 2)	48.241221N, 19.012381E	1.7.2021	100	20	30	10
Kr7	Krupinica (downstream the confluence with Litava)	48.153776N, 18.961596E	2.6.2020	90	20	50	10
Kr8	Krupinica (Veľké Túrovce)	48.111964N, 18.943706E	18.8.2021	110	30	50	10
Kr9	Krupinica (near the mouth to Ipeľ/Ipoly)	48.074912N, 18.932581E	18.8.2021	50	30	30	12
Li1	Litava (Čabraď)	48.243652N, 19.102903E	18.8.2021	100	25	40	5
Li2	Litava (above the confluence with Krupinica)	48.154384N, 18.962312E	2.6.2020	100	20	20	6

After identificating the species and recording the number and the age category (0+, juveniles, adults) of sampled specimens, all individuals of native fish species were returned to the water. Data on the relative abundance of species at sampling sites were recalculated on the Catch per unit of effort (CPUE) of 100 m of the investigated section of the stream. Species dominance was assessed according to Losos et al. (1984). The Diversity Index (Shannon 1948) and the Equitability Index (Sheldon 1969) were calculated and faunistic similarity of the monitored localities was expressed by the Jaccard index (Losos et al. 1984) to evaluate differences between sites. The calculations were performed in the R software ver. 4. 0. 3 (R CORE TEAM 2020) using vegan packages (Oksanen et al. 2020), resp. in the Microsoft Excel ® environment. The classification of species into ecological groups is according to Schiemer & Waidbacher (1992). The categorization into conservation categories is in compliance with the Decree of the Ministry of the Environment of the Slovak Republic no. 170/2021 Z.z. implementing the Nature and Landscape Protection Act, as

amended (hereinafter the "Decree"). The threat categories of the species is in accordance with the annotated Red list of lampreys and fishes in Slovakia (Koščo & Holčík 2008).

Results

In Krupinica we recorded 22 fish species belonging to 6 families, of which 15 species and 4 families were recorded in Litava stream (*Table 2*). The composition of the fish community of both streams varies from the source to mouth. In the upper sections, the Krupinica and Litava streams have the character of a lower trout zone with a dominance of rithral species. In the sections of the Krupinica upstream the town of Krupina (localities Kr1–Kr4) the Eurasian minnow (*Phoxinus phoxinus*) and the stone loach (*Barbatula barbatula*) were eudominant species. Brown trout (*Salmo trutta* m. *fario*) and carpathian barbel (*Barbus carpathicus*) were also constantly represented. Similarly, in the upper part of the Litava stream, the stone loach, spirlin (*Alburnoides bipunctatus*) and the Eurasian minnow belonged to eudominant species. The representation of Carpathian barbel, brown trout and chub (*Squalius cephalus*) was also substantial.

Table 2. Relative abundance of species in % on sampling sites (the order of sites according to Table 1)

Species	**Kr1**	**Kr2**	**Kr3**	**Kr4**	**Kr5**	**Kr6**	**Kr7**	**Kr8**	**Kr9**	**Li1**	**Li2**
Alburnus alburnus					1.46		16.51	0.36			5.36
Alburnoides bipunctatus				50.00	15.05	29.01	28.90	25.45	11.27	22.22	0.45
Barbus barbus				3.85	1.46	0.38	1.90	18.18	6.30		0.45
Barbus carpathicus	4.55	7.02	6.41	3.85	12.14	6.11	0.32	1.45		9.03	
B. barbus x B. carpathicus							1.27				2.68
Barbatula barbatula	18.83	23.98	33.33	3.85	21.36	34.73	17.14	4.36	0.33	22.92	42.86
Gobio obtusirostris	4.55	22.22		7.69	15.05	4.96	10.79	16.73	6.95	2.08	16.07
Chondrostoma nasus					15.05	2.67	11.11	0.73	11.92		1.79
Leuciscus aspius									0.33		
Leuciscus idus									4.97		
Leuciscus leuciscus					1.94			1.09	6.62		0.89
Lota lota									0.33		
Phoxinus phoxinus	64.94	40.94	34.62	15.38	8.25	6.87	1.27	1.45		15.97	0.45
Proterorhinus semilunaris									0.99		
Pseudorasbora parva					0.49					13.89	
Rhodeus amarus						0.38	0.63	9.09	17.89		1.79
Romanogobio kesslerii									12.58		0.45
Romanogobio sp.					0.97				1.32		
Romanogobio vladykovi								0.36	3.31		
Rutilus rutilus								0.36	0.33		
Salmo trutta m. *fario*	6.49	3.51	25.64							7.64	
Sabanejewia bulgarica						1.53		1.45	7.28		6.70
Scardinius erythrophthalmus	0.65										
Squalius cephalus		2.34		15.38	6.80	13.36	10.16	18.91	7.28	6.25	20.09
Total number of specimens	154	171	76	26	207	260	315	275	303	144	224

Table 3. Species richness (S), Shannon diversity (H´) and equitability (J´) of sampling sites.

Site	**Kr1**	**Kr2**	**Kr3**	**Kr4**	**Kr5**	**Kr6**	**Kr7**	**Kr8**	**Kr9**	**Li1**	**Li2**
S	6	6	4	7	12	10	10	14	17	8	12
H'	1.09	1.43	1.26	1.50	2.10	1.71	1.91	1.96	2.43	1.91	1.7
J'	0.61	0.80	0.91	0.77	0.85	0.74	0.83	0.74	0.86	0.92	0.68

In the lower sections of Krupinica, the spirlin, stone loach and chub (*Squalius cephalus*) were of dominant representation. The species *Gobio obtusirostris*, common nase (*Chondrostoma nasus*) and the carpathian barbel were also of important representation. In terms of species diversity, the most interesting was the lower section of the Krupinica River (Kr7 and especially Kr9), where we recorded 19 fish species, of which 7 species are of European importance and 5 species are protected at national level (see *Table 2*). Also in the lower part of Litava stream, the diversity of fish community was higher. The eudominant species were the stone loach, chub and *G. obtusirostris*. The representation of the Bulgarian spined loach (*Sabanejewia bulgarica*) and the bleak (*Alburnus alburnus*) above the confluence with the Krupinica was also abundant.

In total, we recorded 4 species of European importance and 3 species protected at national level (*Table 2*). It is also worth to mention the presence of the interspecific hybrid *Barbus barbus x B. carpathicus* at the confluence of the Krupinica and Litava streams. Among the non-native alien species, the stone moroko (*Pseudorasbora parva*) was recorded in two sampling sites, moreover it was dominant species in Litava stream section near Čabraď (Li1) (*Table 2*).

*Table 4. Occurrence of recorded fish species in the area in comparison with published works, conservation status, threat category and ecological guilds. Explanations: NV – specieces protected on national level; EV – Species of European importance; Threat categories: LC (least concerned), NT (Near Threatened), EN (Endangered), *) indicates species for which the nomenclature has been changed from the cited red list; EU - eurytopic; RI - ritral, REA - rheophil type A, REB - rheophile type B, LIM - limnophile.*

	Species	Kux & Weisz (1964)	Andreji & Stráňai (2006)	Our data	Conserv. status	Threat category	Ecol. guild
1	*Alburnus alburnus*	+	+	+	-	LC	EU
2	*Alburnoides bipunctatus*	+	+	+	NV	LC	RI
3	*Barbus barbus*	+	+	+	EV	LC	REA
4	*B. barbus x B. carpathicus*	+	-	+	-	-	RI/REA
5	*Barbus carpathicus*	+	+	+	EV	LC*	RI
6	*Barbatula barbatula*	+	+	+	-	LC	RI
7	*Blicca bjoerkna*	+	-	-	-	LC	REB
8	*Esox lucius*	+	+	-	-	LC	EU
9	*Gobio obtusirostris*	+	+	+	-	LC*	REA
10	*Chondrostoma nasus*	+	+	+	NV	NT	REA
11	*Leuciscus aspius*	-	-	+	EV	LC	REB
12	*Leuciscus idus*	-	-	+	NV	NT	REB
13	*Leuciscus leuciscus*	-	+	+	NV	NT	REA
14	*Lota lota*	+	+	+	NV	LC	REB
15	*Perca fluviatilis*	+	-	-	-	LC	EU
16	*Phoxinus phoxinus*	+	+	+	-	LC	RI
17	*Proterorhinus semilunaris*	-	-	+	-	LC	REB
18	*Pseudorasbora parva*	-	-	+	INV	-	EU
19	*Rhodeus amarus*	+	+	+	EV	LC	EU
20	*Romanogobio kessleri*	+	+	+	EV	EN	REA
21	*Romanogobio sp.*	-	-	+	-	-	REA
22	*Romanogobio vladykovi*	+	-	+	EV	NT*	REA
23	*R. vladykovi x R. kessleri*	+	-	-	-	-	REA
24	*Rutilus rutilus*	+	+	+	-	LC	EU
25	*Salmo trutta* m. *fario*	-	-	+	-	LC	RI
26	*Sabanejewia bulgarica*	-	-	+	EV	NT*	REA
27	*S. erythrophthalmus*	-	-	+	-	LC	LIM
28	*Squalius cephalus*	+	+	+	-	LC	REA
29	*Vimba vimba*	+	+	-	NV	NT	REA
	Species number	18	16	22	-	-	-

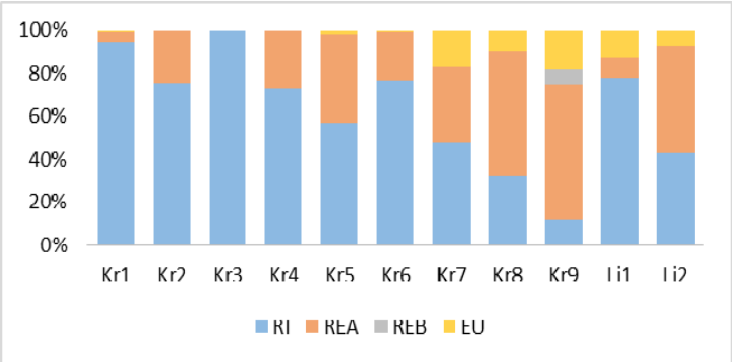

Fig. 1. Representation of ecological guilds on sampling sites. RI – rithral species, REA – A rheophils, REB – B rheophils, EU – eurytopic species.

Discussion

While 59 fish species have been historically documented in the entire Ipeľ/Ipoly river basin (Weiperth et al. 2020), in Krupinica according to our results and published works (Andreji & Stráňai 2006, Kux & Weisz 1964) the occurrence of 26 fish species can be expected (*Table 4*). The total species diversity of the ichthyofauna of Krupinica therefore makes up about 44% of the diversity of the Ipeľ River species. Compared to previous surveys, we recorded up to seven more fish species in the Krupinica River. While Kux & Weisz (1964) found 20 fish species in Krupinica, Andreji & Stráňai (2006) reported 16 fish species, during our survey we recorded up to 22 fish species (*Table 2 and 4*).

In comparison with historical data, we recorded brown trout (*Salmo trutta* m. *fario*) on the upper course of the Krupinica, the occurrence of which is not reported in previous surveys (Kux & Weisz 1964). According to information from local fishermen (Mr. Gálik, *in verb.*) we suppose that the constant occurrence of this species is related to the regular stocking by fishermen. This is also supported by historical data on the ichthyofauna of the upper part of the Krupinica River from the second half of the last century (Kux & Weisz 1964), which do not document the occurrence of brown trout above the town of Krupina. Also, the occurrence of the Carpathian barbel (*Barbus carpathicus*) in the localities together with the brown trout points rather to the transient nature of the fish community of this stream section. The reasons of the spirlin's (*Alburnoides bipunctatus*) absence in Krupinica upstream from the town of Krupina (sampling sites Kr1 - Kr3) are unclear, even though the preferred habitats of the species are present and previous investigations have confirmed the occurrence of the species in this stream section as well (Kux & Weisz 1964).

As our and previous results have shown, the character of the Krupinica River changed significantly by reaching the urban area of Krupina, where rheophilic cyprinid fish species became dominant. The proportion of the rithral species declines (*Fig. 1*) and the diversity index increases (*Table 3*). In addition to the natural change in the slope conditions of the area (the transition of the flow from the colder upland to the warmer hilly area), this alteration in fish community can be also related to increasing anthropogenic pollution and flow regulation in the urban area. Another important change occurs from the confluence of the Krupinca and Litava rivers near Plášťovce. Downstream from here the average annual flow of Krupinica increases, as well as the stream width and depth, which is reflected in increase of the relative abundance of barbel (*Barbus barbus*) at the expense of Carpathian barbel. The change in the character of the stream can also be indicated by the presence of interspecific hybrids between the two barbel species downstream from the confluence with Litava. In contrast to our data, Kux & Weisz (1964) reported the occurrence of these hybrids only from the lower part of the stream at the mouth of Krupinica to Ipeľ. Similarly, we noticed the occurrence of visually identified *Romanogobio* hybrids, in addition to the lower section, also in the middle part of the river (we marked these individuals in our table as

Romanogobio sp.). These deviations compared to past results may be associated with change in temperature and flow conditions, indicating the possible impact of climate change.

The relatively high proportion of bleak in the middle section of Krupinica (Kr 7), as an eurytopic species characteristic rather for lowland rivers, may indicate its upstream spawning migration from Ipeľ. Similar migratory behavior of bleak has been reported also by other authors (Kotusz et al. 2006). A clear increase in the share of eurytopic species and B rheophiles (mostly 0+ individuals) in the lower part of Krupinica stream (*Fig. 1*) points to their penetration from Ipeľ. In this context, the lower Krupinica stream is not only an important habitat of endangered and protected fish species, but also an important nursery habitat of fish fry originating from the Ipeľ.

Compared to historical data from Krupinica, we did not record white bream (*Blicca bjoerkna*), European perch (*Perca fluviatilis*), vimba bream (*Vimba vimba*) and northern pike (*Esox lucius*), but we do not exclude their presence in the river due to their possible immigration from Ipeľ and stocking by fishermen. In comparison with previous works, we confirmed the occurrence of ide (*Leuciscus idus*) and asp (*L. aspius*) at the mouth of the Krupinica stream to Ipeľ. The occurrence of *Sabanejewia bulgarica* deserves special attention. We recorded this fish species in four localities, and it is not mentioned either by previous authors. The range expansion of this species upstream the Krupinca River could have been caused by the improvement of water quality. Similar upstream expansion following reduced pollution was also observed by Lusk et al. (2002) in the Vlára River (Váh River basin). The finding of the western tubenose goby (*Proterorhinus semilunaris*) is also interesting, which indicates the progressive spread of this species in the tributaries of the Ipeľ and the Danube since the first surveys were executed in the river basin (Kux & Weisz 1964). The occurrence of rudd (*Scardinius erythrophthalmus*) and the invasive stone moroko (*Pseudorasbora parva*) in the foothill sections of Krupinica and Litava (*see Table 2*) is related to their supposed escape from fishponds or small water reservoirs in the river basin.

The relatively long sections of Krupinica rivers and Litava stream have preserved their natural foothill character with meandering riverbeds and preserved riparian vegetation. Numerous deeper pits alternate with rapids here, creating a colorful mosaic of habitats. While the bottom of the stream in the upper sections is covered mainly by boulder, cobble and gravel substrate, in the middle and lower sections there are accumulations of finer sediments - gravel and sand. Such variability of conditions provides a suitable habitat for a relatively wide variety of aquatic animal species, including several protected and endangered species. The occurrence of the species of European importance, such as Kesslers´ gudgeon (*Romanogobio kesslerii*) and Bulgarian spined loach (*Sabanejewia bulgarica*) was bound to the lower and middle section of the stream. During the survey, other species of protected animals were observed in several examined localities, such as the thick shelled river mussel (*Unio crassus*) and the European crayfish (*Astacus astacus*). The findings above suggest that the Krupinica stream, especially in its lower and middle sections, deserves special attention for nature protection by declaring it a protected area and inclusion in the Natura 2000 network.

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A Krupinica folyó Medovarce község feletti szakasza (Fotó: Juraj Hajdú)