AACL BIOFLUX

Aquaculture, Aquarium, Conservation & Legislation
International Journal of the Bioflux Society

Fish faunal studies in the Körös river system

Károly Györe, Vilmos Józsa, Péter Lengyel, Dénes Gál

Research Institute for Fisheries, Aquaculture and Irrigation, 5540 Szarvas, Hungary.
Corresponding author: D. Gál, gald@haki.hu

Abstract. The species composition and structure of fish communities were studied in 15 sampling areas of the most important rivers of the Körös drainage system. In the paper, our results are compared with recent literature data on the same waterflows. The fish community was sampled twice in each sampling area, on 16-25 August 2011 and between 25 June and 11 July 2012, using electric fishing gear according to the WFD protocol. The occurrence of a total of 49 fish species was confirmed in the 17 sampling areas of the six rivers, the number of indigenous species was 41. No new species was found in the studied reaches compared to the recent data. We proved the occurrence of 41 species in the Crisul Repede/Sebes-Körös, 31 species in the Crisul Negru/Fekete-Körös, 29 species in the Crisul Alb/Fehér-Körös, 18 species in one reach of the Kettős-Körös and 16 species in one reach of the Hármas-Körös river. The most frequent fish species was *Squalius cephalus*, other frequent species were *Alburnus alburnus, Rutilus rutilus, Rhodeus amarus, Alburnoides bipunctatus, Barbus barbus* and *Carassius gibelio.* Of the 15 sampling areas, those of Körösladány and Körösszakál (Sebes-Körös), Ineu (Crisul Alb) and Tinca (Crisul Negru) were found to be rich in species (20-22 species). The species richness of the Saliste de Vascau (Crisul Negru) sampling areas is well below the average (14.5). The differences between the rivers in their species richness can be explained partly with the differences in their habitat structure (fast or slow waterflow, silty, sandy or gravelly bottom), partly with water pollution and hydraulic constructions (water barrages, spillover dams).
Key words: similarity of fish communities, β-diversity, rarefaction.

Introduction. The Criş/Körös valley once used to be an ancient riverbed of the Tisza river (Györe et al 2011). The regulations and hydraulic constructions have considerably modified the area, the present ecosystems are different from what they looked like several centuries ago, especially in the lower, lowland reaches of the rivers. The history of fish faunal research is relatively continuous in some rivers of the Criş/Körös water system (Harka 1996; Harka et al 1998; Györe & Sallai 1998; Sárkány-Kiss et al 1999; Telcean & Bănărescu 2002; Telcean & Cupşa 2007; Telcean et al 2007; Wilhelm 2002). However, there was only one occasion when the survey of its major water courses was done more or less in the same period and using the same method (Bănărescu et al 1997).

In the frame of two Hungarian-Romanian international transborder projects (HURO/0901; HURO/1001), besides surveying the accumulation properties of some medical drugs and the current status of the crayfish fauna, we also studied the fish community structure of water courses in the most important rivers of the Hungarian-Romanian border area, mainly in the vicinity of major towns, dams and weirs. The number of sampling areas was proportional to the length of the water course, and thus, five sampling areas of the Crişul Repede/Sebes-Körös, four sampling areas of the Crişul Negru/Fekete-Körös, three sampling areas of the Crişul Alb/Fehér-Körös, one sampling area of the Kettős-Körös and one sampling area of the Hármas-Körös were surveyed by electric fishing in the summers of 2011 and 2012. Our objective was to determine and compare the species composition and the structural characteristics of the fish stock in different rivers and river reaches of the water system.

Material and Methods

Study area. The Crişul Repede (Sebes-Körös) river rises in the a Muntii Gilaului range, near Izvoru Crișului, at an altitude of 710 m. There are four dams and barrages on the river: three dams which collect water into so-called accumulation reservoirs (Lac. Lugaşu, Lac. Tileagd, Lac. Fughiu), while one barrage (Körösladány) only increases the water level within the river channel. Between Aleşd and Oşorhei, the old riverbed between the reservoirs and the diversion canal preserves remains of the original fish community. The free flow of the water and the migration of fishes are impeded by a further 17 weirs, whereof 13 are situated on the territory of Oradea. Sampling areas were located in Hungary at Körösladány and Körösszakál, while in Romania, near Sântion, Fughiu and Bratca (Figure 1 and Table 1).

The Crişul Negru (Fekete-Körös) river rises on the northern slope of the Cucurbata Peak, at an altitude of 1,460 m. The river gradient is 30 m/km at Poiana, 2-4 m/km at Beius, 0.5-0.8 m/km at Tinca and only 0.2-0.3 m/km at Gyula. A reservoir with a considerable capacity is in construction near Ginta, and there are also two significant weirs increasing the water level of the river in the same area. The barrages built at Tăut and Beius can only rise the water level within the river channel.

Table 1

Coordinates of the sampling areas in the Körös-Berettyó river system

River	*Sampling area*	*Coordinates*	
		lower	upper
Sebes-Körös/ Crişul Repede	Körösladány	46º57'08,85"/21º04'55,81"	46º57'22,32"/21º05'19,48"
	Körösszakál	47º00'51,18"/21º37'24,50"	47º00'52,95"/21º37'32,28"
	Sântion	47º04'57,58"/21º47'54,30"	47º04'52,51"/21º48'25,71"
	Fughiu	47º03'30,01"/22º02'26,24"	47º03'37,63"/22º02'31,99"
	Bratca	46º55'31,50"/22º35'51,49"	46º55'25,32"/22º36'03,42"
Fekete-Körös/ Crişul Negru	Gyula-Városerdő	46º42'01,28"/21º18'42,96"	46º42'08,88"/21º19'00,05"
	Tinca	46º46'17,45"/21º57'23,98"	46º46'17,71"/21º57'29,65"
	Beius	46º39'41,10"/22º20'36,21"	46º39'36,73"/22º20'40,13"
	Sălişte de Vaşcău	46º25'56,78"/22º33'19,32"	46º26'01,96"/22º33'20,36"
Fehér-Körös/ Crişul Alb	Chişineu-Criş	46º31'40,74"/21º30'26,37"	46º31'34,36"/21º30'26,60"
	Ineu	46º25'53,85"/21º51'39,00"	46º25'55,88"/21º51'47,86"
	Vârfurile	46º17'26,44"/22º30'48,01"	46º17'30,85"/22º30'47,79"
Kettős-Körös	Békés	46º46'07,39"/21º08'50,39"	46º45'49,03"/21º09'0926"
Hármas-Körös	Békésszentandrás	46º53'31,76"/20º29'00,70"	46º53'28,29"/20º29'33,03"

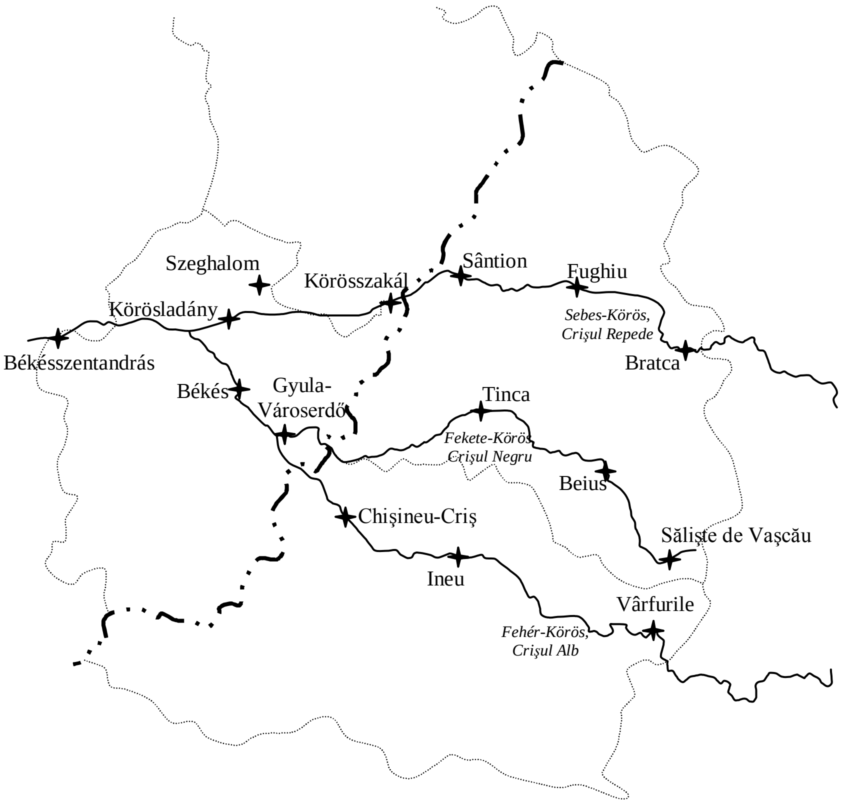

Fig. 1. Sampling areas in the Körös river system (–··– country border,····· county border).

In addition to these, there are several weirs and overflow dams of different size in the section between Borz and Beius. Sampling areas were located in Hungary downstream of Gyula-Városerdő, while in Romania, near Tinca, Beius and Sălişte de Vaşcau (Figure 1 and Table 1).

The Crişul Alb (Fehér-Körös) river rises on the western slopes of the Bihor Mountains, at an altitude of 980 m above sea level, below the Certezu Peak. Near Vârfurile, the river gradient is significant, 17 m/km. After reaching the lowland, the river slows down, the slope decreases to 1.2 m/km at Ineu and 0.7 m/km at Chisineu-Cris (Újvári 1972). There is one weir increasing the water level in the river channel in the Romanian section of the river at Buteni, and another one in the Hungarian reach at Gyula. The Mihăileni valley dam, being built in the trout zone of the water course, has been finished only in part. Because of the shortness of the Hungarian section, the fish community was studied only in the Romanian part, in the area of Vârfurile, Ineu and Chisineu-Cris (Figure 1 and Table 1).

The Kettős-Körös river is formed by the confluence of the Fehér-Körös and Fekete-Körös rivers at Szanazug and bears this name until the Sebes-Körös river enters it from the right side, its total length is 37.3 km. Strictly speaking, it cannot be considered a separate river. From the confluence to the Dánfok barrage, in flows in a straight artificial bed. The river gradient is only 8 cm/km in this section (Andó 1997). We designated our sampling area downstream of the barrage, at Békés (Figure 1, Table 1).

The Hármas-Körös river is formed by the confluence of the Sebes-Körös and Kettős-Körös rivers at rkm 91.3. The river bed is similar to the Kettős-Körös, generally straight and flanked by closely situated dykes. The river gradient is very small, 4-6 cm/km. The fish community was sampled downstream of the Békésszentandrás barrage (Figure 1 and Table 1).

Sampling method, sample processing. The fish community was sampled twice in each sampling area, between 16-25 August 2011 and between 25 June and 11 July 2012, using a battery-powered SAMUS 725MP type (640 V, 60 Hz, 1 msec active period) pulsating direct current fishing gear. The electric fishing was done from a boat on 3x200 m river sections of the Hármas-Körös at Békésszentandrás, the Kettős-Körös at Békés, the Berettyó at Szeghalom, the Crişul Repede/Sebes-Körös at Körösladány and Sântion and the Crişul Negru at Gyula-Városerdő. In the other 11 sampling areas, 3x50 m were fished wading in the water. After identification and counting, the fish were released to their habitats. Catch data were immediately registered on an OLYMPUS WS-550M digital voice recorder.

The use of species names was based on the FishBase database (2012.08.21.) and the currently valid nomenclature (Kottelat & Freyhof 2007; Harka 2011).

Statistical analysis. Of the diversity indices, we used the species richness, the Berger–Parker dominance, the local Shannon–Wiener α-diversity, the Wilson–Shmida β-diversity, the effective species number, the expected species number in a rarefied sample and the maximum species richness estimated with the second-order jackknife method. The diversity indices were estimated using the Species Diversity and Richness IV software package (Seaby & Henderson 2006). The significance of the difference between the diversity of two sampling areas was tested with a statistical test described by Solow (1993).

Results and Discussion. Interpretation of animal occurrence in a specific area is not an easy task (Nemes & Hartel 2010). The occurrence of a total of 49 fish species was confirmed in the 15 sampling areas of the five rivers (Table 2). The number of native species is 41. The 8 adventive (introduced or immigrated) species are *Ctenopharyngodon idella, Pseudorasbora parva, Carassius gibelio, Ameiurus melas, Lepomis gibbosus, Perccottus glenii, Proterorhinus semilunaris, Neogobius fluviatilis*. Nineteen of the 33 legally protected fish species of Hungary occur in the sampled sections, whereof the number of strictly protected species is 4: *Eudontomyzon danfordi, Barbus petenyi*, *Zingel zingel*, *Zingel streber*. Of the protected species, specimens of 8 were collected in Hungary (*Alburnoides bipunctatus, Barbus petenyi, Romanogobio valdykovi, Rhodeus amarus, Cobitis elongatoides, Sabanejewia balcanica, Gymnocephalus baloni, Zingel streber*), while only *Gymnocephalus baloni* was not found in the Romanian reaches of the rivers. The list of protected species in the two countries overlap only partly. Of the detected species, *Phoxinus phoxinus, Alburnoides bipunctatus, Barbatula barbatula* and *Thymallus thymallus* are not protected in Romania. Five fish species of the sampling areas are endemic for the water system of the Danube: *Eudontomyzon danfordi, Gobio carpathicus, Romanogobio vladykovi, Romanogobio uranoscopus, Gymnocephalus schraetser*.

Table 2

Structure of the fish community in 15 sampling areas of the Körös river system

Taxon	Köröstladány	Körösszakál	Sântion	Fughiu	Bratca	Gyula	Tinca	Beius	Vaşcău	Chişineu-Criş	Ineu	Vârfurile	Békés	Békésszentandrás
	Sebes-Körös					Fekete-Körös				Fehér-Körös			KK	HK
Eudontomyzon danfordi									16			27		
Rutilus rutilus	27	61	23	31		15	17			5	1		23	12
Ctenopharyngodon idella													1	
Scardinius erythrophthalmus	1													
Leuciscus leuciscus							5			1	2			
Leuciscus idus	7												1	10
Squalius cephalus	3	15	23	94	7	5	59	223		17	94	45	13	
Phoxinus phoxinus					57			13	432			1		
Aspius aspius			1			1							15	12
Alburnus alburnus	162	26	32			34	140	5		36	73		628	292
Alburnoides bipunctatus		2		11	65		156	387		87	157	86		
Blicca bjoerkna	6												68	35
Abramis brama	1										1		4	1
Ballerus sapa	1									2	5		1	
Vimba vimba			3				5			14	6			
Chondrostoma nasus		7					27	57		28	24	9		
Tinca tinca				1										
Barbus barbus		6	4	1		33	98	2		10	59	20		
Barbus petenyi		2		7	39		34	121	119			46		
Gobio carpathicus		26		23			12	115		3	9	2		
Romanogobio valdykovi	1	20	2				15			8	18			
Romanogobio uranoscopus					1		6	69				2		
Romanogobio kessleri					1		4	13			9	3		
Pseudorasbora parva		21					17							2
Rhodeus amarus	5	240	52	196		1	73			21	20	3	4	3
Carassius gibelio		1	49	4		11	1				2		2	3
Cyprinus carpio	2	1	2										2	2
Cobitis elongatoides	22	82		18		6				3				
Sabanejewia balcanica		21		14	1			8		6	1	17		
Misgurnus fossilis											1			
Barbatula barbatula				5	4			18	67			8		
Ameiurus melas										1	2			
Silurus glanis	3					1	1							
Esox lucius	1			1		1							3	8
Salmo trutta					10				2					
Thymallus thymallus					1									
Lota lota	6	2											2	
Cottus gobio					7				69					
Lepomis gibbosus	20	4	3				1			7				3
Perca fluviatilis	6	22	22	6			2			3	10		5	2
Gymnocephalus cernua	1	13												
Gymnocephalus baloni	1													
Gymnocephalus schraetser												5		
Sander lucioperca	2												3	
Zingel streber		2					5			2	2			
Zingel zingel										4	1	2		
Perccottus glenii														1
Proterorhinus semilunaris	12	1				2							12	13
Neogobius fluviatilis	1					2							12	13
SPECIES RICHNESS	22	21	12	14	11	12	20	12	6	19	21	15	18	16
	41					31				29				

KK = Kettős-Körös, HK = Hármas-Körös.

During our sampling events, no species was found to occur in all sampling areas. The species *Squalius cephalus* was found to have the highest frequency of occurrence, it was collected from 15 sampling areas (88.2%), it was missing only from the trout zone of the

Crişul Negru (Sălişte de Vaşcau) and the Békésszentandrás section of the Hármas-Körös. The populations of the species tolerate human activity and moderate water pollution relatively well, moreover, in the opinion of some authors (Telcean & Banarescu 2002, Telcean et al 2007) these factors favour the increase of their abundance and, partly, their spreading to new territories. Further frequent species were *Alburnus alburnus* (76.5%), *Rutilus rutilus* (70.6%), *Rhodeus amarus* (70.6%), *Alburnoides bipunctatus* (58.8%), *Barbus barbus* (58.8%) and *Carassius gibelio* (58.8%). Most of the listed species had high abundances in the sampling areas. Bleak, roach and Prussian carp have high tolerance to most environmental factors, they were absent almost only from fast-flowing sampling areas of the studied rivers (Bratca, Vascau, Vârfurile). Spirlin and barbel are sensitive and habitat specialist species (Telcean & Banarescu 2002), they are absent from the lower reaches of the studied rivers (Körösladány, Gyula, Békés, Békésszentandrás), or they occur there only rarely, with low abundance (Körösszakál). The species *Ctenopharyngodon idella, Scardinius erythrophthalmus, Tinca tinca, Misgurnus fossilis, Thymallus thymallus, Gymnocephalus baloni, Gymnocephalus schraetser* and *Perccottus glenii* were found to be very rare, as each of them was found in only one sampling area during the survey, usually with only one specimen. The occurrence of *Misgurnus fossilis* in the relatively fast-flowing Ineu reach of the Crişul Alb is a faunal curiosity. The only adult specimen of the species was caught in a habitat with a bottom covered by rough sand and gravel. There are several flood control reservoirs in the area (e.g. Lac. Rovina) (Konecsny 2008), which are partly filled even in periods without floods. These emergency reservoirs could provide potential habitats for the species. In spite of the relatively big distance from the river, the habitat specialist limnophilous fish could reach the river through the connecting canals. *Thymallus thymallus* naturally occurs only in the section of the Crişul Repede between Huedin and Ciucea (Bănărescu 1964), and in two of its tributaries, the Drăgan and Iad streams (Bănărescu et al 1997). We caught a specimen in the Crişul Repede, near Bratca, accompanied by several individuals of *Phoxinus phoxinus*, *Salmo trutta* and *Cottus gobio*, i.e. not in the typical grayling zone. The species was also reported from the river by Telcean et al (2007), who did not specify the location more precisely. A specimen of *Perccottus glenii* was collected from the Békésszentandrás reach of the Hármas-Körös. Previously, the species had already been known from the Hungarian section of the Berettyó (Halasi-Kovács et al 2011), the Hármas-Körös, and the Sebes-Körös upstream of the Körösladány barrage (Sallai, personal communication).

Of the 15 sampling areas, those of Körösladány and Körösszakál (Sebes-Körös), Ineu (Crişul Alb) and Tinca (Crişul Negru) were found to be rich in species (*Table 3*). As noted before, the first two sampling areas are situated downstream of a barrage dam and a major weir, respectively. Weirs blocking the migration of fishes enrich the fish stock of the downstream section significantly. In addition, this reach, which has a considerably faster water flow than the slow-flowing upstream section, features several fish species characteristic of upper zones, e.g. *Alburnoides bipunctatus*, *Chondrostoma nasus*, *Barbus petenyi* and *Zingel streber*, besides the typical species of the middle reaches. The species richness of the Ineu and, especially, the Tinca reaches is due to their higher river gradient as compared to the upstream and downstream river kilometres (share of rheophilic species: 45-48%), and their extremely diverse microhabitats. The species richness of the Marghita and Abram (Barcău) and the Sălişte de Vaşcau (Crişul Negru) sampling areas is well below the average (14.5). The latter sampling area is situated in the trout zone of the river (river gradient: 30 m/km), its fish community consists of only 6 habitat specialist species. In addition to the already analyzed Békés and Békésszentandrás reaches, the Berger–Parker dominance index was high only in case of the fish communities of the Sălişte de Vaşcau, Szeghalom and Körösladány sampling areas. The Shannon–Wiener diversity index was the lowest in the sampling areas with below-the-average species richness (Sălişte de Vaşcau), or higher Berger–Parker-dominance (Békés, Békésszentandrás, Szeghalom). The diversity indices of the Körösszakál, Tinca, Chisineu-Cris, Ineu and Vârfurile fish communities were high. The effective species number was the highest in the same sampling areas, here the fish community is dominated by 8-10 species. While in the Sălişte de Vaşcau fish community, which consists of only 6 species, the effective species number was only 3, this was not as conspicuous than in the Békés or Békésszentandrás sampling areas, where the fish communities consisting of 18 and 16 species, respectively, were also dominated by only 2-3 species. The species richness values belonging to the rarefied samples of the individual sampling areas (expected species richness) were calculated at the abundance level of the Abram sampling area (n=111). According to the expected species richness values, the fish community was the most diverse in the Körösladány reach of the Sebes-Körös and the Chisineu-Cris reach of the Crişul Alb (Table 3).

Table 3

Diversity indices of the fish communities

Sampling area	River	N	S	n_{max}/N	H	expH	ES(m)
Körösladány	Sebes-Körös/ Crişul Repede	291	22	0.5567	1.776	5.9	16
Körösszakál		575	21	0.4174	2.072	7.9	15
Sântion		216	12	0.2407	1.976	7.2	11
Fughiu		412	14	0.4757	1.668	5.3	11
Bratca		193	11	0.3368	1.633	5.1	9
Gyula-Városerdő	Fekete-Körös/ Crişul Negru	112	12	0.3036	1.827	6.2	12
Tinca		678	20	0.2301	2.242	9.4	14
Beius		1 031	12	0.3754	1.793	6.0	10
Sălişte de Vaşcău		705	6	0.6128	1.154	3.2	5
Chişineu-Criş	Fehér-Körös/ Crişul Alb	258	19	0.3372	2.258	9.6	16
Ineu		497	21	0.3159	2.084	8.0	14
Vârfurile		276	15	0.3116	2.060	7.8	13
Békés	Kettős-Körös	799	18	0.7860	0.966	2.6	10
Békésszentandrás	Hármas-Körös	381	16	0.7664	1.107	3.0	12

N=number of individuals, S=species richness, n_{max}/N=Berger-Parker dominance, H=Shannon-Wiener index, expH=effective species number, ES(m)=species number of the rarefied sample.

In comparison with the original species richness, the expected species richness decreased the least in the Gyula and Sântion sampling areas (0% and 8%, respectively). In case of Gyula-Városerdő, the agreement of the actual species richness and the expected one is understandable, as the total number of individuals in the area is only one individual higher than the base individual number in the species number intrapolation. The Beius sample, which has the highest number of individuals, conspicuously contradicts the rule that the more the number of individuals in a sample differs from the base individual number in the species number intrapolation, the higher is the difference between the actual and the expected species richness values. The latter sampling area yielded the most individuals (1,031 ind.), yet the expected species richness is only 16% lower than the actually registered species number. Based on this index, the biggest decrease in the species richness of the fish community (44%) was observed in the Békés sampling area.

The variability of the species composition of the fish communities in the sampling areas along the longitudinal profile of the rivers was quantified using the Wilson & Shmida β-diversity index (β_T) imbedded into the SDR IV software package (Table 4). The calculated index of species turnover between two or more sampling areas shows a close correlation with the similarity of the fish communities in the sampling areas. The highest and lowest species turnover rates were found in the Crişul Repede/Sebes-Körös and in the Crişul Alb/Fehér-Körös, respectively.

In case of the Crişul Repede/Sebes-Körös, the changes of the species composition between the different habitats seems to be uniform, the highest β_T value was calculated between Fughiu and Bratca. Hierarchical classifications also grouped the two sampling areas into a separate cluster. The second highest β_T value in the Körös catchment area was found between the species compositions of the fish communities of the middle-reach Beius sampling area and the Sălişte de Vaşcau sampling area belonging to the trout zone, as the complementarity of the two habitats is high. The situation is opposite in the Chisineu-Cris and Ineu sampling areas of the Crişul Alb river where the similarity of the fish communities is high (Ji=0.739), while the species turnover rate and the complementarity of the habitats are low.

Table 4

Values of the Wilson & Shmida β-diversity indices

River	Sampling areas	Index
Sebes-Körös/ Crişul Repede	Körösladány ⇨ Körösszakál	0.442
	Körösszakál ⇨ Sântion	0.394
	Sântion ⇨ Fughiu	0.538
	Fughiu ⇨ Bratca	0.600
	Körösladány ⇨ Körösszakál ⇨ Sântion ⇨ Fughiu ⇨ Bratca	*1.906*
Fekete-Körös/ Crişul Negru	Gyula-Városerdő ⇨ Tinca	0.563
	Tinca ⇨ Beius	0.438
	Beius ⇨ Sălişte de Vaşcău	0.667
	Gyula-Városerdő ⇨ Tinca ⇨ Beius ⇨ Sălişte de Vaşcău	*1.760*
Fehér-Körös/ Crişul Alb	Chisineu-Criş ⇨ Ineu	0.150
	Ineu ⇨ Vârfurile	0.500
	Chisineu-Criş ⇨ Ineu ⇨ Vârfurile	*0.654*

The α-diversity, which is suitable for characterizing the local variability, is generally considered an index whose application to habitat evaluation is difficult (Jost 2006; Bíró 2011) as it can only be explained by short-term ecological processes (Horváth & Martínez-Castellanos 2006). Of the factors determining the structural relationships of fish communities, habitat architecture is the most important. The local vertical spatial structure has a minor role in the discussed shallow water courses, while ecological niches rather have a determining role in the horizontal spatial structure only. Water courses with an obviously high heterogeneity (Crişul Repede/Sebes-Körös, Crişul Negru/Fekete-Körös) have a higher complementarity and species turnover rate. In water courses exposed to higher disturbance, pollution and human activity, the changed conditions significantly increase the competition between populations, resulting in the well-measurable consequence of shanging fish community structure. Instead of a community consisting of numerous species with approximately the same abundance, one or two species become dominant besides some rare species, which are probably declining towards a local extinction. In our present study, the differences in the species richness values found among the different sections of the rivers can be explained partly by differences in the habitat structure (fast or slow waterflow, silty, sandy or gravely bottom), partly by water pollutions and hydraulic constructions (barrages, weirs). A direct consequence of the strongly degraded structure of disturbed habitats is the reduction of the stock size of limited-distribution habitat specialist species and the decrease of the diversity indices of the fish community. The first indication of habitat degradation is not always the disappearance of rare species but rather the decreasing frequency of occurrence of habitat specialist species.

Acknowledgements. The research project was implemented under the Hungary-Romania Cross-Border Co-operation Programme 2007-2013 (www.huro-cbc.eu), and is part-financed by the European Union through the European Regional Development Fund, Hungary and Romania.

References

Andó M., 1997 Hydrographic desription of the Körös/Criş riversystem. In: Sárkány-Kiss A. & Hamar J. (eds), The Cris/Körös Rivers' Valleys. TISCIA Monograph Series, 15-36.

Bănărescu P. M., 1964 Pisces/Osteichthyes. Vol 13. Edit. Acad. R. P. Romîne, Bucureşti, p. 959.

Bănărescu P. M., Telcean I., Bacalu P., Harka Á., Wilhelm S., 1997 The fish fauna of the Criş/Körös river basin. In: Sárkány-Kiss A. & Hamar J. (eds) The Cris/Körös Rivers' Valleys. TISCIA Monograph Series, p. 301-325.

Bíró K., 2011 Vizsgálati módszerek és értékelő eljárások a halbiológiában. Debreceni Egyetemi Kiadó, p. 271.

Györe K., Józsa V., Wilhelm S., 2011 Monitoring of the fish community in the Hungarian reach of River Tisza in 2009. Studia Universitatis "Vasile Goldiş" Seria Ştiinţele Vieţii 21(4):793-801.

Györe K., Sallai Z., 1998 A Körös-vízrendszer halfaunisztikai vizsgálata. Crisicum 1:211-228.

Harka Á., 1996 A Körösök halai. Halászat 89/4. 144-148.

Harka Á., 2011 Tudományos halnevek a magyar szakirodalomban. Halászat 104:99-103.

Harka Á., Györe K., Sallai Z., Wilhelm S., 1998 A Berettyó halfaunája a forrástól a torkolatig. Halászat 91:68-74.

Horváth A., Martínez-Castellanos R., 2006 Élőhely-értékelés állatközösségek diverzitása alapján a dél-mexikói Montebello-i Tavak Nemzeti Parkban. Állattani Közlemények 91: 95-116.

Jost L., 2006 Entropy and diversity. Oikos 113:363-375.

Konecsny K., 2008 A Fehér-Körös vízgyűjtő felszíni vízkészleteinek hasznosítási lehetőségei. MHT 26. Országos Vándorgyűlése, Miskolc. www.hidrologia.hu/vandorgyules/26

Kottelat M., Freyhof J., 2007 Handbook of European freshwater fishes. Kottelat, Cornol, Switzerland and Freyhof, Berlin, Germany, p. 646.

Nemes S., Hartel T., 2010 Summary measures for binary classification systems in animal ecology. North-West J Zool 6(2):323-330.

Sárkány-Kiss E., Sîrbu I., Macalik K., Drăgulescu C., 1999 A Berettyó. In: Sárkány-Kiss E., Sîrbu I., Kalivoda B. (eds.): Fluvii Carpatorum. A Körös medence folyóvölgyeinek természeti állapota. Szolnok-Târgu Mureş, 144-146.

Seaby R. M., Henderson P. A., 2006 Species Diversity and Richness Version 4. Pisces Conservation Ltd., Lymington, England.

Solow A. R., 1993 A simple test for change in community structure. J Anim Ecol 62(1): 191-193.

Telcean I. C., Bănărescu P., 2002 Modifications of the fish fauna int he upper Tisa River and its southern and eastern tributaries. In: Sárkány A., Hamar J. (eds.), Ecological aspects of the Tisa River Basin. Tiscia Monograph 6:179-186.

Telcean I., Cupsa D., 2007 The influence of the habitats upon the fishfauna of the lower sevtor of Crisuri Rivers (North-Western Romania). Pisces Hungarici 2:31-39.

Telcean I. C., Cupşa D., Covaciu-Marcov S. D., Sas I., 2007 The fishfauna of the Crisul Repede River and its threatening major factor. Pisces Hungarici 1:13-18.

Újvári J., 1972 Geografia apelor României. Editura Stiinţifică, Bucureşti.

Wilhelm S., 2002 A Bisztra-patak halfaunája, különös tekintettel a Berettyó folyó halfaunájával való kapcsolatára. Múzeumi Füzetek, Kolozsvár 11:73-78.

Received: 17 October 2012. Accepted: 18 November 2012. Published online: 23 November 2012.
Authors:
Károly Györe, Research Institute for Fisheries, Aquaculture and Irrigation, 8. Anna-Liget, 5540 Szarvas, Hungary, European Union, e-mail: gyorek@haki.hu
Vilmos Józsa, Research Institute for Fisheries, Aquaculture and Irrigation, 8. Anna-Liget, 5540 Szarvas, Hungary, European Union, e-mail: jozsav@haki.hu
Dénes Gál, Research Institute for Fisheries, Aquaculture and Irrigation, 8. Anna-Liget, 5540 Szarvas, Hungary, European Union, e-mail: gald@haki.hu
Péter Lengyel, Research Institute for Fisheries, Aquaculture and Irrigation, 8. Anna-Liget, 5540 Szarvas, Hungary, European Union, e-mail: lengyelp@haki.hu

How to cite this article:
Györe K., Józsa V., Gál D., Lengyel P., 2013 Fish faunal studies in the Körös river system. AACL Bioflux 6(1):34-41.