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The effect of the barrage at Ginta (Gyanta) on the upper Crisul Negru River upon the distribution of potamodromous and small-sized fish species

A Gyantánál (Ginta) létesített duzzasztógát hatása a Fekete-Körös felső szakaszán élő potamodrom és kis termetű halfajok megoszlására

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Kulcsszavak: halfauna, duzzasztógát, biológiai kontinuitás, migráció, potamodrom halak

Abstract

We have studied the effects of aquatic habitat connectivity interruption upon the fish fauna in the riverbed of the upper sector of Crisul Negru River (ROSCI 0049). Earlier, a small barrage was built in that area, and we have analyzed its affects onto the species distribution of local fish fauna. Sampling of nine km sections each of the river above and below the barrage in 2015 yielded the total of 28 fish species. We have noticed that species were not affected evenly by the habitat fragmentation caused by the barrage. The population size of small-sized fish species (*Sabanejewia balcanica, Romanogobio kessleri, R. uranoscopus, Gobio carpathicus (sin. Gobio gobio)* and *Zingel streber*) and also potamodromous species (*Chondrostoma nasus, Vimba vimba* and *Barbus barbus*) has affected by biotope fragmentation in the barrage region. The increased number of specimensbelow the barrage is caused principally by their inability to pass this barrier. In addition, reduction of the water speed and the resulting increase in sediment accumulation upstream the barrage has favored population overgrowth of several exotic invasive species, including *Pseudorasbora parva, Carassius gibelio* and *Lepomis gibbosus*.

Kivonat

Munkánk során azt tanulmányoztuk, hogy egy korábban épült, a hosszanti átjárhatóságot akadályozó duzzasztógát milyen hatást gyakorolhat a Fekete-Körös felső szakaszának (ROSCI 0049) halfaunájára. Vizsgálatunkat 2015-ben műtárgy alatt és felett egyaránt egy-egy 9 km hosszú szakaszon végeztük, mely során összesen 28 halfajt azonosítottunk. Eredményeink arra utalnak, hogy ezen halfajok nem egyformán reagáltak a gát élőhely-fragmentáló hatására. A kisebb méretű (*Sabanejewia balcanica, Romanogobio kessleri, R. uranoscopus, Gobio carpathicus (sin. Gobio gobio)* és *Zingel streber)* és a potamodrom halfajok (*Chondrostoma nasus, Vimba vimba* és *Barbus barbus*) populáció felszaporodtak a gát alatti területen, feltehetően az élőhely kettéválasztása miatt. Ezzel szemben a felvízi duzzasztott szakaszon, ahol a víz sebességének lecsökkenése miatt megnőtt az üledék felhalmozódása, nagymértékben elszaporodtak az idegenhonos inváziós halfajok, mint a *Pseudorasbora parva, Carassius gibelio* és a *Lepomis gibbosus*.

Introduction

The fish fauna of numerous rivers from the Tisa (Tisza) River system is affected by human activities mainly by dam constructions and water pollution (Harka 1996, 2006, Telcean et al. 2006). Aquatic biotopes of the rivers are continuously connected and species occupy these biotopes according to their specific adaptations. Thus, the River Continuum Concept (Vannote et al. 1980) explains why the species do not spread equally along the entire river and why the entire river channel is important to maintain biodiversity and biological integrity of that water body. The connectivity of the river habitats also seems to play an important role for maintenance of ichthyofauna diversity and fish population density. When the river connectivity is affected, the population size for most of fishes tends

to decrease and new species assemblages are established (Telcean 1997, Telcean & Bănărescu 2002, Telcean et al. 2006). Some discrete influences are affecting the fish species according to their size and migration tendency. The majority of fishes from the rivers manifests a tendency of rheophilic mobility during the seasons and also is influenced by water debit fluctuations. The irregular movement of shoals, especially those formed by small-sized fishes, can be considered as an adaptive process and it contributes to an efficient foraging and exploitation of the entire river habitat. On the other hand, we have observed regulated movements of those shoals that consist of medium or large size fishes (*Chondrostoma nasus, Barbus barbus* and *Vimba vimba*). Fish migrations generally not exceeding their own river system are called potamodromous, a subcategory of diadromous migrations (Myers 1949). To date we do not have a comprehensive list of potamodromous fish species, primarily due to species peculiarities that are induced by numerous conditions in each river system. Such potamodromous species are the subject of our long-term studies in the middle stretch of river Crisul Negru/Fekete-Körös.

Along the majority of the dammed rivers, which do not have a reservoir, species migration is blocked even if facilities permitting the passing of the fishes are present (Telcean and Cupsa 2015). Altogether, the species occupy the downstream riverbed section where their populations tend to decrease continuously during the following years. Fluctuations in water level and temperature are both harming the fish populations downstream to the barrage also in the Crisuri (Körös) rivers system (Telcean 1997, Györe et al. 2013). A different evolution occurs in the rivers affected by small barrages or overflow dams without reservoirs. These structures retain the water partially and during major increases of debits the water exceeds the barrage level and passes through them forming waterfalls. Such barrage was built on the main channel of Crisul Negru/Fekete-Körös river near Ginta (Gyanta) in 1980 and the present study was focusing onto its harmful effects on the fishes.

Material and methods

The study was carried out on the affected site of a barrage on the main channel of Crisul Negru/Fekete-Körös River, close to the locality Ginta (Gyanta) (Bihor County). The river section from there pertains to upper N2000 ROSCI 0049 site. The fish samples were collected on the 15th of July and 2nd of September 2015. Our observations were focused on the occurrence of fish species along the riverbed to a distance of 9 km upstream and downstream of the small barrage and also in a small lateral pond. This small biotope characterized by standing water and muddy bottom differs from the others in upper side of the dam and also it is connected to the river. The species occurrence close to the barrage construction (along to 30 m) was registered separately in order to observe which species are forming agglomerate groups in the proximity of the barrage. Samples were collected using an electro fishing gear type Samus and a supplementary fishing net (mesh size 0.5 cm). The sampling methods were adapted each to the local biotope and did not involve a fishing boat. The riverbed of the studied area consisted exclusively of gravels and pebbles. The water flow was predominantly fast and the depth ranged between 0.5 and 1.5 m, corresponding to epipotamal habitat type (Illies & Botosaneanu 1963).

The collected fish specimens were identified at the sampling site and immediately released. The occurrence of species was registered using a voice recorder, thus the final counting of specimens was performed later, after the sampling procedure. The percentage of fish specimens upstream and downstream the barrage was also calculated in order to investigate potential changes and harmful effects of river habitat disconnection. Specimens sampled from the lateral pond are considered to pertain to the sample from upper side of the dam (*Figure 2* marked 3P) because of the connectivity to the river.

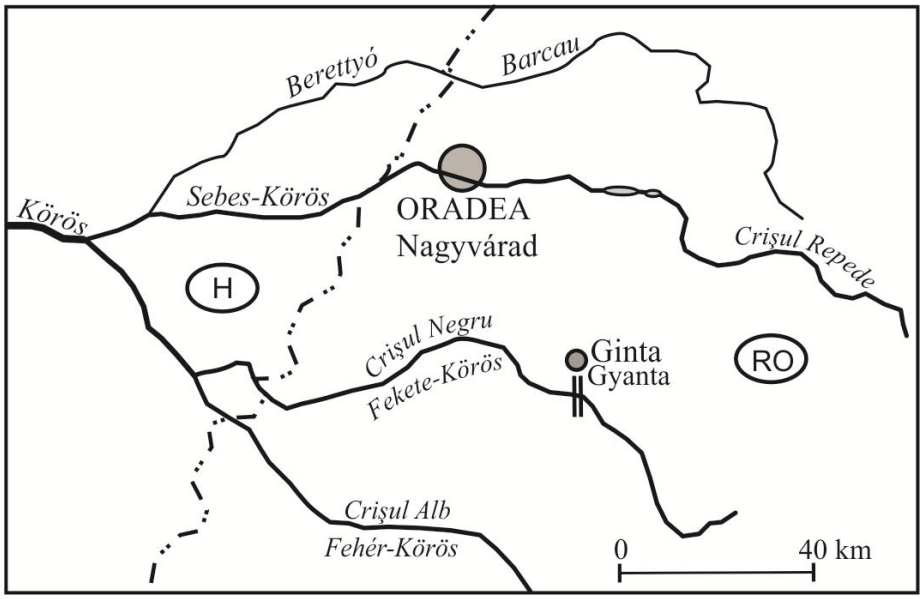

Fig. 1. The barrage localization in Crisul Negru/Fekete-Körös River
1. ábra. A duzzasztógát elhelyezkedése a Crisul Negru/Fekete-Körös folyón

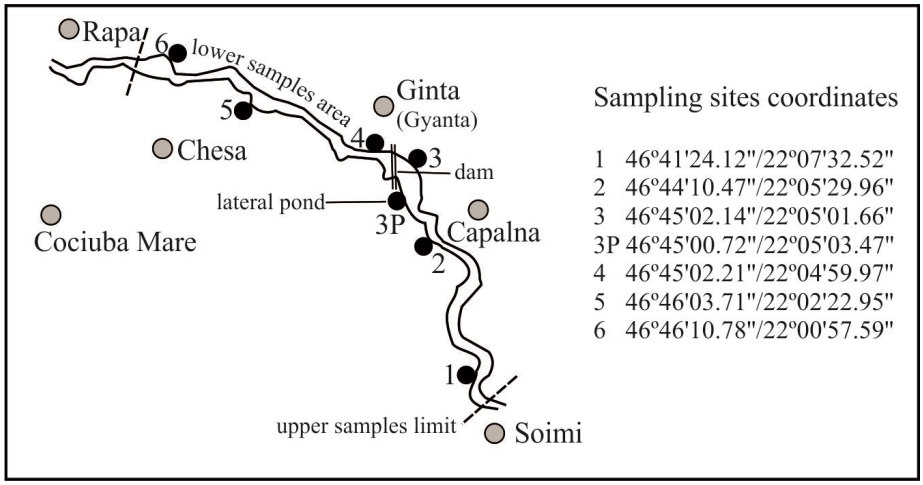

Fig. 2. Detail on the sampling area.
2. ábra. A mintavételi terület helyszínrajza

Results

Altogether, 28 fish species were identified in the sampling area consisting ca. 9 km upstream and 9 km downstream section of the river Crisul Negru /Fekete-Körös around the Ginta (Gyanta) barrage during July and September 2015 (*Table 1*). Ten of these species were rare and protected and an additional four were exotic invasive. On the proper barrage site (*Fig. 1 and 2*) on the each side we collected only 18 fish species.

The percentages of these species on the two sides of the barrage were quite different. This proved that the habitat interruption and modifications in the upper reach are influencing those species (*Table 2*).

Table 1. Fish species collected from the barrage area from the river Crisul Negru/Fekete-Körös
1. táblázat. Fogott halfajok a Crisul Negru/Fekete-Körös duzzasztógátja közeléből

Species Faj	Upstream Gát fölött	Downstream Gát alatt	Pond Tó	Total Összesen
Alburnoides bipunctatus	39 (11)	176 (42)	2 (2)	217
Alburnus alburnus	2(2)	51 (8)	1 (1)	54
Ameiurus melas	0	1	0	1
Barbatula barbatula	4	0	0	4
Barbus barbus	(1)	21 (5)	0	22
*Barbus biharicus (B. carpathicus)**	1	5 (2)	0	6
Carassius gibelio	(11)	2	(6)	19
Chondrostoma nasus	9	188 (18)	(1)	198
Cobitis elongatoides	1	4	0	5
Cyprinus carpio	(1)	0	(4)	5
Esox lucius	0	3	0	3
Gobio carpathicus	3 (2)	8	(1)	12
Lepomis gibossus	(1)	0	(1)	2
Leuciscus aspius	0	5	0	5
Leuciscus leuciscus	(1)	7	0	8
Perca fluviatilis	0	3	(1)	4
Pseudorasbora parva	(2)	0	(2)	4
Rhodeus amarus	36 (35)	83 (1)	(38)	157
Romanogobio kessleri	6 (2)	20 (6)	(1)	27
Romanogobio uranoscopus	6	9 (1)	0	15
Romanogobio vladykovi	3	16	0	19
Rutilus rutilus	0	30	0	30
Sabanejewia balcanica	0	5 (2)	0	5
Silurus glanis	0	10	0	10
Squalius cephalus	46 (17)	51 (8)	(27)	124
Vimba vimba	0	4	(1)	5
Zingel streber	0	14	0	14
Zingel zingel	0	8	0	8

** Based on Antal et al. 2016;* ( ) *Specimens number collected in the immediate vicinity of barrage site. Pond - corresponds to samples collected in the lateral pond at the upstream side of barrage.*

The majority of fish species were cyprinids which are typical for the hilly rivers characterized by rocky bottoms and fast running waters (*Fig. 3 and 4*). The barrage affected the species unequally. Two representatives of the perk family, *Zingel streber* and *Z. zingel,* showed a scarce presence and they were distributed downstream of the barrage (Table 1). Similarly, the small tailed gudgeon species (*Romanogobio uranoscopus, R. kessleri* and *R. vladykovi)* were distributed predominantly downstream to the barrage with low number of specimens. Our findings upon these species reveals their preferences for rheophilic unaffected habitats.

Upstream migration of potamodromous species, e.g. *Chondrostoma nasus*, *Barbus barbus* and *Vimba vimba,* was presumably blocked by the construction. Thus, the number of their specimens encountered upstream of the barrage was either smaller or some of them were lacking entirely (*Table 2*). Balcan spined loach, *Sabanejewia balcanica,* was detected only in small numbers downstream, where the natural conditions in the river habitats remained unchanged.

Table 2. Relative percentage of fish species from upstream and downstream the barrage
2. táblázat. A halfajok százalékos gyakorisága a duzzasztógát fölött és alatt

Species Faj	Upstream Gát fölött (%)	Downstream Gát alatt (%)	Remarks Mgjegyzések
Cyprinus carpio	100	0	Introduced species
Lepomis gibossus	100	0	Exotic/Invasive
Pseudorasbora parva	100	0	Exotic/Invasive
Carassius gibelio	89.5	10.5	Exotic/Invasive
Squalius cephalus	58.9	41.1	very common /nagyon gyakori
Rhodeus amarus	47.2	52.8	protected /védett
Romanogobio uranoscopus	40	60	protected /védett
Romanogobio kessleri	25.9	74.1	protected /védett
Gobio carpathicus	25	75	very common /nagyon gyakori
Vimba vimba	25	75	
Alburnoides bipunctatus	18.9	81	
*Barbus biharicus (B. carpathicus)**	16.7	83.3	protected /védett
Leuciscus leuciscus	12.5	87.50	rare /ritka
Alburnus alburnus	5.5	94.5	very common /nagyon gyakori
Chondrostoma nasus	5	95	very common /nagyon gyakori
Barbus barbus	4.5	95.5	
Sabanejewia balcanica	0	100	protected /védett
Zingel streber	0	100	protected /védett

** Based on Antal et al. 2016*

Although the representatives of invasive exotic species (*Pseudorasbora parva, Lepomis gibossus* and *Carassius gibelio)* were encountered on both side of barrage, their populations showed increased numbers upstream where the slow flowing waters favored the deposition of sediment. Another fish species with increased numbers upstream of the barrage was *Rhodeus amarus* (47.2% upstream and 52.8% downstream). This cyprinid fish prefers the non-rheophilic habitats like those upstream of the barrage.

The very common cyprinids fishes, *Squalius cephalus*, *Alburnus alburnus* and *Alburnoides bipunctatus*, were largely distributed on both sides of the barrage. *Squalius cephalus* became more frequent due to its opportunistic habits, considering the supplementary food resources and shelters over there. The last two species were also present in large number downstream where the water had increased levels of oxygen saturation. In addition, their inability to pass the barrage is caused their increased occurrence downstream.

The small biotope offered by the lateral pond accommodated 13 species, mainly the exotic invasive ones (*Carassius gibelio, Pseudorasbora parva* and *Lepomis gibossus*), ubiquitous (*Alburnus alburnus, Squalius cephalus*) and juveniles of potamodromous *Chondrostoma nasus* and *Vimba vimba.* Numerous specimens of *Rhodeus amarus* were also encountered.

Fig. 3. Barrage area at summer
3. ábra. A gát környéke nyáron

Fig. 4. Barrage area at winter in a overflow period
4. ábra. A gát környéke télen áradáskor

Discussion

Our research findings showed that the fish species are unequal affected by barrage, especially because of their specific ecological requirements and body size. Occurrence of species upstream and downstream the barrage site argued the conclusion regarding to the barrage effect on fishfauna. The river habitat connectivity interruption is affecting mainly the small sized fishes and the potamodromous species, which are not able to pass the dam

and to reach the upper stretches of the river. Modified habitat at the upper side of the dam has encouraged the ubiquitous and exotic invasive species which responded by increased numbers.

The population segregation on both sides of barrage was most dramatic in case of *Chondrostoma nasus* and *Vimba vimba*. Their percentage on the upstream attains only 5% for *Ch. nasus*, and 25% for *Vimba vimba*. On the other hand, the percentages rose to 95 % and 75%, respectivelydownstream. In this context it should be noted that *Vimba vimba* is one of the recent identified intruders in the Cris/Körös river system (Bănărescu, 1981). It seems that its advancing along the upper rivers of the system is now negatively affected by damming and regulation of the rivers. Another potamodromous fish species, *Barbus barbus* showed a similar trend with 95.5% of its specimens from downstream (*Table 2*). The drastic reduction of its numbers in the upstream region is most likely due to a presence of transverse barrier.

Potential disruption of fish spawning by transverse barriers was a subject of numerous studies and it is considered one of the most harming effects on the freshwater fish populations. Spawning alteration and progressive depopulation are associated phenomena in these rivers (Peňáz 1996, Keckeis, 2001, Heggenes & Röed 2006). Similarly to river damming, river regulation is also harmful to the fish fauna (Bănărescu 1994, Harka 2006).

The three most common species, namely *Squalius cephalus*, *Alburnus alburnus* and *Alburnoides bipunctatus,* were apparently not affected by river damming. However, these species seem to have larger populations downstream the barrage than upstream. *Alburnoides bipunctatus* is a representative of sensitive species and habitat specialist species category as well (Telcean & Banarescu 2002). A recent study carried out on the fish fauna along the Crisuri/Körös rivers system revealed the same abundance for *Squalius cephalus*, *Alburnus alburnus* and *Alburnoides bipunctatus* (Györe et al. 2013).

Exotic and invasive *Pseudorasbora parva, Carassius gibelio* and *Lepomis gibossus* are present also in the upper stretch of the river and probably they found an opportunity in the changed biotope characterized by slow waters and rich sediment deposits. The native species *Rhodeus sericeus,* which spawns only in bivalve mollusks was encouraged here by silt deposits and submerged vegetation. The occurrence of juvenile specimens of *Cyprinus carpio* is a curiosity and we suppose that they were introduced here by local anglers.

A discrete influence was observed regarding the distribution of small-sized fish species which occupy the barrage area (*Romanogobio kessleri, R. uranocopus, Sabanejewia balcanica,*). These are affected by the presence of the transverse structures and their inability to cross the barrage area. Our results showed reduced population sizes of these species upstream to the barrage.

The rheophilic *Zingel zingel* and *Z. streber* were not encountered on the barrage site, although they form stable populations in well-conserved biotopes along the river Crisul Negru/Fekete-Körös. However, these species usually form disperse populations characterized by smaller number of individuals (Bănărescu 1994), and our findings suggest that they are well represented in this river.

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