FISH BIODIVERSITY OF THE GABCIKOVO WATERWORKS

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A historical full list of lamprey and fish species of the Danube between the mouth of the Morava and Ipel rivers had been prepared in the past and consists of 66-69 species. Mihalyi,1 revising fish collections of the Hungarian Museum of Natural Sciences in 1954, determined 47 species. Balon2 collected 56 species in 1966. In 1967, Busnita3 enumerated 54 species for this stretch of the river and, in 1973, J. Holcik et al.4 identified 61 species. In 1981, Holcik et al5. found two species of lamprey and 64 species of fish. In 1993, Vida6, omitting the Mihalyi paper,1 compiled data for 63 species. Finally, in 1992, Holcik7 identified 69 species, including one species of lamprey.

Pre-dam long-term development

Not all species appear at the same time. In 1994, Rovný8 also enumerates 69 species. He explains that in the time of monitoring, carried out between 1990 and 1992, he collected 43 species. This list included the ichthyological data of past research on the Danube river and its region. Rovný8 compiled data for 64 species and warned that the presence of five of these species had been confirmed only by one specimen, and that 17 species were very rare, so their occurrence validity was seriously complicated. The four original species of fish were declared extinct.

According to the resources available, the Danubian ichthyofauna in general and especially in our region, was significantly affected at the beginning of the 1970s. A decrease of total catches of Rheophilous, Litophilous and other commercial fish species was noticeable. During that period, Huso huso, Acipenser stellatus, Acipenser nudiventris and Acipenser gueldenstaedti went extinct from the Slovak-Hungarian stretch of the Danube river. The occurrence of Acipenser ruthenus, Cyprinus carpio - danubian carp, Silurus glanis, Esox lucius, Stizostedion lucioperca, Aspius aspius, Barbus barbus and without any doubt, Hucho hucho and Salmo trutta morpha fario had seriously decreased. In general, this was the result of human activities, and the excessive pressures of fishing, waterworks and water pollution.

After 1971, when the Iron Gate dam of the Danube at the Yugoslav-Romanian border began to function, the migration of big acipenserids was seriously stopped. On the other hand, from the beginning of this century, the introduction of exotic species of fish has gradually increased, not only in the Slovak Republic but in neighbouring countries also. These activities resulted in the fact that, at the time of river damming which took place in autumn 1992, there occurred 61 species of fish belonging to 16 families.9,10,11

Changes after putting the Gabcikovo structures into operation

At present, there are claims that the fish species diversity has drastically declined.12,13,14 Undoubtedly, this is an expression of the big bias against the waterworks. On the other hand, it should be pointed out that, compared with the past, the recent monitoring uses different, less effective methods of fishing. Moreover, the change of the river topography was sure to cause the relocation of fish populations from less favourable habitats to other, better and more permanent ones. For example, in the old river bed, the occurrence of 45 out of 50 species and, in the branches, the occurrence of 31 out of 56 fish species has been confirmed (Table 1).

Up to now, there is no significant evidence concerning extinction of any species. On the contrary, some cold water species that have been living in the river for years can be observed: Salmo trutta morpha fario, Oncorhynchus mykiss, Hucho hucho. New habitats, such as rocky chutes, are predominantly inhabited by Barbus barbus. Also living there are Leuciscus cephalus, Lota lota, Chondrostoma nasus, Gymnocephalus schraetser, Leuciscus leuciscus, Oncorhynchus mykiss, Abramis bjoerkna, Abramis brama, Aspius aspius, Leuciscus idus, Perca fluviatilis, Scardinius erythrophthalmus and Gobio gobio. A very important fact is the occurrence of rare and protected species: Zingel zingel, Cottus gobio, but mainly Gobio uranoscopus, observed only three times in the last 50 years.15,16,17 This means that the bare, smooth river bed does not create such quantity of microhabitats for Rheophilous fish species and macrozoobenthos as do rocky chutes and underwater weirs.

Studies by Kirka et al.18 provided the only concrete data on the positive effect of rocky chutes used for the improvement of the river bed in the former Czechoslovakia. As compared with the original natural stretch devastated by erosion, a considerable increase in fish abundance and biomass was observed in the section of the Torysa River, downstream of the village of Brezovica, which was improved by building a number of rocky chutes.

Table 1. Actual state of ichthyofauna in the territory affected by dam construction

SPECIES	**Reservoir**	**Tailrace canal**	**Original river bed**	**Branch system**
I. ACIPENSERIDAE				
1. Acipenser ruthenus	+	++	++	+
II. SALMONIDAE				
2. Hucho hucho	-	+	++	++
3. Oncorhychus mykiss	+	++	++	++
4. Salmo trutta morfa fario	+	++	++	+
5. Salvelinus fontinalis	-	+	?	-
III. COREGONIDAE				
6. Coregonus lavaretus	+	+	++	+
7. Coregonus peled	+	+	-	+
IV. ESOCIDAE				
8. Esox lucius	+	++	++	++
V. UMBRIDAE				
9. Umbra krameri	-	-	-	+
VI. ANGUILLIDAE				
10. Anguilla anguilla	+	++	+	+
VII. CYPRINIDAE				
11. Abramis ballerus	+	++	++	+
12. Abramis bjoerkna	+	++	++	++
13. Abramis brama	+	++	++	++
14. Abramis sapa	-	++	++	+
15. Alburnoides bipunctatus	-	-	+	+
16. Alburnus alburnus	+	++	++	++
17. Aristichthys nobilis	+	+	++	+
18. Aspius aspius	+	++	++	++
19. Barbus barbus	+	++	++	++
20. Carassius auratus	+	++	++	++
21. Carassius carassius	+	-	?	+
22. Chondrostoma nasus	+	++	++	++
23. Ctenopharyngodon idella	+	++	++	+
24. Cyprinus carpio	+	++	++	++
25. Gobio albipinnatus	+	+	++	++
26. Gobio gobio	+	+	++	+

27. Gobio kessleri	-	+	+	+
28. Gobio uranoscopus	-	+	++	+
29. Hypophthalmichthys molitrix	+	+	++	+
30. Leucaspius delineatus	+	-	-	+
31. Leuciscus cephalus	+	++	++	++
32. Leuciscus idus	+	++	++	++
33. Leuciscus leuciscus	-	+	++	+
34. Pelecus cultratus	?	++	++	+
35. Pseudorasbora parva	+	+	+	+
36. Rhodeus sericeus amarus	+	-	++	++
37. Rutilus frisii meidingeri	?	+	+	-
38. Rutilus pigus	+	+	++	+
39. Rutilus rutilus	+	++	++	++
40. Scardinius erythrophthalmus	+	+	++	++
41. Tinca tinca	+	+	++	++
42. Vimba vimba	+	++	++	++
VIII. COBITIDAE				
43. Cobitis taenia	+	+	+	++
44. Misgurnus fossilis	-	-	-	++
45. Orthrias barbatulus	+	+	+	++
46. Sabanejewia aurata	-	-	?	?
IX. ICTALURIDAE				
47. Ictalurus nebulosus	?	?	?	+
X. SILURIDAE				
48. Silurus glanis	+	++	++	++
XI. GADIDAE				
49. Lota lota	+	++	++	++
XII. GASTEROSTEIDAE				
50. Gasterosteus aculeatus	+	++	++	+
XIII. CENTRARCHIDAE				
51. Lepomis gibbosus	+	?	++	++
XIV. PERCIDAE				
52. Gymnocephalus baloni	+	+	++	++
53. Gymnocephalus cernuus	+	+	+	++
54. Gymnocephalus schraetser	-	+	++	+

55. Zingel streber	-	++	++	+
56. Zingel zingel	-	+	++	-
57. Perca fluviatilis	+	++	++	++
58. Stizostedion lucioperca	+	++	++	++
59. Stizostedion volgense	?	++	++	+
XV. GOBIIDAE				
60. Proterorhinus marmoratus	+	+	++	++
XVI. COTTIDAE				
61. Cottus gobio	+	+	++	++
Total species confirmed		**28**	**45**	**31**

(+) probable occurrence, (++) confirmed occurrence, (-) improbable occurrence, (?) uncertain occurrence

In the unimproved stretch, the total abundance and biomass were 1,158 pcs/ha and 35.9 kg/ha, respectively, while in the rocky chute area the corresponding values were 4,223 pcs/ha and 391.1 kg/ha; this means that the former value increased by 264% and the latter by as much as 909%. These values illustrate explicitly the positive effect of the rocky chutes upon the fish stock of the Torysa River.19 Similar conditions can be estimated in the underwater weir at the 1,843th km, close to the Dunakiliti dam, in the main river bed of the Danube river.

Due to its parameters and properties, the river bottom is one of the most decisive factors for riparian fish populations, primarily as regards species diversity and number.20 The bottom is a dynamic subsystem of any water ecosystem. In relation to fishes, the river bottom is their habitat, food source and the substrate on which they deposit eggs during spawning. Concerning fish populations, the following properties should be considered the most important:

- longitudinal and transverse diversity, a prerequisite for the necessary variety of microhabitats meeting the ecological requirements of particular fish species - rapids, ripples, currents, pools, backwaters, shallows, deep sections with different stream velocities
- heterogeneity and granulation of bottom substrates: organic substances, debris, clay, sand, gravel, rocks, boulders, bases for food sources, spawning substrate, shelters
- stability - although the bottom is a dynamic element, a considerable measure of stability is required by fishes

These properties seem to be more important than flow velocity alone. From the viewpoint of their origin, fish biodiversity in the territory in question is also interesting. The most numerous group is formed by original species with a big European distribution; 33-34 species. There are also 13 introduced species. The group of species of pontic-caspian origin consists of 14 species. The group of endemic species, living only in the Danube and its tributaries, is made up of 5-6 species. The eel Anguilla anguilla is the only catadromous species.

After completion of the Danube-Main-Rhine canal, the Black Sea and the Atlantic will have been connected. Despite the fact that a ship-lock is considered an insurmountable barrier for fish, some experts believe in the equalisation of the species potential of the fish of these systems, within the next 50 years. Species that can easily adapt to the prevalent natural, but especially artificial, microhabitats and those with a stronger migration instinct, will prevail in this process. The new phenomenon of the trans-European waterway will be accompanied by passive transfers of eggs by water birds and by ship bodies. Moreover, the fish larvae and fingerlings will be moved through ship-locks together with massive waves of water. The passive transport of water invertebrates will be the most intensive.

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