The ecological development to the Iron Gate I reservoir

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Introduction

After crossing the Pannonian Plain, the Danube enters the Carpathian basin. Known as the Iron Gates area, the defile covers a length of 40 km. The Carpathians bordering the Iron Gates area are crossed by more than 40 small streams, tributaries of the big river. In these streams a rich flora and fauna from several biogeographic regions can be found: Ponto-Caspic, Mediterranean, and Carpathian elements meet in the area (Buşniță, Brezeanu et al., 1970).

Before the construction of the Iron Gate reservoir, numerous Ponto-Caspic relict species were discovered in the river: *Manayunkia caspica, Hypania invalida, Hypania kowalevschi, Limnomizis benedeni, Diamisis pengoi, Aselus acvaticus, Dikerogamarus, Chaetogamarus, Pontogamarus.* Species like *Acipenser ruthenus, Huso huso, Acipenser stelatus, Acipenser guldenstaedti, Alosa pontica* used to go upstream for reproduction.

Results and discussion

The Danube's damming, a technical event with ecological implications.

The damming of the Danube and the construction of a reservoir able to hold 69.50 m.d.m.m., the depth of which was more than 50 m bigger than before, led to significant changes in the Iron Gates area. The newly formed fluvial reservoir suddenly and irreversibly changed the morphological and hydrological characteristics of more than 100 km river course (Fig. 1).

The influence of the river's damming can be detected up to Bratislava, but its intensity, especially with regard to water level fluctuations, increases as one gets closer to the dam. With the increase of the water level near the dam with about 30 m above the former level, large areas were flooded; the total flooded areas count more than 10,000 ha only within the Romanian territory. Several types of habitats can be identified within the new ecosystem, such as: the gulfs of the tributaries' mouths; the flat areas on the terraces located near the river before flooding; the former course of the Danube.

Water velocity decreased from 3-5m/sec. – as it has been registered along the sectors characterized by a steeper slope (especially between 991 and 1018 km) – to 1m/sec., while within certain areas (in the gulfs and along the flat areas) it is almost 0. Due to the decrease of the water velocity, the organic-mineral deposits are extremely high and represent one of the most important phenomena in the economy of the reservoir. During a period of 10 years, the deposits on the bottom of the reservoir reached a thickness of 10-11 m, especially in the areas where the water velocity is low.

Biocoenosis structures; formation and evolution of the main biocoenosis and of the plant and animal population within the reservoir area. As the water level increased and the nearby areas were flooded, the structure of the biocoenosis was radically transformed (Brezeanu et al, 1974). In these new environmental conditions, certain species disappeared (those characteristic to the springs and to the floodable ground areas), some restricted their

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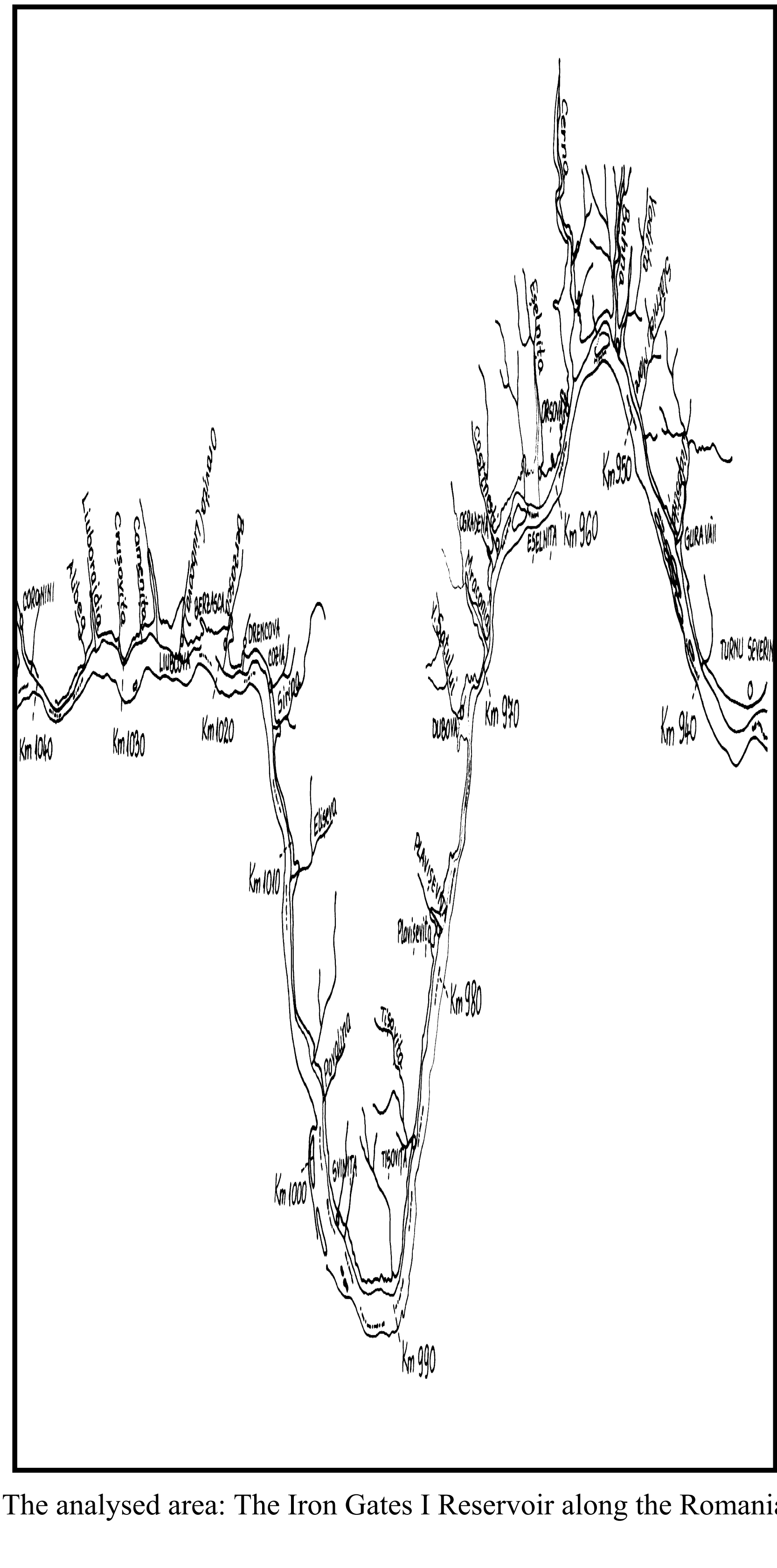

Fig. 1 The analysed area: The Iron Gates I Reservoir along the Romanian sector

habitats (mainly fish), while others, which occupied a limited area before the construction of the reservoir, rapidly increased in number and became dominant species (for example the zebra mussel *Dreissena polymorpha*) (Brezeanu, Gruia, 2000).

The new man-made ecosystem combines lotic and lenthic conditions and the biota reflect this diversity: rheophilic organisms are still an important part of the biocoenosis, but other organisms also found their place here (Fig. 2).

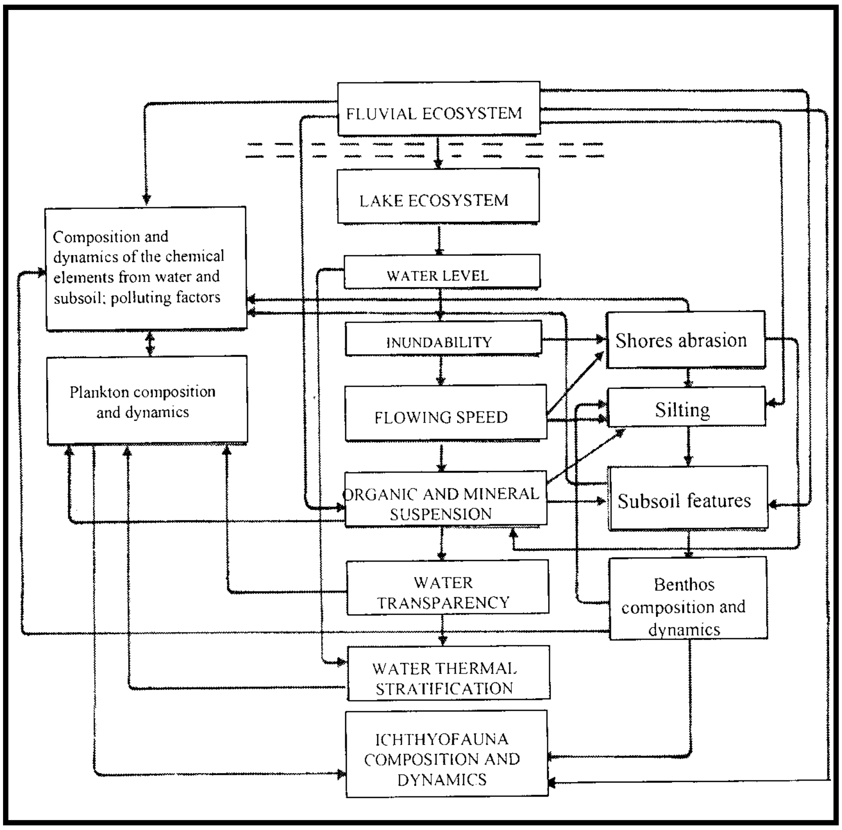

Fig. 2 The structural-functional relationship of the Iron Gates I Reservoir

The development of the phytoplankton.

Following the construction of the reservoir, the phytoplankton community changes quantitatively, as well as qualitatively (Oltean, Niculescu, 1974). Especially in the first years after the construction of the reservoir, but also afterwards, mass development of phytoplankton blooms was observed during the hot periods of the year.

Before damming, the density of the algae was no higher than tenth of million of samples per cubic meter. Afterwards, more than five times higher densities (hundredth of million per cubic meter) were registered. In some areas (especially the Cerna gulf), algal blooming phenomena take place. This development is a direct consequence of the eutrophication of the river water, due to the high content of mineral and organic nutrients originating from waste water both upstream and along the Romanian sectors of the Danube. Generally speaking, the maximum values in numerical density (as well as of the biomass) of the phytoplankton are produced by a low number of species: *Pandorina morum*, *Chlamidomonas*, belonging to the Chlorophyceae group, and of *Peridinium* from the Pyrrophyceae group.

The development of zooplankton.

Investigations revealed several stages in the development of the zooplankton (Brezeanu et al., 1973, 1983). Based on the variance in density and on the main zooplankton groups biomass (Rotifers, Cladocera, Copepoda), four development stages can be determined.

The first stage (1971-1972) is characterized by a rapid, explosive increase, of the zooplankton density in a short period of time (2-3 months since the construction of the reservoir): from 30,000 individuals of total zooplankton per cubic meter (before damming) values rose to a maximum value of 4,654,500 individuals per cubic meter. In certain areas the Copepods were more numerous than the Rotifers. The second stage (1972-1973) is characterized by the stabilization of the zooplankton production at the level of the first stage, even if one can notice a slight decreasing tendency, especially by the end of this stage. The third stage (1973-1974) is characterized by the decrease of the zooplankton quantity (450,000 individuals/cubic meter, respectively 800 mg/cubic meter as a maximum average). The fourth stage (beginning with 1974) is characterized by the stabilization of the density number and of the biomass at the level registered in 1974, probably indicating that the pelagic community stabilised at a new equilibrium.

The development of zoobenthos.

The construction of the reservoir led to the most profound and significant modifications in this group. Of the 493 taxa determined before damming, 353 disappeared during the first years after the construction of the reservoir. Nowadays, only about 90 taxa have been identified. Thus, the benthic community has a completely new spatial and taxonomic structure. Due to the intensification of the depositing of mineral and organic suspensions induced by the low water velocity, about 80 per cent of the surface of the reservoir bottom (especially the gulfs and flat areas) are covered by a silt layer and the pelophylic biocoenosis is the most largely spread.

As the rock, sand, clay and their combinations disappeared, a large part of the organisms that used to populate these substrates disappeared as well. It must be emphasised that the loss in biodiversity did not mean a reduction in density and biomass. On the contrary, one can notice an increase in the number and biomass of the benthic invertebrates between 1971 and 1980 in a reverse trend to the number of taxa.

The dominant groups are Chironomidae, Oligocheta and Corophydae, but we must underline the explosive development of the mussel species *Dreissena polymorpha* and *Speaerium riviculum*. Densities and biomass of these two species there were more than 30,000 individuals/square meter, respectively more than 2,500 g/sq m. These values are ten times higher than those registered before damming (Brezeanu, 1970).

There can be distinguished three stages in the development of the zoobenthos between 1971 and 1980: the first stage (1971-1973) is characterized by the total or partial disappearance of the cryophilic, rheophilic, and stagnophilic benthic populations from their specific ecosystems; the second stage (1973-1974) represents the stage when the benthic biocoenosis typical for lakes appeared; the third stage (1974-1980) represents the stage when a dynamic equilibrium in the structure of the benthic invertebrate populations appeared. At present, the structure of the zoobenthos, as well as of the phytoplankton and zooplankton is characteristic to the limnic-reophilic ecosystem (Cioboiu, Brezeanu, 2000).

The development of the ichthyofauna.

The ichthyofauna changes as well (Brezeanu et al., 1974; Bănărescu, Brezeanu, 1978). The abundance of the plankton characteristic for the first stage led to an increase in the number of the zooplanktivorous species. According to the amateur fishermen's information (who did not give me exact quantitative data), it results that especially *Alburnus alburnus, Pelecus cultratus* and *Rutilus rutilus* increased in number between 1972 and 1974. Consequently, the frequency of predators, such as *Esox lucius*, *Perca fluviatilis*, *Aspius aspius* and *Stizostenian lucioperca*, increased a lot as they had plenty of food. At the same time, the species feeding on benthos, such as *Abramis brama* and *Abramis ballerus,* became dominant during times when they had an abundant food base. This situation is also obvious if taking into account the experimental fishing during 1974. As the experimental fishing was limited, it cannot render the entire qualitative and quantitative structure of the ichthyofauna of the reservoir (Table 1).

Table 1 Composition of ichthyofauna shortly after the construction of the reservoir: experimental fishing – 1974 (after P. Bănărescu and Gh. Brezeanu)

Species	Number of individuals	Biomass (Kg)
Leuciscus cephalus	11	1.785
Leuciscus idus	4	1.140
Rutilus rutilus	35	3.277
Scardinus erythrophthalmus	3	0.265
Abramis brama	81	25.645
Abramis ballerus	126	17.493
Abramis sappa	8	0.615
Blicca bjoerkna	55	3.085
Aspius aspius	22	8.815
Barbus meridionalis	1	0.010
Acerina cernua	1	0.005
Stizostedion lucioperca	2	0.020
Chondrostoma nasus	29	7.120
Pelecus cultratus	13	2.345
Perca fluviatilis	1	0.090
Total	392	71.710

Due to the accumulation of silt on the bottom of the reservoir and to the decrease in water velocity, the structure of the population of *Acipenser ruthenus* changed: the adults migrate upstream, where they reproduce, while downstream, the high density of the juveniles *Acipenser ruthenus* was one of the most significant ichthyofaunistic changes taking place within the reservoir. The anadrome species *Huso huso, Acipenser guldenstaedti, A. stelatus* and *Alosa pontica* along this sector disappeared, as a direct consequence of the building of the dam.

Conclusions

After the construction of the dam on the Danube – Iron Gates area – there appeared the widest reservoir within the hydrographic basin of the river the length of which is of about 100 km. The presence of the reservoir led to fundamental modifications of the Danube biocoenosis structures. Certain populations of invertebrates disappeared while others appeared and the structure of ichthyofauna modified, as well.

During the reservoir development there can be noticed three significant stages: the first stage – disappearance of reophilic biocoenosis; the second stage – stabilization of the plankton and benthos production; the third stage – appearance of a dynamic equilibrium in the structures of fluvial-lacustrine biocoenosis, process that is still developing.

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