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ABSTRACT – In the period between 1991 and 2011 the multidisciplinary research team explored the Upper Tisa and the main Transylvanian tributaries of the Tisa river. In the present review we intend to offer a summary of our former results, indicating those risk factors that himper the biodiversity of rivers, and pointing out those river sectors where anthropic influences endanger the aquatic organisms. Because of the extended dimension of the database, we only illustrate our findings with a few relevant examples. For a better documentation, we have introduced in the end of this article the bibliographical references which contain the information regarding these results. Our results reflect that the natural characteristics of the rivers in the Tisa catchment area are very specific. The anthropic influences that determine physical, chemical and biological parameters of the affluents are also many-sided and particular. This diversity is brought about by the affluent rivers, and their knowledge is necessary for the correct interpretation of the ecology of Tisa river.

Key words: Tisa river, Transylvanian tributaries of the Tisa river, physico-chemical parameters, flora, fauna.

1. Introduction

During the study of freshwater molluscs in Transylvanian rivers, performed in the 1970s and 1980s, we observed that the spreading area of less tolerant species became more and more restricted because of increasing water pollution. Household, industrial and agricultural pollution became so complex along the river sectors, that it caused the complete extinction of some fauna components (such as
Unionidae shells) from hundreds of kilometers along specific river sectors (e.g. from the lower 420 kilometers of the Mures river). After 1990 the political changes made possible the investigation of rivers across country borders, along their whole length from the spring to the indraught in the Tisa river. This study was made in the first years mainly by individual specialists organized through grants obtained by non-governmental organizations (Pro Europa Liga - Tg. Mures, Romania and Tisza Klub Szolnok, Hungary), while later it was done in the frame of research programmes of universities and research institutes. We intended to apply a complex approach for revealing changes in physical, chemical and biological parameters of rivers, therefore we formed multidisciplinary teams for field measurements, sample collection and further processing of data. The main results are summarized in the volumes of the *Tiscia monograph series*, and we also created an internet database: (http://folyok.adatbank.transindex.ro/). For a better documentation, we have introduced in the end of this article the bibliographical references which contain the information regarding these results. We are convinced that this database created by us may be a useful starting point for further monitoring of the ecological state of the tributaries of Tisa river.

In the present review we intend to offer a summary of our former results, indicating those risk factors that himper the biodiversity of rivers, and pointing out those river sectors where anthropic influences endanger the aquatic organisms. Because of the extended dimension of the database, we only illustrate our findings with a few relevant examples.

2. Materials and methods

The multidisciplinary research team explored the below-mentioned rivers, and from previously established sampling points water samples and different biological samples were collected. Some samples were processed on site, while others were conserved and analysed in specific laboratories. The main results were presented in a common conference, where the different specialists had the opportunity to corroborate their results and to better understand the cause-effect relationships among the changes detected in physical, chemical and biological parameters related to the ecological state of different river sectors. In the period between 1991 and 2011 we have succeeded to study the Upper Tisa and the main Transylvanian tributaries of the Tisa river (Fig. 1). In the catchment area of the Mures river similar investigations were also performed in the period 1969-1991, and these results were used to illustrate temporal changes (SÁRKÁNY 1977, 1983, 1986a, 1988).

The different rivers were investigated several times during the above-mentioned period, to reveal changes in their ecological state on a shorter timescale. The periods of the study of different rivers are the followings:

- **Crisul Alb, C. Negru / Fehér- és Fekete-Körös**..........................................................1994
- **Crisul Repede / Sebes-Körös, Barcău /Berettyó**..........................................................1995
The sampling sites were established upon a previous survey of the regions, taking into account different morphological and pollution parameters of the river beds.

Figure 1
The marked rivers were surveyed between 1991-1996. Additional samplings were performed at several sites during 1997-2011.
3. Results and discussion

3.1. Upper Tisa

The Upper Tisa originates from the springs of White Tisa and Black Tisa in Ukraine, and the two components unite at Rahiv. Our research team has studied this sector until the inflow of the Szamos river (HAMAR and SÁRKÁNY-KISS 1999; SÁRKÁNY-KISS and HAMAR 2002). In this sector the water is clean, pollutants of the household wastewaters decompose quickly under the high oxygen concentration. In this region the main problem is flooding, water level may vary even 4-5 meters. Because large areas are affected by deforestation, precipitation runs off heavily from the mountains. This is especially obvious in the catchment areas of the Terebja and Teresva rivers, where inundations form stone dams at the inflow region into the Tisa. Because of the frequent floods, in this river sector the macrozoobenthos density is very low. For example, the gastropod *Ancylus fluviatilis*, which is characteristic for alpine waters, is present in a density of only 1-2 individuals per square meter.

The upper Tisa sector is polluted for decades by mining activity along the Vişeu and Szamos tributaries. Heavy metal pollution became extremely high after the cyanide catastrophe at Bozinta Mare, from where the Lăpuş river carried into the Tisa very high amounts of cyanide and of different heavy metals. From our investigations, we present here one example concerning heavy metal content of the upper Tisa sediment, determined in February 2002 (Fig. 2).

Investigations of the fish fauna of different rivers sectors offer a specific insight into the ecological state of the aquatic environment.

Figure 2
Metal content of the sediment of Tisa river in February 2002. Site 6 is downstream to the inflow of Szamos river.
The Upper Tisa river has been assessed as a quite natural river in which the sectors with altered ecological conditions are less present. However it is necessary to mention here the negative influences of waste waters derive river (Vişeu). Their negative effects upon the entire aquatic fauna are visible from the river springs until the river junction to d from the mining industry which leak into the tributary Vişeu Tisa (TELCEAN and GYÖRE 2000).

The carpathian brook lamprey *Eudontomyzon danfordi* became extinct in the tributary Vişeu and retained its populations only in a few sub-tributaries of this river, as well as in the main channel of Tisa (TELCEAN and CUPŞA 2011). The fish fauna from the upper stretch of Tisa is plentiful and it numbers 64 fish species just on the sector between the headwaters from Ukraine and the locality Tokaj in Hungary (HARKA and BÂNĂRESCU in HAMAR and SĂRKÂNY 1999). Among the native species, there also exist some adventives species. Our findings pointed out that the fish community has maintained its natural structure and diversity, despite of the human pressure. The only change observed here is related to the fish species location across the riverbed. There is a tendency of relocation in spreading for many rheophilic species in the upper sectors of the river. Someş gregarious fish which belong to the specialized and sensitive species category (TELCEAN and BÂNĂRESCU in SĂRKÂNY and SÎRBU 2002), such as *Chondrostoma nasus*, *Barbus barbus* and *Vimba vimba* have extended their spreading upstream in the river channel. Consecutively, the species representatives of the salmon group *Salmo trutta fario*, *Thymallus thymallus* and *Hucho Hucho*, have been retired upward on the river. The grayling *Thymallus thymallus* from the lower Vişeu (downstream to the junction of tributary Ruscova) represents potentially the largest population of this species from the Romanian rivers. It is presently menaced by numerous human activities, especially by the mining industry and the gravel extraction directly from the riverbed. A supplementary risk is represented by the sawdust deposits located near the riversides and the alluvial vegetation cutting. These are indirectly affecting the aquatic life. Two fish species are favored by the riverbank deforestation and the increasing tendency of water temperature: *Chondrostoma nasus* and *Squalius cephalus* (sin. *Leuciscus cephalus*). This phenomenon was also reported from other Romanian rivers which have been affected by riverbank deforestation and the increasing amount of algal coating layer on the river bottom. Responsible for the second effect is the increasing water eutrophication level downstream to the above mentioned localities.

Another river stretch in which the anthropogenic impact can be observed, is located downstream to the junction of the tributary Iza. There are numerous sites in which the gravels and sands are extracted directly from the river channel. This riverbed affecting process leads to numerical decrease of some rare and endemic fish species: *Lota lota*, *Zingel streber*, *Leuciscus leuciscus* and *Telestes souffia*. These fish have encountered a numerical decline downstream of Iza junction along a few kilometers. As a conclusion regarding the fish fauna from the upper Tisa valleys, we can state that the species diversity and communities’ structure from these rivers are almost in natural condition excepting the tributary Vişeu and partially the Iza river.
3.2. Tur / Túr river

The Tur / Túr river presents an unpolluted water until the inflow of the Turţ river. Until the year 2000 there was an intense mining activity along the upper sector of this river. Because of this, for example, a massive decline of Unionidae shells was observed in 1995 (SÁRKÁNY-KISS and SÎRBU 1999). In 2011, an average of 39 individuals of this shell could be found per square meter along the Tur river. The highest value was 131 individuals/m² (SÁRKÁNY-KISS, unpublished data). On the upper river sector, at Călinesti Oaş, a dam was built for electric energy production. During dry periods only a small water quantity is let into the river, as a consequence many shells dry out and die. When the dam is opened, the high water quantity suddenly rises the river level with 1.5-2 meters and causes the drifting of benthic fauna. The Egheňul Mare / Nagy Éger river, which flows parallel with the Tur river, has a wide waterbed (10 – 12 m), it is densely inhabited by aquatic plants, offering shelter for many protected species, such as the *Anisus vorticulus* aquatic gastropod.

Along the Tur river (which is the main polluting source for the Tur river), where the acid mine drainage enters the river, physico-chemical parameters of the water suffer obvious changes, e.g. water pH drops to values around 3.0. Due to this increased acidity, species diversity of periphyton becomes very low. In these acidic water sectors a special indicator protist species, the *Euglena mutabilis* was identified, the same species which form extended green covers in the polluted sectors of the Arieş river, an influent of the Mureş river, where mining activity also pollutes water with heavy metals and confers acidity to the aquatic environment. The abundance of *Euglena mutabilis* proved to be a good bioindicator of water pollution caused by heavy metal extraction and processing, related to acidification of the water (NAGY et al. 2008; NAGY-KORODI et al. 2011).

3.3. Someş / Szamos river

The Someş / Szamos river originates from three springs: the Warm Someş (68.8 km) and the Cold Someş (50.5 km) flow in the Western Carpathians, their confluence gives rise to the Someşul Mic (110.7 km), while the other branch, the Someşul Mare flows from the Eastern Carpathians. These two branches unite at Dej and form the so-called unified Someş, which has a total length of 415.5 km.

Investigation of the Someş river was the subject of four ample research projects, as a consequence this is the mostly well-known Transylvanian river from the ecological point of view, but this is also the one where the aspects of pollution are the most complex (SÁRKÁNY and HAMAR 1999, 2002; SÁRKÁNY and SÎRBU 2000, 2002; SÁRKÁNY in UJVÁROSI 2003). The sectorial nature and the temporal dynamics of water pollution along the Someş river is well reflected by the distribution of Unionidae shells (Fig. 3).

The main sources of domestic and industrial pollution of the Someş river are the towns of Cluj, Dej and Satu Mare, while in the Baia Mare region the major source of pollution is extraction of gold and polimetallic ores. Polluting agents originating in mining activities are mainly transported by the Lăpuş river. Concomitantly, the Someşul Mare is carrying from the Rodnei mountains the remainings of cupper extraction. Heavy metal pollution of the lowest sector of Someş river became very intense after the cyanide spill catastrophe that occurred...
on 30 January 2000 (SÁRKÁNY-KISS 2006). The cyanide-containing water also carried complexed heavy metals and dissolved the heavy metals that had formed sediments during the last geological periods (CORDOŞ et al. 2003; SÁRKÁNY et al. 2006), Fig. 4.

Figure 3
Segmental changes in the occurrence of Unionidae molluscs along the Someş river.

Water quality affects the abundance and the diversity of the aquatic microbiota, therefore the changes appearing in the composition of microbial populations and communities express the degree of water contamination. Because the waterborne microorganisms are the major cause of illness associated with the consumption of contaminated water, a detailed microbiological study is necessary for the evaluation of water quality (DABY et al. 2002). This includes the determination of the total number of aerobic heterotrophic bacteria and the quantification of some groups of bacteria that serve as indicators of water contamination. The presence and the amount of different inorganic and organic compounds in the water allow the development of a specific saprophyte microbiota, therefore the quantitative and qualitative changes occurring in the diversity, abundance and activity of microbial communities give useful information about the degree of water contamination and the nature of the major polluting sources (PAPP and FODORPATAKI 2002).

The total number of bacteria presents high values in all sampling sites along the Someş river, with a maximum at Buzesti, situated upstream to the confluence point of Someş with Lăpuş river. The coliform group of bacteria that consists of members of the genera Escherichia, Citrobacter, Klebsiella and Enterobacter serve as indicators of the fecal contamination of the water. The fecal
Coliforms are a termotolerant subgroup of total coliforms and include mainly members of *Escherichia* and *Klebsiella*. Because the fecal coliforms are almost exclusively found in the waste of warm-blooded organisms, this group reflects more accurately the presence of fecal contamination from animals in water than does the total coliform group.

![Figure 4](image)

Dynamics of heavy metal content in the water of the Someș and Lăpuș rivers during the four seasons of the years (winter, spring, summer, autumn).

Fecal enterococci have also been used as indicators of fecal contamination of the water, members of this group persisting longer time in the water than coliforms (ROMPRÉ et al. 2002). Compared to the high values of the amount of heterotrophic bacteria, the number of fecal coliforms and enterococci presents relatively low values, indicating that in this region of the river there is not a significant fecal contamination caused by household wastewater and the by-products coming from agriculture and animal husbandry. The heterotrophic microbiota of the river is composed mainly of degradative bacteria and physiological groups that play a major role in the metabolization of organic pollutants and autopurification processes. The obtained results confirm that the ammonifying bacteria, that utilize nitrogen-containing organic compounds are well represented in all sampling sites and are followed in number by the aerobic denitrifying bacteria, that under anaerobic conditions use nitrate as terminal electron acceptor for the metabolization of organic substances. The number of iron-reducing and sulfate-reducing bacteria presents the highest values downstream from Dej, where the water is loaded with polluting substances coming...
from different human activities of Cluj, Gherla and Dej, and lower values in the last two sampling sites, Bozinta Mare and Pomi (Fig. 5 and 6).

Figure 5
Distribution of different physiological groups of bacteria along the Somes river.

Figure 6
Distribution of bacterial indicators of water quality along the Somes river.
Figure 7
Dynamics of cell density in cultures of *Scenedesmus opoliensis* exposed to water samples from different sectors of the Somes river. C – control; Cd – 25 µM CdCl₂ in the nutrient medium; uCj – water from Somes river upstream Cluj city; dCj – water from downstream Cluj city; Dej – Someş water from the town of Dej; BM – water of Someş river from the Baia Mare region. Bars represent standard errors from means (n = 5).

As a river that crosses urban and industrial areas, the Someş contains fluctuating amounts of various inorganic and organic pollutants. Studies on the influence of pollutants on aquatic organisms involve standardized single-species test systems. Microalgae are highly suitable for ecotoxicological tests, but one has to identify those physiological and biochemical parameters which are good markers for a sensitive, reliable and cost-efficient bioindication of water quality (FODORPATAKI et al. 2001). The main reason for including algae in environmental monitoring programs is their key role in mediating the flux of energy and nutrient availability in aquatic ecosystems. Algal indicators can be used in all aquatic habitats and for a wide range of environmental stressors. Individual species are generally widely distributed among ecosystems and geographical regions, and this widespread occurrence reduces problems associated with standardizing metrics. Because of their short response times, algae often provide one of the first signals of aquatic ecosystem impacts. Metabolic changes induced in algae by chemical stressors are important not only for bioindicating water quality, but also for designing efficient wastewater treatment systems, and for protection of endangered aquatic habitats (FODORPATAKI and PAPP 2000, 2002). Cultures of *Scenedesmus opoliensis* P. RICHTER, used as single-species test systems, were exposed to differently polluted water samples collected in distinct sectors of the
Somes river, in order to identify physiological and molecular markers suitable for a reliable bioindication of changes in the quality of aquatic environments. Algal cultures grown in Bold’s basal nutrient medium were used as control, and another reference consisted of cultures exposed to 25 µM CdCl₂. Reproductive capacity of algae is a relevant endpoint of acclimation to adverse condition, and reflects how the populations cope with stress factors. From the different parameters that reflect growth and developmental dynamics of algal populations, the variation of cell density was found to be the best indicator of disturbances caused by water pollution along the sectors of the Someș river. The presence of household and industrial pollutants carried by the river downstream to the cities of Cluj and Dej delayed the growth of algal populations, but the most obvious inhibition of cell divisions was observed in the water of Baia Mare region, loaded with heavy metals. This inhibition was similar with the one registered in the presence of micromolar amounts of cadmium in the culture medium (Fig. 7). In our experiments, the most sensitive parameter of the induced chlorophyll fluorescence, which showed significant changes in all of the polluted water samples collected from the Somes river, was the relative fluorescence decrease (Rfd), also known as the vitality index (Fig. 8).

![Figure 8](image-url)

Vitality index deduced from chlorophyll fluorescence parameters in *Scenedesmus opoliensis* exposed to water samples from different sectors of the Somes river. C – control; Cd – 25 µM CdCl₂ in the nutrient medium; uCj – water from Someș river upstream Cluj city; dCj – water from downstream Cluj city; Dej – Someș water from the town of Dej; BM – water of Someș river from the Baia Mare region. Bars represent standard errors from means (n = 5), asterisk indicates significant differences from control (P < 0.05).
Benthic macroinvertebrate community richness is clearly decreased along the Someș. We can observe a decline in the density of more sensitive organisms at downhill sampling sites, where benthic communities become dominated by more tolerant taxa like Oligochaeta. Research completed on bioaccumulation capacity of *Unio crassus* (SÁRKÁNY-KISS and HAMAR 2002) (Fig. 9) and *H. contubernalis* (Fig. 10) (BÁLINT et al. 2006) shows that anthropogenic heavy metal contamination represents a major stressor for the river’s ecosystem.

**Figure 9**
Heavy metals accumulation in *Unio crassus* gills after 3 weeks of exposure to water of the Someș river downstream to the influence of Lăpuș river.

The total number of fish species identified in the Someș watershed is 62 species, most of them (42 species) are native and 13 are introduced (BĂNĂRESCU et al. in HAMAR and SÁRKÁNY 1999). The human influence is strikingly observed along the river branch Someșul Mic which is affected by the river damming on its spring areas and by the wastewaters leakage from the localities and industrial settlements. Sensitive species like *Thymallus thymallus*, *Gobio uranoscopus*, *Sabanejewia aurata* and *Rhodeus sericeus* became extinct early upstream the city of Cluj-Napoca. Other two common species *Chondrostoma nasus* and *Squalius*
cephalus underwent a drastic numerical decline. Because of the river pollution caused principally by industries, the fish fauna was totally extinct from the city of Cluj-Napoca to the locality Răscruce (about 20 km downstream the river).

Another affected river stretch is located on the united Someș at the confluence of the tributary Lăpuș. This is a strongly polluted site which is affected by cyanide wastes from the gold extraction industry. Our findings proved the negative effects of cyanide wastes upon the fish fauna. The samples from upstream Lăpuș river junction indicates a relative increased number of species, including the specialized and sensitive fishes Chondrostoma nasus, Barbus barbus, Sabanejewia aurata and Rhodeus sericeus. Samples originating from the united Someș, downstream the junction of Lăpuș river indicated the scarce presence of the fish species. There were identified only the ubiquitous and tolerant species Squalius cephalus, Alburnus alburnus, Gobio gobio and Pseudorasbora parva. The total number of individuals was decreased comparing to the samples from the upstream river sector.
3.4. Criș / Körös rivers system

The rivers forming the Criș/Körös river system are the Crișul Alb/Fehér Körös, Crișul Negru/Fekete Körös, Crișul Repede/Sebes Körös, Barcău/Berettyó, Kettős Körös and Hármas Körös. The first two of these can be considered as being in a natural site only in the upper reaches, in the spring zone. Significant human influences have been identified in the middle and lower reaches of these rivers. One of these is the pollution with drainage- and wastewater, due to which the disruption of the continuous areal of sensitive species like Ancylus fluviatilis and some Plecoptera and Ephemeroptera species have been noticed. The abundance of Oligochaeta species is considerably high, as the consequence of the sediments rich in organic matter (SÁRKÁNY and HAMAR 1997, 2002; SÁRKÁNY and SÎRBU 2002; GALLÉ 2005).

The Unionidae shells are quite common in this reach. The other human influence is that the rivers are bordered with agricultural lands from which they receive nutrient-enriched waters. On the lower reach of the Crișul Alb/Fehér Körös the sensitive shell and fish species are present, but their heavy metal content is high, this endangers their survival (PONTA et al. 2002).

The upper stream of the Crișul Repede has a very slow run. It carries a lot of organic matter from the marsh springs and a thick muddy sediment characterizes this slightly sloping riverbed. Organisms typical for the hilly section stock the river. Downstream the inflows of the two main tributaries, the Drăgan and Iad rivers, the Crișul Repede/Sebes Körös runs down in a steep slope, and enters the Vadu Crișului Defile among the limestone rocks, where the water is deep (up to 1.5 m) and the water speed reaches 1.5 m/sec. Although the water is clean and rich in oxygen, Plecoptera and Ephemeroptera species typical to mountain region are missing, probably due to the above mentioned abiotic factors. Downstream the Defile to Aleșd locality, species characteristic of submountain region have been identified. Between Aleșd and the city of Oradea three dam lakes used as hydroelectric power plants have been built. Downstream these, the fluctuation of the flowing regime and of the temperature influences the fauna. In the old riverbed a varied benthic fauna have been identified, but this is endangered due to diversion of the water in concreted canals, which are unfavorable for the living organisms. In the dam lakes the deposition of the sediment allows some living organisms characteristic to lakes to establish (e.g. Anodonta cygnea) (SĂRKĂNY et al. 1999).

Downstream to Oradea the industrial and household wastewater, as well as the pollution of the stock-raising farms leave their marks on the biota of the river.

The river-head of the Barcău/Berettyó river is on a hilly region, its water has a very good quality. It can be stated that the river is very polluted downstream of Suplacu de Barcău, where the oil-pollution resulting from oil production was very significant. The quality of the water is improving downstream the oil-polluted sector (Sphaerium rivicola has been found).

The Sinanodonta woodiana Unionidae adventive species was first recorded in Europe from the Criș river system, from where it spread in the Tisa and Danube rivers (SĂRKĂNY-KISS 1986b; SÎRBU et al. 2000, 2006).

On the plain sections all the rivers are pressed between dam-systems, which are very close to the riverbed, tighten the rivers so these cease to have a
flood area. During the regulation, the bends were cut through, so the rivers resemble view of canals. The slow velocity of the water creates favourable conditions for eutrophication processes to occur, indicated by the high chlorophyll-a content of the water and presence of large number of macrophytes.

The main threats to the fish fauna of these rivers are represented by the river regularization and meander shortening, the levees and river damming (TELCEAN et al. 2006). The influence of the hydropower plants upon the rivers fish fauna consists in large amplitude fluctuation of water level and of temperature downstream the dams. These have a negative effect upon the entire fish fauna, reflected by reduction of species diversity and by the numerical decline of fish populations (TELCEAN 1997). The other major threatening factors, represented by levees and meander shortenings are affecting the natural alternation of the microhabitats along the lower stretch of the three Criș river (TELCEAN et al. 2006; TELCEAN és CUPSA 2007). The same levees were built up also in the valley of the other lowland rivers (e.g. Timiș in Banat), where the levees are distant and allow the river to maintain its original course with meanders and various depths and water velocities (BĂNĂRESCU et al. in SÁRKÁNY and HAMAR 1997). Our findings regarding the fish species from the three Criș river are referring to a number of 40 species identified here. We observed the prevalence of common species Squalius cephalus, Chondrostoma nasus, Barbus petenyi and the scarcity of sensitive species Gymnocephalus schraeter, G. cernuus, Stizostedion lucioperca (Sander lucioperca), Zingel streber and Zingel zingel. The last species are pertaining to the rheophilic perch-group which is sensitive to organic pollutants and riverbed modifications (TELCEAN et al. 2006). However, the state of the fish fauna of the three Criș rivers is better than that of most other rivers in Romania and Hungary (BĂNĂRESCU et al. in SÁRKÁNY and HAMAR 1997). In the upper Crișul Repede river the endangered species Thymallus thymallus is native being at the southernmost limit of its distribution area. In the same river the rare species Leuciscus leuciscus is still surviving in good conditions. The Crișul Alb is the only river in Romania where the species Zingel streber and Gymnocephalus schraetser apparently maintain their former abundance.

In the river Barcău, tributary of Crișul Repede river, the ecological state is drastically deteriorated by wastewater leakages from the oil industry at Suplacu de Barcău locality and urban wastes from the locality Marghita. The former fish fauna has completely changed in this river. The species Leuciscus leuciscus, Gobio kessleri and Gymnocephalus schraetser became extinct. The only species which survived here are the ubiquitous fish Squalius cephalus, Rutilus rutilus, Alburnus alburnus, Gobio gobio and Orthrias barbatulus.

3.5. Mureș / Maros river

The Mureș / Maros river is the longest Transylvanian river, with a total length of 766 km. It flows among very diverse surface forms. After a very short mountain sector it flows as a meandering stream through the peat bog area of the Gheorghiemi basin. It continues its course between the Gurghiu and Călimani mountains through a narrow gorge, where its altitude drops with 110 m along a distance of 45 km. The middle sector crosses the Câmpia Transilvaniei (Erdélyi-Mezőseg), and its deep and slow water enters into the Southern Carpathians. The
lower river sector is deep and flows slowly in the Pannonian plain until it reaches the Tisa river. According to the different geographic areas it crosses, the wildlife of the Mureş river exhibits a great diversity. Its sectorial distribution is enhanced by the fact that it flows through bigger towns like Tg. Mures, Deva, Alba Iulia and Arad. Water chemistry is modified by household wastewaters and by industrial settlements, many of which being located along the tributary rivers (Târnava, Arieş) (SÁRKÁNY-KISS 1983; HAMAR and SÁRKÁNY-KISS 1995; SÁRKÁNY-KISS and HAMAR 2002; SÁRKÁNY-KISS and SÎRBU 1998, 2002; SÁRKÁNY-KISS et al. 1997). At present the Mureş river is directly polluted mainly with nitrogen compounds from the fertilizer factory in Targu Mureş (Fig. 11). The Târnava river transported high amounts of heavy metals into the Mureş (Fig. 12) until the chemical factories of Târnăveni and Copşa Mică had been closed. Because of this pollution, the Unionidae molluscs disappeared from the lower 420 kilometers of the Mureş river, and they started to repopulate this river sector only after 1999, when the chemical factories were shut down.

![Figure 11](image1.png)

Changes in the concentration of nitrites and nitrates along the Mureş river. Left Y axis: nitrites (mg/l), right Y axis: nitrates (mg/l).

The Arieş river also transports into the Mureş significant quantities of heavy metals, originating from mine drainages related to ore exploitation. Fig. 13 illustrates that downstream to the inflow of Roşia (Veres) creek, benthic macroinvertebrates are totally absent from the Arieş river. The dynamics of inorganic salts and organic substances along the Mureş river is reflected by distribution of algae (Fig. 14) and of Rotatoria (Fig. 15).

The fish species list from Mureş river contains 56 species, most of them distributed mainly on the upper river stretch. The sector included between the spring areas and the city of Târgu-Mures contains the richest fish fauna of this river (NALBANT in HAMAR and SÁRKÁNY 1995; TELCEAN 2001). The middle river stretch from locality Ungheni downstream to localities Sântimbru and Deva is affected by
numerous and diverse human activities including the wastes derived from industries and the human settlements. This river sector is passing over the Transylvanian county, a region with numerous localities, industries and intensive land use for agriculture. All of these are affecting the aquatic fauna, especially the fish which are in most cases the subject of over-fishing and poaching. Our findings regarding to the fish fauna reflects the prevalence of species which belong to the ubiquitous ecological category (TELCEAN and BĂNĂRESCU in SĂRKĂNY and HAMAR 2002). The other categories of rare and sensitive species are present here in a smaller proportion because of human pressure. A special remark is needed concerning the specialized fish category represented here by the species Chondrostoma nasus, Barbus barbus, Vimba vimba, Aspius aspius and three Abramis species. Their occurrence on the middle stretch of the river is favored by the large riverbed which allows them to find optimal condition for feeding and spawning. The natural mosaic of habitats which is shaping on the large riverbeds together with the adjacent tributaries and river arms represents natural refuges and the main resource for resettlement process (TELCEAN and CUPŞA 2009a). However, the smaller frequency of the sensitive species is maintained along the lower river stretch between localities Zam and Pecica. During the last decades the reduction of amount of industrial wastes from the Romanian stretch of Mureş was favorable for a range of fish species which have been restored their former populations in the lowland Mureş (TELCEAN and CUPŞA 2009b). Thus some species considered almost extinct from the lower Mureş were recently identified in this river stretch: Zingel zingel, Z. streber, Lota lota and Gymnocephalus schraetser. Many of these fish are passing upstream from Tisa.

![Figure 12](image.png)
Pb concentrations in the Mureş River; grey = in 1991, black = in 2000, 4 = upstream Târnava, 5 = upstream Arieş.
The relative abundance of the main taxonomic groups from the macrozoobenthos of the Arieş river at different sampling sites (a dip – other Diptera, ch – Chironomidae, tr – Trichoptera, pl – Plecoptera, ep – Ephemeroptera, ol – Oligochaeta). Site 6 is downstream to the inflow of Roşia Montana creek.

Dynamics of taxa and cells counts of algae along the Mureş river.

Based on the physical and chemical parameters, as well as on the aquatic living communities and on the anthropic influence along the Mureş river, the ecological state of the different river sectors has been mapped (SÁRKÁNY-KISS and MACALIK 1999).
4. **Conclusions**

Our results reflect that the natural characteristics of the rivers in the Tisa catchment area are very specific. The anthropic influences that determine physical, chemical and biological parameters of the affluents are also many-sided and particular. Water chemistry, completed with ecotoxicological tests and with the examination of different categories of aquatic organisms and communities give an insight into the spatial and temporal distribution of ecological processes that occur in the catchment area of the Tisa river. In many cases a certain aquatic species occurs only in one river or only in one of its sectors, even though some of these rare species are able to perform active movement (such as fish species). These specialist species are the most eloquent proofs of the special environment in which they live. This diversity is brought about by the affluent rivers, and their knowledge is necessary for the correct interpretation of the ecology of Tisa river.

**References**


