An Ecological Assessment of the Fish Fauna in the Upper Course of the Crasna River, North-Western Romania

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Abstract
In this study, the ichthyofauna of the upper course of the Crasna River was analyzed in order to assess the diversity, structure, and ecological status of fish communities along its course. Nine sectors of this watercourse were established and surveyed, each sector having lengths ranging between 150 and 200 meters. A total of 15 fish species were identified, belonging to three orders and eight families, as follows: Ord. Cypriniformes (Fam. Acheilognathidae: *Rhodeus amarus*; Fam. Cobitidae: *Cobitis elongatoides*; Fam. Cyprinidae: *Barbus carpathicus*, *Carassius gibelio*; Fam. Gobionidae: *Gobio carpathicus*, *Pseudorasbora parva*; Fam. Leuciscidae: *Squalius cephalus*, *Alburnoides bipunctatus*, *Alburnus alburnus*, *Rutilus rutilus*, *Leuciscus aspius*; Fam. Nemacheilidae: *Barbatula barbatula*), Ord. Perciformes (Fam. Percidae: *Perca fluviatilis*, *Gymnocephalus cernua*), and Ord. Centrarchiformes (Fam. Centrarchidae: *Lepomis gibbosus*). The number of fish species increased as the altitude of the surveyed sectors decreased. Considering all surveyed sectors, the highest percentage share was recorded for Carpathian barbel (26.9%), while asp and pumpkinseed showed the lowest proportions (0.1% of each). Based on the obtained data, a relatively high diversity of fish populations was observed in the upper course of the Crasna River, with a complex community structure for a river of relatively small size.

Keywords: anthropogenic factors, ecological indices, electrofishing, fish biodiversity.

1. Introduction

Freshwater aquatic ecosystems represent essential components of the natural environment, playing a major role in maintaining biodiversity and supporting ecological balance. Within these systems, fish communities constitute a particularly important biological element, as they are sensitive to variations in environmental factors and to anthropogenic influences [1, 2].
For this reason, ichthyological studies are frequently used as tools for assessing the ecological status of watercourses, providing valuable information on habitat quality and ecosystem dynamics [3, 4].
Rivers located in the hilly regions of Transylvania are characterized by a high variability of hydromorphological conditions, determined by the alternation of sectors with moderate slopes, diverse substrates, and relatively fluctuating hydrological regimes [5]. Although these watercourses generally have lower discharge compared to large rivers, they can reach considerable lengths and traverse multiple habitat types, ranging from near-natural

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areas to sectors influenced by anthropogenic activities.

This diversity of conditions supports the development of varied fish communities adapted to local environmental characteristics. In the current context, marked by increasing anthropogenic pressures on aquatic environments [6, 7], such as pollution, hydrotechnical modifications [8, 9, 10], river channel regulation [11], and the introduction of non-native species [12], the assessment of lotic ecosystem status has become a necessity [13, 14, 15].

The present study aims to analyze the ichthyological characteristics of the upper course of the Crasna River, a river with relatively low discharge but a significant longitudinal development of 173 km, of which 127 km lie within Romania. Through the direct investigation of the studied sector, the objective is to obtain an overall picture of fish diversity and its relationship with specific environmental conditions.

The results obtained may contribute to a better understanding of the functioning of the analyzed ecosystem and may serve as a starting point for future studies or for the development of conservation strategies and sustainable management of aquatic resources.

2. Materials and methods

This study was conducted from June to September 2023 in the Someș–Tisa river basin, in the upper course of the Crasna River, Sălaj County, Romania. A total of nine sectors were surveyed, from the springs of the Crasna River to its discharge into Vârșolț Lake [Table 1]. The length of the surveyed sectors ranged between 150 and 200 m, with sampling in each sector carried out from downstream to upstream.

Fish fauna in the upper course of the Crasna River was surveyed using single-pass electrofishing techniques. A SAMUS 528 MS electrofisher powered by a 12 V, 10 A battery was used. The frequencies applied during sampling ranged between 40 and 50 Hz, thus covering the ranges recommended by the FAO for different fish families [16].

Table 1. Surveyed sectors of the upper course of the Crasna River and their GPS coordinates

Sector	Name	GPS coordinates	Altitude (m)
Sector 1	Crasna Springs	N47.051827-E22.862561	460
Sector 2	Cizer Village	N47.059723-E22.860481	320
Sector 3	Pleșca Village	N47.079760-E22.887522	307
Sector 4	Stârciu Village	N47.098374-E22.891682	283
Sector 5	Horoatu Crasnei Village	N47.132549-E22.897922	271
Sector 6	Crasna Village – entry	N47.151292-E22.872978	251
Sector 7	Crasna Village – exit	N47.166414-E22.877351	241
Sector 8	Mărtăuța Village	N47.171836-E22.882180	237
Sector 9	Estuary – Vârșolț Lake	N47.177942-E22.906502	235

All captured specimens were measured (total length – TL) and weighed (BW) in order to subsequently calculate the condition index (Fulton's condition factor – K). The condition factor was calculated using the following formula: $K = [(Bw / Tl^3) \times 100]$.

The taxonomic classification of the identified species was determined at the level of orders, families, and genera. Alpha diversity (α-diversity), expressed as species frequency, was also calculated, along with the distribution of species across sectors and along the altitudinal gradient.

3. Results and discussion

The analyzed community comprises 15 species, distributed across three main orders (Cypriniformes being dominant, followed by Perciformes and Centrarchiformes) and several families. The dominance of the order Cypriniformes is characteristic of freshwater ecosystems in Central and Eastern Europe, including Transylvania [Table 2]. The presence of a relatively high number of species belonging to different families indicates a moderate to high level of diversity. The community includes native species characteristic of the Danube basin (e.g., Carpathian barbel, Carpathian gudgeon), widely

distributed European species (e.g., roach, European perch), and non-native/invasive species such as stone moroko, Prussian carp, and pumpkinseed. The fish community comprises multiple trophic levels: predators that regulate populations of small fish (asp and European perch), benthic invertebrate consumers dependent on substrate type and sediment quality (Carpathian gudgeon, stone loach, and Danubian spined loach), omnivorous/planktivorous species (roach, bleak, and chub), as well as opportunistic species (stone moroko and pumpkinseed). The trophic chain is complete and functional; however, pressure from invasive species may destabilize the system, particularly through competition and predation on the juvenile stages of native species.

Table 2. Taxonomic composition of fish species identified in the study area

Order	Family	Species	Common name (EN)
Cypriniformes	Acheilognathidae	*Rhodeus amarus* (Bloch, 1782)	European bitterling
	Cobitidae	*Cobitis elongatoides* Băcescu & Mayer, 1969	Danubian spined loach
	Cyprinidae	*Barbus carpathicus* Kotlík, Tsigenopoulos, Ráb & Berrebi, 2002	Carpathian barbel
		Carassius gibelio (Bloch, 1782)	Prussian carp
	Gobionidae	*Gobio carpathicus* Vladykov, 1925	Carpathian gudgeon
		Pseudorasbora parva (Temminck & Schlegel, 1846)	Stone moroko
	Leuciscidae	*Squalius cephalus* (Linnaeus, 1758)	Chub
		Alburnoides bipunctatus (Bloch, 1782)	Schneider
		Alburnus alburnus (Linnaeus, 1758)	Bleak
		Rutilus rutilus (Linnaeus, 1758)	Roach
		Leuciscus aspius (Linnaeus, 1758)	Asp
	Nemacheilidae	*Barbatula barbatula* (Linnaeus, 1758)	Stone loach
Perciformes	Percidae	*Perca fluviatilis* Linnaeus, 1758	European perch
		Gymnocephalus cernua (Linnaeus, 1758)	Ruffe
Centrarchiformes	Centrarchidae	*Lepomis gibbosus* (Linnaeus, 1758)	Pumpkinseed

Species frequency (α-diversity) highlights a fish community characterized by a non-uniform structure, in which a few dominant species account for the majority of total abundance [Figure 1]. In this context, Carpathian barbel, chub, stone loach, and Carpathian gudgeon exhibit the highest frequency values, suggesting effective adaptation to local environmental conditions and high competitive capacity [17].

These species are primarily associated with well-oxygenated lotic habitats with rocky or sandy substrates, indicating that the analyzed ecosystem exhibits characteristics typical of riverine environments. Subdominant species, such as roach, European bitterling, European perch, and bleak, contribute to the overall diversity of the community but have a lower proportional representation. Their presence reflects the existence of diverse microhabitats and complementary ecological conditions, allowing the coexistence of multiple ecological types, including species adapted to slower-flowing waters or marginal zones.

A number of species exhibited very low frequency values, as observed in taxa such as stone moroko, Prussian carp, and pumpkinseed. These are generally invasive or opportunistic species [18], and their low abundance suggests that, at the time of the study, their impact on the community was limited.

Overall, the alpha diversity of the fish community can be characterized as moderate, despite the relatively high number of identified species, due to the pronounced dominance of a few taxa. This structure indicates a functional ecosystem, but one that is sensitive to disturbances, where stability largely depends on maintaining habitat conditions favorable to the dominant species.

Fulton's condition factor (K) is not directly comparable among species with markedly different morphologies [19]. This index is widely used to assess the physiological condition of fish; however, its interpretation must be made in relation to species-specific morphological characteristics [20, 21].

The index assumes a standardized relationship between length and weight. Consequently, species with deep, laterally compressed bodies, such as Prussian carp, tend to exhibit higher K values, without necessarily reflecting a superior ecological condition. In contrast, species with elongated

bodies adapted to benthic habitats, such as Carpathian gudgeon and Danubian spined loach, naturally display lower values of this index.

These differences are driven by distinct ecological strategies and morphological adaptations, such as movement close to the substrate or the exploitation of benthic niches, which involve a more hydrodynamic body shape and a relatively lower mass relative to length [Figure 2]. The asp and pumpkinseed values are not included as mean values due to having captured one individual per each species.

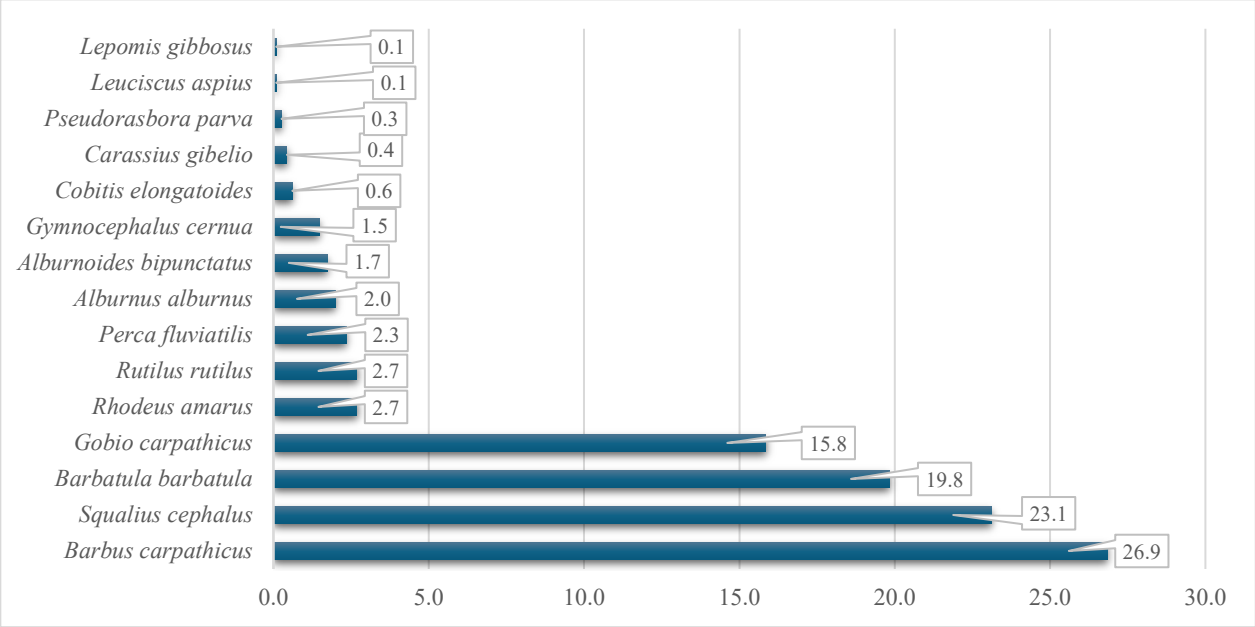

Figure 1. Species frequency in the upper course of the Crasna River

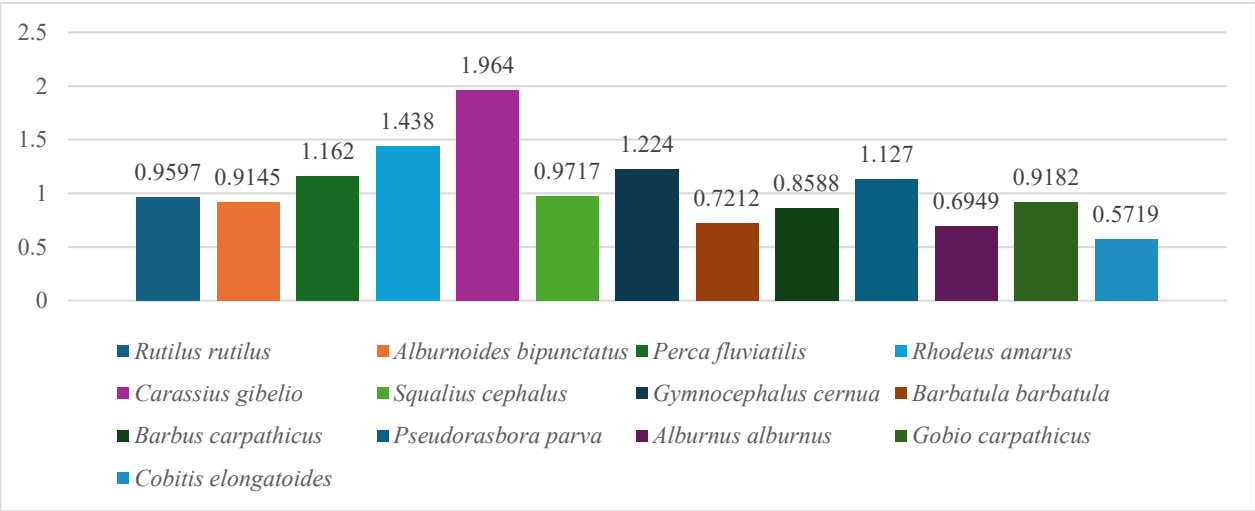

Figure 2. Average values of Fulton's condition factor (K) for the analyzed species

Overall, the values of Fulton's condition factor indicate a fish community generally well adapted to local environmental conditions, but with interspecific differences that reflect both trophic strategies and the degree of ecological tolerance. The presence of higher values in opportunistic species, alongside lower values in certain benthic species, suggests a complex ecological dynamic, potentially influenced by anthropogenic factors or habitat variability [22].

The distribution of fish species along the altitudinal gradient [Figure 3] reveals a clear structuring of the fish community along the analyzed river sector, from upstream (higher altitudes) to downstream (lower altitudes). This zonation reflects variations in environmental conditions, such as water

temperature, current velocity, oxygenation, and substrate type.

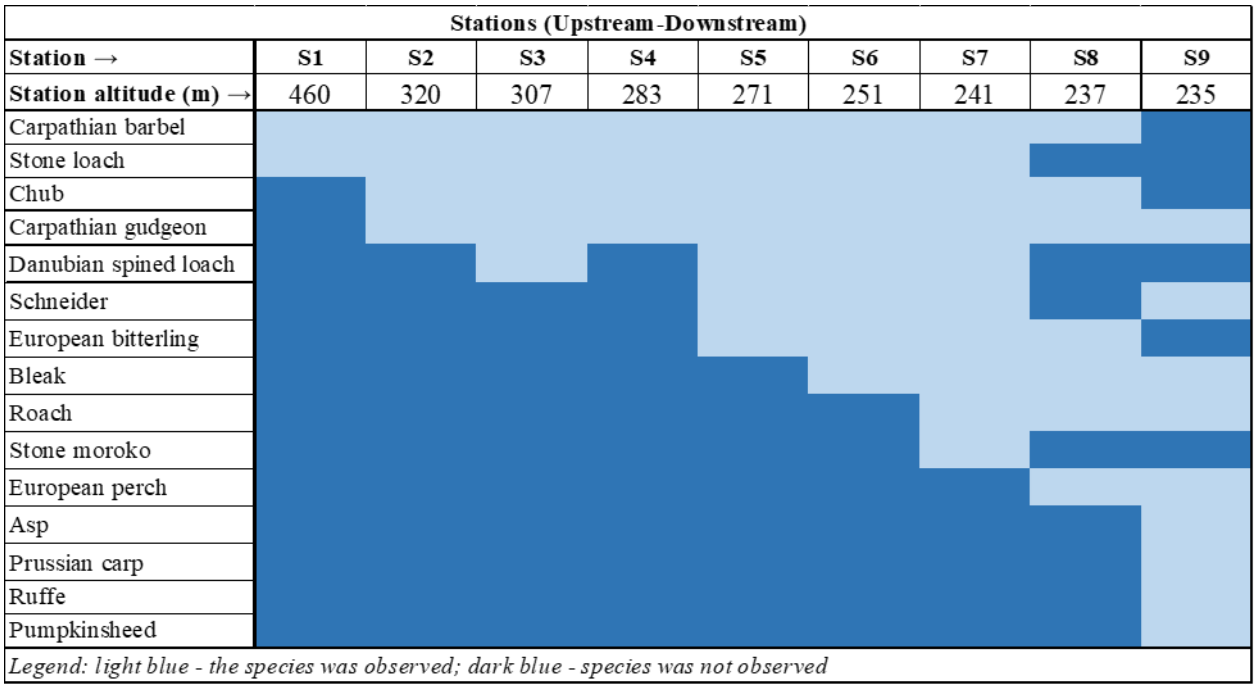

Figure 3. Distribution of observed fish species across sectors and along the altitudinal gradient

In the upper sector (S1–S3; ~460–307 m), the fish community is relatively species-poor and is dominated by taxa adapted to conditions typical of cold, well-oxygenated waters. The consistent presence of species such as Carpathian barbel, as well as, to a lesser extent, benthic species (stone loach and Danubian spined loach), indicates a habitat characterized by a rocky substrate and fast-flowing water. The absence of most limnophilic or eurytopic species in these sectors suggests restrictive environmental conditions for such taxa.

In the middle sector (S4–S6; ~283–251 m), an increase in species diversity is observed, accompanied by the occurrence of species characteristic of transitional zones. Species such as spirlin (Schneider), Carpathian gudgeon, and chub are present, reflecting more variable hydromorphological conditions and greater availability of trophic resources. This sector can be considered an ecotonal zone, where species from both upstream and downstream coexist.

The lower sector (S7–S9; ~241–235 m) is characterized by the highest species diversity and by the presence of taxa typical of slower and warmer waters. Species such as roach, bleak, European perch, and stone moroko are frequently encountered, indicating reduced flow velocity, higher temperatures, and increased productivity. Additionally, the presence of invasive species (Prussian carp and pumpkinseed) exclusively in the lower sectors suggests stronger anthropogenic influence and a higher tolerance of these species to variable or degraded environmental conditions [23].

An important pattern is the gradual replacement of rheophilic species in upstream sectors with eurytopic and limnophilic species downstream, reflecting a classical ecological gradient in river systems [24]. At the same time, certain species, such as chub, exhibit a wide distribution along the entire gradient, demonstrating high ecological plasticity.

4. Conclusions

The analysis of the fish community highlights a structure typical of lotic ecosystems in Transylvania, characterized by moderate diversity and a pronounced dominance of species adapted to flowing water conditions. The distribution of species frequency (alpha diversity) indicates an uneven structure, in which a limited number of species accounts for the majority of total abundance, while most species are weakly represented.

The analysis of Fulton's condition factor (K) reveals significant interspecific variation, determined partly by the availability of trophic resources, but primarily by species-specific morphological characteristics. The distribution of species along the altitudinal gradient reveals a clear longitudinal zonation, with increasing diversity toward the downstream sectors of the river.

Overall, the analyzed fish community can be characterized as relatively well structured and adapted to local environmental conditions, but with moderate diversity and a certain vulnerability to disturbances, as indicated by the dominance of a few species and the presence, albeit limited, of invasive taxa.

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