THE STRUCTURE OF FISH COMMUNITIES IN BISTRIȚA RIVER, UPSTREAM THE CONFLUENCE WITH SIRET RIVER (ROMÂNIA)

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Abstract. The researches were carried out in 2020 on the main course of Bistrița River, upstream the confluence with Siret River. The biological material was sampled in 10 sampling sites placed on the main course of Bistrița River. Seventeen fish species were identified, one of them being a non-native one: *Pseudorasbora parva*. We found that the chub and the Prussian carp are characteristic species. Species diversity is quite high, being identified even 12 fish species in some of the sampling sites. There is an unequal distribution of individuals by species. The main threats in the research area are the organic inputs and the increase of turbidity. However, there are no great imbalances, and there is a good capacity for self-support of aquatic communities.

Introduction

Fish communities are extremely important links in food chains of aquatic ecosystems since they include all food categories and occupy various habitat niches. Moreover, ichthyofauna is one of the most precious natural resources for human interest. The human impact in the last decades has affected both aquatic ecosystems and groups of aquatic organisms. Having in mind the importance of water for socio-economic systems and the importance of ichthyofauna for human beings and the environment, it is imperative to know as accurately as possible the state of limnic ecosystems and their structural and functional changes.

This can be achieved by biomonitoring of some groups of characteristic organisms, indicators for a certain habitat. Fish are one of the most important group of organisms used for the assessment of the limnic ecosystems state for the following reasons: they live in almost all types of waters, they have a lifespan of several years, they do not show significant changes in their population structure, and through the position of final consumer in food chains, they include the changes appeared in the lower trophic levels.

The interest for the presence or absence of some fish species or fish communities, for determining their density and abundance, respectively for knowing the structure and diversity of fish communities is justified by the importance of this group of organisms in lotic ecosystems, as well as their usefulness in biomonitoring studies.

Material and methods

In this study, the research were carried out on the Bistrița River, upstream the confluence with Siret River, on which a number of 10 sampling stations were established, as shown in table 1 and figure 1.

The field stage was carried out in August - September 2020. Ichthyofauna was sampled from each sampling site using an FEG 5000 electric fishing gear. The samples were placed in vessels with fresh water to keep the fish alive. The individuals were determined, counted, and weighed, and then released in the water.

Table 1. The sampling sites on the Bistrița River, upstream the confluence with the Siret River

No.	Sampling site	River	GPS Coord.	(GMS)	(GZ)	Alt. (m)
1	Upstream CET Bacău	Bistrița	N	46°32'28.3"	46.541194	147
			E	26°56'42.3"	26.945083	
2	CET Bacău side	Bistrița	N	46°32'01.7"	46.533805	145
			E	26°56'43.3"	26.945361	
3	Ruși Ciutea village side	Bistrița	N	46°31'11.0"	46.519722	141
			E	26°57'06.8"	26.950188	
4	Downstream aval bridge, Ruși Ciutea village side	Bistrița	N	46°31'10.9"	46.519694	141
			E	26°57'06.9"	26.950191	
5	SOFERT side, Ruși Ciutea village side	Bistrița	N	46°31'00.1"	46.516694	141
			E	26°57'09.8"	26.950272	
6	SOFERT side, Ruși Ciutea village side, right shore	Bistrița	N	46°30'55.7"	46.515472	140
			E	26°57'02.3"	26.950638	
7	Downstream SOFERT, Siretu village side	Bistrița	N	46°30'47.9"	46.513305	140
			E	26°57'02.9"	26.950805	
8	3+126 km upstream bridge	Bistrița	N	46°30'16.5"	46.504583	137
			E	26°57'19.6"	26.955444	
9	3+126 km downstream bridge	Bistrița	N	46°30'14.4"	46.504000	137
			E	26°57'21.2"	26.955888	
10	3 +126 km downstream brid- ge, 9 sampling site side	Bistrița	N	46°30'15.5"	46.504305	137
			E	26°57'20.3"	26.955638

Figure 1. The sampling sites on the Bistrița River, upstream the confluence with the Siret River

Results and discussions

The seventeen fish species which were identified in Bistrița River, upstream the confluence with the Siret River are presented in the table 2.

Table 2. The fish species identified in Bistrița River, upstream the confluence with the Siret River

No.	Scientific name	Common name
1	<i>Esox lucius</i> L., 1758	pike
2	<i>Squalius cephalus</i> L., 1758	chub
3	<i>Scardinius erythrophthalmus</i> L., 1758	rudd
4	<i>Aspius aspius</i> L., 1758	asp
5	<i>Alburnus alburnus</i> L., 1758	bleak
6	<i>Abramis brama</i> L., 1758	freshwater bream
7	<i>Vimba vimba</i> L., 1758	vimba bream
8	<i>Rhodeus amarus</i> Bloch, 1782	European bitterling
9	<i>Gobio obtusirostris</i> Valenciennes, 1842	-
10	<i>Pseudorasbora parva</i> (Temminck & Schlegel, 1846)	stone moroko
11	<i>Carassius gibelio</i> Bloch, 1782	Prussian carp
12	<i>Cobitis taenia</i> L., 1758	Spined loach
13	<i>Sabanejewia balcanica</i> (Karaman, 1922)	Balkan spined loach
14	<i>Perca fluviatilis</i> L., 1758	European perch
15	<i>Neogobius fluviatilis</i> (Pallas, 1814)	monkey goby
16	<i>Babka gymnotrachelus</i> (Kessler, 1857)	racer goby
17	<i>Proterorhinus marmoratus</i> (Pallas, 1814)	tubenose goby

Frequency of the fish species. Two of the seventeen fish species (Prussian carp and European bitterling) were identified in all the 10 sampling sites, with a frequency of 100%. Other two species with a high frequency are the chub and the stone moroko (90%). The bleak was recorded with a frequency of 80%, and other three species have had a frequency of 70% (spined loach, *Gobio obtusirostris* and rudd). European perch was identified in 4 sampling sites (40%), the pike and the monkey goby were identified in 3 of the 10 sampling sites (30%). The rest of 5 species were identified in less than 3 sampling sites, with a very low frequency (fig. 2).

Numerical stock (ind/100 m²) and weight stock (g/100 m²) of the fish species

The fish species that have recorded significant stock in research area are: *Squalius cephalus*, *Scardinius erythrophthalmus*, *Alburnus alburnus*, *Rhodeus amarus*, *Gobio obtusirostris*, *Pseudorasbora parva*, *Carassius gibelio*, *Cobitis taenia*, *Proterorhinus marmoratus*.

Numerical stock (ind/100 m²) and weight stock (g/100 m²) of the fish species are presented in table 3 and table 4.

The chub (*Squalius cephalus*) was identified in 9 of the 10 sampling sites. The numerical stock of the chub in the 9 sampling sites ranges between 1,27 and 128 ind./100 m², while the weight stock is significantly higher, ranging between 1,90 and 1453,27 g/100 m² since the chub

Figure 2. Frequency of the fish species in Bistrița River, upstream the confluence with Siret River

is a relatively large species.

The rudd (*Scardinius erythrophthalmus*) was identified in 7 sampling sites. The numerical stock of the chub in the 7 sampling sites ranges between 8,00 and 382,35 ind./100 m² while the weight stock ranges between 6,80 and 313,65 g/100 m².

The bleak (*Alburnus alburnus*) was identified in 8 sampling sites. The numerical stock of the bleak in sampling sites ranges between 1,27 and 208,67 ind./100 m² while the weight stock ranges between 3,04 and 523,60 g/100 m².

The European bitterling (*Rhodeus amarus*) was identified in all the 10 sampling sites. The numerical stock of the bleak in sampling sites ranges between 0,56 and 5,33 ind./100 m² while the weight stock ranges between 1,17 and 14,20 g/100 m².

Gobio obtusirostris was identified in 7 of the 10 sampling sites. Its numerical stock in sampling sites ranges between 1,11 and 39,26 ind./100 m² while the weight stock ranges between 1,44 and 302,89 g/100 m².

The stone moroko (*Pseudorasbora parva*) was identified in 9 sampling sites. The lowest value of the numerical stock of the stone moroko in sampling sites was 1,33 and the highest value was 40,00 ind./100 m² while the weight stock ranges between 3,30 and 110,40 g/100 m².

Table 3. Numerical stock (ind/100 m²) of the fish species in Bistrița River, upstream the confluence with Siret River

No. of sampling sites	<i>Squalius cephalus</i>	<i>Scardinius erythrophthalmus</i>	<i>Alburnus alburnus</i>	<i>Rhodeus amarus</i>	<i>Gobio obtusirostris</i>	<i>Pseudorasbora parva</i>	<i>Carassius gibelio</i>	<i>Cobitis taenia</i>	<i>Proterorhinus marmoratus</i>
1	22,96	14,81	2,96	2,22	39,26	1,48	9,63	3,70	4,44
2	50,67	8,00		1,33	20,00	1,33	1,33	5,33	5,33
3	45,88	382,35	76,47	2,35	27,06		9,41	1,18	3,53
4	128,00	66,00	208,67	5,33	35,33	3,33	12,67	1,33	2,00
5	1,27	29,21	1,27	0,63	22,86	2,54	41,27	0,63	2,54
6	32,92	35,00	6,25	1,67	5,00	9,17	40,83	1,25	0,83
7				0,56	1,11	8,89	26,11		
8	3,81	13,33	68,57	3,81		3,81	32,38	1,90	
9	23,20		48,80	4,80		33,60	87,20		0,80
10	10,67		109,33	5,33		40,00	128,00		2,67

Table 4. Weight stock (g/100 m²) of the fish species in Bistrița River, upstream the confluence with Siret River

No. of sampling sites	<i>Squalius cephalus</i>	<i>Scardinius erythrophthalmus</i>	<i>Alburnus alburnus</i>	<i>Rhodeus amarus</i>	<i>Gobio obtusirostris</i>	<i>Pseudorasbora parva</i>	<i>Carassius gibelio</i>	<i>Cobitis taenia</i>	<i>Proterorhinus marmoratus</i>
1	739,85	19,33	3,04	6,22	302,89	7,93	35,93	7,48	3,78
2	711,73	6,80		4,27	141,60	6,93	8,27	8,27	4,80
3	602,24	313,65	113,65	8,00	215,29		97,76	2,59	3,65
4	1453,27	107,00	523,60	14,20	294,07	16,13	106,20	4,53	1,27
5	24,38	21,33	0,89	2,67	78,86	3,30	294,29	1,71	2,48
6	570,96	168,08	9,08	6,08	47,04	31,67	364,21	4,83	1,08
7				1,17	1,44	26,11	601,17		
8	1,90	12,19	12,95	6,10		8,00	2582,29	3,24	
9	11,12		25,28	6,72		58,72	1118,40		0,72
10	32,27		50,13	9,07		110,40	2815,47		5,87

The Prussian carp (*Carassius gibelio*) was identified in all of the 10 sampling sites. The numerical stock of the Prussian carp in sampling sites ranges between 1,33 and 128,00 ind./100 m² while the weight stock ranges between 8,27 and 2815,47 g/100 m².

The spined loach (*Cobitis taenia*) was identified in 7 sampling sites. The numerical stock of the spined loach in sampling sites is quite low, ranging between 0,63 and 5,33 ind./100 m². Its weight stock ranges between 1,71 and 8,27 g/100 m².

Finally, the tubenose goby (*Proterorhinus marmoratus*) was identified in 8 of the sampling sites. The lowest value of the numerical stock of the tubenose goby in sampling sites was just 0,80 and the highest value was 5,53 ind./100 m² while the weight stock ranges between 0,72 and 5,87 g/100 m².

Biodiversity indices. Table 5 display the values of some of biodiversity indices which were calculated to characterize the fish communities in the research area: species richness (Margalef and Menhinick), heterogeneity (Simpson and Shanon-Wiener) and equitability (evenness) in sampling sites.

According to Margalef and Menhinick indices, the greatest species richness was highlighted in the following sampling sites: 6 - Bistrița, SOFERT side, Ruși Ciutea village side, right shore and 8 - Bistrița, 3+126 km upstream bridge.

Heterogeneity indices values indicate that, based on similar species frequencies, the highest biodiversity for the fish communities was recorded in the sampling site 6 - Bistrița, SOFERT side, Ruși Ciutea village side, right shore. In the sampling sites 6 (Bistrița, SOFERT side, Ruși Ciutea village side, right shore), 4 (Bistrița, Downstream aval bridge, Ruși Ciutea village side) and 1 (Bistrița, upstream CET Bacău) we found the highest species richness (12, 12, and 11 species respectively).

Table 5. Biodiversity indices in sampling sites in Bistrița River, upstream the confluence with Siret River

Sampling sites	No. of species	Species richness		Heterogeneity		Equitability
		Margalef	Menhinick	Simpson	Shanon-Wiener	
1. Bistrița, upstream CET Bacău	11	3,881	0,567	0,645	0,242	0,101
2. Bistrița, CET Bacău side	9	3,803	0,799	0,702	0,126	0,057
3. Bistrița, Ruși Ciutea village side	8	2,591	0,357	0,553	0,290	0,139
4. Bistrița, Downstream aval bridge, Ruși Ciutea village side	12	3,796	0,427	0,757	0,345	0,139
5. Bistrița, SOFERT side, Ruși Ciutea village side	10	3,724	0,619	0,783	0,203	0,088
6. Bistrița, SOFERT side, Ruși Ciutea village side, right shore	12	4,086	0,541	0,834	0,288	0,116

7. Bistrița, Downstream SOFERT, Siretu village side	5	2,168	0,598	0,493	0,081	0,050
8. Bistrița, 3+126 km upstream bridge	9	3,897	0,847	0,720	0,117	0,053
9. Bistrița, 3+126 km downstream bridge	8	2,787	0,444	0,768	0,231	0,111
10. Bistrița, 3 +126 km downstream bridge, 9 sampling site side	7	2,812	0,600	0,740	0,363	0,186

Equitability values range from 0.050 to 0.186, but far from the value of 1 which would imply a fair distribution of individuals by species. The highest value of equitability was recorded for the sampling site 10 (Bistrița, 3 +126 km downstream bridge, 9 sampling site side), even if there were identified just 7 fish species.

Conclusions

An amount of 17 fish species were identified in the 10 sampling sites placed on Bistrița River, upstream of the confluence with Siret River. One of the 17 fish species is a non-native species: *Pseudorasbora parva*.

The chub (*Squalius cephalus*) and the Prussian carp *Carassius gibelio*) are the two main characteristic species in the research area, being dominant both numerically and by weight.

At the same time, the European bitterling (*Rhodeus amarus*) and the stone moroko (*Pseudorasbora parva*) are other two species with a great frequency, even constant and dominant species.

Species diversity is quite high, being identified even 12 fish species in some of the sampling sites (4 - Bistrița, Downstream aval bridge, Ruși Ciutea village side and 6 - Bistrița, SOFERT side, Ruși Ciutea village side, right shore). However, heterogeneity indices and equitability indicate an unequal distribution of individuals by species.

The main threats in the research area are the organic inputs and the increase of turbidity.

Although some threats have also been identified since the research area is in a highway construction zone, the fact that 17 fish species were found suggests that the fish communities are diverse, and there are still favorable environmental conditions.

Having in mind that the highway construction involves many changes in habitat conditions, we can say that there are no great imbalances, and there is a capacity for self-support of aquatic communities.

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