5. Fish fauna from Lower Romanian Mureș River

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Abstract: In the summer 2019 ichthyofauna was investigated in 4 localities sites of Lower Romanian Mureș River: Lipova, Sâmbăteni, Semlac and Nădlag. The status of fish fauna and presence of community interest species (An. II, III and V / H.D.) inside of ichthyocenoses, as abundance and frequency, anthropogenic impact, were assessed. In all 4 sites it were recorded 23 fish species included some species reported by authorized persons and fisheries literature in lower Mures River. From 23 species 7 are community interest fish species (*Leuciscus aspius, Barbus petenyi, Romanogobio kessleri, R. vladykovi, Rhodeus amarus, Zingel zingel* and 1 sturgeon's species *Acipenser ruthenus*. Fish fauna was dominated in abundance by *Alburnus alburnus, Squalius cephalus* and *Chondrostoma nasus*, but in biomass by *Hypophthalmichthys molitrix, Leuciscus aspius, Chondrostoma nasus* and *Silurus glanis*. Main anthropogenic pressures consists legal and illegal overfishing, ballast activity and pollution.
Keywords: fish species richness, ecological parameters, Lower Mureș River

INTRODUCTION

Mures River has 749 km full length from its source to the confluence with Tisa river, with 30,000 km² large drainage basin been one of the most significant river of the Carpathian basin, mostly of its drainage is cover with mountains and hills, only a smaller proportion is plain surface (Ando in Hamar J. & Sárkány-Kiss, 1995). Lower Romanian Mures River taken in the study is part of this small proportion of plain surface (lowland, flatland).

Analysing the flora and vegetation, the flatland course of the river (Lipova-Szeged) is the most deteriorated (Drăgulescu in Hamar J. & Sárkány-Kiss, 1995), also this section is most polluted with high mineral content (Hajdu in Hamar J. & Sárkány-Kiss, 1995) and chemical components in water and sediments (Waijandt in Hamar J. & Sárkány-Kiss, 1995) by human activities, which affect biota specially in lowland river (e. g. missing mollusc population Sarkany-Kiss in Hamar J. & Sárkány-Kiss, 1995, due to pollution, affect some fish species).

Literature of fish fauna from Mureș River include 56 species (Nalbant in Hamar J. & Sárkány-Kiss, 1995), richness species list increased periodically, but must be specified that mostly species are very rarely (Nalbant in Hamar J. & Sárkány-Kiss, 1995) and very hard to find, being found only in some periods and never after. Lowland fish species in Mureș River include also some rare species, which Nalbant in Hamar J. & Sárkány-Kiss, 1995 couldn't find. Recent some studies indicate 13 fish species in lowland Mureș River respectively 19 fish species upstream Mureș River (Năstase & Oțel 2016, 2017).
Present paper actualize fish fauna status from Lowland of Romanian sector of Mureș River.

MATERIAL AND METHODS

The research was conducted during the year 2019 in the summer (July) in 4 sites located near Lower Romanian Mureș River: Lipova, Sâmbăteni, Semlac and Nădlag (**Fig. 1**). The following devices were used for fish sampling: an aluminium boat of 3-persons, nylon Nordic (mesh size a=5-55 mm) gillnets of 30 m long and electric fishing device SAMUS 725 MP (12 VDC Input Voltage by any accumulator

with 60 Amperes maximum, also maximum 1000 W output voltage). It was assessed fish fauna, the presence of fish species from DH annexes, with their quantitative structure at electric fishing main sampling methods (relative abundance and biomass in Catch per Unit Effort CPUE), ecological parameters (constancy, dominance, ecological significance, biodiversity indicators and Biological Integrity Indicator-IBI – **table 2** and **3**) of specimen dimensions, and overall status of aquatic habitats in terms of existing anthropogenic pressures. Both parts of the riverbed, with 100 meters long section, were sampled in each sites. Totally was captured 133 individuals weighing 16.4 kg of fish species.

The fish species was identified after Antipa 1909, Bănărescu (1964 and 2004), and taxonomic name after revision by Kottelat 1997, Kottelat & Freyhof 2007, Nelson 2006, Kotlík et. al. 2002 and Froese & Pauly 2020 www.fishbase.org 2020).

The frequency of occurrence (F) or constancy (C) was calculated as proportion of samples containing a species and used to characterize species distribution according to Botnariuc & Vădineanu 1982, Schwerdtfeger (1975) quoted by Schindrilariu et al. (2002): $F_i = b_i/a \cdot 100$ (%), where, F_i = frequency of occurrence of specie i, b_i = the number of samples in which species i was observed and a = total number of samples.

The relative abundance or dominance (D) was calculated as proportion of species to the total catch according to Mühlenberg (1993): $D_i = n_i/N \cdot 100$ (%), where, D_i = dominance of species i, n_i = individuals of the species i, and N = total number of individuals.
Five classes of frequency, 6 for abundance/dominance and 5 classes of ecological significance were used for data interpretation (**Table 1**)

Table 1 Frequency (constancy), dominance and ecological significance classification (Odum 1975, Botnariuc & Vădineanu 1982, Gomoiu & Skolka, 2001, Sârbu & Benedek, 2004, Schwerdtfeger 1975, Şindrilariu et. al. 2002)

Abundance /Dominance (D) Class	%	Frequency /Constancy (C) Class	%	Ecological significance (W) Class	%
sporadic D1	<1	very rare	C1=0-10	accidental	W1< 0.1
subrecedent D2	$1 (2^0)$ - <2	rare	C2=10.1-25	accessory	W2=0.1-1
recedent D3	$2 (2^1)$ - <4	widespread	C3=25.1-45	associate	W3=1-5
subdominant D4	$4 (2^2)$ - <8	frequent	C4=45.1-70	complementary	W4=5-10
dominant D5	$8 (2^3)$ – 16	very	C5=70.1-100	characteristic	W5=10-20
eudominant D6	$>16 (2^4)$			main, leading	W6>20

The biodiversity (Hs) was calculated according to the Shannon-Weiner formula (Gomoiu & Skolka, 2001; Sârbu & Benedek, 2004). The equitability Evenness (Gomoiu & Skolka, 2001; Sârbu & Benedek, 2004) means the quantum of unequal distribution of different effective species proportion as an ideal community, where every species has the same number of individuals. The value of equitability Evenness index is included between a range of 0 and 1.

Table 2 Criteria of fish determining IBI (biological integrity index) (Ureche, 2008 after Battes, 1991, Karr, 1986 and Miller, 1985), adapted for big rivers and lakes by Năstase in *****, 2017

PARAMETERS CATEGORIES	PARAMETER	EVALUATION INTEGRITY CLASS		
		5	3	1
Composition and abundance of species	1. Total number of fish species (from initial)	> 90% (abund.)	50-90 % constant	<50% (rare)
	2. Total number of cyprinids	> 45%	20-45%	<20%
	3. Total number of salmonids or percids	> 5%	1-5%	<1%
	4. Others fish species	> 20%	5-20%	<5%
	5. Total number of native fish species	> 68%	35-67%	<34%
	6. Total number of non-native species	<1%	1-10%	>10%
	7. Total number of disappearing fish species	<1%	1-10%	>10%
Composition of the food fish populations	8. Proportion of zoobentofagous species	> 45%	20-45%	<20%
	9. Proportion of carnivore species	> 5%	1-5%	<1%
	10. Proportion of carnivore and planctonofagous	<20%	20-45%	>45%
	11. Proportion herbivorous and detritivores	<25%	25-50%	>50%

Stock and general state of fish populations	12. Numerical Stock (ex./100 m²) (ex./100 m linear / collectors)	> 100 ex (>20 ex)	10-100 (5-20)	<10 (<5)
	13. Gravimetrical Stock (g/100 m²) (g/100 m linear / collectors)	> 1000 g (>5000 g)	100-1000 (500-5000)	<10 (<5)
	14. Proportion of hybrid individuals	0%	0-1 %	> 1%
	15. Proportion of ill individuals	0%	0-1 %	> 1%

Table 3 Framing levels of the evaluation integrity degree in fish ecosystems (Ureche 2008 after Battes, 1991, Karr 1986 and Miller, 1985)

No.	APRECIATION	SCORE Small rivers (Miller A, 1985)	Medium and big rivers and reservoirs Karr J. R. & Co., 1986	Battes K. W., 1991	EVALUATION INTEGRITY CLASS
1	Excellent	37-40	57-60	70-75	I
2	Excellent-good	34-36	53-56	66-69	II
3	Good	30-33	48-52	59-65	III
4	Moderate-good	28-29	45-47	55-58	IV
5	Moderate	23-27	39-44	47-54	V
6	Poor-Moderate	21-22	36-38	43-46	VI
7	Poor	16-20	28-35	35-42	VII
8	Poor-Very low	12-15.	24-27	20-34	VIII
9	Very low	<12	<23	<20	IX

Figure 1. Location of the fish sampling sites from Lower Romanian Mures River in 2019

The physico-chemical parameters were found on the field using the HACH electronic multiparameter (HQd Field Case with 4 sensors for pH, Oximeter, thermometer and conductivity meter), the Secchi disc used for water depth and transparency, Van Veen grab sampler for the benthic substrate used with sieve, GPS for geographical coordinates, flowmeter FLO-MATE 2000 model for water current values (**Photo 1**).

Photo 1. FLO-MATE 2000 model

RESULTS

Using two complementary fish sampling methods (gillnets fishing and electrofishing), more accentuated by main method of sampling for rivers - electrofishing, we found that fish fauna from Lower Mures River is very diversification, with a lot of fish species (**Photo 2**).

Photo 2. The main method of sampling used - Electric fishing and its species richness for one sample, quickly released alive in natural environment

Totally was observed 23 fish species belongs to 5 families, from this 23 species a number of 16 species was collected by us on Lower Romanian Mures River, 7 species of these are included in Annexes of Habitat Directive and with many appreciations are present of 3 fish species from Red Book of Romania (Bănărescu, 2005): *Romanogobio kessleri, Zingel zingel* and *Acipenser ruthenus* (**Table 4**).

Mostly species are reophilic species, but sometimes appears some limnophilic species like *Esox lucius*, also here cohabits submountain and hills fish species (as *Barbus petenyi* and *Chondrostoma nasus* zones) with flatland fish species (as *Barbus barbus* and *Cyprinus carpio* zones) according with Bănărescu, 1964 ecological zoning of fish (**Table 4**). Furthemore *Acipenser ruthenus* was observed by local authorized persons, more sites waters of Lower Romanian Mures River were populated with *Acipenser ruthenus* specimens near Pecica locality to restocking their populations.

The majorities of fish species adults include zoobentivorous species, but also are present piscivorous and planktivorous species. Regarding origin most of species are native, but exotic species like *Hypophthalmichthys molitrix* appear as new species in the area caused by accelerated eutrophication, results of intensive human activity in sense of increase pollution in condition of continuous clime change and sheltering pits made by ballast careers (**Table 4**).

Table 4 Richness fish species from Lower Romanian Mures River and some ecological classifications (Symbols used: 1 = species presence, Family Cy = Cyprinidae, Ac=Acipenseridae, Pe = Percidae, Es = Escidae, Si = Siluridae,; <u>Origin</u>: n = native, e = exotic; <u>Preference to water current:</u> Migr.=migrator, Limn=limnophilic, Stag=stagnant, Reo=rheophilic; eurit=eurytope, <u>Adult feed</u>: zoobent=zoobentivorous, bent=bentivorous, planct=planctivorous, omni=omnivorous, pisc=piscivorous, fitopl=fitoplanctivorous, erb=erbivorous, detri=detritivorous, zoo=zoophagous)

Family	Species	Fishing in 2019	Literature (Tiscia 1995)	Observed by local authorized persons	Origin	Preference to water current	Adult feed	Community interest (HD Annexes)
Cy	*Abramis brama*		1	1	n	reo-stag	zoobent	
Cy	*Ballerus sapa*	1	1		n	reo	zoobent	
Ac	*Acipenser ruthenus*		1	1	n	reo	zoobent	5
Cy	*Alburnoides bipunctatus*	1	1		n	reo	zoobent	
Cy	*Alburnus alburnus*	1	1	1	n	reo-stag	planct	
Cy	*Barbus barbus*	1	1	1	n	reo	bent	
Cy	*Barbus petenyi*	1	1		n	reo	zoobent	2
Cy	*Blicca bjoerkna*	1	1	1	n	euri	bent	
Cy	*Carassius gibelio*		1	1	n	euri	omni	
Cy	*Chondrostoma nasus*	1	1	1	n	reo	fito+detri	
Cy	*Cyprinus carpio*		1	1	n	Reo-stag	bent	
Es	*Esox lucius*		1	1	n	limn	pisc	
Cy	*Hypophthalmichthys molitrix*	1		1	e	reo-stag	fitopl	
Cy	*Leuciscus aspius*	1	1	1	n	reo-stag	pisc	2
Cy	*Pseudorasbora parva*	1	1		e	euri	zoo	
Cy	*Rhodeus amarus*	1	1		n	euri	erb	2
Cy	*Romanogobio kessleri*	1	1		n	reo	bent	2
Cy	*Romanogobio vladykovi*	1	1		n	reo	bent	2
Cy	*Rutilus rutilus*		1	1	n	euri	omni	
Pe	*Sander lucioperca*		1	1	n	euri	pisc	
Si	*Silurus glanis*	1	1	1	n	reo-stag	pisc	
Cy	*Squalius cephalus*	1	1	1	n	reo	pisc	
Pe	*Zingel zingel*	1	1		n	reo	zoobent	5
5	23	16	22	14				

Relative abundance is dominated by species like *Alburnus alburnus*, *Squalius cephalus*, *Chondrostoma nasus* and *Barbus barbus* (Figure 2), but in relative biomass are dominant *Hypophthalmichthys molitrix, Leuciscus aspius, Chondrostoma nasus*, *Silurus glanis* and *Squalius cephalus* (Figure 3).
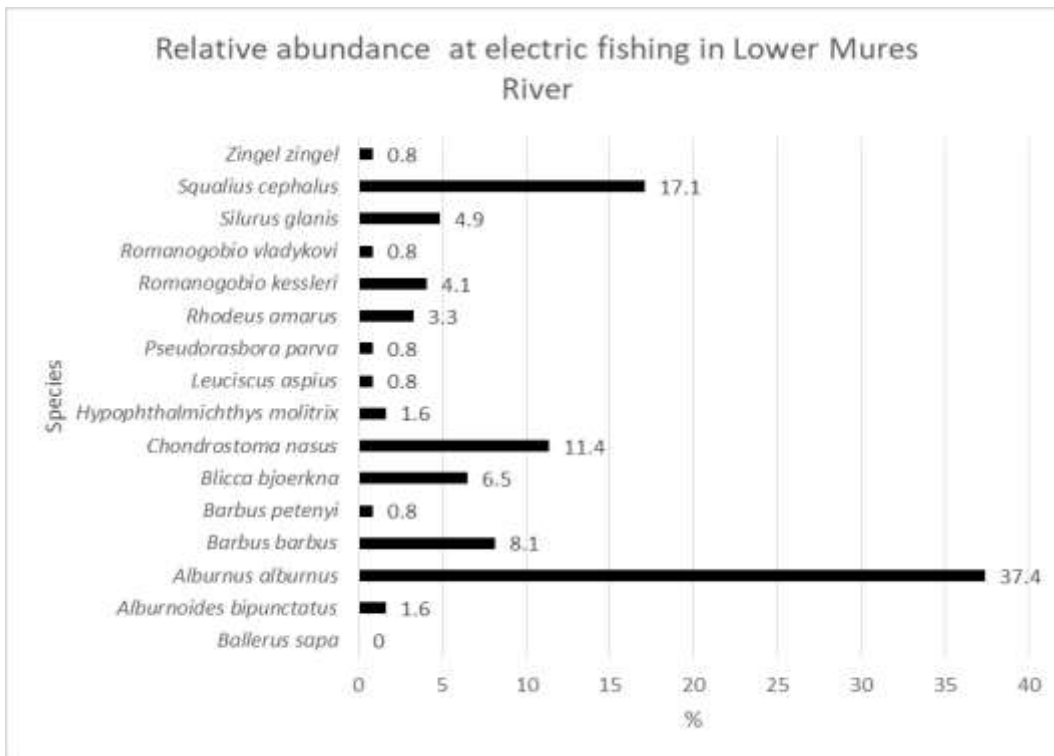
Figure 2. Relative abundance of fish species in Lower Romanian Mures River at most relevant fish sampling method (electric fishing)
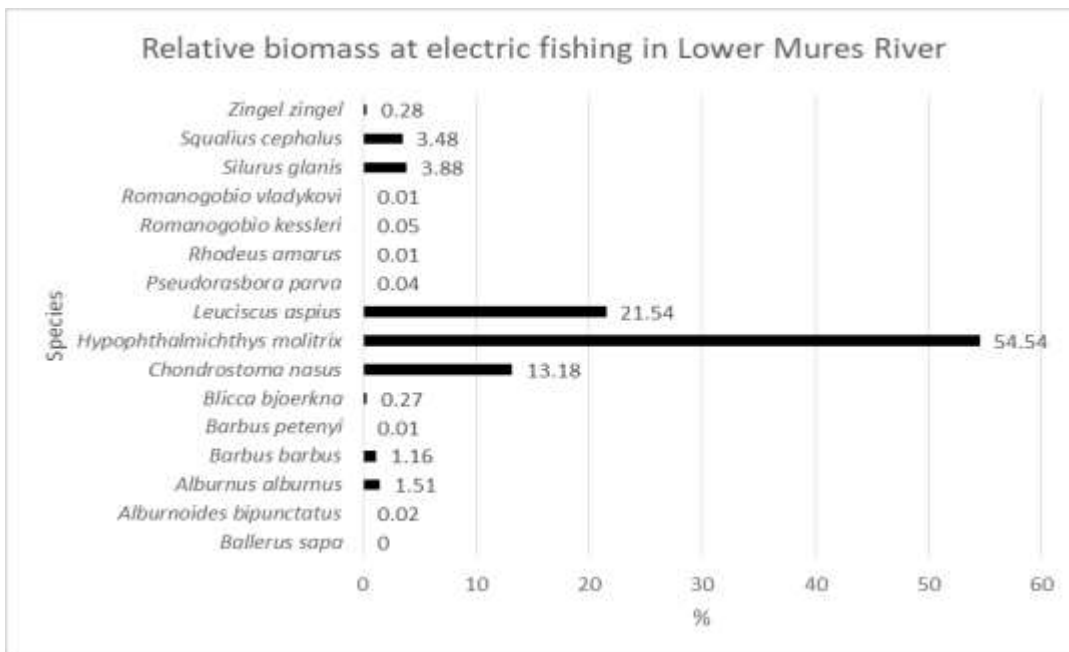

Figure 3. Relative biomass of fish species in Lower Romanian Mures River at most relevant fish sampling method (electric fishing)

Regarding ecological parameters of fish fauna from Lower Romanian Mures River in summer of year 2019 main species is *Alburnus alburnus*, follow by characteristic species like *Squalius cephalus*, complementary species (*Barbus barbus* and *Chondrostoma nasus)* and associate species (*Blicca bjoerkna, Romanogobio kessleri* and *Silurus glanis*), others species being accessory or even accidental in the area (**Table 5**).

Table 5 Ecological parameters in the year 2019 (summer) of fish fauna from Lower Romanian Mures River

Species	D class	C class	W class
Ballerus sapa	D1	C1	W1
Alburnoides bipunctatus	D2	C2	W2
Alburnus alburnus	D6	C5	W6
Barbus barbus	D5	C5	W4
Barbus petenyi	D1	C2	W2
Blicca bjoerkna	D4	C4	W3
Chondrostoma nasus	D5	C4	W4
Hypophthalmichthys molitrix	D2	C2	W2
Leuciscus aspius	D1	C2	W2
Pseudorasbora parva	D1	C2	W2
Rhodeus amarus	D3	C2	W2
Romanogobio kessleri	D4	C5	W3
Romanogobio vladykovi	D1	C2	W2
Silurus glanis	D4	C4	W3
Squalius cephalus	D6	C5	W5
Zingel zingel	D1	C2	W2

Romanian part of lowland Mures River has an increased Shannon-Wiener biodiversity index more than 2, but also equitability index (Evenness) is increased more than 0.7 indicate a stable ichthyocoenoesis (**Table 6**).

Table 6 Biodiversity indicators for Lowland Mures River in 2019

H	Hmax	E
2.017	2.708	0.745

Regarding IBI (integrity biological index) the scores studied areas are incorporate in Good appreciation (**Table 7**) means score 65 for Lowland Mures River in Evaluation marks class III (**Table 7**).

Table 7. IBI results for fish fauna from lowland Mures Rivers in 2019

No.	Score	Evaluation
1	5	plus one more
2	5	18 species
3	5	2 species
4	3	3 species
5	5	21 species
6	3	2 species
7	5	0 species
8	5	11 species
9	5	5 species
10	3	7 species
11	5	2 species
12	3	30 individuals / 100 meters linear
13	3	4010 g / 100 meters linear
14	5	0
15	5	10
TOTAL	65	
CLASS	III	Good

Geografical coordinates, environmental parameters in sampling period, time and fishing duration are in **Table 8** and **9**: 25,3-26,5°C water temperature, 0,2-0,6 index of depth and transparency rapport, bottom with stones and periphyton upstream river and sand/gravel with *Corbicula sp.* (mollusk) downstream river (downstream Sâmbăteni and Mândruloc localities). Conductivity (µS/cm) has values between 500-594, Oxygen (mg/L) 11,13-14,42 and pH 8.98-9.02 (**Table 9**).

Table 8 Geographical coordinates and some environmental parameters from sampled points of Lower Mures River in summer of 2019

SITE	GEOGRAPHICAL COORDINATES		TIME	HOUR OF BEGINING	DURATION (h)	SUBSTRATE	T°C water	DEPTH	TRANSPARENCY	T/D
	LATITUDE	LONGITUDE					°C	cm	cm	
Lipova	46°05.353'	21°41.032'	23.07.2019	16:00	01:00	stone	26.4	100	60	0.6
Sâmbăteni	46,113208°	21,524762°	24.07.2019	10:00	01:00	stone and mud	25.3	130	50	0.4
Semlac	46°07.459'	20°58.120'	24.07.2019	15:00	01:00	gravel	26.5	100	40	0.4
Nădlag	46°07.554'	20°46.737'	25.07.2019	11:00	01:00	Sand and gravel	26.3	130	25	0.2

Water current has increased values at surface (0,9-1,4 m/s) than bottom (0,7-0,8 m/s) **(Table 9).** Environmental conditions are favorable for the development of a diversified fish fauna with submountain fish species (from *Barbus peteny* zone) inhabits near lowland fish species (from *Cyprinus carpio* zone).

Table 9. Environmental parameters from sampled points of Lower Mures River in summer of 2019

SITE	CONDUCTIVITY	OXYGEN	SATURATION	pH	WATER CURRENT		Benthos
	µS/cm	mg/L	% Oxygen		Surface (m/s)	Bottom (m/s)	
Lipova	538	14.42	184.2	9.02	1.4	0.8	stones with periphyton
Sâmbăteni	594	11.69	145.7	9	1	0.7	stones with periphyton
Semlac	500	11.35	142.6	9.01	0.9	0.7	Gravel with Corbicula
Nădlag	532	11.13	139.4	8.98	1.4	0.7	Sand with Corbicula

CONCLUSIONS

Environmental conditions are favorable for the development of a diversified fish fauna, totally was observed 23 fish species belongs to 5 families, from these 23 species a number of 16 species was captured in summer of 2019 in Lower Romanian Mures River, 7 species of these are included in Annexes of Habitat Directive.

Mostly are reophilic species, but sometimes appears some limnophilic species like *Esox lucius*, also here cohabits submountain and hills fish species (as *Barbus petenyi* and *Chondrostoma nasus* zones) with flatland fish species (as *Barbus barbus* and *Cyprinus carpio* zones) in ecological zoning of fish.

Acipenser ruthenus was observed in Lower Romanian Mures River, moreover waters were populated with individuals of this species near Pecica locality to restocking their populations in the near past.
Regarding origin most of species are native, but exotic species like *Hypophthalmichthys molitrix* appear as new species in the area caused by accelerated eutrophication, results of intensive human activity in sense of increase pollution in condition of continuous clime change and species sheltering pits made by ballast careers.

Relative abundance is dominated by species like *Alburnus alburnus*, *Squalius cephalus*, *Chondrostoma nasus* and *Barbus barbus*, but in relative biomass are dominant *Hypophthalmichthys molitrix, Leuciscus aspius, Chondrostoma nasus*, *Silurus glanis and Squalius cephalus.*
Ecological parameters indicate main species *Alburnus alburnus*, follow by characteristic species like *Squalius cephalus*, complementary species (*Barbus barbus* and *Chondrostoma nasus)* and associate species (*Blicca bjoerkna, Romanogobio kessleri* and *Silurus glanis*), others being accessory or even accidental in the area.

Romanian part of lowland Mures River has an increased biodiversity index more than 2 value, also equitability index (Evenness) is increased more than 0,7 indicate a stable ichthyocoenoesis, even IBI index indicate a Good appreciation of fish fauna status, but all these results are in condition of medium to a small numbers of fish individuals for a significant sector of Mureș River.

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