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ECOLOGICAL AND NATURE CONSERVATIONAL EVALUATION OF THE FISH FAUNA OF THE LĂPUŞ RIVER

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ABSTRACT. The fish population of the Lăpuş river was assessed in 2003. Later studies was assessed in 2009 in the Zazar river basin, tributary of the Lăpuş river, this occasion we have supplemented the list with two more species (*Eudontomyzon danfordi* and *Perca fluviatilis*). We have ranked the found species into ecological and reproductional guilds and grouped them according to their origin. Based on the criteria of Bănărescu we have determined the Romanian spreading of the different species, the development of their spreading and frequency and their ecological state. We have tried to apply the fish ranking method of Guti based on their endangerment onto the Romanian conditions. Based on this we have calculated their score of nature conservational value. In order to characterize the fish communities, we have used the values suggested by Pricope et al. According to this we have calculated the abundancy, frequency, stability and dominancy of the different species, and we have estimated their significance in the whole area. The ecological quality of the ichtiocenosis has been determined by calculating the Shannon-Wiener diversity index, and the modified index suggested by Salyi. Based on the scores suggested by Guti we have calculated the absolute and relative nature conservational value of the river.

KEYWORDS: ecological and reproductional guilds, spreading, abundancy, frequency, dominancy, significance, ecological quality, absolute and relative nature conservational value

INTRODUCTION

The Lăpuş river gathers the waters of the Southeastern slopes of the Gutîi, Ţibleş and Lăpuş mountains. It has a length of 114.6 km with a 1820 km^2 drainage area. It has its origin beneath the Văratec peak at 1356 m above sea level. At the upper parts it has a drop of 10-15 m/km, which - although decreasing - still reaches 3-4 m/km beneath Tg. Lăpuş where the river flows through a 30 km long pass. The river does not have a real plain part until reaching its mouth into the Someş. The drainage area of the Lápos river is asymmetrical, having only one important left hand side affluent, the 35 km long Suciu. However, the majority of its right affluents (Strâmbu Băiuţ, Cavnic, Săsar) pollute the Lăpuş with substances originating from the mining and processing of non-ferrous metals, which continuously harm the fish fauna of the river from both quantitative and qualtitative point of view.

MATERIAL AND METHODS

We have studied the fish population of the Lăpuş basin several times (Wilhelm, Ardelean, 2004, Wilhelm et all, 2009), sampling altogether 59 gathering points, catching 3061 exemplars of 24 fish species, which after identification were replaced into the water at the same place where they had been caught. The sampling was performed using an electrical fishing apparatus.

The origin of the species of the fish fauna was determined after Györe (1995), while the ecological guilds were described after Spindler (1997) and Sallai (2002) (RA – *rheophilic A*, RB – *rheophilic B*, EU – *euritopi*c, EX – *exote*). The *reproductive guilds* were identified after Balon (1975).

A study comprising more decades has been performed by Bănărescu (1994), determining specific features of the Romanian condition of the native fish species, including their *Romanian spread* (R.Ro) which can be *general* (w), *geographically restricted* (gr) or *ecologically restricted* (er). Comparing the distribution of the certain fish species in 1964 and 1993, he showed that their spreading area has either *increased* (exp), *decreased* ® or *not changed* ©. He has also determined the *abundancy* of the certain species, being also either increasing (i), *decreasing* (d) or *constant* ©. Based on these data he has determined the *present condition* of the certain species, describing the following categories: *extinct* (ex), *severely threatened* (s.th), *threatened* (th), *vulnerable* (vu), *less vulnerable* (l.vu) and *not threatened* (S).

Guti (1993) described similar cathegories, ranking the native species into the following groups: *extinct* (K), disappearing (E), *endangered* (V), *rare* ® and *abundant* (T). He classified the foreign species as *immigrant* (B), *exotic* (X) and *unical* (U). He scored the ecological value of the native species as follows: E=4, V=3, R=2, T=1, giving one extra point for endemic species, while foreign species getting no points.

Pricope et al. (2004) suggested indicators describing the structure of fish communities. They calculated the *abundancy of the number of fish* (A), representing the the number of exemplars of a given species compared to the total number of fish in the sample. According to this calculation, they distinguished *very frequent, frequent, relatively rare* and *rare* species.

Another indicator is the frequency:

$$F = P/Pt*100,$$

where P is the number of samples in which the given species is present and Pt is the total number of samples. Accordingly, the stability © of the species in the

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biocenosis can be determined, the certain species being *stable* (F>50), *accessory* (F=25-50) and *circumstantial* (F<25).

The *dominancy* (D) of the species is given by the following equation:

$$D = nA / N \times 100,$$

where nA is the number of the exemplars of the given species and N is the total number of exemplars. A value of D>10% indicates a *eudominant* species, D is 5-10% in case of *dominant*, D = 2.1-5% in case of *subdominant*, D = 1-2% in case of recedent and D<1% in case of *subrecedent* species.

The *ecological significance* (W) of the species is calculated according to the formula:

$$W = C \times D / 10000 \times 100,$$

where C is stability and D is dominancy. Based on this formula the species can be *leader* (W>20), *characteristic* (W = 10-20), *complementary* (W = 5-10), *associate* (W = 1-5), or *accessory* (W<1) species.

The ecological quality of the ichthiocenosis can be characterized using the known *Shannon-Wiener diversity index* (H), or – as suggested by Guti – using numerical values by calculating the *absolute natural value of the ichthiocenosis* according to the following formula:

$$T_A = 4nE + 3nV + 2nR + nT + nX + n,$$

and the relative natural value:

$$T_R = T_A/(nE + nV + nR + nT + nX + nU).$$

Sály (2007) suggested the introduction of the *naturality index of the species collective* (ATI) calculated from the ratio of the modified Shannon index and the original Shannon index. The modified index is calculated as follows:

$$H_{mod} = H*a,$$

where

$$a = 1-(S_{in}*N_{in}-1)/S*N,$$

S_{in} being the number of settled species, N_{in} the number of settled exemplars, S the total number of species and N the total number of gathered exemplars.

For the characterization of the environmental value of the area we have taken into account the number of species included in the Red List of the IUCN, in the Convention of Bern, in the Habitat Directive and in the Red List of Romanian Vertebrates.

RESULTS

Among the 24 fish species three were endemic (Eudontomyzon danfordi, Gobio kessleri, G. uranoscopus), three were introduced (Pseudorasbora parva, Carassius gibelio, Lepomis gibbosus), the rest were native (Table 1).

Among the native and endemic species there were four rithral species known to be accustomed to fast mountain waters (*Eudontomyzon danfordi*, *Phoxinus phoixinus*, *Thymallus thymallus*, *Salmo trutta fario*) and only three euritopic species with large ecological spectrum (*Alburnus alburnus*, *Rhodeus sericeus*, *Perca fluviatilis*). These latters were present in a small number and only in a few places. Unambiguously the most frequent were the rheophilic A species accustomed to fastly flowing waters, and only a few rheophilic B species, accustomed to slow waters, were found (Table 1).

Regarding the reproductive guilds, the dominant species were lithophilic, which spawn onto stony beds, and psammophilic species preferring sandy beds. However, we have also found one species spawning in shells (*Rhodeus sericeus*) and one spawning in cavities (*Cottus gobio*) (Table 1).

According to Bănărescu's consideration only two species (*Leuciscus leuciscus*, *Thymallus thymallus*) can be identified as ecologically restricted ones and four as geographically restricted species (*Eudontomyzon danfordi*, *Gobio kessleri*, *Sabanejewia aurata*, *Cottus gobio*), while the rest can be considered generally distributed species (Table 2).

According to him four species (*Leuciscus leuciscus*, *Gobio kessleri*, *Barbus barbus*, *Thymallus thymallus*) have decreasing spreading territory in the last period and one more (*Gobio uranoscopus*) presents a decreasing number of exemplars as well. Taking together Bănărescu labels *Leuciscus leuciscus* as an extinct species, two species (*Gobio kessleri*, *Thymallus thymallus*) as threatened, two (*Eudontomyzon danfordi*, *Gobio uranoscopus*) as less threatened and the rest as species being in a satisfactory situation (Table 2).

According to Guti's indicators three are disappearing species (*Eudontomyzon danfordi*, *Gobio uranoscopus*, *Thymallus thymallus*), seven are endangered (*Phoxinus phoxinus*, *Alburnoides bipunctatus*, *Vimba vimba*, *Barbus petenyi*, *Gobio kessleri*, *Sabanejewia aurata*, *Cottus gobio*), five (*Leuciscus leuciscus*, *Chondrostoma nasus*, *Barbatula barbatula*, *Cobitis elongatoides*, *Salmo trutta fario*) are rare and the rest are abundant or exotes (Table 2).

Regarding the stability of the species (after Pricope et all) only one (*Phoxinus phoxinus*) is stable. The accessory species are: *Squalius cephalus*, *Barbus petenyi*, *Barbatula barbatula*, *Cobitis elongatoides*, *Cottus gobio*, which fortunately are native species (Table 3).

Calculating the dominancy of the species, four (*Squalius cephalus*, *Phoxinus phoxinus*, *Barbus oetenyi*, *Cottus gobio*) are eudominant, *Barbatula barbatula* is dominant, five (*Alburnus alburnus*, *Alburnoides bipunctatus*, *Gobio gobio*, *Rhodeus sericeus*, *Sabanejewia aurata*) are subdominant and the rest are subrecedent (Table 3).

Regarding ecological significance, the characteristic species is *Phoxinus phoxinus*, complementary species are the *Squalius cephalus* and *Barbus petenyi*, associate species are the *Barbatula barbatula* and *Cottus gobio*, while the other 19 species have only accessory significance (Table 3).

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The territory has a Shannon-Wiener diversity index of H = 2.28.

Taking into account Guti's formulae, the absolute ecological value of the fish fauna of the river is $T_A = 50$, while the relative ecological value is $T_R = 2.17$.

The naturality ATI index is 0.995.

Regarding the protection of the species, six (*Eudontomyzon danfordi, Gobio kessleri, G. uranoscopus, Sabanejewia aurata, Cottus gobio*) are enumerated in the Red List of the IUCN. Nine species (*Alburnoides bipunctatus, Chondrostoma nasus, Barbus petenyi, Gobio kessleri, G. uranoscopus, Rhodeus sericeus, Cobitis elongatoides, Sabanejewia aurata, Thymallus thymallus*) are indicated in Supplement 3 of Bern Convention, seven species (*Eudotomyzon danfordi, Barbus petenyi, Gobio uranoscopus, Rhodeus sericeus, Cobitis elongatoides, Sabanejewia aurata, Cottus gobio*) in Supplement 2, three (*Barbus barbus, barbus petenyi, Thymallus thymallus*) in Suppliment 5 of Habitat Directive. In the Red List of Romanian Vertebrates six species (*Eudontomyzon danfordi, Barbus petenyi, Gobio kessleri, G. uranoscopus, Rhodeus sericeus, Cobitis elongatoides*) are enumerated (Table 4).

DISCUSSION

The 24 fish species found in the Lăpuş basin represent a rather low number, especially taking into account the environmental conditions of the area. Out of these species four are endemic, 17 are native, and only three are adventive, which is a very good ratio.

Studying the ecological guilds the absence of stagnophilic elements is striking. This fact can be explained by the environmental conditions. There are only four euritopic species, while the majority are rhitral and rheophilic species, which can also be considered natural taking ibto account the environmental conditions.

Regarding the reproduction, the high number of lithophilic and psammophilic species corresponds also to the environmental conditions.

In contrast to Bănărescu's opinion, who considered the *Leuciscus leuciscus* an extinct species, we were able to find it in the hill region of a few rivers, however, only in an insignificant number.

The differences between Bănărescu's and Guti's point of view regarding the judgement of a number of species (*Leuciscus leuciscus, Phoxinus phoxinus, Alburnoides bipunctatus, Barbus petenyi, Sabanejewia aurata, Thymallus thymallus, Cottus gobio*) are striking. The differences between the international protection of the certain species and the national situation is even more evident. The *Leuciscus leuciscus* is a typical example, which is considered extinct by Bănărescu, rare by Guti, however, it is not included in any international list. On the other hand, the *Rhodeus sericeus*, considered by both Bănărescu and Guti an abundant species with adequate situation, is mentioned as a rare protected species in two international lists. Therefore, all ecologists need to specifically adapt the suggestions of colleagues working in other places to his own local experiences. It would be desirable to take this into account during preparation of the lists of protected species, to avoid the mechanical adoption of these lists, and to edit regional red lists instead of national ones.

Despite the relatively high number of species, the structure of the fish fauna of the Lăpuş river is relatively simple with only a few stable and many occasionally occuring species.

Regarding dominancy, the situation is more balanced: besides four eudominant species we have found five subdominant species, however, the rest were only subrecedent.

Considering the ecological value of the species, the characteristic species is the rheophilic *Phoxinus phoxinus*, the complementary species are the *Squalius cephalus* and *Barbus petenyi*, while the associate species are the *Barbatula barbatula* and *Cottus gobio*.

The value of the Shannon-Wiener diversity index is H=2.28, which corresponds to the rivers of the nearby territories (Tur: 2.36, Crasna: 2.45, Barcău: 1.94). The absolute natural value of the ichthiocenosis (T_A=50) is higher in comparison with the nearby rivers (Tur: 43, Crasna: 22, Barcău: 29). The situation is similar in case of the relative value (T_R=2.17), which is 1.79 in case of the Tur, 1.37 in case of Crasna and 1.81 in case of the Barcău (Wilhelm, A.S., 2007). This is surprising since an extraordinary anthropogenic pressure is put onto the river, given partly by the residues of mining and processing of non-ferrous metals and partly by the communal wastes of the highly populated territories.

The naturality ATI index is 0.995, and this high value is due to the fact that we could gather only a few exemplars of a few foreign species.

Five of the found species are included in the Red List of the IUCN. Annexe 3 of the Bern Convention contains nine, Annexe 2 of the Habitate Directive contains seven, while Annexe 5 contains three species, the Red List of Romanian Vertebrates sex species.

CONCLUSION

The basin of the Lăpuş river has been affected by extremely pressing environmental effects. In spite of this fact, the fish fauna has remained considerably diverse. Due to the hydrological characteristics of the area the rheophilic species are dominant. The most relevant reproductory modes are the lithophilic and psammophilic guilds. Regarding the origin of the species, the majority of them is native, moreover, there are four endemic among them. Fortunately the number of foreign species is low and are represented by a low number of exemplars.

The relatively high number of protected species would justify to put more emphasis on the protection of the fish fauna of the Lăpuş river.

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Table 1.
The origin, ecological and reproductive guilds of fish species

No	Fish species	Origin	Ecological guilds	Reproductive guilds
1	*Eudontomyzon danfordi*	endemic	rithral	psammophil
2	*Leuciscus leuciscus*	native	reophil A	phytolithophil
3	*Squalius cephalus*	native	reophil A	lithophil
4	*Phoxinus phoxinus*	native	rithral	lithophil
5	*Alburnus alburnus*	native	eurytop	phytolithophil
6	*Alburnoides bipunctatus*	native	reophil A	lithophil
7	*Vimba vimba*	native	reophil A	lithophil
8	*Chondrostoma nasus*	native	reophil A	lithophil
9	*Barbus barbus*	native	reophil A	lithophil
10	*Barbus petenyi*	endemic	reophil A	lithophil
11	*Gobio gobio*	native	reophil B	psammophil
12	*Gobio kessleri*	endemic	reophil A	psammophil
13	*Gobio uranoscopus*	endemic	reophil A	psammophil
14	*Pseudorasbora parva*	introduced accidentaly	exotic	lithophil guarder
15	*Rhodeus sericeus*	native	eurytop	ostracophil
16	*Carassius gibelio*	introduced intencionally	eurytop	phytophil
17	*Barbatula barbatula*	native	reophil A	phytolithophil
18	*Cobitis elongatoides*	native	reophil B	psammophil
19	*Sabanejewia aurata*	native	reophil B	psammophil
20	*Thymallus thymallus*	native	rhitral	lithopelagophil
21	*Salmo trutta fario*	native	rhitral	lithopelagophil
22	*Perca fluviatilis*	native	eurytop	phytophil guarder
23	*Lepomis gibbosus*	introduced intencionally	exotic	psammophil guarder
24	*Cottus gobio*	native	reophil A	speleophil guarder

Table 2.
The situation of fish species after Bănărescu and Guti

No	Fish species	Bănărescu				Guti	
		Range in Romania	Range evolution	Abundance evolution	Status	Status	Value
1	*Eudontomyzon danfordi*	g.r.	±c	±c	l.vu	E*	5
2	*Leuciscus leuciscus*	e.r.	r.e.	d	ext	R	2
3	*Squalius cephalus*	w	ex	i	S	T	1
4	*Phoxinus phoxinus*	w	c	c	S	V	3
5	*Alburnus alburnus*	w	ex	i	S	T	1
6	*Alburnoides bipunctatus*	w	c	c	S	V	3
7	*Vimba vimba*	w	ex	c	S	V	3
8	*Chondrostoma nasus*	w	c	±c	S	R	2
9	*Barbus barbus*	w	r.e.	d	S	T	1
10	*Barbus petenyi*	w	c	c	S	V	3
11	*Gobio gobio*	w	ex	i	S	T	1
12	*Gobio kessleri*	g.r.	r.e.	d	vu	V*	4
13	*Gobio uranoscopus*	w	+c	d	l.vu	E*	5
14	*Pseudorasbora parva*					X	0
15	*Rhodeus sericeus*	w	c	c	S	T	1
16	*Carassius auratus*					T	1
17	*Barbatula barbatula*	w	c	c	S	R	2
18	*Cobitis elongatoides*	w	c	c	S	R	2
19	*Sabanejewia aurata*	g.r.	c	c	S	V	3
20	*Thymallus thymallus*	e.r.	r.e.	d	vu	E	4
21	*Salmo trutta fario*	w	c	c	S	R	2
22	*Perca fluviatilis*	w	c	i	S	T	1
23	*Lepomis gibbosus*					X	0
24	*Cottus gobio*	g.r.	c	c	S	V	3

Table 3.
The frequency (F), stability (C), dominance (D) and ecological importeance (W) of fish species

No	Fish species	F	C	D		W	
1	*Eudontomyzon danfordi*	1.69	circumstantial	0.09	subrecedent	0.001	accessory
2	*Leuciscus leuciscus*	8.47	circumstantial	0.22	subrecedent	0.01	accessory
3	*Squalius cephalus*	49.15	accessory	17.83	eudominant	8.76	complementary
4	*Phoxinus phoxinus*	57.62	stable	20.83	eudominant	12.02	characteristic
5	*Alburnus alburnus*	11.86	circumstantial	4.67	subdominant	0.55	accessory
6	*Alburnoides bipunctatus*	23.72	circumstantial	3.78	subdominant	0.89	accessory
7	*Vimba vimba*	5.08	circumstantial	0.16	subrecedent	0.008	accessory
8	*Chondrostoma nasus*	1.69	circumstantial	0.03	subrecedent	0.001	accessory
9	*Barbus barbus*	6.77	circumstantial	1.56	subrecedent	0.10	accessory
10	*Barbus petenyi*	40.67	accessory	19.53	eudominant	7.94	complementary
11	*Gobio gobio*	32.20	circumstantial	3.03	subdominant	0.97	accessory
12	*Gobio kessleri*	11.86	circumstantial	0.78	subrecedent	0.09	accessory
13	*Gobio uranoscopus*	8.47	circumstantial	0.62	subrecedent	0.05	accessory
14	*Pseudorasbora parva*	5.08	circumstantial	0.42	subrecedent	0.02	accessory
15	*Rhodeus sericeus*	11.86	circumstantial	2.48	subdominant	0.29	accessory
16	*Carassius gibelio*	10.16	circumstantial	0.49	subrecedent	0.04	accessory
17	*Barbatula barbatula*	27.13	accessory	9.01	dominant	2.44	associate
18	*Cobitis elongatoides*	25.42	accessory	0.42	subrecedent	0.10	accessory
19	*Sabanejewia aurata*	11.86	circumstantial	2.12	subdominant	0.25	accessory
20	*Thymallus thymallus*	11.86	circumstantial	0.78	subrecedent	0.09	accessory
21	*Salmo trutta fario*	1.69	circumstantial	0.84	subrecedent	0.01	accessory
22	*Perca fluviatilis*	1.69	circumstantial	0.03	subrecedent	0.001	accessory
23	*Lepomis gibbosus*	5.08	circumstantial	0.09	subrecedent	0.004	accessory
24	*Cottus gobio*	28.81	circumstantial	10.02	eudominant	2.88	associate

Table 4.
Protected fish species

No	Fish species	IUCN Red list	Bern Convention	Habitat Directive	Red List Vertebr. Romania
1	Eudontomyzon danfordi	DD		Annexe 2	minim. preocc.
2	*Leuciscus leuciscus*				
3	*Squalius cephalus*				
4	*Phoxinus phoxinus*				
5	*Alburnus alburnus*				
6	*Alburnoides bipunctatus*		Annexe 3		
7	*Vimba vimba*				
8	*Chondrostoma nasus*		Annexe 3		
9	*Barbus barbus*			Annexe 5	
10	Barbus petenyi		Annexe 3	Annexe 2, 5	minim. preocc.
11	*Gobio gobio*				
12	*Gobio kessleri*	DD	Annexe 3		vulnerable
13	Gobio uranoscopus	DD	Annexe 3	Annexe 2	minim. preocc.
14	*Pseudorasbora parva*				
15	*Rhodeus sericeus*		Annexe 3	Annexe 2	minim. preocc.
16	*Carassius gibelio*				
17	*Barbatula barbatula*				
18	*Cobitis elongatoides*		Annexe 3	Annexe 2	minim. preocc.
19	*Sabanejewia aurata*	DD	Annexe 3	Annexe 2	
20	*Thymallus thymallus*		Annexe 3	Annexe 5	
21	*Salmo trutta fario*				
22	*Perca fluviatilis*				
23	*Lepomis gibbosus*				
24	*Cottus gobio*	DD		Annexe 2	

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