CZU: 597.2/.5(282.243.7)(478) **https://doi.org/10.59295/sum1(171)2024_04**

REVIEW OF THE RECENT FINDINGS ON THE ICHTHYOFAUNA OF THE PRUT RIVER, REPUBLIC OF MOLDOVA

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The investigations carried out in 2010-2022 in the Prut River basin within territorial limits of the Republic of Moldova revealed an ichthyofaunistic diversity consisting of 62 species from 13 orders and 22 families, of which 14 species are considered endemic to the Danube basin. A new species was identified in the Prut River in 2010 – *Gymnocephalus baloni* (Holcík & Hensel, 1974). Later, in 2015, the species *Benthophilus nudus* (Berg, 1898) was recorded for the first time in the Prut River, and in 2022 – *Rutilus virgo* (Heckel, 1852). The obvious biological progression of *Gobiidae* species in last decades is an alarming sign related to the stability of native ichthyocenoses. The analysis of the flow, spatial, trophic and reproductive preferences of fish denoted that most of species are eurytopic, benthic, omnivorous, lithophilous or phytophilous.

Keywords: *Prut River, Danube basin, ichthyofauna, climate change, allogenic species, endemic species.*

ANALIZĂ A DESCOPERIRILOR RECENTE PRIVIND IHTIOFAUNA DIN RÂUL PRUT, REPUBLICA MOLDOVA

Investigatiile efectuate în perioada 2010-2022 în bazinul râului Prut în limitele teritoriale ale Republicii Moldova au relevat o diversitate ichtiofaunistică formată din 62 de specii din 13 ordine și 22 de familii, din care 14 specii sunt considerate endemice pentru bazinul Dunării. O nouă specie a fost identificată în râul Prut în 2010 - *Gymnocephalus baloni* (Holcík & Hensel, 1974). Mai târziu, în 2015, specia *Benthophilus nudus* (Berg, 1898) a fost înregistrată pentru prima dată în râul Prut, iar în 2022 - *Rutilus virgo* (Heckel, 1852). Progresia biologică evidentă a speciilor din fam. *Gobiidae* în ultimele decenii este un semnal alarmant legat de stabilitatea ichtiocenozelor native. Studiul afenității în raport cu regimul de curgere, preferințele spațiale, trofice și reproductive ale peștilor a arătat că majoritatea speciilor sunt euritope, bentonice, omnivore, litofile sau fitofile.

Cuvinte-cheie: *râul Prut, bazinul Dunării, icthiofaună, schimbări climatice, specii alogene, specii endemice.*

Introduction

Aquatic ecosystems face rapid environmental change. The prevailing threats are habitat loss and degradation, invasive species, pollution, over-exploitation and climate change, and the synergy between them can complicate the impact on fish to a large extent [1]. In order to identify the long-term temporal changes in fish communities, or to track the changes in the status of vulnerable and threatened species, or to allow an early detection of alien species, permanent monitoring works are required [2].

The ecological state of the Danube largely depends on the well-being of its tributaries. This fact also refers to the fish diversity, the ecosystems of the tributaries often serving as oases of refuge and conservation for the endemic species of the entire Danube basin.

The Prut River, with a length of 926 km, is the third longest tributary of the Danube. It flows for the first 211 km eastward in Ukraine and then forms the border between Ukraine and Romania (32 km) and between Romania and Moldova (695 km) [3]. The lower Prut floodplain lake Beleu is the largest natural lake in Moldova. In order to protect, preserve and study the lake floodplain ecosystem of the lower Prut, in particular to create the favorable conditions for the reproduction of rare and endangered species and other species of plants and animals, the State Reserve Lower Prut was created in 1991, with a total area of 1691 ha [4]. Later, in 2000, an area of 19152 ha, located in the lower Prut basin (Cahul county), including a sector of the Prut riverbed, permanent freshwater lacustrine water bodies (Beleu, Manta, Rotunda, Dracile etc.) and 1 fish pond was designated as the Ramsar site no. 1029 Lower Prut Lakes, as recognition of the system importance for groundwater recharge, flood control, sediment trapping and support for numerous rare and threatened species of flora and fauna [5, 6]. The site extends to the Prut confluence with the Danube, this fact explaining the strong connection between the ichthyofauna of both rivers.

Fish diversity of the Prut River basin reflects the presence of distinct habitats: riffle-pool sequences in the upper part of the river bed, typical sequences for a plain river in its lower part, artificial and natural lakes, temporary or permanent water surfaces, which are supplied by the Prut River during floods.

Costești-Stânca reservoir, which was put in use in 1976, is located on the Prut riverbed on 580 km from the confluence with the Danube and is the largest aquatic unit of the Prut basin, having several functions: flood defense and flow regulation downstream reservoir, hydropower generation and water supply [7]. Obviously, the construction of the reservoir of Costești-Stânca hydropower plant (HPP) determined the breaking of the longitudinal connectivity of the river, causing harmful consequences, first of all, on the hydromorphological balance of the river, but also on the aquatic habitats and their ecological functions.

Fish diversity of Costești-Stânca reservoir consisted of 23 species - representatives of 4 orders and 6 families - in 2020, but, for example, between 1997 and 2021 the number of recorded fish species varied from 22 to 34 [8, 9]. In order to develop de potential of capture fisheries, the reservoir has been stocked with fry, yearlings or two-summer-old fish since 1984. Data on the stocking of the reservoir with pikeperch, common bream, common carp, Chinese major carps, silver crucian carp and even common roach are available for the period 1984-2009 [10]. Nevertheless, the fish production of Costești-Stânca reservoir is considered to be much lower than its potential volume, due to, first of all, non-compliance with scientific recommendations for maintaining the water level during the reproduction period, by illegal fishing and the lack of ameliorative-fishery measures [8].

Recent analysis of multiannual hydrological data revealed that the creation of Costești-Stânca reservoir and the construction of a hydropower plant of a mean capacity have not showed a statistically significant effect on annual water discharge downstream, but changed its seasonal distribution according to the interests of certain water users, including those dealing with fishery and aquaculture [11]. The last published comprehensive work on the hydrochemistry of the Prut River, based on the investigations carried out in 2013-2014 on the Costești-Stânca reservoir, Criva-Tețcani sector (the river sector within the territorial limits of the Republic of Moldova placed upper the reservoir) and Branișteе-Giurgiulești sector (placed downstream the reservoir dam), demonstrated that in most cases the waters of the Prut River were satisfactory for hydrobiont development, but the concentrations of suspensions and nutritive elements were not always favorable for development of planktonic organisms [12]. Both droughts, with low water levels and high temperatures, and floods affect the state of ichthyofauna, as during such extreme hydrological events the saturation of water with dissolved oxygen and the content of suspension are drastically changed in the river [13].

Per total, there is recoded an increase of the number of fish species in the Prut river basin in the last decade. Thus, 50 species, belonging to 8 orders and 11 families were identified in 2010-2013 [14], but the summarising of the data for 2010-2016 revealed the presence of 56 species, belonging to 10 orders and 15 families [15]. The identification of 2 new species for the Prut river basin, and namely in its lower part, has been reported since 2010: of *Gymnocephalus baloni* [16] and of *Benthophilus nudus* (Berg, 1898) [17].

The present work aims to update the information on the fish diversity of the Prut river basin within the boundaries of the Republic of Moldova, based on data collected in 2010-2022.

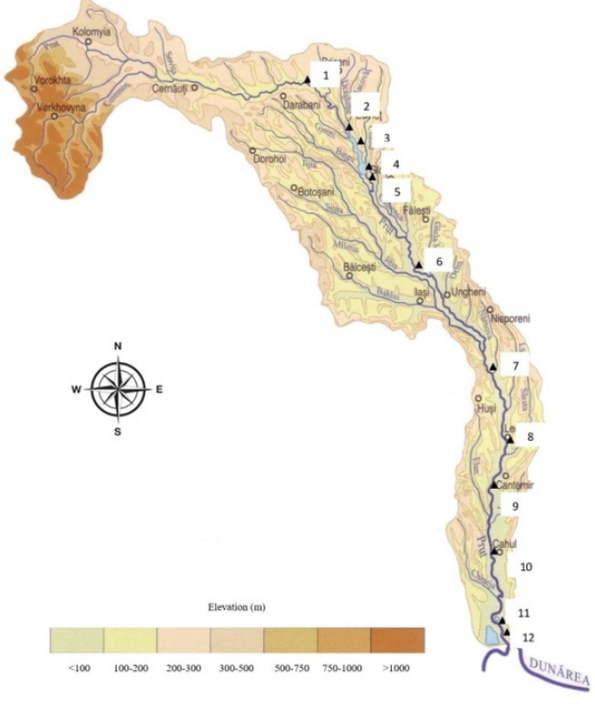
Materials and Methods

Study area

The Prut River, which takes its beginning from the woody Carpathians of Ukraine (Mount Goverla), is the last left tributary of the Danube River in the Black Sea basin, Eastern Europe. It discharges in the Danube south of Giurgiulești village, at about 164 km from de Danube mouth. Of the total area of the Prut basin (27540 km^2), 28% are located on the territory of the Republic of Moldova (PRBMP, 2016).

Fish samples were collected along the course of the Prut River (Fig. 1), in its tributaries Vilia (50 km), Lopatnic (57 km), Racovăț (67 km), Ciuhur (90 km), Larga (33 km) and also from Beleu Lake and Manta ponds. The Vilia and Lopatnic Rivers discharge their waters upstream to Costești-Stânca reservoir, Racovăț and Ciuhur Rivers – into the Costesti-Stânca reservoir and Larga River – into the Lower Prut [18]. Fish sampling was performed in the tributaries at least in two points, of which one placed not far from the tributary confluence with the Prut River.

Fig. 1. Fish sampling points in the Prut riverbed within the borders of the Republic of Moldova: 1– Lipcani, 2 – Bădrajii Noi, 3 – Cuconeștii Noi, 4 – Costești, 5 – Branițe, 6 – Sculeni, 7 – Leușeni, 8 – Leova, 9 – Țiganca, 10 – Cahul, 11 – Slobozia Mare, 12 – Giurgiulești. Source of the Prut River basin map: [18].



Collection and identification of samples

Ichthyological investigations have been carried out in the Prut River basin during 2010-2022. Scientific and control fishing was done by using various fishing gears: nets, fishing triple-walled nets (length – 75 m, mesh size – from 20x20 mm to 90x90 mm) and seine net (length – 5 m, mesh size – 5x5 mm). Electrofishing was not used, as the [19] prohibits it in the Republic of Moldova. The captured specimens were identified, a range of biological features were analysed (morphometric parameters, age structure, sex structure, growth rate, degree of development of sexual products, etc.) and some of ecological indices (analytical and synthetic) were calculated [20, 21, 22].

Results

The results obtained on the fish diversity in the Prut River basin, Republic of Moldova, in 2010-2022, together with other reported information for previous periods, are presented in Table 1.

There was revealed an ichthyofaunistic diversity consisting of 62 species, which belong to 13 orders and 22 families: Petromyzontiformes, with Petromyzontidae family (1 species), Acipenseriformes, with Acipenseridae family (2 species), Clupeiformes, with Clupeidae family (1 species), Salmoniformes, with Salmonidae family (1 species), Esociformes, with Esocidae family (1 species), Umbridae family (1 species), Cypriniformes, with Cyprinidae family (4 species), Xenocyprididae family (3 species), Tincidae family (1 species), Acheilognathidae family (1 species), Leuciscidae family (15 species), Gobionidae family (4 species), Nemacheilidae family (1 species), Cobitidae family (6 species), Siluriformes, with Siluridae family (1 species), Gadiformes, with Lotidae family (1 species), Perciformes/Gasterosteoidei, with Gasterosteidae family (2 species), Sygnathiformes, with Sygnathidae family (1 species), Perciformes/Percoidei, with Percidae (7 species), Gobiifomes, with Gobiidae family (6 species), Odontobutidae family (1 species), Centrarchiformes, with Centrarchidae family (1 species).

Gobies (Gobiidae) can serve as a model of expansion and biological progression of species or even families. Thus, if only two species of gobies – *Proterorhinus semilunaris* and *Neogobius fluviatilis* – were identified in 1976-1977 [cited by14], then currently 6 species have been already reported.

Table 1. Ichthyofauna of the Prut River in the territorial limits of the Republic of Moldova in various investigation periods.

	Fish species	Prut River basin, 1976-1977 (Popa 1977) [cited by 15]	Prut River basin (Usatîi 2004) [23]	Prut River riverbed (Moshu et al. 2006) [24]	Prut River basin, 2010-2022	Abundance in catches in Prut River basin, 2010-2022	Allogeneic and endemic fish species in the Danube River basin	IUCN statute and populational trend in Prut River
Petromizontiformes order, Petromyzontidae family								
1	*Eudontomyzon mariae* (Berg, 1931)	+	-	-	+	*		LC ?
Acipenseriformes order, Acipenseridae family								
2	*Acipenser ruthenus* (Linnaeus,1758)	+	+	-	+	*		EN ↓
3	*Acipenser stellatus* (Pallas, 1771)	+	-	-	+	*		CR ↓
4	*Acipenser nudiventris* (Lovetsky, 1828)	+	-	-	-	0		CR ?
Clupeiformes order, Clupeidae family								
5	*Alosa tanaica* (Grimm,1901)	-	+	-	+	***		LC ↑
Salmoniformes order, Salmonidae family								
6	*Hucho hucho* (Linnaeus,1758)	+	-	-	-	0	endemic	EN ?
7	*Salmo trutta* (Linnaeus, 1758)	+	-	-	-	0		LC ?
8	*Oncorhynchus mykiss* (Walbaum,1792)	+	-	-	+	*	allogeneic	LC ↑
Esociformes order, Esocidae family								
9	*Esox lucius* (Linnaeus, 1758)	+	+	+	+	***		LC →
Umbridae family								
10	*Umbra krameri* (Walbaum, 1792)	+	-	-	+	*	endemic	VU↓
Cypriniformes order, Cyprinidae family								
11	*Cyprinus carpio* (Linnaeus, 1758)	+	+	+	+	***	endemic	VU↓
12	*Carassius carassius* (Linnaeus, 1758)	+	+	-	-	0		LC ?
13	*Carassius auratus sensu lato* (*C. auratus / C. gibelio*)	+	+	-	+	*****	allogeneic	LC →
14	*Barbus barbus* (Linnaeus,1758)	+	+	+	+	**		LC →
15	*Barbus petenyi* (Heckel, 1852)	+	-	-	+	*	endemic	LC↓
Xenocyprididae family								
16	*Hypophthalmichthys molitrix* (Valenciennes, 1844)	+	+	-	+	****	allogeneic	LC ↑
17	*Hypophthalmichthys nobilis* (Richardson, 1845)	-	+	-	+	**	allogeneic	LC ↑
18	*Ctenopharyngodon idella* (Valenciennes, 1844)	-	+	-	+	**	allogeneic	LC ↑
Tincidae family								
19	*Tinca tinca* (Linnaeus, 1758)	+	-	-	+	*		LC↓

Acheilognathidae family								
20	*Rhodeus amarus* (Bloch, 1782)	+	+	+	+	****		LC ↑
Leuciscidae family								
21	*Chondrostoma nasus* (Linnaeus, 1758)	+	+	+	+	***		LC ↑
22	*Abramis brama* (Linnaeus, 1758)	+	+	+	+	***		LC →
23	*Ballerus sapa* (Pallas, 1814)	+	+	+	+	***		LC →
24	*Blicca bjoerkna* (Linnaeus, 1758)	+	+	+	+	*****		LC ↑
25	*Vimba vimba* (Linnaeus, 1758)	+	+	+	+	**		LC →
26	*Rutilus rutilus* (Linnaeus, 1758)	+	+	+	+	***		LC →
27	*Rutilus virgo* (Heckel, 1852)	-	-	-	+	**	endemic	LC ↑
28	*Leuciscus aspius* (Linnaeus, 1758)	+	+	+	+	***		LC ↑
29	*Pelecus cultratus* (Linnaeus, 1758)	+	+	+	+	**		LC ↑
30	*Squalius cephalus* (Linnaeus, 1758)	+	+	+	+	***		LC →
31	*Leuciscus idus* (Linnaeus, 1758)	+	+	+	+	**		LC →
32	*Phoxinus phoxinus* (Linnaeus, 1758)	+	-	-	-	0		LC ?
33	*Leuciscus leuciscus* (Linnaeus, 1758)	-	+	-	-	0		LC ?
34	*Scardinius erythrophthalmus* (Linnaeus, 1758)	+	+	+	+	***		LC →
35	*Leucaspius delineatus* (Heckel, 1843)	+	+	+	+	*		LC ↓
36	*Alburnus alburnus* (Linnaeus, 1758)	+	+	+	+	****		LC →
37	*Alburnoides bipunctatus* (Bloch, 1782)	+	+	+	+	**		LC ↓
Gobionidae family								
38	*Gobio gobio* (Linnaeus, 1758)	+	+	+	+	*		LC ?
39	*Romanogobio vladykovi* (Fang, 1943)	+	+	+	+	**	endemic	LC ↑
40	*Romanogobio uranoscopus* (Agassiz, 1828)	+	-	-	-	0	endemic	LC ?
41	*Romanogobio kesslerii* (Dybowski, 1862)	+	+	+	+	**		LC →
42	*Pseudorasbora parva* (Temminck & Schlegel, 1846)	-	-	+	+	***	allogeneic	LC →
Nemacheilidae family								
43	*Barbatula barbatula* (Linnaeus, 1758)	+		-	+	*		LC ↓
Cobitidae family								
44	*Cobitis taenia* (Linnaeus,1758)	+	+	+	+	*		LC ?
45	*Cobitis elongatoides* (Băcescu & Mayer, 1969)	-	-	+	+	****	endemic	LC ↑
46	*Cobitis tanaitica* (Băcescu & Mayer, 1969)	-	-	-	+	*		LC ↑
47	*Sabanejewia balcanica* (Karaman, 1922)	+	-	+	+	**	endemic	LC ↓
48	*Sabanejewia bulgarica* (Drensky, 1928)	-	-	-	+	**	endemic	LC ↑
49	*Misgurnus fossili*s (Linnaeus,1758)	+	+	+	+	**		LC ↓
Siluriformes order, Siluridae family								
50	*Silurus glanis* (Linnaeus, 1758)	+	+	+	+	***		LC →
Gadiformes order, Lotidae family								
51	*Lota lota* (Linnaeus, 1758)	+	-	+	+	*		LC ↓

Perciformes/Gasterosteoidei order, Gasterosteidae family								
52	*Pungitius platygaster* (Kessler, 1859)	+	+	-	+	**		LC →
53	*Gasterosteus aculeatus* (Linnaeus,1758)	-	-	-	+	*		LC ?
Sygnathiformes order, Sygnathidae family								
54	*Syngnathus abaster* (Risso, 1827)	+	-	-	+	**		LC ↑
Perciformes/Percoidei order, Percidae family								
55	*Perca fluviatilis* (Linnaeus, 1758)	+	+	+	+	***		LC→
56	*Sander lucioperca* (Linnaeus, 1758)	+	+	+	+	***		LC↓
57	*Gymnocephalus cernua* (Linnaeus, 1758)	+	+	+	+	**		LC↓
58	*Gymnocephalus schraetser* (Linnaeus, 1758)	+	-	+	+	*	endemic	LC↓
59	*Gymnocephalus baloni* (Holcík & Hensel, 1974)	-	-	-	+	***	endemic	LC ↑
60	*Zingel streber* (Siebold, 1863)	+	+	+	+	*	endemic	LC→
61	*Zingel zingel* (Linnaeus, 1766)	+	+	-	+	**	endemic	LC↓
Gobiiformes order, Gobiidae family								
62	*Ponticola kessleri* (Guenther, 1861)	-	+	+	+	***		LC ↑
63	*Babka gymnotrachelus* (Kessler, 1857)	-	-	+	+	****		LC ↑
64	*Neogobius melanostomus* (Pallas, 1814)	-	-	+	+	**		LC ↑
65	*Proterorhinus semilunaris* (Heckel, 1837)	+	+	+	+	****		LC ↑
66	*Neogobius fluviatilis* (Pallas, 1814)	+	+	+	+	****		LC ↑
67	*Benthophilus nudus* (Berg, 1898)	-	-	-	+	***		LC ↑
Odontobutidae family								
68	*Perccottus glenii* (Dybowski, 1877)	-		+	+	**	allogeneic	LC ↑
Perciformes/Cottoidei order, Cottidae family								
69	*Cottus gobio* (Linnaeus, 1758)	+	-	-	-	0		LC ?
70	*Cottus poecilopus* (Heckel, 1837)	+	-	-	-	0		LC ?
Centrarchiformes order, Centrarchidae family								
71	*Lepomis gibbosus* (Linnaeus, 1758)	+	+	+	+	***		LC ↑
	Total	**55**	**42**	**40**	**62**			

Note: Conventional signs regarding the numeric abundance of the species in catches at basin level (territorial limits of the Republic of Moldova), populational trend and IUCN rarity statute:

0 - species absent in catches

* - very rare,

** - rare,

*** - relatively numerous,

**** - abundent,

***** - very abundent.

↑ - positive populational dinamics,

↓ - negative populational dinamics,

↓ - stable populational dinamics,

? – incert populational dinamics.

CR – critically endangered species,

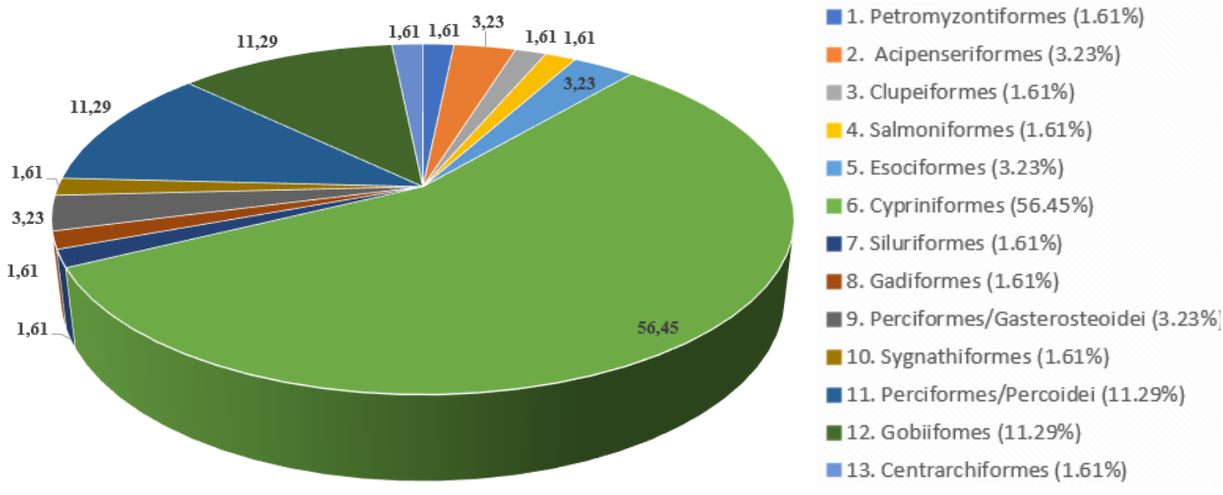
EN – endangered,

VU – vulnerable,

LC – low concern from the conservation point of view.

Analyse of the share of representatives of different orders demonstrated that the absolute majority in the species structure of the ichthyofauna of the Prut River basin belongs to Cypriniformes (56.45%), followed by Perciformes (11.29%) and Gobiiformes (11.29%). The other orders are represented by only one or two fish species (fig. 2).

Fig. 2. Share of different orders in the taxonomic structure of ichthyofauna of the Prut River basin.



According to the status in the IUCN list, 2 species are critically endangered (CR), 2 endangered (EN) and 2 vulnerable (VU) (Table 1), the rest of 56 species being not threatened, of low concern (LC) [26].

From the point of view of trophic preferences most of species in the Prut River basin are part of the omnivorous guild (51 species), followed by the ichthyophagous one (7 species). Two of the three identified planktivores, namely *Hypophthalmichthys molitrix* and *Hypophthalmichthys nobilis*, are introduced species (table 2).

Table 2. Structure of ichthyofauna of the Prut river basin according to trophic guilds.

No.	Trophic guild	Number of fish species
1	detritivorous	1
2	omnivorous	51
3	planktonophagous	3
4	ichthyophagous	6
5	herbivorous	1

Regarding the spatial niches, which are preferred by fish (in the adult stage) for feeding, it was determined that most of them occupy the benthic zone – 46 species. The other 16 species feed in the water column.

According to affinity with the water current, 19 species are rheophilic, 41 species – eurythopic and 2 species – limnophilic.

Among the reproductive guilds of fish species in the Prut river basin, the dominance of lithophilic fish (22 species), which lay their eggs on hard substrate, and of phytophilic fish (19 species), which are dependent on spring floods by entering floodplains to spawn on vegetal substrate, was recorded. There are also numerous phyto-lithophilic fish, which have more flexible demands on the reproductive substrate (Table 3).

Table 3. Structure of ichthyofauna of the Prut river basin according to reproductive guilds.

No.	Reproductive guild	Number of fish species
1	lithophilic	22
2	phytophil	19
3	phyto-lithophilic	10
4	pelagophilic	5
5	ostracophilic	1
6	psammophilic	4
7	pouch brooders	1

As for the structure of ichthyofauna of the Prut river basin according to the life cycle duration of its representatives in the current ecological conditions, fish species with a medium and short life cycle form the largest groups (26 species each). A long life cycle is characteristic only for 10 species, most of which are captured rarely and in small numbers.

Discussion

The Prut River contains a smaller number of fish species compared to the Dniester River, but their diversity and share of endemic ones is higher, which is a firm indicator of the ecological well-being, respectively, of the environmental conditions that ensure a greater degree of conservation of the native biodiversity [15]. For example, of the total number of fish and cyclostomata species identified, 14 species are considered endemic to the Danube basin and 7 species are considered as being anthropophor translocated allogeneic species [21, 26, 27].

Due to numerous meanders of the Prut riverbed, steep banks, riffle-pool sequences and drowned trees, collection of the ichthyological material with legally allowed tools (nets and seines) is quite difficult. This fact, along with the different periods of research, can also explain the large gap between the data on ichthyofauna diversity presented by some authors (Table 1) and makes the comparison of quantitative data uncertain.

Analyze of the data on the ichthyofauna of the Prut River basin (within the territorial limits of the Republic of Moldova) in a multi-annual aspect revealed an insignificant increase in the number of species – from 55 species in 1976-1977 to 62 species in the recent study. This fact is explained, on the one hand, by the active processes of secondary self-expansion and anthropochoric translocation, which led to the artificial enrichment of species diversity, and on the other hand, the artificial increase in ichthyofaunal diversity was compensated by the disappearance or decimation of the populations of some species once representative for this ecosystem [15].

Gobiidae demonstrated lately an obvious biological progression among the group of Ponto-Caspian relicts, *Neogobius fluviatilis*, *Babka gymnotrachelus*, *Ponticola kessleri* and *Proterorhinus semilunaris* becoming representative species for the Prut ecosystem. So far, *Neogobius melanostomus* is rare in catches in the Prut River, despite the fact that it causes an invasive effect in most of rivers in the Ponto-Caspian basin, including the Danube River.

An ichthyofaunistic novelty for this aquatic ecosystem – of the goby *Benthophilus nudus* (Berg, 1898) – was registered in 2015 on the Giurgiuleşti-Câşliţa-Prut river sector [17].

It can be stated that currently *Benthophilus nudus* demonstrates an obvious biological progression, as scientific fishing carried out since the summer of 2022 pointed out the spread of this fish from the lower part of the Prut riverbed up to the dam of Costesti-Stanca reservoir.

After the devastating floods of 2008 and 2010 in the Prut River basin [28], when many fish ponds located in the Prut river basin were damaged, significant amounts of cultured Asian cyprinids (*Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, *Ctenopharyngodon idella*) and European carp (*Cyprinus carpio*) were found in the Prut riverbed. Moreover, the allogene species of cultured rainbow trout (*Oncorhynchus mykiss*) was recorded in Costești-Stanca reservoir [29]. Presumably it has escaped accidentally from the fish farms located in the Ukrainian part of the Prut basin during floods. Based on the control captures of 2011, it can be stated that important changes occurred in the share of these species also in the lower Prut ecosystems, including Beleu Lake and Manta ponds, especially of individuals aged 1+ and 2+ years. For comparison, results for fish catches in the riverbed for 2022 are given (Table 4).

Also, the floods caused the partial interpenetration, with a temporary effect, of the fishing zones within the Prut River ecosystem, as well as of the representatives of the ichthyocenoses of different ecosystems within the Danube basin, which tributary the Prut River is. This fact led to the movement of rheophilic fish species from the upper part of the river to its middle part (for example, catches of *Barbus barbus*, *Chondrostoma nasus* and *Vimba vimba* temporarily increased in Costești-Stanca reservoir) and opposite – both Danubian endemic and allogeneic species actively spread from the Danube upstream along the course of the Prut River [15].

Table 4. Relative abundance (%) of introduced Asian cyprinid species in comparison with other fish species in the lower Prut basin.

No.	Species	Beleu Lake		Manta ponds		Riverbed of the Lower Prut		
		1996-1997 (Usatîi 2004) [23]	2011 (Bulat 2017) [15]	1996-1997 (Usatîi 2004) [23]	2011 (Bulat 2017) [15]	1996-1997 (Usatîi 2004) [23]	2011 (Bulat 2017) [15]	2022
1	*Hypophthalmichthys molitrix*	0.1	7.18	0.6	23.55	0.6	30.05	5.71
2	*Hypophthalmichthys nobilis*	0	2.83	0	4.40	0	3.7	0
3	*Ctenopharyngodon idella*	0	3.05	0	3.65	0	5.2	0
4	*Cyprinus carpio*	4.4	21.43	3.65	9.7	2.0	6.7	5.71
5	other species	95.5	65.51	95.75	58.7	97.4	54.35	88.58

Note: The control fishing in 2011 and 2022 was done with fishing triple-walled net (length of 75 m, mesh size of 50x50 mm).

The occurrence of a new species for the Prut River – *Gymnocephalus baloni* (Holcík & Hensel, 1974) – was recorded in 2010 [16]. In few years the species formed numerous populations in Beleu Lake, Manta ponds and in the lower Prut riverbed (up to Cahul town), becoming an eloquent example of biological progression of a species with short life cycle in the conditions of the Republic of Moldova. Moreover, despite the recognition of this species as an oxyphilic and pollution-sensitive one, the penetrated specimens successfully adapted to muddy substrate and standing waters in some of the channels in the lower Prut floodplain, which have been were flooded during the high waters of 2008 and 2010 [15].

At the end of the summer of 2022, the species *Rutilus virgo* (Heckel, 1852), an endemic of the Danube basin, was recorded for the first time in the lower sector of the Prut River [30].

It should be noted that in the end of October of 2022 the species *Rutilus virgo* was also identified in the catches from Costești-Stânca reservoir, which indicates a high probability of its spreading within the Prut River ecosystem from upstream to downstream.

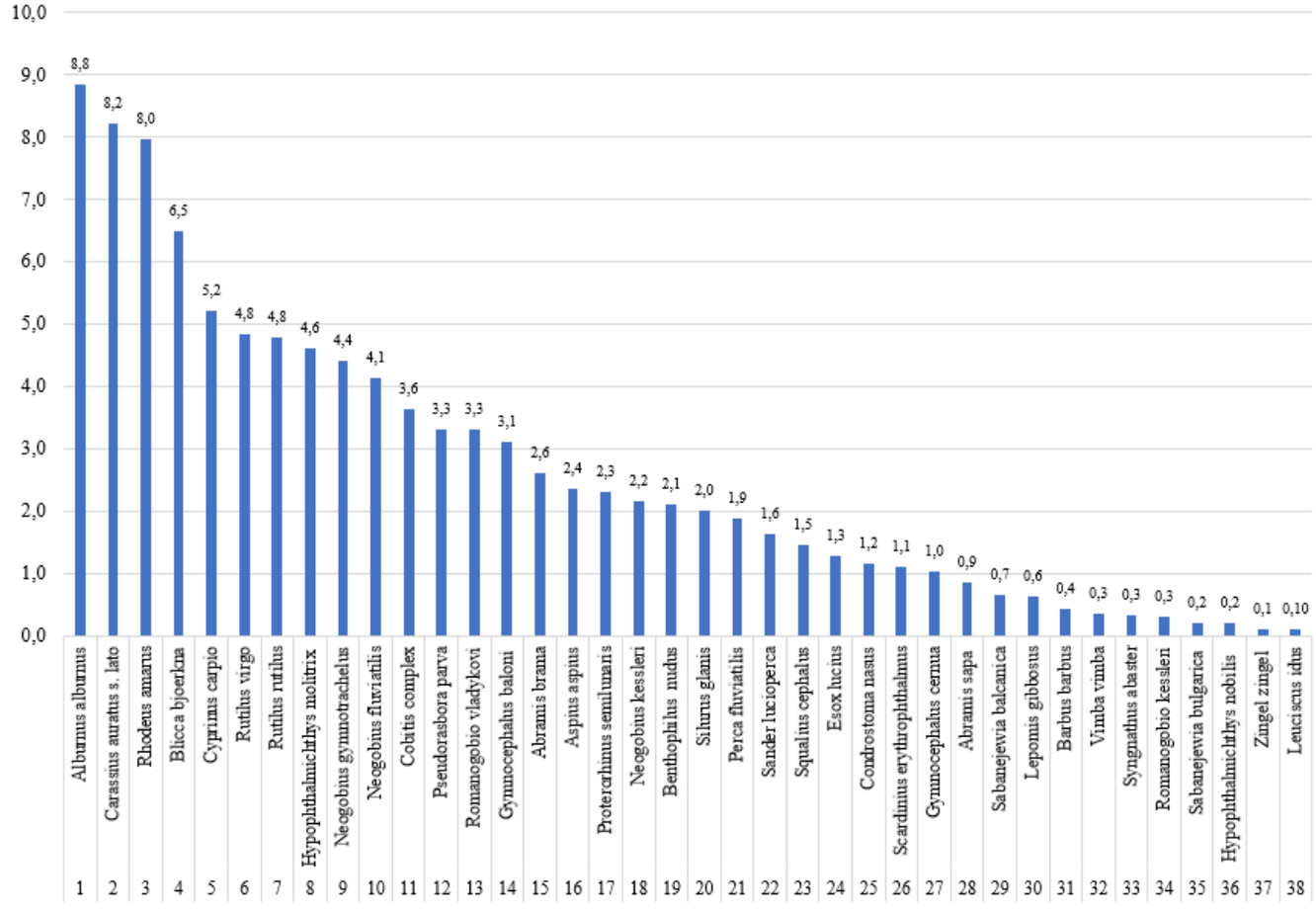
Despite the fact that the Prut River is recognized by the abundance of endemic species of the Danube basin, a major threat to the biodiversity of this ecosystem is the expansion of allogenic species with an invasive effect (fig. 3). For example, in the catches from some biotopes there are significant shares of *Lepomis gibbosus* (floodplains in the Prut meadow), *Carassius auratus* (the entire hydrographic basin), *Hypophthalmichthys molitrix* (the Lower Prut riverbed), *Pseudorasbora parva* (the entire hydrographic basin) and *Perccottus glenii* (the riverbed and tributaries of the middle sector of the Prut riverbed). In the case of *L.gibbosus*, it was demonstrated by [31, p. 143-150], on the base of modelling of certain environmental variables (climate, topography, land cover, soli), that the Lower Danube-Dniester area has a relatively high habitat suitability for the spread of this species.

To point out that the dominance of cyprinids is characteristic for the European lotic ecosystems in the hilly and lowland areas, but the obvious biological progression of *Gobiidae* species becomes worrisome.

In unstable environmental conditions and the overexploitation of fish resources, the biological peculiarities of K-strategic species, such as large size, late maturation and the unitary mode of reproduction, become inappropriate, giving way to the idioadaptations of *r*-strategic opportunistic species, such as small size, short or medium life cycle, early maturation, portioned reproduction mode, wide trophic spectrum and high affinity to different types of habitats.

The effect of climate change, expressed by long-lasting droughts followed by massive flooding, has caused the partial interpenetration of fish zones within the river ecosystem and the more active spread of species, both native and allogeneic, within the Danube River basin.

Figure 3. Relative abundance (A, % of total catch) of species captured with seine net from the Lower Prut riverbed, Brânza – Giurgiuleşti sector, 2022-2023.



In conclusion, in the condition of running waters with medium flow speed, with steep banks and low transparency, such as the Prut River, the advantaged fish taxa will be the omnivorous, benthic and benthos-ophagous ones.

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Acknowledgments: *The investigations were carried out within the framework of the project no. 20.80009.7007.06 AQUABIO (State Program 2020-2023, Republic of Moldova) and EU funded projects MIS ETC 1676 INPOLDE, BSB165 HydroEcoNex, BSB 27 MONITOX, 2SOFT/1.2/38.*

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Presented on 27.03.2024