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Review Article

Changes in the Fish Biodiversity of the Lower Dniester River (Moldova)

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ISSN: 2637-7802

Abstract

This research was conducted to record the fish species inhabiting Lower Dniester River in frames of the Moldovan borders and its drainage between 2011 and 2022. Following the investigations the list of recorded fishes from the study area totaled a number of 78 species, belonging to 18 families, 13 orders and 2 classes. Changes in the composition of fish of the Lower Dniester over a long period are considered. The factors determining the state of the fish fauna are change in the hydrological regime associated with climate change and hydro construction, damming of the riverbed, point and non-point river pollution, developed poaching, and poor cooperation between riparian countries in the joint regulation and use of fish and other biological resources. Measures are proposed for the conservation and restoration of the diversity of the autochthonous fish fauna.

Keywords: Fish; Fauna; Monitoring; Lower dniester river; Moldova

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Submission: August 30, 2022

Published: October 07, 2022

Volume 3 - Issue 3

How to cite this article: Vladimir Romanescu, Alexandru Moshu, Ilya Trombitsky. Changes in the Fish Biodiversity of the Lower Dniester River (Moldova). Biodiversity Online J. 3(3). BOJ. 000561. 2022.

Introduction

The Dniester River is one of the largest rivers in the northwestern part of the Black Sea. The famous ichthyologist Lev Berg was born in Bender on its bank and raised on it, he devoted his youth to studying the biodiversity of fish in this river. In recent decades, when the river has been subjected to intensive economic exploitation, including hydropower and damming, studies and assessments of its biodiversity have been limited. On the other hand, three Ramsar sites and two national parks have been proclaimed in the lower reaches of the Dniester in recent decades. This study aims to assess the current state of the fish biodiversity of the Dniester River in the section from the Dubasari Hydropower Plant to the village of Palanca-within the territory of the Republic of Moldova. The Dniester River is a transboundary watercourse, and both the source and the mouth are located on the territory of Ukraine. A powerful transformative effect on the aquatic biota of the region was exerted by such anthropogenic factors as active water withdrawal, construction of hydropower plants with dams, extraction of sand, gravel and other building materials in river bed and on the banks, as well as chemical and biological pollution of water with various wastes as well as flourishing poaching and weak riparian countries cooperation are provoking irreversible eutrophication, chronic pollution, overfishing, physical destruction of biotopes, led to fundamental changes in the structure of the populations of hydrobionts [1]. Another important problem of the Dniester River is its pollution with municipal effluents from cities and villages in Ukraine and Moldova, as well as effluents from food industry enterprises, which causes an increased content of nitrogen and phosphorus, heavy metals, detergents, and organic substances as a product of fertile soil erosion and washing into the river. Changes in the hydrological regime of the Dniester as a result of runoff regulation and non-fulfillment of the regimes of ecological releases from the Dniester reservoir adversely affect the conditions of spawning watering, which led to a reduction in spawning areas and deterioration in the conditions for fish reproduction [2]. Previous studies clearly show that one of the consequences of the modification of ecological conditions in the

basin is a reduction in the qualitative and especially quantitative structure of the ichthyofauna [2-8]. The aim of the present survey was to ascertain the actual composition and the spatial distribution of the ichthyofauna in the Lower Dniester River and its changes in the last decade.

Materials and Methods

Fishing in the lower reach of the Dniester river (320km section from the Dubasari HPP (47°16'27"N, 29°07'16"E) to Purcari village (46°24'47"N 30°05'44"E) and in the adjacent water bodies of it basin) was conducted (Figure 1). Field surveys time covers the vegetative period between 2011 and 2022. The sampling stations of its branches were determined by taking the ecological conditions into consideration. Fish were caught by expeditionary methods using various fish-rods, a fry dragnet (6.0-10.0mm mesh size, 1.5-2.0m height, 5.0-10.0m length), the gillnets (mesh size of 12 to 50mm, 1.8m height, 30m length), the fyke-nets, as well as float and bottom fishing rods. Working methods and techniques generally accepted in ichthyology and ecology as well as surveys of anglers were used. For the species and age determinations, the following sources were used [9-14]. The following categories have been chosen for quantitative assessment of the values of fish occurrence: + rare species (separate specimens of the fish were observed during the entire period of studies), ++ common and +++ dominant species (more than 100 and more specimens for a year of studies).

Figure 1: Map showing the geographical location of sampling area.

Results and Discussion

Following the investigation, the list of recorded fishes from the study area totaled a number of 78 species taxa, which are systematically grouped into 18 families, 13 orders and 2 classes. In the faunal spectrum of fishes the taxonomic weight is held by *Cyprinidae* (32), *Gobiidae* (12) and *Percidae* (7 species), the rest of the taxonomic families are represented by a small number of species (Table 1). Ichthyofauna of the Lower Dniester has features of endemism and relictism (*U.krameri, Z.zingel, R.kesslerii*). Also, 2 species of the genus *Benthophilus*-B.nudus and B.durelli are characteristic for this part of the river (Figure 2). Out of the indigenous species that were registered in the Lower Dniester basin 16 species (*Eudontomyzon mariae, Acipenser gueldenstaedtii, Acipenser ruthenus, Acipenser stellatus, Umbra krameri, Anguilla anguilla, Leuciscus idus, Pelecus cultratus, Petroleuciscus borysthenicus, Rutilus frisii, Tinca tinca, Lota lota, Caspiosoma caspium, Knipowitschia longecaudata, Sander volgensis, Zingel zingel*) are enlisted in the Red Data Book of the Republic Moldova (2015), and major part of them are also mentioned in the Bern Convention, in the IUCN Red List, and are in the EU Habitats Directive (92/43/EEC) lists. A considerable part of the recorded species is considered native for the regional ichthyofauna. Out of the total number of registered species 11 species are alien (*P.parva, C.auratus auratus. C.auratus gibelio, H.molitrix, A.nobilis, C.idella, A.nebulosus, I.punctatus, P.haematocheilus, L.gibbosus, P.glenii*), are introduced with different purpose-pisciculture or accidentally together with the stocking material. Two individuals of the brown

bullhead (*Ameiurus nebulosus*), were caught in river near Dubasarii Vechi village (in August-September 2019). This is the first report of this alien (originated from the Eastern part of North America) species in the Lower Dniester River basin. Earler it has been reported from the Ukrainian upper part of the Dniester River drainage in the city of Lviv, Ukraine [15]. Also in spring of 2016 four specimens of *P.glenii* were found in mouth of Dniester afluent Botna. This is the first record of this species in the Lower Dniester too.

Table 1: Fish composition of the lower Dniester River basin (in limits of Moldova, 2000-2022)

Nr.	Fish taxa	Sampling Periods			
		2011-2013	2015-2017	2018-2020	2021-2022
Class **Hyperoartia**, Order **Petromyzontiformes**, Family **Petromyzontidae**					
1	Ukrainian brook lamprey - *Eudontomyzon mariae* (Berg, 1931)	-?	+	-?	-?
Class **Actinopterygii**, Order **Acipenseriformes**, Family **Acipenseridae**					
2	Danube sturgeon - *Acipenser gueldenstaedtii* Brandt et Ratzeburg, 1833	+	-?	-?	-
3	Stellate sturgeon - *Acipenser stellatus* Pallas, 1771	-?	+	-	-
4	Sterlet sturgeon - *Acipenser ruthenus* Linnaeus, 1758	+	+	-?	-?
Order **Anguilliformes**, Family **Anguillidae**					
5	European eel - *Anguilla anguilla* (Linnaeus, 1758)	-?	+	-?	-?
Order Clupeiformes, Family Clupeidae					
6	Common kilka - *Clupeonella cultriventris* (Nordmann, 1840)	++	+++	++	+
7	Black Sea shad - *Alosa immaculata* Bennett, 1835	++	++	++	+
8	Ponto-Azov shad - *Alosa tanaica* (Grimm, 1901)	++	++	+	+
Order **Cyprinifirmes**, Family **Cyprinidae**					
9	Common bitterling - *Rhodeus amarus* (Bloch, 1782)	++	++	++	+++
10	Common barbel - *Barbus barbus* (Linnaeus, 1758)	+	+	+	+
11	Amur topmouth gudgeon - *Pseudorasbora parva* (Temminck et Schlegel, 1846)	++	++	+	+
12	Sarmatian gudgeon – *Gobio sarmaticus Berg*, 1949	+	+	+	+
13	Dniester wiskered gudgeon - *Romanogobio kesslerii* (Dybowski, 1862)	+	+	+	+
14	Dniepr whitefinned gudgeon - *Romanogobio belingi* (Slastenenko, 1934)	+	+	+	+
15	Eurasian common carp - *Cyprinus carpio* Linnaeus, 1758 s.str. et varr.	++	+	+	++
16	Chinese golden carp - *Carassius auratus auratus* (Linnaeus, 1758) s. str. et varr.	++	+	+	++
17	Amur gibel carp - *Carassius auratus* gibelio (Bloch, 1782)	+++	+++	++	++
18	Blue bream - *Ballerus ballerus* (Linnaeus, 1758)	-?	-	+	+
19	White-eye bream - *Ballerus sapa* (Pallas, 1814)	+	++	++	+++
20	Silver bream - *Blicca bjoerkna* (Linnaeus, 1758)	++	+	+	+
21	Common bream - *Abramis brama* (Linnaeus, 1758)	++	++	+	+
22	Common zanthe - *Vimba vimba* (Linnaeus, 1758)	-?	-?	+	++
23	Common bleak - *Alburnus alburnus* (Linnaeus, 1758)	+++	+++	++	+
24	Pontian shemaya - *Alburnus sarmaticus* Freyhof et Kottelat, 2007	-	-	+	+
25	Sunbleack - *Leucaspius delineatus* (Heckel, 1843)	+	+	++	++
26	Common asp - *Aspius aspius* (Heckel, 1843)	+	+	++	++
27	Common dace - *Leuciscus leuciscus* (Linnaeus, 1758)	++	+	-	+
28	Common ide - *Leuciscus idus* (Linnaeus, 1758)	+	+	++	++
29	Bobyretz chub - *Petroleuciscus borysthenicus* (Kessler, 1859)	-	-	+	+
30	Common chub - *Squalius cephalus* (Linnaeus, 1758)	++	+++	++	+
31	Pontian vyrezub *Rutilus frisii* (Nordmann, 1840)	++	+++	++	+
32	Common roach - *Rutilus rutilus* (Linnaeus, 1758)	+++	+++	++	++
33	Taran - *Rutilus heckelii* (Nordmann, 1840)	++	+	+	+
34	Common rudd - *Scardinius erythrophthalmus* (Linnaeus, 1758)	+++	++	+	+

35	Common nase - *Chondrostoma nasus* (Linnaeus, 1758)	++	++	++	+
36	Silver carp - *Hypophthalmichthys molitrix* (Valenciennes, 1844)	++	++	+	-?
37	Bighead carp - *Aristichthys nobilis* (Richardson, 1845)	++	+	-?	-
38	Grass carp - *Ctenopharyngodon idella* (Valenciennes, 1844)	++	+	+	+
39	Sabrefish - *Pelecus cultratus* (Linnaeus, 1758)	+	+	+	-
40	Tench - *Tinca tinca* (Linnaeus, 1758)	+	+	+	+
	Family **Cobitidae**				
41	Don spined loach - *Cobitis tanaitica* Băcescu et Maier, 1969	+++	+++	+++	++
42	Danube spined loach - Cobitis cf. elongatoides Băcescu et Maier, 1969 s. str. et s.l.	++	+	+	+
43	Northern spined loach - *Cobitis cf. taenia* Linnaeus, 1758, hybrid complex	+	+	+	+
44	Northern golden spiny loach - *Sabanejewia baltica* (Witkowski, 1994)	+	+	-	-
45	Bulgarian golden spiny loach - *Sabanejewia cf. bulgarica* (Drensky, 1928)	+	-	-	-
46	Common weatherfish - *Misgurnus fossilis* (Linnaeus, 1758)	++	+	+	+
	Order **Siluriformes,** Family **Ictaluridae**				
47	Brown bullhead - *Ameiurus nebulosus* (Lesueur, 1819)	-	-	+	-
48	Channel catfish - *Ictalurus punctatus* (Rafinesque, 1818)	+	-	-	-
	Family **Siluridae**				
49	European wels - *Silurus glanis* Linnaeus, 1758	+	+	+	+
	Order **Esociformes,** Family **Esocidae**				
50	Northern pike - *Esox lucius* Linnaeus, 1758	++	+	+	+
	Family **Umbridae**				
51	European mudminnow - *Umbra krameri* Walbaum, 1792	+	+	+	-
	Order **Mugiliformes**, Family **Mugilidae**				
52	Redlip mullet - *Planiliza haematocheilus* (Temminck et Schlegel, 1845)	+	+	+	-
	Order **Atheriniformes**, Family **Atherinidae**				
53	Big-scale sand smelt - *Atherina boyeri* Risso, 1810	++	++	++	+
	Order **Gasterosteiformes**, Family **Gasterosteidae**				
54	Southern ninespine stickleback - *Pungitius platygaster* (Kessler, 1859)	++	++	+	+
55	Three-spined stickleback - *Gasterosteus aculeatus* Linnaeus, 1758	+++	++	+	+
	Order **Syngnythiformes**, Family **Syngnathidae**				
56	Black-striped pipefish - *Syngnathus abaster* Risso, 1827	++	++	++	++
	Order **Perciformes**, Family **Centrarchidae**				
57	Common pumpkinseed - *Lepomis gibbosus* (Linnaeus, 1758)	++	+++	+++	-
	Family **Percidae**				
58	Don ruffe - *Gymnocephalus acerina* (Güldenstaedt, 1774)	+	-?	-	-
59	Common ruffe - *Gymnocephalus cernua* (Linnaeus, 1758)	+	+	-	-
60	Danube ruffe *Gymnocephalus baloni* Holčík et Hensel, 1974	+	-	-	-
61	Euroasian river perch - *Perca fluviatilis* Linnaeus, 1758	+++	++	+	+
62	Volga zander - *Sander volgensis* (Gmelin, 1789)	-?	-	+	-
63	Common zander - *Sander lucioperca* (Linnaeus, 1758)	+	++	+	+
64	Common chop - *Zingel zingel* (Linnaeus, 1766)	+	+	-?	-?
	Family **Odontobutidae**				
65	Amur sleeper - *Perccottus glenii* Dybowski, 1877	-	-	+	-
	Family **Gobiidae**				
66	Longtail dwarf goby - *Knipowitschia longecaudata* (Kessler, 1877)	+	-	+	-
67	Caucasian dwarf goby - *Knipowitschia caucasica* (Berg, 1916)	-	-	+	-
68	Monkey goby - *Neogobius fluviatilis* (Pallas, 1814)	++	++	+++	+++

69	Round goby - *Neogobius melanostomus* (Pallas, 1814)	++	++	++	+
70	Pontian naked tadpole-goby - *Benthophilus nudus* Berg, 1898	+	+	+	+
71	Don tadpole-goby - *Benthophilus durrelli* Boldyrev et Bogutskaya, 2004	+	+	+	+
72	Pontian flathead goby - *Mesogobius batrachocephalus* (Pallas, 1814)	+	+	-	-
73	Western tubenose goby - *Proterorhinus semilunaris* (Heckel, 1837)	++	++	++	++
74	Racer goby - *Babka gymnotrachelus* (Kessler, 1857)	+	+	+	+
75	Mushroom goby - *Ponticola eurycephalus* (Kessler, 1874)	+	+	+	++
76	Bighead goby - *Ponticola kessleri* (Günther, 1861)	+	+	++	++
77	Syrman goby - *Ponticola syrman* (Nordmann, 1840)	+	-	+	-
Order **Pleuronectiformes**, Family **Pleuronectidae**					
78	European flounder - Platichthys flesus (Pallas, 1814)	+	+	-	-
Total number of the species	74	65	68	57	

Note: "-" - species not found; "+" - species found (Abundance: + - rare, ++ - common, +++ - dominant); "?" – species reported by fishermens to be present, but have not been detected in our catches.

a): *Romanogobio kesslerii.*

b): *Petroleuciscus borysthenicus.*

c): *Umbra krameri.*

d): B*enthophilus nudus.*

e): *Benthophilus durelli.*

Figure 2: The rare fish species of the Lower Dniester River.

A comparison with the data in the preceding studies [3-8] permits us to summarize that the species composition of the ichthyofauna remains almost unchanged for the last 30-40 years. Even if some of the species reported by other authors earlier were not founded by us (*C.carassius, C.gobio, A.gueldenstaedtii, H.huso, A.maeotica, M.piceus, S.typhle, P.demidofii,* and *C.caspium*). The last (brown-spotted caspiosoma goby-*Caspiosoma caspium* was recently found in Lower Dniester [16]. The most common and numerous fish in the surveyed section of the Dniester are monkey goby *Neogobius fluviatilis,* round goby *Neogobius melanostomus,*

bighead goby *Ponticola kessleri* and tubenose goby *Proterorhinus semilunaris*. An increase in the number and distribution of gobies is facilitated by an increase in the number of habitable biotopes, a variety of spawning temperature ranges, nest building and protection of clutches by the male, embryogenesis without larvae, a decrease in the number of competing fish and a decrease in pressure from predators. There is also a numerical abundance of bitterling *Rhodeus amarus*, bleak *Alburnus alburnus*, roach *Rutilus rutilus*, asp *Aspius aspius*, sunbleack *Leucaspius delineatus,* Amur gibel carp *Carassius auratus gibelio*, and such previously rare species as common carp *Cyprinus carpio*, white-eye bream *Ballerus sapa,* and blue bream *Ballerus ballerus*. However, the stations at which the studies were carried out had a wide range of variations in abiotic and biotic parameters, which undoubtedly affected the qualitative and quantitative composition of the ichthyofauna in different areas. The fragmentation of the distribution and abundance of these fish is noted. That is, the distribution and abundance of fish are very variable depending on the biotope. Research indicates low presence of economically significant fish species. There was a decrease in the total number of fish in catches. We caught fish of different size and age groups, mainly undery earlings and yearlings, less often other age groups of fish. There are few older age groups. Otherwise, there was a decrease in linear-weight indicators and "rejuvenation" of the spawning stock, the sexual maturity of some fish species (*A.brama, C.carpio, B.sapa, R.rutilus, E.lucius, S.lucioperca*, etc.). Taking into account the indicators of catches, the dynamics of the age and size-weight structure of populations, we can assume that the state of the populations of these species is at a relatively stable level and tends to increase. We consider this as a result of significant pressure from uncontrolled recreational fishing and poaching. The uncontrolled catch of large fish in the Dniester River played the role of a selective factor, which led to a decrease in the age and average weight of fish, early puberty in some short-cycle commercial species, such as bream, white-eye, and blue bream. Studies have shown that in the Lower Dniester there are quite favorable spawning grounds for fish with different spawning biology. However, for a number of years in a row, during spawning, the water level was constantly decreasing, while many spawning areas were drained. Spawning conditions for fish species in the lower Dniester were unfavorable due to low water levels and spawning itself was inefficient throughout the entire spawning period. Changes in the hydrological regime of the Dniester as a result of flow regulation and failure to comply with the regimes of ecological discharges from the upstream Dniester reservoir adversely affect the conditions of spawning, which led to a reduction in spawning areas and a deterioration in the conditions for fish reproduction. As a consequence of this, apparently, in certain habitats of the Lower Dniester (near villages Purcari, Talmaza and Delacau) there were often difficulties in identifying some species of cyprinid fish. They turned out to be natural interspecific hybrids, which indicate the trouble in providing fish with spawning grounds in these parts of the Dniester. This was due to overlapping of spawning periods of different species, and a noticeable difference in abundance in co-inhabited biotopes. The long-term absence of stocking (since 2017) of the Dniester with fry of commercial fish species (phyto- and plankton feeders) also had a negative impact on the total number of fish in catches. Moreover, allowing angling for migrating Black Sea shad *Alosa immaculata* during general spring spawning fishing prohibition period has led to unrestricted and uncontrolled poaching of other species of fish. During investigation period we observed the raise of a number of a short-cycle fishes, especially of the *Gobiidae* family. Among other species the abundance of younger generations is fixed which demonstrates the pressing of fishing. The number of fish species registered in the last years is lower comparing with those 10 years ago (57 comparing with 74). Hence, to protect this unique portion of river's fish biodiversity**,** measures have to be introduced immediately. Therefore, all responsible governmental organizations have to discuss and made to measure for this situation. The Annex V of the bilateral Dniester River Basin Treaty (2012) between Moldova and Ukraine [17], dedicated water biological resources, should be applied to minimize the negative impacts of the economic activities of both states and to optimize the functioning of hydro energy facilities established on the river.

Conclusion

The study indicated that the species composition of fish of the Lower Dniester is rich and diverse (78 species), consisting mainly of common and widely-distributed species in the Dniester River and other water bodies of the region. Its composition structure is characteristic of highly eutrophic and degradable hydro biotopes. At the same time**,** the fish fauna has features of other parts of the river (is distinguished by originality), namely, there are several endemic species, anadromous fish, and a significant number of brackish water fish. The fish species richness and the abundance of fish fauna in the lowest part of the Dniester River are closely dependent on the effectiveness of the spring ecological water discharge by the Dniester Hydropower Complex as well as on the abundance of spring precipitations which ensure access of phytophilous fishes to their spawning grounds on surrounding meadows. At the same time, the droughts of the last period, dealing with climate change in the North-West Part of the Black Sea region, negatively influence the Dniester River water discharge, especially the amount of water in the Dniester reservoir upstream whose volume is not enough voluminous to guarantee the efficient spring discharge in case of the lack of spring precipitations. Such changes produce the raise of short-cycle fishes and the lowering of the commercial fish species. To protect the Dniester River biodiversity it is absolutely necessary to minimize the Dniester River pollution from the point- and non-point sources, prevent the deterioration of the fish micro-habitats, and improve the transboundary management of spring Dniester River water discharge by two riparian state-Moldova and Ukraine-based on water temperature and access to existing spawning grounds, and ensure the protection of the Lower Dniester wetlands. Such cooperation should be a task of the bilateral Dniester River Basin Commission and the ministries of environment of both river basin states.

Acknowledgment

This study was supported by the Research Fund of Center "Acvagenresurs" (Project 10.80009.5107.24: " Management of fish resources and the genetic fund of aquaculture in accordance with the principles of sustainable development, intended to use the aquatic biological potential in the long term"), the OSCE-UNECE GEF Dniester Project, the 00104226 project of the European Union-Confidence Building Measures Programme, and the EU Black Sea Regional Cooperation BSB165 and BSB963 projects. The content of this publication is the sole responsibility of the authors, and in no case should it be considered to reflect the views of any project funding agency.

Conflict of Interest

The authors declare that they have no conflict of interest.

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