

THE ZOOBENTHOS AND THE PRODUCTION POTENTIAL OF BENTHOPHAGOUS FISH FROM THE IAGORLÎC RESERVE AND DUBĂSARI AND CUCIURGAN RESERVOIR LAKES

Sergey Filipenko, Dinu Bogatyj and Mihail Mustya

Received: 10.04.2023 / Accepted: 01.08.2023

Abstract: Backwater Iagorlîc and reservoirs Dubăsari and Cuciurgan are located on the territory of the Republic of Moldova in the Dniester river basin. The "soft" zoobenthos (fodder) of these water bodies is characterized by a rich diversity of species, of which oligochaetes and chironomids are dominant, both qualitatively and quantitatively (abundance and biomass). The biomass of the "soft" zoobenthos, which forms the fodder base for benthophagous fish, is 7.5 g/m² in the Iagorlîc backwater and 12.9 g/m² in the Dubăsari and Cuciurgan reservoirs. The ichthyocenosis includes 16 benthophage species in the Iagorlîc backwater, 22 species in the Dubăsari reservoir and 20 species in the Cuciurgan reservoir. Due to the main components of the "soft" zoobenthos, such as oligochaetes, polychaetes, higher crustaceans, chironomids and larvae of other amphibious insects, the potential increase of ichthyomass, based on the "soft" zoobenthos, can reach an average of 17.07 kg/ha in the Iagorlîc backwater, 18.08 kg/ha in Dubăsari reservoir and 25.25 kg/ha in Cuciurgan reservoir.

Keywords: benthophages, Dniester basin, fish productivity, ichthyofauna, reservoir, zoobenthos

Introduction:

In the Dniester basin on the territory of Moldova, there are two large reservoirs:

- Lake Cuciurgan, lacustrine type (Fig. 1 and 1a, Annexes)
- Lake Dubăsari, fluvial type (Fig. 1 and 1b, Annexes), which is connected with the Iagorlîc backwater in the Iagorlîc Reserve (Fig. 1 and 1c, Annexes)

The reservoirs are under the pressure of a strong anthropic impact. The Cuciurgan reservoir, of refrigerant type, is influenced by

the thermoelectric plant in the area, and the reservoir in Dubăsari, by the Hydropower Complex on the Dniester river. The Dniester Hydropower Complex is located upstream on the Dniester river and includes four plants, three of which are located in the Cernăuți region of Ukraine, and the last one is located in the Republic of Moldova, respectively:

- Novodnistrovsk Hydroelectric Power Station
- Nahoreanî Hydroelectric Power Station
- Reversible Hydroelectric Power Station on the Dniester river

Sergey Filipenko, Dinu Bogatyj and Mihail Mustya:

Shevchenko Transnistria State University
25th October Street no. 128
MD 3300, Tiraspol
Republic of Moldova
e-mail (for all authors): zoologia_pgu@mail.ru

- Dubăsari Hydroelectric Power Plant

The Cuciurgan reservoir ecosystem is characterized by thermal impact, pollution with chlorides, sulfates, heavy metals and increased water mineralization. The Dubăsari reservoir is affected by siltation and excessive increase of macrophytes.

Despite the impact of anthropic factors, the zoobenthos of these aquatic ecosystems is distinguished by the diversity of component species. The benthic fauna of the Dubăsari reservoir currently consists of approximately 130 species, that of the Cuciurgan of 170 species, and that of the Iagorlîc backwater in the Iagorlîc reserve of 69 species (Filipenko 2023; Bogatîi 2018). The "soft" zoobenthos, which is the nutritional basis of the ichthyocenosis, consists mainly of oligochaetes, higher crustaceans, chironomid larvae and other amphibious insects (Ceratopogonidae, Trichoptera, Ephemeroptera).

The ichthyofauna of the reservoirs and the Iagorlîc backwater is also diverse. In the Cuciurgan reservoir there are 42 species of fish (Mustya and Filipenko 2022), in the Dubăsari reservoir 40 species (Bulat 2017), and in the Iagorlîc backwater 31 species (Sharapanovskaya et al. 2020).

Materials and methods:

The Dubăsari reservoir was formed in the period 1954-1955 as a result of the construction of the Dubăsari Hydroelectric Dam on the Dniester river (Fig. 2). The installed power of the Dubăsari Hydropower Plant is approximately 48,000 kW. The lake dam is located at 351 km from the confluence of the Dniester River into the Black Sea and has an area of 53,590 km².

Figure no. 2 The dam of the Dubăsari Hydroelectric Power Plant



The reservoir is located on the segment of the Dniester river between the towns of Camenca and Dubăsari. The length of the

lake is 128 km, the width varies from 200 to 1800 m, and the average depth is 7.19 m. The surface of the lake is 67.5 km², and the

volume of the lake decreased in the last decades from 485 m³ to 277.4 million m³ as a result of siltation. The water current speed of the Dniester in the lake drops down to 0.1 m/s, varying from 0.05 to 0.15 m/s (Bulat et al. 2014; Filipenko 2023).

The Iagorlîc backwater (Fig. 3) is an artificial water basin, created after the filling of the Dubăsari reservoir, and is found in the

shedding area of the tributaries of the Dniester, respectively the rivers Iagorlîc and Iagorlîc Uscat (Fig. 1c, Annexes). The Iagorlîc backwater occupies an area of 210 ha in the territory of the Iagorlîc reserve, with a maximum depth of 5 - 9 m in the central area; 5 m in the middle areas and 1.5 – 2.0 m in the shore area (Shabanova 2011).

Figure no. 3 Iagorlîc backwater



The Cuciurgan reservoir is located in the south-east of the Republic of Moldova, on the border with Ukraine. Since 1964, it represents a cooling lake for the Thermal Power Plant of Moldova, with a recirculating water supply system with a designed capacity of 2.52 GW (Fig. 4).

The water area of the cooling lake occupies approximately 2,730 ha, has an average depth of 3.5 m and a maximum of 5.0 m, and the volume of water is 88 million m³. The length of the lake is between 14 km and 20 km, and the maximum width at the bottom of the basin is 3 km (Filipenko 2023).

As a result of the stagnant flow and the impact of the thermoelectric plant, the water of the Cuciurgan reservoir is characterized by an increased mineralization and a high content of chlorides and sulfates (Tab. 1).

The research material that was the basis of this work was represented by zoobenthos samples, collected seasonally, as follows:

- in the Iagorlîc reserve, Iagorlîc backwater: 550 samples
- in the Dubăsari reservoir: 320 samples
- in the Cuciurgan reservoir: 700 samples

The collection of samples was carried out in the period 2010-2022, from the boat, with a Petersen dredger, having an area of 0.025 m². The sampling of benthic invertebrates was

carried out according to the methods recommended in the Republic of Moldova (Bulat et al. in: Toderaş et al. 2015; Bilețchi and Zubcov 2021).

Figure no. 4 The Cuciurgan cooling reservoir of the Thermoelectric Power Plant from the Republic of Moldova



Table no. 1 Hydrochemical indicators of water quality in the Iagorlîc backwater, Dubăsari and Cuciurgan reservoirs (Kasapova et al. 2019; Filipenko et al. 2020)

Hydrochemical indicators	Iagorlîc backwater (2017)	Dubăsari reservoir (2017-2019)	Cuciurgan reservoir (2017-2021)
pH	10.4	7.64	8.31
Ammonium ions and ammonia (mg/dm ³)	0.04	0.05	0.128
Nitrate nitrogen (mg/dm ³)	0.44	0.69	0.332
Nitrite nitrogen (mg/dm ³)	0.09	0.02	0.028
Chlorides (mg/dm ³)	48.8	29.15	492.31
Sulfates (mg/dm ³)	N/A	N/A	1068.65
Mineralization (mg/dm ³)	670.0	360.2	2367.4
Suspended substances (mg/dm ³)	40.0	23.34	18.8
Biological oxygen consumption (mg O ₂ /l)	1.89	1.66	3.21
Oil products pollution (mg/dm ³)	N/A	N/A	0.078
Alkalinity (mg/dm ³)	N/A	201.3	279.9
Total hardness (mmol./dm ³)	6.27	4.04	17.94

The ichthyological material was collected during the control catches from the Cuciurgan and Dubăsari reservoirs in the period 2018-2022. The data related to the ichthyological fauna of the Iagorlîc backwater were made available to us by the director of the Iagorlîc Reserve, T. Sharapanovskaia, respectively taken from the specialized literature (Sharapanovskaya et al. 2020). Ichthyological research was carried out in the area by Bulat et al. (2015, 2021).

The potential fish productivity (ichthyomass increase), depending on the nutrient resources of the zoobenthos, was calculated in accordance with the methodologies approved in the Republic of Moldova (Ordin Nr. 206/2003).

Thus, for the calculation of ichthyomas increase, the following formula was used:

$$X_z = B \times \frac{P}{B} \times K_3 \times K_2^{-1} \times n^{-1}$$

where:

X_z - ichthyomas increase

B - the average biomass of macrozoobenthos (g/m^2)

P/B - the conversion coefficient of the biomass of fodder organisms in production

K_2 - the fodder coefficient for the conversion of zoobenthos production into ichthyomas increase

K_3 - the indicator of maximum use of the macrozoobenthos biomass

n - the number of species of fish that consume the zoobenthos.

Results and discussion:

The basis of the "soft" zoobenthos of the studied aquatic ecosystems is represented by the oligochaete - chironomid complex, which in the structure of the benthic fauna of the Iagorlîc backwater represents 86.2% of the total population of fodder zoobenthos, in the Dubăsari reservoir 94%, and in the Cuciurgan reservoir 93.6 %. In order of value, the higher crustaceans follow, after which the other groups of zoobenthos, represented by polychaetes and larvae of amphibious insects, with the exception of chironomids, are few in number (Tab. 2).

Table no. 2 Abundance (ex/m^2) and biomass (g/m^2) of "soft" zoobenthos (2010-2022)

Groups of "soft" zoobenthos	Iagorlîc backwater	Dubăsari reservoir	Cuciurgan reservoir
Oligochaeta	Ab 1268	2353	3133
	Bi 1.23	4.29	2.84
Polychaeta	Ab -	10	61
	Bi -	0.07	0.29
Higher crustaceans	Ab 105	121	155
	Bi 0.48	0.4	0.64
Chironomidae	Ab 679	827	640
	Bi 5.21	7.9	8.96
Ceratopogonidae	Ab 43	63	32
	Bi 0.15	0.23	0.12
Chaoboridae	Ab 149	-	2
	Bi 0.42	-	0.001
Ephemeroptera	Ab 2	1	1
	Bi 0.009	0.09	0.08
Trichoptera	Ab 11	3	1
	Bi 0.002	0.02	0.007
Total	Ab 2257	3378	4025
	Bi 7.519	13	12.938

Note: Ab-abundance; Bi-Biomass

The results regarding the trophic characteristics of fish from the Republic of Moldova (Bulat et al. 2014; Bulat 2017), as well as the composition of fish species from the Dubăsari and Cuciurgan reservoirs (Mustya and Filipenko 2016, 2021; Filipenko et al. 2018, 2021), are given in Table 3 (Annexes).

The average potential increase of ichthyomas in the studied aquatic ecosystems, depending on the fodder resources of the main "soft" zoobenthos groups, was calculated separately for the economically valuable species but also for the other fish species (Tab. 4).

Table no. 4 Average potential increase of ichthyomass in the Iagorlīc backwater, Dubăsari and Cuciurgan reservoirs, depending on the main food resources of the "soft" zoobenthos (2010-2022)

Group of zoobenthos	Commercially valuable species			Other species			Total			
	IB	DR	CR	IB	DR	CR	IB	DR	CR	
Oligochaeta	0.0378	0.1448	0.160	0.083	0.120	0.068	0.1208	0.265	0.228	
Polychaeta	0	0.0019	0.0136	0	0.0016	0.0058	0	0.0035	0.0194	
Higher crustaceans	0.0172	0.0158	0.0421	0.0378	0.0131	0.0179	0.055	0.0289	0.0599	
Chironomidae	0.4667	0.8177	1.5487	1.0257	0.6786	0.6584	1.4924	1.4963	2.2071	
Ceratopogonidae	0.0031	0.0052	0.0045	0.0067	0.0043	0.0019	0.0098	0.0095	0.0064	
Other	0.0092	0.0025	0.0033	0.0202	0.0021	0.0014	0.0294	0.0046	0.0047	
Total	g/m ²	0.534	0.9879	1.7722	1.1734	0.8197	0.7534	1.7074	1.8078	2.5255
	kg/ha	5.34	9.879	17.722	11.734	8.197	7.534	17.074	18.078	25.255

Note: Other: Other Amphibiotic Insects; IB-Iagorlīc backwater; DR-Dubăsari reservoir; CR-Cuciurgan reservoir

Although on average for the studied period, the total biomass of the forage zoobenthos in the reservoirs Dubăsari (12.99 g/m²) and Cuciurgan (12.87 g/m²) was practically the same, there are differences regarding the main groups of the "soft" zoobenthos (see Tab. 2; Fig. 5).

Chironomids represent the most valuable group from a fodder point of view. Thus, the biomass of chironomids is higher in the Cuciurgan reservoir, and even if here we encounter a smaller number of fish species of economic value, still the total potential fish productivity is higher by 1.4 times in terms of the "soft" zoobenthos of the Lake Cuciurgan (25.25 kg/ha), compared to that of Lake Dubăsari (18.08 kg/ha) (Fig. 6).

The methodology for calculating the potential increase of ichthyomas based on the fodder resources of the zoobenthos approved in the Republic of Moldova (Order no. 206/2003), is similar to the methodology used in Russia (Shashulovskij and Mosiyash 2014), however, it differs in the fact that when calculating fish productivity, the number of fish species consuming a certain food base is also taken into account (bentophages, planktophages, phytophages). Thus, the productivity of fish in the aquatic ecosystems of the Dniester river basin in the Republic of Moldova, depending on the fodder resources, would have been 4 times higher if it had been calculated according to the Russian methodology.

Figure no. 5 Distribution of the "soft" zoobenthos biomass (g/m^2) in the three aquatic ecosystems studied: Iagorlîc backwater (a); Dubăsari reservoir (b); Cuciurgan reservoir (c)

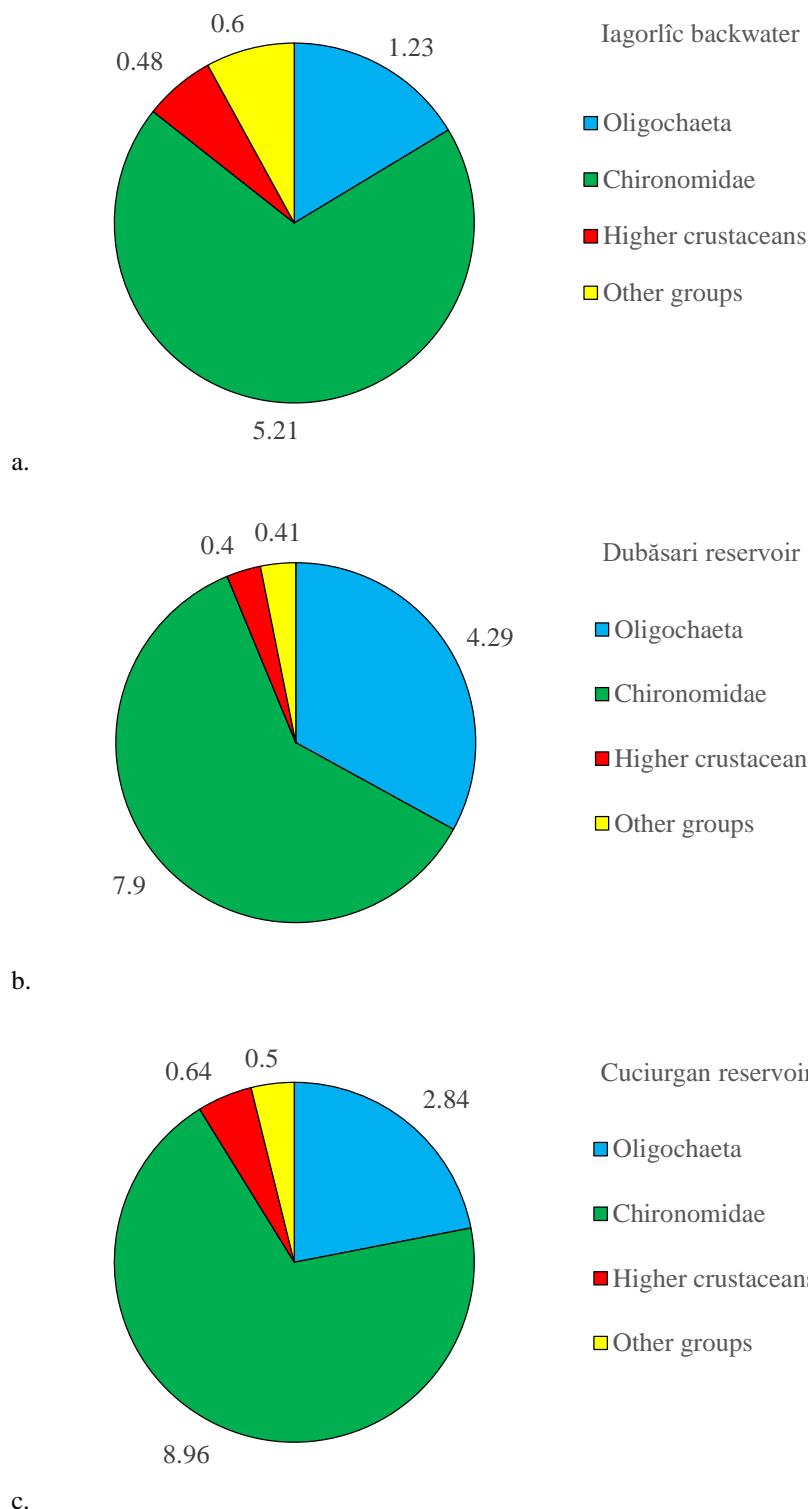
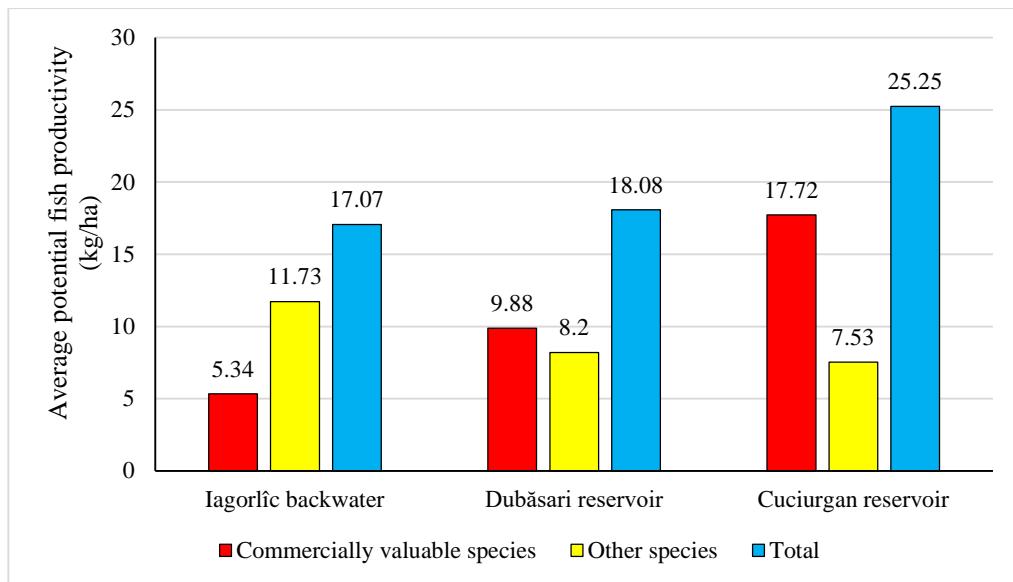


Figure no. 6 Average potential fish productivity (kg/ha) in the Iagorlîc, Dubăsari and Cuciurgan water basins, according to the main «soft» zoobenthos groups (2010-2022)



Conclusions:

The aquatic ecosystems from the Dniester River basin of the Republic of Moldova represent a rich food base for benthic fish. Due to the main components of the "soft" zoobenthos, such as oligochaetes, polychaetes, higher crustaceans, chironomids and the larvae of other amphibious insects, the potential increase of ichthyomas, on average for the period 2010-2022, is 17.07 kg/ha in the Iagorlîc backwater, 18.08 kg /ha in Dubăsari reservoir and 25.25 kg/ha in Cuciurgan reservoir.

Rezumat:

ZOOBENTOSUL ȘI POTENȚIALUL DE PRODUCȚIE AL PEȘTILOR BENTOFAGI DIN REZERVATIA IAGORLÎC ȘI LACURILE DE ACUMULARE DUBĂSARI ȘI CUCIURGAN

Gârla Iagorlîc și lacurile de acumulare Dubăsari și Cuciurgan sunt situate pe teritoriul Republicii Moldova în bazinul

râului Nistru. Zoobentosul «moale» (furajer) al acestor bazine acvatice se caracterizează printr-o diversitate bogată de specii, dintre care dominante calitativ și cantitativ (abundență și biomasa) sunt oligochetele și chironomidele. Biomasa zoobentosului «moale», care formează baza furajeră pentru peștii bentofagi, este de 7.5 g/m^2 în gârla Iagorlîc și de 12.9 g/m^2 în lacurile de acumulare Dubăsari și Cuciurgan. Ihtiocenoza cuprinde 16 specii bentofage în gârla Iagorlîc, 22 specii în lacul de acumulare Dubăsari și 20 specii de pești în lacul de acumulare Cuciurgan. Datorită componentelor principale ai zoobentosului «moale», cum ar fi oligochetele, polichetele, crustaceele superioare, chironomidele și larvele altor insecte amfibiotice, creșterea potențială a ihtiomasei, pe baza zoobentosului «moale», poate atinge în medie 17.07 kg/ha în gârla Iagorlîc, 18.08 kg/ha în lacul de acumulare Dubăsari și 25.25 kg/ha în lacul de acumulare Cuciurgan.

References:

- BILEȚCHI L., ZUBCOV E. (eds.) (2021), *Guidance on the Monitoring of Water Quality and Assessment of the Ecological Status of Aquatic Ecosystems*, Ministry of Education, Culture and Research, Institute of Zoology, Chișinău, S.n. (î.S. F.E.-P. „Tipografia Centrală”), 92 p.
- BOGATÎI D. (2018), Diversitatea comunităților macrobentonice în rezervația «Iagorlîc», *Buletinul Academiei de Științe a Moldovei. Științele vieții* 3(336): 144-150.
- BULAT Dm. (2017), *Ihtiofauna Republicii Moldova: amenințări, tendințe și recomandări de reabilitare*, Chișinău, Foxtrot, 343 p.
- BULAT Dm., BULAT Dn., TODERAŞ I., USATÎI M., ZUBCOV E., UNGUREANU L. (2014), *Biodiversitatea, bioinvazia și bioindicația (în studiul faunei piscicole din Republica Moldova)*, Chișinău: S.n. (Tipografia "Foxtrot"), 430 p.
- BULAT Dm., BULAT Dn., TODERAŞ I., USATÎI M. (2015), Fauna piscicolă, In: *Monitoringul calității apei și evaluarea stării ecologice a ecosistemelor acvatice*. Îndrumar metodic (I. Toderaș, E. Zubcov, L. Bilețchi (red.)) pp. 65-84, Acad. de Științe a Moldovei, Inst. de Zoologie, Univ. Acad. de Științe a Moldovei, Chișinău.
- BULAT Dn., BULAT Dm., USATÎI M. (2021), *Ihtiofauna în condițiile construcțiilor hidrotehnice din ecosistemele riverane*, Ghid metodologic pentru monitorizarea impactului hidroenergetic asupra ecosistemelor fluviale transfrontaliere, Chișinău, Tipografia centrală, pp. 42-56.
- FILIPENKO S. (2023), *Zoobentos Dubossarskogo i Kuchurganskogo vodohranilishch*, Kishineu, B.i., (PGU), 215 p.
- FILIPENKO S.I., ZUBKOVA N.N., TIKHONENKOVA L.A., FILIPENKO E.N. (2018), *Promyslovaya ikhtiofauna Kuchurganskogo vodokhranilishcha i rol' otdel'nykh vidov v nakoplenii metallov v vodoeme-okladitele Moldavskoy GRES*, International symposium «Functional ecology of animals»: dedicated to the 70th anniversary from the birth of academician Ion Toderaș, 21 september 2018, Chișinău, Imprint Plus, pp. 413-420.
- FILIPENKO E.N., FILIPENKO S.I., TIKHONENKOVA L.A. (2020), *Dinamika gidrohimicheskikh pokazatelej kachestva vody Kuchurganskogo vodohranilishcha*, The Conference dedicated Associate Professor L.L. Popa, Tiraspol', Eco-TIRAS, pp. 181-190.
- FILIPENKO S.I., MUSTYA M.V., FILIPENKO E.N. (2021), Promyslovaya ihtiofauna Kuchurganskogo i Dubossarskogo vodohranilishch, *Vestnik Pridnestrovskogo universiteta*, Tiraspol', Izd-vo Pridnestr. un-ta, *Mediko-biologicheskie i himicheskie nauki* 2 (68): 136-145.
- KASAPOVA L.V., FILIPENKO S.I., BOGATYJ D.P., FILIPENKO E.N. (2019), *Razlichiy nekotoryh gidrohimicheskikh pokazatelej Dubossarskogo vodohranilishcha i zavodi zapovednika Yagorlyk*, Hydropower impact on river ecosystem functioning: Proceedings of the International Conference, Tiraspol, Moldova, October 8-9, 2019, Tiraspol, Eco-Tiras (Tipogr. «Print-Caro»), pp. 151-155.
- MUSTYA M.V., FILIPENKO S.I. (2016), *Sovremennoe sostoyanie promyslovoj ihtiofauny Dubossarskogo vodohranilishcha*, Akademiku L.S. Bergu – 140 let., Bendery Eco – TIRAS, pp. 457 – 460.
- MUSTYA M.V., FILIPENKO S.I. (2021), *Osobennosti ihtiofauny vodoema-ohladitelya Moldavskoj GRES*, Sovremennye problemy biologii i ekologii: materialy dokladov III Mezhdunarodnoj nauchno-prakticheskoj konferencii, 4-5 marta 2021 g., Mahachkala: ALEF, pp. 68-72.
- MUSTYA M.V., FILIPENKO S.I. (2022), *Ihtiofauna Kuchurganskogo (limana) vodohranilishcha ot F.F. Egermana (1922-1925) do nashih dnej: literaturnyj obzor*, Vestnik Pridnestrovskogo universiteta. Ser.: Mediko-biologicheskie i himicheskie nauki: 2(71): 132-143, Tiraspol', Izd-vo Pridnestr. un-ta.
- ORDIN (OMECDT) Nr. 206/2003 (2003), *Instrucțiune privind evaluarea prejudiciului cauzat resurselor piscicole din bazinile acvatice ale Republicii Moldova*, Ministerul Ecologiei Construcțiilor și Dezvoltării Teritorialui, 07.10.2003, Chișinău. Disponibil: <http://amac.md/Biblioteca/data/03/02.34.1.pdf>
- SHABANOVA G.A. (nauch. red.) (2011), *Zapovednik «Yagorlyk». Plan rekonstruktsii i upravleniya kak put' sokhraneniya biologicheskogo raznoobraziya / Mezhdunarodnaya ekol. assotsiatsiya khraniteley reki „Eco-TIRAS”*, Dubossary: Mezhdunarodnaya ekol. assotsiatsiya khraniteley reki „Eco-TIRAS” („Elan Poligraf” SRL), 128 p.

SHARAPANOVSKAYA T.D., TISHCHENKOV A.A., IZVERSKAYA T.D. (i dr.) ([2020](#)), *Zapovednik «Yagorlyk» - zhenschina prirody Pridnestrov'ya*, Bendery: «Poligrafist», pp. 101-105.

SHASHULOVSKIY V.A., MOSIYASH S.S. ([2014](#)), *Metodicheskiy podhod k opredeleniyu sovokupnogo dopustimogo ulova ryb malyh vodoyomov*, Trudy VNIRO, T. 151, pp. 136-140.

Annexes:

Figure no. 1 Spatial distribution of the Dubăsari (DR) and Cuciurgan (CR) reservoirs, and the Iagorlîc backwater (IB) in the Dniester river basin of the Republic of Moldova

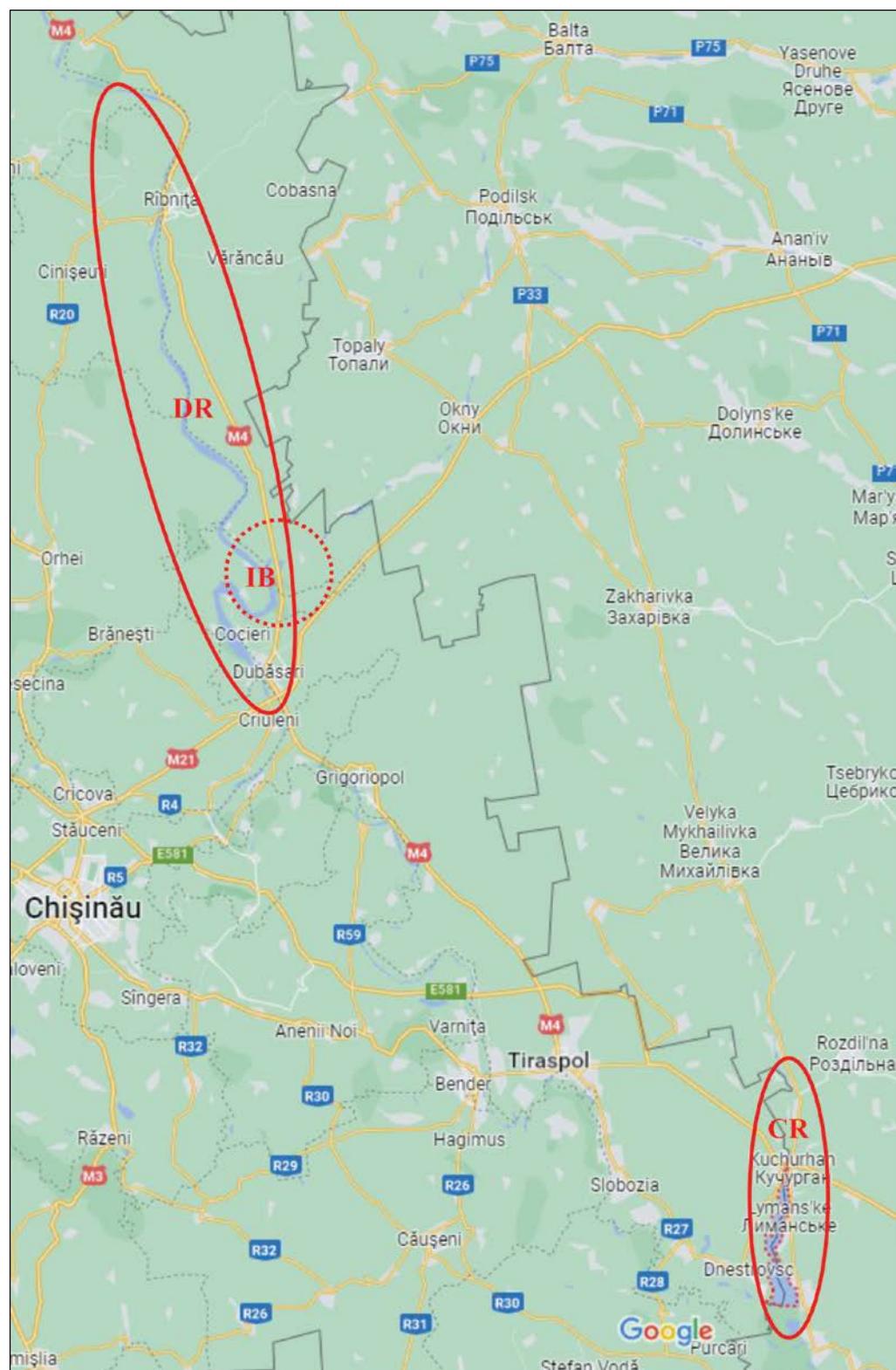


Figure no. 1a The Cuciurgan reservoir

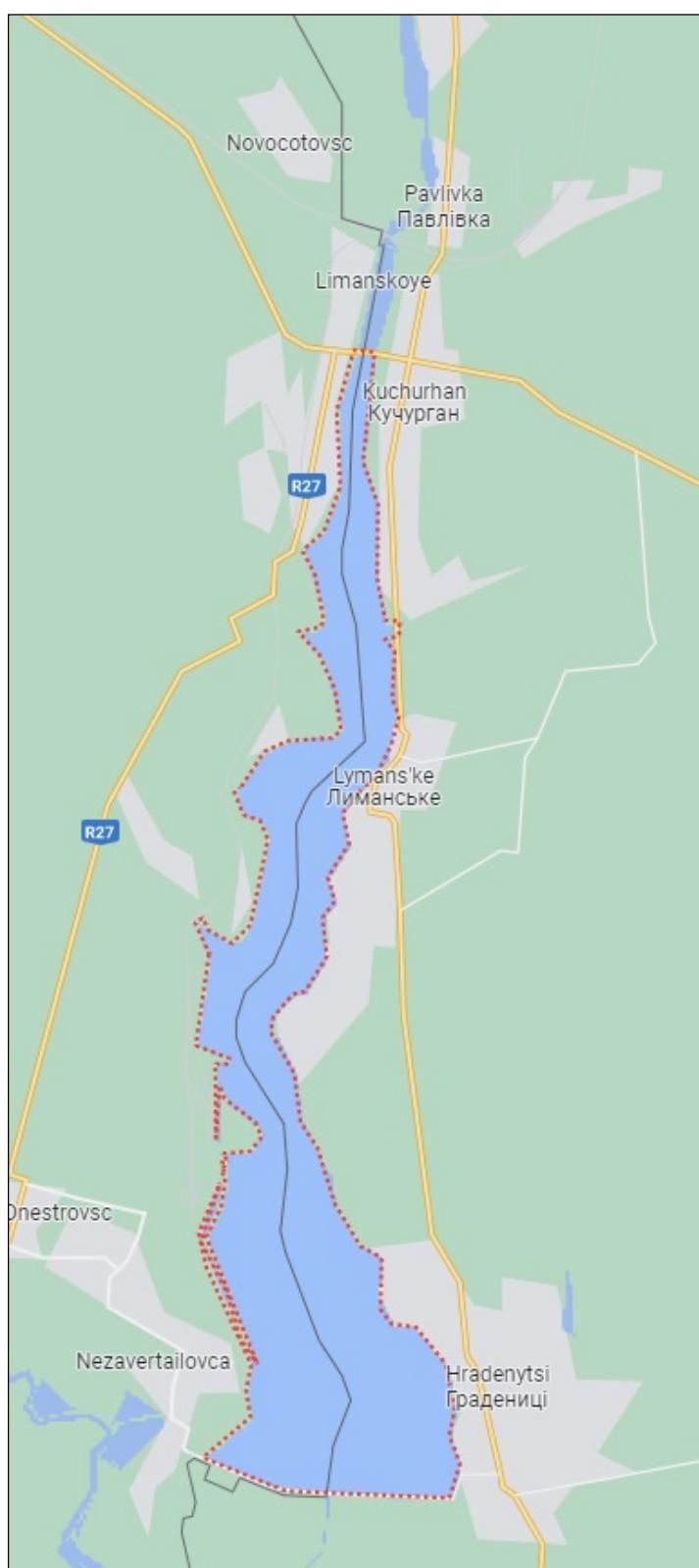


Figure no. 1b The Dubăsari reservoir

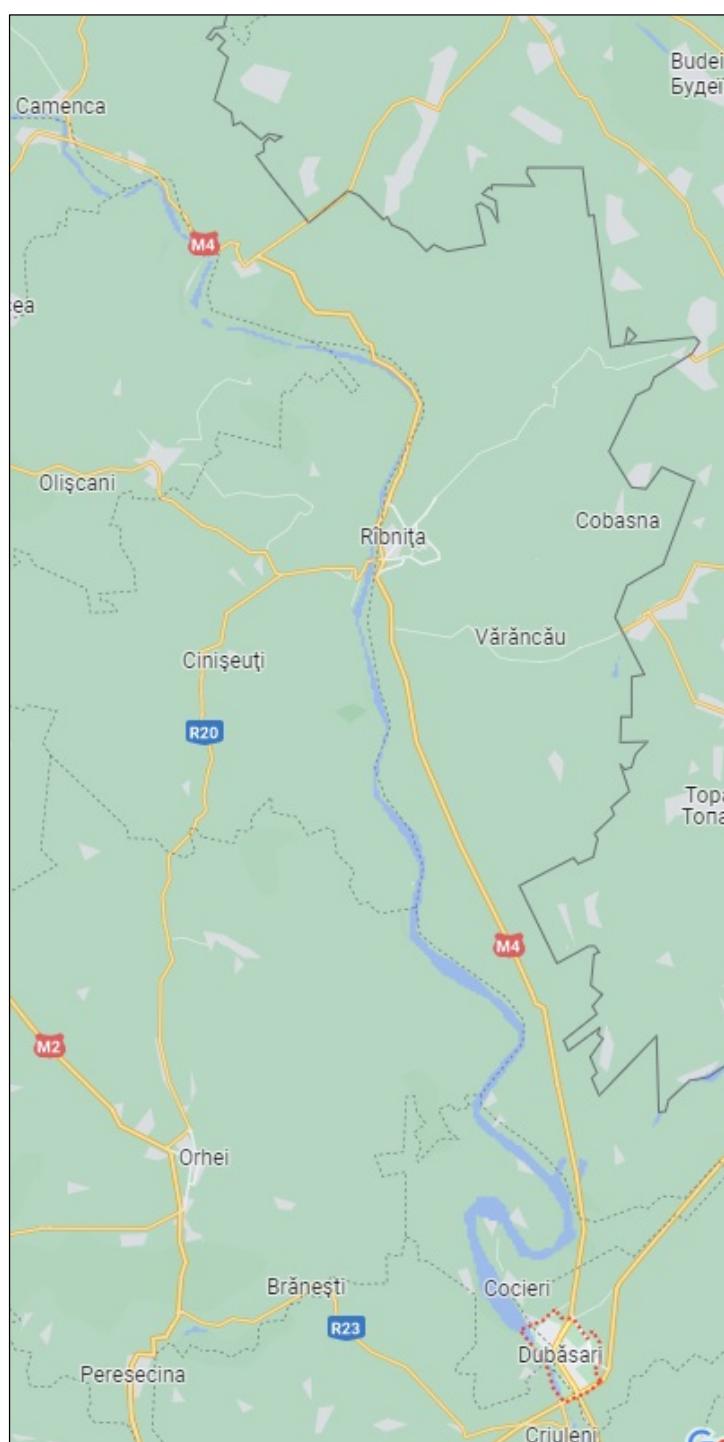


Figure no. 1c The Iagorlîc backwater

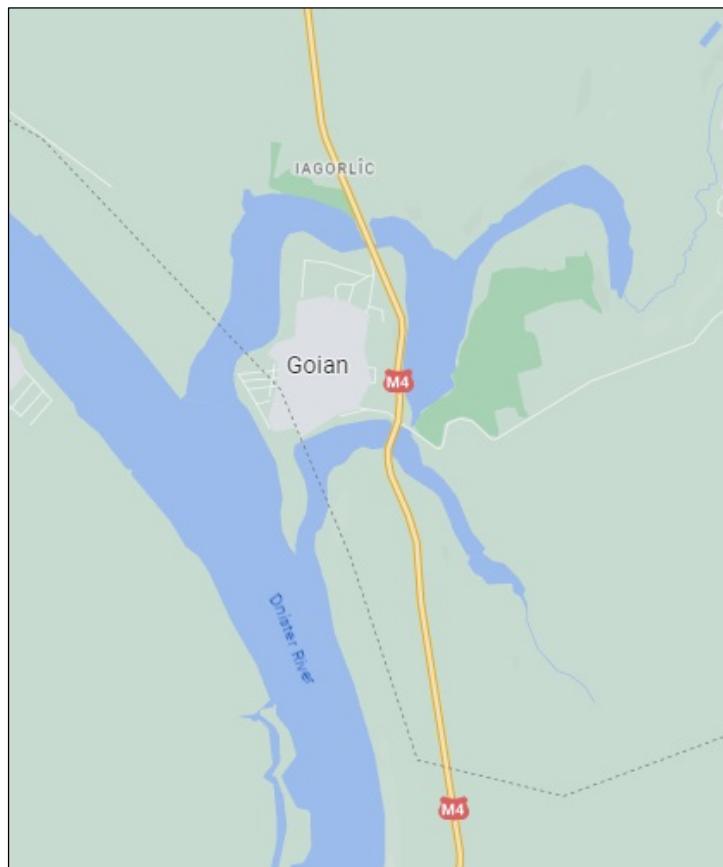


Table no. 3 Fish species that consume zoobenthos

Fish species	Iagorlîc backwater	Dubăsari reservoir	Cuciurgan reservoir
Commercially valuable species			
<i>Abramis brama</i>	+	+	+
<i>Cyprinus carpio</i>	+	+	+
<i>Barbus barbus</i>	+	+	-
<i>Rutilus frisii</i>	+	+	+
<i>Rutilus heckelii</i>	+	+	+
<i>Rutilus rutilus</i>	+	+	-
<i>Vimba vimba</i>	+	+	-
<i>Tinca tinca</i>	+	+	+
<i>Carassius gibelio</i>	+	+	+
<i>Acipenser ruthenus</i>	+	+	-
<i>Carassius carassius</i>	+	-	-
Other species			
<i>Pseudorasbora parva</i>	-	+	+
<i>Blicca bjoerkna</i>	-	-	+
<i>Ballerus sapa</i>	+	+	-
<i>Gobio sarmaticus</i>	-	+	-
<i>Leuciscus leuciscus</i>	-	+	+
<i>Misgurnus fossilis</i>	-	+	-
<i>Petroleuciscus borysthenicus</i>	-	-	+
<i>Cobitis taenia</i>	-	+	+
<i>Gymnocephalus cernua</i>	+	+	+
<i>Gymnocephalus acerina</i>	+	+	-
<i>Neogobius fluviatilis</i>	+	+	+
<i>Neogobius melanostomus</i>	-	+	+
<i>Proterorhinus semilunaris</i>	-	+	+
<i>Babka gymnotrachelus</i>	+	+	+
<i>Caspiosoma caspium</i>	-	-	+
<i>Ponticola eurycephalus</i>	-	-	+
<i>Benthophilus nudus</i>	-	-	+
<i>Knipowitschia longecaudata</i>	-	-	+
Total	16	22	20