NEW CONTRIBUTIONS TO THE KNOWLEDGE OF THE STATUS OF FRESHWATER PEACEFUL FISH AND PREDATORY SPECIES IN THE DANUBE RIVER KM 1047 – 1071

M.D. Stroe[1*], D. Mirea[1], N. Patriche[1], F.M. Dima[1]

[1]*Research-Development Institute for Aquatic Ecology, Fishing and Aquaculture, Galați, Romania*

Abstract

This study aims to contribute to the identification of the ichthyofauna structure for the most important fish species in the Danube River, sector km 1047-1071 by quantifying the data obtained during 2021 through scientific fishing, compared to the studies carried out in 2020. The purpose of this work is also to analyze the influence of environmental factors on catches and the structure of the ichthyofauna. Compared to 2020, the appearance of the species Hypophthalmichthys molitrix (Valenciennes, 1844) in catches and changes in the ratios between catches per species and fishing seasons can be noted. Both temperature and water level showed variations in correlation with total catches. Water levels and flows show a direct correlation with both the number of specimens caught and the catches.

Key words: *Danube River, abiotic factors, fish stocks, catches, fish communities*

INTRODUCTION

The Iron Gates, (Гвоздена врата/ Gvozdena Vrata in Serbo-Croatian), the last gorge of the Đerdap gorge system on the Danube River separates the Carpathian and Balkan Mountains and is part of the border between Serbia and Romania. It is approximately 3 km long and 162 meters wide, with towering cliffs that makes it one of Europe's most dramatic natural wonders. A joint Romanian-Yugoslav development project on the Danube River (including a dam and hydroelectric power) was completed in 1972, providing equal amounts of power to each country and doubling the annual tonnage of river transport. The name Iron Gates is applied to the entire 145 km long system of keys (Stroe et al.2021)

The execution of the Romanian-Yugoslav project began in 1964, and through the construction of the dam, the Danube valley below Belgrade was transformed into a reservoir, the water level upstream of the dam rising by 35 m. With a volume of over 2,200 million cubic meters, the reservoir stretches from the dam to the confluence with the Tisa River. In 1985, the construction of a second dam, The Iron Gates II (km 863), was completed.

The construction of dams has had a major impact on the environment. For example, the breeding routes of several fish species were permanently interrupted, thus limiting the sturgeon migration route to a length of 863 km on the river and isolating important spawning areas on the Middle Danube for these species.

The Iron Gates dams are not equipped with technical equipment such as bypasses or bypasses designed to facilitate fish migration. However, the sporadic capture of migratory fish upstream of the Iron Gates demonstrates that a small number of individuals manage to pass through the locks used by ships.

Out of the total number of 132 species currently present in Romania, 28 species are currently the object of commercial fishing

*Corresponding author:
sdesimira.icdeapa@gmail.com
The manuscript was received: 30.09.2022
Accepted for publication: 13.12.2022

(Antipa, 1909). For the area studied in 2021, a total of 212 tons of fish were allocated for fishing, of which 180 (84.90%) tons for commercial fishing, and 32 (15.10%) tons for recreational fishing. Fishing effort was also capped by the allocation of fishing licenses to 147 vessels (Order no.42/558/2022).

Due to the geographical location on the continent in the Danube River basin, at the contact between the temperate-oceanic climate in the west, temperate-continental climate in the east and the Baltic influences in the north, the hydrological regime of the Danube River is characterized by significant variations in level and flow, during the year and in time (Chioveanu et al. 2020).

Therefore, it is very well known that the Danube River is an important river with an extreme spatial and temporal variability of its physical, chemical, hydrological and biological characteristics (Sandu (Calin) et al. 2013). The scientific community has demonstrated in numerous studies that the seasonal variation of physical parameters chemical and hydrological can have extremely important consequences on the structure and dynamics of fish communities (abundance, migration, feeding, growth, reproduction, recruitment, mortality, catch, etc.) (Chowdhury et.al. 2011; Gheorghe, 2010).

The present study aims to contribute to the identification of the ichthyofauna structure for the most important fish species in the km 1047-1071 sector, with the purpose of establishing the total allowable catches and represents the data obtained during 2021 through scientific fishing, compared to the studies carried out in year 2020. The purpose of this work was also to analyze the influence of environmental factors on catches and the structure of the ichthyofauna. Compared to 2020, the appearance of the species Hypophthalmichthys molitrix in catches and changes in the ratios between catches per species and fishing seasons can be noted. Both temperature, water level and flow rates were directly correlated with total catches.

MATERIAL AND METHODS

Fishing area

The monitoring took place between January and December 2021 on the river sector km 1047-1071 at The Iron Gates I reservoir (Figure 1), where water levels and temperatures were monitored in two hydrometeorological stations as follows: S1 - Baziaș (GPS coordinates 44.822760, 21.387634) and S2 – Moldova Veche (GPS coordinates 44.723698, 21.615794). Water temperature was measured using the Hach-Lange HQ40D two-channel portable digital multiparameter, while water levels were measured against the reference level for stations S1 and S2. The fish samples analyzed were obtained by scientific fishing on the Danube sector km 1047-1071 from January to December 2021, inclusive. The results obtained were compared with those of 2020 in the same study area.

Figure 1 Location of the study area in the years 2020 and 2021

Fishing gear and methods

The fishing was done with filter fishing gear: fixed nets and floating nets. Depending on the season and the size group tracked, their sizes varied as follows: fixed nets - the length of the set Lp: 100-200 m; standing height Hp:

2.5-3.5 m, eye side a: 40-60 mm; floating nets - Lp: 150-200 m, Hp: 2.5-4.0 m, a: 40-80 mm. Fishing gear is made of synthetic materials (relon and nylon).

Catch data analysis

The data on the catches come from the scientific fishing carried out by the fishermen coordinated by the researchers of the Research-Development Institute for Aquatic Ecology, Fishing and Aquaculture in Galati, and the obtained data were processed by the researchers in the laboratory. Statistical analysis included one-way ANOVA test to analyze the significance of variance, followed by Tukey's Test to observe any significant differences between data sets.

RESULTS AND DISCUSSIONS

The distribution and abundance of fish are strongly influenced by precipitation and the variation of levels and temperature (Holcik; 2003).

The level of the Danube varied at Baziaș station (km 1071) as follows: in spring between 540-640 cm, with an average of 590±14.65 cm, in summer between 560-594 cm, with an average of 577±14.45 cm, in autumn between 550-590 cm, with an average of 563±9.46 cm and in winter between 556-662 cm, with an average of 603±24.91 cm (Figure 2).

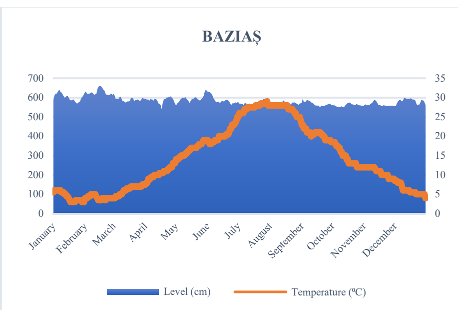

Figure. 2 Dynamics of water levels (cm) and temperatures (°C) in the year 2021 in station S1

The level of the Danube varied at Moldova Veche station as follows: spring between 660-750 cm, with an average of 716±15.11 cm, summer between 700-746 cm, with an average of 715±8.83 cm, autumn between 690- 730 cm, with an average of 708±9.04 cm and in winter 680-760 cm, with an average of 720±14.94 cm (Figure 3).

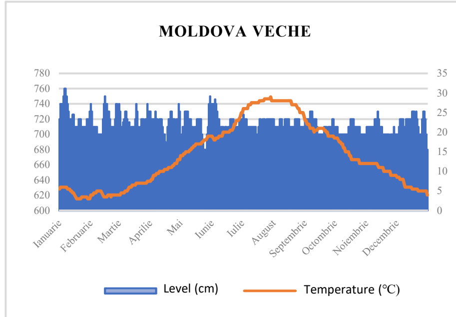

Figure 3. Dynamics of water levels (cm) and temperatures (°C) in 2021 at station S2

The temperature of our planet has gradually increased over the last century. Global average air temperatures have increased by 0.75°C over the past century, with the rate of change increasing since the 1970s [Harrod, 2016]. The average water temperature in the study areas of both stations during spring varied between 4-19ºC, with an average of 11±4.51ºC, in summer between 19-28ºC, with an average of 25±3.52ºC, in autumn between 9 -23ºC, with an average of 15±4.41ºC and winter varied between 3-8.5ºC, with an average of 5±1.54ºC, (Figures 2 and 3).

Correlation analysis revealed a direct positive correspondence between water temperatures (Pearson coefficient = 0.98753), respectively water level (Pearson coefficient = 0.99218) and catches of peaceful fish species in the study area.

During 2021, 2602 fish were caught, 2.76% less than in 2020, including 7 species and 4 families (Table 1, Figure 4), identified as follows: *Cyprinus Carpio* (Linnaeus, 1758), Carassius gibelio (Linnaeus, 1758), *Abramis brama* (Linnaeus, 1758),), *Hypophthalmichthys molitrix* (Valenciennes, 1844), *Silurus glanis* (Linnaeus,1758), *Sander lucioperca* (Linnaeus, 1758) and *Exos lucius* (Linnaeus, 1758) (Table 1, Figure 4). Following the ichthyological studies, the fish specimens were divided into two categories according to the trophic regime as follows: peaceful species - *Cyprinus carpio* (carp), *Carassius gibelio* (crucian carp), *Abramis brama* (freswaterbream), *Hypophthalmichthys molitrix* (silver carp) and predatory species. - *Silurus glanis* (catfish), *Sander lucioperca* (pike - perch) and *Exos lucius* (pike). The structure of fish communities, by species, in 2020 and 2021, is presented in Figures 4 and 5.

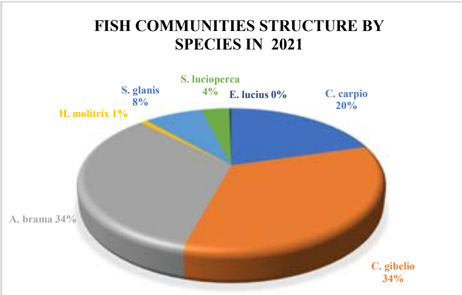

Fig. 4 Structure of fish communities, by species, in the year 2021

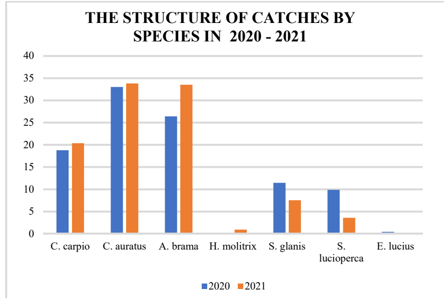

Fig. 5 Structure of catches, by species, in the years 2020 and 2021

Table 1 Structure of fish communities in the fishing area in 2021 (in number of fish)

Crt No.	Month	Species							No. of fish	Percent (%)
		Carp	Crucian Carp	Freswater bream	Silver Carp	Catfish	Pikep erch	Pike		
1	January	7	25	14			9		55	2,11
2	February	54	79	98		4	22		257	9,88
3	March	96	149	168		26		7	446	17,14
4	Aprill	78	124	132		32			366	14,07
5	May	80	138	123	24	41			406	15,60
6	June	63	113	113		25			314	12,07
7	July	43	74	46		22	10		195	7,49
8	August	54	88	78		24	22		266	10,22
9	September	26	23	44		12	12		117	4,50
10	Octomber	7	20	31		5	6		69	2,65
11	November	5	16	13			6		40	1,54
12	December	17	31	12		5	6		71	2,73
	TOTAL	**530**	**880**	**872**	**24**	**196**	**93**	**7**	**2602**	**100,00**

The highest recorded catch was in 2021, of 1218 fish (46.81% of the total catch) in the spring season (March-May), followed by the summer season (June-August) with 775 fish (29.78 % of the total catch), the winter season (January-February and December) - 383 fish (14.72% of the total catch) and the autumn season (September-November) - 226 fish (8.69% of the total catch) (Figure 6).

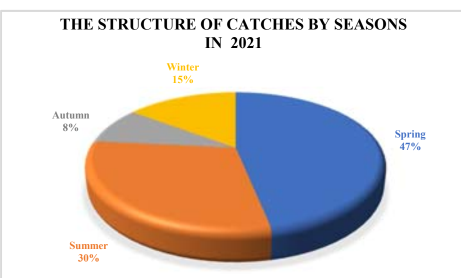

Figure 6. Catch structure by season in the year 2021

Compared to the year 2020, in 2021 a substantial change is observed in the structure of catches by season (in terms of the number of fish and species) (Table 1, Fig. 6 and 7).

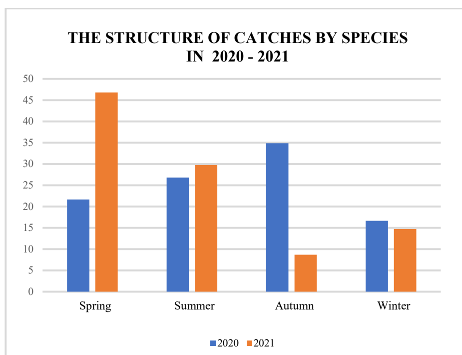

Figure 7. Catch structure by season in the years 2020 and 2021

Also, the appearance or disappearance of some species of low frequency (*Hypophthalmichthys molitrix* and *Esox* *lucius*) seem to be directly related to the biology of the respective species, especially migrations for feeding and reproduction (Figures 4 and 5). The dominant family, Cyprinidae (88.63% in number of specimens) is followed by the families Siluridae (7.52%), Percidae (3.58%) and Esocidae (0.27%) (Fig. 8 and 9). (Radu; 2012; Chioveanu et al., 2019; Stroe et al. 2021).

We note that there is the same order of appearance in catches of the mentioned fish species in both years, but, in 2021 compared to 2020, a substantial increase in the percentage of specimens from the Cyprinidae family (by 10.42%) and a decrease of the percentage of Siluridae (by 3.95%), Percidae (by 6.28%) and Esocidae (by 0.18%) species caught (Fig. 8 and 9).

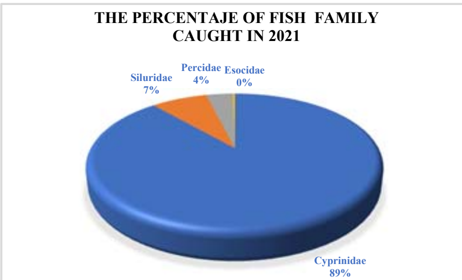

Figure 8 The percentage of fish families caught in the year 2021

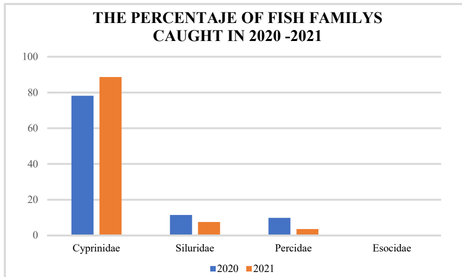

Figure 9. The percentage of fish families caught in the years 2020 and 2021

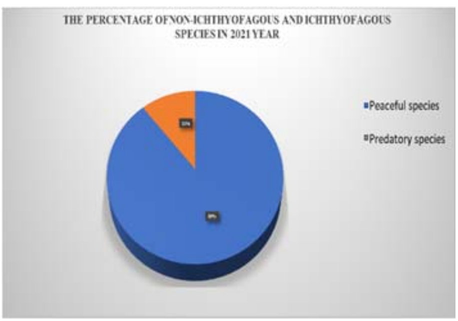

Figure 10. The percentage of peaceful to predatory species in the year 2021

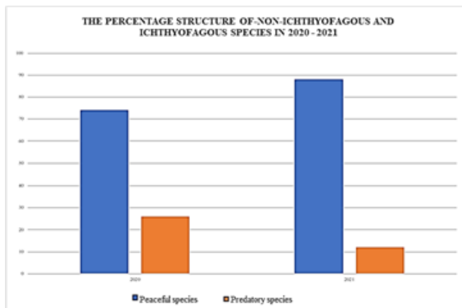

Figure 11. The percentage of peaceful to predatory species in the years 2020 and 2021

It was observed that in years or seasons with higher water levels and flow, peaceful species are advantaged in terms of reproduction and growth, with more chances to escape the attack of predators, comparative to years or seasons with low water levels favoring predatory fish species, a fact confirmed by our studies conducted on fish populations in the Danube River in the period 1981-2022.

We note that the percentage of peaceful fish species caught in 2021 are higher than those for predatory fish species in both years (Fig. 10 and 11).

CONCLUSIONS

The composition of fish communities is a basic ecological aspect, necessary for the proper exploitation, regulation and management of water and fisheries resources. The influence of abiotic and biotic factors on total catches and the composition of fish communities was analysed for both years. The total number of fish species caught in the Danube River area between km 1047-1071 in 2021 was 7, belonging to 4 families. Cyprinidae, the dominant family, was represented by 4 species (*Cyprinus Carpio, Carassius gibelio, Abramis Brama and Hypophthalmichthys molitrix).* Other families had the following structure: single-species Siluridae (*Silurus glanis*), single-species Percidae (*Sander lucioperca*) and single-species Esocidae (*Esox lucius*). The collected data showed the presence of a stable ichthyocenosis, especially for the Cyprinidae family. Research confirms that the structure of ichthyofauna is dependent on ecosystem characteristics and, consequently, is affected by ecological processes and fishing methods used.

As the main conclusion, it can be said that there is a direct positive correlation between the water levels and temperatures recorded in the Danube River (in the area km 1047-1071) and the total fish catches of peaceful species in the study area (Baziaș-Moldova Veche).

The conclusions resulting from this study were used to develop specific management plans for the protection of fish species in the Danube River.

ACKNOWLEDGEMENTS

The authors would like to thank the Ministry of Agriculture and Rural Development of Romania for financially supporting this research under budget code ADER 13.1.2.

REFERENCES

1. Antipa Gr., 1909. The ichthyological fauna of Romania. Publ. Fond Adamachi No. XVI, pp. 1-129.
2. Chioveanu, M.C., Stroe M.D., Tenciu M. The status of peaceful and predatory freshwater fish species in the Danube River in the km 1020-km 1071 sector in correlation with the variations in temperatures and river levels in the period August-November 2019, Scientific papers - University of Agricultural Sciences and Veterinary Medicine, Series - Animal Husbandry, 2020 Vol. 74 p. 134-138.
3. Chioveanu M.C., Simionov I.A., Patriche N., Tenciu M., Dragomir E., Cristea V., Mînzală D.N. The influence of hydrographic and thermal factors of the Danube River on the dynamics of fish stocks in the Razim-Sinoe system, 16th International Symposium on Environmental Science and Engineering, Rhodes, Greece, 4-7 September 2019.
4. Chowdhury, M. S. N., Hossain, M. S., Das, N. G. and Barua, P. Environmental variables and fisheries diversity of the Naaf River Estuary, Bangladesh, Springer Science and Business Media B.V., J Coast Conserv., 2011, 15, 163–180.
5. Gheorghe, DC. Research on the foundation of the sustainable exploitation of the fishing resources of the Danube and the Danube Meadow, PhD Thesis, 2010, University of Galați.
6. Harrod C. Climate change and freshwater fisheries, Freshwater Fisheries Ecology, First Edition, Published by John Wiley and Sons Ltd., 2016.
7. Holcík, J. Changes in the fish fauna and fisheries in the Slovak section of the Danube River: a review, Annales de Limnology, International Journal of Limnology, 2003, 39(3), 177-195.
8. Order no. 42/558/2022 on the approval of measures to regulate fishing effort and fishing quotas allocated for 2022, by species and areas, Issuer Ministry of Agriculture and Rural Development No. 42 of February 23, 2022, and Ministry of the Environment, Waters and Forests No. 558 of March 7, 2022, published in the Official Monitor no. 254 of March 15, 2022.
9. Radu (Geru) L. Reproduction ecomorphology of the Danube pike, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Veterinary Medicine, 2012.
10. Sandu (Călin) P.G. Oprea L. The Influence of Environmental Abiotic Factors on the Qualitative and Quantitative Structure of Ichthyofauna from Predeltaic Danube area, Animal Science and Biotechnologies,2013, 46(1).
11. Stroe M.D., Mirea D., Patriche N., Crețu M., Dima F.M. Status of peaceful and predatory freshwater fish stocks in the Danube sector km 1047-km 1071 in correlation with the variation of river temperatures and levels during the 2020 year, Papers-Animal Science Series Zootechnics, 2021, Book 77 (in press);