

ICHTYOFAUNA OF KRIVAJA RIVER CATCHMENT AREA

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IHTIOFAUNA SLIVNOG PODRUČJA REKE KRIVAJE

Apstrakt

Terenski dio ihtioloških istraživanja rijeke Krivaje i njenih pritoka obavljen je u periodu oktobar-novembar 2010. godine na području opština Olovo, Vareš i Zavidovići za potrebe izrade Ribarske osnove za područje Zeničko-dobojskog kantona. Izlov ribe je obavljen elektroagregatima marke "Honda": „FEG 15.000“ snage 15 kW i „OHV 5.5“ snage 3,0 kW. Elektro-ribolov je izvršen na 18.870 m vodotokova, odnosno na 591.140 m² ukupne vodene površine. Prikupljeni uzorci ribe obrađeni su na terenu i vraćeni u njihovo prirodno stanište, dok je manji broj reprezentativnih primjeraka fiksiran u 4%-tnom formaldehidu i dopremljen u laboratorije Centra za akvakulturu i ribarstvo Poljoprivredno-prehrambenog fakulteta Sarajevo na dalju analizu. Sistematska determinacija riba je vršena po Vukoviću i Ivanoviću (1971) i Sofradžiji (2009). Najveću brojnost u mješovitoj populaciji riba u rijeci Krivaji imale su jedinke iz porodice *Cyprinidae* sa procentualnim učešćem od 93,92%. Ostale evidentirane vrste iz porodica *Thymalidae*, *Cottidae*, *Salmonidae* i *Cobitidae* bile su zastupljene od 0,33-2,64%. Najveću brojnost iz pritoka rijeke Krivaje imale su vrste iz porodice *Cyprinidae* sa procentualnim učešćem od 54,93%. Nižu brojnost u istraživanim pritokama rijeke Krivaje imale su vrste iz porodice *Salmonidae* 31,54% i *Thymallidae* sa 9,34%. Najnižu brojnost imale su vrste iz porodice *Cottidae* sa 4,53%. Na osnovu dobivenih podataka o kvantitativno-kvalitativnom sastavu ihtiofaune sliva rijeke Krivaje, generalno se može zaključiti da ovo istraživano područje ima zadovoljavajuće ekološke uslove za život mnogih vrsta riba.

Ključne riječi: Krivaja, populacija, brojnost, ihtiouzorak, sliv

Keywords: Krivaja, populations, abundance, fish sample, catchment

INTRODUCTION

Freshwater fish fauna of Bosnia and Herzegovina, by the riches of interesting species, is a unique phenomenon in our continent. Ichthyofauna of Bosnia and Herzegovina can be divided into two parts, each very different in composition: ichthyofauna of the Adriatic catchment area, which is characterized by a number of endemic forms, and ichthyofauna of the Black Sea catchment area, where there is no endemic form but the species that have a wider distribution in Europe. First research of ichthyofauna in Bosnia and Herzegovina was carried out in mid and late nineteenth century, when Heckel, Kner and Steindachner described a number of interesting and hitherto unknown to science forms from the waters of Bosnia and Herzegovina (according to: Vuković and Ivanović, 1971). The second period of research of the ichthyofauna in the former Yugoslavia, and thus also in Bosnia and Herzegovina, occurs in the first half of the twentieth century. In this period, the most significant are works of Karaman (1924, 1928 and 1938), who described a number of species and subspecies of the family *Salmonidae*, *Cyprinidae*, *Cobitidae* and *Gasterosteidae*, especially from the Vardar river catchment, Prespa and Ohrid lakes and some flowing rivers in Yugoslav areas of the Adriatic catchment. Significant contribution to the understanding species composition of the Bosnia and Herzegovina was also given by other researchers: Čurčić (1938), Taler (1945 and 1953), Zaplata and Taler (1932). In their works, they mostly dealt with distribution of certain freshwater fish.

Modern ichthyofauna research in the second half of the twentieth century have been sustained, complex and particularly organized. Intensive study of ichthyofauna (with various aspects) in Bosnia and Herzegovina began in the 50s of XX century. Investigations of fish during this period to the present day include also knowledge of the composition and structure of fish populations and the different impacts on their living conditions.

Waters in catchment area of the Krivaja River belong to the Black Sea catchment and they are inhabited by fish species that have the widest range area in Europe. Although in this catchment area has no endemic form, it does not diminish the importance of these ichthyofauna researches.

Krivaja is a river in Central Bosnia, which does not have its source crest, but is created by connecting two mountain rivers: Bioštica and Stupčanica that drain the surface water and groundwater, and the two rivers joining in Olovo city. Krivaja River flows in north-west through the canyon-gorge valley. After a long course of 72 kilometers, Krivaja River flows into the Bosna River in urban zone of Zavidovići as its right tributary. Krivaja River catchment area drains surface water from the central part of Eastern Bosnia. It is located on the border between geographic regions, Central and Northern Bosnia. Southeastern parts of this catchment area drain surface water from Central Bosnia and lower parts of this catchment area from the southern parts of Northern Bosnia.

With an area of 1,350.8 km², Krivaja River catchment ranks among the medium-sized catchment areas of Bosnia and Herzegovina. This catchment has a length of 94.5 km and an average width is 14.7 km. The maximum width of 30 km catchment refers to the area of the source crests of Bioštica and Stupčanica, and minimum of 5.4 km to its lower part. Catchment area is quite symmetrical, which indicates symmetry coefficient of 1.4.

Ichthyologic research in the Krivaja River catchment area made in the Fish base study for the Bosna river catchment area (Kosorić *et al.* 1983) and Fish base study for the area of Zenica-Doboj Canton (Muhamedagić *et al.* 2011). The obtained data about state of ichthyo-populations are taken directly from these scientific research projects and presented and argued in this paper.

MATERIAL AND METHODS

The field work part of ichthyologic research of Krivaja River and its tributaries was carried out October and November 2010 in Olovo, Vareš and Zavidovići municipalities for the purpose of Fish base study for the area of Zenica-Doboj Canton. Assessment of the structure of fish populations by longitudinal sequence of catchment area of the Krivaja river and its tributaries treated at 10 locations; 6 locations in the municipality Olovo (Boganovići, Čuništa, Maoča, Bioštica, Stupčanica and Duboštica), 2 locations in the municipality of Vareš (Očevlja and Tribija) and 2 locations in the municipality of Zavidovići (Krivaja and Skroze).

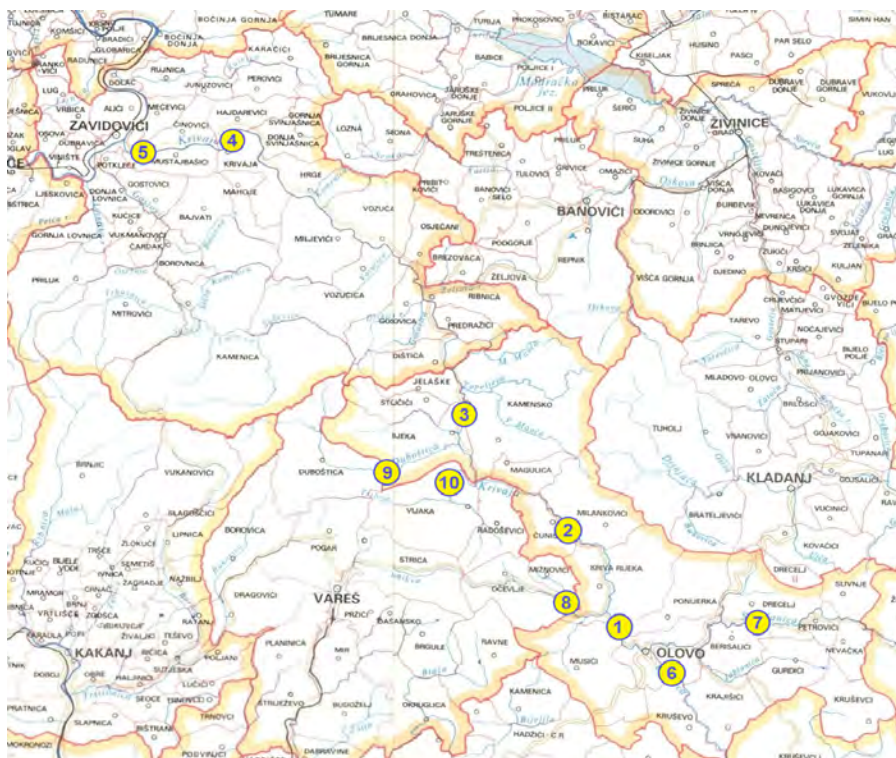


Figure 1. Investigated locations (1. Boganovići, 2. Čuništa, 3. Maoča, 4. Krivaja, 5. Skroze, 6. Bioštica, 7. Stupčanica, 8. Očevlja, 9. Duboštica i 10. Tribija)

Catching of fish is done by "Honda" brand aggregates: "FEG 15,000", with power of 15 kW and "OHV 5.5", with power of 3.0 kW. Electro-fishing is carried out on 18,870 m of watercourses, or on 591,140 m² of total water surface.

Collected fish samples were processed on the field and returned to their natural habitat, while a smaller number of representative specimens fixed in 4% formaldehyde and brought to the laboratory of Center for Aquaculture and Fisheries at Faculty of Agricultural and Food Sciences in Sarajevo for further analyses.

Systematic determination of fish is done by Vuković and Ivanović (1971) and Sofradžija (2009). Statistical analysis was performed according to Petz (1985).

RESULTS AND DISCUSSION

Results of the ichthyologic research of watercourses in Krivaja River catchment area (in municipalities Olovo, Vareš and Zavidovići) are presented in the following tables and charts.

Krivaja River

Results of qualitative and quantitative composition of ichthyo-populations in the Krivaja River from area of municipalities Olovo and Zavidovići are presented in Table 1.



Figures 2 and 3. Krivaja River: headwaters and its mouth to Bosna River



Figure 4 and 5. Part of ichthyofauna of Krivaja River and Danube salmon (*Hucho hucho* Linnaeus, 1758)



Figure 6 and 7: Part of ichthyofauna of Krivaja River: Common nase (*Chondrostoma nasus* Linnaeus, 1758) and Danube barbel (*Barbus balcanicus* Kotlík, Tsigenopoulos, Ráb & Berrebi, 2002)

Table 1. Qualitative and quantitative composition of ichthyo-populations in the Krivaja River

Family	Fish species	Locations					Total	
		Boganoići	Čuništa	Maoča	Krivaja	S kroze		
		n	n	n	n	n	n	%
<i>Salmonidae</i>	Danube salmon - <i>Hucho hucho</i> (Linnaeus, 1758)	2	3	1	1	2	9	0.6
	Brown trout - <i>Salmo trutta</i> Linnaeus, 1758	–	4	–	–	–	4	0.27
<i>Thymallidae</i>	Grayling - <i>Thymallus thymallus</i> (Linnaeus, 1758)	20	14	5	–	–	39	2.64
<i>Cyprinidae</i>	Chub - <i>Squalius cephalus</i> (Linnaeus, 1758)	16	16	15	102	123	272	18.4
	Common nase - <i>Chondrostoma nasus</i> (Linnaeus, 1758)	30	50	7	12	54	153	10.4
	Danube barbel - <i>Barbus balcanicus</i> Kotlík, Tsigenopoulos, Ráb & Berrebi, 2002	15	14	16	22	18	85	5.75
	Schneider - <i>Alburnoides bipunctatus</i> (Bloch, 1782)	122	116	140	202	142	722	48.9
	Gudgeon - <i>Gobio gobio</i> (Linnaeus, 1758)	–	–	–	6	–	6	0.4
	Danubian longbarbel gudgeon - <i>Romanogobio uranoscopus</i> (Agassiz, 1828)	8	7	–	–	–	15	1.01
	Belica - <i>Leucaspius delineatus</i> (Heckel, 1843)	–	–	–	37	62	99	6.7
	Bitterling - <i>Rhodeus sericeus</i> (Pallas, 1776)	–	–	–	22	–	22	1.49
	Eurasian minnow - <i>Phoxinus phoxinus</i> (Linnaeus, 1758)	13	–	–	–	–	13	0.88
<i>Cottidae</i>	Bullhead - <i>Cottus gobio</i> Linnaeus, 1758	19	13	–	–	–	32	2.16
<i>Cobitidae</i>	Balkan loach - <i>Sabanejewia balcanica</i> (Karaman, 1922)	–	–	1	2	2	5	0.33
Total catch (in number of individuals)		245	237	185	406	403	1,476	100.00

Ichthyo-populations of the Krivaja River are presented with fourteen species from five families: *Salmonidae*, *Thymallidae*, *Cyprinidae*, *Cottidae* and *Cobitidae*. Cyprinids are the largest fish group in this river. In total, it was registered nine species: Chub,

Common nase, Danube barbel, Schneider, Gudgeon, Danubian longbarbel gudgeon, Belica, Bitterling and Eurasian minnow. *Salmonidae* family was presented with two species: Danube salmon and Brown trout. Other families are represented by one species. Family *Thymallidae* was presented by Grayling, *Cottidae* by Bullhead and *Cobitidae* by Balkan loach.

By representative sampling at five locations in Krivaja River (Boganovići, Čuništa, Maoča, Krivaja and Skroze), 1,476 individuals of various fish types were catch in total. Ichthyology analysis of the number of individuals of certain fish species was provided data on the relative abundance of fish populations in the Krivaja River. Results of the quantitative structure of fish families in the studied river are shown in Chart 1.

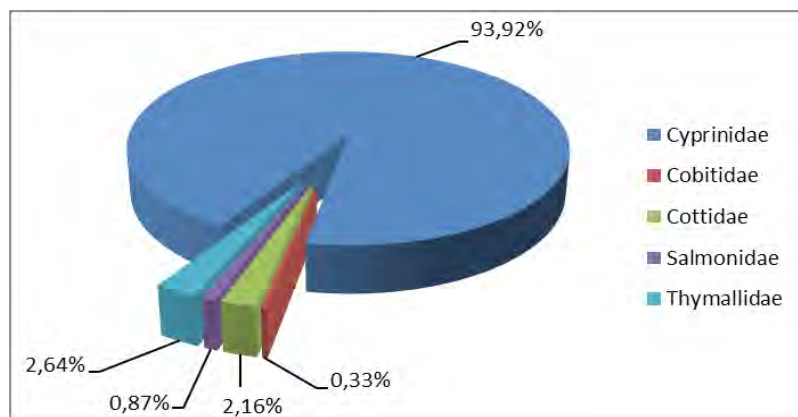


Chart 1. Percentage of families in the total fish catch in Krivaja River

In total fish population of Krivaja River representatives of cyprinids have registered in the highest number of caught individuals, and constitute 93.92% of the total number, while families *Thymallidae* makes 2.64%, *Cottidae* 2.16% and *Salmonidae* 0.87%. *Cobitidae* family makes the lowest share of ichthyo-populations with only 0.33%.

Among cyprinids, and generally in the overall fish population, population of Schneider is presented by the largest number of individuals (722), and makes 48.90% of Krivaja River fish population. By significant number of individuals, it was also registered population of Chub with 271 individuals, which is 18.40% in relative terms. Population of Common nase stands with high abundance. It was caught 153 individuals, so in the total fish population Common nase accounts for 10.40%. Danube salmon has been registered in the whole course of the Krivaja River and in total it was caught nine specimens of this species (0.6%). The lowest number was recorded for population of Brown trout (4 individuals or 0.27%), Balkan loach (5 or 0.33%) and Gudgeon (6 individuals or 0.40%).

Tributaries of Krivaja River

In order to determine the current state of fish populations in tributaries of Krivaja River, fish samples were collected from five tributaries: Bioštica, Stupčanica, Očevlja, Duboštica and Tribija. Rivers Bioštica and Stupčanica are source crests that merge in Olovo city and so create Krivaja River, while Očevlja, Duboštica and Tribija are left tributaries of Krivaja River. The results of the quantitative and qualitative composition of fish populations in these tributaries are shown in Table 2.



Figures 8 and 9. Location 6 - Bioštica and location 7 - Stupčanica

Table 2. Qualitative and quantitative composition of ichthyo-populations in tributaries of Krivaja River

Family	Fish species	Tributaries of Krivaja River					Total	
		Bioštica	Stupčanica	Očevlja	Duboštica	Tribija		
		n	n	n	n	n	n	%
<i>Salmonidae</i>	Danube salmon - <i>Hucho hucho</i> (Linnaeus, 1758)	2	–	2	–	–	4	1.13
	Brown trout - <i>Salmo trutta</i> Linnaeus, 1758	43	35	28	–	–	106	30.02
<i>Thymallidae</i>	Grayling - <i>Thymallus thymallus</i> (Linnaeus, 1758)	12	15	6	–	–	33	9.34
<i>Cyprinidae</i>	Chub - <i>Squalius cephalus</i> (Linnaeus, 1758)	–	5	–	–	8	13	3.68
	Barbel - <i>Barbus barbus</i> (Linnaeus, 1758)	12	–	–	–	–	12	3.39
	Danube barbel - <i>Barbus balcanicus</i> Kotlík, Tsigenopoulos, Ráb & Berrebi, 2002	36	7	7	3	4	57	16.14
	Schneider - <i>Alburnoides bipunctatus</i> (Bloch, 1782)	–	–	14	–	39	53	15.01
	Eurasian minnow - <i>Phoxinus phoxinus</i> (Linnaeus, 1758)	10	16	–	33	–	59	16.71
<i>Cottidae</i>	Bullhead - <i>Cottus gobio</i> Linnaeus, 1758	4	–	12	–	–	16	4.53
Total catch (in number of individuals)		119	78	69	36	51	353	100.00

After conducted ichthyological research, it is concluded that fish populations in tributaries of Krivaja River consist of nine fish species from four families: *Salmonidae*, *Thymallidae*, *Cyprinidae* and *Cottidae*. Family *Cyprinidae* is the largest with five representatives: Chub, Barbel, Danube barbel, Schneider and Eurasian minnow. Danube salmon and Brown trout were recorded from *Salmonidae* family, grayling from *Thymallidae* and Bullhead from family *Cottidae*. Sampling from five tributaries of Krivaja River: Bioštica, Stupčanica, Očevlja, Duboštica and Tribija, has resulted in caught of 353 individuals of different fish species in total. Relative abundance of fish populations in the studied tributaries is shown in Figure 2.

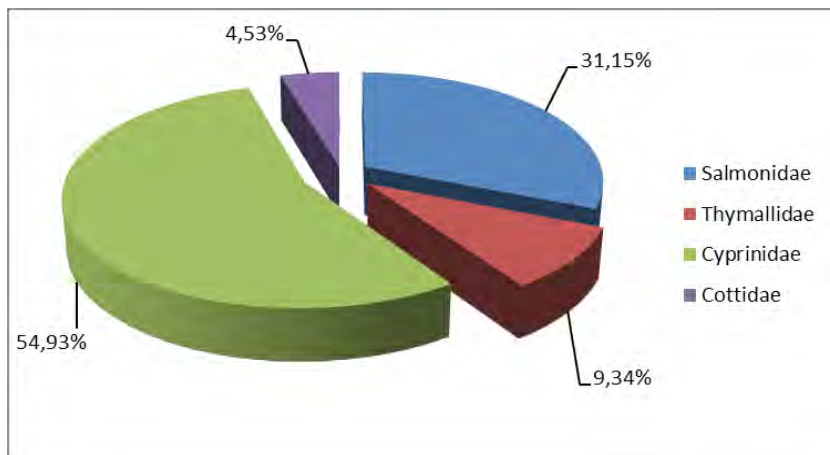


Chart 2. Percentage of families in the total fish catch in tributaries of Krivaja River

Cyprinids in the tributaries of the Krivaja River, with 194 individuals caught, constitute 54.93% of the total number. A significant number have fish of the *Salmonidae* family, with 110 specimens, which made 31.15% of the total number. Family *Thymallidae* with 33 grayling makes 9.34% of the total number. The smallest number has fish species from *Cottidae* family, with 16 individuals (4.53%).

Among salmonids, and generally in the overall fish settlement of these tributaries, the population of Brown trout is the largest with 106 specimens, which in relative terms is 30.02% of the total number. The second largest is population of Eurasian minnow with 59 registered individuals in the sample or with 16.71% share in the total fish number. They are followed by Danube barbel population with 57 individuals, which makes 16.14% and Schneider populations with 53 individuals caught or 15.01% of the total number.

Other species are recorded by much smaller number of individuals, including their participation numerically less. The lowest number was recorded in populations of Danube salmon, only four specimens, which makes 1.13% of the total number of fish in these tributaries.

Based on the obtained results it can be concluded that in the Krivaja river and its tributaries: Bioštica, Stupčanica, Očevlja, Duboštica and Tribija primarily represented cyprinid fish species: Chub, Common nase, Danube barbel, Schneider, Eurasian minnow, etc.

The data obtained on the qualitative and quantitative composition ichthyo-population of Krivaja River catchment are coincide with earlier data known from the literature on the

composition and structure of the ichthyofauna of the Bosna River catchment area, such as: Mučibabić *et al.* (1967 and 1971), Kosorić (1976), Kosorić *et al.* (1980), Kosorić and Mikavica (1981), Proha (1997), Sofradžija *et al.* (2003), Korjenić (2003), etc.

Also, the data fit the literature data, which relate to the composition and structure of the ichthyofauna of Neretva River catchment area and Drina River catchment area, such as: Kosorić and Vuković (1966), Kosorić (1974 and 1978), Vuković *et al.* (1987), Škrijelj (1995), Mikavica, Sofradžija and Dizdarević (1991), Mašović (2000), Sofradžija *et al.* (2003), etc.

On the basis of the presented data on quantitative and qualitative composition of ichthyofauna Krivaja River catchment area and comparisons with earlier published data of this and other catchment areas in Bosnia and Herzegovina, in general it can be concluded that this studied catchment area has sufficient environmental living conditions for many fish species.

CONCLUSIONS

Based on the results of qualitative and quantitative analyses of fish population's structure in investigated Krivaja River catchment area, it is possible to present the following basic conclusions:

In the analyzed samples provided by study of Krivaja River catchment area it was observed the presence of 15 fish species that are classified into five families of freshwater ichthyofauna: *Salmonidae*, *Thymallidae*, *Cyprinidae*, *Cottidae* and *Cobitidae*.

During field research in Krivaja River, 1,476 individuals were caught in total. The largest number in a mixed fish population had individuals from *Cyprinidae* family with share of 93.92%. Other recorded species from families *Thymallidae*, *Cottidae*, *Salmonidae* (Danube salmon is registered in the whole course of Krivaja River) and *Cobitidae* were represented from 0.33 to 2.64%.

In tributaries of Krivaja River, 194 individuals in total were caught during our research. The highest abundance was for species of *Cyprinidae* family with proportional share of 54.93%. Lower abundance in the studied tributaries of Krivaja River had species of families *Salmonidae* (31.54%) and *Thymallidae* (9.34%). Lowest abundance had species from family *Cottidae* with share of 4.53%.

Comparing the results from 1983 with results from the 2004 it can be concluded that the Krivaja river and its tributaries predominantly inhabited by cyprinids species, but their numbers declined (in 1983 cyprinid species were represented with 68% and in 2004 with 59.33%), while the number of salmonid species grows (in 1983 they were represented with 10% and in 2004 with 33.47%). The number of species from families *Cobitidae* and *Thymallidae* is also decreases, compared to the data from 1983 (in 1983 *Thymallidae* family was represented with 7% and in 2004 with 1.44%, while *Cobitidae* family in 1983 was represented by 6% and in 2004 with 5.74%).

Based on the results of the quantitative and qualitative composition of ichthyofauna of Krivaja River catchment area, it generally can be concluded that the studied area has favorable environmental conditions for the life of many fish species.

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