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The Ichthyofauna of Three Reservoirs in Northeastern Armenia and The Factors Affecting its Formation

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Abstract: *10 fish species belonging to Cypriniformes order have been found in Tavush, Joghaz and Aygedzor reservoirs located in the North of Armenia. The Ichtyofauna of all three reservoirs are quite different (the Jaccard similarity index was from 0.11 to 0.43), which indicates that the fish communities of each of the reservoirs have been formed independently and spatially, depending on the influence of factors such as irregular and uncontrolled acclimatization, disruption of fish migration due to hydraulic structures, drastic changes in a number of hydrogeological indicators in the freshwaters, poaching, etc. As a result, the ichthyofauna of the studied reservoirs has undergone drastic changes and mainly consists of low-cost waste fish.*
Keywords: *Ichthyofauna, Republic of Armenia, Tavush reservoir, Joghaz reservoir, Aygedzor reservoir.*

1. Introduction

About 85 reservoirs have been built in Armenia and are currently in operation, most of which lack reliable scientific descriptions of the species composition and quantitative relationships of individual species. It is known that the dams of most of these reservoirs, being built on the banks of various rivers, lack fish leaders, which has a negative impact on the natural fish communities of these rivers. As a result, within a few years, river-dwelling species disappear from these reservoirs, and in their place appear new species of fish preferring to live in lake conditions. In this regard, so far there has been only some information about some fish species in Armenia: Spandaryan, Angeghakot, Tolors, Shamb, Azat, Akhuryan, Tavush, Aparan reservoirs. In particular, the formerly numerous fish species such as *Barbus cyri* De Filippi, 1865 (Kura barbel), *Salmo caspius* Kessler, 1877 (Caspian trout) have become rare in the Tavush reservoir (Pipoyan, 2012). These studies, which were conducted about 15-20 years ago, do not give a full picture of the current species composition of the reservoir and possible further changes, which makes it relevant to study the Ichthyofauna of reservoirs in Armenia as an object of perspective development of fish farming. The Ichthyofauna of Tavush Reservoir was re-examined in 2017 and was found the following fish species *Carassius gibelio* (Bloch, 1782) (Crucian carp), *Alburnoides eichwaldii* (De Filippi, 1863) (Kura chub), *Capoeta capoeta* (Güldenstädt, 1773) (Caucasian scraper), *Barbus cyri*, *Squalius agdamicus* Kamensky, 1901 and *Cyprinus carpio* L., 1758 (Common carp) are identified in Tavush reservoir (Arakelyan et al, 2017).

Tavush, Joghaz and Ayghedzor reservoirs which are located in the north and north-east of Armenia, at state borders with Azerbaijan the Ichthyofauna of Joghaz and Ayghedzor reservoirs has not been studied yet. Water from these reservoirs flows into the territory of the neighboring countries and into the Kura River.

The goal of the current study is to explore the Ichthyofauna composition and the identification of the main factors of its formation.

2. Material and methodology

During our studies over the periods 2015-2019 (n=599), 10 fish species have been revealed, captured from Tavush (n=403) (2017-2019), Joghaz (n=161) (2015-2019) and Aygedzor (n=35) (2017) reservoirs. The fish was caught with a 70 cm diameter fishing net, a 55 cm diameter hand fishing net, fishing hooks, a screen, and a hand fishing hook. The caught fish were kept in a 4% formalin solution and then underwent study. While collecting and processing the material (selection of tools and methods of fishing) the methods of research used in Ichthyology were used (Pravdin, 1966). The species identification of the individuals studied was carried out according to the determinant of the fish of Armenia (Pipoyan, Tigranyan, 2010). The final adjustments of systematics were done according to Kaya et al (2020) and Kuljanishvili1 *et al.* (2020).

The similarity coefficient of fish communities of different aquifers was calculated according to the Jacquard index (K_J).

$$K_J = \frac{c}{a + b - c}$$

Where ***a*** indicates the number of fish species found in one area, ***b*** is the number of fish species found in another area, and ***c*** is the number of total fish species found in both areas (Jaccard, 1912).

The terms "numerous", "ordinary", and "rare" were used to describe the frequency of occurrence of certain fish species in a given river or freshwater. Conventionally, "numerous" indicated the fish species, the number of which exceeded 30% in the sample, "ordinary" the number of which did not exceed 30% are "rare" when the number in the sample did not exceed 10% (Pipoyan, 2012).

3. Research Findings

According to the data collected between the periods 2017-2019 not only previously discovered species in Tavush Reservoir -*Carassius gibelio, Alburnoides eichwaldii, Capoeta capoeta, Barbus cyri, Squalius agdamicus, Cyprinus carpio*- but also a new fish species *Pseudorasbora parva* Temminck & Schlegel 1846 (Topmouth gudgeon) were reavealed. (Figure 1). From which *Cyprinus carpio*, *Pseudorasbora parva* and *Carassius gibelio* are exotic fish species (Kaya et al. 2020).

Carassius gibelio is the leading in quantity and forms 48.6% (numerous) of the total fish caught. *Capoeta capoeta* in the second place in quantity (22.6 %) (ordinary), *Pseudorasbora parva* in the third place (20.8%) (ordinary), *Squalius agdamicus* forms 6.2% (rare), and *Alburnoides eichwaldii*, *Barbus cyri* and *Cyprinus carpio* are found in unique individuals, and their quantity formed just the 0.3-1.0 % (rare) of the total fish caught (Figure 2).

Few fish species are found in Aygedzor reservoir, such as *Alburnoides eichwaldii, Capoeta capoeta*, *Barbus cyri*. During the studies conducted in 2017 in Aygedzor reservoir, the dominant fish species was *Capoeta capoeta*, which formed 57.1% (numerous) of the total fish caught. *Alburnoides eichwaldii* was in the second place (37.1 %) (numerous), and *Barbus cyri* was in the third place (5.7%) (rare) (Figure 3).

Currently the following fish species are found in Joghaz reservoir: *Capoeta capoeta*, *Carassius gibelio*, *Pseudorasbora parva*, *Alburnus filippii* Kessler, 1877 (Kura bleak) (Figure 4, A), *Cyprinus carpio*(Figure 4, B), *Sabanejewia aurata* (De Filippi, 1863) (Golden spined loach) (Figure 4, C) and *Cobitis derzhavini* (Spined loach) (Figure 4, D). From the above mentioned only the 3 fish species are leading in the reservoir: *Carassius gibelio* 34.8% (numerous), *Pseudorasbora parva* - 23.6% (ordinary) and *Capoeta capoeta* 19.9 % (ordinary), *Alburnus filippii* 13.0%, and the rest species 1.2-5.0% (rare) (Figure 5).

A)

B)

C)

D)

E)

F)

Figure 1. Fish species found at Tavush reservoir A) Carassius gibelio, B) Alburnoides eichwaldii, C) Capoeta capoeta, D) Barbus cyri, E) Squalius agdamicus, F) Pseudorasbora parva

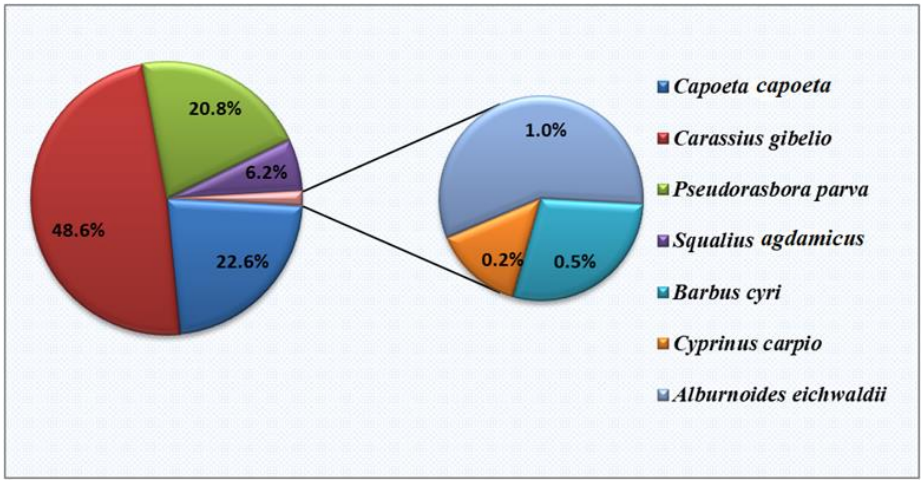

Figure 2. Fish species of Tavush reservoir and frequency

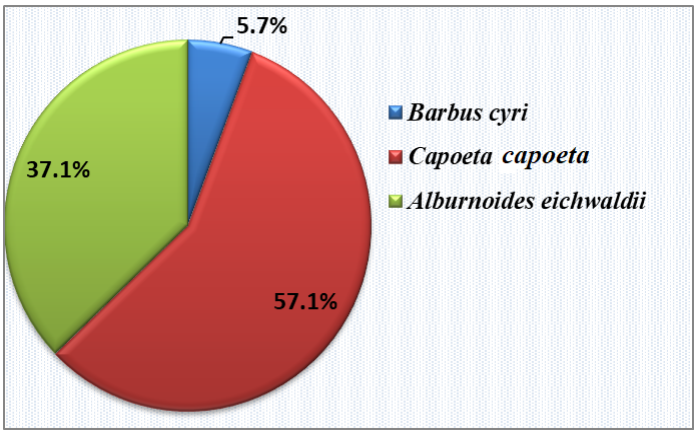

Figure 3. Fish species of Aygedzor Reservoir and frequency

A)

B)

C)

D)

Figure 4) Fish species found at Joghas reservoir A) *Cyprinus carpio*, B) *Alburnus filippii,C) Sabanejewia aurata* D) *Cobitis derzhavini*

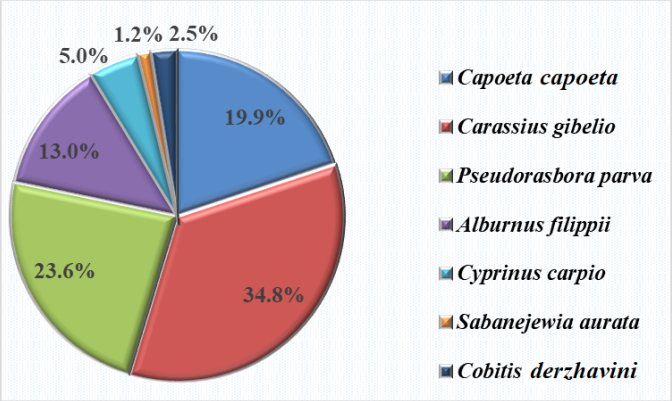

Figure 5 Fish species of Joghaz Reservoir and frequency

4. Discussion

Our studies conducted showed that fish species found in the three reservoirs belong to order Cypriniformes. River trout, *Salmo caspius* belonging to Salmoniformes order isn't found in the reservoirs at present, whereas previously it was found in the rivers, and visit those reservoirs for feeding (Dadikyan, 1986; Pipoyan, 2012). Today it is nearly at risk of extinction because of negative changes of environment, disappearance of migration routes and poaching.

At the same time, in all three reservoirs, the numerous species are species that prefer to inhabit in lake conditions (*Carassius gibelio*), and the ones which feels well both in river and lake conditions (*Capoeta capoeta*, *Pseudorasbora parva*).What the scarcity of preferring to inhabit in lake conditions.

Cyprinus carpio regards, then its quantity is greatly affected by selective fishing and the release of its fingerlings in the given reservoirs, as this species is rarely reproduced here. Other species which are mostly common in river conditions usually are in small quantities, and especially where the river flows into the reservoir and the level of oxygen and other hydrological conditions are better. It is worth mentioning that the two more numerous fish species *Carassius gibelio* and *Pseudorasbora parva* aren't native and have accidently flown into the freshwaters of Armenia in the 60-70s of last century (Pipoyan, 2012). During the following years the two species could expand nearly in the whole territory of the country and are currently considered the most numerous species in Armenia. One of the reasons for such widespread and climatic management is the large-scale reservoir construction, which significantly changes the water and thermal regimes of the rivers, in turn creating unfavorable conditions for aborigine rheophile species, which are now gradually being extinct by giving way to species that are resistant to water temperature changes such as *Carassius gibelio* as well as *Pseudorasbora parva*. The development of such a situation was anticipated, as during the design and subsequent exploitation of the reservoirs in Armenia no possible changes in the coexistence of fish have been taken into consideration and no scientific projections or suggestions and targeted fishery work have been followed before.

Under such formation conditions of ecosystems and because of numerous biotic and abiotic impacts, the Ichthyofauna of many reservoirs in Armenia has undergone radical changes and mainly consists of low-cost waste fish species which is indicated in the three reservoirs studied.

5. Conclusions

In this regard, the comparison of the similarity of fish species composition of the three reservoirs with the help of the Jaccard similarity indexes of utmost importance. As our studies have indicated, the ichthyofauna of all three reservoirs is quite different (the Jaccard similarity index was from 0.11 to 0.43),

which witnesses that the fish communities of each of the reservoirs have been formed independently and spatially, depending on the influence of the above-mentioned factors.

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