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Original Article

Assessment of ichthyofaunal diversity of family Cyprinidae in River Panjkora Dir, Khyber Pakhtunkhwa, Pakistan

Avaliação da diversidade ictiofaunística da família Cyprinidae no rio Panjkora Dir, Khyber Pakhtunkhwa, Paquistão

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Abstract

The study explores the Ichthyofaunal diversity of freshwater Cyprinidae fish in the Panjkora River of Dir, Khyber Pakhtunkhwa, Pakistan. A total of 911 fish samples were collected from 5 different sites along the river and identified using standard identification keys. Out of the 911 fish samples, 204 were related to family Cyprinidae, having 4 sub families, i.e Cyprininae representing 3 species i.e *Carassius auratus, Cyprinus carpio, Cyprinus watsoni*, Danioninae representing 6 species i.e *Barilius modestus, Barilius vagra, Barilius pakistanicus, Amblypharangodon mola, Salmophasia punjabensis, Rasbora daniconius*, Labeoninae representing 5 species i.e *Tor putitora, Crossocheilus diplocheilus, Gara gotyla, Labeo rohita, Labeo diplocheilus,* and Barbinae representing 6 species i.e *Puntius ticto, Puntius sophore, Puntius chonchonius, Schizothorax esocinus*, *Schizothorax labiatus and Schizothorax plagiostomus*. This study adds 6 new species i.e *Amblypharangodon mola, Salmophasia punjabensis, Labeo rohita, Labeo diplocheilus, Puntius chonchonius and Rasbora daniconius* for the 1st time which are not reported earlier. EXCEL 2019 and XLSTAT were used for principal components analysis to study richness and correlation of fish diversity. Eigenvalues obtained from Sheringal to Zulam are 3.72, 0.511, 0.37, 0.29 and 0.09 respectively. The higher eigenvalue of Sheringal site shows higher diversity. Water quality study shows that the mean values of water temperature was 16.8°C, pH 7.08, total hardness134.6 mg/L, alkalinity 89.3 mg/L, Nitrate 5.93 mg/L, Chlorine 0.87 mg/L, Nitrite0.02 mg/L and Copper 0.04 mg/L, Iron 0.07 mg/L, Lead 0.002 mg/L. The physicochemical parameters of river Panjkora during the study time remained within the permissible limits as prescribed by the WHO (2005). Gut analysis revealed the presence of algae, nymphs insect's larvae, macroinvertebrates and protozoans.

Keywords: Cyprinidae, ichthyofauna, diversity, River Panjkora, Danioninae, Labeoninae.

Resumo

O presente estudo explora a diversidade ictiofaunística de peixes *Cyprinidae* de água doce no rio Panjkora de Dir, Khyber Pakhtoonkhwa, Paquistão. Um total de 911 amostras de peixes foram coletadas em 5 locais diferentes ao longo do rio e identificadas usando chaves de identificação padrão. Das 911 amostras de peixes, 204 eram relacionadas à família Cyprinidae, com 4 subfamílias, ou seja, *Cyprininae* representando 3 espécies, isto é, *Carassius auratus*, *Cyprinus carpio*, *Cyprinus watsoni*, *Danioninae*, representando 6 espécies, ou seja, *Barilius modestus*, *Barilius vagra*, *Barilius pakistanicus*, *Amblypharangodon mola, Salmophasia punjabensis*, *Rasbora daniconius*, *Labeoninae* representando 5 espécies, ou seja, *Tor putitora, Crossocheilus diplocheilus, Gara gotyla, Labeo rohita, Labeo diplocheilus* e *Barbinae*, representando 6 espécies, ou seja, *Puntius ticto, Puntius sophore, Puntius chonchonius, Schizothorax esocinus, Schizothorax labiatus* e *Schizothorax plagio estoma*. Este estudo adiciona 6 novas espécies, como *Amblypharangodon mola, Salmophasia punjabensis, Labeo rohita, Labeo diplocheilus, Puntius chonchonius* e *Rasbora daniconius* pela primeira vez, que não foram relatadas anteriormente. EXCEL 2019 e XLSTAT foram usados para análise de componentes principais para estudar a riqueza e correlação da diversidade de peixes. Os autovalores obtidos de Sheringal a Zulam são 3,72, 0,511, 0,37, 0,29 e 0,09, respectivamente. O autovalor mais alto do site Sheringal mostra maior diversidade. O estudo da qualidade da água mostra que os valores médios da temperatura da água foram 16,8 °C, pH 7,08, dureza total 134,6 mg/L, alcalinidade 89,3 mg/L, Nitrato 5,93 mg/L, Cloro 0,87 mg/L, Nitrito 0,02 mg/ L e Cobre 0,04 mg/L, Ferro 0,07 mg/L, Chumbo 0,002 mg/L. Os parâmetros físico-químicos do rio Panjkora durante o tempo de estudo permaneceram nos limites permitidos conforme prescrito pela OMS (2005). A análise intestinal revelou a presença de algas, ninfas, larvas de insetos, macroinvertebrados e protozoários.

Palavras-chave: Cyprinidae, ictiofauna, diversidade, rio Panjkora, Danioninae, Labeoninae.

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1. Introduction

Districts Upper and Lower Dir have been split in to half by River Panjkora, which rises in Kohistan, District Dir (Upper), and flows south. The Kumrat-Kohistan, Lawari, Barawal, Usherai, and Guldai streams are the sources of the Panjkora River, and two tributaries enter the river in Lower Dir district at two distinct locations (Konhaye Stream at Koto and Round Stream at Thrai bypass). The total area for this study is about 220 kilometers from its origin. River Panjkora merges with River Swat at District Malakand, Bosaq Pul, Sharbatti behind Totakan. The Panjkora River is used for both energy production and irrigation. The development of the region is significantly influenced by this river (Hasan et al., 2015b).

Fishes are one of the major vertebrate group found in fresh, brackish, and marine waters (Seethal et al., 2013). In aquatic ecosystems, ichthyofauna is essential since it typically dominates the biotic components in terms of numbers. Both fish and fishery products contain all the essential nutrients needed for a healthy life in the right proportions, such as protein, polyunsaturated fatty acids, vitamins, and minerals (Hamzah, 2007). In addition to being a cheap source of highly nutritious protein, fish also contain essential nutrients needed by the human body, fish plays a vital role in nation's development (Muhammad et al., 2014). Fish meal, flour, glue, silage, and many other fish products of significant economic value are obtained from freshwater and marine fishes all over the world (Gupta and Gupta, 2006).

Fish Base lists 35,100 different species of fish, 14,000 of which are freshwater fish (Froese and Pauly, 2019). In contrast to groups like birds or mammals, fishes are paraphyletic collection of taxa that includes lampreys, hagfish, ray-finned fish, sharks and rays, lungfish and coelacanths (Helfman et al., 1997).

Class Pisces has been classified into three main super classes i.e Agnatha, Chondricthyes and Osteichthyes. Just like other super classes, Osteichthyes has also been classified into different orders and families, in which one is family Cyprinidae (Day et al., 2012). Family Cyprinidae of freshwater fish contain minnows and true carps. Family Cyprinidae is considered to be the broadest family, which contains 220 genera and 2400 species (Haseeb et al., 2015). Cyprinids have been considered as most important food fish all over the world. Beside this, much of the cyprinids species like goldfish are now-a-days used as popular pond and aquarium fish for ornamental purposes (Ahmad et al., 2020). Due to their increasing demands, many of the cyprinids like *Cyprinus carpio*, *Cirrhinus mrigala*, *Labeo rohita* and *Catla catla* are commonly used for aquaculture all over the world including Central and Eastern Europe and Asian countries like China, Japan, Bangladesh, India and Pakistan (Nelson, 2006; Billard, 1995).

In a study on Sagar Lake Madya Pradesh, India Wani and Gupta (2015) reported 21 species of freshwater fish in which 10 were members of family Cyprinidae. Sixteen species of family Cyprinidae have been reported from Charju River Arunachal Pradesh, India (Tesia and Borodolai, 2012). Thirty freshwater fish species were collected from the Tamor River, Himalayan region, Nepal, of which 61% of the fish belonged to the Cyprinidae family (Shrestha et al., 2009). In a study 66 species of fish were reported from the Similipal Bioshere Reserve, of which 29 were from the family Cyprinidae (Baliarsingh et al., 2013). Fifteen species of family Cyprinidae have been documented from Tons River India (Negi and Mamgain, 2013). Rafique and Khan (2012) reported 86 species of freshwater fish from Pakistan. Fourteen species of Cyprinidae family have been reported from River Kabul in District Nowshera (Khattak et al., 2015). Twenty one freshwater fish species related to 7 orders and 9 families have been documented from Hub Sindh Reservoir (Begum and Zehra, 2014).

Fifty one species of fish were collected from Jhelum River, 25 species of which were related to family Cyprinidae (Mirza et al., 2011). Six species of Cyprinidae family were collected from River Zhob in Baluchistan (Hasan et al., 2015a). Twenty species of Cyprinidae have been documented from the Swat River in Charsada (Yousafzai et al., 2013). Ten species of family Cyprinidae were collected from River Swat (Ishaq et al., 2014). Nine species of Cyprinidae have been identified in different streams of the Bajaur Agency (Hasan et al., 2014). In the Lower Dir district's Konhaye stream, a tributary of the Panjkora river, eleven freshwater fish are reported (Ullah et al., 2014). Fish samples from the River Panjkora District Dir Upper included 11 different species as reported by Ahmad et al. (2014) in which Cyprinidae was the richest. In another study 10 cyprinid species have been identified in River Panjkora Dir Lower by Wahab and Yousafzai (2017).

There are many risks to the freshwater ecosystem's broad array of species, including low nutrient levels, water contamination, and the dwindling number of important species (Dudgeon et al., 2006). These elements have an adverse influence on the ecosystem's general health and have both acute and chronic effects on aquatic animals (Dixit et al., 2015; Boyd, 2010; Hossain et al., 2019). The variety and richness of algae, insects, and macro invertebrates have a significant impact on the diversity of freshwater fish species and are essential components of the food chain (Bhat et al., 2014). These food species are crucial for the health of water body in addition to being a source of food for fish (Kar et al., 2006).

As Cyprinidae is the most important and largest human food family, so it is important to study its diversity and distribution. It has already been studied by the neighboring countries like China, India and Bangladesh etc. Natural water resources are abundant in our province. There are numerous large rivers including River Kabul, Swat, Kurram, and Panjkora, which merge to form the Indus River. Numerous more minor rivers, including Tochi, Kalpani, Jindi, and others, run the length of the province and empties into Swat and Kabul rivers. The study area is mostly unexplored in terms of Ichthyofaunal diversity and this study will provide basic information in this regard. The present study was conducted with the aim to explore the distribution, fish fauna and present status of Cyprinidae family in River Panjkora, Dir, Khyber Pakhtunkhwa.

2. Material and Methods

Total area explored in this study is about 220 kilometers river belt from its source of origin. Fish sampling was

carried out with the help of local fishermen using nets, hooks and rods from the selected sites of the river included Sheringal, Chukyatan, Wari, Ranai, and Zulam Pul (Figure 1). Immediately photographs were taken prior to preservation as formalin decolorizes the fish color on long preservation (Figure 2). Formalin (10%) was used for preservation of fish samples. Morphometric characteristics were taken. Fish were identified according to the standard identification keys like Inland fishes of India and adjacent countries by Talwar and Jhingram (1992), the freshwater fishes of the Indian region by Jayaram (1999), Fishes of the Punjab Pakistan. Lahore by Mirza and Sandhu (2007). Density, relative density, frequency and relative frequency of each sample was calculated by using the formula mentioned below (Wahab and Yousafzai, 2017) (Formulas 1-4):

$$\textbf{Density} = \frac{\textit{Number of fish sample of a specie collected from all monitoring sites}}{\textit{Total number of monitoring sites}} \quad (1)$$

$$\textbf{Relative Density} = \frac{\textit{Density of particular fish species}}{\textit{Total densities of all fish species}} \times 100 \quad (2)$$

$$\textbf{Frequency} = \frac{\textit{Number of monitoring sites at which a fish specie was found}}{\textit{Total number of monitoring sites}} \quad (3)$$

$$\textbf{Relative Frequency} = \frac{\textit{Frequency of particular fish species}}{\textit{Total frequencies of all fish species}} \times 100 \quad (4)$$

Water samples were collected from various sites and stored in a clean, sterilized plastic bottles. Temperature and pH were studied on the spot by using digital thermometer and pH meter respectively, while for analysis of total hardness, alkalinity, copper, iron, lead, nitrate, chlorine, and nitrite preserved samples were carried to the Pakistan Council of Scientific and Industrial Research Center (PCSIR) lab Peshawar.

Planktonic nets with various mesh sizes, including 40, 60, and 80 mm, were used to gather plankton. Stones and rocks searching was also carried out to catch the macrophytes. Submerged and floating flora were collected and identified by using identification key i.e Introduction to aquatic plants of North America (Faridi, 1971; Ali and Qaisar, 2012). Moreover, macro invertebrates were collected and identified using Guide to aquatic insects of New Zealand (Winterbourn and Gregson, 1981).

2.1. Principal component analysis (PCA)

PCA is a linear combination of many elements used to standardize factors for comparative analysis. It is then utilized to identify the variables that affect the sample and provides a definitive justification for the most important element. For numerous studies in this publication, XLSTAT and Excel 2019 were employed.

3. Results

A total of 20 fish species i.e *Carassius auratus, Cyprinus carpio, Cyprinus watsoni, Barilius modestus, Barilius vagra, Barilius pakistanicus, Amblypharyngodon mola, Salmophasia punjabensis, Rasbora daniconius, Tor putitora, Crossocheilus diplocheilus, Garra gotyla, Labeo rohita, Labeo diplocheilus, Puntius ticto, Puntius sophore, Puntius chonchonius, Schizothorax plagiostomus, Schizothorax esocinus and Schizothorax labiatus* were collected from all selected sites (Table 1). Family Cyprinidae was represented by four sub families i.e 3 species of sub family Cyprininae, 6 species of sub family Danioninae, 5 species of sub family Labeoninae and 6 species of sub

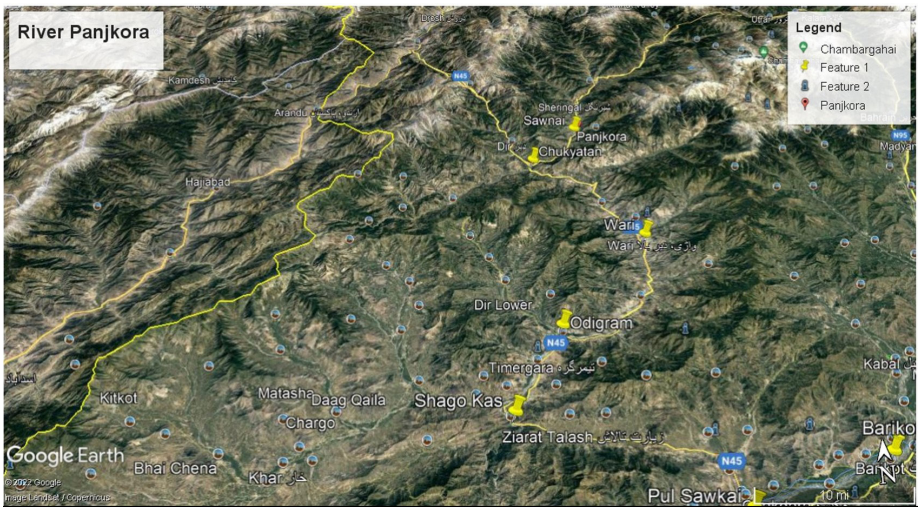

Figure 1. Showing different collection sites of River Panjkora.

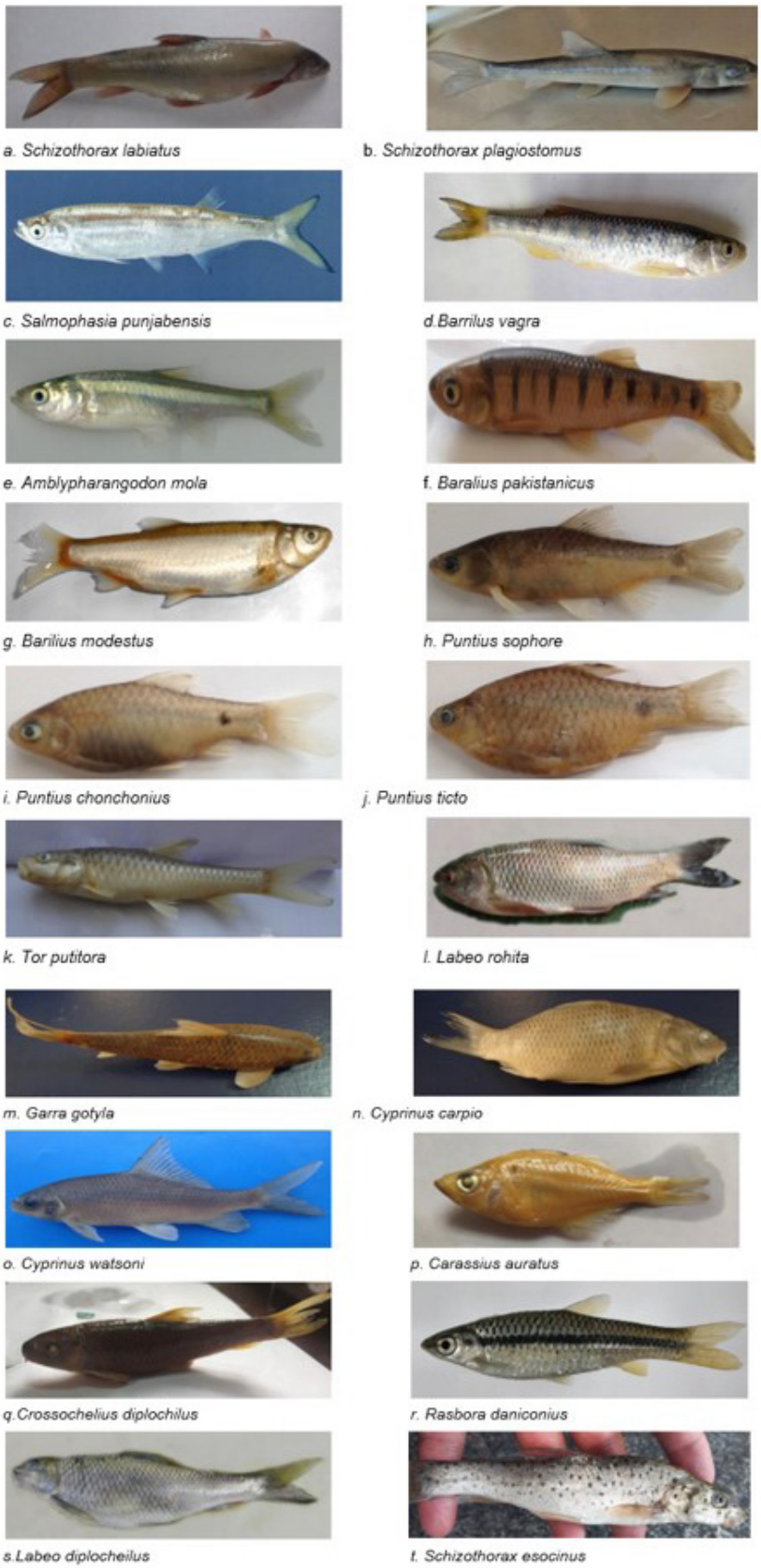

Figure 2. Showing ichthyofaunal diversity of family Cyprinidae in River Panjkora Dir KP.

Table 1. Showing classification of fish species of family Cyprinidae collected from River Panjkora.

S. No	Order	Family	Sub Family	Genus and Species
1	Cypriniformes	Cyprinidae	Cyprininae	*Carassius auratus*
2				*Cyprinus carpio*
3				*Cyprinus watsoni*
4			Labeoninae	*Baralius modestus*
5				*Baralius vagra*
6				*Baralius pakistanicus*
7				*Amblypharangodon mola*
8				*Salmophasia punjabensis*
9				*Rasbora daniconius*
10			Danioninae	*Tor putitora*
11				*Crossocheilus diplocheilus*
12				*Garra gotyla*
13				*Labeo rohita*
14				*Labeo diplocheilus*
15			Barbinae	*Puntius ticto*
16				*Puntius sophore*
17				*Puntius chonchonius*
18				*Schizothorax plagiostomus*
19				*Schizothorax esocinus*
20				*Schizothorax labiatus*

family Barbinae. *Schizothorax plagiostomus* was the most prevalent species with a relative density value of 18 and a relative frequency value of 6.66 followed by *Garra gotyla* with relative density 9.5 and relative frequency value of 6.6 (Table 2). Morphometric measurements of all collected fish were taken and tabulated (Table 3). In the present study *Schizothorax esocinus, Amblypharangodon mola, Rasbora daniconius, Cyprinus watsoni, Puntius ticto, Puntius sophore,* and *Puntius chonchonius* were scarce species. The species richness was higher at Wari as compared to other collecting sites which was 12, 16, 18, 15 and 14. The Physicochemical parameters of native water have been studied and summarized (Table 4).

Feeding items collected from the guts of dissected fishes were mud, debris, *Volvox globator, Spirogyra aequinocitalis, Ulothrix aequalis, hydrodictyon reticulatum,* chironomous larvae, caddis fly larvae and nymphs of dragonfly, mayfly and daphnia. Macroinvertebrates collected included mayfly, stonefly, dragonfly and damselfly, *Hydrodictyon reticulatum*, oedogonium, and *Spirogyra aequinocitalis* (Table 5). Correlation was taken between different collection sites in which the values of Sheringal is correlated with Chukyatan which shows that their fish diversity is correlated with each other (Table 6).

The factor loadings (FL) can be categorized into strong, moderate, and weak according to PCA, as shown (Figure 3). It is considered strong if FL is greater than 0.75 and moderate if FL is between 0.75 and 0.50. If FL is 0.50 to 0.30, it is considered weak (Shaw, 2009). For diversity of Cyprinidae the factor loading are presented in (Table 7) which shows that all the sites have contributed well to this research. Eigenvalues obtained from Sheringal to Zulam Pul are 3.72, 0.511, 0.37, 0.29 and 0.09 respectively. The higher value of Sheringal site shows higher diversity (Figure 4).

4. Discussion

Results of the present study agrees with the work done in the past on River Panjkora by Hasan et al. (2015b) who reported *Schizothorax plagiostomus, Garra gotyla, Cyprinus watsoni, Crossocheilus diplocheilus, Barilius vagra, Barilius pakistanicus,* Wahab and Yousafzai (2017) explored 10 species i.e *Barilius pakistanicus, Barilius vagra, Crossocheilus diplocheilus, Tor putitora, Schizothorax labiatus, Schizothorax plagiostomus, Schizothorax esocinus, Carassius auratus, Garra gotyla Cyprinus carpio*, and Muhammad et al. (2014) who reported 7 species i.e *Schizothorax esocinus, Racoma labiata, Orienus plagiostomus, Crossocheilus diplocheilus, Garra gotyla, Barilius pakistanicus* and *Carassius auratus*. Compared to the study of Muhammad et al. (2014) 2 species *Racoma labiata and Orienus plagiostomus* have not been reported in my study which may be due to the collection time difference or any other climatic changes. During my study, 6 new species are reported from River Panjkora which are not reported earlier by any

Table 2. Showing quantitative attributes of Ichthyofaunal diversity of family Cyprinidae at different sites in River Panjkora KP.

S. No	Name of fish	Sheringal	Chukyatan	Wari	Ranai	Zulam Pul	Density	Frequency	Relative Density	Relative Frequency
1	*Carassius auratus*	0	2	6	3	4	3	0.8	7.5	5.33
2	*Cyprinus carpio*	2	2	3	3	2	2.4	1	6	6.66
3	*Cyprinus watsoni*	0	0	2	0	1	0.6	0.4	1.5	2.66
4	*Baralius modestus*	2	1	2	0	2	1.4	0.8	3.5	5.33
5	*Baralius vagra*	3	2	5	4	3	3.4	1	8.5	6.66
6	*Baralius pakistanicus*	2	4	3	3	8	4	1	10	6.66
7	*Amblypharangodon mola*	0	0	1	2	1	0.8	0.6	2	4
8	*Salmophasia punjabensis*	2	1	0	2	0	1	0.6	2.5	4
9	*Rasbora daniconius*	1	2	0	0	0	0.6	0.4	1.5	2.66
10	*Tor putitora*	2	3	2	1	1	1.8	1	4.5	6.66
11	*Crossocheilus diplocheilus*	0	0	3	1	2	1.2	0.6	3	4
12	*Garra gotyla*	4	4	6	3	2	3.8	1	9.5	6.66
13	*Labeo rohita*	2	2	3	2	3	2.4	1	6	6.66
14	*Labeo diplocheilus*	3	2	3	3	2	2.6	1	6.5	6.66
15	*Puntius ticto*	0	0	2	1	0	0.6	0.4	1.5	2.66
16	*Puntius sophore*	0	1	1	1	0	0.6	0.6	1.5	4
17	*Puntius chonchonius*	0	1	2	0	0	0.6	0.4	1.5	2.66
18	*Schizothorax plagiostomus*	5	8	12	5	6	7.2	1	18	6.66
19	*Schizothorax esocinus*	0	1	2	0	0	0.6	0.4	1.5	2.66
20	*Schizothorax labiatus*	2	2	1	3	3	2.2	1	5.5	6.66
	Total	30	38	59	37	40	40.8	15		

Table 3. Showing morphometric measurements of different fishes of family Cyprinidae collected from River Panjkora KP.

S. No	Fish Name	T.L	S.L	F.L	H.L	E.D	Sn. L	Pre DL	Post D.L	Pre-PL	Post-PL	LCP	BD	BW
1	*Carassius auratus*	10.8	9.7	10	1.2	0.7	0.8	4.3	4.5	4.7	4.9	2.9	3.7	1.1
2	*Cyprinus carpio*	35	28	31	7.8	1.2	1.9	13.3	13.8	14	14.3	4.5	11	6.3
3	*Cyprinus watsoni*	15	12.7	13	2.3	0.8	2.8	6.12	6.7	2.3	2.9	3.6	3.6	3
4	*Baralius modestus*	6	4.6	4.9	1.8	0.4	1.4	3.1	3.3	2.1	2.3	1.5	2	1.9
5	*Baralius vagra*	4.8	4.3	4.6	0.9	0.3	0.5	2.9	3	2.6	2.7	1	0.8	0.9
6	*Baralius pakistanicus*	9.2	7.7	8.5	1.7	0.5	0.5	5.8	6	6.2	6.4	1.5	1.7	1.9
7	*Amblypharangodon mola*	5	4.2	4.5	0.97	0.3	0.8	2.1	2.2	1.9	2	0.9	1.3	0.8
8	*Salmophasia punjabensis*	12.5	10.2	11.1	1.9	0.4	1.8	7.8	8.2	7.7	8	1.7	2.4	0.8
9	*Rasbora daniconius*	12.5	10.5	11	2.2	0.5	2.1	6.8	7.1	7	7.2	1.6	2.5	1.7
10	*Tor putitora*	18.8	15	16.7	3.2	0.8	1.5	13.2	13.8	13.9	10.2	3.4	3.6	2.3
11	*Crossocheilus diplocheilus*	12	10.4	11	2.2	0.5	1.1	7.3	7.5	6.8	7	2.1	3	2.5
12	*Garra gotyla*	18.5	15.7	17.4	3.3	0.5	1.7	13.2	13.6	13.5	13.8	3.2	3	2.4
13	*Labeo rohita*	14	12.6	12.3	3.3	0.8	2	9.3	9.5	10	0.3	3.2	4.5	2.4
14	*Labeo diplocheilus*	17	14.3	15.5	3.4	0.5	1.8	6.9	7.1	8.1	8.4	3	4.7	2.7
15	*Puntius ticto*	10	8	9.1	2.4	0.4	1.3	6.5	7	7.8	8.1	2.5	4.2	2.9
16	*Puntius sophore*	8.3	6.7	7.6	1.8	0.4	1.2	6.5	4.3	4.5	5.1	1.3	2.3	2
17	*Puntius chonchonius*	6	4.8	5.4	1.2	0.3	1.1	3.9	4.1	4	4.3	2.5	2.2	1.9
18	*Schizothorax plagiostomus*	22.1	17.7	19.8	3.6	0.8	2.4	14.5	14.9	16.1	16.4	4.2	4.3	3.2
19	*Schizothorax esocinus*	25	20.5	23	3.5	0.7	2.2	14.5	14.9	19.1	20.4	5.2	4.2	3.1
20	*Schizothorax labiatus*	22	16.5	19	3.8	0.8	2.3	13.5	13.8	16.1	16.5	4.1	4.5	3.3

Table 4. Showing Physicochemical parameters (Mean±SD) of different Collection sites in study area.

Parameters	Sheringal	Chukyatan	Wari	Ranai	Zulam Pul	WHO Limit
Temp(°C)	16±0.83	15±0.83	17±0.83	17±0.83	**19±0.83**	16°C-40°C
Total Hardness(mg/L)	120±13.63	120±13.63	140±13.63	**148±13.63**	145±13.63	10mg/L-400mg/L
Alkalinity(mg/L)	76.5±10.74	80±10.74	91±10.74	99±10.74	**100±10.74**	10mg/L-400mg/L
Copper (mg/L)	0.035±0.008	0.035±0.008	**0.05±0.008**	**0.05±0.008**	**0.05±0.008**	2mg/L
Nitrate(mg/L)	4.25±1.49	4.05±1.49	6.55±1.49	7.1±1.49	**7.7±1.49**	45mg/L
PH	7±0.16	6.9±0.16	7±0.16	**7.25±0.16**	**7.25±0.16**	6.5-8.5
Iron(mg/L)	0.065±0.01	0.065±0.01	0.07±0.01	**0.085±0.01**	**0.085±0.01**	0.3
Lead (mg/L)	0.0025±0.0002	0.002±0.0002	**0.002±0.0002**	**0.002±0.0002**	0.0025±0.0002	0.01mg/L
Chlorine(mg/L)	0.75±0.12	0.75±0.12	0.85±0.12	**1±0.12**	**1±0.12**	5mg/L
Nitrite(mg/L)	**0.02±0.002**	**0.02±0.002**	**0.02±0.002**	0.025±0.002	0.025±0.002	0.1mg/L

Note: Bold figures show the maximum mean values.

Table 5. Showing algae, insects and macroinvertebrates in the study area.

Feeding items collected from the guts of dissected fish					
Algae	**Sheringal**	**Chukyatan**	**Wari**	**Ranai**	**Zulam Pul**
Spirogyra aequinocitalis	+	+	+	+	+
Ulothrix aequalis.	+	+	+	+	+
Volvox globator	+	+	+	+	+
Hydrodictyon reticulatum	+	-	+	+	+
Insects					
caddis fly larvae	+	+	+	+	+
Chironomous larvae	+	-	+	-	+
Nymphs of					
Mayfly	+	-	+	+	-
Dragonfly	+	+	+	+	+
Daphnia	-	-	+	+	+
Macro invertebrates and algae collected from water and surroundings					
Stonefly	+	-	+	+	+
Mayfly	-	-	+	-	-
Damselfly	+	+	+	+	+
Dragonfly	+	+	+	+	+
Oedogonium	+	-	-	+	+
Caddis fly	+	+	-	+	+
Spirogyra aequinocitalis	+	+	-	+	+
water strider	-	-	+	+	+
water beetle	+	+	+	+	+
water scorpion	+	+	+	+	+
Water Spider	+	-	-	+	+
Crawling Water Beetle	+	+	+	+	+
Protozoan	+	+	+	+	+
Paramecia	-	-	-	+	+

Table 6. Showing correlation between different Collection sites of River Panjkora Dir

Variables	Sheringal	Chukyatan	Wari	Ranai	Zulam Pul
Sheringal	1	0.808	0.615	0.713	0.510
Chukyatan	0.808	1	0.783	0.675	0.678
Wari	0.615	0.783	1	0.687	0.622
Ranai	0.713	0.675	0.687	1	0.694
Zulam Pul	0.510	0.678	0.622	0.694	1

Values in bold are different from 0 with a significance level alpha=0.05.

Table 7. Showing factor loading of family Cyprinidae in River Panjkora Dir.

	F1	F2	F3	F4	F5
Sheringal	0.848	-0.448	-0.211	-0.104	-0.159
Chukyatan	0.918	-0.166	0.169	-0.238	0.210
Wari	0.861	0.034	0.439	0.233	-0.099
Ranai	0.874	0.093	-0.314	0.343	0.108
Zulam Pul	0.808	0.523	-0.099	-0.240	-0.082

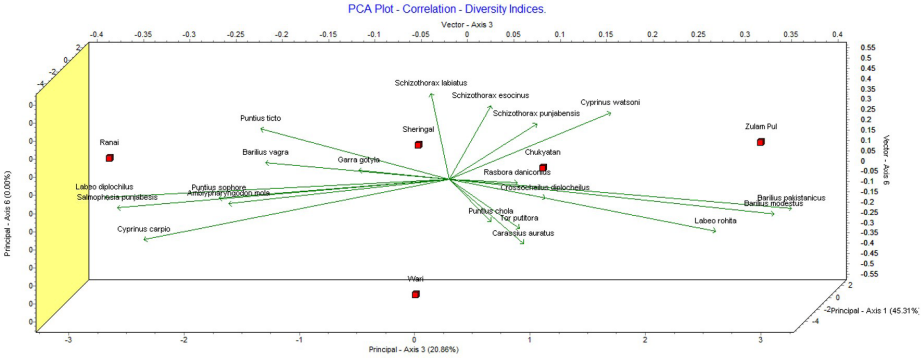

Figure 3. Showing 3D PCA plots of different species of family Cyprinidae collected at different sites of River Panjkora.

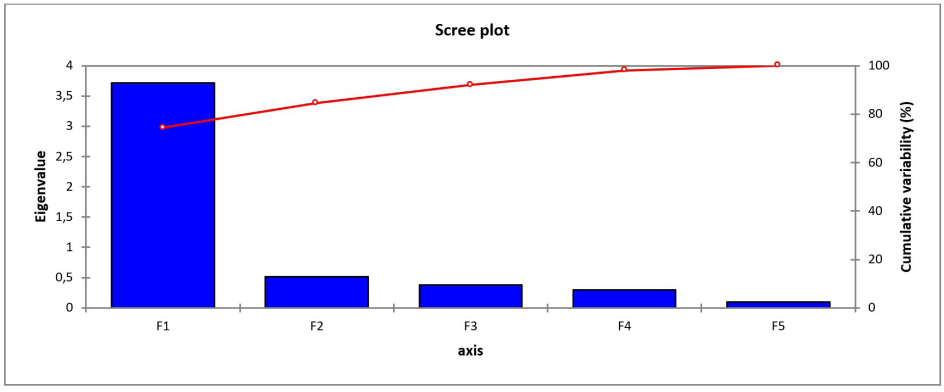

Figure 4. Showing Eigen values at different Collection sites of River Panjkora Dir.

author from this study area i.e *Amblypharangodon mola, Salmophasia punjabensis, Labeo rohita, Labeo diplocheilus, Puntius chonchonius,* and *Rasbora daniconius*. In a survey on the Panjkora River upper Dir carried out by Ahmad et al. (2014) five orders and five genus of fish were reported including six species of family Cyprinidae, comprising *Schizothorax esocinus, Crossocheilus diplocheilus, Racoma labiata, Garra gotyla, Orienus plagiostomus,* and *Carassius auratus*. However two of these species *Racoma labiata* and *Orienus plagiostomus* have not been reported in my study.

Schizothorax plagiostomus was the most abundant species with a relative density value of 21.85 and relative frequency value 4.04. This was followed by *Garra gotyla* with relative density and relative frequency values of 12.42 and 4.04 respectively. *Schizothorax esocinus, Amblypharyngodon mola, Salmophasia bacaila, Rasbora daniconius, Cyprinus watsoni, Puntius ticto, Puntius sophore, Puntius chola, Puntius chonchonius* were rare in the study area.

The alteration in diversity of fish at different collecting sites is due to variation in habitat and depth of water. Subfamily Labeoninae and Barbinae emerged as the most dominant groups having 6 number of species each.

In Pakistan economically important species are: *Labeo rohita, Gibelion catla, Cirrhinus mrigala, Cirrhinus reba,*

Channa straita, Channa marulius, Sperata sarwari, Wallago attu, Rita rita, Bagarius bagarius, Tenualosa ilisha, Notopterus notopterus, Nemacheilus spp., Tor macrolepis, Schizothorax spp. and *Clupisoma naziri* (Peter, 1999).

The present collection also contains the commercially important fishes related with family Cyprinidae, namely *Schizothorax plagiostomus, Schizothorax esocinus, Cyprinus carpio, Carassius auratus, Garra gotyla* and *Tor Putitora*. Among the commercial fishes the *Schizothorax esocinus, Tor Putitora* and *Cyprinus carpio* are becoming very rare in these Rivers because of the illegal fishing activity like using electric current, dynamite etc. Proper conservation and management are required for the protection of such fishes.

In the last four decades, Pakistan has introduced several alien exotic fish species e.g. grass carp (*Ctenopharyngodon idella*), bighead carp (*Hypophthalmichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), common carp (*Cyprinus carpio*), gold fish (*Carassius auratus*), three species of tilapia (*Oreochromis aureus, Oreochromis mossambicus, Oreochromis niloticus*) in warm waters and two trout species: the rainbow trout (*Oncorhynchus mykiss*) and the brown trout (*Salmo trutta fario*) in colder regions for various purposes like sport fishing, yield enhancement for the biological control of aquatic weeds and mosquito (Khan et al., 2015). The present collection contains some exotic species like *Cyprinus carpio* and *Carassius auratus.*

Fish diversity is more apparent than in their morphology. Fishes range in size from the very small to the very large, adult gobies may be just 8 mm, whereas the whale shark, *Rhincodon typus*, may reach 12 m (Nelson, 2006). The present collection contains both the small and large size fishes. The *Barilius modestus, Barilius vagra, Barilius pakistanicus, Amblypharyngodon mola, Salmophasia punjabensis, Crossocheilus diplocheilus* and *Puntius sophore*, are the smaller size fishes collected from this river. Due to their size these fishes have no marketing value. But due to the part of biodiversity its play a very important rule as an integral part of food chain and food web of the riverine ecosystem. Among the small size fishes reported in this study i.e Carassius auratus, *Barilius pakistanicus* and *Puntius sophore* are the beautiful ornamental fishes used to keep alive in aquarium and bear great economic value.

The Panjkora River runs through a developed, populated area, therefore the discharges of domestic, industrial, and municipal sewage as well as agricultural and industrial waste might have affected the fish population.

Industrialization and population growth have an indirect effect on the aquatic environment, which has an impact on aquatic organisms abundance and diversity (Hasan et al., 2015b). Through a variety of methods including application of strict environmental laws, annual fish stocking, catch regulation, prevention of catch during breeding season, and fishing only fish of market size can make it possible to maintain fish stocks, species diversity, and abundance in the natural environment.

Various parameters like (Temperature, pH, Total Hardness, Alkalinity, Copper, Iron, Lead, Nitrate, Chlorine and Nitrite) effects the fish diversity as reported by Khan et al. (2015). According to the finding of current study all physicochemical parameters fall within the safe limits of WHO (2005).

Study on feeding habits confirms results of work carried out by Piska et al. (1991), Hajisamae et al. (2003), Kausar et al. (2012) and Jan et al. (2018). They have reported algae, diatoms, planktons and insects in fish guts and the surrounding environment.

5. Conclusion

A total of 20 species (*Carassius auratus, Cyprinus carpio, Cyprinus watsoni, Barilius modestus, Barilius vagra, Barilius pakistanicus, Amblypharyngodon mola, Salmophasia punjabensis, Rasbora daniconius, Tor putitora, Crossocheilus diplocheilus, Garra gotyla, Labeo rohita, Labeo diplocheilus, Puntius ticto, Puntius sophore, Puntius chonchonius, Schizothorax plagiostomus, Schizothorax esocinus and Schizothorax labiatus)* are reported in the present study, out of which 6 species (*Amblypharangodon mola, Salmophasia punjabensis, Labeo rohita, Labeo diplocheilus, Puntius chonchonius* and *Rasbora daniconius*) are reported for the 1st time.

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