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Current Status of Fish Diversity and Abundance at Panjnad Headworks Bahawalpur, Punjab, Pakistan

Saima Naz[1], Ahmad Manan Mustafa Chatha[2], Rifat Ullah Khan[3*], Saba Iqbal[1], Nimra Amjad[1], Azka Kiran[1], Ammara Javed[1], Maria Lateef[1] and Amna Nawaz[1]

[1]*Department of Zoology, Government Sadiq College Women University, PK63100, Bahawalpur, Punjab, Pakistan*
[2]*Department of Entomology, Faculty of Agriculture and Environment, The Islamia University of Bahawalpur, PK63100, Bahawalpur, Punjab, Pakistan*
[3]*College of Veterinary Sciences, Faculty of Animal Husbandry and Veterinary Sciences, The University of Agriculture, Peshawar, Pakistan*

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Key words
Fish diversity, Relative abundance, Diversity indices, Panjnad headworks

ABSTRACT

Present study is conducted to collect the information about current fish diversity at famous public place at Panjnad Headworks, Punjab, Bahawalpur, Pakistan. All fish samples were collected from three different sites (Panjnad, Abasia, Abu Dhabi canal) during February 2020 to January 2021 using different fish inclusive. The evident fish groups found were Cyprinids, Catfishes and others including (*Channa punctata, Oreochromis niloticus, Oreochromis mossambicus, Bagarius bagarius*). The data was statistically analyzed using ANOVA. Further relative abundance (Panjnad canal=57.81%, Abbasia canal=25.56%, Abu Dhabi canal=16.61%) and Simpson diversity index (D) (Panjnad canal=0.957335, Abbasia canal=0.923277, Abu Dhabi canal=0.893188) and Shannon-Wiener index (H) (Panjnad canal=3.19433, Abbasia canal=1.54355, Abu Dhabi canal=1.067311) were also calculated. Results revealed the diversity of fish population at Panjnad Headworks may be varied with seasonal variations. Maximum species originated belongs to family Cyprinidae which were 12 in number. It is suggested that there is a need of comprehensive strategies to conserve the nearly extinct group of fish species.

INTRODUCTION

In the whole world, fish contributes half of the total number of vertebrates. Mostly they inhabit all possible aquatic surroundings. Out of 39,900 vertebrate's species, almost 21,723 fish species have been documented, from which freshwater species are recognized as 8,411 and marine species are 11,650 in figure (Shinde *et al*., 2009). Fish identification is one of the most important measures of taxonomy which is commonly counted on observable external morphology. Most identification of fish has been conceded with the use of standard keys (Ward, 2009). Further studies have been completed in this concern on diverse lentic and lotic areas of province Khyber Pakhtunkhwa as 94 fish species have been identified (Khan and Hasan, 2011).

Pakistan represented the largest canal system correspondingly with more than 225 wetlands while only 19 are enumerated as Ramsar sites. About 780,000 hectares area has been covered by Pakistan which comprises 26.06% of coastal wetland areas out of total wetland area of the country and consequently 73% of freshwater area (IUCN, 1989; Altaf *et al*., 2014). Approximately more than 27,977 fish species have been recorded which are represented by 515 families and 62 orders (Helfman *et al*., 2009). Additional studies have been accompanied about the aquatic fish fauna of different places at different times in Pakistan (Mirza, 1975, 1980, 1990; Mirza and Sadiq, 1978; Rafique *et al*., 2003). Another study revealed that Pakistan has more than171 species including marine and freshwater fishes (Peter, 1999; Mirza, 2004). Minimum 193 fish species were also documented during a study which relates to class Actinopterygii, subclass Teleostei, three cohorts, thirteen orders, six super orders, thirty families and eighty-six genera (Rafique, 2007).

Fish health and abundance describe the health of

* Corresponding author: rukhan@aup.edu.pk
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whole aquatic life (Hamzah, 2007). Population growth and economic aspects also become infected by a decline in population of fishes and fisheries (Limburg *et al*., 2011). Pakistan has presented a number of alien exotic fish species listed as common carp (*Cyprinus carpio*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idella*), gold fish (*Carassius auratus*), bighead carp (*Hypophthalmichthys nobilis*) and 3 species of tilapia as *Oreochromis aureus, Oreochromis mossambicus, Oreochromis niloticus* in warm waters along with 2 other trout species known as rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta fario*) in colder areas which concerning for particular objectives such as yield improvement, sport fishing, biological control of mosquitoes and aquatic weeds (Khan *et al*., 2011).

Status of three major carps called *Cirrhinus mrigala, Catla catla* and *Labeo rohita* was analyzed at Downstream Indus River. In one study 77 freshwater fish species were confirmed which comprises 6 exotic and 71 native fish species (Sheikh *et al*., 2017). Another study was conducted at River Barandu, KPK which is the most familiar water line system as it links all local rural areas and ultimately falls into the Indus River at Kala Dhaka (Khan *et al*., 2012). Fish fauna of Pakistan with specific IUCN status was discussed in a study. Total 86 fish species were identified, out of which 34 species have been revealed as endemic, 31 commercially essential, 11 with special IUCN status and 8 recognized as very rare species (Rafique and Khan, 2012). A study was conducted by (Altaf *et al*., 2014) at 3 heads of River Chenab named as Head Khanki, Head Marala and Head Qadir Abad. Total 34 species were recorded during sampling. A diversity index shows the highest rate of fish diversity at Head Qadir Abad as compared to Head Khanki and Head Marala. Total 11 species were recorded from Barandu River district Buner Khyber Pakhtunkhwa, Pakistan which belongs to 3 orders and 4 families (Saeed *et al*., 2013). Head Panjnad is river which located at Bahawalpur, Punjab, Pakistan. This river is formed by consecutive confluence of 5 rivers of district Punjab (Rive, Sutlej, Jhelum, Base, Chenab). Ravi and Jhelum both rivers join at river Chenab, Base join river Sutlej and both Chenab and Sutlej rivers join to form this Panjnad Head. A dam on this headworks has been constructed which provide Channels for irrigation of both Provinces (Punjab and Sindh) of east of Indus River and south of Sutlej Rivers. Previously, no study has been conducted on fish species diversity on this Panjnad Head. This research was, therefore, is to investigate the diversity of fish fauna and their distribution of Panjnad Headworks Punjab, Bahawalpur, Pakistan.

MATERIALS AND METHODS

Location of sampling areas

Sample collection was carried out at different locations of Panjnad Headworks targeted as Abu Dhabi, Abbasia and Panjnad Canal as shown in Figure 1. Fish samples were collected randomly at daytime using different types of available nets such as common fish trap nets, drag nets, cast nets, bait hooks and hand nets. Sampling was done for the duration of 12 months starting from February 2020 to January 2021.

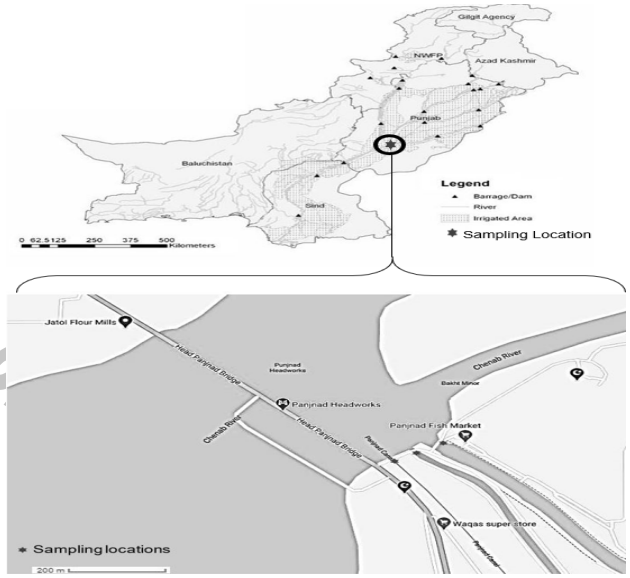

Fig. 1. Map showing the location of sampling areas.

Sampling

All fish samples were labeled and kept at -20°C. Initial identification and common name of fish species was confirmed with the assistance of common fish catchers and fish sellers. All species photographs were taken from a digital camera and these photographs were labeled temporarily. Later all species were identified taxonomically, and misidentifications were removed by an expert taxonomist using systematic keys (Rafique and Khan, 2012).

Diversity and relative abundance

The relative abundance of all fish species is calculated by applying the specific formula given as:

$$R.A\ (\%) = ni/N \times 100$$

Here ni is taken as the number of individuals of a single fish species in one month and N represents the number of individuals of fish species in all months (calculated relative abundance shown in Table I).

Table I. Relative abundance and diversity indices of fish in Panjnad canal, Abbasia canal and Abu Dhabi canal.

Scientific name	Local name	Panjnad canal			Abbasia canal			Abu Dhabi canal		
		n	RA (%)	FO (%)	N	RA (%)	FO (%)	N	RA (%)	FO (%)
Family Clariidae										
1. Clarias batrachus	Asian catfish	26	2.11	66.6	2	0.36	8.3	0	0	0
Family Ailiidae										
2. Clupisa garua	Bachwa, Sher mahi	43	3.50	91.6	8	1.47	16.6	8	2.26	25
Family Schilbeidae										
3. Eutropiichthys vacha	Jhali	19	1.54	41.6	2	0.36	16.6	52	14.73	91.6
Family Siluridae										
4. Wallago attu	Mulli	6	0.48	16.6	2	0.36	8.3	50	14.16	75
Family Bagridae										
5. Rita rita	Desi khagga	46	3.74	66.6	3	0.55	25	35	9.91	75
6. Sperata sarwari	Singhari	39	3.17	50	3	0.55	16.6	42	11.89	66.6
Family Channidae										
7. Channa marulius	Soul	53	4.31	75	1	0.18	8.3	5	1.41	8.3
8. Channa punctata	Daula, Gudo	44	3.58	58.3	18	3.31	33.3	7	1.98	16.6
Family Cyprinidae										
9. Catla catla	Thaila	69	5.61	91.6	47	8.65	75	7	1.98	25
10. Cirrhinus mrigala	Mori	58	4.72	83.3	48	8.83	83.3	2	0.56	8.3
11. Cyprinus carpio	Gulfaam	46	3.74	75	43	7.91	58.3	7	1.98	25
12. Labeo rohita	Rohu	47	3.82	50	30	5.52	41.6	34	9.63	50
13. Labeo calbasu	Kalbans	55	4.47	75	39	7.18	66.6	1	0.28	8.3
14. Labeo gonius	Sereeha	51	4.15	66.6	46	8.47	58.3	3	0.84	8.3
15. Labeo boga	Bhangan	54	4.39	75	56	10.31	66.6	2	0.56	8.3
16. Ctenopharyngodon Idella	Grass Carp	60	4.88	83.3	54	9.94	66.6	1	0.28	8.3
17. Hypophthalmichthys molitrix	Silver Carp	74	6.02	91.6	50	9.20	66.6	1	0.28	8.3
18. Carassius auratus	Goldfish	25	2.03	66.6	3	0.55	8.3	0	0	0
19. Crossocheilus diplocheilus	Dogra	44	3.58	75	1	0.18	8.3	5	1.41	8.3
20. Aristichthys nobilis	Bighead carp	18	1.46	58.3	0	0.0	0	2	0.56	8.3
Family Cichlidae										
21. Oreochromis niloticus	Nile tilapia	73	5.94	75	44	8.10	66.6	1	0.28	8.3
22. Oreochromis mossambicus	Chira	67	5.45	75	36	6.62	50	1	0.28	8.3
Family Sisoridae										
23. Bagarius bagarius	Mujahid	55	4.47	75	1	0.18	8.3	0	0	0
Family Notopteridae										
24. Notopterus notopterus	But Pari	66	5.37	75	2	0.36	16.6	10	2.83	16.6
25. Chitala chitala	Cheetal Pari	60	4.88	66.6	1	0.18	8.3	17	4.81	25
Family Ambassidae										
26. Parambassis ranga	Sheesha	13	1.05	41.6	1	0.18	8.3	0	0	0
Family Mastacembelidae										
27. Mastacembelus armatus	Baam	17	1.38	25	2	0.36	16.6	60	16.99	75

Further diversity indices i.e., Shannon-Wiener index (H) and Simpson diversity index (D) were also calculated using the formula mentioned below:

$$H' = -\sum_{i=1}^{s} \frac{ni}{N} ln \frac{ni}{N}; D = 1 - \frac{\sum_{i=1}^{s} ni(ni-1)}{N(N-1)}$$

Here, ni signifies an individual's number and N indicates total species number.

RESULTS AND DISCUSSION

In the present study, survey of fish fauna of Panjnad Head Works district Bahawalpur Punjab, Pakistan was inclusively carried out for 12 months of the year 2020 to 2021. During this investigation total 27 species were recorded which belongs to Phylum Chordata, Class Actinopterygii, 7 Orders siluriformes, Anabantiformes,

Cypriniformes, Cichliformes, Osteoglossiformes, Perciformes and Synbranchiformes and 12 families Clariidae, Ailiidae, Schilbeidae, Siluridae, Bagridae, Channidae, Cyprinidae, Cichlidae, Sisoridae, Notopteridae, Mastacembelidae. In this study we explored maximum specimens of family Cyprinidae as 601, 417 and 65 at and minimum specimens of family Ambassidae as 13, 1 and 0 specimens were found at Panjnad, Abbasia and Abu Dhabi canal respectively. All groups belong to Phylum Chordata and Class Actinopterygii (ray-finned fishes). A similar study conducted by Akhtar *et al*. (2014) at river Barandu District Buner, Khyber Pakhtunkhwa, Pakistan, they reported that 10 species belong to 3 orders and 4 families, including: *Tor putitora, Schizothorax plagiostomus, Channa gachua, Schistura punjabensis, Barilius pakistanicus, Garra gotyla, Mastacembelus armatus, Crossocheilus latius, Puntius sophore,* and *Triplophysa naziri*. In another study, in the spring of 2015, 28 samples of fish were collected from the Swat River. These fish species belong to the *Schizothorax* (Heckle) and *Schizothoraicthys* (Misra). Six species of *Schizothoraicthys macropthalmus, Schizothoraicthys labiatus, Schizothorax richardsonii, Schizothoraicthys esocinus, Schizothorax sinuautus* and *Schizothorax plagiostomus* were identified from 12 different locations on the Swat River. *Schizothtorax plagiostomus* was recorded among the most abundant (46.82%) species of Swat River, followed by *Schizothoraicthys esocinus* (17.85 %), *Schizothoraicthys labiatus* (14.28 %), *Schizothorax richardsonii* (10.92 %), *Schizothorax sinuautus* (7.14 %) and *Schizothoraicthys macrophthalmus* (3.57 %). *Schizothtorax plagiostomus* was the only species that was distributed throughout the Swat River (Khan *et al*., 2020). All studies have shown differences between the number of actual fish caught and the number of species of fish at different locations (Hassan *et al*., 2013; Saeed *et al*., 2013). The number of indigenous fish species has decreased due to various factors such as water pollution, irreversible effects of heavy metals, construction of dams, loss of habitat, drainage of wetlands, eutrophication (Majagi *et al*., 2008; Khan *et al*., 2012). Therefore, effective measures have been proposed to stabilize large carp and other fish species on the river Indus (Sheikh *et al*., 2017). It is predicted that the population of the species has deteriorated by more than 50% in the past and no unnecessary conditions remain, the population may be affected by up to 80% in the future (IUCN, 2011). In the last three decades, the distribution of some species has shrunk dramatically. Environmental degradation and habitat loss has a strong effect on various species such as, *Rita rita, Megarasbora elanga, Monopterus cuchia, Nandus nandus, Danio rerio, Macrognathus aral* and *Badis badis* (Rafique and Khan, 2012).

In present research, fish species showed a high frequency of occurrence (≥50%). One-way ANOVA demonstrated a significant difference (P<0.000, df=26, F=2.451) between abundance of different fish species. Other fish species such as *Clarias batrachus, Parambassis ranga* and *Aristichthys nobilis* occurred infrequently with very low abundance (≤ 20%). On the other hand, relative abundance of different fish species among families also highlights a significant result as P<0.001, df =11, F=2.86 between groups. Two-way ANOVA between relative abundance of different fish species according to different locations and seasons demonstrated that results are highly significant (P<0.000, df=6, F=13.375). Similarly, research on Indus River with Pakistan's freshwater fish (Mirza, 1975, 1994; Khan *et al*., 2012; Urooj *et al*., 2011; Muhammad *et al*., 2017). Fish samples (22) which belonging to sixteen genera and ten families were recorded from the Lentic aquifer of the Indus River at Ghazi Ghat, Dera Ghazi Khan. There are 10 species of cyprinids, 5 catfish, 3 percids and 4 belonged to other groups. Most abundant fish is *Labeo rohita* followed by *Catla catla, Cirrhinus mrigala, Labeo gonius, Oreochromis mossambicus, Wallagu attu and Aorichthys aor* throughout the study. These species also showed high frequency of occurrence (≥50%). One way ANOVA showed a significant difference between the abundance of fish species (P <0.001, df = 21, F = 3.90). Other species such as, *Cirrhinus reba, Clupisoma garua, Labeo bata, Rita rita, Colisa fasciata and Gadusia chapra* are rarely occurring with very low frequency (≤ 20%) (Hussain *et al*., 2016). Habitat loss and degradation, water scarcity, wetland drainage, dam construction, pollution and eutrophication have led to declining population of some species. These factors have led to significant reductions and/ or changes in domestic fish species (Khan *et al*., 2012). Olán-González *et al*. (2020) compared fish diversity (taxonomic and functional) between four local bodies with analyzes of mutations (ANOVA). A general distribution (only to convert density to log) was applied to the data, but different characteristics of the difference between regions were found. They found a positive and significant, weak, relationship between genetic and species diversity for marine and freshwater fish (modified T-test for locally dependent variants = 0.21; p = 0.010 for marine species); modified t-test 0.36, p 0.015 freshwater types). Specifically, the average value of genetic diversity per cell is twice as high in freshwater (0.011% interquartile range: 0.0041-0.0200) as compared to marine fish (0.0052; interquartile range: 0.0023-0.012). Species diversity per cell is greater for freshwater (median= 300 species; interquartile range= 109–741 species) marine fish (median = 268 species; interquartile range = 97–797 species, subspecies), although no significant difference is

accounting for latitude (Manel *et al*., 2020).

At Panjnad canal, the cyprinids (*Catla catla, Cirrhinus mrigala, Cyprinus carpio, Labeo rohita, Labeo calbasu, Labeo gonius, Labeo boga, Ctenopharyngodon idella, Hypophthalmichthys molitrix, Carassius auratus, Crossocheilus diplocheilus, Aristichthys nobilis*) constituted 48.87% of total relative abundance, while cichlidae (*Oreochromis niloticus* and *Oreochromis mossambicus)* formed 11.39% and others (*Channa punctata, , Bagarius bagarius, Notopterus notopterus, Chitala chitala, Parambassis ranga, Mastacembelus armatus, Clarias batrachus, Clupisoma garua, Eutropiichthys vacha, Wallago attu, Rita rita, Sperata sarwari* and *Channa marulius*) contributed as 39.74% (Fig. 2). The maximum occurrence percent was calculated as 91.6% regarding *Clupisoma garua, Catla catla* and *Hypophthalmichthys molitrix* and minimum recorded as 25% of *Mastacembelus armatus* (Table I). Similar results were obtained by Ortega *et al*. (2007) in which they studied many fish species at Peru. Nevertheless, a comprehensive study is required to diagnose complete fish fauna in Pakistan and to study the role of invasive fish if one is close to the declining diversity of fish. A comprehensive strategy is needed to protect the endangered species of fish. Basically, hilly and sub-mountainous areas are important components of Pakistan's native fish. Due to dam construction, site, blocking rivers and streams which can lead to the disappearance of this important component (Regnier *et al*., 2009). Total 480 specimens of fish belong to 4 families and 10 species were collected from Malakand District, Khyber Pakhtunkhwa, Pakistan. About 11 (78.57%) of individuals to eleven species belonged to family Cyprinidae followed by 1 (7.1%) of individual of Channa punctata belonged to Channidae 1 (7.1%) of individual *Mastacembalus armatus* belonged to Mastacembelidae and 1 (7.1%) of individual *Acanthobitis biota* belonged to Nemachelidae. It clearly shows that the family Cyprinidae is the most dominant family in Malakand KP District, Pakistan. Small and large fish are found in the streams of Malakand district. *Barilius pakistanicus, Danio devario, Puntius chola, Barilius vagra, Acanthocobitis botia, Ompak pabda, Puntius conchonius, Crossocheilus diplocheilus* are small fish of Malakand District. These small fish have no marketing values because of their size, but because of their biodiversity, they play a significant role in the aquatic ecosystem (Ali *et al*., 2020).

At Abbasia canal, the cyprinids (*Catla catla, Cirrhinus mrigala, Cyprinus carpio, Labeo rohita, Labeo calbasu, Labeo gonius, Labeo boga, Ctenopharyngodon idella, Hypophthalmichthys molitrix, Carassius auratus, Crossocheilus diplocheilus, and Aristichthys nobilis*) constituted 68.09% of total relative abundance, Cichlidae (*Oreochromis niloticus* and *Oreochromis mossambicus)* formed 14.72% and others (*Channa punctata, Bagarius bagarius, Notopterus notopterus, Chitala chitala, Parambassis ranga, Mastacembelus armatus, Clarias batrachus, Clupisoma garua, Eutropiichthys vacha, Wallago attu, Rita rita, Sperata sarwari* and *Channa marulius*) contributed as 17.19% (Fig. 2). The maximum occurrence percent was calculated as 83.3% regarding *Cirrhinus mrigala* and minimum recorded as 8.3% of *Clarias batrachus, Wallago attu, Channa marulius, Carassius auratus, Crossocheilus diplocheilus, Bagarius bagarius, Chitala chitala* and *Parambassis ranga. Aristichthys nobilis* show zero percent of occurrence (Table II). The Kabul River was divided into two zones (upstream and downstream) with six sampling sites (3 sites per zone). Total 1,190 fish were collected in which Cypriniformes was the dominant order with one family, six genera, and eight species. Cyprinidae was the dominant family (n = 969) in this order, with 81.4% of the total fish population. In almost all study, the abundance of species was recorded heigh at upstream level. Upstream sites recorded 11 species, while seven species were recorded from downstream sites. The abundance of fish species was significantly more at higher upstream than in the downstream (9.67 ± 1.53 vs. 6.33 + .58; U = .00, z = -1.99, .04, r = .81). The diversity of species was significantly higher than the upward flow (H'= 1.90 ± 0.15, D1= 0.81±0.02). Low diversity, abundance, and access to downstream potential are due to human activities affecting the city of Kabul and its environs (Kelzang *et al*., 2021).

At Abu Dhabi canal, the cyprinids constituted 18.36% of total relative abundance, Bagridae formed 21.8% and others 59.84% (Fig. 2). The maximum occurrence percent was calculated as 91.6% regarding to *Eutropiichthys vacha* and minimum recorded as 8.3% of *Channa marulius, Cirrhinus mrigala, Labeo calbasu, Labeo gonius, Labeo boga, Ctenopharyngodon idella, Hypophthalmichthys molitrix, Crossocheilus diplocheilus, Aristichthys nobilis, Oreochromis niloticus* and *Oreochromis mossambicus. Clarias batrachus, Bagarius bagarius* and *Parambassis ranga* show zero percent of occurrence (Table III). Total 9355 fish were identified into 107 species, 69 genera and 18 families at middle and lower reaches of the Ganjiang River. Cypriniformes were the most abundant fish species oder (67.3%) followed by Siluriformes (15.0%), Beloniformes and Synbranchiformes (0.9%) which were the lowest of total population of fish. *Squalidus argentatus*, *Cyprinus carpio*, *Carassius auratus* and *Silurus asotus* were the dominant fish species. There were 43 Chinese endemic species which contributed 40.20 % of total fish population. The species of fish which is least concern contributing 79.4% of the total population according to the Chinese Red List (Jiang *et al*., 2016). Critically endangered species

of fish were *Myxocyprinus asiaticu* and *Ochetobius elongatus*. *Siniperca roulet* and *Pseudobagrus pratti* were vulnerable species, but *Siniperca obscura* was near threatened fish species. Sampling completeness was relatively high, with Chao I estimate more than 95% of each sample section. The last slopes of the observed and estimated species accumulation for fish in each section were closed for non-symbolic (Guo *et al*., 2018).

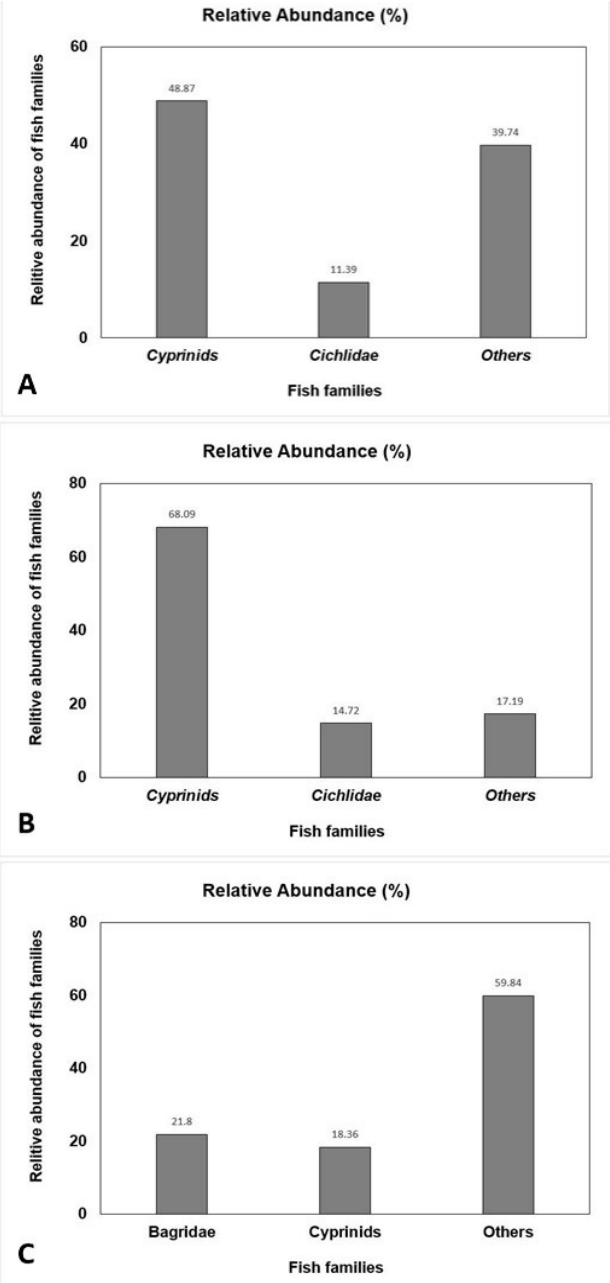

Fig. 2. Relative abundance (%) of various fish species groups at Panjnad Canal (A), Abbasia Canal (B) and Abu Dhabi Canal (C).

Table II. Shannon-Wiener index and relative abundance.

Sampling sites	Total no. of species found	R.A (%)	H	D
Panjnad canal	1228	57.81	3.19433	0.957335
Abbasia canal	543	25.56	1.54355	0.923277
Abu zehbi canal	353	16.61	1.067311	0.893188

The Shannon-Wiener index (H) of three different sites showed variations ranged from 3.19-1.06. The highest fish diversity was recorded at Panjnad canal followed by Abbasia canal and Abu Dhabi canal. Relative abundance (RA%) of Panjnad canal, Abbasia and Abu Dhabi canal was 57.81%, 25.56% and 16.61% respectively. Simpson's diversity index (D) of three different sites also showed variation ranged from 0.95- 0.89. Total number of species that were found at Panjnad, Abbasia and Abu Dhabi canal are 1228,543 and 353 respectively (Table II). Same research was done by Hussin *et al*. (2016). They calculated that Simpson Diversity Index Value as 0.13, Shannon Weiner Index Value as 2.34, Margalif Index Value as 2.44 and Evenness Index Value as 0.76 throughout the study period. Simpson's diversity index minimum value (0.11) was observed in April 2008 and maximum (0.18) in March 2008; The Shannon Weiner Index minimum value (1.88) was observed in March 2008 and maximum (2.38) in April 2008. The Margaleff Index minimum value (1.07) was found in September 2008 and maximum (2.44) in April 2008. While evenness index minimum value (0.82) was found in December 2007 and maximum (0.94) in May 2008. The Shannon-Weaver diversity (H), Margalef's richness (D) index and Pielou's evenness (e) of the Dharla River during the study period ranged from 3.00 (July) to 3.71 (January), 3.94 (July) to 7.95 (January), and 0.62 (September) to 0.94 (June). The higher value of Shannon-Weaver diversity and Margalef's richness indices were found between October and February, whereas Pielou's evenness was higher between May and August (Alam *et al*., 2021). The Shannon Weaver Diversity Index (H) showed a low value in the months of April to August because the water level was high, which making it very difficult to catch fish (Galib *et al*., 2013). The low values of the Shannon Weaver Diversity Index during the monsoon months also due to environmental stress (Acharjee and Barat, 2014). Shannon Weaver's diversity values (H) (3.49-3.66) and Margalef's richness (D) values (6.00-7.72) were higher in the winter months, but evenness rates were lower (0.89-0.75), indicating the fish species are not evenly distributed in the water column. This is because the

absence of deep-water levels hindered the separation of the niche (Samal *et al*., 2014).

CONCLUSIONS AND RECOMMENDATION

The present study is conducted at Panjnad Headworks, Punjab, Bahawalpur, Pakistan to observe the diversity of existing fish. Samples of all the fish were collected from February 2020 to January 2021 by adding different fish from three different locations (Panjnad, Abbasia, Abu Dhabi Canal). Specific fish groups found include cyprinids, catfish and others, including *Bagarius bagarius, Channa punctata, Oreochromis mossambicus, Oreochromis niloticus*. Oil spills are also a major factor affecting aquatic life. It is suggested that fisheries authorities investigate and practice proper exploitation and management of inland fishing resources in accordance with environmental principles. They should recommend and determine storage standards and reasonable introduction according to the productivity of the fish and the role of this aquifer. Work is to be done on scientific fishing standards and fishing quotas. It will play an important role in protecting the environment and water resources and its biodiversity. Therefore, every individual needs to play an active role in achieving the goals of sustainable development of fisheries and handing over resources to future generations in healthy conditions. Identify the industrial units that pollute river water the most in Buner district. Drainage system should be improved. Introduce regular government oversight to improve environmental conditions. The EPA should inspect and strictly monitor these marble factories. The Fisheries Department of Bahawalpur District should also play an active role in conserving the fishes of Panjnad Headworks. The government should set up fish hatcheries in Buner district to improve fish conservation and production. Awareness should be created among the people about the extinction of aquatic animals in Panjnad Headworks. Tree planting can be started to reduce water pollution.

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Statement of conflict of interest

The authors have declared no conflict of interest.

REFERENCES

Acharjee, M.L., and Barat, S., 2014. Seasonal dynamics of ichthyodiversity in a hill stream of the Darjeeling Himalaya, West Bengal, India. *J. Threat. Taxa*, **6**: 6635-6648. https://doi.org/10.11609/JoTT.o3404.6635-48

Alam, M.D., Ashraful, A.Y., Parvez, I., Roy, J.K., and Khan, M.A., 2021. Fish diversity and its threatened status of the Dharla river in Bangladesh. *Croatian J. Fish.,* **79**: 163-172. https://doi.org/10.2478/cjf-2021-0018

Ali, U., Zaman, Q., Farooq, M., Ali, J., and Ullah, R., 2020. 14. Identification and distribution of fishes in fresh water of District Malakand, Khyber Pakhtunkhwa Pakistan. *Pure appl. Biol. (PAB)*, ***9***: 2297-2304. https://doi.org/10.19045/bspab.2020.90244

Altaf, M., Javid, A., and Umair, M., 2014. *Biodiversity of Ramsar sites in Pakistan wildlife and ecology*. LAP.

Akhtar, N., Saeed, K., Khan, N. and Rafiq, N., 2015. Fish fauna of River Barandu with new record (*Cyprinus carpio*) from District Buner, Khyber Pakhtunkhwa Pakistan. *World J. Fish Mar. Sci.,* **7**: 418-420. https://doi.org/10.5829/idosi.wjfms.2015.7.6.94275

Galib, S.M., Naser, S.A., Mohsin, A.B.M., Chaki, N., and Fahad, M.F.H., 2013. Fish diversity of the River Choto Jamuna, Bangladesh: present status and conservation needs. *Int. J. Biodivers. Conserv.,* 5: 389-395.

Guo, Q., Liu, X., Ao, X., Qin, J., Wu, X. and Ouyang, S., 2018. Fish diversity in the middle and lower reaches of the Ganjiang River of China: Threats and conservation. *PLoS One*, ***13***: e0205116. https://doi.org/10.1371/journal.pone.0205116

Hamzah, N., 2007. *Assessment on water quality and biodiversity within Sungai Batu Pahat.* Doctoral dissertation, University Technology Malaysia.

Hasan, Z., Ahmad, I., Yousuf, M., and Khan, J., 2013. Fish biodiversity of river Swat. *Pakistan J. Zool*., **45**: 283-289.

Helfman, G.S., Collette, B.B., Facey, D.E. and Bowen, B.W., 2009. *The diversity of fishes, biology, evolution, and ecology*. A John Wiley and Sons, Ltd. Publication.

Hussain, M.Z., Latif, A., Shahzadah, W.A., Hussain, S., Iqbal, R., and Ali, M., 2016. Diversity, abundance and seasonal variations of fish community in lentic water bodies of Indus River at Ghazi Ghat, Pakistan. *Pakistan J. Zool.*, **48**: 59-65.

IUCN, 1989. *Pakistan fact sheet water*. Journalist Resource Centre for the Environment, IUCN Pakistan.

IUCN, 2011. *IUCN red list of threatened species.*

Jiang, Z., Jiang, J., Wang, Y., Zhang, E., Zhang, Y., Li, L., Xie, F., Cai, B., Cao, L., Zheng, G. and Dong, L., 2016. Red list of China's vertebrates. *Biodivers. Sci.*, **24**: 500. https://doi.org/10.17520/biods.2016076

Kelzang, U., Habibi, A.F., and Thoni, R.J., 2021. Evaluation of fish diversity and abundance in the Kabul River with comparisons between reaches above and below Kabul City, Afghanistan. *J. Threat. Taxa*, **13**: 19743-19752. https://doi.org/10.11609/jott.7532.13.12.19743-19752

Khan, A.M., Ali, Z., Shelly, S.Y., Ahmad, Z., and Mirza, M.R., 2011. Aliens a catastrophe for native fresh water fish diversity in Pakistan. *J. Anim. Pl. Sci.,* **21**: 435-440.

Khan, M.A. and Hasan, Z., 2011. A preliminary survey of fish fauna of Changhoz dam, Karak, KPK, Pakistan. *World J. Fish. mar. Sci.,* **3**: 376-378.

Khan, M.A., Khan, S. and Miyan, K., 2012. Length–weight relationship of giant snakehead, *Channa marulius* and stinging catfish, *Heteropneustes fossilis* from the River Ganga, India. *J. appl. Ichthyol.*, **28**: 154–155. https://doi.org/10.1111/j.1439-0426.2011.01901.x

Khan, M.R., Rakha, B.A., and Ansari, M.S., 2020. Diversity and distribution of genera *Schizothorax* and *Schizothorichthyes* in River Swat, Pakistan. *Pakistan J. Zool.*, **52**: 2419. https://doi.org/10.17582/journal.pjz/20180904060941

Limburg, K.E., Hughes, R.M., Jackson, D.C. and Brain, C.Z., 2011. Human population increase economic growth, and fish conservation collision course or savvy stewardship. *Fisheries*, **36**: 27-34. https://doi.org/10.1577/03632415.2011.10389053

Majagi, S., Vijaykumar, K., Rajshekhar, M. and Vasanthkumar, B., 2008. Chemistry of groundwater in Gulbarga district, Karnataka, India. *Environ. Monit. Assess.*, **136**: 347-354. https://doi.org/10.1007/s10661-007-9690-6

Manel, S., Guerin, P.E., Mouillot, D., Blanchet, S., Velez, L., Albouy, C. and Pellissier, L., 2020. Global determinants of freshwater and marine fish genetic diversity. *Nat. Commun.*, **11**: 1-9. https://doi.org/10.1038/s41467-020-14409-7

Mirza, M.R., 1975. Freshwater fishes and zoogeography of Pakistan. *Bijdr. Dierkd.*, **45**: 143-180. https://doi.org/10.1163/26660644-04502001

Mirza, M.R., 1980. *The systematic and zoogeography of the freshwater fishes of Pakistan and Azad Kashmir*. Proceedings of 1st Pakistan Congress Zool, Part A.

Mirza, M.R., 1990. *Freshwater fishes of Pakistan*. Published by Urdu Science Board Lahore. pp. 125.

Mirza, M.R., 1994. Geographical distribution of freshwater fishes in Pakistan: A review. *Punjab Univ. J. Zool.*, **9**: 93-108.

Mirza, M.R., 2004. *Fresh water fishes of Pakistan*. Published by Urdu Science Board, **1**: 256.

Mirza, M.R., and Sadiq, M., 1978. *Barilius vagra pakistanicus* (Pisces, Cyprinidae), a new fish from Pakistan. *Biologia* (*Lahore*), **24**: 1-5.

Muhammad, H., Iqbal, Z., and Saleemi, S., 2017. Diversity and distribution of fish fauna of Indus river at Taunsa barrage in Punjab, Pakistan. *Pakistan J. Zool.*, **49**. 149-154. https://doi.org/10.17582/journal.pjz/2017.49.1.149.154

Olán-González, M., Reyes-Bonilla, H., Álvarez-Filip, L., Pérez-España, H., and Olivier, D., 2020. Fish diversity divergence between tropical eastern pacific and tropical western Atlantic coral reefs. *Environ. Biol. Fishes*, **103**: 1323-1341. https://doi.org/10.1007/s10641-020-01026-y

Ortega, H.H, Guerra and Ramirez, R., 2007. The introduction of nonnative fishes into freshwater system of Peru.. *Ecol. Genet. Implicat. Aquac. Activit.,* pp. 247–278. https://doi.org/10.1007/978-1-4020-6148-6_14

Peter, T., 1999. Coldwater fish and fisheries in Pakistan. *FAO Rome Fish. Tech. Pap.,* **385**: 122-137.

Rafique, M. and Khan, N.U., 2012. Distribution and status of significant freshwater fishes of Pakistan. *Rec. Zool. Surv. Pakistan*, **21**: 90-95.

Rafique, M., 2007. *Biosystematics and distribution of the freshwater fishes of Pakistan with special references to the subfamilies Noemacheilinae and Schizothoracinae*. Doctoral dissertation, Ph. D. dissertation, UAAR. pp. 220.

Rafique, M., Akhtar, S. and Niazi, H.K., 2003. Fish fauna of Jinnah Barrage and adjoining areas. *Pakistan J. Zool*., **35**: 95-98.

Regnier, C., Fontaine, B. and Bouchet, P., 2009. Not knowing, not recording, not listing: Numerous unnoticed mollusk extinctions. *Conserv. Biol*., **23**: 1214–1221. https://doi.org/10.1111/j.1523-1739.2009.01245.x

Saeed, K., Khan, S. and Haq, F., 2013. Diversity and population status of fish fauna of river Barandu district Buner Khyber Pakhtunkhwa Province Pakistan. *J. Biodiver. Environ. Sci*., **3**: 83-88.

Samal, N.R., Roy, P.K., Majumadar, M., Bhattacharya, S. and Biswasroy, M., 2014. Six years major historical urban floods in west Bengal state in India: Comparative analysis using neuro-genetic model. *Am. J. Water Resour.,* **2**: 41-53. https://doi.

org/10.12691/ajwr-2-2-3

Sheikh, M., Laghari, M.Y., Lashari, P.K., Khooharo, A.R. and Narejo, N.T., 2017. Current Status of Three Major Carps (*Labeo rohita*, *Cirrhinus mrigala* and *Catla catla*) In the Downstream Indus River, Sindh. *Fish Aquac. J.,* **8**: 222. https://doi.org/10.4172/2150-3508.1000222

Shinde, S.E., Pathan, T.S., Bhandare, R.Y. and Sonawane, D.L., 2009. Ichthyofaunal diversity of Harsul Savangi dam, district Aurangabad, (M.S) India. *World J. Fish. Mar. Sci.,* **1**: 141-143.

Urooj, N., Sahato, G.A., Lashari, K.H., Korai, A.L., Palh, Z.A. and Naqvi, H.S., 2011. Ichthyodiversity of River Indus, at Jamshoro District, Sindh. *Sind. Univ. Res. J., Sci. Ser*., **43**: 13-18.

Ward, R.D., 2009. DNA barcode divergence among species and genera of birds and fishes. *Mol. Ecol. Res*., **9**: 1077–1085. https://doi.org/10.1111/j.1755-0998.2009.02541.x