



Diversity, Abundance and Seasonal Variations of Fish Community in Lentic Water Bodies of Indus River at Ghazi Ghat, Pakistan

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ABSTRACT

The Indus drainage system has a key role in sustaining agriculture and aquatic biodiversity of Pakistan. Fish exhibit enormous biodiversity, inhabiting a variety of habitats and are important indicators of water quality. In present study, fish sampling was conducted from November 2007 to October 2008, using cast and drag nets. The fishes were identified following standard key. The data was statistically analyzed by one way ANOVA. A total of 22 fish species belonging to 10 families were recorded. The maximum fish species belonged to Cyprinidae (10) and minimum to Clupeidae (1). The cyprinids show higher relative abundance (72.27 % of total catch) compared to other fish families during the whole study period. *Labeo rohita*, *Cirrhinus mrigala*, *Catla catla* were the most abundant species with high frequency of occurrence. The relative abundance (%) of cyprinids was more in winter months compared to summer months. Highest species richness (as taxa numbers) was observed in December and lowest in September. There was no significant effect of season on fish abundance ($P < 0.05$). Diversity indices values indicate low fish biodiversity at this site.

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Authors' Contributions

MA designed the study. SWA, MZH and SH performed the experiments. AL and RI performed statistical analysis. MZH, AL and SWA wrote the article.

Key words

Fish community, seasonal variations, Indus River, cyprinids, diversity indices.

INTRODUCTION

Biological diversity is the variety of living forms, the ecological role they perform and genetic diversity they contain (Wilson, 1988). Fish exhibit enormous diversity in their morphology, in the habitats they occupy and in their biology (Froese and Pauly, 1988). The extra ordinary diversity and the significant influence on the distribution and abundance of other aquatic organisms render fish as the key monitors of ecosystem quality (Moyle and Leidy, 1992). Thus, the health of fish populations generally predicts the healthy aquatic ecosystems (Beverton, 1992).

Biodiversity has attracted worldwide attention with respect to its implications for conservation and land management strategy. The increasing decline in biodiversity has alarmed the world conservation community (Wilson, 1988; Nielson, 1995). Approximately 20% of the world's freshwater fish is currently either endangered or extinct (Postel, 2002). Identification and characterization of existing species has been described as an important part of the process of conservation and given considerable attention in the

scientific literature (Wilson, 1988; Nielson, 1995). The fish species composition and relative abundance may change due to seasonal variations (Pires *et al.*, 1999; Horpilla *et al.*, 2000).

The River Indus and its drainage basin form a dominant physiographic feature over large part of the Pakistan (Roberts, 1977). The variety of aquatic habitats is inhabited by diverse forms of aquatic life, the fish being a significant constituent (Mirza and Bhatti, 1999). The present study was carried out to determine the composition and seasonal changes in the biodiversity and relative abundance of fish community of lentic water bodies of Indus River at Ghazi Ghat, Dera Ghazi Khan, Pakistan.

MATERIALS AND METHODS

Sampling area

The fish sampling was conducted from lentic water bodies (locally called dhands) near Indus River at Ghazi Ghat (30°3'48" N and 70°48'51" E), Dera Ghazi Khan, Pakistan. The sampling area is an important wetland for natural fisheries and is being exploited commercially for the purpose. These lentic water bodies are located approximately 2-5 Km away from main Indus River. Some of these water bodies are inundated by river water during monsoon season. The depth and extent of these water bodies is variable depending upon the

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monsoon rainfall.

Sampling

The fishes were collected on monthly basis from November 2007 to October 2008 (excluding July and August as fishing is prohibited in these months), using cast and drag nets (mesh size 2 cm²) with the assistance of local fishermen. For the purpose of analysis of seasonal effects, November, December, January and February were considered as winter months; March and April as spring months; May and June as summer months; while September and October constituted post monsoon months. Five catches were taken each month. Each catch was handled separately and sorted by species and counted. The fishes for purpose of identification were preserved in ice box and then brought to Fish Laboratory, Zoology Department, Bahauddin Zakariya University, Multan. The fishes were identified with the help of standard taxonomic key (Mirza and Sharif, 1996). The relative abundance (%) was calculated by using the formula as given;

$$R.A (\%) = n_i/N,$$

Where, n_i = number of individuals of a fish species/fish group/in one season, N = number of individuals of all fish species (for relative abundance during whole study period presented in Table I, Fig. 1 and Fig. 3),

n_i = number of individuals of fish species in one month, N = number of individuals of fish species in all months (for monthly variations in relative abundance presented in Table II),

n_i = number of individuals of a single fish species in one month, N = number of individuals of that fish species in all months (for monthly variations in relative abundance presented in Figure 2, Figure 3 and Figure 4).

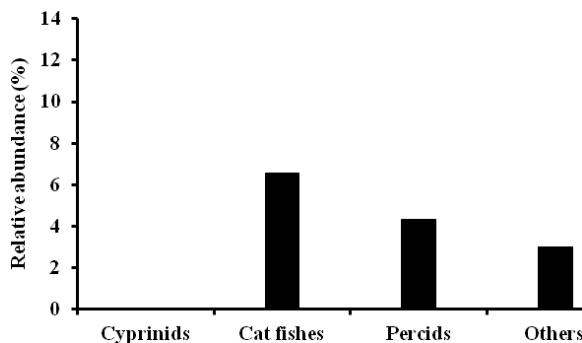


Fig. 1. Relative abundance (%) of various fish groups during whole study period.

Further, frequency of occurrence (%) and diversity indices *i.e.*, Simpson diversity index (D),

Shannon-Weiner index (H), Margalef index (d) and Evenness index (E) were also calculated.

Statistical evaluations

One way analysis of variance (ANOVA) was conducted to assess the statistical significance of difference between abundance of various fish species as well as effect of monthly and seasonal variations on species richness and abundance, using statistical package SPSS.

RESULTS

From fish collection, twenty two (22) fish species belonging to sixteen genera, and ten families were recorded from the lentic water bodies of Indus River at Ghazi Ghat, Dera Ghazi Khan (Table I). There are 10 species of cyprinids, 5 of cat fishes, 3 of percids and 4 belonged to other groups. *Labeo rohita* was the most abundant species followed by *Cirrhinus mrigala*, *Catla catla*, *Labeo gonius*, *Oreochromis mossambicus*, *Wallagu attu* and *Aorichthys aor* during whole study period (Table I). These species also showed a high frequency of occurrence ($\geq 50\%$). One way ANOVA demonstrated a significant difference ($P < 0.001$, $df = 21$, $F = 3.90$) between abundance of fish species. Other species such as *Gadusia chapra*, *Clupisoma garua*, *Colisa fasciata*, *Labeo bata*, *Rita rita* and *Cirrhinus reba* occurred infrequently with very low abundance ($\leq 20\%$).

The cyprinids constituted 72.27 % of the total relative abundance; cat fishes formed 13.13 %; percids 8.64 % and others 5.96 % (Fig. 1). There was a non-significant effect for abundance of fish species between families (one way ANOVA, $P > 0.05$, $df = 9$, $F = 1.02$). The seasonal pattern of relative abundance showed a considerable variation during study period (Table II). Monthly variations in fish abundance (number of individuals) were significant (one way ANOVA, $P < 0.001$, $df = 9$, $F = 4.89$). The maximum value (23.45%) was observed in January 2008 and minimum value (1.23 %) in May 2008. The monthly distribution of all dominant species showed variation with season. The maximum abundance of *Labeo rohita* was found in December 2007 and minimum in February 2008. *Cirrhinus mrigala* showed maximum relative abundance in November 2007 and minimum in February 2008 (Fig. 2A). Among cat fishes, *Aorichthys aor* showed peak in April 2008 and *Wallagu attu* in October 2008 (Fig. 2B). Among percids, *Oreochromis mossambicus* showed peak value in March 2008 (Fig. 2C). Overall relative abundance of species was higher in winter months compared to summer months

Table I.- Number of individuals, relative abundance and frequency of occurrence of each fish species of Indus River at Ghazi Ghat, Dera Ghazi Khan, Pakistan.

S. No.	Scientific name	Local name	n	RA (%)	FO (%)	Comm. value*
	Family Clupeidae					
1	<i>Gadusia chapra</i>	Pali	8	0.14	20	Moderate
	Family Notopteridae					
2	<i>Notopterus notopterus</i>	But Pari	198	3.58	60	Moderate
3	<i>Notopterus chitala</i>	Chitail Pari	66	1.19	60	Moderate
	Family Cyprinidae					
4	<i>Labeo calbasu</i>	Calbans	179	3.24	40	High
5	<i>Labeo gonius</i>	Sereha	521	9.42	60	High
6	<i>Labeo rohita</i>	Rohu	1337	24.18	100	Very High
7	<i>Labeo bata</i>	Bata Bata	11	0.20	20	Low
8	<i>Labeo fimbriatus</i>	Chitra rohu	15	0.27	30	Low
9	<i>Cirrhinus mrigala</i>	Mori	1031	18.73	100	Very High
10	<i>Cirrhinus reba</i>	Sooni	13	0.24	20	Moderate
11	<i>Catla catla</i>	Thaila	532	9.62	70	Very High
12	<i>Barbodes sarana</i>	Khurni	261	4.72	70	Low
13	<i>Cyprinus carpio</i>	Gulfam	95	1.72	30	High
	Family Bagridae					
14	<i>Aorichthys aor</i>	Seenghari	281	5.08	90	High
15	<i>Rita rita</i>	Khaga	12	0.22	20	Very High
	Family Siluridae					
16	<i>Wallago attu</i>	Malli	352	6.37	80	Very High
	Family Schilbediae					
17	<i>Eutropiichthys vacha</i>	Jhalli	77	1.39	40	Very High
18	<i>Clupisoma garua</i>	Bachwa	52	0.94	30	Low
	Family Channidae					
19	<i>Channa punctata</i>	Daula	7	0.12	20	Low
	Family Osphronemidae					
20	<i>Colisa fasciata</i>	Bari Khangi	10	0.18	20	--
	Family Cichlidae					
21	<i>Oreochromis mossambicus</i>	Tilapia	451	8.16	90	High
	Family Mastacembelidae					
22	<i>Mastacembelus armatus</i>	Bam	16	0.29	30	High

n, number of organisms; RA, relative abundance (%); FO, frequency of occurrence; comm. value, commercial value; *Rafique and Khan (2012).

(Fig. 3). However, there was a non-significant effect of seasons (one way ANOVA, $P > 0.05$, $df = 3$, $F = 3.55$) on abundance of fish. Species richness (as taxa number) fluctuated during study period. It was highest (15) for December 2007 and lowest (8) for September 2008 (Table II). There was a non-significant effect of seasons (one way ANOVA, $P > 0.05$, $df = 3$, $F = 0.61$) on species

richness.

Our study results exhibited Simpson diversity index value as 0.13, Shannon-Weiner index value as 2.34, Margalef index value as 2.44 and Evenness index value as 0.76 during whole study period (Table II). The minimum value of Simpson diversity index (0.11) was found in April 2008 and maximum (0.18) in March 2008;

Table II.- Monthly variations in number of individuals, species richness (as taxa number), relative abundance (%) and biodiversity indices of fish community in lentic water bodies of Indus River at Ghazi Ghat, Dera Ghazi Khan, Pakistan.

Months	n	SR	RA (%)	D	H	d	E
November 2007	812	11	12.44	0.15	2.22	2.14	0.82
December 2007	688	15	12.44	0.15	2.22	2.14	0.82
January 2008	1294	12	23.40	0.13	2.15	1.54	0.87
February 2008	435	9	7.87	0.16	1.96	1.32	0.89
March 2008	384	9	6.94	0.18	1.88	1.35	0.86
April 2008	202	14	3.65	0.11	2.38	2.44	0.90
May 2008	68	10	1.23	0.13	2.17	2.13	0.94
June 2008	245	12	4.43	0.12	2.23	2.00	0.90
September 2008	678	8	12.26	0.15	1.98	1.07	0.95
October 2008	724	10	13.09	0.17	1.98	1.37	0.86
Whole study period	5530	22	100	0.13	2.34	2.44	0.76

N, number of organisms; SR, specie richness; RA, relative abundance; D, Simpson index of diversity; d, Margalef index; H, Shannon-Weiner index of diversity; E, Evenness index.

minimum value of Shannon-Weiner index (1.88) was found in March 2008 and maximum (2.38) in April 2008; minimum value of Margalef index (1.07) was found in September 2008 and maximum (2.44) in April 2008; while minimum value of Evenness index (0.82) was found in December 2007 and maximum (0.94) in May 2008 (Table II).

DISCUSSION

Several studies have been conducted to explore the fish fauna of Indus drainage system. These studies have documented variable number of fish species from different lentic and lotic habitats viz., 32 fish species including 11 of cyprinids; 8 of cat fishes and 6 of percomorphs from Manchar lake (Jafri *et al.*, 1999); 36 fish species belonging to 27 genera and 13 families from Chenab River (Mehmood and Salam, 1997) and 33 species from Chenab River (Khan *et al.*, 2008). The fishes namely *Gadusia chapra*, *Notopterus chitala*, *Labeo calbasu*, *Labeo rohita*, *Cirrhinus mrigala*, *Cirrhinus reba*, *Wallagu attu*, *Eutropiichthys vacha*, *Aorichthys aor sarwari*, *Mastacembelus armatus* and *Channa punctata* are the common fish fauna of Indus drainage system and have been recorded from different localities of Punjab, Pakistan (Khan *et al.*, 2008; Mahmood and Salam, 1997; Mirza and Ahmed, 1987; Rafique, 2000; Rafique and Khan, 2012) as well as in present study. This suggests a wide range of distribution of the above mentioned species in Punjab and hence, adaptability to different habitats.

The Indus drainage has quite a fair number of endemism and about 38 species are exclusively reported

from the Indus drainage in Pakistan while 12 are exotic of which two species *i.e.*, *Oreochromis mossambicus* and *Cyprinus carpio* has been recorded from this site. Family Cyprinidae has been described as the most speciose of Indus drainage system having 70 species (Rafique, 2000). Present study also verifies this finding with 10 species belonging to cyprinidae and hence being the most speciose.

It is evident that the fish diversity is poor at this site as indicated by low values of Margalef index (d), (Table II). The values less than 3 indicate poor biodiversity. Fish fauna of the Indus River is poor compared to other major rivers of the Asia viz., Ganges, Brahmaputra, Salween, Mekong, Yangtz and Hawang Ho. The Mekong, Ganges and Yangtz basins are the richest in fish fauna with 400, 350 and 300 species respectively (Wellcome, 1985). Fish diversity in reservoirs, derived from river fishes, is not usually as extensive as in natural lakes that have more stable conditions under which the fish evolve as is the case of the evolution of cichlids flocks in the African great lakes. Riverine species have to live under harsher and more variable conditions. When a reservoir is formed, several of the riverine species do not adopt and either die or move out of the area (Craig, 1992). Nutrient concentration (especially phosphorus); lake area and depth are the factors that determine the fish community structure. In lakes of large size or high trophic state, more fish species occur (Helminen *et al.*, 2000; Jeppensen *et al.*, 2000).

Catla catla, *Labeo rohita* and *Cirrhinus mrigala*, the commercially important Indian major carps of South East Asian region (Talwar and Jhingran, 1991) were

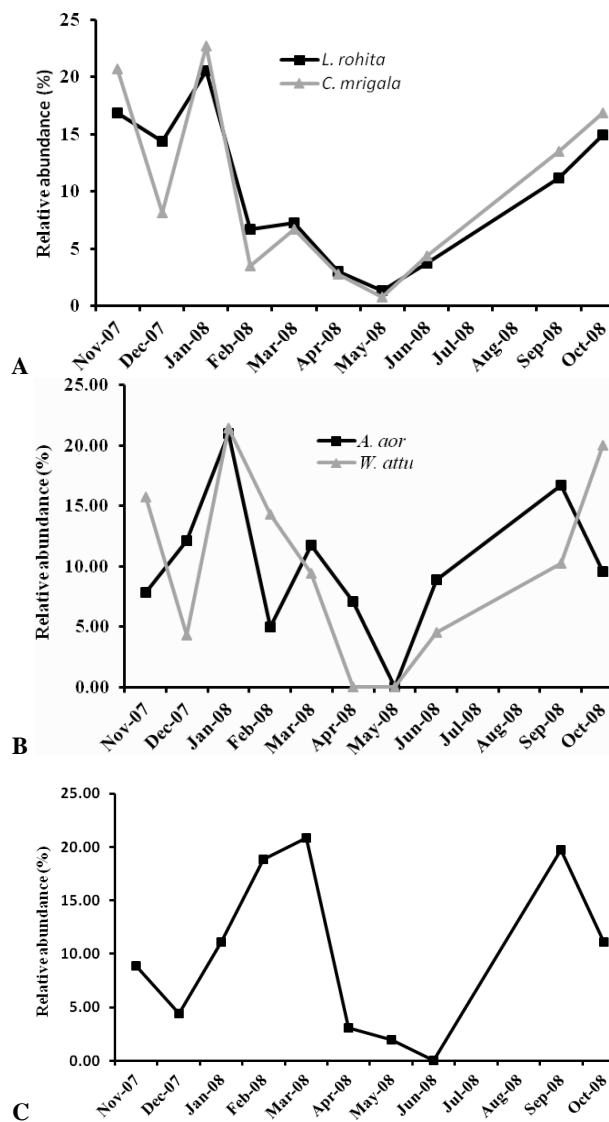


Fig. 2. Monthly variations in relative abundance (%) of dominant cyprinid species (A), cat fish (B) and percid (C) from November 2007-October 2008.

found to be quite frequent and abundant in this study. However, *Cyprinus carpio*, the commercially important Chinese carp was found to have little contribution in overall relative abundance (Table I). *Aorichthys aor*, *Wallago attu* and *Rita rita* are the important cat fishes of this area with considerable fishery value (Talwar and Jhingran, 1991). *Rita rita* has been reported to be common in Indus River (Rafique, 2000). However, in present study, *Rita rita* has been recorded occasionally. Its population may have declined due to intensive fishing. *Oreochromis mossambicus*, a cichlid, capable of

tolerating brackish waters (Rafique, 2000) was found abundantly throughout study period. The rare fish species found in this study like *Gadusia chapra*, *Mastacembelus armatus*, *Clupeosoma garuua*, *Cirrhinus reba*, *Labeo fimbriatus* were recorded from particular ponds, however, pond to pond variation in species diversity is not a part of this study and has not been discussed.

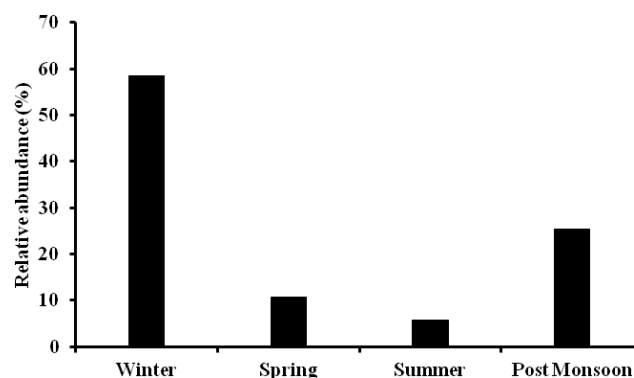


Fig. 3. Seasonal variations in relative abundance (%) of fish population during whole study period.

It is clear from the results that cyprinid is the most abundant and dominant group at this site (Table I, II; Fig. 1). This finding is consistent with several other studies (Horpilla *et al.*, 2000; Reichard *et al.*, 2002). The cyprinid dominance has also been observed from another site (Attock) of Indus River (Iqbal *et al.*, 2013) as well as from Swat River, Pakistan (Akhtar *et al.*, 2014; Ishaq *et al.*, 2014). Similarly cyprinid dominance has been observed in small sized lakes with high total phosphate where species number ranged from three to twelve (Olin *et al.*, 2000) and in eutrophic lakes (Tammi *et al.*, 1999). Similarly, the cyprinid dominance has been strongly linked with productivity and eutrophic status of lakes (Persson *et al.*, 1991; Jeppensen *et al.*, 2000). Cyprinid dominance at study sites suggests eutrophic nature of these water bodies. However, phosphates, nitrates and other nutrient concentration parameters need to be investigated for confirmation.

There were considerable monthly variations in relative abundance (%) of several fishes (Figs. 2, 3, 4). The relative abundance (%) was higher in winter season compared to summer season (Fig. 5). It is interesting that the relative abundance of fish was almost zero during month of May. This could be due to the weather and feed effect. The fish may hide itself under natural shelters in ponds and lakes in the month of May because of low water level and hence chances of fish capture by cast/drag net are poor. The values of diversity indices *i.e.*,

Shannon-Weiner (H) and Simpson diversity index (D) did not reflect seasonal variations. Species richness varied in months but there was no specific seasonal trend. The variations in species richness and diversity in relation to different sampling periods and months have been observed in several studies (Ornellas and Coutinho, 1998; Pires *et al.*, 1999; Reichard *et al.*, 2002).

In summary, the fish diversity is comparatively low at this site, the cyprinid being the most abundant group at this site. The relative abundance (%) fluctuated with months and season. Future research is needed to determine factors influencing cyprinid dominance in these lentic water bodies as well as eutrophic status and its relation with biodiversity.

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