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Studies on the fish biodiversity of River Ravi in Punjab Pakistan

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Abstract

The study was aimed to evaluate the present status of fish faunal biodiversity in River Ravi in view of rapidly increasing water contaminations through various sources. The study area of River Ravi comprised of about 350 km starting from Lahore to Head Sidhnai, District Khanewal. Fish sampling was conducted at four selected sampling sites. Each site was visited twice during the study year. One year fish sampling survey of the River was conducted from July, 2014 to June, 2015. Present paper consists of a total number of 381 fish samples belonging to 38 species, 21 genera and 10 families elucidating the present distribution of various fish species in River Ravi, Punjab Pakistan.

Keywords: fish fauna, biodiversity, river ravi

1. Introduction

Freshwater ecosystems are the world's most endangered ecosystems and decline in freshwater biodiversity is more when compared with even the worst affected land based terrestrial ecosystem [6]. Around 20% of the world's freshwater fish is currently either endangered or extinct [28]. Fish exhibit enormous diversity in morphology, habitats and in their biology. Unlike the other commonly recognized vertebrates, fish are a heterogeneous assemblage [7]. Pakistan is enriched with freshwater fish fauna comprising about 193 fish species [30]. These natural fish populations are under consistent stress of over exploitation, degradation and destruction of natural breeding habitats due to construction of dams, introduction of exotic species, consecutive droughts, frequent hybridization, indiscriminate use of pesticides and release of untreated sewage and industrial effluents in natural river systems [15, 33].

Rapidly increasing anthropogenic activity adds deterioration in the riverine habitats. This habitat degradation when combines with change rivers flow patterns, it not only modifies ichthyofaunal distribution [26], but also alters the species composition and fish community structure of those water bodies [38]. Therefore, fish biodiversity particularly of high valued species, being an invaluable tool has widely been used to categorize habitats variability, diagnose temporal changes in the aquatic environment and helps formulating the conservation and management plans [4, 5, 14, 16]

Previously, in Pakistan, fish fauna of different areas and tributaries of Indus River System has been studied by many ichthyologists [19, 20, 21, 23, 29, 24, 30, 31, 26, 10] but Pakistan has been facing consecutive drought for last many years due to change in weather patterns. Engineering Constructions on River Jhelum, blocking of water of River Chenab by India, after the Indus water basin treaty and throwing of massive amounts of industrial effluents from India and from our local industries particularly in Ravi are permanent major threats to fish biodiversity. In last four decades, several alien fish species like *Cyprinus* sp. *Oreochromis* sp. *Carassius auratus*, *Hypophthalmichthys molitrix*, *Aristichthys nobilis* and *Ctenopharyngodon idella* have been introduced directly or indirectly in our natural river systems [12]. Many of these fish species, like *Cyprinus* sp. and *Oreochromis* sp. have been established as wild species.

The environmental changes and anthropogenic modifications have diminished the natural fish breeding grounds of almost all indigenous fish fauna [32]. Further, consistent inbreeding and frequent natural and artificially induced hybridization among carps and other fish species has created a genetic depression in fish gene pool [34]. Prevalence of this distressing situation might have lead to loss of speciation and fish biodiversity. Though no exact data on percentage decline in annual catch and number of fish species is available; however, on ground there is a

drastic decrease in commercial fish catches. The exact statistical information on fish biodiversity, population dynamics and recruitment patterns, as a regular feature, is of utmost importance to devise fish conservation and management plans of our natural fisheries resources. River Ravi is a small river of Indus water basin system with a total length of 750 km in Punjab province, Pakistan. The River has origin in neighboring country i.e., India and enters Pakistan at Narowal district, After covering about 450 km joins River Chenab near Head Sidhnai at District Khanewal. The River has highly been affected through various kinds of anthropogenic activities like dumping of industrial and civics wastes in last two decades which has severely affected its enriched fauna.

2. Materials and Methods

2.1 Study Area

The fish collection was done from four sampling sites of river Ravi i.e., Ravi Syphon (Lahore, Sheikhpura), River Ravi Shahdara area, Balloki Head works (District-Kasur) and Sidhnai Head works (District-Khanewal). One year fish sampling survey of the River was conducted from July, 2014 to June, 2015. The sampling was done twice from each sampling site to collect maximum number of species.

2.2 Collection and Preservation

The specimens were collected by applying cast nets, drag nets, Kunja nets, scoop nets and through commercial catches of the concerned contractors. The global positioning system (GPS) oriented data for each of the four sampling site was recorded as Table-I. The large sized specimens were injected by 10% formalin; all the sampled fishes were preserved, on the spot in 10% buffered formalin solution in plastic jars and were brought to Fisheries Research & Training Institute Manawan, Lahore for laboratory studies.

3. Results and Discussion

Fish were identified carefully up to species level, using appropriate fish identification keys [37, 25, 13]. After identification, representative of each identified species were shifted in appropriate plastic/glass jar containing 70 % alcohol solution and were brought properly tagged and displayed in museum as record [22].

The systematic account of present fish collection is detailed as under.

Systematic Account

Cohort: euteleostei
Super Order: ostariophysii
Order: Cypriniformes
Family: Cyprinidae

(1) *Aspidoparia morar* (Hamilton)

Fourteen specimens varying from 2.4 to 3.5 cm in total length were collected from all the four sampling site. Site wise detail is A=3, B=3, C=2 & D=6.

(2) *Barilius bendelisis* (Hamilton)

Eight specimens varying from 2.1 to 3.2 cm in total length were collected from all the three sampling site. Site wise detail is A=3, C=4 & D=1.

(3) *Barilius modestus* (Day)

Eight specimens varying from 2.7 to 3.3 cm in total length

were collected from all the three sampling site. Site wise detail is A=2, B=1 & C=5.

(4) *Barilius vagra* (Hamilton)

Seven specimens varying from 3.1 to 4.1 cm in total length were collected from two sampling site. Site wise detail is C=5 & D=2.

(5) *Cirrhinus mrigala* (Hamilton)

Sixty five specimens varying from 6 to 19 cm in total length were collected from all the four sampling site. Site wise detail is A=7, B=20, C=26 & D=12.

(6) *Cirrhinus reba* (Hamilton)

One specimen of 11 cm in total length was collected from sampling site-C.

(7) *Cyprinus carpio* Linnaeus

Twenty three specimens varying from 6 to 18 cm in total length were collected from two sampling site. Site wise detail is C=7 & D=16.

(8) *Carasius auratus* (Linnaeus)

Three specimens varying from 3.5 to 4.6 cm in total length were collected from two sampling site. Site wise detail is C=2 & D=1.

(9) *Gibleon catla* (Hamilton)

Twelve specimens varying from 12 to 19 cm in total length were collected from two sampling site. Site wise detail is C=7 & D=5.

(10) *Labeo rohita* (Hamilton)

Twenty six specimens varying from 6 to 22 cm in total length were collected from two sampling site. Site wise detail is C=19 & D=5.

(11) *Labeo gonius* (Hamilton)

Six specimens varying from 6 to 11 cm in total length were collected from one sampling site-D.

(12) *Labeo calbasu* (Hamilton)

Seventeen specimens varying from 6 to 16 cm in total length were collected from three sampling site. Site wise detail is B=11, C=2 & D=4.

(13) *Labeo dyocheilus pakistanicus* Mirza & Awan

Two specimens of 16 & 18 cm in total length were collected from two site. Site wise detail is A=1 & D=1.

(14) *Puntius punjabensis* (Day)

Four specimens varying from 2.5 to 3.8 cm in total length were collected from three sites. Site wise detail is A=1, B=1 & C=2.

(15) *Puntius sophore* (Hamilton)

Five specimens varying from 3.1 to 3.8 cm in total length were collected from two sampling site. Site wise detail is B=2 & C=3.

(16) *Puntius ticto* (Hamilton)

Six specimens varying from 3.5 to 4.1 cm in total length were collected from three sampling site. Site wise detail is A=3, C=2 & D=1.

(17) *Salmophasia punjabensis* (Day)

Eight specimens varying from 6 to 9.5 cm in total length were collected from two sampling site. Site wise detail is C=2 & D=6.

(18) *Securicula gora* (Hamilton)

Fourteen specimens varying from 20-22 to 11 cm in total length were collected from all the four sampling site. Site wise detail is A=2, B=8, C=1 & D=3.

Order: siluriformes

Family: Schilbeidae

(19) *Clupisoma garua* (Hamilton)

One specimen of 5 cm in total length was collected sampling site-C.

Order: perciformes

Family: Chandidae

(20) *Chanda nama* Hamilton

Eleven specimens varying from 2.5 to 3.7 cm in total length were collected from three sampling site. Site wise detail is A=5, B=4 & C=2.

Family: Belontiidae

(21) *Colissa fasciata* (Schneider)

Seven specimens varying from 4.5 to 5.6 cm in total length were collected from two sampling site. Site wise detail is C=3 & D=4.

(22) *Colissa lalia* (Hamilton)

Eight specimens varying from 2.5 to 3.1 cm in total length were collected from three sampling site. Site wise detail is A=3, B=4 & D=1.

Order: Channiformes

Family: Channidae

(23) *Chana marulius* (Hamilton)

Six specimens varying from 8 to 161 cm in total length were collected from two sampling site. Site wise detail is C=3 & D=3.

(24) *Chana punctatus* (Bloch)

Four specimens varying from 6 to 9 cm in total length were collected from three sampling site. Site wise detail is A=1, B=2 & D=1.

(25) *Chana striatus* (Bloch)

Three specimens varying from 6 to 8 cm in total length were collected from two sampling site. Site wise detail is C=2 & D=1.

(26) *Chana gachua* (Hamilton)

Five specimens varying from 4 to 6.5 cm in total length were collected from two sampling site. Site wise detail is C=3 & D=2.

Order: siluriformes

Family: Schilbeidae

(27) *Eutropichthys vaucha* (Hamilton)

Two specimens of 5.5 & 8.5 cm in total length were collected from sampling site-C only.

Family: Heteropneustidae

(28) *Heteropneustes fossilis* (Bloch)

Five specimens varying from 10 to 13 cm in total length were collected from two sampling sites. Site wise detail is C=3 &

D=2.

Order: synbranchiformes

Family: Mastacembelidae

(29) *Mastacembelus armatus* (Lacepede)

Seven specimens varying from 8 to 26 cm in total length were collected from two sampling site. Site wise detail is C=3 & D=4.

Order: Osteoglossiformes

Family: Notopteridae

(30) *Notopterus notopterus* (Pallas)

Nine specimens varying from 16 to 28 cm in total length were collected from two sampling site. Site wise detail is C=5 & D=4.

(31) *Notopterus chitala* (Hamilton)

Seven specimens varying from 12 to 18 cm in total length were collected from two sampling site. Site wise detail is C=6 & D=1.

Order: Perciformes

Family: Cichlidae

(32) *Oreochromis aureus* (Steindachner)

Fourteen specimens varying from 3.5 to 7.5 cm in total length were collected from three sampling site. Site wise detail is B=2, C=7 & D=5.

(33) *Oreochromis mosambicus* (Peters)

Seventeen specimens varying from 2.7 to 8.5 cm in total length were collected from all the four sampling site. Site wise detail is A=8, B=3, C=4 & D=2.

(34) *Oreochromis niloticus* (Linnaeus)

Twelve specimens varying from 2.5 to 6.5 cm in total length were collected from all the four sampling site. Site wise detail is A=1, B=5, C=2 & D=4.

Family: Chandidae

(35) *Parambassis baculis* (Hamilton)

Nine specimens varying from 2.5 to 3.5 cm in total length were collected from three sampling site. Site wise detail is A=3, B=5 & C=1.

(36) *Parambassis ranga* (Hamilton)

Eight specimens varying from 2.8 to 3.1 cm in total length were collected from all the four sampling site. Site wise detail is A=2, B=1, C=2 & D=3.

Order: Siluriformes

Family: Bagridae

(37) *Sperata sarwari* (Mirza, Nawaz & Javed)

Four specimens varying from 16 to 36 cm in total length were collected from one sampling site-D.

Family: Siluridae

(38) *Wallago attu* (Bloch & Schneider)

Six specimens varying from 25-35 cm in total length were collected from one sampling site-D only.

Earlier three ichthyo-taxonomic studies of River Ravi in Punjab have been conducted by Dr. Nazir Ahmed (1943), Dr. Muhammed Ramzan Mirza (1970) and Zahoor Ahmed & M.R. Mirza (2002). A comparison of these studies has analyzed some characteristics informations (Table-II). Dr.

Nazir Ahmed (1943) reported 49, Mirza (1970) 65 and Zahoor & Mirza (2002) 49 fish species in the said River. During present study 38 fish species have been reported in the study area.

Some earlier reported fish species such as *Ailia punctata*, *Ailia coilia*, *Amblypharyngodon mola*, *Aspidoparia morar*, *botia lohachita*, *Chanda ranga*, *Chanda baculis*, *Crossocheilus diplocheilus*, *Chela cachius*, *Chela laubuca*, *Esomus danricus*, *Gagata cenia*, *Gara gotyla*, *Glossogobius giuris*, *Gudusia chapra*, *Glyptothorax stocki*, *Glyptothorax punjabensis*, *Labeo dero*, *Macrognathus aculeatus*, *Monopterus cuchia*, *Macrognathus pancalus*, *Mystus Sp.*, *Nandus nandus*, *Nemacheilus Sp.*, *Ompok bimaculatus*, *Puntius chola*, *Puntius conchoniis*, *Pseudotropis atherinoides*, *Rita rita*, *Sicamugal cascasia*, *Sisor rhabdophorus*, *Salmophasia bacaila*, *Systomus sarana*, *Tor macrolepis*, *Xenetodon cancila* are missing in the present study. Some of commonly occurring fish species of River Ravi in the past are not only missing in the present collection but have not been reported since many decades. *Tor macrolepis* has been reported by Nazir Ahmed (1943) and Mirza (1970) but this species has not been reported by Zahoor & Mirza 2002. Absence of such characteristic biological indicator species is an alarming sign with respect to conservation of ichthyo-biodiversity in the region.

4. Conclusion

The study was planned to assess the current status of fish biodiversity and to compare it with previously recorded fish

species in river Ravi from District Narowal to its confluence with river Chenab in District Khanewal in Punjab, Pakistan. During last few decades, rapidly increasing human population and consequent upon various kinds of anthropogenic activities, industrial effluents discharge, civic sewerage etc. the water quality of the River Ravi has badly affected. Water flow through the river has already been declined many folds after Indus water Basin treaty with the neighboring country India. In such unfavorable scenario, there are visible threats to the remaining existing ichthyo biodiversity in this part of the country which require immediate urgent focused concerted efforts.

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Table I: GPS Record of Sampling Sites at River Ravi (Four)

GPS-CO-ORD.	A	B	C	D
N/E Degree	31/73	31/72	31/73	30/72
MIN	15/54	43/28	15/54	33/13
SEC	2.3/57.7	4.8/2.9	2.4/58.2	28.7/3.1

Note Site A= Sagian Bridge; **B=Ravi** Siphon; **C=Head** Ballok; **D=Head** Sidhnai

Table II: Comparative Account of Various Taxonomic Studies of Ichthyofauna at River Ravi

S.#	Species	2014-15	2002	1970	1943
	<i>Ailia punctatus</i>		✓	✓	
	<i>Aspidoparia morar</i>	✓	✓		✓
	<i>Ailia coilia</i>			✓	✓
	<i>Amblypharyngodon mola</i>		✓	✓	✓
	<i>Aspidoparia morar</i>		✓	✓	
	<i>Barilius bendelisis</i>	✓		✓	✓
	<i>Barilius modestus</i>	✓	✓		
	<i>Barilius vagra</i>	✓	✓	✓	✓
	<i>Botia lohachita</i>			✓	✓
	<i>Cirrhinus mrigala</i>	✓	✓	✓	✓
	<i>Cirrhinus reba</i>	✓	✓	✓	✓
	<i>Cyprinus carpio</i>	✓			
	<i>Chupisoma garua</i>	✓	✓	✓	✓
	<i>Carasius auratus</i>	✓			
	<i>Chanda nama</i>	✓	✓	✓	✓
	<i>Chanda ranga</i>		✓	✓	✓
	<i>Chanda baculis</i>		✓	✓	✓
	<i>Colissa fasciata</i>	✓	✓	✓	✓
	<i>Colissa lalia</i>	✓	✓	✓	✓
	<i>Chana marulius</i>	✓		✓	✓
	<i>Chana punctatus</i>	✓	✓	✓	✓
	<i>Chana striatus</i>	✓		✓	✓
	<i>Chana gachua</i>	✓			
	<i>Crossocheilus diplocheilus</i>		✓	✓	
	<i>Chela cachius</i>		✓	✓	
	<i>Chela laubuca</i>			✓	
	<i>Chanda nama</i>			✓	
	<i>Esomus danricus</i>		✓	✓	
	<i>Eutropichthys vaucha</i>	✓	✓	✓	✓
	<i>Gibleon catla</i>	✓	✓	✓	✓
	<i>Gagata cenia</i>			✓	✓
	<i>Gara gotyla</i>		✓	✓	
	<i>Glossogobius giuris</i>		✓	✓	✓
	<i>Gudusia chapra</i>		✓	✓	✓
	<i>Glyptothorax stocki</i>			✓	

	<i>Glyptothorax punjabensis</i>				✓	
	<i>Heteropneustes fossilis</i>	✓	✓	✓	✓	✓
	<i>Labeo dyocheilus pakistanicus</i>	✓	✓	✓		
	<i>Labeo rohita</i>	✓	✓	✓	✓	✓
	<i>Labeo gonius</i>	✓	✓	✓	✓	✓
	<i>Labeo calbasu</i>	✓	✓	✓	✓	✓
	<i>Labeo dero</i>		✓	✓	✓	✓
	<i>Macragnathus aculeatus</i>			✓	✓	✓
	<i>Mastacembelus armatus</i>	✓			✓	✓
	<i>Monopterusuchia</i>				✓	✓
	<i>Macragnathus pancalus</i>		✓			
	<i>Mystus bleekeri</i>		✓		✓	
	<i>Mystus cavasius</i>		✓		✓	✓
	<i>Mystus vitatus</i>		✓		✓	✓
	<i>Mystus tengra</i>				✓	
	<i>Notopterus notopterus</i>	✓	✓		✓	✓
	<i>Notopterus chitala</i>	✓			✓	✓
	<i>Nandus nandus</i>				✓	✓
	<i>Nemacheilus sp.</i>				✓	
	<i>Oreochromis aureus</i>	✓	✓			
	<i>Oreochromis mossambiques</i>	✓				
	<i>Oreochromis niloticus</i>	✓				
	<i>Osteobrama cotio</i>		✓		✓	✓
	<i>Ompok bimaculatus</i>		✓		✓	✓
	<i>Puntius punjabensis</i>	✓				
	<i>Puntius sophore</i>	✓	✓		✓	✓
	<i>Puntius ticto</i>	✓	✓		✓	✓
	<i>Puntius chola</i>		✓			
	<i>Puntius conchonius</i>		✓			
	<i>Pseudotropis atherinoides</i>		✓			
	<i>Parambassis baculis</i>	✓				
	<i>Parambassis ranga</i>	✓				
	<i>Rasbora daniconius</i>					✓
	<i>Rita rita</i>		✓		✓	✓
	<i>Sicamugal cascasia</i>		✓		✓	
	<i>Sisor pakistanicus</i> *					✓
	<i>Salmophasia punjabensis</i>	✓	✓		✓	✓
	<i>Salmophasia bacaila</i>		✓		✓	✓
	<i>Securicula gora</i>	✓	✓		✓	✓
	<i>Sperata sarwari</i> **	✓	✓		✓	✓
	<i>Systemus sarana</i>		✓		✓	✓
	<i>Tor macrolepis</i> ***					✓
	<i>Xenotodon cancila</i>		✓		✓	✓
	<i>Wallagu attu</i>	✓			✓	✓

*Earlier named as *Sisor rhabdophorus***Synonym: *Mystus seenghala* & *Mystus aor****Earlier mis-identified as *Tor putitora* (Pervaiz *et al.*, 2012)**Table III:** Detail OF Fish Sampling From Four Sites

S.#	Species	IST Sampling				IIND Sampling				Total No.
		A	B	C	D	A	B	C	D	
1.	<i>L. rohita</i>			11				8	7	26
2.	<i>L. gonius</i>								6	6
3.	<i>L. calbasu</i>			2			11		4	17
4.	<i>L. dyocheilus pakistanicus</i>	4							5	9
5.	<i>C. mrigala</i>	7	20	13	1			13	11	65
6.	<i>C. reba</i>			1						1
7.	<i>C. carpio</i>			3	8			4	8	23
8.	<i>S. sarwari</i>				1				3	4
9.	<i>W. attu</i>								6	6
10.	<i>C. garua</i>							1		1
11.	<i>E. vaucha</i>							2		2
12.	<i>N. notopterus</i>			2	2			3	2	9
13.	<i>N. chitala</i>			2				4	1	7
14.	<i>A. Morar</i>	2	1		4	1	2	2	2	14
15.	<i>B. bendelisis</i>	3		1	1			3		8
16.	<i>S. punjabensis</i>			2	1				5	8
17.	<i>S. gora</i>		4	1	3	2	4			14
18.	<i>C. modestus</i>	2	1	4			1			8

19.	<i>B. vagra</i>			3	1			2	1	7
20.	<i>P. punjabensis</i>	1		2			1			4
21.	<i>P. sophore</i>		1	1		1	2			5
22.	<i>P. ticto</i>	3		2	1					6
23.	<i>C. auratus</i>			1	1			1		3
24.	<i>H. fossilis</i>			2	1			1	1	5
25.	<i>M. armatus</i>			2	2			1	2	7
26.	<i>C. nama</i>	2	3			3	1	2		11
27.	<i>P. basilus</i>	1	3	1		2	2			9
28.	<i>P. ranga</i>	1	1		2	1		2	1	8
29.	<i>A. Aureus</i>		1	2	3		1	5	2	14
30.	<i>O. mossambiques</i>	1	2	2	1	7	1	2	1	17
31.	<i>O. niloticus</i>	1	4	1	3		1	1	1	12
32.	<i>C. fasciatus</i>			2	2			1	2	7
33.	<i>C. lalia</i>	1	2		1	2	2			8
34.	<i>C.marulius</i>			2	2			1	1	6
35.	<i>C.punctatus</i>	1	1				1		1	4
36.	<i>C.striatus</i>			2					1	3
37.	<i>C.gachua</i>			1	1			2	1	5
38.	<i>G.catla</i>			4	3			3	2	12
	G.TOTAL	29	45	75	45	19	32	64	74	381

6. References

- Ahmad N. Second Annual Report of the Directorate of Fisheries, West Pakistan, 1961.
- Ahmad N. Inland fish and fisheries of Pakistan. Agriculture Pakistan. 1962; 13:271-275.
- Ali M, Sajjad H, Akhter MJ, Rehana I, Amjad F. Fish diversity of freshwater bodies of Suleman mountain range, Dera Ghazi Khan Region, Pakistan, Pakistan Journal of Zoology. 2010; 42(3):285.
- Costa PU, Schulz. The fish community as an indicator of biotic integrity of the streams in the Sinos River basin, Brazil. Brazil Journal of Biology. 2010; 70:1195-1205.
- Dale VH, Beyeler SC. Challenge in the development and use of ecological indicators. Ecological Indicators. 2001; 1(1):3-10.
- Dudgeon D, Arthington AH, Gessner MO, Kawabata ZI, Knowler DJ, Leveque C, et al. Freshwater biodiversity: importance, threats, status and conservation challenges. Biological Review. 2006; 81:163-182.
- Froese RD, Pauly. Fish Base: Concepts, Design and Data sources, Manila: International Center for Living Aquatic Resources Management. 1998; 66-94.
- Hora SL. The fish of Chitral. Records of the Indian Museum. 1934; 36:279-320.
- Hora SL. Comparison of fish fauna of the northern and southern faces of the great Himalayan Range. Records of the Indian Museum. 1937; 39:241-250.
- Iqbal Z, Pervaiz K, Javed MN. Population dynamics of *Tor macrolepis* (Teleostei: cyprinidae) and other fishes of Attock region, Pakistan. Canadian Journal of Pure & Applied Sciences. 2013; 7:2195-2201.
- Javed MN, Pervaiz K, Mirza MR, Bhatti, M.N., Fishes of the River Indus from Ghazi to Garyala, Pakistan. Biologia. 2005; 51(1):1-13.
- Khan AM, Shakir HA, Khan MN, Abid M, Mirza MR. Ichthyofaunal survey of some freshwater reservoirs in Punjab Journal of Animal & Plant Sciences. 2008; 18(4):151-54.
- Jayaram KC. The Freshwater Fishes of Indian Region, 2nd Edition. Narendra Publishing House Delhi, India, 2010.
- Lakra W, Sarkar U, Kumar R, Pandy A, Dubey V, Gusain O. Fish diversity, habitat ecology and their conservation and management issues of a tropical River in Ganga basin, India. The Environmentalist. 2010; 1-14.
- Lakra W, Mohindra V, Lal KK. Fish genetics and conservation research in India: status and perspective. Fish Physiology & Biochemistry. 2007; 33:475-487.
- Lin DSC, Caramaschi EP. Responses of fish community to the flood pulse and siltation in a floodplain Lake of the Trombetas River, Brazil. Hydrobiologia. 2005; 545(1):75-91.
- McClelland J. Calcutta Natural History. 1842; 584-588.
- Menon AGK. Fish geography of Himalayas. Proceeding National Institute of Sciences India. 1954; 14:23-32.
- Mirza MR. The systematic and zoogeography of the freshwater fishes of Pakistan and Azad Kashmir. Proceedings of 1st Pakistan Congress Zoology. 1980.
- Mirza MR. Freshwater fishes and zoogeography of Pakistan. In: Bijdragen tot de Dierkunde. 1975; 45:143-180.
- Mirza MR. Freshwater Fishes of Pakistan. Published by Urdu Science Board Lahore, 1990; 125.
- Mirza MR. Checklist of freshwater fisheries of Pakistan. Pakistan Journal Zoology Supplementary Series. 2003; 3:1-30.
- Mirza MR, Awan MJ. Fishes of the Sonsakesar valley, Punjab, Pakistan with the description of new sub-species. Biologia, Pakistan. 1976; 22:27-49.
- Mirza MR, Bhatti MN. Fishes of Kohat district and the adjoining parts of river Indus, Pakistan. Biologia, Pakistan. 1995; 41:25-27.
- Mirza MR, Sandhu AA. Fishes of Punjab, Pakistan. Polymer Publications, Lahore, Pakistan. 2007; 71.
- Mirza ZS, Mirza MR, Mirza MA, Sulehria AQK. Ichthyofaunal diversity of the River Jhelum, Pakistan. Biologia (Pakistan). 2011; 57(1&2):23-32.
- Pervaiz K, Iqbal Z, Mirza MR, Javed MN, Naem M, Ishtiaq A. Length-weight, length-length relationships and feeding habits of wild Indus Mahseer, *Tor macrolepis* from Attock, Pakistan. Journal of Applied Ichthyology. 2012; 28:673-676.
- Postel S. Water and sustainability: Dimensions of the global challenges, Global Water Policy Project, World Watch Institute, Amherst, Massachusetts. 2002; 22-75.
- Qureshi NA, Rafique M, Awan FA, Mirza MR. Fishes of river Haro, Pakistan, Biologia, Pakistan. 1988; 34:179-191.
- Rafique Khan, NUH. Distribution and status of significant freshwater fishes of Pakistan. Record

- Zoological Survey Pakistan. 2012; 21:90-95.
31. Rafique M, Akhtar S, Niazi HK. Fish fauna of Jinnah Barrage and adjoining Areas. Pakistan Journal of Zoology. 2003; 35:1214-1221.
 32. Rahman ZSM, Khan MR, Islam S, Alam S. Genetic variation of wild and hatchery populations of the Indian major carp *Catla catla* (Hamilton 1822: Cypriniformes, Cyprinidae) revealed by RAPD markers. Genetics and Molecular Biology. (Online), 2009.
 33. Rauf A, Javed M, Ubaidullah M. Heavy metal levels in major carps (*Catla catla*, *Labeo rohita* and *Cirrhina mrigala*) from the river Ravi, Pakistan. Pakistan Veterinary Journal. 2009; 29(I):24-26.
 34. Simonsen V, Hansen MM, Mensberg KLD, Sarder RI, Alam S. Widespread hybridization among species of Indian major carps in hatcheries, but not in the wild. Journal of Fish Biology. 2005; 67:794-808.
 35. Sufi SMK. Revision of the oriental fishes of the family Mastacembelidae. Raffles Bulletin of Zoology. 1956; 27:93-146.
 36. Sodhi AS, Saroch JD, Verma J. Fisheries Resources of Kashmir: A case Study of River Jhelum. Journal of Chemical Biological & Physical Science. 2013; 3(2):1194-1200.
 37. Talwar PK, Jhingran AG. Inland Fishes of India and Adjacent Countries. Oxford & IBH publishing Co. Pvt. Ltd. 1991; 1(2).
 38. Taylor CM, Holder TL, Fiorillo RA, Williams LR, Thomas RB, Waren ML. Distribution, abundance and diversity of stream fishes under variable environmental conditions. Canadian Journal of Fish & Aquatic Sciences. 2006; 63:43-54.