



## RESEARCH PAPER

## OPEN ACCESS

## Icthyofauna of River Chenab at Head Trimmu, District Jhang, Pakistan

Maria Latif<sup>\*1</sup>, Imtiaz Begum Minhas<sup>2</sup>, Muhammad Zafar Ullah<sup>1</sup>, Samavia Latif<sup>3</sup>

<sup>1</sup>Fisheries Research & Training Institute, Manawan, Lahore, Department of Fisheries, Punjab, Pakistan

<sup>2</sup>Department of Fisheries, Punjab, Pakistan

<sup>3</sup>College of Statistical and Actuarial Sciences, University of The Punjab, Quaid-e-Azam Campus, Lahore, Pakistan

**Key words:** Diversity, Species, Wetland, Headworks, Punjab

<http://dx.doi.org/10.12692/ijb/11.6.201-208>

Article published on December 30, 2017

### Abstract

River Chenab is an important wetland in Pakistan supporting diverse fauna and flora. Present study deals with the ichthyodiversity of river Chenab at Trimmu Headwork and reports 43 species belonging to six orders, 13 families and 34 genera. On the basis of number and percentage contribution of families to their orders, order Siluriformes was found dominant represented with five families (38.5%) followed by Perciformes (30.7%). Fish species belonging to family Cyprinidae were found dominant (44.2%) in the present collection. *Systomus sarana* has shown highest value of relative abundance followed by *Puntius sophore* and *Barilius modestus*. Population of commercially important fish species has declined in this river due to the various anthropogenic pressures. The values for species diversity, richness and evenness from the study area were 3.56, 13.98 and 0.95 respectively. Conservation measures are strongly recommended for protecting this diverse fish fauna.

\* Corresponding Author: Maria Latif ✉ [marialatif5847@gmail.com](mailto:marialatif5847@gmail.com)

## Introduction

Pakistan is bestowed with many inland water resources such as rivers and their tributaries, network of inter-linked irrigation canals, streams, earth-filled dams, lakes and waterlogged areas. Freshwater ichthyofauna of Pakistan is very rich and diverse represented with a minimum of 193 species out of which 31 species are considered as economically high valued species (Rafique and Khan, 2012). River Chenab is an important wetland in Pakistan supporting diverse fauna and flora. Extensive work on freshwater fish fauna of Chenab river has been done by many researchers in Pakistan (Shaheen, 1976; Khan *et al.*, 1991; Afzal *et al.*, 1995; Mirza, 1997; Mirza and Javed, 2003; Altaf *et al.*, 2011a,b; Altaf *et al.*, 2015; Latif *et al.*, 2016a-c). Fishes belonging to family Cyprinidae superseded rest of the families regarding to their number of genera and species in Pakistan (Mirza, 2003). Fishes are highly sensitive to water quality changes and respond to both direct and indirect changes in the aquatic ecosystem (Borkovic *et al.*, 2008). Globally fish and fisheries are in severe decline due to the rapid economic and population growth (Limburg *et al.*, 2011). Climatic changes are adversely affecting freshwater biodiversity (Heino *et al.*, 2009). Lentic and lotic ecosystems are considered to be the most sensitive ecosystems to climate change, invasion of exotic species and land use changes (Sala *et al.*, 2000). Pakistan has introduced several alien fish species into its rivers for various purposes such as fish yield enhancement; sport fishing, aquatic weeds and mosquito's control (Khan *et al.*, 2011). These introductions have resulted in severe decline of native species. Aquatic pollution is another major threat to the fish fauna of Pakistan. The highly polluted water from river Tawi enters into Pakistan and joins with river Chenab resulting in the degradation of water quality of Chenab River (Elahi and Sikder, 2010). Fishes of head Trimmu have shown skin and fins infections indicating water pollution in this river (Iqbal *et al.*, 2013). Annual fish catches are significantly decreasing in Pakistan as a result of abrupt climatic changes and aquatic pollution (Allison *et al.*, 2009). The present study was aimed to assess fish species composition and their relative abundance at Trimmu headwork by using various diversity indices.

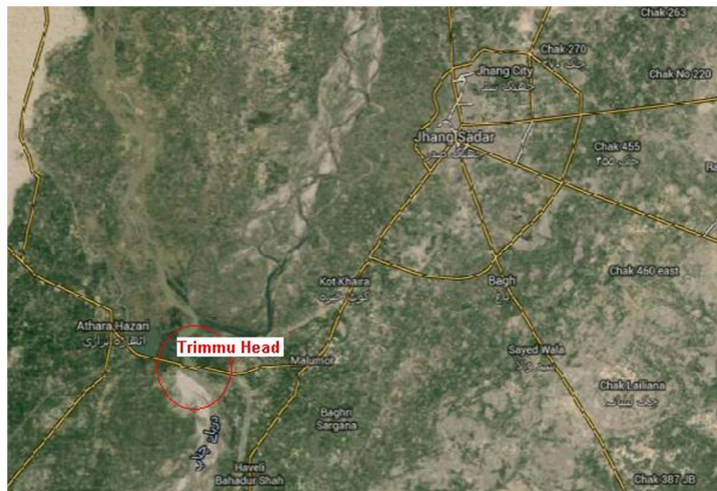
## Materials and methods

### Study area

Punjab is the land of five rivers namely; Chenab, Jhelum, Ravi, Sutlej and Bias Rivers. Among these five rivers, river Chenab is a life line for the Punjab, Pakistan. It originates from India and passes through Jammu and Kashmir State and then finally enters into Pakistan near Diawara village, district Sialkot. In Pakistan, catchment area of river Chenab is about 13469 square miles. Annual water flow is 26.44 billion cubic meters. Marala, Khanki, Qadirabad and Trimmu Headworks are important water reservoirs situated on the river Chenab (Siddiqui and Tahir-Kheli, 2004). Head Trimmu was constructed between 1937 and 1939 primarily as flood control mechanism. It is situated at the confluence of Jhelum and Chenab rivers and is about 25 Km away from the district Jhang, near Atharan Hazari village. Head Trimmu feeds three major canals, two from the left bank (Trimmu-Sidhnai link canal and Haveli Link) and one from the right bank (Rangpur canal). Head Trimmu supports diverse fauna and flora of both aquatic and terrestrial ecosystems. Head Trimmu is located at 31°8'41.71" N, 72°8'45.7" E and elevation of 150m (Fig. 1).

### Sampling

Fish sampling was done on monthly basis from September 2015 to July 2016 mainly from upstream and downstream of Trimmu headwork. Both direct (Total count) and indirect (meetings with local fishermen, surveying nearby fish markets and remains of fishes) methods were applied to find out fish diversity from the study area. Collected samples were preserved in 10% formalin and then brought to the Fish Museum, Fisheries Research & Training Institute, Lahore. Preserved specimens were identified up to the species level on the basis of their meristics and morphological characteristics. Standard taxonomic keys were used for taxonomic classification (Mirza and Sharif, 1996; Mirza and Sandhu, 2007). Identified specimens were shifted into 70% alcohol and displayed in glass jars at Fish Museum, FR&TI, Lahore, Pakistan.



**Fig. 1.** Map showing study area (Head Trimmu), Punjab, Pakistan.

### Statistical analysis

For estimating fish species diversity, abundance and evenness from the study area diversity indices were used (Shannon and Weaver, 1963; Margelf, 1958; Hill, 1973).

### Results

A total of 43 species belonging to 34 genera, 13 families and six orders were recorded from head Trimmu (Table. 1). Among the collected fishes major portion consisted of indigenous species along with single endemic (*Salmophasia punjabensis*) and five

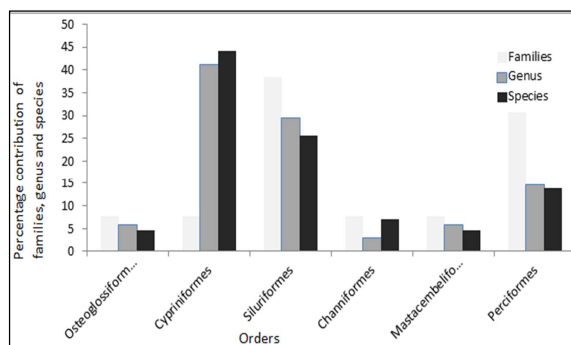
exotic species namely; *Cyprinus carpio*, *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Oreochromis mossambicus* and *Oreochromis niloticus* (Rafique and Khan, 2012). Order Siluriformes was found dominant contributing five families (38.5%) followed by Perciformes contributing four families (30.7%) to the present collection (Fig. 2). Four orders namely Osteoglossiformes, Cypriniformes, Channiformes and Mastacembeliformes each contributed only a single family (7.69%) to this collection.

**Table 1.** List of recorded fish species from Trimmu headwork, Chenab, Pakistan.

Sr. No	Order/Family	Scientific Name	Common Name	R.A	PilnPi
I	Osteoglossiformes				
I-1	Notopteridae	<i>Chitala chitala</i>	Chital Pari	0.008	-0.039
2		<i>Notopterus notopterus</i>	But Pari	0.016	-0.066
II	Cypriniformes				
II-3	Cyprinidae	<i>Labeo rohita</i>	Rohu	0.023	-0.087
4		<i>Labeo boga</i>	Bhangan	0.014	-0.059
5		<i>Labeo calbasu</i>	Kalbans	0.006	-0.031
6		<i>Labeo gonius</i>	Sariha	0.019	-0.075
7		<i>Cirrhinus mrigala</i>	Mori	0.036	-0.119
8		<i>Cirrhinus reba</i>	Reba	0.013	-0.056
9		<i>Gibelion catla</i>	Thaila	0.009	-0.042
10		<i>Puntius sophore</i>	Sphor Popra	0.062	-0.172
11		<i>Puntius chola</i>	Chola popra	0.042	-0.133
12		<i>Systemus sarana</i>	Khirmi	0.078	-0.199
13		<i>Salmophasia punjabensis</i>	Punjabi Chal	0.049	-0.148
14		<i>Securicula gora</i>	Bari Chal	0.023	-0.087
15		<i>Esomus danricus</i>	Somara	0.019	-0.075
16		<i>Osteobrama cotio</i>	Pali-ro	0.021	-0.081
17		<i>Barilius modestus</i>	Lhori Chlwa	0.062	-0.172
18		<i>Chela cachius</i>	Budha	0.011	-0.049
19		<i>Cyprinus carpio</i> *	Gulfam	0.013	-0.056
20		<i>Ctenopharyngodon idella</i> *	Grass Carp	0.011	-0.049
21		<i>Hypophthalmichthys molitrix</i> *	Silver Carp	0.009	-0.042
III	Siluriformes				
III-22	Bagridae	<i>Sperata sarwari</i>	Singhari	0.016	-0.066
23		<i>Rita rita</i>	Desi Khaga	0.029	-0.103

Sr. No	Order/Family	Scientific Name	Common Name	R.A	PilnPi
I	Osteoglossiformes				
24		<i>Myristicivora cavasius</i>	Kanghar	0.032	-0.11
25		<i>Myristicivora bleekeri</i>	Kanghar	0.016	-0.066
IV-26	Siluridae	<i>Wallago attu</i>	Malli	0.021	-0.081
27		<i>Ompok pabda</i>	Pafta	0.016	-0.066
V-28	Schilbeidae	<i>Eutropiichtys vacha</i>	Jhalli	0.042	-0.133
29		<i>Clupiosoma garua</i>	Bachwa	0.018	-0.072
VI-30	Sisoridae	<i>Bagarius bagarius</i>	Fauji Khaga	0.011	-0.049
31		<i>Gagata cenia</i>	Gagata cenia	0.009	-0.042
VII-32	Heteropneustidae	<i>Heteropneustes fossilis</i>	Sanghi	0.026	-0.095
IV	Channiformes				
VIII-33	Channidae	<i>Channa marulius</i>	Saul	0.013	-0.056
34		<i>Channa punctata</i>	Daula	0.029	-0.103
35		<i>Channa gachua</i>	Dauli	0.006	-0.031
V	Mastacembeliformes				
IX-36	Mastacembelidae	<i>Mastacembelus armatus</i>	Baam	0.017	-0.069
37		<i>Macrogathus pancalus</i>	Garoj	0.004	-0.022
VI	Perciformes				
X-38	Chandidae	<i>Chanda nama</i>	Sheesha	0.036	-0.119
39		<i>Parambassis ranga</i>	Ranga Shsha	0.019	-0.075
XI-40	Gobiidae	<i>Glossogobius giuris</i>	Golu	0.019	-0.075
XII-41	Belontiidae	<i>Colisa fasciata</i>	Bari Kanghi	0.018	-0.072
XIII-42	Cichlidae	<i>Oreochromis niloticus*</i>	Chirra	0.033	-0.112
43		<i>Oreochromis mossambicus*</i>	Chirra	0.029	-0.103

\*Indicates exotic species; R.A: Relative abundance; Com. Value: Commercial value (Rafique & Khan, 2012; Hussain *et al.*, 2016).



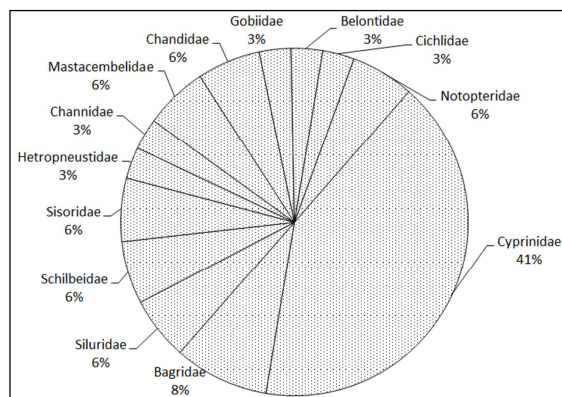
**Fig. 2.** Number and percentage contribution of families, genus and species under various orders.

On the basis of number and percentage contribution of genus and species to their orders, fishes belonging to order Cypriniformes were found dominant contributing 14 genera (41.2%) and 19 species (44.2%) followed by Siluriformes contributing 10 genera (29.4%) and 11 species (25.6%) to this collection. Order Perciformes contributed five genera (14.7%) and six species (13.9%) to the present collection. Order Channiformes contributed single genera (2.94%) and three species *Channa marulius*, *C. punctata* and *C. gachua* (6.98%) to this collection. Orders Osteoglossiformes and Mastacembeliformes each contributed two genera (5.88%) and two species (4.65%) to the present collection. On the basis of number and percentage contribution of genus and species to their family, fishes belonging to family

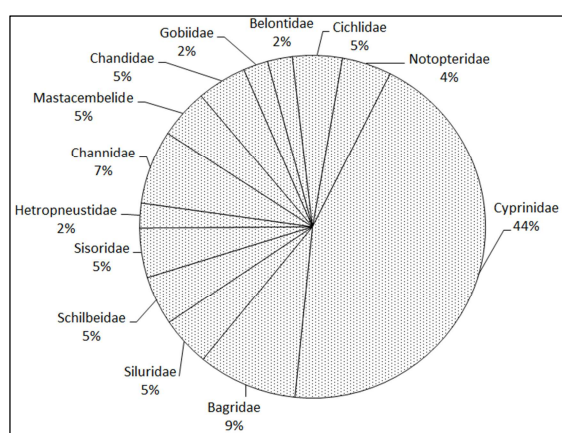
Cyprinidae were found dominant contributing 14 genera (41.2%) and 19 species (44.2%) followed by Bagridae contributing three genera (8.82%) and four species (9.30%) to this collection. Families Notopteridae, Siluridae, Schilbeidae, Sisoridae, Mastacembelidae and Chandidae each contributed two genera (5.88%) to present collection. Fishes belonging to families Heteropneustidae, Channidae, Gobiidae, Belontiidae and Cichlidae each contributed only a single genus (2.94%) to this collection (Fig 3A).

Major portion of the present collection comprised of the fish species belonging to family Cyprinidae (44.2%), among these fishes most are commercially high valued species (*Labeo rohita*, *Cirrhinus mrigala*, *Gibelion catla*, *Labeo gonius*, *Cyprinus carpio*, *Ctenopharyngodon idella* and *Hypophthalmichthys molitrix* in Pakistan (Rafique and Khan, 2012; Hussain *et al.*, 2016). Families Notopteridae, Siluridae, Schilbeidae, Sisoridae, Mastacembelidae, Chandidae and Cichlidae each contributed two species (4.65%) to this collection. Three families namely Heteropneustidae, Gobiidae and Belontiidae each contributed only a single species (*Heteropneustes fossilis*, *Glossogobius giuris* and *Colisa fasciata* respectively) contributing 2.32% to the present collection (Fig 3B).



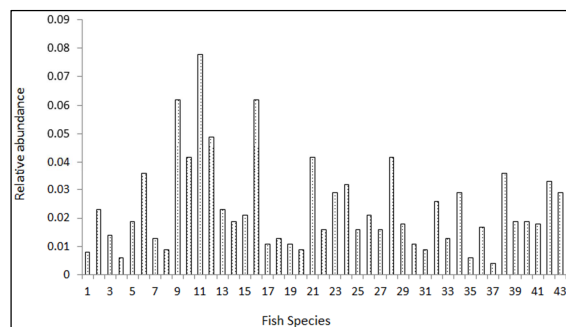


**Fig. 3A.** Percentage contribution of each genus to their families.



**Fig. 3B.** Percentage contribution of each species to their families.

Major portion of the present collection comprised of commercially low valued species showing high values for their relative abundance such as *Systemus sarana* has shown highest value for its relative abundance (0.199) followed by *Puntius sophore* and *Barilius modestus* (0.172). Commercially high valued species *Gibelion catla*, *Chitala chitala*, *Channa marulius* and *Channa gachua* has shown low values for their relative abundance due to their indiscriminate fishing. Commercially and economically high valued fish species are declining in the river Chenab due to the various anthropogenic stresses such as overfishing, pouching, pollution and introduction of alien species (Latif *et al.*, 2016a-c). *Oreochromis niloticus* and *Cyprinus carpio*, an exotic fish species in this river has shown comparatively high values for their relative abundance (Fig. 4). Many researchers have reported exotic fish species are becoming invasive in the rivers of Pakistan (Khan *et al.*, 2011; Iqbal *et al.*, 2013). Their results support our findings.



**Fig. 4.** Fish species and their relative abundance recorded from head Trimmu, river Chenab.

The value for fish species diversity, abundance and evenness from the study area were 3.56, 13.9 and 0.95 respectively (Table. 2). Similar studies were conducted on three other head works (Marala, Qadirabad and Khanki headworks) situated on river Chenab during the period 2015-2016 reported low fish species diversity when compared to the present fish species diversity found at head Trimmu (Latif *et al.*, 2016a-c).

**Table 2.** Statistical analysis of the fish diversity of head Trimmu, river Chenab, Pakistan.

Diversity Indices	Values
Fish species	43
Shannon-Weaver diversity (H)	3.56
Margelf,s richness (R)	13.98
Hill,s evenness (E)	0.95

**Discussion**

A total of 43 fish species were recorded from the study area during this study. 32 fish species were reported from Trimmu Headworks pond area, district Jhang (Iqbal *et al.*, 2013). Seven fish species namely *Aspidoparia morar*, *Salmophasia bacalia*, *Ompok bimaculatus*, *Schistura macrolepis*, *Schistura shadiwaensis*, *Xenentodon cancila* and *Botia lohachata* were reported in their collection but not found in our collection. 25 fish species in present collection are common to their collection. *Chitala chitala*, *Labeo boga*, *Labeo calbasu*, *Labeo gonius*, *Cirrhinus reba*, *Systemus sarana*, *Salmophasia punjabensis*, *Securicula gora*, *Esomus danricus*, *Osteobrama cotio*, *Cyprinus carpio*, *Mystus cavasius*, *Mystus bleekri*, *Ompok pabda*, *Macrognathus pancalus*, *Chanda nama*, *Parambassis ranga* and *Glossogobius giuris* are exclusively part of present collection not reported in their findings.

30 fish species were recorded from head Trimmu and threats were reported to economically high valued species of this river (Khan *et al.*, 2011). *Amblypharyngodon mola*, *Aspidoparia morar*, *Salmophasia bacalia*, *Mystus vittatus*, *Ailia punctata*, *Xenentodon cancila* and *Sicamugil cascasia* were reported in their collection but were not found in present collection. 23 fish species recorded in our collection were also reported in their collection while *Chitala chitala*, *Labeo boga*, *Labeo goni*, *Systomus sarana*, *Esomus danricus*, *Barilius modestus*, *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Rita rita*, *Mystus bleekeri*, *Wallago attu*, *Ompok pabda*, *Bagarius bagarius*, *Gagata cenia*, *Heteropneustes fossilis*, *Channa marulius*, *Channa gachua*, *Parambassis ranga*, *Colisa fasciata* and *Oreochromis mossambicus* were not reported in their collection. *Sisor pakistanicus* was reported from river Chenab at head Trimmu (Javed and Mirza, 2011). This species was not found in the present collection.

38 fish species were recorded from Marala headworks situated on river Chenab during the period 2015-16. The values for species diversity and richness were low showing decrease in the populations of commercially important species in this river (Latif *et al.*, 2016a). 43 species were reported from head Qadirabad, river Chenab (Latif *et al.*, 2016b). Major portion of their collection comprised of native species along with five exotic species. They reported that exotic species are becoming invasive in the river. Their findings support our results. 34 fish species from Khanki headwork during September 2015- May 2016. The values for diversity indices were low indicating loss of fish diversity from their study area (Latif *et al.*, 2016c). 34 fish species were reported from river Chenab at Marala, Khanki and Qadirabad headworks (Altaf *et al.*, 2015). The diversity indices values showed higher diversity at head Qadirabad followed by Khanki and Marala headworks. 32 fish species reported from river Jhelum in their study are overlapping with our collected species from head Trimmu. 22 fish species were reported from river Indus at Ghazi Ghat (Hussain *et al.*, 2016). Major portion of their collection comprised of fishes belonging to family Cyprinidae.

Similar results are found in present study. Freshwater ichthyofauna at Chashma and Taunsa reservoirs was represented with 20 and 22 species respectively (Khan *et al.*, 2008). Major portion of their collection comprised of native species along with exotic fishes like *Ctenopharyngodon idella*, *Hypophthalmichthys molitrix*, *Hypophthalmichthys nobilis*, *Cyprinus carpio*, *Carassius auratus*, *Oreochromis aureus*, *Oreochromis mossambicus* and *Gambusia affinis*. 3 exotic species (*Hypophthalmichthys molitrix*, *Cyprinus carpio* and *Oreochromis mossambicus*) reported in their collection were also found in our collection from Trimmu headwork.

Fish fauna found at head Trimmu was found diverse. However, population of commercially high valued species has seemed to be declined. Various anthropogenic stresses are responsible for this decline such as aquatic pollution, introduction of alien species, overharvesting and destruction of feeding and breeding places. For conserving fish fauna at Trimmu headwork, strict controls on overfishing, illegal fishing, elimination of invasive species, regular water quality assessment is highly recommended.

#### Acknowledgement

Authors are grateful to the field staff of district Jhang, Fisheries department, Punjab for their assistance in the field work. We are also highly obliged to the Private fish contractors and fisherman for their help in sampling.

#### References

- Afzal M, Javed MN, Mirza MR.** 1995. Fishes of river Chenab in district Jhang. *Biologia Pakistan* **41**, 133-137.
- Allison EH, Perry AL, Badjeck MC, Adger NW, Brown K, Conway D, Halls AS, Pilling GM, Reynolds JD, Andrew NL, Dulvy NK.** 2009. Vulnerability of national economies to the impacts of climate change on fisheries. *Fish and Fisheries* **10(2)**, 173-196.
- Altaf M, Javid A, Khan AM, Hussain A, Umair M, Ali Z.** 2015. The status of fish diversity of river Chenab, Pakistan. *Journal of Animal and Plant Sciences* **25(3-2)**, 564-569.

- Altaf M, Khan AM, Umair M, Chattha SA.** 2011a. Diversity of Carps in River Chenab, Pakistan. Punjab University Journal of Zoology **26(2)**, 107-114.
- Altaf M, Khan AM, Umair M, Irfan M, Munir MA, Ahmed Z.** 2011b. Ecology and diversity of freshwater fishes of head Qadirabad, Gujranwala. Punjab University Journal of Zoology **26(1)**, 1-7.
- Borkovic SS, Pavlovic SZ, Kovacevic TB, Stajn AS, Petrovic VM, Saicic ZS.** 2008. Antioxidant defence enzyme activities in hepatopancreas, gills and muscle of spiny cheek crayfish (*Orconectes limosus*) from the River Danube. Comparative Biochemistry and Physiology–Part C: Toxicology and Pharmacology **147**, 122-128.
- Elahi KM, Sikder MT.** 2010. Mega dams in the Himalayas: An assessment of environmental degradation and global warming. CCO1 Proceedings of International Conference on Environmental Aspects of Bangladesh (ICEAB10) Japan.
- Heino J, Virkkala R, Toivonen H.** 2009. Climate change and freshwater biodiversity: Detected patterns, future trends and adaptations in northern regions. Biological Review **84**, 39-54.
- Hill MO.** 1973. Diversity and its evenness, a unifying notation and its consequences. Ecology **54**, 427-432.
- Hussain MZ, Latif A., Ahmed SW, Hussain S, Iqbal R, Ali M.** 2016. Diversity, abundance and seasonal variations of fish community in lentic water bodies of Indus river at Ghazi Ghat, Pakistan. Pakistan journal of Zoology **48(1)**, 59-65.
- Iqbal Z, Mahmood T, Pervaiz K, Muhammad H.** 2013. Skin and fin infections in some fishes of Trimmu area district Jhang, Pakistan. European Journal of Veterinary medicine **2(2)**, 98-108.
- Iqbal Z, Pervaiz K, Javed MN.** 2013. Population dynamics of *Tor macrolepis* (Teleostei: Cyprinidae) and other fishes of Attock region, Pakistan. Canadian journal of pure and applied sciences **7(1)**, 2195-2201.
- Javed MN, Mirza MR.** 2011. *Sisor pakistanicus* (Teleostei, Sisoridae), a new catfish from the river Chenab, Pakistan. Biologia (Pakistan) **57(1-2)**, 15-21.
- Khan AM, Ali Z, Shelly SY, Ahmad Z, Mirza MR.** 2011. Aliens; A catastrophe for native freshwater fish diversity in Pakistan. Journal of Animals and Plants Sciences **21**, 435-440.
- Khan AM, Shakir HA, Khan MN, Abid M, Mirza MR.** 2008. Ichthyofaunal survey of some fresh water reservoirs in Punjab. Journal of Animals and Plants Sciences **18(4)**, 151-154.
- Khan MI, Irshad R, Saga FH.** 1991. Fishes of river Chenab in Multan district. Biologia **37(1)**, 23-25.
- Latif M, Pervaiz K, Minhas IB, Latif S.** 2016c. Current status of fish fauna at head Khanki, river Chenab, Pakistan. Journal of biodiversity and environmental sciences **9(4)**, 279-285.
- Latif M, Siddiqui S, Minhas IB, Latif S.** 2016a. Diversity and abundance of fish fauna at head Marala, Chenab river, Punjab, Pakistan. Canadian journal of pure and applied sciences **10(3)**, 3971-3979.
- Latif M, Siddiqui S, Minhas IK, Latif S.** 2016b. Studies on Ichthyofaunal diversity of head Qadirabad, river Chenab, Punjab, Pakistan. International journal of fisheries and aquatic studies **4(6)**, 25-29.
- Limburg KE, Hughes RM, Jackson DC, Czech B.** 2011. Human population increase, Economic growth, and Fish conservation collision course or savvy Stewardship? Fisheries **36(1)**, 27-34.
- Margelf R.** 1958. Temporal succession and spatial heterogeneity in phytoplankton. In: Perspective in Marine Biology, Ed. A.A. Buzzati-Traverso, Berkeley, California, USA: University of California Press 323-347.
- Mirza MR, Javed MN.** 2003. Fishes of the river Chenab in Pakistan. Biologia **49(1-2)**, 57-64.

- Mirza MR, Sandhu IA.** 2007. Fishes of the Punjab, Pakistan. Polymer Publications, Pakistan.
- Mirza MR, Sharif HM.** 1996. A Key to the fishes of Punjab. Ilmi Katab Ghar, Urdu Bazar Lahore.
- Mirza MR.** 1997. Biodiversity of fishes of the river Chenab between Khanki and Qadirabad in Pakistan. *Biologia Pakistan* **43(2)**, 149-156.
- Mirza MR.** 2003. Checklist of freshwater fishes of Pakistan. *Pakistan journal of Zoology* **3**, 1-30.
- Rafique M, Khan NUH.** 2012. Distribution and status of significant freshwater fishes of Pakistan. *Record of Zoological Survey of Pakistan* **21**, 90-95.
- Sala OE, Chapiniii FS, Armesto JJ, Berlow E, Bloomfield J, Dirzo R, Huber-Sanwald E, Huenneke LF, Jackson RB, Kinzig A, Leemans R, Lodge DM, Mooney HA, Oesterheld M, Poff NL, Sykes MT, Walker BH, Walker M, Wall DH.** 2000. Global biodiversity scenarios for the year 2100. *Science* **287(5459)**, 1770-1774.
- Shaheen ZA.** 1976. Ichthyodiversity of River Chenab at district Jhang, Punjab. *Pakistan journal of Agricultural sciences* **13**, 97-106.
- Shannon CE, Weaver W.** 1963. *The Mathematical Theory of Communication*. Urbana, University of Illinois Press 31-35.
- Siddiqui TA, Tahir-Kheli S.** 2004. Water and security in South Asia. *WASSA* 234.