

FISH FAUNA AND POPULATION DYNAMICS OF ECONOMICALLY IMPORTANT FISH SPECIES OF MANMADE FRESHWATER RESERVOIR

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Abstract: Chashma reservoir is located at latitude of N° 32'26.110 and longitude of E° 71'25.571 and is constructed on the river Indus at District Mianwali on Dera Ismail Khan Road in the province of Punjab, Pakistan. It is the third largest multi-purpose reservoir in Pakistan and covers a surface area of 360 Km². It is used for flood control, irrigation, power generation and fish production. Its fish biodiversity was studied during a period of twenty-four months from September 2013 to September 2015. Various fishing gears like hand nets, mosquito nets, rod and line, cast nets, drag nets and gill nets etc. were employed for sample collection. Total 74 numbers of fish species distributed over 9 orders, 21 families and 54 genera were recorded. Population dynamics of commercial fish species was also studied. Their numbers and biomass in the fish catch were recorded. *Labeo gonius* is the most prevalent species and found 50% in number and 37.34% in biomass in the total harvest whereas *Wallago attu* is the most commercial fish species which represent 5.37 % in number and 18% by weight in the total fish catch. Fish species are classified as common (C), not common (NC), rare (R), and very rare (VR) based on how frequently they appeared in the samples. Species utilized for aquaculture are marked as (CU) and the exotic species are represented as (E). This reservoir hosts around 39% of Pakistan's entire freshwater fish biodiversity.

Keywords Chashma reservoir, biomass, fish, irrigation, biodiversity

Introduction

Fish always remained a source of healthy food, income, employment, and recreation for the human. The ancient civilizations and human societies evolved around the water resources. Therefore, fish remained a point of common interest for the man and it fascinated the human imagination in his art and craft. The impressions of various fishes and paintings on the remains of ancient pottery discovered during excavation of five thousand years old sites near Nal (Latitude 27° 40'N and Longitude 66° 48'E) in Baluchistan (Pakistan) are so accurate, that identification up to species level is possible. The Nal River is a tributary of Hingol River which finally falls in Arabian Sea near Karachi. Paintings on sherd near Harappa in Punjab (Indus civilization) also prove that man was aware of fishing methods through hooks and nets. Hora (1919) identified the *Garra gotyla* (Gray), *Cyprinion watsoni* (Day), *Crossocheilus diplocheilus* (Heckle), *Labeo dero* (Hamilton), *Tor putitora* (Hamilton), *Botia birdi*

(Chaudhry), *Schistura balochorium* (Zugmayer), *Glyptothorax naziri* (Mirza & Naik) from these paintings and impressions.

Regarding the economic value of fish, Linnaeus (1758) once said: "So great is the importance of fish to the enjoyment of the rich and the necessities of the poor that he might, with less inconvenience, give up the whole class of birds and many of mammals than be deprived of finny tribes". At present, about 59.6 million people all over the world are related to fisheries and aquaculture sector. Fish and fisheries products account for around 27% of all animal protein and 143 billion (\$) of global export revenues (FAO, 2018). Fish serves not only as an energy source, but also contribute in high-quality, digestible animal proteins and fulfills micronutrient requirements of human diet. Moreover, it offers a lot of ecological advantages to humanity on a worldwide scale. Most important among them are the provision of food chain and the continuity of the biological cycles, recycling of nutrients and ornamental values (Ullah et al., 2014). Their seasonal and spatial migrations are an important



source of reserved genetic pool, energy and nutrient supply in addition to their role as an effective dispenser (Sthanadar *et al.*, 2015).

Although Fresh waters occupy only 1% of the total earth's surface yet they provide home to more than 11952 fish species out of total 27977 recognized fish species (Nelson, 1994; Helfrich *et al.*, 2009). Out Of the total recognized fish species 58% are marine and 41% are freshwater whereas 1% of them are diadromous in nature (Helfrich *et al.*, 2009). Freshwater fisheries resources of Pakistan are dominated by the Indus River system and possess 193 fish species (Rafique & Khan, 2012). River Indus originates in the south-western Tibet from the lake Ngangla Ringco near Mount Kailas and after covering a distance of 1700 Km from its origin and receiving many tributaries like river Shingo, Shyok, Shigar, Hunza, Gilgit, Kabul and Soan, it enters in to present study area i.e. Chashma reservoir (Mirza & Alam, 2000). Despite of the significant role of the rivers for human in tropical Asia, little attention was paid to their study and understanding on scientific basis (Kottelat, M., 1996). The river Indus and its tributaries being the largest drainage basin of Pakistan and inhabited by a variety of fish fauna remained a field of interest for many ichthyologists. Therefore, a number of research reports regarding the ichthyodiversity of this river are available which include Ahmad *et al.*, (2010); Day, (1880); Mirza & Hussain, (1998); Mirza (1987, 1994, 2006); Mirza & Sharif (1996); Khan, & Ali, (2003); Mirza & Alam (2000); Mirza *et al.* (2011); Pervaiz *et al.* (2013), Muhammad *et al.* (2018); Rafique (2001); Rafique *et al.* (2003); Rafique *et al.* (2012) and Mirza & Mirza, (2014). About 180 number of fish species have been reported from this river system (Mirza, 2003). Chashma reservoir is a very important wet land which expands over a 360 Km² surface area and plays significant role in flood control, irrigation, power generation and fish production. It provides employment to more than 1000 families in various fields including the fisher folks.

Materials and method

A-Collection of Samples, Preservation and Identification

Fish samples were collected with the help of fishermen using the fishing gears like hand nets,

mosquito nets, cast nets, rod and line, gill nets, Drag/seine nets and electric fishing and were segregated on the basis of their apparent morphological characteristics. The fish sample were preserved in 10% formalin (Commercial grade) and placed at fish biodiversity Hatchery at Chashma district Mianwali (**Figure 2**). Intraperitoneal injection of 10% formalin was also given to the larger specimens (Mirza, 2006). The samples were identified up to species level on the basis of morphological characteristics as shown in the figure 1 with the help of standard keys (Mirza,1990, Mirza & Sandhu,2007, Jayram,2010). Population dynamics of Commercial fish species harvested by the contractor was also studied. Total fish catches were segregated species wise and total number and weight of each species was recorded and their percentage occurrence and biomass were calculated (**Figures 4 & 5**). Hence, their percentage occurrence was calculated. Fish species on the basis of their frequency of occurrence in the samples were classified as common(C) occurring in up to 60% samples, not common (NC) occurring in less than 60% samples, Rare (R) occurring in less than 30% samples and very rare (VR) occurring in less than 10% samples. Fish Species used in aquaculture are marked as (Cu) and exotic species as (E) (**Table-1**).

B-Climate & Hydrography of the Study Area

Chashma reservoir area has extreme hot summer season and cool winters with 300-500 mm annual rain falls. Relative humidity ranges from 22 to 85% and water temperature varies from 4.5 °C in winter to 41°C in summer. It is a shallow and eutrophic water reservoir with maximum 6.096-meter depth and 950,000 cusecs water discharge capacity. Its pH value ranges from 8.33 to 8.50 whereas its conductivity and total dissolved solid contents range from 177.12 to 327.38µs/cm and 120 to 220 mg/l respectively (Mirza, 1993, 1994). Mean annual flow for Chashma Reservoir is 117,000 ft³/s (3313 m³/s) while the highest annual discharge is 313,627 ft³/s (8881 m³/s) (Ali & Shakir, 2018). Original gross storage capacity of reservoir was 0.87-million-acre feet (MAF) with live storage capacity of 0.72 MAF and dead storage capacity of 0.15 MAF. Its Average sedimentation rate remained 0.0124 MAF/year up to 2012 and about 0.233 MAF (73%) reduction in storage capacity of reservoir has been predicted up to the year 2054 (WAPDA Hydrographic survey report,2012-13). About 56 Km up Stream of this barrage, there is another barrage known as Jinnah Barrage and the fish fauna between the two barrages is almost localized.

Results and discussion

The fish fauna in Chashma reservoir is represented by 74 number of fish species belonged to 9 orders, 18 families and 51 genera. Among which 19 species are most common (C) whereas 27 species are in the category of not common (NC). 10 numbers of species are rare (R) & 18 species fall in the category of very rare (VR). 26 species have the commercial value among which 7 number of fish species including three exotic species are used for aquaculture (CU). Total 4 numbers of exotic species (E) are recorded from the reservoir (**Table.1**). *Labeo gonius* is the most prevalent species and found 50% in number and 37.34% in biomass whereas *Wallago attu* is the most commercial fish species which represent 5.37 % in number and 18% in biomass in the total fish catch (**Table. 2**). Family Cyprinidae is the most dominant family and is represented by 21 Genera and 37 fish species. The families Cichlidae, Gobiidae, Belonidae, Mugilidae, Belontiidae, Heteroneustidae, Cobitidae, Channidae and Clupeidae are represented by single Genus and single species except the family Belontiidae which has two species and Channidae which has three species.

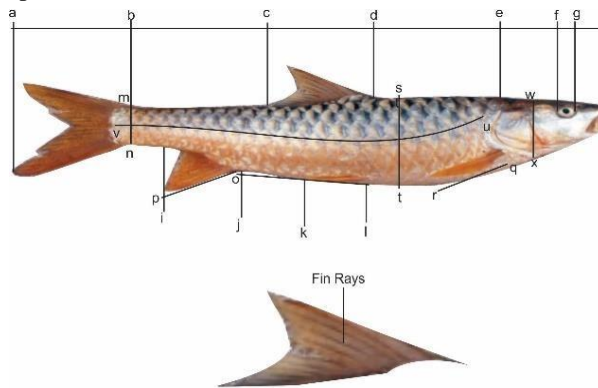


Figure 1: Schematic diagram representing general body and head measurements

ah (Total length), bh (Standard length), eh (head length), wx (head height), fg (inter orbital width), dh (pre-dorsal length), st (body depth), op (pelvic fin length), uv (lateral line scales), mn (least height of caudal peduncle), ab (caudal fin length), qr (pectoral fin length)

Figure 1. Morphological characteristics used for Identification

The families Notopteridae, Siluridae and Nemacheilidae are represented by two genera and two species each and families Mastacembelidae and Chandidae each is represented by two Genera and three species.

The family Sisoridae, Bagridae and Schilbeidae are represented by three genera and four, six and five species respectively (Figure 3). 26 number of fish species have the commercial value. Khan et al. (2008) described 30 number of fish species from the Chashma reservoir. *Oreochromis aureus* reported by them was not found in the present collection. However, *Oreochromis mossambicus* was recorded during present study. *Nangra* genus reported by Mirza and Mirza, (2014) from the downstream of Jinnah barrage was also not recorded from the Chashma reservoir. The genus *Sicamugil*, reported by Mirza & Mirza (2014) was found which was represented by one species. However, *Nangra* genus reported by Mirza and Mirza, (2014) from the downstream of Jinnah barrage was also not recorded from the Chashma reservoir. They reported 49 genera, 16 families and 9 orders of native fish species from the Indus River. In the present collection of Chashma reservoir 74 number of fish species belonged to 51 genera, 18 families and 9 orders have been recorded. Muhammad & Saleemi, (2018) recorded 70 number of fish species belonging to 43 genera and 17 families from the Taunsa reservoir downstream of Chashma reservoir on Indus River. No representative of family Nemacheilidae was reported by them in the Taunsa reservoir. The fish species *Gonialosa manminis* (Hamilton), *Labeo boggut*, *Puntius punjabensis*, *Puntius tero*, *Salmophasia bacaila*, *Salmophasia punjabensis*, *Oreochromis niloticus*, *Oreochromis aureus*, *Mystus horai*, *Mystus tengara*, *Rita macracanthus*, *Nangra nangra*, *Sisor rabdophorus*, *Glyptothorax punjabensis* and *Channa striatus* reported by them in the Taunsa reservoir were not found in the Chashma reservoir. Whereas, the species like *Channa gachua*, *Gagata cenia*, *Naziritor zhobensis*, *Tor macrolepis*, *Nemacheilus corica* (Hamilton), *Schistura afasciata* Mirza & Banarescu, *Barilius vagra* (Day) and *Barilius pakistanicus* (Hamilton) reported from the Chashma reservoir were not recorded from the Taunsa Reservoir. Only four to five specimens of the Species *Channa gachua* and *Botia lohachata* were found during the whole study period of which depicts that perhaps these species are at the verge of extinction from the Chashma reservoir. Only one specimen of *Naziritor zhobensis* and *Racoma labiata* each was collected from the Chashma reservoir which were not recorded in the previous studies from this area. They might have been introduced in heavy flood. Similarly, very few specimens of *Tor macrolepis* (Heckle) were found This species has good presentation upstream at Jinnah barrage which has water temperature lower than that of Chashma Barrage.

Although Chashma reservoir falls under the carp's region as described by Mirza & Alam (2000) but presence of Gibleon catla is very limited (0.18%) in this reservoir. This may be due to the self-sustained population of the highly carnivorous species "*Wallago attu*". The population of the *Cirrhinus mrigala* (0.40%) is also very small as compared to the population of *Labeo rohita* (1.90%) which might be due to the presence of its food & space competitor exotic species "*Cyprinus carpio*" (2.50%) which is also a bed feeder,

omnivorous in nature and prolific breeder with good fecundity rate and shares ecological niche with *Cirrhinus mrigala* and other bottom feeder fish species.

Freshwater Fish fauna of Pakistan is represented by 193 number of fish species (Rafique & Khan, 2012). Mirza & Mirza (2014) have described 180 number of fish species from the Indus River in Pakistan. Chashma reservoir is a hot spot of freshwater fish biodiversity and represents about 39% of the fish species found in all the Freshwaters of Pakistan.



Figure 2. Preserved Type specimens

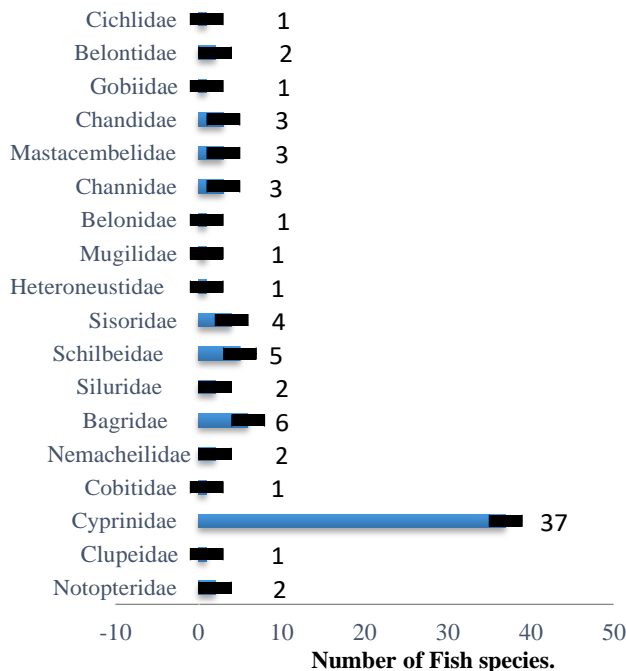


Figure 3. Number of fish species throughout the study period

Conclusion

Although many ichthyologists worked on the fish fauna of river Indus but most of the work is of superficial and casual nature. Therefore, a most comprehensive description is still difficult to be referred and a lot of space exists, which need to be filled through persistent work efforts to make it more understandable for the best management of fish biodiversity. Because biodiversity conservation is now considered as an investment which gives substantive benefits to the society & mankind in shape of food security, revenue generation and sustainability of ecological processes.

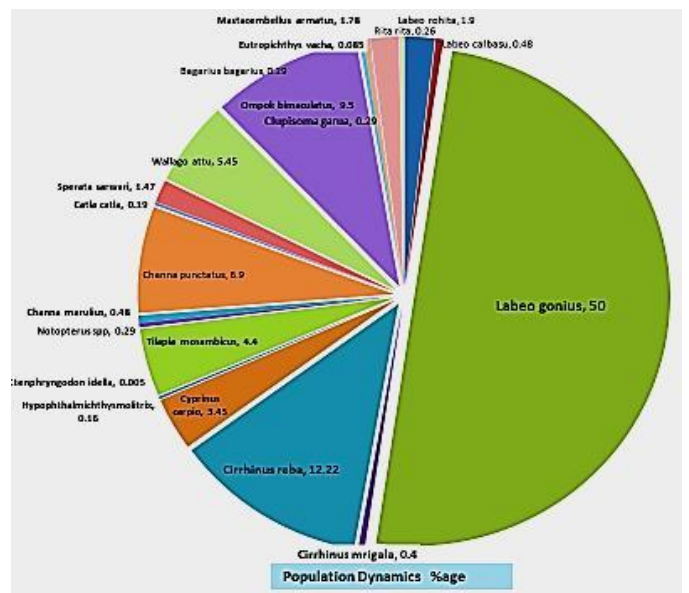


Figure 4. %age Population of Fish species

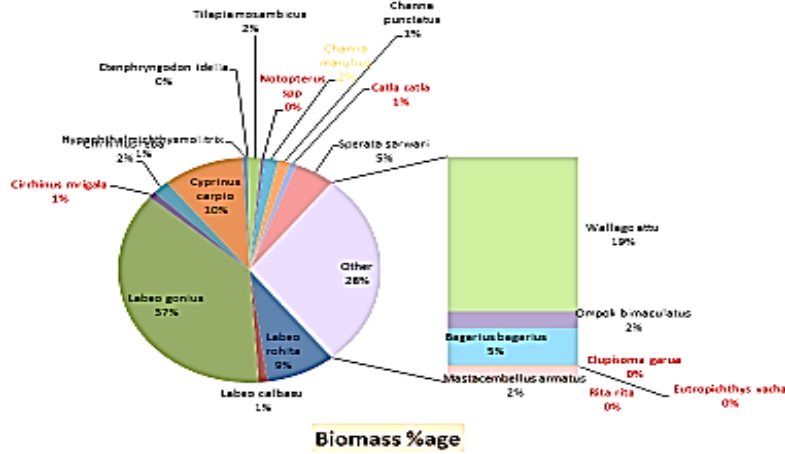


Figure 5. %age Biomass of commercially Harvested Fish species

Table 1. Systematic account of fish biodiversity of chashma reservoir and its status of occurrence

Order	Family	Species	Status
OSTEOGLOSSIFORMES	i-Notopteridae	1- <i>Chitala chitala</i> (Hamilton)	NC
		2- <i>Notopterus notopterus</i> (Pallas)	NC
CLUPEIFORMES	ii-Clupeidae	3- <i>Gudusia chapra</i> (Hamilton)	C
	iii-Cyprinidae	4- <i>Chela laubuca</i> (Hamilton)	NC
5- <i>Chela cachius</i> (Hamilton)		NC	
6- <i>Salmophasia punjabensis</i> (Day)		C	
7- <i>Securicula gora</i> (Hamilton)		NC	
8- <i>Aspidoparia morar</i> (Hamilton)		NC	
9- <i>Amblypharyngodon mola</i> (Hamilton)		NC	
10- <i>Barilius vagra</i> (Day)		C	
11- <i>Barilius pakistanicus</i> (Hamilton)		C	
12- <i>Esomus danricus</i> (Hamilton)		NC	
13- <i>Cirrhinus mrigala</i> (Hamilton)		NC & CU	
14- <i>Cirrhinus reba</i> (Hamilton)		C	
15- <i>Giblion catla</i> (Hamilton)		R & CU	
16- <i>Labeo boga</i> (Hamilton)		R	
17- <i>Labeo calbasu</i> (Hamilton)		R & CU	
18- <i>Labeo diplostomus</i> (Heckle)		R	
19- <i>Labeo dero</i> (Hamilton)		NC	
20- <i>Labeo dyocheiluspakistanicus</i> (Mirza and Awan)		NC	
21- <i>Labeo gonius</i> (Hamilton)		C	
22- <i>Labeo rohita</i> (Hamilton)		C & CU	
23- <i>Naziritor zhobensis</i> (Mirza)		VR	
24- <i>Osteobrama cotio</i> (Hamilton)		C	
25- <i>Puntius chola</i> (Hamilton)		NC	
26- <i>Puntius conchoni</i> (Hamilton)		NC	
27- <i>Puntius sophore</i> (Hamilton)		C	
28- <i>Puntius ticto</i> (Hamilton)		C	
29- <i>Systemus sarana</i> (Hamilton)		NC	
30- <i>Tor macrolepis</i> (Heckle)		VR	

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		31- <i>Crossocheilus diplocheilus</i> (Heckle)	NC
		32- <i>Crossocheilus lalius</i> (Hamilton-Buchanan)	R
		33- <i>Crossocheilus reticulatus</i>	R
		34- <i>Racoma labiata</i> (McClelland)	VR
		35- <i>Carassius auratus</i> (Linnaeus)	VR
		36- <i>Cyprinus carpio</i> (Linnaeus)	C, CU & E
		37- <i>Ctenopharyngodon idella</i> (Valencien)	VR, CU & E
		38- <i>Hypophthalmichthys molitrix</i>	VR, CU & E
	iv-Cobitidae	39- <i>Botia lohachata</i> (Chaudhuri)	VR
	v-Nemacheilidae	40- <i>Nemacheilus corica</i> (Hamilton)	VR
		41- <i>Schistura afasciata</i> (Mirza&Banarese)	VR
SILURIFORMES	vi-Bagridae	42- <i>Rita rita</i> (Hamilton)	R
		43- <i>Batasio pakistanicus</i> (Mirza&Jan)	C
		44- <i>Mystus bleekeri</i> (Day)	NC
		45- <i>Mystus cavasius</i> (Hamilton)	NC
		46- <i>Mystus vittatus</i> (Bloch)	NC
		47- <i>Sperata sarwari</i> (Mirza, Nawaz&Javed)	NC
	vii- Siluridae	48- <i>Ompok bimaculatus</i> (Bloch)	C
		49- <i>Wallago attu</i> (Bloch&Schneider)	C
	viii- Schilbeidae	50- <i>Clupisoma garua</i> (Hamilton)	VR
		51- <i>Clupisoma naziri</i> (Mirza&Awan)	VR
		52- <i>Clupisoma murius</i> (Hamilton)	VR
		53- <i>Eutropichthys vacha</i> (Hamilton)	R
		54- <i>Pseudeutropius atherinoides</i> (Bloch)	R
	ix- Sisoridae	55- <i>Bagarius bagarius</i> (Hamilton)	C
		56- <i>Gagata cenia</i> (Hamilton)	VR
		57- <i>Glyptothorax cavia</i> (Hamilton)	VR
		58- <i>Glyptothorax stocki</i> (Mirza&Nijssen)	VR
	x- Heteroneustidae	59- <i>Heteropneustes fossilis</i> (Bloch)	NC
MUGILIFORMES	xi-Mugilidae	60- <i>Sicamugil cascasia</i> (Hamilton)	R
BELONIFORMES	xii-Belonidae	61- <i>Xenentodon conceal</i> (Hamilton)	NC
CHANNIFORMES	xiii-Channidae	62- <i>Channa gachua</i> (Hamilton)	VR
		63- <i>Channa marulius</i> (Hamilton)	NC
		64- <i>Channa punctata</i> (Bloch)	C
MASTACEMBELIFORMES	xiv- Mastacembelidae	65- <i>Macrogathus pancalus</i> (Hamilton)	VR
		66- <i>Macrogathus aral</i>	VR
		67- <i>Mastacembelus armatus</i> (Lacepede)	C
PERCIFORMES	xv-Chandidae	68- <i>Chanda nama</i> (Hamilton)	C
		69- <i>Pseudambassis baculis</i> (Hamilton)	NC
		70- <i>Parambassis ranga</i> (Hamilton)	C
	xvi- Gobiidae	71- <i>Glossogobius giuris</i> (Hamilton)	NC
	xvii- Belontiidae	72- <i>Colisa fasciatus</i> (Bloch& Schneider)	NC
		73- <i>Colisa lalius</i> (Hamilton)	NC
	xviii- Cichlidae	74- <i>Oreochromis mossambicus</i> (Peters)	NC & E

Note: C=Common NC= Not common R=Rare VR=Very rare CU=Cultured E=Exotic

Table-2. Percentage occurrence of important commercial fish species of Chashma reservoir

Sr. No	Name of Species (Local Name)	Occurrence %	Biomass %
1	<i>Sperata sarwari</i> (Singahri)	1.43	5.00
2	<i>Labeo rohita</i> (Rohu)	1.90	8.60
3	<i>Cyprinus carpio</i> (Gulfam)	2.50	10
4	<i>Tilapia mossambicus</i> (Chirra)	4.40	1.60
5	<i>Wallagu attu</i> (Malli)	5.20	18
6	<i>Labeo gonius</i> (Sariha)	50	37.34
7	<i>Notopterus spp.</i> (Pari)	0.29	0.43
8	<i>Cirrhinus reba</i> (Sohni)	12.17	2.20
9	<i>Ompok bimaculatus</i> (Palu)	9.50	2.10
10	<i>Cirrhinus mrigala</i> (Mori)	0.40	0.96
11	<i>Bagarius bagarius</i> (Mujahid)	0.29	4.70
12	<i>Crossocheilus diplocheilus</i> (Bhangan)	0.59	0.43
13	<i>Heteropneustes fossilis</i> (Lohaata)	0.68	0.16
14	<i>Labeo calbasu</i> (Kalbans)	0.48	1.10
15	<i>Hypophthalmichthys molitrix</i> (Silver carp)	0.16	0.56
16	<i>Channa marulius</i> (Soal)	0.48	1.70
17	<i>Giblion catla</i> (Thaila)	0.18	0.84
18	<i>Ctenopharyngodon idella</i> (Grass carp)	0.004	0.03
19	<i>Clupisoma garua</i> (Bachwa)	0.25	0.14
20	<i>Channa punctatus</i> (Dola)	6.90	1.50
21	<i>Mastacembelus armatus</i> (Baam)	1.68	1.80
22	<i>Eutropichthys vacha</i> (Jhalli)	0.08	0.04
23	<i>Rita rita</i> (Desi Khagga)	0.16	0.20
24	<i>Carassius auratus</i> (Palpat)	0.004	0.001

Conflict of interest

The authors declared absence of conflict of interest.

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