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Characteristics and Distribution of the First Recorded Chirruh Snow Trout, *Shizothorax esocinus* and Khont, *Shizothorax plagiostomus* from River Panjkora at Shaheed Benazir Bhutto University (SBBU), Sheringal, Khyber Pakhtunkhwa, Pakistan

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Abstract: The present study was conducted to determine the characteristics and distribution of the first recorded fish from River Panjkora at Shaheed Benazir Bhutto University (SBBU), Sheringal, Dir Upper (DU), Khyber Pakhtunkhwa (KP), Pakistan from June 2013-July 2014. During the present research, 3 species belonging to 2 families, and 2 genera (n_t=102: total; n_i=61: identified; n_{ui}=41: unidentified) were recorded. Larger family was Cyprinidae, which contained chirruh snow trout, *Shizothorax esocinus* Heckle, 1838 (n= 43) and Khont, *Shizothorax plagiostomus* Heckle, 1838 (n_S= 13). It was concluded that 91.8% of the fish collected from the study area were belonging to Cyprinidae. A detailed study is required for further exploration of fish fauna of River Panjkora, Sheringal, KP, Pakistan with special reference to the taxonomy, physiology and ecology.

Key-words: Cyprinidae, *Shizothorax esocinus*, *Shizothorax plagiostomus*, Sheringal, Siluriformus

Introduction

Fishes are distinct group of aquatic and cold blooded vertebrates with backbone. They have fins for swimming and gills for breathing. Most fishes have scales for protection, and a streamlined body for moving easily in water (Premium, 2009; Perveen and Shah, 2015). They are one of the prime important organisms, which play a key role in economy of many nations, as they have been used in the diet of many people (Essetchi *et al*., 2003; Shaikh *et al*., 2011). In the world, according to their statistic, there are 28,900 species of fresh- and salt-waters fishes, out of these 13,000 are freshwater species (2,513 genera and 170 families). They live in lakes and Rivers that cover only 1%, while the remaining 16,000 species live in salt-water that cover 70% of the earth surface (Leveque *et al*., 2008).

Fishes are classified differently by various zoologists. Some of the classifications are very complex and divide fishes into more than 100 orders and suborders. In the most generally used system, the subphylum Vertebrata is divided into 2 super classes: Agnatha, which includes the lamprey and other fishes without jaws, and Gnathostomata, which includes fishes with hinged jaws. The latter are further divided into the class Chondrichthyes, the cartilaginous fishes such as the sharks, rays and chimaeras,

however, the class Osteichthyes, the bony fishes. The bony fishes are made up of the subclass Sarcopterygii, lobe-finned fishes, and the subclass Actinopterygii, ray-finned (or spiny-finned) fishes. The recent ray fins consist of 2 groups, the Chrondrostei and Neopterygii, which includes the large division Teleostei or modern bony fishes (Bihar *et al*., 2012). According to the recent data, about 179 fish species were found in Pakistan. They belong to 82 genera, 26 families, 10 orders, 5 super classes and 3 cohorts (Mirza and Bhatti, 1999; Akhtar *et al*., 2011). There are 2 exotic and 26 indigenous cold water fish species in Pakistan, mainly restricted to the Khyber Pakhtunkhwa (KP). The stocks of indigenous fish have been threatened by overfishing and deterioration of the environment. Exotic species like brown trout, *Salmo trutta fario* L, 1758 has been established self-reproducing stocks in a number of Rivers, and the rainbow trout, *Onchorhynchus mykiss* Walbaum, 1792 has also been cultured. Indigenous fish protection and domestication are major priorities (Perveen and Shah, 2013; 2015). To raise awareness among the local population about the need to protect fishery resources and social uplift of fishers, which are 2 major areas for future action. Other requirements are the establishment of a database management system, and encouraging regional cooperation and networking to resolve issues of common interest (Yaqoob, 2002).

Sheringal valley is located between the 72°-20° east longitudes and 35°-28° north latitude in Pakistan. Altitude is approximately 2000 m above the sea level. This is a small valley situated northern site of district Dir Upper (DU), KP, Pakistan. Bajauar Agency and Jandool is located toward the west, while it is surrounded by district Swat and Malakand Agency from the East and South, respectively. Total area covered by this hilly valley is 7992.7 hec. The northern part is generally covered with forests. The River Panjkora flows towards the north-south. The climate is extremely cold in winter and warm in summer. The minimum and maximum temperature in January has been recorded as -2.3 and 11.2 °C, respectively (Fig. 1).

The Sheringal is home for a number of wildlife species including mammals such as the snow leopard, *Panthera uncia* (Schereber, 1775); common leopard, *Panthera pardus* (L, 1758); musk deer, *Moschus anhuicnsis* (L, 1758); black bear, *Ursus americanus* (Pallas, 1780); wolf, *Canis lupus* (L, 1758); yellow throated marten, *Martes flaviqula* (Pinel, 1792); red fox, *Vulpes vulpes* (L, 1758); pika, *Ochotona daurica* (Link, 1795); golden marmot, *Marmota caudate* (Geoffroy, 1844) and rhesus monkey, *Macaca mulatta* (Zimmermann, 1780). The Himalayan monal pheasant, *Lophophorus impejanus* (Latham, 1790); Himalayan snow cock, *Tetraoggallus himalayensis* (Gray, 1848) and snow partridge, *Lerwa lerwa* (Hodgson, 1837) are some of the key bird species found here. At different elevation, different types of vegetation occur in Sheringal. The blue pine, *Pinnus wallichiana* (Jacks, 1839) is dominated species with scattered trees of Himalayan cedar, *Cedrus deodara* (Don, 1831) with frequent occurrence of Himalayan popular, *Populous ciliatae* (Royle, 1888) (Hazrat *et al*., 2011). The objective of the present research is to determine the characteristics and distribution of the first recorded 2 fish of genus, *Shizothorax* for educating and creating awareness in the people of Sheringal about the importance of fish.

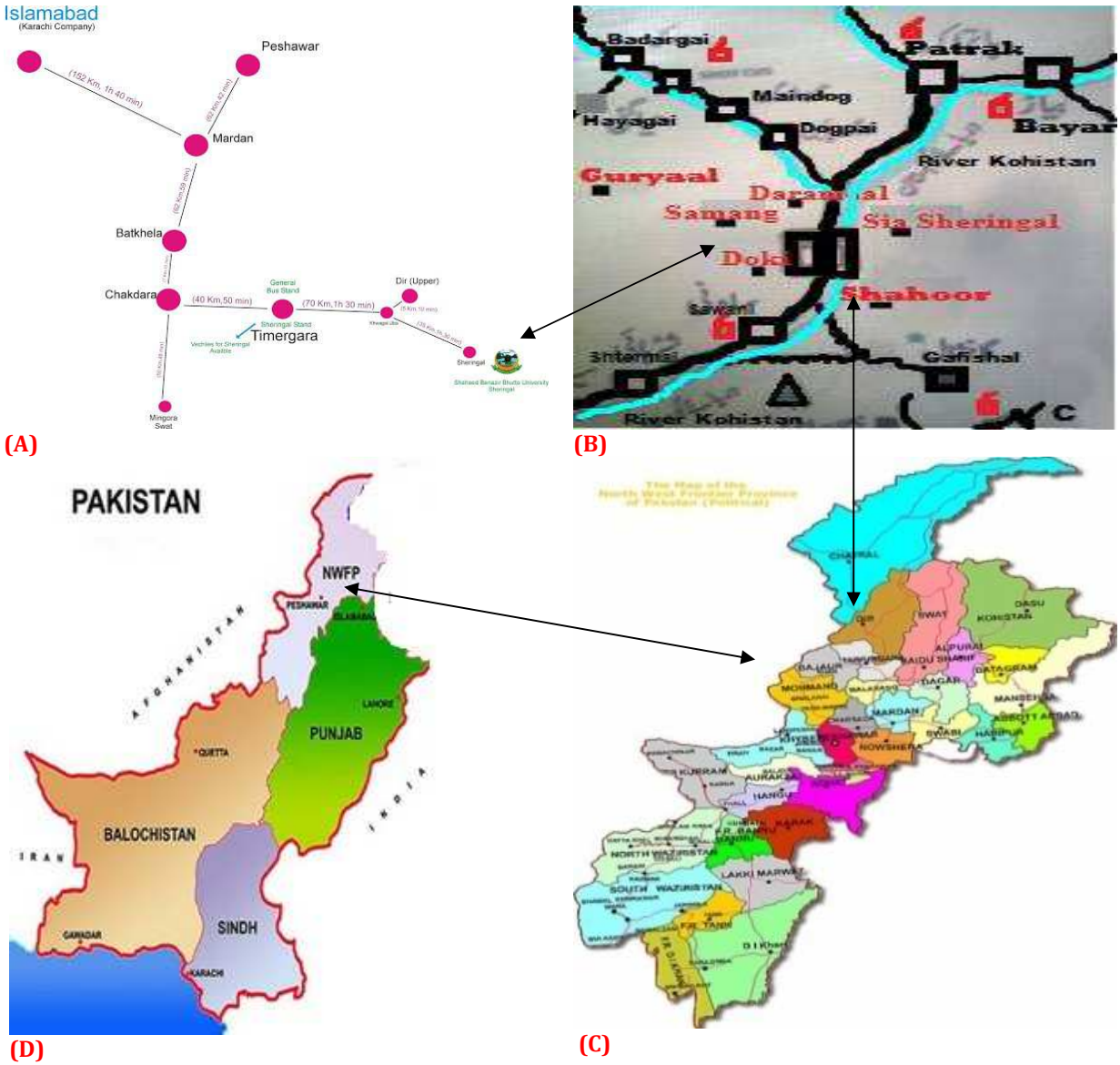

Fig. 1 Characteristics and distribution of the first recorded 2 fish of genus *Shizothorax* of River Panjkora at Sheringal, Dir Upper, Khyber Pakhtunkhwa (KP), Pakistan (PK): arrows show map of the study area: **A**) map of Shaheed Benazir Bhutto University (SBBU), where the present research was conducted; **B**) map of Sheringal where SBBU is located; **C**) map of KP, which is one of the provinces of Pakistan and; **D**) map of PK (Online, 2013).

Materials and methods

Study area

The people of Sheringal, Dir Upper (DU), Khyber Pakhtunkhwa (KP), Pakistan (PK) usually concern with agriculture. Total area covered by this hilly valley is 7992.7 acres. The population is about 20,000 and literacy rate is 51%. River Panjkora flows, meanderingly, through this lush green valley. Its average depth is about 3 feet, while width is 15-25 feet. It is located northern in KP and north- western in Pakistan. It raises high in the Hindu Kush and flows south through DU and Lower Dir (LD) districts and joins the Swat River near Chakdara, Malakand, KP. The present research was conducted during June 2013-August 2014 in the study area, River Panjkora located in Sheringal, DU, KP, PK (Fig. 1; Hazrat *et al*., 2011).

Collection and photography

The first time fishes were collected (n=61) from different sites of River Panjkora at

Shaheed Benazir Bhutto University (SBBU), Sheringal. The collection was made for 3 months daily basis during October-December 2013. During collection, different types of instruments were used like hand net, cast net, hooks, and other locally adopted methods were also used. The collected fish were brought to the laboratory (Department of Zoology, SBBU, Sheringal, DU, KP, Pakistan) and were fainted by mortin® (CIC interpriser, Lahore, Pakistan) in a bottle. Then pictures of the fishes (dorsal, ventral and lateral sites) were taken with the camera® (Nikon, Tokyo, Japan: 12 mega pixel lense) (Perveen and Uddin, 2015a, b, c).

Identification and tagging

The first collected fish from the River Panjkora at Sheringal were identified with the help of keys (Mirza and Sandhu, 2007; Jayaram, 1999), literature available, experts, pictorials, already identified specimens and internet, and then they were tagged (Perveen and Uddin, 2015a, b, c).

Morphometry and deposition

The morphometric measurements of total body length, standard length, fork length and diameter of fishes were calculated with the help of measuring scales and vernier calipers, respectively. These specimens [n_t=102 (total); n_i=61 (identified)] were preserved in 10% formalin solution. The specimens were deposited in Laboratory cum Museum, DOZ, SBBU (Perveen and Uddin, 2015a, b, c).

Results

River Panjkora

The Panjkora is a river in northern KP (northwestern), Pakistan. It rises high in the glaciers of Hindu Kush Mountains and flows downstream south through Upper Dir and Lower Dir. The Panjkora Valley contains important sites of the Gandhara grave culture (Fig. 2).

During the present research, the first time collected specimens were belonging to chirruh snow trout, *Shizothorax esocinus* Heckle, 1838 ($n_{S. esocinus}$=43); Khont, *Shizothorax plagiostomus* Heckle, 1838 ($n_{S. plagiostomus}$=13) and Chukaysary, *Nangra robusta* Mirza and Awan, 1973 ($n_{N. robusta}$=5) which was discussed in another paper. However, due to unavoidable circumstances 41 specimens has been spoiled and remained unidentified. Moreover, identified specimens (n_i=61) were belonging to 2 families, further, the dominant family was Cyprinidae ($n_{Cyprinidae}$=56), furthermore, the less number of species were recorded from family Sisoridae ($n_{Sisoridae}$=5).

Fig. 2: The study area River Panjkora at Shaheed Benazir Bhutto University (SBBU), Sheringal, Dir Upper (DU), Khyber Pakhtunkhwa (KP), Pakistan where the first collection of fish fauna was recorded for the present research

The characteristics of species of the genus *Shizothorax* collected during the present research are as follows:

Chirruh snow trout, Shizothorax esocinus

The chirruh snow trout, *Shizothorax esocinus* Heckle, 1838 was collected (n=43) from River Panjkora at SBBU, Sheringal, DU, KP, Pakistan during the present research. The body of fish is grayish-brown on the dorsal side and yellowish below, dorsal and caudal fins are grayish and other fins are pinkish. Its morphometric measurements were- total body length 18±3 cm, fork length 16±2 cm, standard length 14±2.3 cm and diameter 3.4±0.5 cm. Furthermore, its fin formula was dorsal 4/8, pectoral 20, ventral 11, anal 3/5, caudal 19 and lateral lines 98 in number. It has an elongated sub cylindrical body with

short, blunt and slightly prognathous upper jaw. However, ventral surface of head and anterior part of body is flattened, short, somewhat cone shaped and blunt. Moreover, snout is usually smooth. During breeding season, male fish possesses small nodes like structures on the upper side of snout, which are called warys. They are sensory organs used for keen caution, watchful prudence and detection of strangers etc. Further, inter-orbital space is broad and flat. Dorsal fin is inserted opposite to pelvic fins, its last undivided ray is osseous, strong and serrated posterior, short than head. Additionally, caudal fin is deeply emarginated. Though, scales are very small and elliptical shape (flattened circle or not cycloid shape or rounded with irregular margin made up of fats (lipids). On the other hand, caudal fins may be continuous with one or both dorsal and anal fins. However, the anal fin is generally single and short, positioned between anus and caudal fin (Fig. 3).

Distribution

It was usually found in the hilly parts of KP, northern areas, northern hilly areas in the Indus River and its tributaries up to Chasma Barrage, Punjab, River Gomal, Zhob, head water of the River Bolan up to Bibi Nani, northeastern parts of Baluchistan of Pakistan, Afghanistan, Iran, Indus system, India, Tibet and China (Fig. 3).

Local

This species was reported from River Swat, KP by Ishaq *et al*. (2014); from Khwaza Khela, Fatehpur, Madyan and Kalam of River Swat, KP by Sohail *et al*. (2014); from Konhaye stream district DL, KP by Ullah *et al*. (2014); and from Shakarparian, Islamabad by Rafique and Khan (2012).

Worldwide

This species was reported from Kashmir Himalaya by Mir *et al*. (2013); from Kashmir, Srinagar, India by Kausar *et al*. (2012); from River Jhelum in Kashmir, India by Qureshi *et al*. (2007); from Dal lake, Manasbal and River Jhelum of Kashmir, India by Dar *et al*. (2015); in Mizoram, tripura and barak drainage of the north-eastern India by Kar and Sen (2006); from the north-east India, inclusive of the Himalayan and Indo-Burma Biodiversity Hot-Spots Zones (BHSZ) by Goswami *et al*. (2012) and from West Bengal by Mahapatra *et al*. (2015) (Fig. 3; Table 1).

Systematic classification		
Phylum	:	Chordate
Sub-phylum	:	Vertebrata
Super-class	:	Actinopterygii
Class	:	Pisces
Sub-class	:	Neopterigii
Super- order	:	Ostariphysi
Order	:	Cypriniformes
Family	:	Cyprinidae

Fig. 3. Classification, characteristics and distribution of the first recorded Chirruh snow trout, *Shizothorax esocinus* Heckle, 1838; a: dorsal; b: ventral; and c: lateral sides from River Panjkora at Shaheed Benazir Bhutto University (SBBU), Sheringal, Dir Upper (DU), Khyber Pakhtunkhwa (KP), Pakistan was collected during June 2013-August 2014; bars on photographs indicate 10 cm.

Table 1: The chirruh snow trout, *Shizothorax esocinus* Heckle first record from Panjkora River at Shaheed Benazir Bhutto University (SBBU), Sheringal, Dir Upper, Khyber Pakhtunkhwa, Pakistan during June 2013-August 2014

SNo	Scientific name	n*	Total length M±SD* (cm)*	Fork length M±SD* (cm)*	Standard length M±SD* (cm)*	Dm* M±SD* (cm)*	Date of collection	Status
1.	*Shizothorax esocinus*	43	18±3*	16±2*	14±2.3*	3.4±0.5*	1/6/2013-30/8/2014	F*
		Lateral line No*	**Dorsal fin formula**	**Anal fin formula**	**Pectoral**	**Ventral**	**Caudal**	**Native**
		98	4/8	3/5	20	11	19	Asia
		H.L	**E.D**	**P.O.L**	**B.D**	**Environment**	**Ecology**	**Range**
		4	0.8	0.3	4	freshwater	benthopelagic	tropical
		IUCN status				**Threat to human**		
		not evaluated				harmless		

*n: number of specimen collected; Dm: diameter; HL: Head Length; ED: Eye Diameter; POL: Post Orbital Length; BD: Body Depth; M: mean; SD: standard deviation; cm: length and Dm measured in centimeter; No: number; F: frequent; data were analyzed by MS Excel at $P<0.01$;

Khont, Shizothorax plagiostomus

The khont, *Shizothorax plagiostomus* Heckle, 1838 was collected (n=13) from River Panjkora at SBBU, Sheringal, DU, KP, Pakistan. It was grayish-brown on the dorsal side, yellowish below, dorsal and caudal fins are grayish, and other fins are pinkish. The morphometric measurements were- total body length 17±4 cm, fork length 15±2 cm, standard length 12.4±1.4 cm and dm was 3±1 cm. The fin formula is dorsal 4/8, pectoral 20, ventral 11, anal 3/5 caudal 19 and lateral lines 110 in number. The numbers of scales above lateral lines are more than 29 rows and below lateral line are more than 22 rows. It is a species of ray-finned fish in the genus *Schizothorax*, therefore, it has an elongated sub-cylindrical body with short, blunt and slightly prognathous upper jaw. However, ventral surface of head and anterior part of body is flat, short, somewhat cone- shaped and blunt. Moreover, its snout is usually smooth. During breeding season, male fish possesses small nodes like structures on the upper side of snout, which are called warys. They are sensory organs used for keen caution, watchful prudence and detection of strangers etc. Further, its inter-orbital space is broad and flat. The mouth is inferior, wide and slightly arched, although, lips are fleshy, continuous, marginally sharp and attenuated. Lower lip with papillae and reflected from jaw, the margin of lower lip sharp, covered with firm and hard horny cartilage. Furthermore, a strip of papillae labial plate is present at chin. There are 2 pairs of arbells. Its' pharyngeal teeth are in 3 rows. Dorsal fin is inserted about opposite to pelvic fins. Its last undivided ray is osseous, strong and serrated posterior, short than head. In addition, caudal fin is deeply emarginated. However, scales are very small and elliptical shape (flattened circle or not cycloid shape or rounded with irregular margin made up of fats (lipids) (Fig. 4).

Distribution

It was usually found in mountain and Rivers. It is distributed in hilly parts of KP, the northern hilly areas in the Indus River and its tributaries up to Chasma Barrage, Punjab, River Gomal, Zhob, and head water of the River Bolan up to Bibi Nani, north-eastern parts in Baluchistan of Pakistan, Afghanistan, Iran, Indus system, India, Tibet and China (Fig. 4).

Local

This species was reported from Allai Khoar by Mirza (2006); from Shakarparian, Islamabad, Pakistan by Rafique and Khan (2012); from Behrain, Madyan, Fateh Pur, Khwaza Khela, Fizagat, Kanju and Barikot, Swat, KP, PK by Ahmad *et al*. (2014).

Systemic classification		
Phylum	:	Chordate
Sub-phylum	:	Vertebrata
Super-class	:	Actinopterygii
Class	:	Pisces
Sub-class	:	Neopterigii
Super order	:	Ostariphysi
Order	:	Cypriniformes
Family	:	Cyprinidae

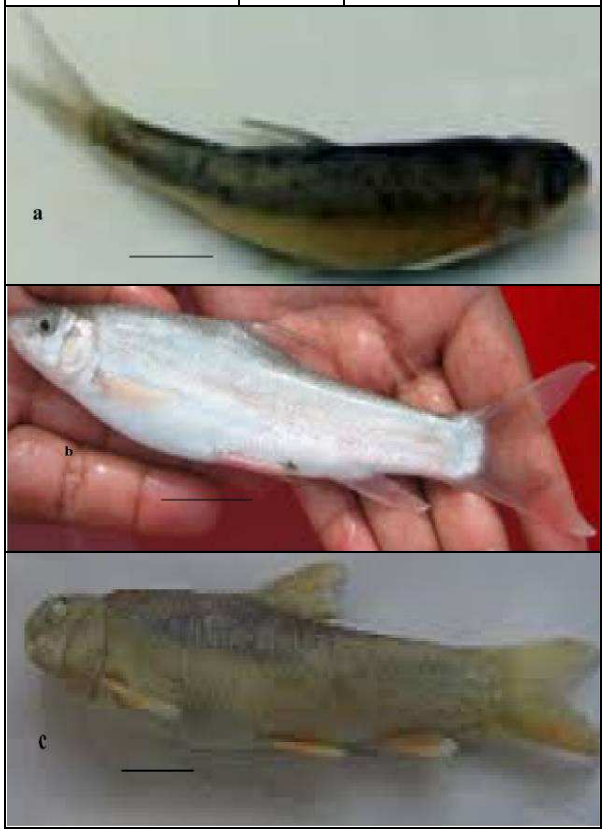

Fig. 4: Classification, characteristics and distribution of the first recorded Khont, *Shizothorax plagiostomus* Heckle, 1838; a: dorsal; b: ventral; and c: lateral sides; of River Panjkora at Shaheed Benazir Bhutto University (SBBU), Sheringal, Dir Upper (DU), Khyber Pakhtunkhwa (KP), Pakistan was collected during June 2013-August 2014; bars on photographs indicate 10 cm.

Worldwide

This species was reported from Kashmir Ladakh, Kashmir by Dar *et al*. (2013); from River Jhelum in Kashmir, India by Qureshi *et al*. (2007); from Mizoram, Tripura and Barak drainage of the north-eastern India by Kar and Sen (2006); from north-east India, inclusive of the Himalayan and Indo Burma, Biodiversity hotspots zones by Goswami *et al*. (2012); from West Bengal by Mahapatra *et al*. (2015); from River Alaknanda of Garhwal Himalaya, Srinagar, India by Agarwal *et al*. (1988) and from River Jhelum, Chattabal and Kadalbal, Kashmir, India by Jan *et al*. (2014) (Fig. 4; Table 2).

Discussion

In the present study, characteristics and distribution of the first recorded fishes of River Panjkora near SBBU, Sheringal, DU, KP, Pakistan was conducted during June 2013-August 2014. For this, fishes samples (n=61) were collected from both sites (East and South) of River. However, 3 species under 2 genera, 2 families and 2 orders were recorded.

Muhammad *et al*. (2014) reported fish species belonging to 4 orders and 4 families from River Panjkora at DU. The richest family was Cyprinidae (*Shizothorax esocinus*, *Racoma labieta*, *Shizothorax plagiostomus*, *Crossocheilus diplocheilus*, *Barilius pakistanicus* and *Carassius auratus*) followed by Sisoridae (*Gara gotyla*, *Gagata cenia* and *Glyptothorax punjabensis*). The family Channidae and Salmonidae were comprised of one species each, *Channa punctata* and *Onchoryncus mykiss*, respectively. In the present ichthyofauna study, the dominant family was Cyprinidae represented by 2 species (*S. esocinus* and *S. plagiostomus*) followed by family Sisoridae represented by only 1 species (*N. robusta*). Less number of species was observed in the current study, which may be due to limited area and short timing for collection.

Table 2: The khont, *Shizothorax plagiostomus* Heckle first record from Panjkora River at Shaheed Benazir Bhutto University (SBBU), Sheringal, Dir Upper, Khyber Pakhtunkhwa, Pakistan during June 2013-August 2014

Sno	Scientific name	n*	Total length M±SD* (cm)*	Fork length M±SD* (cm)*	Standard length M±SD* (cm)*	Dm* M±SD* (cm)*	Date of collection	Status
2.	*Shizothorax plagiostomus*	13	17±4*	15±2*	12.4±1.4*	3±1*	1/6/2013-30/8/2014	N*
		Lateral line No*	**Dorsal fin formula**	**Anal fin formula**	**Pectoral**	**Ventral**	**Caudal**	**Native**
		110	4/8	3/5	20	11	19	Asia
		Environment		**Ecology**	**Range**	**IUCN status**	**Thread to human**	
		freshwater		benthopelagic	Tropical	not evaluated	harmless	

*n: number of specimen collected; Dm: diameter; M: mean; SD: standard deviation; cm: length and Dm measured in centimeter; N: normal; No: number; data were analyzed by MS Excel at $P<0.01$.

Hasan *et al*. (2013) worked on River Swat and reported fish (n=50) species consisting of 16 edible fish species including *Carassius auratus*, *Channa gachua*, *Corydoras punctatus*, *Crossocheilus diplocheilus*, *Clupisoma garua*, *Clupisoma naziri*, *Cyprinus carpio*, *Eutropiichthys vacha*, *Labeo diplostomus*, *Mastacembuls armatus*, *Mystus bleekeri*, *Oncorhynchus mykiss*, *Racoma labiata*, *Salmotrutta fario*, *Schizothorax plagiostomus* and *Tor macrolepis* after their survey from 2004-2010. In the present study, the total numbers of species collected were 3. All of them were edible, i.e., *S. esocinus* and *S. plagiostomus* and *N. rhobusta* and no non-edible fish were found. It shows that the numbers of edible fish diversity are less as compared to non-edible fish noticed by Hasan *et al*. (2013). The difference in the results may be either due to variation in the environment or natural disaster such as flood, which occurred in 2010 at River Panjkora, Sheringal, DU and a lot number of fishes were lost during that time.

Bhat *et al*. (2005) investigated the biology of fishes of River Lidder (Jammu and Kashmir) during 2003-2005. Seven species of fishes were collected from the River, out of which, 3 was commercially important species, i.e., *Schizothorax plagiostomus* (n=133), *Schizothorax esocinus* (n=70) and *Schizothorax labiatus* (n=40). In the present ichthyofauna study, the observed commercially important species collected belong to family Cyprinidae, i.e., *S. plagiostomus* (n=13) and *S. esocinus* (n=43), which shows somewhat similarity in both studies.

The family Cyprinidae species like *S. plagiostomus* and *S. esocinus* distribution were reported from Allai Khoar by Mirza (2006); from Shakarparian, Islamabad, Pakistan by Rafique and Khan (2012); from Behrain, Madyan, Fateh Pur, Khwaza Khela, Fizagat, Kanju and Barikot Swat, KP, PK by Ahmad *et al*. (2014). They were also reported from Kashmir Ladakh by Dar *et al*. (2013); from River Jhelum in Kashmir, India by Qureshi *et al*. (2007); from Mizoram, tripura and Barak drainage of Northeastern India by Kar and Sen, (2006); from North East India, inclusive of the Himalayan and Indo Burma biodiversity hotspots zones by Goswami *et al*. (2012). In the present study, Cyprinidae species such as *S. plagiostomus* and *S. esocinus* were the first time collected from River Panjkora near SBBU, Sheringal, DU, KP, PK, which shows close similarity in both studies.

The present study is the first report, in which the fishes were collected first time from River Panjkora at Sheringal near SBBU. Presently, the collection was made for very limited period, i.e., during October-December 2013, During mentioned period, collection of fishes was very difficult because they were dwelling in the bottom of the River. In the present study, a total of 102 (N) fishes were collected, however, out of which 61 (n) were identified, thus 41 fishes were unidentified because they were damaged due to unavoidable circumstances. Further, 3 species belong to 2 families, and 2 genera were first time recorded from this River near SBBU at Sheringal. In 2010, there was a great flood in River Panjkora at Sheringal near SBBU. A very large area was affected with great destruction of property, animals, farming, poultry and belongings etc. In the mean time, ichthyofauna of the area was also greatly affected. In addition, in both side of River Panjkora, fishers and other people do fishing by generating strong electric shocks made by generators to collect the great number of fishes. On the other hand, people of Sherigal are mostly illiterate; therefore, they poured every type of garbage in the River, which is not only polluted the water of River as well as harm to fish fauna of River. Therefore, at the present, only 3 different species were collected. Therefore, great measures should be required to conserve ichthyofauna in this River at Sheringal near SBBU.

Conclusion/Recommendations

For further exploration of fish fauna of River Panjkora, Sheringal, KP, Pakistan, a detail study is required. The community of Sheringal should be educated to create awareness about the importance and conservation of fishes. The fish diversity can be improved by monitoring the fish fauna regularly in River Panjkora. The following specific suggestions at the local level must be taken: 1) The rules regarding fishing in River Panjkora need to be established and oriented more towards protection, should be reinforced to the community, 2) Monitoring the factors behind poor reproduction and adding new stocking fish, 3) Fishing during breeding season and catching non-marketable size fish should be avoided for enhancing fish fauna of the river, 4) Expand cooperation and collaboration among ichthyologists, conservationists and fishermen working in the breeding range of fish populations, 5) The eco-tourism measures should be improved and extend public education programs involving fishermen, 6) For preserving water quality, River Panjkora should be protected from agro-industrial chemicals, discharge of pollutants, throw of garbage and drain of sewage, and house-hold pollutions etc., 7) Rangers or security guards should be appointed and placed at adequate distances throughout the River Panjkora, who look after illegal fishing, 8) More research as should be conducted with special reference to the taxonomy, physiology and ecology of fishes.

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