

ORIGINAL ARTICLE

Fish diversity in rivers, streams, and springs of Buner district along the Indus River, Khyber Pakhtunkhwa, Pakistan

Awal SYED^{1,2}, Amina ZUBERI¹, Zaigham HASAN³,
Muhammad AHMAD¹, Layaq JAN³, Muhammad NOORULLAH¹, Muhammad KAMRAN⁴,
Muhammad ALTAF^{5*}

¹Fisheries and Aquaculture Program, Department of Animal Sciences, Quaid-i-Azam University, Islamabad, 45320, Pakistan.

²University of South Bohemia in České Budějovice, Faculty of Fisheries and Protection of Waters, South Bohemian Research Centre of Aquaculture and Biodiversity of Hydrocenoses, Research Institute of fish culture and Hydrobiology, Zátěží 728/II, 389 25 Vodňany, Czech Republic.

³Department of Zoology, University of Peshawar, Peshawar, Pakistan.

⁴Department of Biology, East Carolina University, Greenville, North Carolina, 27858-4353, USA.

⁵Institute of Forest Sciences, The Islamia University of Bahawalpur, Bahawalpur, Pakistan.

Correspondence

altaf_mughal450@yahoo.com

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Abstract

The present study investigated the ichthyodiversity of 7 streams, 2 springs, and the River Barandu, located in the northwestern region of Pakistan. A field survey was conducted, followed by collection using cast nets, scoops, dragnets, gill nets, and mesh cloth. Overall, identified specimens belonged to 22 species within 5 families and 4 orders. Out of these, *Ctenopharyngodon idella*, *Puntius ticto*, *Crossocheilus diplochilus*, *Puntius conchonus*, and *Labeo calbasu* were recorded from the River Barandu; *Puntius ticto*, *Crossocheilus diplochilus*, *Puntius conchonus*, *Barilius modestus*, and *Schistura naseeri* were recorded from Chagharzi Stream; and *C. diplochilus*, *P. ticto*, *Barilius vagra*, *B. modestus*, and *Schistura alepidota* were recorded from the site of Chamla for the first time in these particular areas. During the investigation, it was noted that the highest number of species and specimens were documented from Chagharzi and Chamla, while the highest dominance was recorded at Surhaw ($D=0.53$). The results showed a loss of some previously recorded species from the same locations and suggested protective conservation measures.

Keywords: Fish fauna, Streams, River Barandu, Species, Richness, Diversity

INTRODUCTION

The distribution and abundance of species depend on habitat features, including biotic and abiotic factors (Arunachalam 2000). Hence, the degree of spatial or temporal variability in factors such as water depth, substrate characteristics, water current velocity, food availability, and interspecific and intraspecific interactions contributes to habitat diversity (Ahmad et al. 2011). Higher habitat diversity supports greater biomass and species diversity (Lyons & Schneider 1990). Thus, less disturbed sites are characterized by diverse fish faunas across a variety of habitats (Lakra et al. 2010), whereas altered or degraded habitats support fewer biological communities.

Since the 1990s, the loss of biological diversity due to habitat destruction has emerged as a major issue worldwide. With the increase in human population

and urbanization, freshwater resources are more prone to habitat degradation, overexploitation, and pollution than seawater, leading to a severe decline in freshwater fish diversity and abundance. Habitat degradation can be assessed using fish assemblages (Ahmad et al. 2011), whereas changes in fish assemblage diversity can be used to quantify ecosystem disturbances.

Pakistan has abundant freshwater resources comprising 73% of the total 780,000 hectares of wetland (IUCN 1989; Altaf et al. 2014). These resources include 193 freshwater fish species belonging to 86 genera (Rafique 2007). Among them, 31 species are economically important (Rafique & Khan 2012). Pakistan has a high diversity of fish fauna (Altaf 2016; Altaf 2021) but is unfortunately facing the problem of loss of fish species richness and

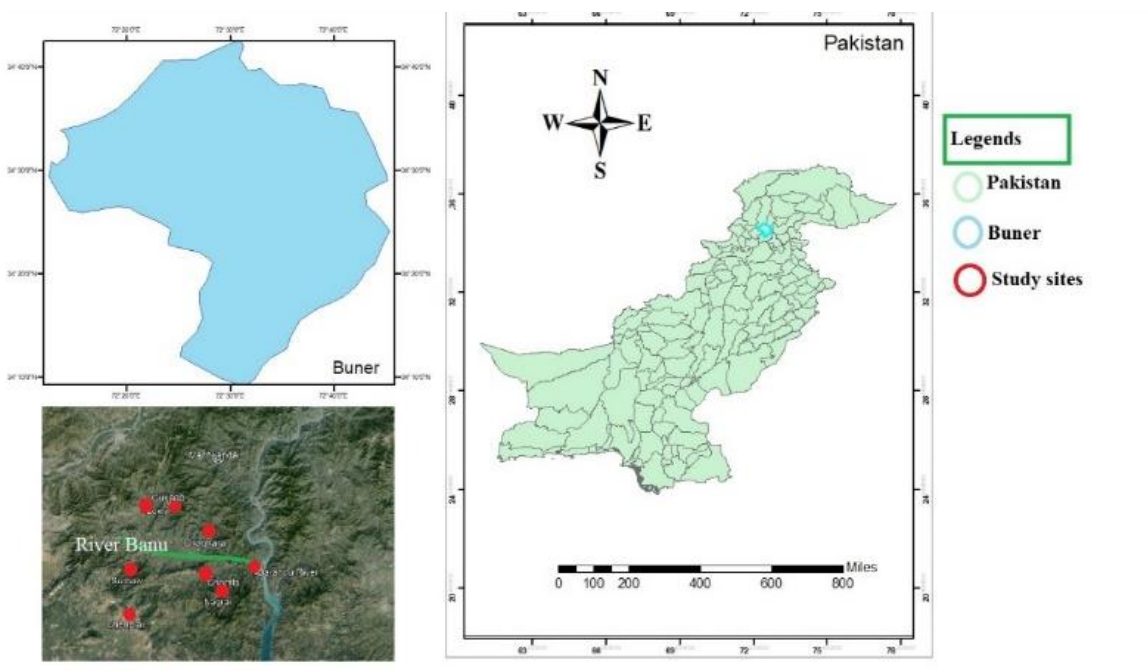


Fig.1. Map of the study area.

evenness due to habitat destruction (Moyle & Leidy 1992), invasive species (Imran et al. 2021; Abideen et al. 2023), pollution (Ilyas et al. 2023), overexploitation (Altaf et al. 2021; Iqbal et al. 2023; Muhammad et al. 2023; Ali et al. 2024), and the initiation of hydroelectric projects (Rafique & Khan 2012). This situation reflects the need for assessment and resource conservation.

The entire fish fauna of the Buner district is unknown. Previously, it was reported, based on selected sites that it is rich in fish fauna, but due to anthropogenic activities, agricultural runoff, etc., it faces a significant threat (Saeed et al. 2013; Akhtar et al. 2015). Here, an attempt has been made to investigate the status of the ichthyofauna of River Barandu, to explore additional aquatic resources (springs and streams), and to update the existing list reported in many investigations (Saeed et al. 2013; Akhtar et al. 2014; Hasan et al. 2014; Din et al. 2016).

MATERIALS AND METHODS

Study area: River Barandu is the largest river in the district of Buner (Hamayun et al. 2003), originating from the Dosara and Elum mountains and fed by many streams and springs across the district. It is the main source of water for irrigation, drinking, and

industry in the Buner valley (Said 2000; Hamayun et al. 2003). Four streams, Gukand, Machkandai, Lowy, and Chagharzi, flow into River Barandu at Sonigram, Elai, and Rial villages, respectively. The Chamla stream originates from the Ambela, Mandaw, Nawagai, Sorah, Agarai, Koza Nawagai, Amazokoto, Jangai, and Korea streams and joins the Dara Stream at the Banjal Malasar point, which then joins the Nagrai Stream at the Karh point. The Nagrai stream originates from the Malka Mountains and joins River Barandu at Mujahideen point. The Chenglai stream originates from the Bawo and Balethar streams, which join each other at Baba Ziarat or Dambarai point, with the Sheikh Mamo stream at Dabando, and at Dandar point with the Chenglai stream, and finally links with the Terbeli dam to Bekay. Moreover, the Garu and Surhaw springs originate from the Banda and Surhaw mountains, respectively. However, these springs are not connected with River Barandu or other streams. Finally, River Barandu joins with the Abaseen at the Kala Daka or Torghar point (Fig. 1).

Climate: The climate of Buner district is moderate. The summer season is short and mild; the climate is hot in lower Buner (Ambele) but pleasant in the upper parts (Gadezai and Gokand). During the

Table 1. All species with their family, order, local name, scientific name, common name abundance and IUCN status.

Sr.	Family/Order	Species/ Common name	Status	Barandu	Chenglai	Chamla	Chagharzi	Nagrai	Lowy	Machkandai	Gukand	Surhaw	Garu	Total	Percentage
1	Cyprinidae/Cypriniformes	<i>Barilius pakistanicus</i> / Pakistani chilwa	NE	0	1	3	10	3	20	5	14	0	0	56	7.48
2		<i>Barilius vagra</i> / Lahori chilwa	LC	0	0	0	6	0	3	4	0	0	0	13	1.73
3		<i>Barilius modestus</i> / Lahori chilwa	NE	0	0	1	7	0	0	2	0	0	0	10	1.33
4		<i>Crossocheilus diplocheilus</i> / Dogra	NE	71	5	6	7	4	0	0	0	0	0	93	12.43
5		<i>Cyprinus carpio</i> / Common carp	VU	1	0	0	0	0	0	0	0	0	0	1	0.13
6		<i>Ctenopharyngodon idella</i> / Grass carp	NE	1	0	0	0	0	0	0	0	0	0	1	0.13
7		<i>Danio devario</i> / Zebra fish	NE	0	1	0	0	0	0	0	0	0	0	1	0.13
8		<i>Labeo calbasu</i> / Kalbans	LC	1	0	0	0	0	0	0	0	0	0	1	0.13
9		<i>Puntius ticto</i> / Ticto popra	LC	10	40	20	39	1	0	5	17	0	0	144	19.25
10		<i>Puntius conchoni</i> / Rosy barb	LC	4	27	25	0	0	0	24	0	0	0	80	10.69
11		<i>Puntius sophore</i> / Sophora popra	LC	2	13	0	0	0	0	0	0	0	0	15	2.00
12		<i>Puntius chola</i> / Chola popra	LC	0	20	0	0	0	0	0	0	0	0	20	2.67
13		<i>Schizothorax plagiostomus</i> / Swati	NE	4	0	0	50	0	0	0	14	0	0	68	9.09
14		<i>Tor putitora</i> / Indus golden mahasher	EN	11	0	0	0	0	0	0	0	0	0	11	1.47
15	Channidae/ Channiformes	<i>Channagachua</i> / Duli	LC	0	1	1	0	0	0	1	1	3	0	7	14.43
16	Mastacembelidae/ Mastacembeliformes	<i>Mastacembelus armatus</i> / Eel	LC	0	0	2	1	0	0	0	2	0	0	5	5.88
17	Cichlidae/ Perciformes	<i>Oreochromis mossambicus</i> / Mozambique Tilapia	NT	0	14	0	0	0	0	0	0	0	0	14	0.40
18	Nemacheilidae/ Cypriniformes	<i>Schistura alepidota</i> / Sundali	NE	0	0	0	2	0	14	0	2	60	30	108	6.55
19		<i>Schistura naseeri</i> / Sundali	NE	0	0	6	0	2	0	3	0	15	18	44	0.53
20		<i>Schistura arifi</i> / Sundali	NE	0	0	0	0	0	0	0	0	3	0	3	0.93
21		<i>Schistura nalbanti</i> / Sundali	NE	0	0	0	0	0	0	0	0	4	45	49	0.66
22		<i>Schistura prashari</i> / Sundali	NE	0	0	0	0	0	0	0	0	0	4	4	1.87

summer season, temperatures seldom rise above 44°C. However, the winter season is very cool and extends from November to February (Hamayun et al. 2003), with temperatures gradually dropping to 20°C. **Fish collection:** To collect data on fish diversity in seven streams (Chamla, Chagharze, Gukand, Chenglai, Machkandai, and Lowy), two springs (Garu and Surhaw), and a river (Barandu), fish were collected every week from October 2017 to January 2018 with the assistance of local fishermen using cast nets and drag nets (mesh size 2cm²), scoop nets (mesh size 1cm²), and mesh cloth. Direct (total count) methods were used to monitor population abundance at the study sites, and photographs of the fish were

taken at the time of collection with a digital camera (Nikon D5200). Fish were preserved in 10% formalin and brought to the Fisheries Laboratory at the University of Peshawar for identification. The fish were identified using taxonomic keys, including the Freshwater Fish of the Indian Region (Jyaram 1999), Fishes of Punjab, Pakistan (Mirza & Sandhu 2007), Inland Fishes of India and Adjacent Countries (Talwar & Jhingran 1991), and Freshwater Fishes of Pakistan (Mirza 1990). During the survey, coordinates and elevation of the sample collection area were also recorded using GPS (Table 1).

Statistical analysis: The diversity indices richness, Simpson (S), Shannon-Wiener diversity (H'),

Evenness (E), Margalef (R), and Dominance (D) were calculated using the statistical software PAST (version 2.17c) (Hammer 2001).

RESULTS AND DISCUSSION

The number of fish species caught at different sites, along with their local and common names, families, orders, and conservation statuses, is listed in Table 2. A total of 748 fish were captured across all selected sites, belonging to 22 species, 13 genera, 5 subfamilies, 5 families, and 4 orders. The Cyprinidae appeared as the dominant family with 14 species, followed by Nemachilidae with 5 species, while Cichlidae, Channidae, and Mastacembelidae were rare families with 1 species each (Fig. 2, Table 1).

The research reveals that Chagharzi and Chamla exhibited the highest species diversity and the largest number of samples collected among all the sites surveyed. In contrast, Surhaw demonstrated the highest dominance ($D = 0.53$), indicating lower species diversity but greater abundance. Diversity indices showed spatial variations: Chenglai had the highest Simpson diversity index ($S = 0.7902$), Chamla recorded the highest Shannon-Wiener index ($H' = 1.556$), Lowy achieved the highest evenness ($E = 0.82$), and Barandu presented the greatest Margalef richness index ($R = 1.719$). The values of the Shannon-Wiener Diversity Index usually range between 1.5 and 3.5, with higher values indicating greater diversity (Kent & Coker 1992).

Based on the results, Shannon's Index value ranged from 0.9 to 1.732 at all sampling sites, confirming a moderate level of diversity at Chagharzi, Chamla, and Chenglai, while indicating low diversity at other sites in the study area. These variations among locations suggest differences in habitat quality and associated ecological conditions. Similar patterns of diversity and dominance at specific sites have been documented in other ecological studies, highlighting the significant impact of environmental factors and resource availability on species distribution and composition (Bai et al. 2025).

Low diversity in the Machkandai stream may be related to pollution. This site is the dumping point for

the effluent from the commercial area (Pirbaba Bazar). The harmful effects of effluent on fish populations and other aquatic life have already been suggested (Olojo et al. 2005; Ayoola 2008a, b). The absence of some species could be due to variable habitat, such as thick vegetation around the water body, and to water fouling from the deterioration of vegetation, which was observed during sample collection. It appears that spring habitats are more favorable for the diversity and conservation of the genus *Schistura*, as the current study shows trends consistent with this.

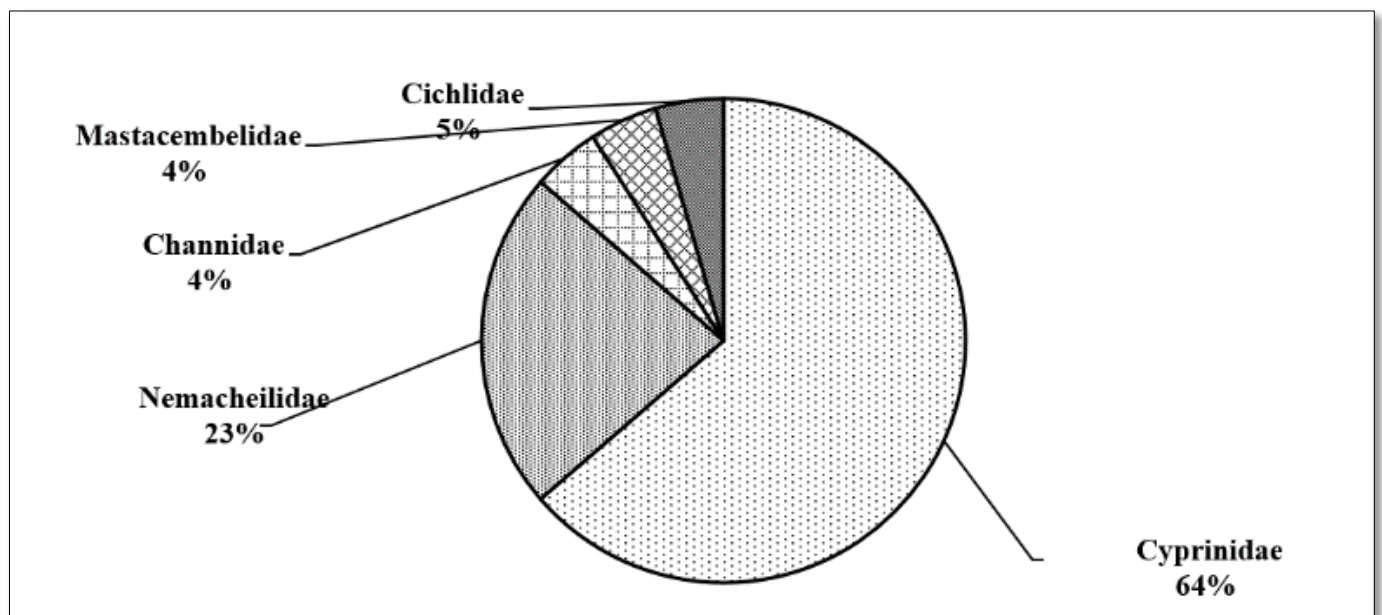
Several species including *Ctenopharyngodon idella*, *Danio devario*, *Schistura arifi*, *S. nalbanti*, *S. prashari*, *S. arifi*, *S. alepidota*, *S. naseeri*, *Oreochromis mossambicus*, *Labeo calbasu*, *Barilius vagra*, *Puntius chola*, *Puntius conchoni*, *P. ticto*, *Crossocheilus diplochilus* and *Barilius modestus* are first time recorded, while some previously reported species like *Triplophysa naziri*, *Crossocheilus latius*, *Gara gotyla*, *Glyptothorax punjabensis* and *Schistura punjabensis* were not captured in present survey. Moreover, some species, such as *Barilius pakistanicus* and *Puntius ticto*, were collected from most of the study sites and have previously been reported in district Buner (Saeed et al. 2013; Akhtar et al. 2014; Akhtar et al. 2015; Hasan et al. 2014), indicating their wide distribution (Table 3). However, some species, such as *D. devario*, *O. mossambicus*, *P. chola*, *Cyprinus carpio*, *C. idella*, *L. calbasu*, *Tor putitora*, and *S. prashari*, were present at specific sites in the study area (Table 3).

The present study indicated comparatively higher species richness and lower dominance in the Chenglai stream, whereas the Lowy stream appeared to have the highest dominance and the lowest species richness. The fish diversity estimators across water bodies indicated comparatively higher diversity and low dominance of ichthyofauna at Chenglai stream (Table 3).

The ichthyodiversity of some water bodies in the Buner Valley, such as the Barandu River, the Chagharzi River, and the Chamla stream, has already been reported (Saeed et al. 2013; Akhtar et al. 2014; Akhtar et al. 2015; Din et al. 2016).

Table 2. Value of different Diversity indices throughout District Buner.

Diversity Indices	River					Streams			Springs	
	Barandu	Chenglai	Chagharzi	Nagrai	Lowy	Chamla	Gukand	Machkandai	Garu	Surhaw
Species	9	9	8	4	3	8	6	7	4	5
Captured specimen	105	122	116	28	37	64	50	44	97	85
Dominance (D)	0.4808	0.2098	0.2845	0.5	0.44	0.272	0.276	0.3388	0.3	0.53
Simpson Index (S)	0.5192	0.7902	0.7155	0.5	0.56	0.729	0.724	0.6612	0.7	0.47
Shannon-wiener Index (H')	1.182	1.732	1.535	0.97	0.9	1.556	1.415	1.452	1.2	0.93
Evenness (E)	0.3624	0.6279	0.58	0.66	0.82	0.593	0.686	0.6105	0.8	0.51
Margalef (R)	1.719	1.665	1.473	0.9	0.55	1.683	1.278	1.586	0.7	0.9

**Fig.2.** Percentage of each family in the study area.

However, the present extensive study covered six more streams, two springs, and the river Barandu in district Buner, Khyber Pakhtunkhwa, and provides valuable information about the current status of the fish fauna in the previously reported areas, as well as in some unexplored streams (Chenglai, Chagharzi, Nagrai, Lowy, Gukand, Machkandai) and springs (Garuand Surhaw). Several studies have reported cyprinid abundance in water bodies of different regions of Pakistan (Iqbal et al. 2013; Akhtar et al. 2014; Ishaq et al. 2014) and suggested their dominance. Cyprinid abundance in any water body indicates its productivity and eutrophic status (Persson

et al. 1991; Jeppensen et al. 2000).

Variation from previously reported species in the River Barandu, which were missing in the present study, may be due to climate change, habitat destruction, pollution, and human intervention (Alturiqi & Albedair 2012), or perhaps due to severe cold, as most previous studies collected samples during spring and summer, while we collected during winter. Some species reported at specific sites may be due to habitat preference. During sampling, the highest number of individuals was captured using a dragnet and cast net. The addition of new species not previously recorded might also be related to fish migration, as the Barandu stream at Bekay (a village

Table 3. Previous diversity of some sites in Buner valley.

Sr.	Species	previous status			Present status									
		Barandu	Chagharzi	chamla	Barandu	Chenglai	Chamla	Chagharzi	Nagrai	Lowy	Machkandai	Gukand	Sunhaw	Garu
1	<i>Barilius pakistanicus</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	Akhtar et al. (2015)	Din et al. (2016)	×	√	√	√	√	√	√	√	×	×
2	<i>Cyprinus carpio</i>	Akhtar et al. (2015)	*	*	√	×	×	×	×	×	×	×	×	×
3	<i>Puntius sophore</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	Akhtar et al. (2015)	*	√	√	×	×	×	×	×	×	×	×
4	<i>Schizothorax plagiostomus</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	Akhtar et al. (2015)	Din et al. (2016)	√	×	×	√	×	×	×	√	×	×
5	<i>Tor putitora</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015)	Akhtar et al. (2015)	Din et al. (2016)	√	×	×	×	×	×	×	×	×	×
6	<i>Channa gachua</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	Akhtar et al. (2015)	Din et al. (2016)	×	√	√	×	×	×	√	√	√	×
7	<i>Mastacembelus armatus</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	Akhtar et al. (2015)	Din et al. (2016)	×	×	√	√	×	×	×	√	×	×
8	<i>Triplophysa naziri</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	*	*	×	×	×	×	×	×	×	×	×	×
9	<i>Crossocheilus latius</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	Akhtar et al. (2015)	*	×	×	×	×	×	×	×	×	×	×
10	<i>Gara gotyla</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	*	Din et al. (2016)	×	×	×	×	×	×	×	×	×	×
11	<i>Glyptothorax punjabensis</i>	Saeed et al. (2013), Zaigham et al. (2014)	*	*	×	×	×	×	×	×	×	×	×	×
12	<i>Schistura punjabensis</i>	Saeed et al. (2013), Akhtar et al. (2014), Akhtar et al. (2015), Zaigham et al. (2014)	*	Din et al. (2016)	×	×	×	×	×	×	×	×	×	×
13	<i>Barilius vagra</i>	*	*	*	×	×	×	√	×	√	√	×	×	×
14	<i>Barilius modestus</i>	*	*	*	×	×	√	√	×	×	√	×	×	×
15	<i>Crossocheilus diplocheilus</i>	Zaigham et al. (2014)	*	*	√	√	√	√	√	×	×	×	×	×
16	<i>Ctenopharyngodon idella</i>	*	*	*	√	×	×	×	×	×	×	×	×	×
17	<i>Danio devario</i>	*	*	*	×	√	×	×	×	×	×	×	×	×
18	<i>Labeo calbasu</i>	*	*	*	√	×	×	×	×	×	×	×	×	×
19	<i>Puntius ticto</i>	Zaigham et al. (2014)	*	*	√	√	√	√	√	×	√	√	×	×
20	<i>Puntius conchoni</i>	*	*	*	√	√	√	×	×	×	√	×	×	×
21	<i>Puntius chola</i>	*	*	*	×	√	×	×	×	×	×	×	×	×
22	<i>Oreochromis mossambicus</i>	*	*	*	×	√	×	×	×	×	×	×	×	×
23	<i>Schistura alepidota</i>	*	*	*	×	×	×	√	×	√	×	√	√	√
24	<i>Schistura naseeri</i>	*	*	*	×	×	√	×	√	×	√	×	√	√
25	<i>Schistura arifi</i>	*	*	*	×	×	×	×	×	×	×	×	√	×
26	<i>Schistura nalbanti</i>	*	*	*	×	×	×	×	×	×	×	×	√	√
27	<i>Schistura prashari</i>	*	*	*	×	×	×	×	×	×	×	×	×	√
28	<i>Tor macrolepis</i>	Zaigham et al. (2014)	*	*	×	×	×	×	×	×	×	×	×	×

Note= *, absence of species in previous status of some sites, ×, absence of species in present status, √, presence of species in present status

in the district of Buner, Khyber Pakhtunkhwa) joins the Tarbela Dam.

Currently, various diversity estimators are used to assess fish diversity in specific areas. Two of the

simplest methods are richness, which measures the number of species per sample, and evenness, which evaluates their relative abundance (Muhammad et al. 2024). Maximum diversity occurs when all species

within a community are equally abundant (Clarke & Warwick 2001). In the case of Chenglai Stream, fish diversity estimators indicated higher diversity and lower dominance of ichthyofauna, likely due to the clean, unpolluted water observed there.

Changes in the biodiversity of the river Barandu may be related to changes in habitat features due to pollution from marble factories in the area, overexploitation, habitat loss, or degradation of breeding grounds (Pompeu & Alves 2003; Pompeu & Alves 2005; Shukla & Singh 2013; Mohite & Samant 2013). It seems that the present habitat is now more favorable to newly observed fish compared to previously reported species. Din et al. (2016) reported 7 species, with *T. putitora* as the dominant species. However, we observed 8 species, including 5 not previously reported in the stream. Previously, Akhtar et al. (2015) reported *Crossocheilus latius*, *T. putitora*, and *C. gachua* from this stream (Table 5), but we did not collect *T. putitora*. This might be due to the low temperature at the time of the survey. This is the coldest area in the Buner district; therefore, the survival of this species at low temperatures is impossible. Furthermore, although the water of the Gukand stream appeared clean and unpolluted, low temperatures and overexploitation of fish through illegal means (traps, gill nets, and electrofishing) resulted in only six species being observed. The unpolluted, clear water of these streams depicts an environment favorable for fish. Local people in the Chagharzi area have reported greater fish diversity (at least 12-14 species), but the collection of only 8 species may be explained by the unfavorable, cold weather during this survey.

CONCLUSIONS

The present study documented the loss of some previously recorded species from the study area and identified possible reasons. This study suggests protective measures to conserve fish fauna. Several species, including *C. idella*, *D. devario*, *S. arifi*, *O. mossambicus*, *L. calbasu*, *S. nalbanti*, *S. prashari*, *B. vagra*, *S. alepidota*, *S. naseeri*, *P. chola*, *P. conchoni*, *P. ticto*, *C. diplochilus*, and *B. modestus*, are recorded

for the first time.

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مقاله کامل

تنوع گونه‌ای ماهیان در رودخانه‌ها، جویبارها و چشمه‌های شهرستان بونر در امتداد رود سند، خیبر پختونخوا، پاکستان

عوض سید^{۱،۲}، امینه زبیری^۱، ضیغم حسن^۳، محمد احمد^۱، لایق جان^۳، محمد نورالله^۱، محمد کامران^۴، محمد الطاف^{۱،۵*}

^۱برنامه شیلات و آبی‌پروری، گروه علوم دامی، دانشگاه قائد اعظم، اسلام‌آباد ۴۵۳۲۰، پاکستان.

^۲دانشگاه بوهم جنوبی در چسکه بودیویتسه، دانشکده شیلات و حفاظت از آب‌ها، مرکز پژوهشی بوهم جنوبی در زمینه آبی‌پروری و تنوع زیستی زیست‌بوم‌های آبی،

مؤسسه پژوهشی پرورش ماهی و آبی‌شناسی، 389 25 Zátíší 728/II، وودنیانی، جمهوری چک.

^۳گروه جانورشناسی، دانشگاه پیشاور، پیشاور، پاکستان.

^۴گروه زیست‌شناسی، دانشگاه کارولینای شرقی، گرینویل، کارولینای شمالی، ۴۳۵۳-۲۷۸۵۸، ایالات متحده آمریکا.

^۵مؤسسه علوم جنگل، دانشگاه اسلامی بهاولپور، بهاولپور، پاکستان.

چکیده: مطالعه حاضر با هدف بررسی تنوع گونه‌ای ماهیان در هفت جویبار، دو چشمه و رودخانه باراندو، واقع در شمال غرب پاکستان، انجام شد. به منظور گردآوری داده‌ها، مطالعات میدانی صورت گرفت و نمونه‌های ماهی با استفاده از تور پرتابی (Cast Net)، تور دستی (Scoop Net)، تور کششی (Drag Net)، تور گوشگیر (Gill Net) و پارچه توری (Mesh Cloth) جمع‌آوری شدند. در مجموع، نمونه‌های شناسایی شده متعلق به ۲۲ گونه، ۵ خانواده و ۴ راسته بودند. از میان این گونه‌ها، *Ctenopharyngodon idella*، *Puntius ticto*، *Crossocheilus diplochilus*، *Labeo calbasu* و *Puntius conchoni* برای نخستین بار از رودخانه باراندو ثبت شدند. همچنین گونه‌های *Schistura naseeri* و *Barilius modestus*، *Barilius vagra*، *Puntius ticto*، *Crossocheilus diplochilus*، *Chagharzi Stream* و گونه‌های *alepidota* برای نخستین بار از منطقه چاملا (Chamla) گزارش شدند. نتایج بررسی نشان داد که بیشترین تعداد گونه‌ها و نمونه‌های صیدشده در مناطق چاگهرزی و چاملا ثبت شده است، در حالی که بیشترین میزان غالبیت گونه‌ای (Dominance) در منطقه سورهاو (Surhaw) با مقدار $D=0.53$ مشاهده شد. همچنین یافته‌ها بیانگر حذف یا عدم مشاهده برخی از گونه‌هایی بود که در مطالعات پیشین از همین مناطق گزارش شده بودند. این نتایج ضرورت اتخاذ و اجرای اقدامات حفاظتی و برنامه‌های مؤثر مدیریت و حفاظت از تنوع زیستی آبزیان این مناطق را مورد تأکید قرار می‌دهد.

کلمات کلیدی: فون ماهیان، جویبارها، رودخانه باراندو، گونه‌ها، غنای گونه‌ای، تنوع زیستی