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A study on diversity and ecology of ichthyofauna of Rajouri district, Jammu and Kashmir, India

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Abstract

Jammu and Kashmir is bestowed with rich lotic and lentic water resources, and with diversified fish fauna. The aim of present study was to investigate the status of fish diversity in Rajouri district of Jammu division. Both morphometric and meristic characteristics were considered in identification of fish species. Present studies documented 16 species belonging to twelve genera, two orders and four families. The order *Cypriniformes* is represented by three families Cyprinidae with thirteen species, Danionidae and Nemacheilidae each with one species while the remaining one species *Glyptothorax pectinopterus* belongs to the order *Siluriformes* and family Sisoridae. Calculated community indices like Shannon-Wiener Index (H'), Simpson's diversity Index (D), Pielou's evenness (J') and Margalef's Richness index (MgI) will predict the deviation of community structure and water health quality.

Keywords: Community Indices, Fish Diversity, Morphometric, Meristic, Water Health

Introduction

Freshwater biomes are among the fruitful and diverse ecosystems likely to support over 18,000 species of fishes in the world (Fricke *et al.*, 2020). Fishes are most abundant class of vertebrates mutually in terms of amount and diversity in size, biology, outline, and the habitat (Kour *et al.*, 2015) and constitute nearly half of the total vertebrates in the world. India represents one of the mega diversity countries of the biosphere and occupies 9th position in terms of freshwater biodiversity (Mittemeier and Mittemeier, 1997).

Studies of freshwater fishes in the Indian sub-continent have been restricted to commercial fisheries of some major rivers like Ganges and Yamuna. Of the total 3439 fishes reported from India (Chandra *et al.*, 2020), 1027 fishes inhabit or visit freshwater bodies (Gopi *et al.*, 2017). The fish fauna of Rajouri has been on continuous decline possibly due to habitat loss, pollution and extensive use of insecticides and pesticides. Except for some literature on the fish fauna of Jammu (Dutta *et al.*, 2016), Sunderbani (Gandotra and Sharma, 2015) there is scanty literature available regarding the current fish fauna, their distribution, and threats in district Rajouri of Jammu division. Further no attempt seems to have been made so far to study the fish diversity of this district. The fish diversity of the most lotic water bodies of district Rajouri still appears to be unmapped and not properly documented. The main hill streams of Rajouri are inhabited by several fishes which are exploited for food and commercial use by the native community. An attempt has been made to document fish species from different streams of Rajouri district of the Union Territory (UT) of Jammu and Kashmir (J & K), India in this paper.

Material and Methods

Study Area: The study areas investigated in current study includes different regions of the district Rajouri, UT of J & K, India. It has an average elevation of 915m (3001 feet). Fish samples were collected from five different sites shown in Table 1 and Figure 1.

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Table 1. Sampling sites from where fishes were collected

Sites	Longitude	Latitude
Site 1 (Rajouri)	74°31′52″ E	33°37′16″ N
Site 2 (Thanamandi)	74° 36′93″ E	33° 53′86″ N
Site 3 (Chingus)	74°15′30″ E	33°14′36″ N
Site 4 (Nowshera)	74°14′24″ E	33°09′36″ N
Site 5 (Sunderbani)	74° 49′07″ E	33° 04′93″ N

Figure 1. The highlighted areas in the map shows the sampling sites.

Collection and Identification: The field work has been carried out from November 2015 to August 2016. Fishes were collected from various lotic water bodies of district Rajouri with the help of local fisher men. Cast nets, drag nets, rods and hooks besides hand picking were used for catching fishes at different water bodies (Figure 2). The fishes caught from different sites were preserved in 4% formaldehyde solution. Species identification and validation was done with the help of available literature (Day, 1875-1878; Jayaram, 2010; Talwar and Jhingran, 1991). Current valid species names were followed by Catalogue of Fishes (Fricke *et al.*, 2020). After identification morphometric and meristic characters were recorded and further preservation was done in 10% formalin solution and different species were preserved in separate jars.

Community Analysis: Species richness, evenness or diversity as whole may serve as a tool for calculating species diversity. Species diversity can be calculated with different indices, of which two frequently used are Shannon-Weiner Index (H') and Simpson's index (D). Shannon's index has direct relationship with the species diversity, whereas Simpson's index has an inverse relationship. Species evenness was measured with Pielou's evenness index (denoted by J).

Figure 2. Some water bodies where sampling was done.

Shannon-Wiener Index (H′): H′ = -∑ Pi ln Pi, where pi is the proportion of each taxon in the total population (Shannon & Weaver, 1964).

Simpson's diversity Index (D): D=S (n-1)/N (N-1) where n=the total number of individuals of a particular species and N is the total individuals of all species counted (Simpson's Index, 1949).

Pielou's evenness (J′): *J′* = H′/ ln S, where H is the Shannon-Wiener Index and *S* is the taxa number (Pielou's, 1966).

Margalef's Richness index (SR): *SR* = (*S*-1) / ln (*N*), where *S* is the taxa number and *N* is the number of individuals identified (Margalef, 1958).

Results

The present study reported 16 species belonging to 2 orders, Cypriniformes with three families, Cyprinidae, Danionidae and Nemacheilidae, and Siluriformes with one family Sisoridae. The results show a difference in fish diversity and fish assemblages across 5 study sites in the district.

At both the upstream sites (Site 1 and Site 4) seven fish species were recorded and in the midstream site (Site 2) five fish species were found while at downstream sites (Site 3 and Site 5) nine and ten species were found respectively (Table 2).

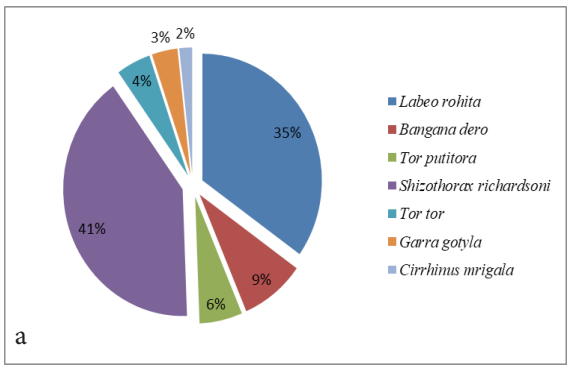
It is apparent that *Schizothorax richardsonii, Garra gotyla, Tor tor* and *Labeo rohita* were present in all the study sites. Current studies further revealed that *Schizothorax richardsonii* shows domination at site 1st, 2nd and 4th by 41%, 24% and 35% respectively. In site 3rd *Garra gotyla* was observed to dominate by 17%, whereas *Tor pitutora* dominates in 5th site by 18% (Figure 4).

Diversity Indices: Shannon's index (H′) was found to be highest (H′= 2.1) at site 5 (Chingus) followed by site 4 (Nowshera) & site 2 (Thanamandi) each having H′= 1.6

Table 2. List of fish species recorded from streams/ rivers of Rajouri district, Jammu

S. No	Family	Fish species found	Site 1	Site 2	Site 3	Site 4	Site 5
1	Danionidae	*Barilius vagra* (Hamilton 1822)	-	-	-	-	+
2	Nemacheilidae	*Triplophysa* sp.	-	-	+	-	+
3	Cyprinidae	*Cirrhinus mrigala* (Hamilton 1822)	+	-	+	+	-
4	Cyprinidae	*Cyprinus carpio* (Linnaeus 1758)	-	+	-	-	-
5	Cyprinidae	*Garra gotyla* (Hamilton 1822)	+	+	+	+	+
6	Cyprinidae	*Garra lamta* (Hamilton 1822)	-	+	+	+	-
7	Cyprinidae	*Labeo bata* (Hamilton 1822)	-	+	-	-	+
8	Cyprinidae	*Labeo boga* (Hamilton 1822)	-	-	+	-	-
9	Cyprinidae	*Bangana dero* (Hamilton 1822)	+	-	+	+	+
10	Cyprinidae	*Labeo rohita* (Hamilton 1822)	+	-	-	-	-
11	Cyprinidae	*Puntius sophore* (Hamilton 1822)	-	-	-	-	+
12	Cyprinidae	*Pethia ticto* (Hamilton 1822)	-	+	-	-	+
13	Cyprinidae	*Shizothorax richardsoni* (Gray 1832)	+	+	+	+	+
14	Cyprinidae	*Tor putitora* (Hamilton 1822)	+	-	+	-	+
15	Cyprinidae	*Tor tor* (Hamilton 1822)	+	-	+	+	-
16	Sisoridae	*Glyptothorax pectinopterus* (McClelland 1842)	-	-	-	+	+

with least value of H´= 1.4 at site 1 (Rajouri). Simpson's diversity index (D) does not show much variation and is almost similar at all sites. Pielou's eveness (J´) was maximum (J´=1.0) at site 3 (Chingus) and does not show much deviation at remaining sites. Margalef's richness was highest (MgI= 1.5) at site 5 (Sunderbani) followed by site 3 (Chingus) MgI= 1.3 while the lowest value (MgI= 0.67) was found at site 2 (Thanamandi) (Figure 5). Highest abundance was found at site 3-Chingus (462), followed by site 5-Sunderbani, site 2-Thanamandi, site 4-Nowshera and site 1-Rajouri with abundance of 433, 374, 184 and 172 respectively (Figure 3: a-e).



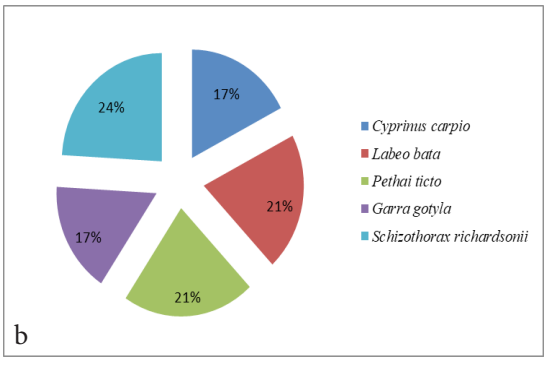
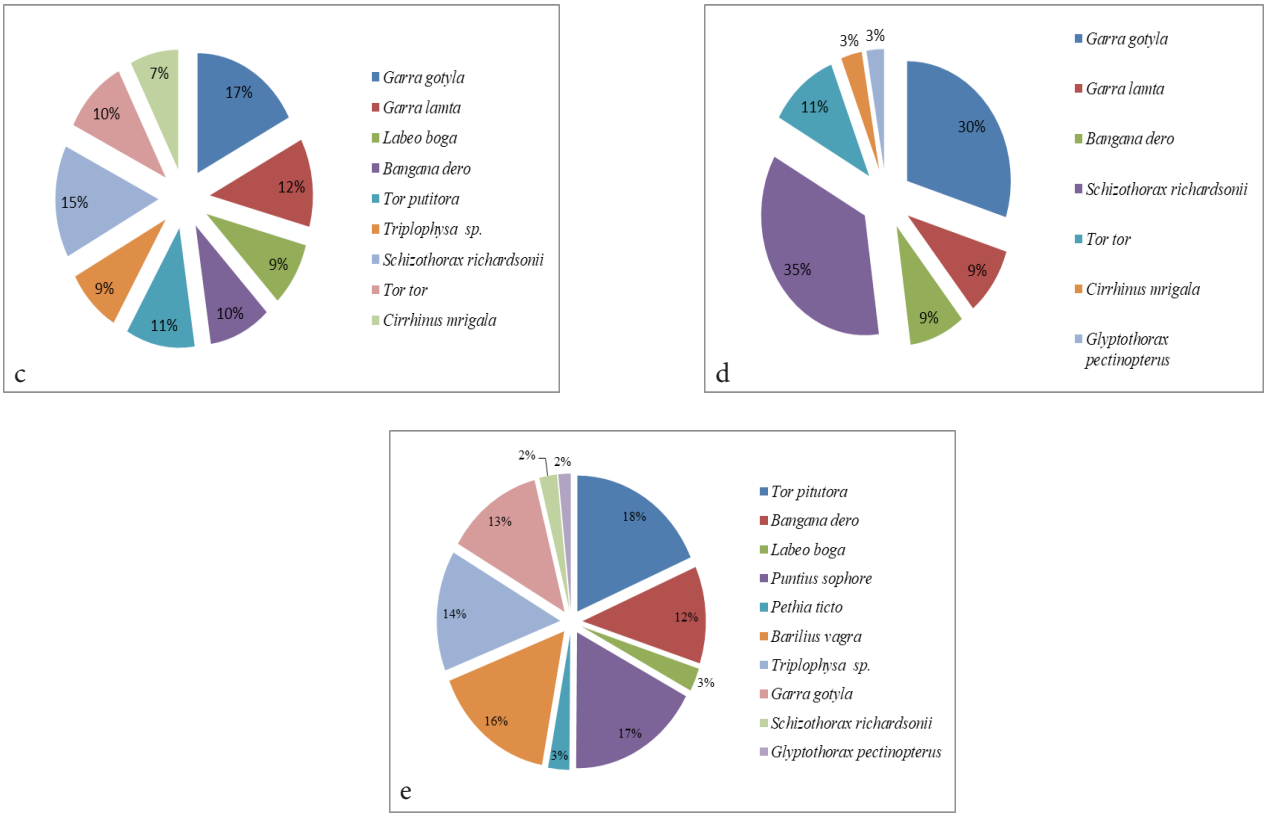


Figure 3. (a-e) Presenting contribution of fish species at all the study sites i.e. I, II, III, IV & V.



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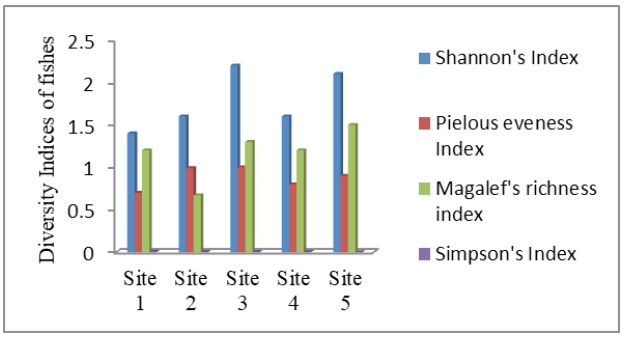

Figure 4. Showing the diversity indices of all the sites.

Discussion

The present study reveals more richness of cold-water fishes in upstream sites (Site 1 and 4) whereas downstream sites (Site 3 and 5) show more richness of warm water and hardy fishes. Sharma and Dutta (2010) also revealed similar pattern of richness of fishes in upstream compared to downstream sites of river Basanter, an important tributary of river Ravi. The cyprinids have been found dominant at all sites. The dominance of cyprinids has also been reported by Das and Nath (1966); Tilak (1971); Malhotra and Dutta (1975); Dutta and Malhotra (1984); Dutta and Kour (1999); Dutta (2003); Johnson and Arunachalam (2010); Kantaraj *et al*., (2011). In the present study, the cyprinids dominate at all study sites due to great adaptive variability to inhabit different habitats available to them. Similar viewpoint has also been upheld by different researchers (Gandotra *et al.,* 2015; Wani *et al*., 2015). During the study period the temperature of water has been observed to vary from 10 °C ± 2 °C to 31 °C ± 3 °C in all the stream sites.

Table 2 clearly reveals that highest number of 10 species at Site 5 followed by 9 species at site 3, then 7 species at sites 1 and 4 with least number of 5 species at site 2. As far as diversity indices of fishes are concerned highest Shannon's diversity index ($H^{'}$ = 2.2) has been observed at site 3 and the lowest was found at site 1 ($H^{'}$= 1.4) (Table- 3). Species richness was greatest at site 5 (Sunderbani) while abundance and evenness were maximum at site 3 (Chingus) indicating abundant, evenly distributed, and rich fauna at site 3 (Chingus) and site 5 (Sunderbani) respectively. Site wise comparative diversity studies (Shannon's index) indicated maximum diversity at downstream sites compared to those of upstream sites (Table 3).

According to Wilhm and Dorris (1966) if Shannon's index ($H^{'}$) value is > 3 it specifies clean water. The range from 1.00 to 3.00 shows moderately clean water and < 1.00 designates severely contaminated water. Present values of $H^{'}$ has been observed to range from 1.4 (Site 1) to 2.2 (Site 3) simply exhibit that water quality of district on an average is of moderate quality. The results further showed that upstream water at site 1 with lowest Shannon's index ($H^{'}$= 1.4) is highly polluted because of anthropogenic activity and disposal of domestic sewage. Compared to site 1, the site 3 at Chingus where value of $H^{'}$= 2.2 has moderate quality of water with very less anthropogenic activity. The present viewpoint coincides with similar results documented earlier (Welcomme, 1985; Bayley and Li, 1994; Granado, 2000; Offem *et al*., 2009). Johnson and Brinkhurst (1971) viewed the SW values extending from 1.00 to 3.66, Mackey *et al*., (1973) described that in their study the Shannon index ranged from 1.3 to 2.5 whereas Osborne *et al*., (1976) and Godfrey (1978) observed values ranging from 0.14 to 2.69 and from 1.938 to 5.34, respectively. Present author also derives support from analogous opinion held by Ransom and Dorris (1972) in their work on Keystone reservoir in the USA, Montajami *et al*., (2012) in Farobroman river water and Gandtora *et al*., (2015) on Thandapani stream. From the forgoing discussion it is apparent that fish diversity which has been observed to decline at site 1 and high diversity at site 3

Table 3. Showing diversity indices at various sites

Sites	Number of Species	Total abundance	Shannon Weiner Index (H´)	Simpson's Diversity Index (D)	Margalef's Richness Index (MgI)	Pielou's evenness (J´)
Site 1 (Rajouri)	7	172	1.4	0.006	1.2	0.7
Site 2 (Thanamandi)	5	374	1.6	0.003	0.67	0.99
Site 3 (Chingus)	9	462	2.2	0.004	1.3	1.0
Site 4 (Nowshera)	7	184	1.6	0.005	1.2	0.8
Site 5 (Sunderbani)	10	433	2.1	0.002	1.5	0.9

finds a definite relation with habitat destruction because of pollution, fishing pressure as well as anthropogenic activities. It may be mentioned that site 1 has highest anthropogenic activities like washing clothes, cattle bath besides runoff from agricultural sites and domestic sewage disposal. This simply destroys the water quality and fish habitat and hence the least diversity index gets justified. Thus, the rich floral and faunal diversity of the district is in significant threat and in imminent danger of being diminished. Previous studies revealed that habitat destruction, fishing pressure besides exotic fish invasion is responsible for decline of fish diversity (Lakra *et al.,* 2008, 2010).

From the study it is revealed that the status of ichthyofauna shows a marked decline in fish diversity as well as richness. This is really an alarming situation which needs immediate attention if we have to safeguard the highly esteemed fishes for future generation. It is not exactly possible to calculate decling rate in the fish diversity, but this report would serve as a reference data for future evaluation and conservation of fishes.

The present study provides a glimpse of status of ichthyofaunal diversity of district Rajouri. During the current study it was enumerated that the fish abundance is directly related to environmental conditions particularly water pollution. It was also found that the streams of district Rajouri were mostly inhabited by cyprinid fishes. Since many local people are directly or indirectly dependent on the Icthyofauna of the current study area, it becomes obvious to take the necessary steps to conserve the said Icthyofauna of this area. Moreover, local government can involve the local people in mass culturing of these fishes so that a great economy can be generated.

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Plate 1. Different species of fishes found in district Rajouri

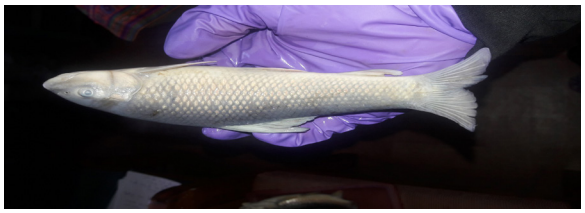		
Bangana dero (Hamilton 1822)		*Puntius sophore* (Hamilton 1822)
		
Tor putitora (Hamilton 1822)		*Labeo boga* (Hamilton 1822)
		
Pethia ticto (Hamilton 1822)		*Barilius vagra* (Hamilton 1822)
		
Glyptothorax pectinopterus (McClelland 1842)		*Cirrhinus mrigla* (Hamilton 1822)
		
Garra gotyla (Hamilton 1822)		*Garra lamta* (Hamilton 1822)

Plate 2. Different species of fishes found in district Rajouri

		
Tor tor (Hamilton 1822)		*Labeo bata* (Hamilton 1822)
		
Schizothorax richardsonii (Gray 1832)		*Cyprinus carpio* (Linnaeus 1758)
		
Labeo rohita (Hamilton 1822)		*Triplophysa* sp.