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Study of Ichthyofaunal Diversity in a stream in Sunderbani, District Rajouri, Jammu (J&K)

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Abstract
The present work was carried out in various sections of a stream in Sunderbani commonly known as Thandapani nallah in District Rajouri (J&K), to investigate its fish diversity and assemblage structure from January to December, 2013. Twelve species of fishes belonging to family Cyprinidae i.e. *Schizothorax richardsonii, Tor putitora, Garra gotyla, Labeo boga, Labeo bata, Labeo dero*, *Crossocheilus latius, Puntius conchonius, Puntius sophore, Puntius ticto, Barilius bendelisis, Barilius vagra* and one species of fish belonging to family Sisordae (*Glyptothorax pectinopterus*) were found. The relative abundance, dominance and diversity indices were also calculated. Station wise data in the order of dominance shows that in downstream at station 1st *Labeo dero* (17.85%) dominates whereas *Tor putitora* dominates (20.72%) at station 2nd (mid-stream) and *Puntius conchonius* (35.03%) dominates at station 3rd (upstream). The maximum fish diversity was reported in Station 1st with 12 number of species (40.43%, H = 2.141) followed by 6 species at Station 2nd (34.83%, H = 1.771) and minimum i.e. 5 species at Station 3rd (24.72%, H = 1.425).

Keywords: Assemblage structure, fish diversity, diversity indices, Sunderbani, Jammu.

Introduction
The fisheries sector has been playing a crucial role in Indian economy through contribution to food and nutrition security, employment generation, and earning valuable foreign exchange through fish export. Out of 2546 species so far listed, 1440 (65.45%) belongs to the marine ecosystem, 544 (24.73%) to the warm freshwater domain, 143 (6.50%) to the brackish water and 73 (3.32%) to the cold freshwater regime (Manimekalan, 2000) [25]. Significant development and improvement of aquaculture needs to be given priority after green revolution to feed ever growing population. Considerable studies of fish diversity from different fresh water bodies of India and adjacent countries were performed by number of researchers.

Indian inland water resources are much noted for their variety, rich ecological heritage, biodiversity and production potential. Due to irrational fishing practice, environmental aberrations like reduction in water volume, increased sedimentation, water abstraction, and pollution over the years, Indian fish diversity is on a decline (National Academy of Sciences, 1983) [29]. In the present context, freshwater fish biodiversity loss is an alarming threat and its conservation is the only solution to the problem.

Rivers of Jammu province arise from middle and outer Himalayas and traverse long routes before entering into the plains of this region. Thus, the riverine system of this area has a great longitudinal stratification, thereby providing a variety of habitats for inhabiting fish fauna (Das and Nath, 1971; Tilak, 1971; Malhotra and Jyoti, 1971; Dutta, 1978; Baba, 2004 and Gandotra, 2006) [5, 37, 23, 7, 2, 12].

Within the river system the number and types of fish species fluctuate with variability of the habitats. Habitat variability includes factors such as food, spawning areas, water quality, substrates and flow within a river system. This will vary along the course of river and its tributaries. They may change considerably during the year.

Though, a diversified ichthyofauna has been reported in Jammu and Kashmir from various water bodies but freshwater fishes are a poorly studied group. Moreover, there is no proper documentation since information regarding distribution, population dynamics and threats is incomplete and most of the information available is from a few well-studied locations only. It is therefore, important to prepare a zone wise database for listing the aquatic fish diversity in our region. Moreover, it will help us to formulate strategies for judicious exploitation and prediction of future fish stocks.

Keeping these facts in view, an attempt has been made to document and enlist fish species from stream in Sunderbani region of J&K State. Tehsil Sunderbani is a town in Rajouri district in the Indian state of Jammu and Kashmir. It is located at 33.04°N 74.49°E. It has an average elevation of 633 metres (2,077 feet) and is about 79 km far from Jammu. Exploring the fish fauna of this area will prove to be of significance to aquaculturists as well as undertaking the conservational and management measures of these resources which would upgrade the socio-economic status of fish farmers of our state on one hand and greater economic returns on the other.

Material and Methods

a. Site Selection

Three different habitat variables in the stream located in Sunderbani (Latitude 33.03°N and Longitude 74.29°E), District Rajouri, Jammu, were selected for present survey viz., Station 1st (downstream) at Baribatan, Station 2nd (mid-stream) at Thandapani and Station 3rd (up-stream) at Doukhade.

b. Collection and Identification

During the present study, fishes were monthly captured from January to December 2013 by using cast net, drag net, hand/dip net and other local contrivances. Collected fish samples were preserved in 10% formalin for detailed examination. The collected specimens were sorted at species level and all the species obtained were counted. Species identification and confirmation were carried out using available literature (Day, 1958; Talwar and Jhingran, 1991; Jayaram, 1999) [6, 36, 16].

c. Population studies

Information on structure of fish assemblages was extracted by adopting different univariate indices, namely, Shannon's diversity index, Margalef's species richness index and Simpson index.

i. Shannon's Diversity Index (H)

$$H = - \sum pi \ln pi$$
$$Pi = ni/N$$

ni = Number of individuals of each species in the Sample.
N = Total number of individuals of all species in the Sample.

ii. Margalef's Species Richness (R)

$$R = (S-1) / \ln N$$

Where, S is the number of species, N is the total number of individuals.

iii. Simpson's index (D)

$$D = \sum (n-1)/N (N-1)$$

n = the total number of organisms of a particular species.
N = the total number of organisms of all species.

iv. Fish Abundance Percentage (A)

$$A = (n / N) \times 100$$

n = the total number of organisms of a particular species.
N = the total number of organisms of all species

Results and Discussion

During the present investigation, a total of 13 species belonging to 8 genera, 2 families (Cyprinidae and Sisoridae) and 2 orders (Cypriniformes and Siluriformes) were reported from different sections of the stream (Table 1).

Table 1: Table showing fish abundance and percentage in the Stream.

Species	Total Abundance	Percentage Abundance (%)
Tor putitora	76	13.72
Labeo dero	75	13.54
Labeo boga	3	0.54
Labeo bata	8	1.44
Puntius conchonius	121	21.84
Puntius sophore	5	0.90
Puntius ticto	4	0.72
Barilius bendelisis	93	16.79
Barilius vagra	74	13.36
Schizothorax richardsonii	3	0.54
Garra gotyla	82	14.80
Crossocheilus latius	5	0.90
Glyptothorax pectinopterus	5	0.90
Total	554	

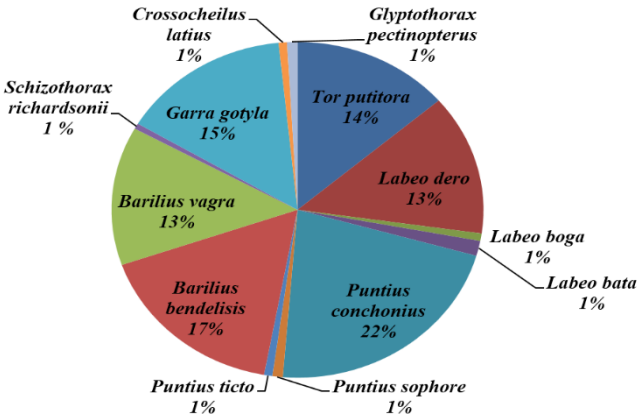

Fig 1: Graph showing percentage of various fish species in the stream.

The results revealed a distinction in fish diversity and fish assemblages across 3 study sites in the stream.

At Station 1st (down-stream) about 12 fish species were collected which were *Schizothorax richardsonii, Tor putitora, Labeo boga, Labeo bata, Labeo dero, Garra gotyla, Crossocheilus latius, Barilius bendelisis, Barilius vagra, Puntius sophore, Puntius ticto and Puntius conchonius.*

At Station 2nd (mid-stream), 6 fish species were found which include *Puntius conchonius, Barilius bendelisis, Barilius vagra, Labeo dero, Garra gotyla and Tor putitora.*

At station 3rd (up-stream), 5 fish species were identified which includes *Puntius conchonius, Garra gotyla, Glyptothorax pectinopterus, Barilius bendelisis and Barilius vagra.*
Puntius conchonius, Barilius vagra, Barilius bendelisis and Garra gotyla were representated in all the study sites.
Labeo dero show dominance at station 1st by 17.85%. *Tor putitora* show dominance by 20.72 % in station 2nd whereas, *Punctius conchonius* dominates by 35.03 % at station 3rd (Fig. 2).

Comparative study of various stations revealed that there was more abundance of cold water fishes in upstream station (station 3rd) where as downstream sections (station 1st) showed more abundance of warm water and hardy fishes. The water temperature in the stream ranged from (10 ºC ± 2 ºC) to (31 ºC ± 3 ºC) throughout the study period in all the stations.

Similar abundance pattern was also advocated by Sharma and Dutta (2010) [34] while studying ichthyofaunal diversity of river Basanter, an important tributary of river Ravi. Cyprinids dominance in the assemblage structure as seen during the present study is in accordance with the observations of Dass and Nath, (1966) [4]; Tilak, (1971) [37]; Malhotra and Dutta (1975) [24]; Dutta and Malhotra, (1984) [10]; Dutta and Kour, (1999) [9]; Dutta *et al.*, (2002) [11]; Dutta, (2003) [8]; Kaur, (2006) [21]; Johnson and Arunachalam, (2010) [17]; Kantaraj *et al.*, (2011) [20]; Johnson *et al.*, (2012) [18]; Murugan and Prabaharan, (2012) [28]; Mishra *et al.*, (2013) [26] who attributed it to their high adaptive variability to occupy all possible habitats.

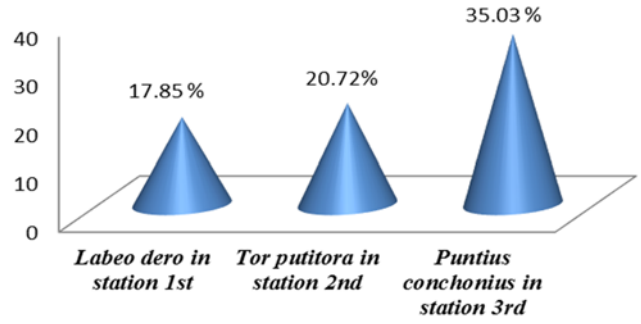

Fig 2: Graph showing percentage of dominant fishes at respective stations.

In the Station 1st, 13 number of species were present followed by 6 species at station 2nd whereas the lowest was recorded in Station 3rd with 5 species.

Similarly, the Station 1st had a high Shannon's diversity index (H = 2.141), followed by station 2nd (H = 1.771) whereas Station 3rd, (H = 1.425) registered the lowest Shannon diversity index (Table- 2).

Station wise fish catch statistics showed comparatively more diversity (as revealed by Shannon's index i.e. H values) at downstream section at Station 1st followed by station 2nd and 3rd (fig - 3).

According to Wilhm and Dorris (1966) [39] species diversity (S-W) index (H) value ranged from > 3 indicates clean water, 1.00 to 3.00 indicates moderately and < 1.00 indicates heavily polluted conditions of water.

The present results are in agreement with Welcomme, 1985 [38]; Bayley and Li, 1994 [3]; Granado, 2000; Slavik and Bartos, 2001 [35]; Offem *et al.*, 2009 [30]; Hina, 2010 [15] and Patra *et al.*, 2011 [32]. Andotra (2014) [1] during her work on river Tawi attributed more diversity at downstream stations to conditions like presence of diversified organic material availability as food to the fish, better breeding areas, less competition, optimum temperature etc.

Johnson and Brinkhurst (1971) [19] observed the SW values ranging from 1.00 to 3.66, Mackey *et al.*, (1973) [22] reported that in their study the Shannon index ranged from 1.3 to 2.5 whereas Osborne *et al.*, (1976) [31] and Godfrey (1978) [13] observed values ranging from 0.14 to 2.69 and from 1.938 to 5.34 respectively.

Ransom and Dorris (1972) [33] made a similar observation in their work on Keystone reservoir in the USA. Montajami *et al.*, (2012) [27] observed during his investigation of some physico-chemical characteristics of Farobroman River water by using benthic macro invertebrates as biological indicator that the somewhat lower values of the index of diversity can be attributed to the residual effect of the pollutants settled at the bottom which come from different domestic sources, municipal wastes disposal, agricultural wastes and industrial wastes discharge to the river.

Table 2: Table showing diversity indices at various stations.

Site Code	Station 1st	Station 2nd	Station 3rd
Total no.of species	13	6	5
Shannon index (H)	2.141	1.771	1.425
Simpson index	0.132	0.168	0.257
Margalef's species richness	2.033	0.950	0.813

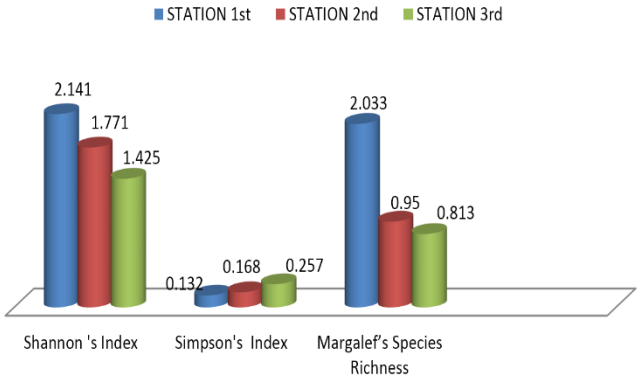

Fig 3: Graph showing fluctuation in diversity indices at respective stations.

Conclusion

Present study provides a comprehensive data on biodiversity of ichthyofauna of Sunderbani, district Rajouri (J&K) which clearly reveals that fish abundance is directly correlated with stream gradient and environmental conditions. Also, the stream is dominated by the cyprinids and majority of species are food fishes along with their ornamental values. Moreover, the water quality of this area is conducive for aquaculture. Therefore, the government must start some schemes in this area with the help of farmers to raise fish farms for mass production which will not only increase the economy but also provide employment to the rural folk.

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