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FISH DIVERSITY AND SPECIES COMPOSITION IN DIFFERENT HABITATS IN THE 1ST, 2ND AND 3RD ORDER STREAMS OF KYUNJA GAD FROM GARHWAL HIMALAYA, INDIA

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AUTHOR'S CONTRIBUTION

The sole author designed, analysed, interpreted and prepared the manuscript.

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ABSTRACT

Present study has been conducted on spring-fed hill stream Kyunja from Rudraprayag District, Uttarakhand, India. In this work author proposed one novel approach *viz*., stream order wise study of distribution and diversity of fish fauna from Garhwal Himalaya, India. A Total 18 fish species (2 species in 1st order, 10 in 2nd and 16 in 3rd order stream) were recorded from Kyunja gad stream. The fish biodiversity recorded belongs to 4 families, 7 genera and 18 species. On the basis of economic importance fishes were divided into three groups, viz. major groups, minor groups and other groups. The hill spring fed stream was divided into 3 zones viz. 2 Rhithron and 1 Potamon zone for fish catch. The lower stretch (3rd order stream) was more diverse and productive and showed fish productivity of 34 CPPs (Calculated productivity points system- 16 fish species). The middle stretch (2nd order stream) showed productivity of 21 CPPs (10 fish species). The upper stretch (1st order stream) had lowest diversity and productive with fish productivity of 06 CPPs (02 fish species).

Keywords: Fish diversity; rhithron; potamon; Garhwal Himalaya.

1. INTRODUCTION

Fishes influence the life of human in various customs. They are a rich source of food, especially as a protein and lipid. Fish lipids contain omega-3 poly-unsaturated fatty acids. Omega-3 fatty acids are essential for normal growth; they reduce cholesterol levels and the incidence of heart disease and preterm delivery. The Garhwal region is drained by a number of large rivers (Alaknanda, Mandakini, Pinder, DhauliGanga, Bhagirathi, Bhilangana Eastern and Western Nayar, Song and Khoh), which later unite to form mighty river-Ganges. A number of small streams or rivulets locally called as Gads or Gadars contribute their water to these large rivers.

Most of the small main streams of upper Ganga river system in Garhwal Himalaya remain overlooked from fish diversity view point. The present work deals with the fish diversity, which is helpful for the management and development of indigenous fishery in the local streams of Garhwal region. However some work has been conducted by Badola [1], Badola and Singh [2], Sharma [3], Singh et al. [4], Dobriyal and Kumar [5], Rautela et al. [6], Bisht et al. [7], Pathak and Mudgal [8], Agarwal et al. [9], Agarwal and Singh [10] and Bahuguna and Joshi [11] on the

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ecology and fish fauna of some of the tributaries of Ganga river system. In this paper author planned one novel approach *viz*., stream order wise study of distribution and diversity of fish fauna from Garhwal Himalaya, India.

2. MATERIALS AND METHODS

2.1 Study Area

The study area lies in Kyunja Gad stream – a spring fed perennial tributary of Mandakini river system from Garhwal Himalaya, India. It originates from Swami Kartik temple at an elevation of 1497 meter. Stream is narrowed in upper course, widening towards its convergence with river Mandakini. Substratum of stream consists of boulders cobbles, pebbles and diminutive sand particles. Habitat heterogeneity (riffle, run, rapid, and pool) is a characteristic feature of the stream. First of all, sampling sites was selected for Kyunja Gad stream i.e., first order stream (origin of stream), second order stream (confluence of two first order streams create a 2nd order stream) and third order stream (confluence of two second order streams forms a 3rd order stream) of Mandakani River. Three sampling Sites: 1st order stream (Spot K_1 - 30°21.11'N and 78°58.40' E) near Monkhal village, 2nd order stream (Spot K_2 - 30°25'20"N and 79°07'38"E) Jayakandi village and 3rd order stream (Spot K_3 - 30°25' 08" N and 79°03'52"E) were studied at Chandrapuri market near the confluence of the stream with the river Mandakani.

2.2 Sampling and Analysis

The fishes were collected with the help of different nets, i.e. cast nets, hand nets, gill nets, hook, baur of 2-4 m long, scoop net and hand picking. The collection was made from different sites to avoid missing of fish species. Fish after collection were euthanized kindly and preserved with 10% dilute formalin solution. The same species were placed in a jar and labeled properly (details of Name of locality and time of collection). Subsequently fish samples were transported to laboratory for further taxonomic studies. Identification was done on the basis of morphometric and meristic characters using standard keys as suggested by Day [12], Tilak [13], Talwar and Jhingran [14], Badola [15] and Jayaram [16].

3. RESULTS AND DISCUSSION

The present study was conducted on to explore the fish fauna of Kyunja Gad Stream district Rudraprayag Uttarakhand, during the period of October 2018 to February 2020 (Table 1). The exploration survey was conducted in three different localities namely near Monkhal village, Jayakandi village and near Chandrapuri market of Kyunja spring fed stream district Rudraprayag. During the studies 105 specimens of fish were collected. This collection was taxonomically treated which revealed that there are 2, 10 and 16 species of fish under 1st, 2nd and 3rd order streams from Kyunja Gad stream (Table 1). The status of presence and absence of ichthyofauna diversity based on the Rhithron and Potamon zones of the spring fed Kyunja Gad stream is presented in the Table 2. The commercially important fish species of spring-fed Kyunja stream were sorted according to their economic importance into major, minor and other categories. *Schizothorax richardsonii, S. plagiostomus*, *Tor putitora, T. tor, T. chilinoide* and *Mastacembelus armatus* belonged to major category; in minor category *Barilius bendelisis, B. barna, B. vagra, B. shacra, Noemacheilus rupicola, N. montanus, N. denisoni, N. bevani, N. savona* were noted while *Pseudecheneis sulcatus, Garra gotyla* and *G. lamta* represented third category of spring-fed Kyunja Gad stream fish fauna.

Calculation of the fish potential at 1st, 2nd and 3rd order streams of the spring fed Kyunja Gad are presented in Table 3. On the Basis of the Stream fish species availability number based theory,Calculated productivity points system (CPP) was used as suggested by Dobriyal and Singh [17] to estimate the fish potential at different order stream spot. It was estimated that the lower stretch (3rd order stream) was more diverse and productive where fish productivity was 34 CPPs (Calculated productivity points system-16 fish species). The middle stretch (2nd order stream) showed productivity of 21 CPPs (10 fish species). Whereas, the upper stretch (1st order stream) with fish productivity of 06 CPPs (02 fish species) was noted as lowest in diversity and productivity.

A total number of 18 fish species (*Schizothorax richardsonii, Schizothorax plagiostomus, Tor putitora, Tor tor, Tor chilinoides, Barilius bendelisis, Barilius barna, Barilius vagra, Barilius shacra, Garra gotyla, Garra lamta, Noemacheilus rupicola, Noemacheilus montanus, Noemacheilus bevani, Noemacheilus denisoni, Noemacheilus savona, Pseudecheneis sulcatus and Mastacembelus armatus*) were recorded from the 1st, 2nd and 3rd order streams and varying altitude of entire stream. The collected species belonged to seven genera and four families. Study specifies that the Cyprinidae family (order - cypriniformes) was the dominating family followed by Cobitidae (order-cypriniformes), Mastacembelidae (order-synbranchiformes) and Sisoiridae family (order-siluriformes). Among Cyprinidae family *Schizothorax richardsonii* was dominating species followed by *S. plagiostomus*, *Barilius bendelisis, B.*

barna, B. vagra,, Noemacheilus rupicola, N. montanus, N. denisoni, *Tor chilinoides, Garra gotyla, Pseudecheneis sulcatus* and *Mastacembelus armatus* while species viz. *Tor putitora, Tor tor, Barilius shacra, Noemacheilus bevani, N. savona* and *G. lamta* were found rarely in the Kyunja Gad stream. It was observed that altitude is the main influential factor. The fish diversity as well as species richness was higher at lower altitudes. The stream headwaters contained few species than to those occurring downstream as discussed by Schlosser [18].

The decrease in diversity and relative abundance with increasing altitude may be related with fast flowing currents, decrease in water temperature, and low total discharge in the upper course towards sampling site 1st order stream. Sarkar et al. [19] also noticed that the fish diversity increase in the lower stretches of stream due to significant contribution of number of rivulets leading to increase in the total discharge. Thomas and Hayes [20] observed that fish species richness generally increased with increasing stream order and was higher in the adventitious streams than in the headwater streams. Sehgal [21] reported that water temperature is an important limiting factor affecting geographical distribution and local occurrence of fish fauna within one water system.

However, the work on the streams of Central Himalaya (Garhwal region) is very scanty and lacking a proper documentation. Therefore, an attempt has been made to study the fish diversity of Kyunja Gad stream, a tributary of river Mandakini in Central Himalaya with regard to 1st, 2nd and 3rd order streams and varying altitude of entire stream of fishes. In the present study we noticed that the lower fish production observed in sampling site 1st (1st order stream) and 2nd (2nd order stream - Rhithron zone) was mainly due to the high water velocity, higher gradient, rocky bottom and absence of epilithic phytobenthos algae and low population of Benthos. Whereas, low water velocity, lesser gradient, pebbly bottom, best feeding and breeding sites at sampling site 3rd (3rd order stream - Potamon zone) were responsible for its

Table 1. List of Ichthyofauna diversity of the 1st order, 2nd order and 3rd order stream Kyunja Gad from Rudraprayag District.

S. No	Systematic position	Name of species	1st order stream Kyunja gad	2nd order stream Kyunja gad	3rd order stream Kyunja gad	Local name
A	Order: Cypriniformes					
1	Family: Cyprinidae					
	A	*Tor putitora* (Ham.)	**NAb**	**NAb**	**Pr**	Kanita.
	B	*Tor tor* (Ham.)	**NAb**	**NAb**	**Pr**	Kanita.
	C	*Tor chilinoides* (Mc Cl.)	**NAb**	**Pr**	**Pr**	Kanita
	D	*Schizothorax richardsonii* (Gray & Hard)	**NAb**	**Pr**	**Pr**	Asale
	E	*Schizothorax plagiostomus* (Heckel)	**NAb**	**NAb**	**Pr**	Asale
	F	*Barilius bendelisis* (Ham.)	**NAb**	**Pr**	**Pr**	Jabula
	G	*Barilius barna* (Ham.)	**NAb**	**Pr**	**Pr**	Jabula
	H	*Barilius vagra* (Ham.)	**NAb**	**Pr**	**NAb**	Jabula
	I	*Barilius shacra* (Ham.)	**NAb**	**NAb**	**Pr**	Jabula
	J	*Garra gotyla* (Gray)	**NAb**	**NAb**	**Pr**	Guthala
	K	*Garra lamta* (Ham.)	**NAb**	**Pr**	**Pr**	Guthala
2.	Family: Cobitidae					
	A	*Noemacheilus rupicola* (Mc Cl.)	**Pr**	**Pr**	**Pr**	Gadiyal
	B	*Noemacheilus montanus* (Mc Cl.)	**Pr**	**Pr**	**Pr**	Gadiyal
	C	*Noemacheilus bevani Gunter*	**NAb**	**NAb**	**Pr**	Gadiyal
	D	*Noemacheilus denisoni* (Day)	**NAb**	**Pr**	**NAb**	Gadiyal
	E	*Noemacheilus savona* (Ham.)	**NAb**	**NAb**	**Pr**	Gadiyal
3.	Family: Sissoridae					
	A	*Pseudecheneis sulcatus* (Mc Cl.)	**NAb**	**NAb**	**Pr**	Kabadiyal
4.	Family: Mastacembelidae					
	A	*Mastacembelus armatus* (Lacep.)	**NAb**	**Pr**	**Pr**	Gair/Bam

(NAb= Not Available; Pr = Available)

higher fish production. Dobriyal and Singh [22] suggested that the low velocity, lesser gradient, pebbly bottom enriched with epilithic phytobenthos, and shallow pockets of lateral waters supported a veritable concept of filamentous algae and insect life providing suitable breeding ground for fish.

Table 2. Ichthyofauna present and absent status based on Rhithron and Potamon zones of the spring fed Kyunja Gad stream

S. no.	Name of species	Rhithron zone		Potamon zone
		1st order stream	2nd order stream	3rd order Stream
1.	*Barilius bendelisis* (Ham.)	-	+	+
2.	*Barilius barna* (Ham.)	-	+	+
3.	*Barilius vagra* (Ham.)	-	+	-
4.	*Barilius shacra* (Ham.)			+
5.	*Garra gotyla* (Gray)	-	-	+
6.	*Garra lamta* (Ham.)	-	+	+
7.	*Mastacembelus armatus* (Lacep.)	-	+	+
8.	*Noemacheilus rupicola (Mc Cl.)*	+	+	+
9.	*Noemacheilus montanus (Mc Cl.)*	+	+	+
10.	*Noemacheilus bevani Gunter*	-	-	+
11.	*Noemacheilus denisoni (Day)*	-	+	-
12.	*Noemacheilus savona (Ham.)*	-	-	+
13.	*Pseudecheneis sulcatus* (Mc Cl.)	-	-	+
14.	*Schizothorax richardsonii* (Gray & Hard)	-	+	+
15.	*Schizothorax plagiostomus* (Heckel)	-	-	+
16.	*Tor putitora* (Ham.)	-	-	+
17.	*Tor tor* (Ham.)	-	-	+
18	*Tor chilinoides* (Mc Cl.)	-	+	+
Total no. of Present species in working sites.		**2**	**10**	**16**

(Absent = - ; Present = +)

Table 3. Calculation of the fish potential at 1st, 2nd and 3rd order streams of the spring fed Kyunja Gad.

S. no.	Name of species	1st order stream	2nd order stream	3rd order stream
		Upper stretch (CPPs)	Middle stretch (CPPs)	Lower stretch (CPPs)
1.	*Barilius bendelisis* (Ham.)	00	**03**	**03**
2.	*Barilius barna* (Ham.)	00	**02**	**02**
3.	*Barilius vagra* (Ham.)	00	**01**	00
4.	*Barilius shacra* (Ham.)	00	00	**01**
5.	*Garra gotyla* (Gray)	00	00	**02**
6.	*Garra lamta* (Ham.)	00	**02**	**02**
7.	*Mastacembelus armatus* (Lacep.)	00	**02**	**02**
8.	*Noemacheilus rupicola (Mc Cl.)*	**03**	**03**	**03**
9.	*Noemacheilus montanus (Mc Cl.)*	**03**	**03**	**03**
10.	*Noemacheilus bevani Gunter*	00	00	**01**
11.	*Noemacheilus denisoni (Day)*	00	**01**	00
12.	*Noemacheilus savona (Ham.)*	00	00	**01**
13.	*Pseudecheneis sulcatus* (Mc Cl.)	00	00	**01**
14.	*Schizothorax richardsonii* (Gray & Hard)	00	**02**	**03**
15.	*Schizothorax plagiostomus* (Heckel)	00	00	**03**
16.	*Tor putitora* (Ham.)	00	00	**02**
17.	*Tor tor* (Ham.)	00	00	**02**
18	*Tor chilinoides* (Mc Cl.)	00	**02**	**03**
Calculated Productivity points (C.P.P.)		**06**	**21**	**34**

('0'= Nil; '1'= Rare; '2'= Common; '3'= Abundant)

4. CONCLUSION

In this paper author proposed one novel approach *viz*., stream order wise study of distribution and diversity of fish fauna from Garhwal Himalaya, India. The investigation was conducted in three different localities namely near Monkhal village, Jayakandi village and near Chandrapuri market of Kyunja spring fed stream district Rudraprayag. During the studies 105 specimens of fish were collected. This collection was taxonomically treated which revealed that there are 2, 10 and 16 species of fish under 1st, 2nd and 3rd order streams from Kyunja Gad stream. In the present study we concluded that the lower fish production observed in sampling site 1st (1st order stream) and 2nd (2nd order stream) was mainly due to the high water velocity, higher gradient, rocky bottom and absence of epilithic phytobenthos algae and low population of Benthos. On the basis of fish diversity and species composition analysis, it was concluded that the diversity of fish species was more at sampling site 3rd (3rd order stream). Moderate current velocity, lesser gradient, pebbly bottom, best feeding and breeding sites in 3rd order stream favored the benthic biota and so were responsible for higher fish production.

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COMPETING INTERESTS

Author has declared that no competing interests exist.

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