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Assessment of Fish Assemblages and Physico-Chemical Parameters of Ranu Ki Gad Stream - A Tributary of River Bhagirathi in Central Himalaya (India)

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Abstract

The present study was conducted to document the fish assemblage structure and physicochemical parameters of an important tributary of river Bhagirathi in central Himalaya, India. The study reported altogether 14 fish species from Ranu-ki-gad stream belonging to two orders, three families and seven genera. Cyprinidae family (order Cypriniformes) was the dominating family, followed by the Cobitidae family (order Cypriniformes) and Sisoridae family (Siluriformes order), respectively. Among the species, *Schizothorax richardsonii* was dominating species, followed by *Tor Putitora*, *Barilius bendelisis*, *Noemacheilus rupicola*, *Tor tor,* and *Pseudecheneis sulcatus.* Habitat variability and hydrological parameters (water temperature, water velocity, pH, dissolved oxygen, free carbon dioxide, total dissolved solids and turbidity) along the stream significantly influenced the species richness and their assemblage structure. The lower stretch of the stream provides critical habitat for many hill stream fishes. The status of fish fauna was ascertained by CAMP (1998) assessment. Out of 14 fish species, the status of 2 species was not assessed due to data deficiency, four species were categorised as lower risk near threatened, four as vulnerable, and four species were under the endangered category.

Keywords: Fish assemblages, Species richness, Central Himalaya, Water quality parameters, Rani-ki-gad stream

1. Introduction

Freshwater resources are unevenly distributed, with some of the water bodies located far from human populations, while others are flowing through thinly populated areas. It is a limited resource and is not essential only for the survival of living organisms but also for fulfilling human requirements such as agriculture, industry and domestic needs (Bartram and Balance, 1996). Freshwater is crucial for sustaining all terrestrial and aquatic ecosystems and human society (Millennium Ecosystem Assessment, 2005). On a global scale, freshwater fish fauna is the most diverse of all vertebrate groups. It is also the most highly threatened group due to various anthropogenic activities, viz., dam building, road construction along the riverside and land-use change in the watersheds (Nel *et al.*, 2009). Globally a total of about 32,513 fish species have been reported (Froese and Pauly, 2013). India has an extensive network of rivers, both in Himalayas and plains, which harbours about 2500 fish species (Jayaram, 2010). These rivers always remain the site of most of our evolutionary history and human activities and have a wide range of diversity in fish and other aquatic organisms. River Alaknanda and Bhagirathi are two major drainage systems constituting the upper Ganga River system with some of their important glacial fed and spring-fed tributaries draining from high mountains to the foothills (Singh and Agarwal, 2013). This vast drainage network endows rich diversity of fishes providing a livelihood for a large number of people living in remote hilly areas. As per the reports of 'Convention on Biological Diversity', information on aquatic biodiversity is lacking at the global and local level. Due to the lack of this information, it is difficult to assess any species' status and prepare the plan for its conservation and management. Fish resources in the fluvial systems of Garhwal (Central Himalaya) had not been completely explored because most of the streams are located in aloof mountainous, steep terrain. Some important studies from the viewpoint of fish diversity have been conducted in central Himalaya (Singh *et al.*, 1987; Lakra *et al.*, 1987; Badola, 2009; Agarwal *et al.*, 2011, 2019; Agarwal and Singh, 2012). Despite these important studies, yet there are some of the streams which have not been explored from the viewpoint of its fish resources and physicochemical characters. The present study is an attempt to explore the fish fauna and water quality parameters of the Ranu-ki-gad stream.

2. Materials and Methods

2.1. Study area

The study area is located at Ranu-ki Gad stream, an important tributary of river Bhagirathi (Fig. 1). It joins River Bhagirathi on its right bank at Raturi Sera (elevation 1132 masl), approximately 10 km downstream to Uttarkashi (Uttarakhand, India). It is a spring-fed perennial stream with moderate water discharge. The stream has pristine water or near-pristine with a high content of dissolved oxygen and transparency. The morphology of the stream varies considerably throughout its length. Usually, the stream is shallow, but occasionally large deep pools are also present mainly in the middle and lower stretch of the stream. It has low water carrying discharge in the upper reaches, which increases downward due to the joining of several 1st and 2nd order tributaries. The uppermost reaches are gorge-like and rocky or full of

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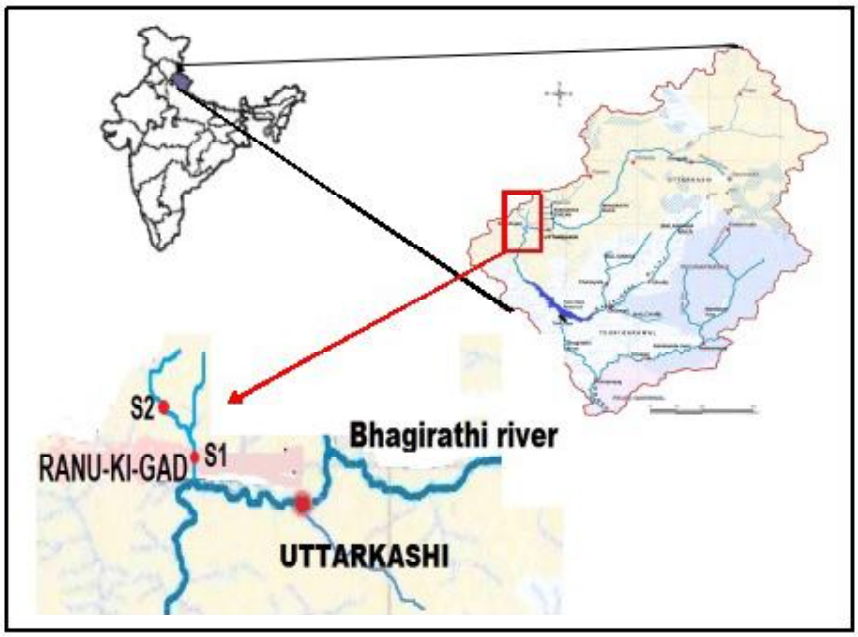

Fig. 1. Geographical location of Ranu-ki-gad stream, Uttarakhand, India

huge boulders. In the middle and lower stretches, the streambed consists of partially or fully matured boulders (Fig. 2). Stream habitat is characterized by diverse microhabitats as pools, riffles, rapids, runs, and cascades. Fish samples were collected from both upper and lower stretches of the stream from March 2012 to February 2013. Experimental fishing was done in different seasons (summer, monsoon and winter) between morning hours to late afternoon and even sometimes also during night hours. Collection of the fish sample was done with the help of various fishing methods *viz.* cast net (1–2 m diameter, mesh size 1-1.8 cm), gill net (mesh size 1.2×1.2 cm, L×B, 12×1.0 m), baur (It is made up of bamboo strips with a conical mouth, fixed where waterfall from a high level and fishes migrating, get entrapped in it). (3–5 m long), goda, handpicking, hammering (A big stone or a hammer is stroked with full force over the stone.) and hooks. All these fishing gears were operated with the help of professional fishermen. Detail of all these fishing methods is also available (Singh and Agarwal 2014a). Collected fish samples were preserved in 10% formalin for further studies. Taxonomic studies were done on the basis of their morphometric, meristic and various descriptive characters following standards keys (Day, 1878; Talwar and Jhingran, 1991; Badola, 2009; Jayaram, 2010). Important water quality parameters were tested on the spot at each study site using standard techniques to understand the state of the aquatic environment. Water temperature was measured using the mercury thermometer of range 0-50°C. Water velocity was measured by float method, pH was measured using digital pH meter (Hanna made-HI98108) while DO, free CO_2, total alkalinity, turbidity and TDS were analysed following APHA (2005).

Data Analysis: The relative abundance (RA) of fish species across the study sites was worked out by the following formula.

RA = Number of samples of particular species × 100/ Total number of samples

Fig. 2. Lower stretch of the stream dominated by large boulders

3. Results and Discussion

3.1. Fish diversity and abundance

The present study was conducted with respect to documentation of the fish species and physico-chemical parameters of Ranu-ki-gad stream. A total of 14 fish species were recorded from the varying habitats of the entire stream during the study period. All the species procured from the stream are endemic and belonged to seven genera, three families and two orders (Table 1; Fig. 3a-n). Among the three families, the family Cyprinidae (order Cypriniformes) was the species-rich, followed by the Cobitidae family (order Cypriniformes) and Sisoridae family (Siluriformes order). Among the species, *Schizothorax richardsonii* was the dominating species, followed by *Tor putitora*, *Barilius_bendelisis*, *Noemacheilus rupicola*, *Tor tor*, and *Pseudecheneis sulcatus*, whereas the species viz. *Tor chilinoides*, *Garra gotyla gotyla* and *Barilius vagra* were found rarely in this stream, but they were found commonly in the main river Bhagirathi.

3.2. Distribution pattern along the stream

Ranu-ki-gad stream is characterised by a variety of habitat features, varying physicochemical features, water depth, meandering nature and erratic hiding covers. These diverse ecological features of the stream provide critical habitat for some important hill stream fluvial specialist species, especially the IUCN (2011) referred endangered species (*Tor* spp.) and vulnerable species (*Schizothorax* and *Pseudecheneis* spp.). During the study, various life stages (juveniles, adults and spawners) of the reported fish species were observed due to the diverse ecological conditions.

The distribution of fish species and their relative abundance was related to a number of factors, viz. nature of substratum, water temperature, flow rate, stream depth, available food in the stream, physicochemical properties, altitude and length of the stream. The fish diversity and their relative abundance were found comparatively low in the upper stretch of the stream, which was characterised by high gradient and fast-flowing water dominated by big boulders. The cascades, falls and rapids type of habitat was dominant in the upper stretch. The study specifies that there was a negative correlation between stream altitude and species diversity as well as relative abundance. The diversity and species abundance increased with a decrease in altitude towards the mainstream. According to Schlosser (1987), this observation is that the stream headwaters contained far fewer species than those occurring downstream. Low species richness and their relative abundance in the upper stretch located at comparatively high altitude may be attributed to rapid flow currents, low water discharge and low water temperature. In related studies, Sarkar *et al*. (2011) and Singh and Agarwal (2013) also confirmed that the fish diversity increases in the lower stretches of the stream due to the significant contribution of a number of rivulets leading to an increase in the total discharge and water temperature. Fish species richness generally increased with increasing stream order and was higher in the adventitious streams than in the headwater streams (Thomas and Hayes, 2006).

Water temperature showed a decreasing trend towards the upper stretches. This decrease in water temperature in the upper stretches was not conducive for survivability of some lesser barils, mahseers and *Crossocheilus* spp. Because these species are not able to survive beyond the temperature range of 10°C. Sehgal (1999) also observed that water temperature is an important limiting factor that affects the geographical distribution and local occurrence of fish fauna within one water system.

Morphological features of some species also played an important role in the distribution of fishes. Species such as *Glyptothorax* and *Pseudecheneis* having some special adhesive apparatus on their ventral surface are highly adapted to the fast currents and were reported from the upper stretch of the stream. Lower stream stretch has comparatively less gradient, a wide channel with moderate currents. Deep and shallow pools followed by some rapids and riffles are characteristic features of the lower stretch of the stream. These features of the stream favour *Tor, Schizothorax, Barilius* and *Noemacheilus* spp. in the lower section. The large boulders in the lower stretch of stream serve as a hiding cover for *Barilius* and N*oemacheilus* spp. Lower stretch also acts as a breeding ground for the brooders of *Tor*, *Schizothorax, Barilius* and *Noemacheilus* spp. It also provides a nursery ground for the early stages of these fishes. Early stages (fingerlings and juveniles) of all these species were found abundantly in this stretch.

Total water discharge of stream also played an important role in the species occurrence. During the study, only small-sized fishes were procured from this particular stream which may be due to less total discharge. The stream has low species richness as compared to the other tributaries of the river Bhagirathi (Assiganga and Bhilangana), having more discharge with rich species richness (Agarwal *et al.*, 2011). A significant correlation between stream volume and fish species abundance has been reported by Johnson and Arunachalam (2010).

3.3. Threat status of fishes

According to the CAMP (Conservation Assessment and Management Plan, 1998), about 28.57% of the total fish fauna of Ranu-ki-gad stream was under the endangered (EN) category. A similar proportion (28.57%) was under vulnerable (VU) and low risk near threatened (LRnt) category; however, 14.29% of fish fauna was not assessed (NA) (Fig. 4).

3.4. Water quality parameters

Some important physico-chemical parameters were also analysed to assess the quality of stream water (Table 2). Analysis of these quality parameters was done on a seasonal basis (summer, monsoon and winter). The water temperature of the stream was in the optimum range throughout the year. On a seasonal basis, the water temperature was recorded comparatively high during the monsoon season while the winters recorded a slightly low temperature. This moderate temperature range of the stream was highly conducive for the survivability of juveniles and fingerling stages of the fishes. Water velocity was recorded high during the monsoon following the high precipitation in this season, while comparatively low velocity was recorded during the winter season. pH in all

a. *Barilius barna*

b. *Schizothorax plagiostomus*

c. *Barilius bendelisis*

d. *Schizothorax richardsoni*

e. *Barilius vagra*

f. *Tor chilinoides*

g. *Garra gotyla gotyla*

h. *Tor tor*

i. *Pseudecheneis sulcatus*

j. *Tor putitora*

k. *Noemacheilus montanus*

l. *Noemacheilus multifasciatus*

m. *Noemacheilus rupicola*

n. *Glyptothorax pectinopterus*

Fig. 3a-n. Fish species reported from Ranu-ki-Ghat stream, Uttarakhand

Table 1. Fish species richness and their relative abundance in different seasons

Order/family/species	Threat status	Relative abundance in different seasons			
		Summer	Monsoon	Winter	Average
Order Cypriniformes: Family Cyprinidae					
Barilius barna	LRnt	5.07	7.19	6.15	6.03
B. bendelisis	LRnt	9.76	8.63	9.62	9.34
B. vagra	VU	3.75	2.64	0	2.56
Garra gotyla gotyla	VU	3.38	4.08	3.85	3.72
Schizothorax richardsonii	VU	12.8	12.5	14.2	13
S. plagiostomus	NA	6.19	9.11	6.15	7.19
Tor tor	EN	8.26	7.67	8.85	8.18
T. putitora	EN	10.9	9.35	11.2	10.4
T. chilinoides	NA	4.13	2.16	5.77	3.8
Order Cypriniformes: Family Cobitidae					
Noemacheilus montanus	EN	8.07	6.71	7.31	7.44
N. multifasciatus	EN	5.07	3.36	3.46	4.13
N. rupicola	LRnt	9.01	9.35	9.23	9.17
Order Siluriformes: Family Sisoiridae					
Glyptothorax pectinopterus	LRnt	6.75	8.15	5.77	7.02
Pseudecheneis sulcatus	VU	6.94	9.11	8.46	8.02
Total	**14**	-	-	-	

EN- endangered, VU- vulnerable, LRnt- low risk near threatened, NA- Not assessed

the seasons was slightly alkaline and found comparatively high in the summer season. Dissolved oxygen ranged from7.0±0.49 to 8.2±0.28 mg l^{-1}. Mean dissolved oxygen content (7.25±1.39 mg/l) can be considered good for the growth of fish species (Rath, 2000). Dissolved oxygen and free carbon dioxide showed the opposite trend. Winters recorded high DO content and low free CO_2, whereas comparatively low dissolved oxygen and high free carbon dioxide was recorded in the monsoon season. Total dissolved solids (TDS) reached their highest value in the monsoon season, the lowest value in summer and moderate value in the winter season. Turbidity in the stream remained very low throughout the year except for the monsoon months, which recorded high turbidity due to increased erosion.

Observations on the water quality parameters very well co-relate the occurrence and distribution of fish species in the Ranu-ki-gad stream. High water flow with clear oxygenated water and rocky- stony substratum in the upper stretch of the stream favoured the survival and existence of *Glyptothorax* and *Pseudecheneis* spp. These fluvial specialist species are found rarely in the lower stretch and reported only in monsoon months when heavy rain washes away these fishes from stones due to turning down by the force of water with heavy silt. Seasonal distribution and relative abundance of fish fauna are directly related to change in physico-chemical properties, channel course, water discharge and pattern and geometry of tributaries (Bisht *et al.*,2009). Further, Poff (1997) also relates that the hydrological variables act as environmental filters for the species and colonization of species in each part of a basin is assigned to hydrological characteristics within the basin.

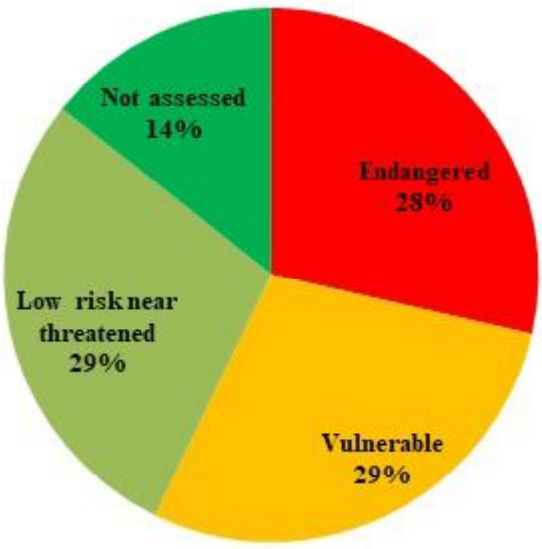

Fig. 4. Threat status of fishes reported from Ranu-ki-gad as per CAMP, 1997

Table 2. Physico-chemical attributes (mean ± SD) of Ranu-ki-gad stream in different seasons

Physio-chemical features	Seasons		
	Summer	Monsoon	Winter
Water temperature (°C)	19.5±1.13	20.0± 2.12	16.0±0.44
Velocity (ms $^{-1}$)	1.58±0.03	1.69±0.44	1.3±0.08
pH	8.5±0.0	7.8±0.08	8.0±0.22
DO (mg l^{-1})	7.80±0.23	7.0±0.49	8.2±0.28
Free CO_2 (mg l^{-1})	0.26±0.04	0.4±0.1	0.2±0.05
TDS (mg l^{-1})	69.0±9.9	75.0±14.1	70.0±9.8
Turbidity (NTU)	8.0±5.66	34.0±11.3	3.0±1.41

4. References

Agarwal, N.K. & Singh, G. 2012. Documentation of fishes and physico-chemical characters of a stream Indrawati- a spring fed tributary of river Bhagirathi at Uttarkashi (Central Himalaya, Garhwal) India. *Environment Conservation Journal*, 13 (3): 117-124.

Agarwal, N.K., Singh, G. & Singh, H. 2011. Present status of Ichthyofaunal diversity of Garhwal Himalayan river Bhilangana and its tributaries with reference to changing environment. Environment Conservation Journal, 12 (3): 101-108.

Agarwal, N.K., Rawat, U.S. & Singh, G. 2019. Fish assemblages and habitat ecology ofRiver Pinder in central Himalaya, India. Iranian Journal of Fisheries Sciences, 18 (1): 1-14. DOI: 10.22092/ijfs.2018.118930.APHA (American Public Health Association). 2005. Standard methods for the examination of water and wastewater. 21th ed. Washington (DC): American Public Association, AWWA, WEF.

Badola, S.P. 2009. Ichthyology of the Central Himalaya. Transmedia Publication Media House, Bhandari Bagh, Srinagar (Garhwal), Uttarakhand, 206 pp.

Bartram, J. and Balance, R. 1996. Water quality monitoring - A practical guide to the design and implementation of freshwater quality studies and monitoring programmes. Published on behalf of united nations environment programme and the world health organization.

Bisht, B., Badoni, A.K. & Bahuguna, S.N. 2009. Seasonal distribution and relative abundance of fish fauna of a small hill stream Dangchaura (Takoli) Gad, along with River Alaknanda. Our nature, 7: 182-186.

CAMP. 1998. Report of the workshop on 'Conservation Assessment and Management Plan (CAMP) for freshwater fishes of India.' Zoo outreach organization and NBFGR, Lucknow, 22-26 September, 1997, India, 156 pp.

Day, F. 1878. The fishes of India: being a natural history of the fishes known to inhabit the seas and freshwater of India, Burma and Ceylon. Today and Tomorrow Book Agency, New Delhi, 778 pp.

Froese, R. and Pauly, D. 2013. Fish Base. World Wide Web electronic publication.Available online at http://www.fishbase.org, version July 2013.

IUCN 2011. IUCN Red List of Threatened Species. *Version* 2011. 2. <www.iucnredlist.org>.

Jayaram, K.C. 2010. The fresh water fishes of the Indian region. Narendra Publishing House, Delhi, India, 616 pp.

Johnson, J.A. & Arunachalam, M. 2010. Relation of physical habitat to fish assemblages in streams of Western Ghats, India. Applied Ecology and Environment Research, 8 (1): 1-10.

Millennium Ecosystem Assessment (MEA) 2005. Ecosystem Services and Human Well-being: Wetlands and Water Synthesis. World Resources Institute, Washington, DC.

Nel, J.L., Roux, D.J., Abell, R., Ashton, P., Cowling, R.M., Higgins, J.V., Thieme, M. & Viers, J.H. 2009. Progress and challenges in freshwater conservation planning. Aquatic Conserv: Marine Freshwater Ecosystem, 19: 474-485.

Poff, N.L. 1997. Landscape filters and species traits: towards mechanistic understanding and prediction in stream ecology. Journal of the North American Benthological Society, 16, 391-409.

Rath, R.K. 2000. Freshwater aquaculture, 2nd edition. Scientific Publishers, Jodhpur, India. 445 pp.

Sarkar, U.K., Pathak, A.K., Sinha, R.K., Sivakumar, K., Pandian, A.K., Panday, A., Dubey, V.K. & Lakra, W.S. 2011. Freshwater fish biodiversity in the River Ganga (India): changing pattern, threats and conservation perspectives. Review in Fish Biology and Fisheries. 22 (1): 251-272.

Schlosser, I.J. 1987. The role of predation in age and size related habitat use by stream fishes. Ecology, 68: 651-659.

Sehgal, K.L. 1999. Coldwater fish and fisheries in the Himalayas: rivers and streams. Technical paper. No 385, *Fisheries Rome*, FAO: 41-63.

Singh, G. & Agarwal, N.K. 2013. Fish diversity of Laster stream, a major tributary of river Mandakini in Central Himalaya (India) with regard to altitude and habitat specificity of fishes. Journal of Applied and Natural Science, 5 (2): 369-374.

Singh, G. & Agarwal, N.K. 2014. Fishing methods in upper Ganga River system of Central Himalaya, India. Journal of Fisheries, 2 (3): 195-202.

Singh, H.R., Badola, S.P. & Dobriyal, A.K. 1987. Geographical distribution list of Ichthyofauna of Garhwal Himalaya with some new records. *Journal of Bombay Natural History Society*, 84: 126-132.

Talwar, P.K. & Jhingran, A.G. 1991. Inland fishes of India and adjacent countries. Vols. 1 and 2, Oxford & IBH Publishing house, New Delhi. 1158 pp.

Thomas, D.A. & Hayes, D.B. 2006. A comparison of fish community composition of headwater and adventitious streams in a coldwater river system. Journal of Freshwater Ecology, 21 **(**2): 265-275.