Uttar Pradesh Journal of Zoology

Volume 44, Issue 21, Page 68-77, 2023; Article no.UPJOZ.2838
ISSN: 0256-971X (P)

Exploration of Ichthyofaunal Diversity in Beas River Near Nadaun Region of Himachal Pradesh, India

Harinder Singh Banyal [a] and Shivali Sharma [a*]

[a] Department of Biosciences, Himachal Pradesh University, Summer-Hill, Shimla, H.P.-171005, India.

Authors' contributions

This work was carried out in collaboration between both authors. Both authors designed the study. Author SS performed the statistical analysis and wrote the first draft of the manuscript. Both authors managed the analyses of the study. Both authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2023/v44i213670

Editor(s):
(1) Dr. Ana Cláudia Correia Coelho, University of Trás-os-Montes and Alto Douro, Portugal.
Reviewers:
(1) Bikramjit Sinha, North Eastern Regional Centre, India.
(2) Mehrajuddin War, The New College affiliated to University of Madras, India.

Original Research Article

Received: 12/07/2023
Accepted: 16/09/2023
Published: 25/09/2023

ABSTRACT

The present research paper deals with studies on fish-faunal diversity in relation to abiotic parameters in the Beas River near Nadaun region of Himachal Pradesh state in India. A total of 12 fish species belonging to 6 orders and 7 families were recorded during the present study. Cypriniformes was the dominant order represented by 7 species. According to IUCN, out of 12 species, 9 species were recorded under the Least Concern (LC) category whereas 1 species each was included in Vulnerable (VU), Endangered (EN) and Not-Evaluated (NE) category respectively. Role of selected physicochemical parameters (Water temperature, PH, Dissolved Oxygen (DO), Total Dissolved Solids (TDS) and Electric current) of river water in governing distributional pattern of fish-fauna was analyzed specifically by Redundancy Analysis (RDA) method. Threats and strategies to conserve fish faunal diversity are also suggested.

Keywords: Abiotic factors; beas; diversity; ichthyofauna; Nadaun.

**Corresponding author: Email: shivali20597@gmail.com;*

1. INTRODUCTION

Rivers are an important part of freshwater ecosystem and are considered as one of the major ecosystems of the world. Rivers provide freshwater habitats for aquatic and semiaquatic fauna and flora, as well as enable terrestrial ecosystems to thrive in the riparian zones. Many human settlements and civilizations are built around and on the banks of different rivers and streams, so they are very important to mankind. Geologically, the river basin is composed of alluvial detritus and composition of clay, sand, silt, gravel, and some boulders. Due to their large basin and differential geology, different rivers support diverse ichthyofauna, providing significant opportunities to locals through fisheries sector [1].

Himachal Pradesh has a large number of perennial snow-fed or spring fed rivers and streams. The eastern portion of the state is drained primarily by the Sutlej River, which originates from Mansarovar, Tibet (Rakestan) and the western part is drained by the Beas, Ravi and Chenab Rivers, which have originated in Himachal Pradesh itself [2].

Beas is a perennial river which originates near Rohtang Pass (Beas Kund) and confluences with Sutlej River at Harike wetland after covering a distance of 470 km before finally meeting with Indus River. The Beas River traverses through 256 km in Himachal Pradesh. The Beas River receives water by melting of snow, surface run-off by rainfall and its banks are covered with extensive cover of vegetation. Its main tributaries in the East are the Parbati, the Spin, and the Malana-nala and the Solang, the Manalsu, the Phojal and the Sarvari streams in the West. In Kangra, its major tributaries in the North are Binwa, Neugal, Gaj, Baner and Chakki and the Khairan, Maseh in South and in Hamirpur district it is joined by Kunah and Man streams. The important towns present on the bank of river Beas in Himachal Pradesh are Manali, Kullu, Mandi, Dharampur, Sujanpur Tihra, Dehra Gopipur and Nadaun [3].

Nadaun a historical town in the Hamirpur district of Himachal Pradesh, India is located at 31.78°N 76.35°E and is situated on the left bank of the river Beas. Previously it was a part of the princely state of Kangra. But at present, Nadaun is an independent small town located on NH 3 and NH 303 in Hamirpur district of Himachal Pradesh in the foothills of Shivalik range [4].

Extensive review of literature has showed significant contribution of following researchers pertaining to different aspects of Ichthyofaunal diversity of Himachal Pradesh: Day [5]; Hora [6]; Menon [7-9]; Sehgal [10]; Sharma & Tandon [11]; Johal et al. [12]; Banyal [13]; Dhanze & Dhanze 2004 [14]; Mehta & Uniyal [15]; Mehta & Sharma [16]; Sharma [17]. Significant scientific investigations on different attributes of fish faunal diversity in Beas River includes work of Dhanze and Dhanze [18] who have worked on Ichthyofaunal habitat shrinkage due to drainage system in Beas River. Subsequently, River Beas ecology was extensively studied by Moza and Mishra [19]. In this context different trends in water quality parameters of the Beas River were studied by the Central Pollution Control Board (CPCB) for the years 2002, 2008, 2009 and 2012 [20,21]. Kumar [22] studied the fish diversity and hydrobiological conditions of the River Beas in Kullu Valley, H.P. (India). Fish diversity in upper portion of the Beas River in H.P. was assessed by Kumar & Khanna [23]. A review on water quality of Beas River was given by Kumar et al. [24]. Analysis of variation in abiotic factors of Beas River near Dharampur, Mandi and Mid-Himalayan zone, India was done by Rana et al. [25] and Jindal et al. [26], respectively. Present research work focuses on analysis of fish faunal diversity in relation to physicochemical parameters following Redundancy Analysis (RDA) method, which is done first time in Beas River at Nadaun town of Himachal Pradesh.

2. MATERIALS AND METHODS

The present study was carried out at three different sites of Beas River near Nadaun region, district Hamirpur (H.P) (Table 1 & Fig. 1).

Fish sampling was done in Beas River during 2023. Fish specimens were collected following random survey technique by using cast, gill, and drift net, operated through local licensed fishermen. Collected specimens were kept in 5–10% formalin, which were then brought to the laboratory for further identification. Taxonomical identification of fish specimens was done by using literature given by Talwar and Jhingran [27], Jayaram [28], and with Fish Base [29]. Various diversity indices were used to evaluate fish faunal diversity. Physicochemical parameters such as water temperature (°C), D.O. (mg/l), pH and TDS (mg/l), EC (µS/cm) were measured in

Fig. 1. Map showing area of study
Source: Google earth

the field by using digital probes to analyze the quality of river water. Redundancy Analysis (RDA) method was used to derive the relation between abiotic factors and ichthyofaunal diversity.

Table 1. Sampling sites

Index	Latitude	Longitude
Site 1 (Vilikleshwar)	31°46'25.67"N	76°22'29.64"E
Site 2 (near Amtar)	31°46'45.90"E	76°21'53.90"E
Site 3 (near Beas pull Nadaun)	31°47'11.22"N	76°20'29.47"E

3. RESULTS AND DISCUSSION

River water quality is a predictor of its productivity and foretells its potential from a fish and fisheries perspective [30]. The water quality of Beas River was interpreted by selecting important physicochemical parameters including water temperature, pH, EC, TDS, and DO.

Table 2. Variation of Physico-chemical parameters at different sites

Physicochemical Parameter	Site Ⅰ	Site Ⅱ	Site Ⅲ
Water Temperature (°C)	29	28.4	29.3
pH	9.3	9.7	8.1
TDS (ppm)	50	54	58
EC (µS/cm)	124	133	150
DO (mg/l)	7.9	7.3	7.5

Variation of different physicochemical parameters is given in Table 2. Water temperature is an important factor which determines the distributional pattern of fishes. It is the vital water quality parameter in aquatic ecosystem [31,32]. Thermal stratification in a river governs distribution of fish species in diverse strata of the river. In the present study the water temperature varied from 28.4 to 29.3°C. Water temperature was found to be a limiting factor in governing differential distribution of many riverine fishes. *Tor putitora* and *Crossocheilus latius diplocheilus* were recorded more in cold water habitats whereas, *Opsarius bendelisis, Garra gotyla, Channa punctata, Glyptothorax spp.* were found in warm water habitats. pH is another important physicochemical parameter influencing the distribution of aquatic flora and fauna. pH recorded ranged from 8.1-9.7, which showed alkaline nature of the river water hence, conducive for aquatic biota including fishes. TDS and EC are two interconnected parameters. High value of total solids (suspended or dissolved) adversely affects the water quality and makes it unsuitable for drinking and irrigation purposes [33]. TDS content was recorded in the range 50-58 ppm and EC varied from 124-150 µS/cm, which were in permissible limit. DO (Dissolved Oxygen) is very important parameter for determining the growth and diversity of ichthyofauna in any water body. As per USEPA [34,35], the requisite value of DO for proper ichthyofaunal growth is >5mg/l. The recorded DO

values in the present study varied from 7.3-7.9 mg/l. The range of DO was adequate for various metabolic activities of ichthyofauna. It is clear from the above observations that all the abiotic parameters recorded in the river are within the permissible limits which predict the productive nature of the river. The present observations are in conformity to earlier studies of Rana et al. [25], Jindal et al. [26], Singh [36].

During the study period, total of 12 fish species belonging to 6 orders (viz., Cypriniformes, Anabantiformes, Perciformes, Synbranchiformes, Beloniformes, Siluriformes) and 7 families (viz., Cyprinidae, Danionidae, Channidae, Ambassidae, Belonidae, Mastacembelidae, Sisoridae) were recorded from the river (Table 1, Fig. 2). Cypriniformes was the dominant order having 7 species, all other orders were represented by one species each. Diversity indices of fish-fauna recorded in the river was calculated using PAST software (version 4.03) (Table 2). Dominance index (D= 0.1154) which is less than 1 shows that there is absence of dominance of any particular species, in addition to this, Simpson index of diversity (1-D = 0.8846) and Shannon-Weiner diversity index (H'= 2.311) show that there is adequate diversity of fish-fauna in the river.

Table 3. Ichthyofauna of Beas River in Nadaun region, Hamirpur (H.P)

Fish Species	Order	Family	IUCN Status	English name
Cyprinus carpio (Linneaus, 1758)	Cypriniformes	Cyprinidae	VU	Common Carp
Tor putitora (Hamilton, 1822)	Cypriniformes	Cyprinidae	EN	Golden Mahseer
Garra gotyla (Gray, 1830)	Cyprinifornes	Cyprinidae	LC	Sucker Head
Crossocheilus latius diplocheilus (Heckel, 1838)	Cypriniformes	Cyprinidae	NE	Stone Roller
Systomus sarana (Hamilton, 1822)	Cypriniformes	Cyprinidae	LC	Olive Barb
Osteobrama cotio (Hamilton, 1822)	Cypriniformes	Cyprinidae	LC	Cotio
Opsarius bendelisis (Hamilton, 1807)	Cypriniformes	Danionidae	LC	Hamilton's Baril
Glyptothorax pectinopterus (McClelland, 1842)	Siluriformes	Sisoridae	LC	River Cat
Channa punctata (Bloch, 1793)	Anabantiformes	Channidae	LC	Spotted Snakehead
Chanda nama (Hamilton, 1822)	Perciformes	Ambassidae	LC	Elongate Glass-perchlet
Xenontodon cancila (Hamilton, 1822)	Beloniformes	Belonidae	LC	Freshwater Garfish
Mastacembelus armatus (Lacepede,1800)	Synbranchiformes	Mastacembelidae	LC	Zig-zag Eel

VU: Vulnerable; EN: Endangered; LC: Least Concern; NE: Not Evaluated

Table 4. Diversity indices of ichthyofauna in Beas River, Nadaun

Taxa (No. of Species)	12
Total no. of Individuals	47
Dominance Index (D)	0.1154
Simpson Index of Diversity (1-D)	0.8846
Shannon Index (H')	2.311
Evenness Index (e^H/S)	0.8405
Marglef Index	2.857

(a)

(b)

(c)

(d)

(e)

(f)

(g)

(h)

(i)

(j)

(k)

(l)

Fig. 2. Ichthyofauna of Beas river near Nadaun, district Hamirpur (H.P). (a) *Cyrinus carpio (*Linneaus, 1758), (b) *Tor putitora* (Hamilton, 1822), (c) *Garra gotyla* (Gray, 1830), (d) *Opsarius bendelisis* (Hamilton, 1807), (e) *Crossocheilus latius diplocheilus* (Heckel, 1838), (f) *Osteobrama cotio* (Hamilton, 1822), (g) *Xenontodon cancila* (Hamilton, 1822), (h) *Mastacembelus armatus* (Lacepede,1800), (i) *Chanda nama* (Hamilton, 1822), (j) *Channa punctata* (Bloch, 1793), (k) *Glyptothorax pectinopterus* (McClelland, 1842), (l) *Systomus sarana* (Hamilton, 1822)

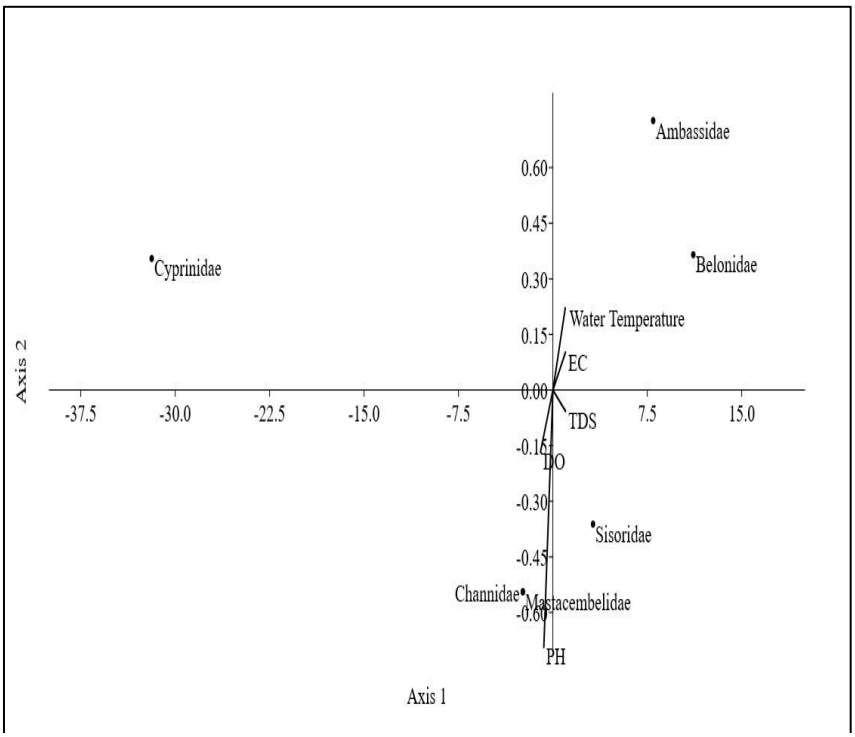

Fig. 3. RDA showing relation between environmental variables and ichthyofaunal diversity

Minnows such as *Opsarius bendelisis, Garra gotyla* were dominant species, whereas commercially significant fishes viz., *Tor putitora, Cyprinus carpio* were less abundant fish species found in total fish catch. *Tor putitora, Cyprinus carpio* and *Crossocheilus latius diplocheilus* preferred slow current and were found mainly in deep pools and riffle habitats, whereas *Barilius bendelisis* was found in riffles and side pools, Mastacembelus *armatus* found hidden under stones and crevices. *Channa punctata* preferred pools with sluggish water current. *Garra gotyla* and *Systomus sarana* were dominant in shallow pools and were also found in riffles, *Glyptothorax pectinopterus* was found in runs and rapids. Deep water pool with slow water current habitat was the most preferred habitat by maximum number of fishes. Similar observations were also made by Banyal [13] and Rawal [37] in the streams of Himachal Pradesh.

Redundancy Data Analysis (RDA) was used to analyze the correlation between environmental variables and ichthyofaunal species (Fig. 3). Different environmental variables viz., pH, TDS, DO, Water Temperature and EC were selected for analysis. Mastacembelidae and Channidae showed similar responses as they are present closer in the plot and showed positive correlation with pH and DO. Sisoridae showed positive correlation with TDS. There is positive correlation between water temperature, EC and Belonidae and Ambassidae, as shown by the plot. Moreover, members of Cyprinidae are equally distributed everywhere as they are present independently of the plot. This shows that species of Cyprinidae are hardy species. Similar results were obtained in Man stream a tributary of Beas river for Cyprinidae and Belonidae [38,39].

4. CONCLUSION

Based on the above observations, it is concluded that fish diversity and its composition is characterized by different abiotic variables, so it is very important to keep a check on these abiotic variables for sustenance of ichthyofaunal diversity in the river. The presence of commercially important fishes such as *Tor putitora* which is also critically endangered highlights importance of the river from commercial fisheries perspective. Furthermore, it is revealed that Beas River is commercially extensively exploited for its fish resources, besides water of the river is used for drinking and various other household purposes (bathing, washing of clothes etc.), irrigation, hydroelectricity generation and many more. It is recommended that by stopping the

degradation of river environment, the level of fish diversity in the river can be amplified. Additionally, different conservation measures such as avoiding illegal fishing, dynamiting, poisoning of fishes with chemicals, recognizing breeding grounds and creating awareness among local inhabitants are required for the sustenance of fish germplasm in the river.

ACKNOWLEDGEMENTS

Authors are thankful to the Chairperson, Department of Biosciences, Himachal Pradesh University, Shimla for providing necessary facilities regarding research work. Thanks, are also due to various licensed fishermen who helped in fish sampling during the present research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anonymous; 2023. River ecosystem - Wikipedia.
2. Anonymous; 2021. Available:https://www.britannica.com/place/Himachal-Pradesh.
3. Anonymous. Britannica, T. Editors of Encyclopedia (2015, April 1). Beas River. Encyclopedia Britannica; 2015. Available:https://www.britannica.com/place/Beas-River
4. Anonymous; 2023. Available:https://www.britannica.com/place/Himachal-Pradesh Nadaun, Himachal Pradesh – Wikipedia.
5. Day F. The fishes of India; Being a Natural History of The Fishes Known to Inhabit the Sea and Freshwater of India, Burma and Ceylon. Reprinted in 1958, William Dawson & Co., London. 1875–1878; 778.
6. Hora SL. Distribution of Himalayan fishes and its bearing on certain paleaogeographical problems. Rec. Indian Mus. 1937;39: 251–259.
7. Menon AGK. A distribution list of fishes of the Himalayas. Journal of the Zoological Society of India. 1962; (1):23–32.
8. Menon AGK. Fauna of India and the Adjacent Countries. Pisces, 4 (Part-I). Homalopteridae, Published by Director Zoological Survey of India, Calcutta. 1987;x+259.
9. Menon AGK. Checklist of freshwater fishes of India. Records of the Zoological Survey of India Occasional Paper. 1999;175: I-xxix: 1–366.
10. Sehgal KL. Fisheries survey of Himachal Pradesh and some adjacent areas with special reference to trout, Mahseer and allied species. J. Bomb. Nat. Hist. Soc. 1974;70(3):458–474.
11. Sharma VK, Tandon KK. The fish and fisheries of Himachal Pradesh state of India. Punjab Fisheries Bulletin. 1990;14(1):41–46.
12. Johal MS, Tandon KK, Tyor AK, Rawal YK. Fish diversity in different habitats in the streams of lower middle Western Himalaya. Pol. J. Ecol. 2002;50(1):45-56.
13. Banyal HS. Ecology of Fish Communities of Some Selected Streams of Western Himalayas in Relation to Stream Morphology. Ph.D. Thesis. Panjab University Chandigarh, India; 2003.
14. Dhanze R, Dhanze JR. Fish diversity of Himachal Pradesh, In: Ayyappan, S., D.S. Malik, R. Dhanze & R.S. Chauhan (eds.). Fish Diversity in Protected Habitats. NATCON Publication, Muzaffarnagar, (U.P.), India. 2004;39–60.
15. Mehta HS, Uniyal DP. Pisces, In: Fauna of Western Himalaya (Part-2), Zoological Survey of India, Kolkata. 2005;255- 268.
16. Mehta HS, Sharma I. Pisces, Fauna of Pin Valley National Park, Conservation Area Series - 34. Zoological Survey of India, Kolkata. 2008;89–92.
17. Sharma I. Limnology of coldwater in lentic and lotic water bodies and fishery status in the streams of Himachal Pradesh, India. Biological Forum – An International Journal. 2021;13(2):184-186.
18. Dhanze JR, Dhanze R. Impact of habital shrinkage on the indigenous fish habitat resources of Beas drainage system, In (Eds) A.G. Ponniah, P. Das, & S.R. Verma). Fish Genetic Biodiversity Conservation. Natcon Publication No.5. 1998;115-126.
19. Moza U, Mishra DN. River Beas Ecology and Fishery, Central Inland Fisheries Research Institute.
20. CPCB, Status of water quality in India-2010. Central pollution control Board, Ministry of Environment, Forest and

Climate Change, Government of India (GOI); 2011.
21. CPCB, Status of water quality in India-2012. Central pollution control Board, Ministry of Environment, Forest and Climate Change, Government of India (GOI); 2014.
22. Kumar A. Hydrological conditions of River Beas and its fish fauna in Kullu Valley, Himachal Pradesh, India. Environment Conservation Journal. 2010;11(3):7-10.
23. Kumar A, Khanna DR. Ichthyofaunal diversity in upper stretches of River Beas, Himachal Pradesh, India. International Journal of Researches in Biosciences, Agriculture & Technology. 2014;2(2):266-272.
24. Kumar V, Sharma A, Thukral AK, Bhardwaj R. Water quality of River Beas, India. Current Science. 2017;112(6):1138-1157.
25. Rana A, Sharma A, Sharma M. Study of variation in abiotic factors of Beas river water near Dharampur, Mandi (H.P.). Proceedings of National Conference. 2019;61-71.
26. Jindal R, Chawla C, Singh D, Shoshta A, Kaur S. Biomonitoring and water quality evaluation of river Beas in Mid Himalayan Zone, India. Current Applied Science and Technology. 2021;**22**(5).
27. Talwar PK, Jhingran AG. Inland Fishes. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. 1991;1(2).
28. Jayaram KC. The freshwater fishes of the Indian region. Narendra Publishing House, Delhi, India; 1999.
29. Froese R, Pauly D, Editors. Fish Base. World Wide Web electronic publication; 2023.
Available;www.fish base.org. version (02/2023).
30. Allan JD. Stream ecology: Structure and function of running waters. Chapman and hall, London; 1995.
31. Vannote RL, Sweeney BW. Geographical analysis of thermal equilibria: A conceptual model for evaluating the effect of natural and modified thermal regimes on aquatic insect communities. Am Nat. 1980;115: 667- 695.
32. Hawkins CP, Hogue JN, Deeker LM, Feminella JW. Channel Morphology, Water temperature and assemblage structure of stream insects. J. North Am Benthol Soc. 1997;16:728-749.
33. Karthikeyan TP, Sashikumar M, Ramesh M. Physicochemical, biological and bacteriological studies of Kaduthur canal water of Amravati River, Tamilnadu. Poll. Res. 2002;21(1):21-23.
34. US. Environmental Protection Agency. Quality Criteria for Water. U.S. Environmental Protection Agency, EPA - 600/4- 82-029, Washington DC; 1976.
35. U.S. Environmental Protection Agency. Quality Criteria for Water. U.S. Environmental Protection Agency, Office of Water Regulations and Standards. EPA/440/5-86-001, Washington, DC; 1986.
36. Singh O. Biology of an Endangered Fish, Golden Mahseer, Tor putitora (Hamilton, 1822) in relation to ecological conditions of Hillstreams of the river Beas in Himachal Pradesh (India). Ph.D Thesis. Panjab University Chandigarh, India; 2002.
37. Rawal YK. Ecology and abundance of fish communities in hillstreams of Western Himalayas and analysis of factors responsible for their distribution. Ph. D. Thesis. Panjab University Chandigarh, India; 2002.
38. Sharma S, Banyal HS. Studies on fish faunal diversity in relation to abiotic parameters in man stream, Beas Riverine System, Himachal Pradesh, India. J. Env. Bio-Sci. 2023;37:61-67.
Available:https://doi.org/10.59467/JEBS.2023.37.61
39. IUCN. The IUCN red list of threatened species. Version 2022-2. www.iucnredlist.org [Last accessed on 2023, July]; 2023.