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FISH DIVERSITY IN GLACIAL AND SPRING-FED WATER BODIES OF CHAMPAWAT DISTRICT IN THE KUMAON REGION OF UTTARAKHAND STATE, INDIA

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Abstract: In the present study, four water bodies of Champawat district, Uttarakhand India, were studied to determine fish diversity in relation to the physical habitat. On the basis of entrenchment ratio, river Chalti was classified as 'D' type. Sharda and Saryu 'F' type and Lohawati as a 'B' type river. The substrate was mainly dominated by boulders, cobbles, gravel and pebble in the Saryu and Chalti rivers, boulders in the Lohawati and sand and silt in the Sharda river. With respect to water velocity, Chalti river was classified as intermediately productive, Lohawati river as less productive whereas, Saryu and Sharda rivers did not fit in the productive or less-productive categories. A total of 10 species belonging to 8 genera, 3 families (Cyprinidae, Cobitidae, Mastacembeliodae) and orders Cypriniformes and Perciformes) were recorded from the selected sites. On the basis of altitude, an inverse relationship was observed with species richness.

KEYWORDS: Fish diversity, glacial, spring, cyprinids, Champawat.

Introduction

Of the Earth's total surface, which comprises approximately 510 million sq. km., about 361 million, or 71%, is occupied by the surfaces of oceans and seas. In addition, up to 2.5 million sq. km., or about 0.5 % of the earth's surface is occupied by inland water bodies. Among these water bodies, rivers and streams are lotic systems dominated by strong unidirectional flow. Ecology of lotic habitat differs from lentic systems by the dominance of linked flow, erosion, deposition and substrate processes. Fish constitutes almost half of the number of vertebrates in the world. They live in almost all conceivable aquatic habitats; c 21,723 living species of fish have been recorded out of 39,900 species of vertebrates (Jayaram, 1999). Of these, 8,411 are freshwater species and 11,650 are marine species. India is one of the most megabiodiverse countries in the world and occupies the ninth position in terms of freshwater megabiodiversity (Mittermeier and Mittermeier, 1997). In India, there are c 2,500 species of fishes of which, c 930 live in freshwater and c 1570 are marine (Kar, 2003a). The biodiversity in the aquatic environment is declining faster than in the terrestrial environment (Moyle & William,1990; Abramovitz, 1995; Liedy & Moyle, 1970) and the problem is particularly acute in streams and rivers (Allan & Flecker,1983; Allan, 1995). In recent years, as a result of technological expansion such as construction of huge dams, lime stone quarrying and frequent natural eco-disasters like soil erosion, land slides, blockade formation, frequent flash floods, deforestation and population pressure, the entire lotic ecosystem of the Kumaon region has been altered. Keeping in mind the above facts, the present study was carried out to determine the fish diversity of some selected aquatic water bodies of the Champawat district in Uttarakhand state, India.

Study area: In the present study, four water bodies viz. Saryu, Sharda, Lohawati and Chalti were studied. Saryu and Sharda rivers were glacial fed with Lohawati and Chalti originating from small tributaries. The rivers were generally dominated by riffle-pools, cascades, and plane-beds at

some point in their flow. Lohawati and Chalti rivers were dominated by cascades. The district of Champawat is situated between 29º 5' N and 29º 30' N and 79º 59' E and 80º 3' E. (Fig.1).

Materials and Methods

The parameters like altitude, water source, channel material, dominant habitat type, entrenchment ratio and width and depth ratio were determined as is Rosgen's (1996) stream classification. The habitat type and substrate were classified after Armantrout (1999). Fishes were sampled at each site by utilising a cast net of 1cm mesh size having a diameter of 1-2 m. Ten-to-fifteen castings were conducted at each study site from January 2008 to April 2008. Fishes were identified to species level in the laboratory by referring to Day (1875 – 1878), Johal and Tandon (1979,1980), Talwar & Jhingran (1991) and Jayaram (1999). The Shannon and Weaver diversity index was use to calculate fish diversity at all sites.

Results and Discussion

All the morphological parameters of rivers is given in Table 1.

Depth and width ratio: There was a great variation in channel width among the four rivers. Sharda river has the largest channel width of 150 metres and a depth of 900cm. Saryu river has a channel width of 111 metres and a depth of 150cm, while Chalti river has a width of 109 metres and a depth of 70cm, Lohawati has smallest channel width and depth of 7metres and 30cm respectively. The maximum depth /width ratio was recorded for Chalti river (145.33) while it was the lowest for Sharda river (16.66).

Entrenchment ratio: All the study sites in the present study are single-thread channels except for Chalti which has two channels. Sharda, Saryu and Chalti rivers are slightly entrenched with an entrenchment ratio of 1.09, 1.24 and 4.54 respectively. Lohawati is moderately entrenched with an entrenchment ratio of 1.75. On the basis of entrenchment ratio, Chalti river is classified as a 'D' type river, Sharda and Saryu rivers as 'F' type rivers and Lohawati river as a 'B' type rivers. In the present study, rivers were classified as per Rosgen's (1996) classification of natural rivers. Hawkin et al. (1993) described a three-level system that can be used to classify (Channel geomorphic unit) riffle and pool habitat classes. Johal et al. (2002) has classified streams on the basis of altitude (850-1440msl as a 'A' type, 380-1150 msl as 'B' type, 400-754msl as 'C' type and 390-400msl as 'F' types streams. Johal and Rawal (2005) classified the western Himalayan streams into three major types of streams namely "A", "B" and "F" type. Negi et al. (2007) has classified the streams of Kicheri as 'B' type and Nandhour and Balia as 'C' type on the basis of entrenchment ratio. They also classified the streams on the basis of stream gradient and recorded gradient of 2.6% at Balia streams, 2% at Kicheri and 1.8% at Nandhour streams respectively. As per Rosgen's (1996) streams and river classification system, the rivers having entrenchment ratio <1.4 are classified as entrenched, 1.4-2.2 are classified as moderately entrenched and >2.2 are classified as slightly entrenched. In the present investigation, the authors have used Rosgen stream classification system for classifying rivers.

Watershed feature: On the basis of land use pattern, Saryu river flows through forest and residential areas. River Lohawati flows through forest and residential areas but with local alteration such as small retention of water flow and channelisation of river for irrigation purpose. Similar features were found at Chalti river. Sharda river flows through forest, residential and commercial areas with local hydrological alteration.

Sediment source: There were no management activities at Saryu, except extraction of sand from the river bed. However, mass wasting (slides and debris) were reported in Saryu. No such activities were reported in Lohwati. The extraction of sand and cobbles were reported in Chalti river. Mining and mass wasting were also reported from Sharda river. Maximum bank-erosion features were reported in Chalti and Sharda rivers. The degree of instream sedimentation was reported maximum in Sharda river. As far as channel stability and depositional features are concerned, all the study sites were unstable.

Substrate: In the present study, river substrate was mainly dominated by boulders, cobbles, gravel and pebbles in the Saryu and Chalti rivers, whereas at Lohawati, boulders were dominant. In the Sharda river, sand and silt were predominant habitat features. Armantrout (1999) has described and classified the substrate materials according to their size, as large boulder, small boulder, cobbles, course gravel, fine gravel, sand, silt and clay.

Riparian vegetation: During the course of study, the extent of riparian buffer zone, width of riparian buffer zone and extent of vegetation encroachment into river and channel were considered. It was noted that the width of the riparian buffer zone was 1.5 channel width at the Saryu, Chalti and Lohawati rivers, while at the Sharda river it was not more then 1 channel width. Encroachment of vegetation into the water bodies was moderate in Sharda while it was minimal at other sites.

Woody debris: There was large woody debris present in the cut banks of Saryu, Sharda and Chalti rivers. Wood logs were also reported from Lohawati river.

Air temperature and water temperature: Air temperature is one of the most important parameter as the water temperature strongly mimics the air temperature, especially in small streams that are shallow. The mean air temperature recorded was 22ºC at Sharda and Saryu, 18ºC at Chalti and 20º at Lohawati. The mean water temperature was 19ºC at Saryu and Lohawati, 15ºC at Chalti, while it was 20ºC at Sharda river.

Water velocity: There was great variation in velocity of water in the entire study site. The average water current in Sharda river was 1.41 m/sec., 1.33m/sec. in Saryu, 1.11 m/sec. in Chalti and 2.33m/sec. in Lohawati river. This variation in water velocity may be due to the different physical habitats of the rivers. De Camp (1971) classified the streams in three groups based on water current viz. moderately productive (water current 1-50cm/sec), intermediately productive (water current 51-125cm/sec) and less productive (water current 126-175cm/sec). Johal et al. (2002) have classified various kinds of habitat according to the water velocity e.g. habitat with velocity 0.3m/sec as run/riffle, and habitat with velocity 1.0m/sec. as rapid.

pH: The pH was recorded at 8.2 in Saryu, 8.4 in Sharda, 7.8 in Chalti and 7.7 in Lohawati rivers. The rivers are alkaline in nature.

Fish species richness

Ten fish species belonging to 8 genera from 4 families (Cyprinidae, Cobiditae, Mastacembeliodae and Channidae) and 2 orders (Cypriniformis and Perciformes) were recorded from the study sites. Cypriniformes was the most dominant order represented by 9 species from 8 genera, and Perciformes were represented by one species from one genera (Table 2). *Tor tor, T. putitora* and *Schizothorax sinuatus* were the most dominant at Saryu river. *Barilius benedelisis* was the most common in Chalti and Sharda rivers, while *Barilius vagra* was recorded at Saryu and Sharda rivers only. *Channa punctatus* was reported from Saryu and Sharda rivers only. *Puntius chonchnius* was dominat at Lohawati river followed by Chalti and Sharda rivers. *Mastacemblelus armatus, Aspidoparia morar* and *Lapidophalichthys guntia* were recorded only from the Sharda river. Cyprinids were the most

dominant group in the rivers under study followed by Perciformes which was represented by only one species. Nelson (1994) reported the greatest freshwater diversity in Cypriniformes and Siluriformes in the freshwater habitats. Similar observations were made by Shrestha (1999) in the Nepal region of the Himalayas. In the present investigation, the Shannon index for fish diversity in the rivers of Champawat district were estimated and values ranged from 1.19 to 3.10. Maximum fish diversity was reported in the river Sharda 'H' (3.10).

Percentage composition of fish diversity in individual rivers

Sharda: Ten species of fishes belonging to 8 genera, 4 families and two orders were recorded from Sharda river (Table 3). The cast-net catch during the study period fishing, comprising mainly *Barilius vagra* (25.565), *Barilius bendelisis* (17.025), *Puntius chonchonius* (21.2%), A*spidoparia morar* (12.7%), *Schizothorax sinuatus* (8.15%), *Tor putitora* (4.25%), *Tor tor* (4.25%) and *Channa punctatus*, *Mastacembelus armatus* and *Lepidocephalus guntea* (2.21%) respectively, were recorded (Table 3). The low percentage composition of the fish species is because of the higher species richnesss in Shada as compared to the other rivers.

Saryu: Icthyofauna of Saryu river included 5 species belonging to 4 genera, 2 orders and four families. Most of the fishes collected during the study were small young fishes. The percentage composition of fishes are *Tor tor* (36.36%), *Tor putitora* (18.18%), *Barilius vagra* (18.18%) and *Channa punctatus* (9.09%).

Chalti: The percentage composition of fish was dominated by *Puntius conchonius* (71.58%), followed by *Barilius bendelisis* (28.42%). The low occurrence of fish species in Chalti river is due to direct human interference in the river. Anthropogenic activities like mining of gravels, cobbles and sand from the river bed and low depth of river led to a decline in the fish fauna.

Lohawati: During the course of study, only one fish species, *Puntius chonchonius*, was recorded from the Lohawati river. This may be due to low depth and large number of anthropogenic activities in the river leading to loss of fish diversity. Among the four rivers surveyed during the study, the Sharda river has the highest species richness followed by Saryu, Chalti and Lohawati. Among the genera, *Tor* and *Barilius* are the dominant fish species of the rivers of the Champawat district.

Fish species richness vs altitude: Highest fish species richness was recorded from the Sharda river which is at an altitude of 228msl, and the lowest fish species richness was recorded at the Lohawati river which is at an altitude of 1706msl (Table 3). The present data suggests an inverse relationship between fish species richness and altitude (Table 2). Shreshta (1995) reported two genera of *Schizothorax* at altitudes ranging from 754 msl to 3323 msl. Altitude as well as slope/ gradient exerts the primary influence on the distribution and abundance of the fish species.

Rever-Gavilan et al. (1996) also observed elevation to be highly negatively-correlated with species richness and diversity. Oberdorff and Porcher (1992), while working on the fish assemblage structure of two Brittany streams, found stream gradient to be significantly correlated with species richness. The role of the different factors like altitude, gradient, habitat and bed material on the fish species richness and 'H' has already been established (Johal et al., 2002; Singh and Kumar, 2003). Triple et al. (1996) showed that due to pollution, dam construction, urbanisation and various human activities, fish biodiversity is decreasing not only in major rivers and streams, but also in hillstreams.

McBains and Trush (1996) were of the view that biological communities, flow regimes, upstream sediment input, dominant particle size of the basin and water quality determines the type of stream and fish communities. In the present investigation, *Schizothorax* species were reported from an altitude (413msl-228msl) at the Saryu and Sharda rivers.

Johal et al. (2002) have reported high value 'H' (0.86 – 0.97) of fish diversity from the an altitude ranging from 380 msl to 1524 msl from 25 streams of the Western Himalayas, India. In the present investigation, the values of Shannon index for fish diversity ranged from 1.19 to 3.10 in the rivers of Chapawat district. Maximum fish diversity 'H' (3.10) was recorded in the Sharda river as compared to other rivers.

In the present study, Sharda and Saryu rivers have dominant small boulders and cobbles and good flow regime leading to good numbers of fish fauna. However, C halti and Lohawati rivers have poor bed material leading to lower fish fauna.

The relationship between habitat diversity and fish community has been analysed by Gorman and Karr (1978) in temperate areas in which they include the diversity of current, depth and substrate which determine the riverine fish communities. According to Hussain (1995), the distributional pattern of fish fauna in relation to the Garhwal & Kumaon divisions of Western Himalayas is very interesting. He recorded 124 species/ sub species of fish belonging to 66 genera, 27 families and 8 orders from 8 districts of Uttarakhand. Out of 124 species/ sub species of fish, 88 species/sub species from Garhwal region and 105 species/sub species have been recorded from the Kumaon region while, 18 species/sub species have been recorded in both regions.

Ogale (1997) has stated that the deteriorating environment, increased industrial activities with a consequent draining of industrial waste into the rivers and streams, construction of dams without any appropriate and adequate provision for fish migration, illegal mining of sand and gravel and indiscriminate killing of indigenous fish by using illegal fishing methods are considered to be responsible for the depletion of the indigenous fishes. In the present study, illegal mining activities in the form of extraction of sand, gravel and cobbles from the Chalti and Sharda rivers leads to depletion of fish diversity. Pathani (2002) has reported 18 fish species belonging to 4 families viz. Cyprinidae, Botinidae, Sisoridae and Mastacembelidae from river Ramganga. During the course of study, only 3 families, Cyprinidae, Cobitidae and Mastacembelidae have been recorded from selected water bodies of Champawat district in the Kumaon region of Uttarkhand state. Negi et al. (2007) have also reported the cyprinidae were the most dominant group of fishes from Kumaon region of Uttarkhand state.

References

Abramovitz, J.N. (1995). Freshwater failure: the crisis on five continents. *World watch* 8: 26-28.

Allan, J.D. (1995). *Stream ecology: structure and function of running water.* New York London: Chapman and Hill.

Allan, J.D. and Flecker, A.S. (1993). Biodiversity conservation in running water. *BioScience* 43: 32-43.

Armantrout, N.B. (1999). Glossary of aquatic habitat inventory in Western Ghats India. *Hydrobiologia*, 430: 1-31.

Day, F. (1878). *The Fishes of India: being a natural history of the fishes known to inhabit the sea and freshwater of India, Burma and Ceylon*. Text and Atlas. Jagmander Book Agency, New Delhi Text 778pp, Atlas 204 pp.

Gorman, O. T. and Karr, J. R. (1978). Habitat structure and stream fish community. *Ecology* 59: 507-515.

Hawkins, C. P. , Kerhner, J. L., Bison, P. A., Bryant, M. D., Decker, l. M., Gregory, S. V., Mc Culough, D. A., Dvrton, C. K., Reeves, G. H., Steedman, R. J. and Joung, M. K. (1993). A hierarchical approach to classifying stream habitat feature. *Fisheries,* 18: 3-12.

Jayaram, K.C. (1999). *The freshwater fishes of the Indian region*. Narendra Publishing House, New Delhi, 551pp.

Johal, M.S. Tandon, K.K. (1979). Monograph on the fishes of the reorganized Punjab. Part 1. *Punjab Fish Bull.,*3: 1-44.

Johal, M.S. Tandon, K.K. (1980). Monograph on the fishes of the reorganized Punjab. Part 11. *Punjab Fish Bull.*,4: 39-70.

Johal, M.S., Tandon, K.K., Tyor, A.K., Rawal, Y.K. (2002). Fish diversity in different habitat I hillstreams of lower middle Himalayas. *Polish J. Ecology*, 50(1): 45-56.

Johal, M.S. and Rawal, Y.K.(2005). Key to the management of the Western Himalayan hill streams in relation to fish species richness and diversity. *Hydrobiologia*, 532: 225-232.

Kar, D. (2003). *Fishes of Barak drainage, Mizoram and Tripura.* In: Kumar, A., C. Bohra and L.K. Singh (eds.) Environment Pollution and Management. APH Publishing Corporation, New Delhi, 604pp.

Leidy, R.A. and Moyle,P. B. (1997). *Conservation status of the world's fish fauna. A overview.* In: Fielder, P.l. and P.M. Kareiva (eds), conservation Biology for the coming decade, Chapman and Hill, New York, 187-227pp.

McBains and Trush, (1996). Physical habitat and fish use of channel rehabilitation project. U.S. Fish and Wildlife Service Coastal California. *Fish and Wildlife Office Arcata,* CA. 21(1): 211-213.

Mittermeier, R.A. and Mittermeier, C.G. (1997). *Megadiversity: earth's biological wealthiest nation.* In: McAllister, D.E., A.L. Hamilton and B. Harvery (eds.) Global freshwater biodiversity. Sea Wind, Cemex, Mexico City, 11: 1-140.

Moyle, P.B. William, J.E. (1990). Biodiversity loss in temperate zone.Decline of the native fish fauna of California. *Conservation Biology* , 4: 473-484.

Negi, R.K., Joshi,B.D.,Negi, Tarana. And Chand, P. (2007). *A study on stream morphology of some selected hiilstreams of district Nainital with special reference to its biotic communities.* Proceeding of National Seminar on Limnology, 288-295pp.

Ogale, S.N. (1997). *Mahseer breeding and conservation and possibilities of commercial culture.* The Indian experiment, Tata Power Company Ltd., Lonawala Pune.

Reves-Gavilan, F. G., Garrido, R., Nicieza, A.G., Toledo, M.M. and Brana, F. (1996). Fish community variation along physical gradients in short streams of northern Spain and disruptive effects of the dams. *Hydrobiologia*, 321(2):155-163.

Rosgen, D. (1996). *Applied river morphology,* Wildland Hydrology. Colorado, United State of America.

Shreshta, J. (1995). *Enumeration of the fishes of Napel.* Biodiversity profile project. H. M. G. of Nepal government. Kathmandu.

Shrestha, J. (1999). Clodwater fish and fisheries in Napel. In: Petr, T.(eds), Fish and Fisheries at higher altitudes: Asia Food and Agricultural Organization, Fisheries Tehnical Paper No. 385, Rome: 13-40.

Singh, H.R. and Kumar, N. (2003). *Some aspects of ecology of hillstreams: Stream morphology, zonation, characteristics and adaptive features of ichthyofauna in Garhwal Himalayas.* In: Datta Munshi, j.S. Ojha and T.K. Ghosh (eds), Advances in Fish Research. Narendera Publishing house, New Delhi, india 3:119-142.

Talwar, P. K. and Jhingran, A. K. (1991). *Inland fishes of India and adjacent countries.* Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi. Vol.1&11: 1158pp.

Tripe, J. A., Christepher, S. G., Mosher, T. D., Kramer, J. D. and Nygren, D. D. (1998). Seasonal variation of fish population characteristics in a warm water stream. Final project report. Federal Aid in sport fish restoration. Project No. 54-F 24 R. Kansas Department of Wildlife and park.

Table 1. Morphological parameters of rivers of Champawat district of Uttrakhand State, India.

S.No.	Rivers morphological parameters	Saryu	Lohawat	Chalti	Sharda
1	Depth(cm)	150	30	75	900
2	Width (m)	111	7	109	150
3	Width/depth rati o	74	23.33	145.33	16.66
4	Entrenchment rati o	1.24	1.75	4.54	1.09
5	Watershed feature	River flows through forest and residential area	River flows through forest and residential area	River flows through forest and residential area	River flows through forest and residential area
6	Channel feature	Stable, riffle, pool	Moderately stable, run	Moderately stable, cascade	Stable, Run, riffle, cascade
7	Sediment sources	Extraction of sand, bank erosion	No such activities	Extraction of sand, cobbles, bank erosion	Mining activity
8	Substrate	Boulders, cobbles gravel and pebbles were dominant substrate	Boulders, were dominant	Boulders, cobbles, gravel ,pebbles were dominant	Sand and silt were predominant
9	Large woody debris	Present in the cut banks	Present in the cut banks	Present in the cut banks	Present in the cut banks
10	Riparian vegetati on	Riparian buffer zone >1.5 channel width	>1.5	>1.5	<1 channel width
11	Air temperature (^{0}C)	22	20	18	22
12	Water temperature(^{0}C)	19	19	15	20
13	Water velocity (m/sec)	1.33	2.33	1.11	1.41
14	pH	8.2	7.7	7.8	8.4

Table 2. Diversity of fish species in the rivers of Champawat district of Uttarakhand State, India. (figures in the brackets indicates the average number of fish species recorded).

Fish species	Saryu	Lohawati	Chalti	Sharda
Tor tor (Hamilton,1822)	(15-24)	-	-	(7-15)
Tor putitora (Hamilton,1822)	(6-12)	-	-	(5-10)
Schizothorax sinuatus (Heckel, 1838)	(6-12)	-	-	(12-20)
Channa punctatus (Hamilton,1822)	(2-5)	-	-	(2-5)
Barilius vagra (Hamilton,1822)	(5-10)	-	-	(10-20)
Barilius bendelisis (Hamilton,1822)	-	-	(2-6)	(12-22)
Puntius conchonius (Hamilton,1822)	-	(2-6)	(6-14)	(12-21)
Aspidoparia morar (Hamilton,1822)	-	-	-	(5-10)
Mastacembelus armatus (Lacepede)	-	-	-	(2-5)
Lapedocephalius guntea (Hamilton,1822)	-	-	-	(2-6)

Table 3. Percentage composition of fish species in the rivers of Champawat district of Uttarakhand State (numbers in brackets denote altitude).

Fish species	Saryu (413msl)	Lohawati (1706msl)	Chalti (242msl)	Sharda (221msl)
Tor tor (Hamilton,1822)	36.36 %	-	-	4.25 %
Tor putitora (Hamilton,1822)	18.18 %	-	-	4.25 %
Schizothorax sinuatus (Heckel, 1838)	18.18 %	-	-	8.51 %
Channa punctatus (Bloch,1793)	9.09 %	-	-	2.12 %
Barilius vagra (Hamilton,1822)	18.18 %	-	-	25.56 %
Barilius bendelisis (Hamilton,1822)	-	-	28.42 %	17.02 %
Puntius conchonius (Hamilton,1822)	-	100 %	71.58 %	21.2 %
Aspidoparia morar (Hamilton,1822)	-	-	-	12.7 %
Mastacembelus armatus (Lacepede)	-	-	-	2.12 %
Lapidocephalus guntea (Hamilton,1822)	-	-	-	2.12 %