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Limnology of Coldwater in Lentic and Lotic Water Bodies and Fishery Status in the Streams of Himachal Pradesh, India

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ABSTRACT: During present studies an attempt has been made to work out water quality parameters of the lotic and lentic water bodies. Further, fishery potential of the selected streams of Beas River has been studied and it is found that it is dominated by the *Tor putitora* (Hamilton, 1822) and *Schizothorax richardsonii* (Gray, 1832). They come under Endangered (EN) and Vulnerable (VU) category respectively. Both these fishes are indigenous and precious fishery of the state. It has been inferred that the limnological parameters for the growth, survival of hill stream fishes are more conducive in lotic water bodies than in lentic habitats. Various anthropogenic activities in the streams of the Beas Rivers have been discussed and threat to the survival of the hill stream fishes. Thus, it is suggested that sustainable measures should be undertaken to rejuvenate/ conservation of the streams.

Keywords: Limnologocal, Indigenous, Lotic, Lentic, Potential.

INTRODUCTION

Himachal Pradesh is a hilly state located between 30°22' and 30°12' north latitude and between 75°47' and 79°4' east longitude and its altitude ranges from 350 to 6975m AMSL. It is bordered by Jammu and Kashmir on North, Punjab on west and south-west, Haryana and Uttar Pradesh on south and Uttrakhand on south-east. Physiographically, the state is divided into four zones *viz*. Shiwalik Himalaya, Lesser Himalaya, Great Himalaya and Trans-Himalaya. The state is blessed with various perennial Rivers *viz.* Beas, Sutlej, Chandra-Bhaga, Ravi and Yamuna River.

Limnology is the study of freshwater ecosystems *i.e.* streams, lakes, reservoirs, ponds, marshes, bogs-even underground waters. It includes physical, chemical and biological studies of these aquatic ecosystems. The aqua resources located above 914m AMSL in Himalayas, sub-Himalayan zone and mountains of the Decan are known as cold waters. The fishery potential of the water body is under influence of the limnobiotic status (abiotic and biotic) and is of prime importance in the upland. The growth rates in the hills are primarily restricted by abiotic factors, especially temperature and trophic status. A lot of work has been done on the hydrobiology in various parts of India but work in these hill streams of the state is meager (Sehgal 1974, 1983 and Dhanze *et al.* 1998, 2001, 2002). Therefore, during the present studies an attempt has been made to work out the comparison of lotic and lentic habitats in the cold water of Himachal Pradesh.

MATERIAL AND METHODS

The study of the lotic and lentic habitats was done for two years. Four sites of the Beas drainage system (Neugal, Mole, Baner and Poon streams) for lotic habitat and similarly four ponds i) without manuring (lentic-I) occupant with fingerlings of the Mahseer ii) Pond manured with cow dung @ 10,000 kg/ha (lentic-II) inhabits with composite fishes (*Cyprinus carpio*, Linnaeus 1758; *Ctenopharyngodon idellus* (Valenciennes, 1844) and *Hypophthalmichthys molitrix* (Valenciennes, 1844) were selected. The limnological parameters *i.e.* temperature was recorded with the ordinary mercury thermometer, pH by standard pH meter, dissolved oxygen by Winkler's method and transparency by sacchi disc. The other parameters were determined by standard titration methods (APHA, 2005).

RESULT AND DISCUSSION

Temperature is one of the most important parameter and affects various factors of the water body *viz.* biota, distribution patterns, feeding, growth rate, reproductive cycles and all other physiological activities. The average temperature of three systems varies from 8.8° to 27.9°C. The amplitude of variation is comparatively more in lentic-I & II than lotic habitat. Low temperature reduces the metabolic activity and therefore responsible for the delayed maturity of the *Tor putitora* (Hamilton, 1822) in the captivity. *Water velocity* varies from 0.31 to 1.21, 0.33 to 1.59 and 0.24 to 0.97 m/s at site I, II, III & IV respectively. The water velocity of all the sites is rapid as more than 0.152 m/s velocity is considered as rapid one (Legler, 1977). *Water transparency* depends on turbidity which is directly proportional to amount of suspended matter. The average transparency varies from 20.52-67.07 cm, 25.31-51.1cm and 18.92-38.75 cm during summer, winter and rainy season

respectively which depict that all the three systems are without turbidity except lentic-II system. The transparency above 20 cm indicates negligible turbidity. In lentic system-II in monsoon due to accumulation of allochthonus material, the transparency becomes below 20 cm and therefore depicts the turbidity of the water. The pH of all the three systems is alkaline and average value of the three systems varies from 6.96 to 8.83 (Table-1). A pH value of water below 5 or much above 9 is harmful to the animals. The average pH of all the three systems is peak in summer months and minimum recorded during the rainy season. *Dissolved oxygen* is one of the important components for the survival of fish. The dissolved oxygen play a role to regulate the metabolic activities of organisms and thus governs metabolism of the biological community as a whole and as used as an indicator of trophic status of the water (Saksena & Kaushik, 1994). The average value of dissolved oxygen varies from 7.53 to 10.9 mg/l and its peak is recorded in winter months in all the three systems (Table 1). It has been found in the present studies that dissolved oxygen declines through summer and generally reaches the lowest value during the rainy season. Maximum value of dissolved oxygen has been recorded during winter months and minima during monsoon season. The average value of free CO_2 in the three systems varies from 3.45 to 17.0 mg/l. The maximum value observed during summer months and its values are comparatively less in the lotic system. The present observation reveals that when pH is more than 8.3 mg/l the level of the free CO_2 is comparatively less. Further, in winter months the minimum free CO_2 is observed in different systems and in lotic system the free CO_2 is least than other two systems. The average value of *alkalinity* ranges from 63.13 to 66.95 mg/l in the lotic system while 20.93-24.95 and 19.85 to 29.25 mg/l in lentic I and lentic II systems respectively. Alkalinity above 48 mg/l is a good sign of productivity and at the same time extremely high value of alkalinity (250 mg/l) decreased productivity and growth (Moyle, 1946). Hence, the lotic water is comparatively more productive. The average value of *chloride* varies from 6.0 to 11.23 mg/l. Its maxima is noticed in winter in all the three systems while minima in summer in lotic and in rainy season in lentic-I and II. The slightly higher concentration of chloride in these water bodies may be due to run-off loaded with contaminated water. The average value of *hardness* in different systems varies from 68.75 to 91 mg/l (lotic), 22 to 28.63 mg/l (lentic-I) and 17.85 to 39.95 mg/l (lentic-II). The maxima are recorded during the summer months in all the three systems and minima during rainy season. It is found that the high values are registered in natural water throughout the year as compared to that of the lentic-I & II water. The hard waters are more productive than the soft water and hardness above 25 mg/l are considered to be productive. The average concentration of *phosphate* varies from .001 to 0.77 mg/l in different water systems. The maxima are observed in winter in lotic and lentic system-II while in lentic system-I during rainy season. The concentration is comparatively more in the lentic systems. The constant supply of the phosphate produces blooms of algae in the lentic system. The average value of *nitrate* varies from nil to 1.8 mg/l. During summer months higher value of nitrate-nitrogen have been recorded as compared to monsoon and winter months in the lotic habitat while in both the lentic system the maxima is experienced in winter months.

Fishery: The fish fauna of the state from lotic and lentic water bodies have been carried out by various workers and some recent contributions are of Mehta and Uniyal, 2005, Sharma, 2010, 2014, 2019 recorded 63 fishes belonging to 44 genera, 14 families and 07 orders from the Beas River of the Himachal Pradesh.

Table 1: Seasonal variation of the water quality parameters of lotic and lentic water bodies.

	Summer			Monsoon			Winter		
	Lotic	**Lentic-I**	**Lentic-II**	**Lotic**	**Lentic-I**	**Lentic-II**	**Lotic**	**Lentic-I**	**Lentic-II**
Temperature (C°)	19.5-27.9 (23.57)	15.1-26.2 (21.4)	16.5-26.4 (22)	23.4-28 (26.0)	19.6-26.3 (23.9)	20.9-26.2 (24.3)	13.6-18.8 (15.7)	8.8-14.7 (11.3)	15.3-15.7 (15.5)
Transparency (cm)	20.8-38.5 (25.65)	33.9-49.8 (41.23)	20.5-67.1 (39.76)	24-36.3 (32.150	31.5-51.1 (38.75)	12.4-22.2 (18.92)	28.8-43.6 (33.79)	51.5-60.9 (57.32)	20.3-29.4 (25.31)
pH	8.3-8.9 (8.53)	8.6-8.9 (8.23)	7.09-7.65 (7.37)	8.1-8.7 (8.4)	7.7-8.7 (8.18)	6.6-7.4 (7.0)	8.3-8.5 (8.36)	8.51-8.8 (8.68)	6.4-9.0 (7.56)
DO (mg/l)	6.2-8.9 (7.9)	9.0-11.6 (10.35)	7.8-9.8 (8.8)	6.0-8.9 (7.83)	8.5-8.8 (8.7)	7.37-7.66 (7.53)	9.3-10.6 (9.9)	10.3-11.2 (10.9)	5-13.2 (8.93)
Alkalinity (mg/l)	48.8-75 (66.950	24.2-26.6 (24.95)	18.9-21.6 (19.85)	57.8-69 (63.65)	22.7-25.8 (24.050	13.9-25.7 (20.79)	21.5-92 (63.13)	19.4-20.7 (20.93)	25-33 (29.25)
Free CO_2 (mg/l)	2.5-8.0 (5.75)	7.6-11.9 (10.1)	14.9-19.6 (17.0)	1.3-6.0 (3.5)	4.8-14.9 (8.95	6.2-16.2 (12.3)	3.9-5.8 (4.93)	3.4-8.3 (6.33)	4-22 (9.0)
Chloride (mg/l)	6.5-11.8 (9.5)	7.5-10.1 (8.83)	7-7.8 (7.46)	7.8-14.3 (10.6)	5.1-6.8 (6.0)	6.42-8.6 (7.38)	9-12.9 (11.23)	7-12.7 (10.33)	8-13 (9.93)
Hardness (mg/l)	65.5-110 (91)	21.7-39 (28.63)	26.2-60.9 (39.95)	56-90 (68.75)	21-22.8 (22)	14.5-21.3 (17.8)	22.5-92 (88.67)	19-33.5 (26.15)	17-34 (28.45)
Phosphate (mg/l)	Traces-.004 (.001)	.03-.6 (0.25)	.06-.18 (0.11)	Traces-0.02 (.0095)	0.02-1.2 (0.77)	0.11-0.2 (0.16)	0-.07 (.024)	.008-0.1 (.054)	.07-.3 (0.18)
Nitrate (mg/l)	0.7-1.6	0.9-2.0	.006-.01	0.4-1.2	0.2-1.5	0.3-0.54	0.6-1.3	1.1-2.4	Nil

During the present studies from three sites of the Beas River *viz.* Neugal, Mole, Baner and Poon streams 12 species of fishes have been recorded. These fishes is mainly dominated by *Tor putitora* (Hamilton, 1822), *Schizothorax richardsonii* (Gray, 1832) and minor fisheries *viz. Barilius bendelesis* (Hamilton, 1822), *Barilius barila* (Hamilton,1822), *Barilius vagra* (Hamilton, 1822), *Pethia ticto* (Hamilton, 1822), *Puntius sophore* (Hamilton, 1822), *Garra gotyla gotyla* (Gray, 1830), *Tariqilabeo latius* (Hamilton, 1822), *Schistura rupecula* (McClelland, 1838), *Channa punctata* (Bloch, 1793), *Mastacembelus armatus* (Lacepede, 1800). The present limnological parameter studied is conducive for the survival and growth of these hill stream fishes.

On the basis of above observations, it is concluded that in the lotic system limnological parameters *viz.* temperature, total dissolved solid, alkalinity and hardness are comparatively more conducive than the lentic systems. The water bodies with alkalinity 16-65 mg/l are considered as moderately rich (Spence, 1964) and thus water of both lotic and lentic water bodies are moderately rich. The average values of the nutrients are comparatively low in the lotic water bodies. The limnological parameters in lotic as well as in the lentic water bodies are comparatively more conducive during winter months than the other seasons. It is not only the physico-chemical parameters which affect the total catch of fish but topography of the site also play an important role as good number of *Mahseer* was recorded in the streams with deep pools and low water velocity. The fish fauna is protected in these pools locally known as "Machyal" in the region. But, during the recent past it has been analyzed that several dry stream patches have been formed due to diversion of water and thus habitation of the large size fishes is vanishing. Some side patches of the water have been formed among the dry patches of the streams and they were recorded with good number of fingerlings of *Barilus* spp. It has been observed that water of the streams is being diverted into the man made channels called "Kulhs" in the region. Several hydroelectric projects are the cause of drying of the natural water resources. The water pollution caused by anthropogenic activities in the upper Beas region mainly constitutes two significant components- phosphates and nitrates discharged directly into the river. There must be a check on such activities by providing good services for waste management and their reuse (Alam and Shivani, 2019).

Therefore, it is recommended that water quality assessment should be continuous process and regularly undertaken for various purposes like restoration of fish habitat, assessment of pollution influence aquaculture, domestic purposes and overall conservation of an ecosystem.

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