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Studies on limnological characteristics and fish fauna of River Bhagirathi in Uttarkashi (Garhwal Himalaya)

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Abstract

Limnological parameter and plankton diversity are an important criterion for determining the suitability of water for irrigation and drinking purpose. River Bhagirathi has greatest importance for humankind. The specific status of Physio-chemical parameter and diversity of plankton in River Bhagirathi have been studied through monthly surveys in two annual cycles (20010-11 and 2011-12) and annual survey of fishes in two annual cycles (20010-11 and 2011-12). The water remained moderately alkaline (pH 7.7) while velocity (1.23m/s), TS (844mg/l), chloride (5.04mg/l), hardness (96.73mg/l) and alkalinity (67.11mg/l) showed low mean values. Average dissolved oxygen levels were at 8.54mg/l while average nitrate and phosphate levels were 0.048mg/l and 0.072 mg/l respectively.

Keywords: *River Bhagirathi, Temperature, pH, Disolved Oxygen, BOD and fish fauna*

Introduction

Biological production in any aquatic body gives direct correlation with its physico-chemical status which can be used as trophic status and fisheries resources potential (Jhingran *et al*., 1969). Water is a prime natural resource, a basic human need and a precious national asset and hence its use needs appropriate planning, development and management (Khanna, *et al*. 2010). Life in aquatic environment is largely governed by physico-chemical characteristics and their stability. The most characteristic criterion to assess the trophic structure of a river remains to be primary productivity studies. Due to tremendous development of industry and agriculture, the water ecosystem has become perceptibly altered in several respects in recent years and as such they are exposed to all local disturbances regardless of where they occur (Khanna and Chugh, 2004). Fishes occupy all three levels such as primary, secondary, tertiary consumer of food web in aquatic ecosystem. Man being the top carnivore in this food system as it is a very good source of protein. Every year, During the Yatra season lacs of tourist come from all over the globe to visit Gangotri and Gomukh and the river has to bear lot of additional stresses caused by a number of factors. As a result, the river has few stress free zones. So study on Limnological characteristic of river has high importance, the study of their trophic status may help in optimum utilization and conservation. Therefore, the present investigation attempt to study of Limnological parameter and their relationship, phytoplankton, zooplankton status and diversity and fishes (species) in River Bhagirathi during the study period.

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Materials and Methods

Study Area

The study area is located in Garhwal Himalaya which is an important zone of Middle Himalaya and a part of state Uttarakhand in India. It encompasses in the Uttarkashi district and the location of Uttarkashi on globe is on latitude 30°22' - 31°25'N and Longitude 77051' - 99°27'E while the height from the sea level is 1180 meters. This area is very rich in biodiversity and the entire region of Himalayas is rich in terms of major fluvial systems of the Ganges, Yamuna and their tributaries. In the Garhwal Himalayas the Ganga river system is formed by two main streams, the Bhagirathi and the Alaknanda. The Bhagirathi is an important river originating from Gaumukh in Gangotri glacier (within the physical boundary of Uttarkashi district) and passes via thickly populated

towns like Uttarkashi, Tehri and Devprayag. At Devprayag it meets the Alaknanda and from the confluence downstream it is called the Ganga, which flows down and emerges as the river of plains at Rishikesh-Haridwar. The river channel of the Bhagirathi at Uttarkashi exhibits a gradual increase in its width; the river bed possesses large boulders and pebbles etc.

Sampling and Analysis

Physico-chemical Analysis

The present study was conducted on River Bhagirathi covering a stretch of approximately 76 km from upstream (S1) at Harsil to downstream (S4) at Uttarkashi. The study was carried out for a time period of two year from October 2010-September 2012 on monthly basis. Seasonal relation was later found to know the effect of different environmental conditions on river water. Water samples were collected every month early in the morning in sterilized sampling bottles and were analyzed for twenty two important physical and chemical Parameters. Few physico-chemical parameters like Temperature (0C), Velocity (m/s), pH, Free CO2 (mg/l), and Dissolved Oxygen (mg/l) were performed on spot and other parameters like Turbidity (JTU), Total Solids (mg/l), TDS (mg/l), TSS (mg/l), Total Alkalinity (mg/l), Total Hardness (mg/l), Chloride (mg/l), BOD (mg/l), COD (mg/l), Phosphate (mg/l) and Nitrate (mg/l) were analyzed in laboratory by following the methodology of APHA (1998); Khanna and Bhutiani (2004); Trivedi, and Goel (1986); Wetzel and Likens (1991). Temperature, Velocity was measured by using Celsius thermometer (0–110 0C), and flow meter. Turbidity, Conductivity and pH were measured by using Jackson Turbidity unit, Conductivity meter and digital pH meter. Total Solids TDS, TSS were measured by volumetric analysis. Total Alkalinity, Total Hardness, Chloride, Free CO_2, DO BOD and COD were analyzed by titration method. Phosphate and Nitrate were analyzed by using UV-VIS Spectrophotometer and Sodium and Potassium by Fame photometer.

Fishes Analysis

For the study of icthyofauna, Fishes were collected by jaal and scoop nets with the help of local fishermen from the selected sites. They were then transferred in prelabeled containers and preserved in 5% formalin. The fishes were identified by following the identification keys of Jhingran et al. (1989); Jayaram, (1999); Day, (1978) and Badola, (1979).

Results and Discussion

Results of Limnological study are summarized in Table- 1. Water temperature was observed to be highest during summer 2011-12 (17.5^{o}C) and lowest during winter 2010-2011 (10.6^{o}C). The overall average value of water temperature was 15.2^{o}C. A good synchronization between temperature and dissolved oxygen was seen. Temperature showed a significant inverse relationship with dissolved oxygen. Such an inverse relationship has also been observed. Same trend of temperature was observed by Khanna (2001) in river Ganga at Hardwar. More or less a similar status of temperatures has been reported by Badola and Singh (1981) in river Alaknanda. Same study was done by Khanna et al. (2000) in river Ganga at Rishikesh.The temperature showed an inverse relationship with the dissolved oxygen almost throughout the study as also reported by Das Khanna et al. (1993). The dissolved oxygen in water is often attributed to the fact that the oxygen is dissolved more during the period of photosynthesis, if the temperature is not too high. Temperature for aquatic life should be at least 200 C for survival. More beyond or less temperature may affect the aquatic life and other characteristics of water quality. During monsoon season water was turbid, pH fluctuated between 7.5 to 7.9. The minimum pH was recorded in monsoon 2010-2011 which was mainly attributed to rain water after a long dry period, and maximum pH was recorded during summer 2011-2012. Higher values of pH may be due to increased bathing / washing activities. Das (1961) reported that pH of water has an important behavior on both plankton and microbial production. He observed that a pH of 7.2 to 8.5 only was favorable for the growth of plankton and the higher values were detrimental to plankton production and thereby to the fish production also. Similar trend of pH were also found by Khanna et al (2001) in river Ganga has also observed the alkaline nature of water of river at Hardwar.

Table 1. Physico-chemical parameters of River Bhagirathi during 2010-2012

Parameters	2010-2011			2011-2012			
	Winter	Summer	Monsoon	Winter	Summer	Monsoon	Average
Water Temp. (°C)	10.62	16.82	17.62	11.52	17.58	17.52	**15.28**
Velocity (m/s) (Fl	0.97	1.30	1.35	1.12	1.26	1.40	**1.23**
Turbidity (JTU)	25.10	30.95	407.87	22.52	30.38	409.45	**154.38**
Conductivity (µmhos/cm^2)	110.11	137.57	321.85	109.70	136.38	319.72	**189.22**
Total Solids (mg/l)	266.91	594.10	1666.43	267.05	596.64	1672.87	**844.00**
TDS (mg/l)	183.93	209.83	471.30	187.90	210.60	476.75	**290.05**
TSS (mg/l)	82.98	384.26	1195.12	79.15	386.03	1196.12	**553.94**
pH	7.93	7.70	7.59	7.77	7.63	7.55	**7.70**
DO (mg/l)	9.75	7.77	8.08	9.67	8.03	7.94	**8.54**
Free CO_2 (mg/l)	1.56	2.70	3.11	1.40	2.59	3.06	**2.40**
B.O.D. (mg/l)	1.93	2.35	3.64	1.80	2.30	2.51	**2.42**
C.O.D. (mg/l)	6.05	5.67	6.02	6.75	5.61	5.60	**5.95**
Total Phosphate (mg/l)	0.08	0.02	0.10	0.08	0.02	0.10	**0.07**
Total Hardness (mg/l)	95.99	85.35	109.43	96.30	84.95	108.38	**96.73**
Alkalinity (mg/l)	67.02	78.51	54.25	68.65	79.45	54.80	**67.11**
Chloride (mg/l)	1.85	2.70	10.75	1.80	2.62	10.56	**5.04**
Nitrate (mg/l)	0.03	0.01	0.05	0.03	0.02	0.12	**0.04**
Sulphate (mg/l)	19.50	11510.98	24.07	19.36	11457.49	24.07	**3842.58**

According to the study, river bhagirathi was characterized by highest levels of dissolved oxygen with average value of 8.54mg/l. The highest oxygen value of 9.7mg/l was observed in winter season of 2010-2011, dissolved oxygen showed a negative trend with water temperature. The dissolved oxygen and free carbon-dioxide usually inversely related to one another because of the photosynthetic and respiratory activities of the biota (Hynes, 1970) and lowest value of 7.7mg/l was observed in summer 2010-20111. Dissolved oxygen shows a significant negative relation with temperature, alkalinity, total hardness, velocity, nitrate, phosphate, chloride and respiration. The observed high value of dissolved oxygen in winter due to the high solubility at low temperature and less degradation of organic matter. So, within the study area we can say that from the point of view of dissolved oxygen the water quality of river Ganga can be good for drinking and bathing purposes. Pahwa and Mehrotra (1966), have discussed the seasonal fluctuation of dissolved oxygen. During the study, the highest value of total alkalinity was in summer 2011-2012 (79.45mg/l) and lowest value was observed in monsoon 2010-11 (54.25mg/l). Total alkalinity shows a positive relationship with temperature, pH, total hardness, TDS, and conductivityTotal alkalinity of water is a measure of weak acid present in it and of the cations against them (Sverdrup et al., 1942). Khanna (1993 and 2003) reported 75.3 mg/1 to 80.4 mg/1 in river Ganga at Hardwar. Similar trends were reported by Chugh (2000), The factors responsible for alkalinity included mixing of ashes, waste water from different ashrams and washing activities. The average value of total hardness during the study was 96.73mg/l with lowest value of 84.95mg/l during summer 2011-2012 and highest value of 109.43 mg/l during monsoon 2010-2011.Khanna et al., (1993, 2003) and Mishra et al. (2003) observed hardness from 62.77 mg/1 to 67.60 mg/1 in river Ganga at Hardwar. Velocity was high during monsoon season, whereas winter season didn't show much variation. The monsoon season of 2010-2011 showed highest value of 1.40 ms/cm and lowest value of 0.975 ms/cm was observed in winter 2010-2011. In the present study, Total Dissolved Solid (TDS) ranged between266mg/l to 1672 mg/l with lowest during winter 2010-2011 and highest during monsoon 2011-12 respectively. Total solids were observed maximum in the monsoon season that may be due to high velocity of river water and waste water runoff from sewage drains and agricultural lands. The higher values of total solids are responsible for

the turbidity in the river. Similar trends were shown by Chugh (2000) in his thesis during the study of water quality of river Ganga at Hardwar and also by Khanna (1993). Total solids were recorded minimum in the winter season that may be due to gradual sedimentation of the settleable particles at the bottom of the river and also due to the lower velocity of the river which favours effective sedimentation. Chloride concentration varied between 1.8mg/l noted during winter 2011-2012 to 10.75mg/l during monsoon 2010-2011. Mishra et al. (2003) recorded chloride values from 2.84 mg/1 to 28.4 mg/1 in river Ganga at Hardwar. According to the study, rich contents of nitrates were observed, with maximum of 0.59mg/l during monsoon 2010-2011 and minimum of 0.14mg/l during summer 2010-2011. Nitrate concentration depends on the activity of nitrifying bacteria. High concentrations of nitrates were recorded after onset of rains (Venkateswarlu, 1969). The minimum values of nitrates were recorded during summer season in the while maximum values of nitrate were recorded during monsoon season.

Fishes were collected from various spot of river Bhagirathi all through of the sampling range. From Bhatwari to Gangori besides S. richardsonii, the river also had two catfishes namely G. pectinopterus and P. sulcatus adapted to fast Flowing current of river. Another species of snowtrout, namely S. plagiostomus, was found at Bhatwari downstream. The two more species of snowtrots found in the Gangori (Bhagirathi-Asiganga confluence) were S. curviforms and S. progastus; they were also recorded from Bhatwari downwards. The famous Mahseer, Tor putitora, an endangered species of the Bhagirathi, was recorded from Gangori downwards. The Brown trout, Salmo truta fario, an introduced sp. In the Asiganga is thriving well since the habitat of stream is quite suitable for this species. From Asigaganga, some individuals of the brown trout also move into the river Bhagirathi and rare recorded there. 8 Species of fishes collected from River Bhagirathi. A systematic list of fish found during the course of study is given in table 2 and Fig. 1.

Table 2. List of Fishes found in River Bhagirathi during 2010-2012

S.N.	Sampling Stations	Fish Species		Status	
				2010-11	2011-12
1.	Harsil	*Schizothrox richardsonii* (Gray)	Common	+	+
2.	Bhatwari	*Schizothrox richardsonii* (Gray)	Common	+	+
		Glyptothorax pectinopterus (McClelland)	Rare	+	-
		Schizothrox plagiostomus (Heckel)	Rare	-	+
		Pseudecheneis sulcatus (McClelland)	Rare	+	-
3.	Gangori	*Schizothrox richardsonii* (Gray)	Common	+	+
		Schizothraichthys curvifrons (Heckle)	Rare	-	+
		Schizothrox plagiostomus (Heckel)	Rare	-	+
		Schizothraichthys progastus (McClelland)	Rare	+	_
		Tor putitora (Hamilton)	Rare	+	_
		Salmo trutta fario (Linnaeus)	Common	+	+
		Pseudecheneis sulcatus (McClelland)	Rare	_	+
		Glyptothorax pectinopterus (McClelland)	Rare	+	_
4.	Uttarkashi	*Schizothrox richardsonii* (Gray)	Common	+	+
		Schizothraichthys curvifrons (Heckle)	Rare	+	_
		Schizothrox plagiostomus (Heckel)	Rare	_	_
		Schizothraichthys progastus (McClelland)	Rare	+	_
		Tor putitora (Hamilton)	Rare	_	+
		Salmo trutta fario (Linnaeus)	Rare	_	_

Earlier reports on the fish fauna of the Bhagirathi recorded seventeen indigenous and one exotic species (Badola and Pant, 1973). However, the present study recorded the presence of eight species only. The study further specified that Schizothorax richardsonii was present throught the stretch and contributed about 80-90% of the total catch. It may be mentioned that Bhatwari upwards, this was the only species present in the river. It may be further stated that the river had no fish species beyond Harsil (Baola and Pant, 1973).

Conclusion

In any aquatic ecosystem Limnological characteristic can affect both fauna and flora. Biodiversity contribute both directly and indirectly to human such as food for good health, security, social relationship, life and freedom for choice etc. In last decade people interfere with ecosystem and over exploitation of natural resources its result that biodiversity decreases. But the losses in biodiversity and change in ecosystem service have adversely affected the well-being. The present study is relevant to limnological study and fishe fauna of in River Bhagirathi. This study explains that River bhagirathi are in rich biodiversity fishes and need to conservation in future.

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