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A Study on Fish Diversity and Physico-Chemical Parameters in a Polluted Water Body (Bharalu River, Meghalaya, India)

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Abstract: Bharalu river is a small tributary of Brahmaputra river originating from the foothills of the Khasi hill in Meghalaya which flow through the heart of the Guwahati city to meet the mighty Brahmaputra. The present study has revealed that the study area which is a part of the Bharalu river flowing near ISBT is facing a tremendous threats due to various anthropogenic activities. Due to these impacts the aquatic system is suffering a lot more problems and thus the whole ecosystem is deteriorating. In this study, total 5 fish species belonging to 3 orders and 4 families were recorded during the study period. The recorded families are- Channidae, Anabantidae, Heteropneustidae and Osphronidae. It has been observed that all the recorded fish species are air breathing fish species possessing accessory respiratory organs. One indigenous ornamental fish *Colisa fasciata* was also recorded. Analysis of different diversity indices has shown that the diversity and abundance of the fish fauna was higher in Autumn season than winter season. The assessment of water quality of the study area revealed that a distinct seasonal variation occurs in selected physico-chemical parameters. The quality of water was also in very poor condition which is not suitable for the survival of the aquatic organisms. Therefore, proper measures and necessary steps should be strictly taken by the concerned authorities for the conservation of the fish diversity and to bring back the natural beauty of the river.

Keywords: Physico-chemical parameters, Bharalu river, Fish fauna, Channidae, Anabantidae, Heteropneustidae, Osphronidae

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Introduction

Biodiversity is the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species,

and of ecosystems. Biodiversity forms the foundation of the vast array of ecosystem services that critically contribute to human well-being. Biodiversity is essential for stabilization of ecosystems, protection of overall environmental

quality and for understanding intrinsic worth of all species on earth (Ehrlich and Wilson, 1991). The Northeastern region of India has a great diversity with full loading of biological resources. Assam is no doubt the heritage of rich biodiversity.

Ichthyodiversity refers to the diversity of fish. Fish are invariably one of the most important biotic components of an aquatic ecosystem which apart from forming protein rich food source for human beings, also act as good indicators of a water body (Deori *et al.*, 2015). They are often used as indicators for the assessment of water quality, river network connectivity or flow regime. Fish constitutes almost half of vertebrates in the world. They live in all conceivable aquatic habitats. About 2500 species of fish have been recognized in the Indian subcontinent out of which 930 are categorized as freshwater species (Jayaram, 1999) and 1570 are marine (Kar, 2003). The Northeastern region of India is one of the hot spots of fish diversity in the world. However, the rich biodiversity of freshwater fishes of India has been rapidly declining over the years due to anthropogenic activities like habitat destruction, pollution, water diversions as well as due to some environmental factors.

Water pollution affects the aquatic organisms to a great extent. Over two third of Earth's surface is covered by water. Earth's population is increasing continuously people are putting ever-increasing pressure on the planet's water resources. Water also known as universal solvent is uniquely vulnerable to pollution as water is able to dissolve more substances than any other liquid on earth. Water pollution occurs when some unwanted materials enter into the water from variety of sources and changes the water quality which is harmful for the environment and also harmful for the human health. Most water pollution does not begin in the water itself. Virtually any human activity can have an effect on the quality of our water environment. There are different major sources of water pollution-domestic sewage, industrialization, pesticides and fertilizers, plastics and polythene bags and many

more. It is reported that 75 to 80% water pollution is caused by domestic sewage. Wastes from industries like sugar, textile, pesticides, pulp and paper pollute the water (Kamble, 2014). Water pollution has severely affects the fish population and proves lethal to them. When the nutrient wash into the waterways through storm runoff, they deplete oxygen in the water that fish need to survive. Overtime these nutrients build up in the water and promote algae and water plant growth, and as they decay after some time, they lower the level of oxygen in water which harm or kill the fish. Moreover pesticides and other chemicals which flow off into the water can also harm and kill fish. Plastic and litter cause adverse effect on fish, as the plastics do not degrade easily in the environment and therefore remain in the same undegraded form in water bodies. So when the fish mistakenly consume plastics as food and ingest them it causes blockage in the digestive system and kill the fish. There is also probability that fish and other aquatic organisms get stuck in plastic items which often cause the fish to starve to death by getting stuck around their mouth making them unable to eat. Without proper treatment discharge of untreated waste in water bodies causes serious harm to both environment and life threatening for the aquatic flora and fauna. Oil spills from industrial sources runoff into the water sources which coat the skin of fish and kill them. Oil provides a source of toxins for fish that can cause different diseases and death. Radioactive waste generated from the industries and other waste enter the water bodies which are then absorbed by the fish present there and then it cause genetic, mutagenic, and teratogenic defects in them (Kivi, 2010). So the pollution from sewage and human waste introduce pathogen into the water sources which results into property of causing diseases in the fish population and kill them. The different sources of the water pollution cause devastating consequences to aquatic organisms. Today the study of fish diversity in a polluted area is a great challenge for the researchers. In future the loss of biodiversity and its effect are predicted to be greater for aquatic

organisms than for terrestrial organisms (Sala *et al.*, 2000).

This study is focused on ichthyodiversity and the physico-chemical parameters of a highly polluted river, Bharalu river. The Bharalu river is declared as one of the most polluted river in the country by Central Pollution Control Board (CPCB) in 2008. It is a small tributary of the Brahmaputra originating in the foothills of the Khasi hills of Meghalaya, it enters Guwahati city through the south eastern corner. It is known as the Bahini or Bihini in its upper reaches. The study area is the part of this Bharalu river which is flowing near the Inter State Bus Terminal of Guwahati (ISBT). The aim of the present study was to highlight the ichthyofaunal diversity of the Bharalu river and to study the physico-chemical parameters of the water body such as temperature, pH, turbidity, dissolved oxygen, hardness, total ammonium concentration which are the most essential factors that are required for sustenance of life of the aquatic ecosystems.

Materials and Methods

Study Area:

Bharalu river originates from the foothills of Khasi hills of Meghalaya, India. It enters the Guwahati city through the Southeastern corner known as Bahini. The Bahini find its way through some thickly residential areas and ultimately join the mighty Brahmaputra at Bharalumukh.

The study area is comprised of a part of the Bharalu river (Figs. 1, 2) which is another stretch that separates out towards the Borsola Beel near Guwahati Railway Station in Paltan bazaar. From there it runs through Sarabhatti locality and flows in a straight manner on the back of the Indira Gandhi Athlete Stadium in Sarusajai crossing the National Highway 37 near the Inter State Bus Terminal of Guwahati (ISBT). This polluted river then continues for 3 to 4 km until it falls into the state's biggest wetland wildlife sanctuary of Deepor Beel located in the south-west part of Guwahati city.

The Bharalu carries a large portion of city's municipal waste (Figs. 3, 4) as well as other wastes which affect this riverine ecosystem or the ichthyofaunal diversity to a great extent. Most of the city's waste water in the form of sanitary sewage and domestic sewage together with liquid waste which used to come from different sources like commercial establishments such as hotels/restaurants, hospitals/health care centers; which actually flow through small drains and then it flow through this tributary which ultimately make this type of tributary a large drain. The contaminated water and waste products are causing harm to the biodiversity of the wetland conservation, home to many aquatic birds and hundreds of aquatic species.

People generally consider the Bharalu water to be extremely polluted and therefore it is regarded as one of the major source of contamination which is affecting the Brahmaputra river. The study area is bounded by 91.7655 longitude and 26.1678 latitude. The climate in Guwahati is warm and temperate. The average annual rainfall is 1698 mm.

Fishes were collected from the particular study area during the autumn season that is in the month of September, October and November 2019. The diversity of fishes was also recorded during the winter season i.e. in February 2020. In these particular months the samples were collected in the early morning at about 4:30-5:00 am with the help of a local fisherman using some fishing gears and nets.

Method for study the diversity of fish and to determine the abundance:

The present study was carried out from the part of the Bharalu river i.e. flowing through NH-37 near ISBT of Guwahati. During the study period a number of species of fishes were collected from the river with the help of a local fisherman using different fishing gears and nets and a total species has been recorded from the sample stretch of the river Bharalu and some photographs were taken.

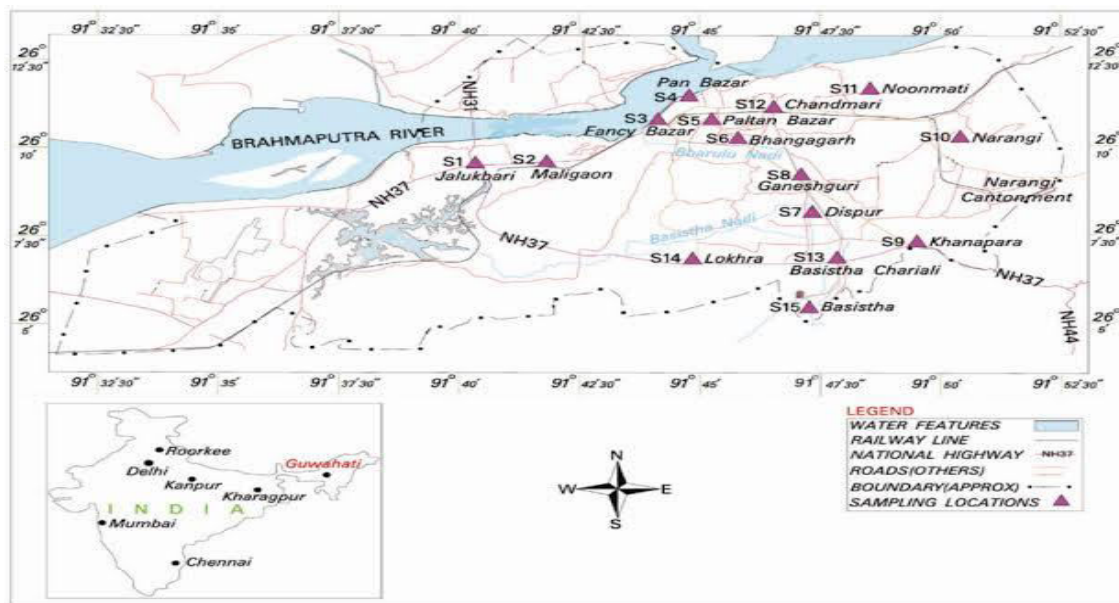


Fig. 1: Location of the study area.



Fig. 2: Location of Bharalu river.



Fig. 3: City's wastes disposal in Bharalu river.



Fig. 4: Municipal wastes disposal in Bharalu river.

A thorough survey of the study area was pursued in the months of September, October and November 2019 (autumn season) and in the winter season i.e. in the month of February 2020. In the particular months, on a particular day the fish samples were collected at least three times with the help of fishing gears and nets and was recorded. Collected specimens were identified.

Species diversity, abundance and richness is determined by following diversity indices as

follow:

Simpson's Dominance index:

$$D = 1 - \sum_{i=1}^N \frac{n_i(n_i-1)}{N(N-1)}$$

$D = \sum \frac{n_i(n_i-1)}{N(N-1)}$, N = total density and n_i = density of individual species

Shannon Weiner index:

$$H = - \sum_{i=1}^N \frac{n_i}{N} \log_2 \frac{n_i}{N}$$

Margalef's index:

$MD = S - 1 / \log N$, S = total number of species

N = total number of individuals

Methods for the assessment of water quality with the help of different physico-chemical parameters:

The physico-chemical parameters of the study area has been recorded like temperature, pH, turbidity etc. The water from the Bharalu river was collected in two seasons i.e. in Autumn and winter in the month of November 2019 and February 2020 and analyzed the physico-chemical parameters as per standard procedures.

Temperature:

To record the temperature a thermometer was used. At first the water was taken in a beaker and placed the thermometer in the water sample and kept the thermometer until the temperature reading has not stopped moving. So after the reading has stopped it was recorded. The reading is taken for at least three times.

pH:

To determine the pH of the water sample of the Bharalu river, digital pH meter was used.

Turbidity:

Turbidity was measured using a Secchi disk. A Secchi disk is a metal disk, 8 inches in diameter that is lowered into the water on a cord or rope. The depth that the Secchi disk can no longer be seen through the water is the Secchi depth. When the water transparency is high, the Secchi depth is high. When the water transparency is low or cloudy, the Secchi depth is low. So, the point at which the disk appears is a function of the lake turbidity.

Hardness:

Liquid soap is used to measure the hardness of water. A qualitative results appear from this method.

Description of some fishing gears and nets:

(i) Ghokajal: It is the commonest form of scopping gear. The net is fitted to a light triangular bamboo frame.

(ii) Barakhi: This type of hook is made up of bamboo, which often exceeds 6 m in length.

Results and Discussion

In the present study, 5 fish species belonging to 3 orders and 4 families were recorded (Table 1). Two species are Least Concern, one is Not Evaluated and the other two species are Data Deficient according to the International Union for the Conservation of Nature and Natural Resources (IUCN 2014). Percentage distribution of conservation scheme of collected fish is shown in Figure 5. Family-wise distribution of collected fish species is depicted in Figure 6.

To evaluate the diversity of fish fauna, study has been done in two seasons, Autumn and Winter. Analysis of Shannon Weiner Index, Simpson's Dominance Index and Margalef's Index of diversity is shown in Table 2.

Diversity of fish fauna was higher in Autumn season than the Winter season (Autumn Shannon Weiner $H = 1.02-1.27$; Winter Shannon Weiner $H = 1.02$; Autumn Simpson's D Index = $0.20-0.75$; Winter Simpson's D Index = 0.69 ; Winter Margalef's Index = $0.86-1.44$; Winter Margalef's Index = 0.86 (Table 2)

The average value of physico-chemical parameters of water recorded from the study area is presented in Table 3.

A qualitative test is done to determine the hardness of the water using liquid soap. It has been found that some bubbles appeared and the water appeared cloudy or milky which determined that water of the study area was hard.

During the study period some photographs were taken of the fish species (Fig. 7) which are found in the studied river.

The present study revealed that the study site of the Bharalu river has rich diversity of some air breathing fish species. A total of 5 fish species were found which belong to 3 orders and 4 families. The fish species includes *Channa punctata* (Goroi), *Anabas testudineus* (Kawai), *Colisa fasciata* (Kholihona), *Heteropneustes fossilis*

Table 1: Comprehensive list of fish species and their IUCN Status encountered in the Bharalu river during study period. (LC- Least Concern, DD- Data Deficient, NE-Not Evaluated)

S. No.	Local Name	Scientific name	Order	Family	IUCN Status
1	Goroi	<i>Channa punctata</i> (Bloch, 1793)	Anabantiformes	Channidae	LC
2	Kawoi	<i>Anabus testudineus</i> (Bloch, 1792)	Anabantiformes	Abantidae	DD
3	Kholihona	<i>Colisa fasciata</i> (Bloch and J.G. Schneider, 1801)	Anabantiformes	Osphronemidae	NE
4	Singhi	<i>Heteropneustes fossilis</i> (Bloch, 1794)	Siluriformes	Heteropneustidae	LC
5	Chengeli	<i>Channa gachua</i> (Hamilton, 1822)	Perciformes	Channidae	DD

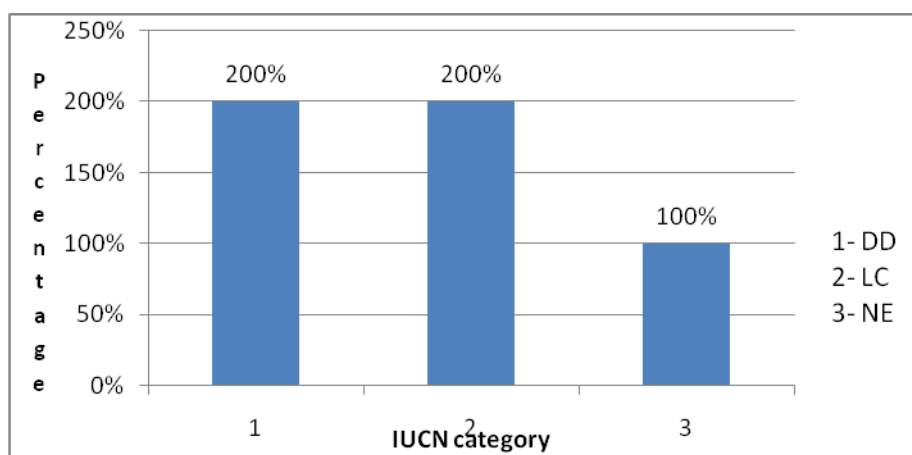


Fig. 5: Percentage distribution of conservation status of collected fish species.

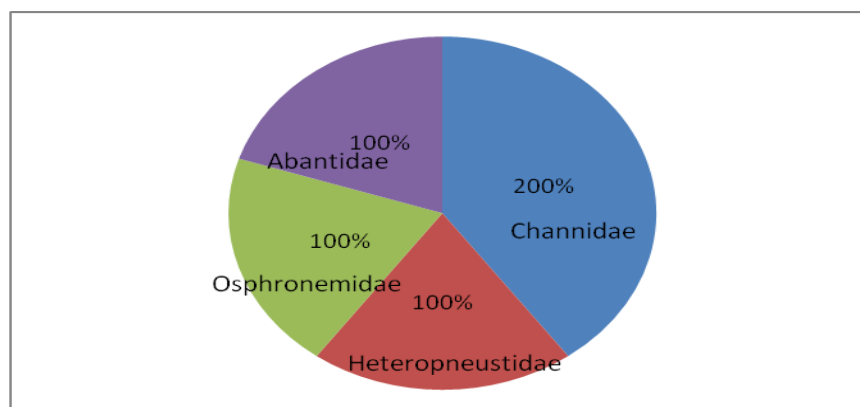


Fig. 6: Family-wise distribution of fish species.

Table 2: Diversity of fish fauna in Bharalu river

S. No.	Diversity Indices	Index Value	
		Autumn	Winter
1	Shannon Weiner Index	1.02-1.27	1.02
2	Simpson's D Index	0.20-0.75	0.69
3	Margalef's Index	0.86-1.44	0.86

Table 3: Different physico-chemical parameters of water from the study area

S. No.	Parameters	Autumn season	Winter season
1	Water temperature (°C)	23	18 degree
2	pH	6.3	6.0
3	Turbidity (cm)	32	28



Channa punctata



Colisa fasciata



Anabas testudineus

Fig. 7: Fish species collected from Bharalu river.

(Singhi) and *Channa gachua* (Chengeli). As the Bharalu river is regarded as one of the most polluted river in the country by Central Pollution Control Board in 2008, the study area which is a part of the Bharalu river is a highly polluted area with full of garbage, sewages, plastics coming from

different sources like markets, industries, restaurants, household waste etc. So as the water contains many harmful contaminants, the concentration of the Dissolved Oxygen (DO) will be very low in such contaminated water. So this fish species which are found can possibly live in

the polluted water with low DO because they are air-breathing fishes. Among the 5 fish species one ornamental fish species was also found that is *Colisa fasciata* (Kholihona). It is a very important indigenous ornamental fish species. According to IUCN Red List of threatened species (2014), out of 5 species, one species (*Colisa fasciata*) is in Not Evaluated category, two species (*Heteropneustes fossilis*, *Channa punctata*) is in Least Concern category and the another two species (*Channa gachua*, *Anabas testudineus*) is in the Data Deficient category (Table 1).

It has been seen that the Bharalu river is facing a tremendous pressure from the increasing human population, industrialization, urbanization, and pollution. So due to the different anthropogenic activities, specially for the pollution the river is converting into a large drain affecting the aquatic system and causing ecological degradation of the river. The other fish species population like *Puntius* species were not found in this river due to the habitat destruction. The fish fauna of the study area is not similar with the neighbouring Deepor Beel Ramsar site which have high diversity of fish fauna. About 54 fish species were found in the Deepor Beel (Goswami and Kalita, 2012). So to evaluate the fish diversity and abundance in the study area, study has been done using 3 different diversity indices. Analysis of the indices showed that, diversity of fish fauna was higher in Autumn season than the winter season and abundance of fish species is also found in the Autumn season (Table 2).

In the present study water quality of the study area was also evaluated using different water parameters like temperature, pH, turbidity, and hardness in autumn and winter seasons. It has been found that in both the autumn and winter season the pH ranges from 6.0-6.3 which is slightly acidic. The water turbidity was also measured and it was found in between 28-32 cm. The transparency value was found to be highest in winter season and lowest in autumn season. High turbidity is considered as unacceptable for survival of the aquatic organisms and can lead to

different harmful diseases and death. The temperature also plays an important role for controlling physico-chemical and biological parameters of water and considered as one among the most important factors in aquatic environment particularly for fresh water (Singh *et al.*, 2005). In the study area the highest water temperature was recorded in Autumn season (23°C) and the lowest temperature was 18°C recorded in the winter season (Table 3). A qualitative test was also done to evaluate the hardness of the water and it has been observed that the water of the study site was very hard which is affecting the aquatic organisms to a great extent. So the water quality is affecting the aquatic system to a great extent, and the contaminated water actually pose threat to the aquatic organisms like fishes, aquatic insects which might create a vast problem in the near future.

Conclusion

This study compiles a preliminary survey to determine the fish diversity, abundance, water quality of the polluted river Bharalu river. It is clear that a distinct seasonal variation is seen in selected physico-chemical parameters of the river. The present study also revealed that the study area of the river does not have a rich diversity of fishes as 5 species of 3 orders and 4 families were found during the study period. It has been observed that all the fish species found (*Channa punctata*, *Anabus testudineus*, *Heteropneustes fossilis*, *Channa gachua*, *Colisa fasciata*) possess accessory respiratory organs and are known for their capacity to tolerate low oxygen. One ornamental fish species -- *Colisa fasciata* was also found which is a very important indigenous ornamental group of anabantids.

So it can be concluded that the ecosystem of the study area is not in a healthy condition and its likely to be seriously damaged because of different anthropogenic activities. So as the water quality is not in a good condition, it become impossible for the aquatic organisms to survive in that harsh condition and ultimately the Bharalu

river which is a small tributary of the mighty Brahmaputra is now converting into a large drain.

In order to sustain the ecosystem and aquatic life some measures should be taken by the government and also some necessary steps should be taken by the concerned authority to control the rate of pollution in the Bharalu river. Some rules should be imposed like not to throw garbages in the river or to filter the waste water by the industries before it is released into the river and also some rules should be provided to the refinery department of the Guwahati city not to release the oil spills in the rivers. So if the rules will be strictly followed by the citizens then it will be possible to bring back the beauty of the river with a rich diversity of aquatic organisms.

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