Research Article

Environmental Impact Study through Physico-Chemical and Ichthyofaunal Diversity Analysis in Selected Major Rivers of Barpeta District, Assam

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ABSTRACT

The present survey was made to study fish diversity and some of the important physico-chemical parameters in the four major rivers passing through Barpeta district, Assam-Chaulkhowa, Palla, Brahmaputra and Beki during the year 2018–2019 at three seasonal intervals. As per the water quality standards, the ph and temperature of the water at all the river locations were found to be stable. The concentrations of arsenic, iron, nitrate and copper in all four rivers were fairly stable. Other nutrients such as calcium showed remarkable variations. The organic matter level was very low during monsoon and high in summer. The fish diversity in accordance with the analysis of the water samples were found to productive, as the total fish species found were 24 in which the most abundant species have found in four rivers was *Puntius sophore* followed by *Cirrhinus mrigala*, while the least abundant species *Hilsa ilisa* (except Brahmaputra River), *Chitala chitala* and *Nandus nandus* were rare species in these rivers.

Keywords: Assam, Barpeta, Fish Diversity, Water quality.

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INTRODUCTION

Assam is an agricultural and natural resource containing state. The total water resource flows through Assam is 749 ha which is cover 0.01% of the total geographical area of the state and 74 percent of the total area under wetlands.[1] Barpeta is the district of the state Assam. It lies in 26°19' northern latitude and 091°00' eastern longitude and 35 m (average) above the mean sea level. It covers a total area of 3245 sq.km with landscape including highlands, plane fertile lands and low-lying areas containing water bodies and swamps.[2]

The river Brahmaputra flows from east to west across the southern part of Barpeta district. The tributaries of these rivers that flow through the district are Beki, Manah, Pohmara, Kaldia, Palla, Nakhanda, Marachaulkhowa and Bhelengi flowing from North to South. Rivers Pohmara and Kaldia join near Barpeta Town to form river Nakhanda whereas Palla and Beki join with to ultimately form Chaulkhowa River (Figure 1). The area has distinct four seasons such as pre-monsoon, monsoon, re-treating monsoon and winter.[3] The present study has been carried out in four rivers of Barpeta district-Chaulkhowa, Palla, Brahmaputra and Beki. Among these Chaulkhowa and Palla flows centrally of the district and other two flow on the periphery of the districts. The objectives envisaged for the study is monitoring the physico-chemical parameters as well as ichthyofaunal diversity of these four rivers. The study area situated between 26°12' to 26°29' N and 90°0' to 91°9'E.

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MATERIALS AND METHODS

Analysis of physico-chemical parameters

Samples were collected from different sites of four rivers. In each river, study was carried out by dividing

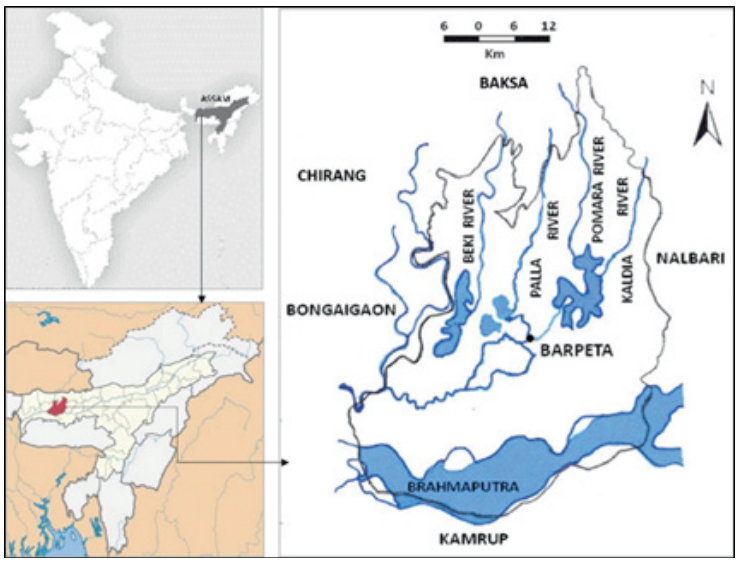


Figure 1: Cartographical representation of the four river locations at Barpeta district, Assam.[4]

river into ten different sites for collection of fish and water samples. GPS enable photography was done at each site and for each fish sample. The pH and temperature of the rivers were calculated on site using digital test kits. The sample collection has been done during three seasons namely pre-monsoon, re-treating monsoon and winter during an entire year.[3] Clean glass bottles were used to collect water samples for testing in the laboratory of Department of Zoology, University of Science and Technology Meghalaya using standard water testing criteria laid down by APHA.[5]

Methods for the study of ichthyofaunal diversity

The fishes were collected from the various fishermen on seasonal basis caught through various traditional fishing craft and gear. The fishes were identified with the help of standard available keys and books.[6-9] The fish diversity indices were calculated as per standard method.[8,9] Shannon diversity index (**H**) = $\sum$**p***i* **ln p***i*, where, **p** is the proportion (**n/N**) of individuals of one particular species found (**n**) divided by the total number of individual (**N**) found, **ln** is the natural log, $\sum$ is the sum of the calculation and s is the number of species.

RESULTS

The results of the physico-chemical parameters analysis have been given and discussed below as per availability from different sites at different seasons of the four major rivers of Barpeta district, Assam.

The suitability of water also depends on the pH values whether it is acidic or basic or neutral. The sample from every river were tested in all the 10 sites and mainly found that the water of river were alkaline in nature with range from 7 to 9. In lentic water system, the temperature is not so important because there have no question about aquatic life, but in river water the situation is totally different as river has most diversified ecosystem where aquatic life are present. The temperature may vary seasonally in the rivers. The variation of temperature in river depends on sample effluents, geographical location and seasonal time.[10] The dissolved oxygen content in water directly impacts the ecosystem. The oxygen molecule mainly depends on the physiological, chemical, microbiological processes dissolved oxygen, CO_2 also needed for maintaining or balancing the ecosystem.[11] The concentration of CO_2 is much important for the aquatic plant. Nitrates are essential source of nitrogen for plants. Nitrate is particular health concern in the body because it causes hemoglobin reduce the amount of oxygen that can be carried in the blood.[12] The increasing concentration of chlorine may pose risk for

Table 1: Analysis of physico-chemical properties at Chaulkhowa River at retreating monsoon.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	7.6	7.5	7.7	7.6	7.2	7.3	7.7	7.6	7.6	7.5	-
Temperature (ºC)	22.8	22.6	22.9	21.9	23	22.7	22.5	22.6	23.1	22.6	-
DO (ppm)	10	11	11	12	10	11	11	12	10	11	13-14
CO_2 (ppm)	16	18	18	20	16	18	20	18	16	16	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	44	43	46.4	45.6	45.4	46.6	46.2	44.2	45	43.6	
Chloride (ppm)	10	10	20	10	10	10	20	10	10	10	250 ppm

Table 2: Analysis of physico-chemical properties at Chaulkhowa River at winter monsoon.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	7.2	7.3	7.1	7.5	7.7	6.9	7.2	7.4	7.3	7.1	-
Temperature (ºC)	19.1	19.4	19	18.9	20.1	18.9	18.8	19.3	19.5	19.2	-
DO (ppm)	10	11	9	11	11	10	12	9	10	11	13-14
CO_2 (ppm)	6	8	6	10	6	8	10	6	8	4	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	62	68	38.4	51.6	68.6	48.2	54.2	64.2	67.6	59.4	
Chloride (ppm)	10	10	10	20	10	10	10	20	10	20	250 ppm

Table 3: Analysis of physico-chemical properties at Chaulkhowa River at winter monsoon.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	7.3	7.4	7.5	7.9	7.8	7.7	7.8	7.3	7.4	7.1	-
Temperature (ºC)	21.5	20.6	22.8	21.1	22.2	21.4	21.7	21.8	21.5	22.4	-
DO (ppm)	10	12	10	11	11	12	10	9	11	12	13-14
CO_2 (ppm)	4	6	6	8	6	4	6	10	8	4	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	31.6	43	43.4	47	49.8	65.8	49.4	58.4	48.6	60.2	
Chloride (ppm)	10	20	20	10	10	20	10	10	20	10	250 ppm

Table 4: Analysis of physico-chemical properties at Palla River at retreating monsoon.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	9.8	9.7	9.7	9.4	9.8	9.5	9	8.6	9.4	9.1	-
Temperature (ºC)	24.3	23.9	23.7	24.1	23.6	24.2	23.8	24.4	24.5	24.1	-
DO (ppm)	13	12	13	11	12	12	13	10	10	11	13-14
CO_2 (ppm)	22	20	20	18	24	20	18	20	18	22	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	38	40	33	34.4	28	34.2	36	39.4	42	41.4	
Chloride (ppm)	10	10	30	20	10	10	10	10	10	20	250 ppm

Table 5: Analysis of physico-chemical properties at Palla River at winter monsoon.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	9.5	9.1	8.6	8.9	9	9.2	9.1	8.9	8.8	8.9	-
Temperature (ºC)	20.1	20.5	20.2	20.9	20.5	20.8	20.9	21.4	21.2	21	-
DO (ppm)	10	10	11	10	9	11	11	10	10	9	13-14
CO_2 (ppm)	6	6	8	6	10	8	6	10	8	6	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	30.4	33	52.8	39	35	42	29.2	38	43.8	40	
Chloride (ppm)	10	20	10	20	10	20	10	10	10	10	250 ppm

Table 6: Analysis of physico-chemical properties at Palla River at pre-monsoon season.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	8.2	8.3	8.1	8.2	8.3	9.1	8.9	9	8.6	8.4	-
Temperature (ºC)	25.4	25.7	26.1	26.3	25.9	26.4	26.9	26.7	27	26.5	-
DO (ppm)	10	11	10	12	11	10	10	12	11	11	13-14
CO_2 (ppm)	8	6	8	8	6	8	10	4	6	8	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	63	43.4	47	50	62	65.2	57.4	59	65.4	66.6	
Chloride (ppm)	10	20	10	20	10	10	20	10	20	10	250 ppm

Table 7: Analysis of physico-chemical properties at Brahmaputra River at retreating monsoon.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	8	7.9	8.1	7.8	7.7	7.8	7.7	7.9	8	8.2	-
Temperature (ºC)	21.3	22.1	21.5	21.9	21.5	21.7	22.2	21.4	21.6	21.9	-
DO (ppm)	15	16	15	15	14	16	15	14	14	16	13-14
CO_2 (ppm)	6	8	8	8	6	6	8	4	4	6	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	31	24	28	33	34.2	20.2	37.4	36	24.2	19.6	
Chloride (ppm)	10	10	20	30	10	10	10	10	10	20	250 ppm

Table 8: Analysis of physico-chemical properties at Brahmaputra River at winter monsoon.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	7.8	7.5	7.6	7.7	7.4	7.7	8	8.2	7.7	7.9	-
Temperature (ºC)	18.1	18.7	18.5	18.3	19	19.2	18.9	18.7	19.1	18.8	-
DO (ppm)	13	12	14	14	12	14	13	14	14	12	13-14
CO_2 (ppm)	6	6	8	10	8	6	4	6	8	10	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	9	24	11.6	27	22	32	28.2	29.4	19.6	14.4	
Chloride (ppm)	10	10	10	10	20	10	10	20	10	10	250 ppm

Table 9: Analysis of physico-chemical properties at Brahmaputra River at pre-monsoon season.

Parameter	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	WHO Standard (ppm)
pH	7.6	8.2	7.9	8.4	8.1	8.3	8.5	8.3	8.1	8	-
Temperature (ºC)	22.1	22.4	22.7	22.1	22.6	23	22.9	22.7	23.1	23.3	-
DO (ppm)	12	11	11	12	11	11	13	12	12	11	13-14
CO_2 (ppm)	4	6	4	8	6	4	6	10	8	10	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	31	26	31	34	28.4	34.2	36.6	22	30.8	28.6	
Chloride (ppm)	10	10	20	10	10	20	10	10	10	20	250 ppm

Table 10: Analysis of physico-chemical properties at Beki River at retreating monsoon.

Parameter	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Site9	Site10	WHO Standard (ppm)
pH	8	7.9	8.1	7.8	7.9	7.8	7.6	7.9	8.2	8.3	-
Temperature (ºC)	17.1	17.5	17.2	18	16.9	17.7	18.1	17.9	17.7	17.6	-
DO (ppm)	13	13	14	12	13	14	14	14	13	12	13-14
CO_2 (ppm)	8	6	8	6	10	6	4	4	8	6	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	34	34	24	40	39	32.6	35	32	28.8	42.2	
Chloride (ppm)	10	10	10	10	10	20	10	10	10	10	250 ppm

Table 11: Analysis of physico-chemical properties at Beki River at winter monsoon.

Parameter	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Site9	Site10	WHO Standard (ppm)
pH	8.2	8.5	8.7	8	7.9	8.6	8.3	7.8	8.3	8.5	-
Temperature (ºC)	15.5	15.7	15.3	15.9	16.1	16	15.8	15.2	14.9	15	-
DO (ppm)	15	14	15	14	13	14	15	14	13	13	13-14
CO_2 (ppm)	6	6	6	8	6	10	4	6	6	8	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	19.6	14.2	24.2	16.2	19.4	26.2	20.2	12.2	22.4	21.2	
Chloride (ppm)	10	10	10	10	10	10	20	10	10	10	250 ppm

Table 12: Analysis of physico-chemical properties at Beki River at pre-monsoon season.

Parameter	Site1	Site2	Site3	Site4	Site5	Site6	Site7	Site8	Site9	Site10	WHO Standard (ppm)
pH	8.8	8.6	8.3	8.9	8.8	8.5	8.8	8.5	8.1	8.3	-
Temperature (ºC)	21.2	21.7	21.5	22.1	21.9	21.1	21.8	22.3	21.6	22	-
DO (ppm)	14	13	14	14	13	13	13	12	13	14	13-14
CO_2 (ppm)	6	4	6	8	4	6	10	6	4	8	-
Arsenic (ppm)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Iron (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	-
Nitrate (ppm)	10	10	10	10	10	10	10	10	10	10	4.5
Copper (ppm)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0 ppm
Acidity (g/L)	29	22	28	33	30.2	26.2	22.4	25.6	27.4	30.2	
Chloride (ppm)	20	10	10	20	10	20	20	10	10	10	250 ppm

Table 13: Annotated checklist of selected fishes at the four different study sites in reference with total species count for Shannon diversity index.

Sl. No.	Brahmaputra River	Shannon diversity index, $H' = -\sum pi\ l$	Beki River	Shannon diversity index, $H' = -\sum pi\ l$	Chaulkhowa River	Shannon diversity index, $H' = -\sum pi\ l$	Palla River	Shannon diversity index, $H' = -\sum pi\ l$
1	*N. notopterus*	-0.105	*N. notopterus*	-0.069	*N. notopterus*	-0.110	*N. nandus*	-0.137
2	*C. carpio*	-0.124	*C. carpio*	-0.115	*C. fasciata*	-0.200	*C. fasciata*	-0.215
3	*N. nandus*	-0.105	*N. nandus*	-0.133	*P. sophore*	-0.353	*P. sophore*	-0.359
4	*C. fasciata*	-0.142	*C. fasciata*	-0.167	*P. chinensis*	-0.066	*C. mrigala*	-0.334
5	*P. sophore*	-0.316	*P. sophore*	-0.285	*X. cancila*	-0.146	*L. rohita*	-0.244

C. idella	-0.087	*C. idella*	-0.115	*C. mrigala*	-0.315	*M. armatus*	-0.137
L. calbasu	-0.039	*L. calbasu*	-0.069	*L. rohita*	-0.066	*E. danricus*	-0.084
X. cancila	-0.124	*X. cancila*	-0.167	*M. armatus*	-0.110	*M. tengara*	-0.244
C. chital	-0.063	*C. chital*	-0.039	*E. danricus*	-0.201	*W.attu*	-0.181
C. mrigala	-0.156	*C. mrigala*	-0.194	*M. tengara*	-0.243		
L. rohita	-0.142	*L. rohita*	-0.232	*W. attu*	-0.262		
H. ilisha	-0.196	*S. aor*	-0.069				
M. armatus	-0.184	*M. armatus*	-0.167				
E. denricus	-0.218	*E. denricus*	-0.252				
H. fossilis	-0.105	*P. pangasius*	-0.069				
A.morar	-0.170	*H. fossilis*	-0.150				
M. tengara	-0.156	*A.morar*	-0.092				
M. vittatus	-0.170	*M. tengara*	-0.133				
W. attu	-0.124	*M. vittatus*	-0.150				
		R. rita	-0.039				
		W. attu	-0.069				
2.726		2.775		2.072		1.935	

Fig 2a. Collection of fishes using traditional fishing gears

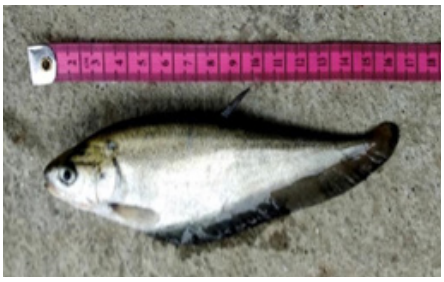
Fig 2b. Collection of water for physico-chemical analysis

Figure 2: Photographic plate of various sampling analysis for physico-chemical properties and ichthyofaunal diversity.

health to all forms of aquatic flora and fauna. It blocks some physiological process in the enzyme. Usually chloride is present in all type of water. The chloride concentration may vary in different types of aquatic resource. The increasing concentration of chlorides in water may trigger to lethality for organisms.[13]

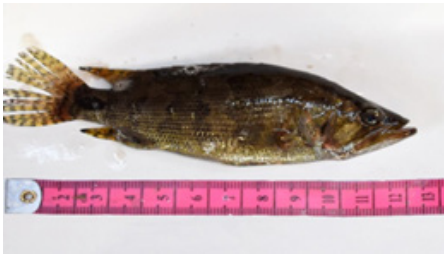
DISCUSSION

There has been no previous attempt to assess and compare the water quality and fish diversity of these four major rivers passing through and along the periphery of Barpeta district. So, practically this can considered as one of the primary observation made for this agriculturally rich district of Assam. It was found that most of the physico-chemical features of the water in all the four rivers are in optimum condition according to the APHA standard but parameters like nitrate concentration are exceeding the limits prescribed. The pH and temperature of four rivers remained nearly to the optimum level as per seasonal changes in a year. The agricultural run-off

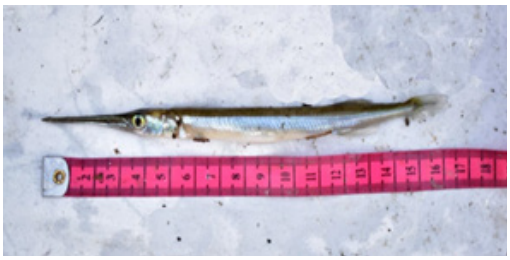


Notopterus Notopterus

Cyprinus carpio

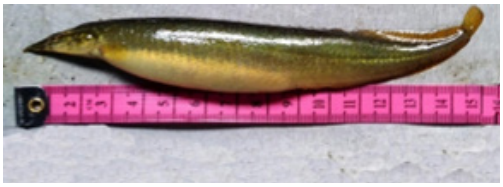


Nandus nandus



Xenentodon cancila

Pampus argentenus



Mastachembelus panculas

Esomus dandricus

Wallago attu

Figure 3: Photographic plate of selected ichthyofaunal diversity found at the four different study sites.

to these rivers consist of high amount of insecticidal or pesticidal load used in the agricultural practices may also add to the total nutrient load leading to increase in nitrate concentration of the rivers that could affect the physico-chemical parameters ultimately affecting the aquatic organism.[15] The changes in the chloride concentration may also be an alarming situation and source may be attributed to the animal waste, washing clothes by nearby villagers and fertilizers with potash concentration.[16,17] The ichthyofaunal diversity has been found higher in Beki River among the four rivers similar to the reports published after this work.[18] Among the total fish species found, the most abundant species have been found in four rivers was *Puntius sophore* followed by *Cirrhinus mrigala*, while the least abundant species *Hilsa ilisa* (except Brahmaputra River), *Chitala chitala* and *Nandus nandus* were the rarest species in these river. The study also revealed a species diversity of Chaulkhowa (*H'*= 2.072) while for Palla River the index is (*H'*=1.935) then for Brahmaputra River (*H'*= 2.726) and at the last Beki river diversity index is (*H'*=2.775) Figures 2 and 3. This study has also noted that all the rivers except Chaulkhowa were seen to be having unchecked fishing activities which certainly affects the diversity and population density of various fish species. The intensive fishing by the leasers greatly affects the

diversity of the species. This requires an immediate intervention by concerned authorities in controlling the use of potash and high nitrate based fertilizers, creating awareness for bringing down the use of river water for discharge of animal wastes, washing clothes dumping of domestic sewage. Strict policies have to be maintained for keeping such damaging activities at check by the local panchayat office and villagers as well.

CONCLUSION

Water must be treated with different physico- chemical parameters and selection of parameter solely depends upon what purpose the study is going to use that water and to what extent it will be needed its quality and purity for aquatic fauna. To evaluate the quality of water, each parameter was compared with the standard desirable limits as prescribed by APHA. From the study, it could be concluded that the water of four rivers is harmless to aquatic organisms but though the high amount of nitrate present will affect the invertebrate, small fishes and amphibians. So it should be maintained otherwise important organisms fail to survive. To re-establish these small organisms proper management should be done and side study of the physico-chemical parameter also carried out every year so that the concentration of the dangerous element is known. The fish diversity studies suggest that as per Shannon Wiener index (H'), the Beki River has more species diversity in comparison to remaining three rivers. *Puntius sophore* was found to one the most abundant species found in all the rivers suggesting a higher presence of phyto- and zoo-plantons load in the rivers. The study on the river concludes that the fish diversity and water quality index of the four rivers are at good and optimum level. Further in depth studies in these rivers individually may give up more detailed results for better management practices.

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ETHICS APPROVAL AND FUNDING

The submitted work is original and not placed for publication in any journal. It has not utilized any animal for study or poses threat to nature. Also, no external fund was utilized for the study and no additional contributors have been involved in the study.

CONFLICT OF INTEREST

The authors declare no conflict of interest among the authors.

SUMMARY

The study emphasizes on the study of water quality parameters and ichthyofaunal diversity of four major rivers (Chaulkhowa, Palla, Brahmaputra and Beki) in Barpeta district, Assam. This attempt on the four rivers is to study and utilize the sustainable use of fish and fishery resources. The survey conducted at the different sites of the rivers revealed a good quality of water parameters and a rich fish diversity of about 24 species with mostly belonging to Cyprinidae family. The water quality index was discovered to having a neutral pH while others showed a little variation due to the rainfall attributes and agricultural run-off from nearby places. The most abundant species in all the four rivers was found to be *Puntius sophore* and the least was *Hilsa ilisha*. Among all the rivers, the diversity richness was found to be the highest in Beki River. A more proper and detailed study individually conducted on each river would help in assessing more diversity, water and soil properties of each river.

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