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Ecology of Baskandi *anua,* an oxbow lake of South Assam, North East India

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Abstract

A study was made on the physico-chemical properties of water and phyto and zooplankton communities of Baskandi *anua*, an oxbow lake of South Assam during March to August, 2009. Analyses of water showed acidic to slightly alkaline pH (5.4 - 7.9) with dissolved oxygen ranging from 4.26 to 11.83 mgl^{-1} and total alkalinity from 31.25 to 65 mg l^{-1}, indicating the productive nature of water. Free CO_2 fluctuated from 2.93 to 15.04 mgl^{-1}. PO_4 and NO_3 concentration ranged from 0.15 to 1.4 mg l^{-1} and 0.06 mg $l^{-1}$to 4.94 mg l^{-1},respectively. Conductivity, pH and free CO_2 were found higher at the sites surrounded by paddy fields. Mean values of physico-chemical parameters significantly varied between the sites and were found to be influenced by one or more of the following factors viz. rainfall, depth and influx from adjacent paddy field. A total of 30 phytoplankton taxa and 12 zooplankton taxa with qualitative dominance of Chlorophyceae were recorded. The study revealed that water quality of the lake was good for aquaculture. Hence, the lake should be protected and best management practices should be implemented for sustainable production.

Key words

Baskandi anua, Ecology, Plankton communities, Oxbow lake

Introduction

Oxbow lakes, the common flood plain features around the globe, are remnants of meandering flood plain rivers that have been physically isolated from their respective main river channels and generally capture small relic drainage (Cooper *et al*., 2003). According to Camargo and Esleves (1995), limnological features in such oxbow lakes can be diverse, depending on environment and study period. Although, the total wetland area of Assam is 9.74 % of the geographic area (NWA, 2010), very few studies on ecology (Das *et al.,* 2011) and limnology (Bhattacharjee and Kapil, 2009 ; Kapil and Bhattacharjee, 2009) of wetlands are in record.

Anua is the local terminology of oxbow lake. This lake is the main source of water as well as livelihood for the inhabitants as the lake harbours variety of fishes. Although wetlands and people are ultimately interdependent, human being have significantly affected wetland ecosystem by their large ecological footprints. Humanities ecological footprint has more than doubled since 1961 and now overshoots the planets regenerative capacity by about 50% (WWF, 2008). The phytoplankton community, which the whole aquatic population depends, is largely influenced by the interaction of a number of physico-chemical factors (Hulyal and Kaliwal, 2009). Studying the composition of plankton species is important in lakes and reservoirs as some species have significant role in determining water quality (Gray, 2008). Most of the studies in the dynamics of phytoplankton in lacustrine environment have been investigated in larger lakes. In small lakes in oxbows, in which there is profusion of water bodies, the available information is scarce (Reynolds,1993). The present paper deals with the study of physico-chemical properties of water and diversity of phyto- and zooplankton communities of the oxbow lake, Baskandi *anua* in Assam.

Materials and Methods

The area of Baskandi *anua* (24°8" and 30.2°8" N and 92°15" and 93°15" E) is 2.2 sq km. The lake is semi horse shoe shaped, oriented in east–south east to west–south west direction, connected with the River Barak by a small channel. Baskandi

Table 1 : Pearson correlation coefficient matrix of different physico-chemical parameters

	WT(ºC)	pH	Cond ($\mu S\ cm^{-1}$)	DO $mg\ l^{-1}$	Free Co_2 ($mg\ l^{-1}$)	TA $mg\ l^{-1}$	Po_4 $mg\ l^{-1}$	No_3 mgl^{-1}	Depth (cm)
RF	.675**	.350**	.306**	.095	.450**	.138	.131	-.118	.210**
WT		.690**	.478**	.122	.526**	.072	.063	.571**	.302**
P^H			.344**	-.077	.274**	.058	-193**	-.495**	.191**
Cond				-.221**	.327**	.029-	.056	-.460**	.588**
DO					-.080	.317**	.028	.386**	-.191**
FCO_2						.081	-.013	-.304**	.168**
TA							.081	.046	.092
Po_4								.205**	-.021
No_3									-.248

**Significant at 0.01 level, n=179

Table 2 : Phytoplankton and zooplankton taxa of the study sites

Phytoplankton	Zooplankton
Chlorophyceae : *Chlorella* sp., *Closterium* sp., *Chaetophora* sp., *Cosmarium sp.*, *Desmidium* sp., *Gloeotilopsis* sp., *Leptosira* sp., *Microspora* sp., *Micractinium* sp. *Spirogyra* sp., *Scenedesmus* sp., *Ulothrix* sp., *Volvox* sp., *Zygnema* sp., *Xanthidium* sp.	**Copepoda:** *Cyclops* sp., *Mesocyclops* sp., *Neodiaptomus* sp., *Diaptomus* sp., *Nauplius* larva, *Streptocephalous* sp.
Cyanophyceae : *Anabaena* sp., *Clorococcus* sp., *Gloeotrichia* sp., *Plectonema* sp., *Synechocystis sp.*, *Nostoc* sp., *Rivularia* sp., *Oscillatoria* sp., *Spirulina* sp.	**Cladocera:** *Daphnia* sp., *Moina* sp., *Chydorus* sp.
Bacillariophyceae: *Navicula* sp., *Nitzschia* sp., *Synedra* sp., *Cyclotella* sp., *Cymbella* sp., *Tabellaria* sp.	**Rotifera:** *Brachionus* sp., *Keratella* sp.
	Ostracoda: *Cypris* sp.

anua, an oxbow lake of River Barak is situated 20 km away from the Silchar city, Cachar, Assam (Fig. 1). Site 1 (Sunarigram), Site 2 (Baskandi), Site 3 (Tulasanagar), Site 4 (Chandpur 2), Site 5 (Chandpur 3), Site 8 (Puranabazar), Site 9 (Chiribazar) are located in the northern bank of the lake, 50 to 80 m away from one another. Site 6 (Arihal) and Site 7 (Ratanpur) are located in the southern bank, around 300 m apart. Site 6, 7 and 10 are surrounded by paddy fields. Site 10 (Naga *anua*) is a small system located very close to Baskandi *anua* but not connected with River Barak.

Water samples were collected monthly from sub-surface layer in PVC and BOD bottles (for estimating dissolved oxygen) from ten different Sites (Site 1-9 from Baskandi *anua* and Site 10 from Naga *anua*) and brought to the laboratory for analyses, for a period of six months from March to August, 2009. Physico-chemical parameters such as dissolved oxygen (DO), total alkalinity (TA), free carbon-di-oxide (CO_2) were analyzed by standard titration method while phosphate (PO_4) and nitrate (NO_3) were analyzed by spectrophotometer (APHA, 2005). Electrical conductivity (EC) and pH were measured by conductivity meter, and pH meter respectively. Water temperature (WT) and depth were measured by mercury thermometer and yardstick, respectively

Qualitative plankton samples were collected monthly by towing nylobolt plankton net (No. 30; mesh size 48µm) and were preserved in 5% formalin. They were later identified by using standard literature (Edmondson, 1959; Anand, 1998). Pearson correlation coefficient analysis was done to examine the significant relationships among different environmental variables, and analysis of variance (ANOVA one way) was computed to see the significant variations among different Sites on the basis of the environmental variables, by using statistical package SPSS 12.

Results and Discussion

During the study period temperature of water of Baskandi *anua* (Site 1-9) ranged from 23.94 to 32.8º C and RF data varied from 9.08 to 24.28 mm. DO ranged from 6.11 to 10.52 mg l^{-1}, highest being in March and lowest in June. pH ranged from 6.2 to 7.4, highest being in August and lowest in April. EC ranged from 148.99 to 290.4 µS cm^{-1}, highest in May and lowest in March (Fig.2a and 2b). In Naga *anua* (Site 10) temperature of water varied from 23.77 to 32.78ºC and RF varied from 9.08 to

24.28mm. DO ranged from 5.69 to 9.24 mg l^{-1} , highest being in April and lowest in June. pH ranged from 5.4 to 7.1, highest being in August and lowest in March. EC ranged from 118.3 to 724.6 mg l^{-1}, highest in June and lowest in March (Fig. 3a, b). Water temperature showed a significant positive relationship with DO at 0.01 level which is in contrast to their classical inverse relationship. Rainfall and depth showed significant positive relationship with WT, pH, EC and free CO_2 while depth showed significant negative relationship with DO at 0.01 level (Table 1).

In the present study, DO and pH range were lower in Naga *anua* (Site 10) than that of Baskandi *anua* (Site 1-9). This might be due to preponderance of macrophyte in the system where decomposition might have played a major role. Many other studies in India revealed low range of DO such as 3.41-6.21 mgl^{-1} in Seetadwar lake (Tewari and Mishra, 2005), 5.30-9.00 mgl^{-1} in Deoriatal (Rawat and Sharma, 2005) and 3.00-6 mgl^{-1} in Kandhar dam (Surve*et al*., 2005). In the present study, in both the systems, lowest DO values were recorded in June.It could be attributed to the fact that during monsoon, surface runoff carried waste and sewage from surrounding areas into the low lying beds of flood plain lakes, thereby increasing the respiratory activity of the heterotrophic organisms. At Site 10 highest CO_2 was associated with lowest DO in the month of June while in Baskandi *anua* no such association could be seen. As significant positive relationship between DO and NO_3 at 0.01 level could be attributed to the fact that moderate NO_3 concentrations at all the Sites likely enhanced the growth of phytoplankton which in turn produced more DO (Bhuiyan and Gupta, 2007). In an another study made in a floodplain lake of Barak valley also revealed similar pattern (Laskar and Gupta, 2009). Absence of classical inverse relationship between DO and CO_2 revealed that DO in the system was not only regulated by photosynthetic activity of algal flora when free CO_2 was utilized (Wetzel, 2001).

Baskandi *anua* (Site 1-9) had slightly acidic to slightly alkaline pH, while Naga *anua* (Site 10) had acidic to neutral pH. In the present study, pH showed a significant positive relationship at 0.01 level with EC, free CO_2, depth and negative relationship with PO_4 and NO_3. Fluctuation of EC in Baskandi *anua* (Site 1 to 9) during different months were not very pronounced and highest value was recorded in the month of May. At Ramsagar reservoir, Datia, MP, India fluctuation of EC was also recorded low, ranging from 108-246.30 µ S cm^{-1} (Garg *et al*., 2009). At Site 10, highest conductivity (724.6 µ S cm^{-1}) value was recorded in June, which was three times of its value in the month of May. Site 10 was a separate small water body covered by macrophytes and surrounded by paddy field all around. The differences were probably associated with environmental factors such as vegetation cover, climate and runoff quality. Laskar and Gupta (2009) recorded high conductivity at Chatla wetland, a flood plain lake of Barak Valley, Assam during pre-monsoon and monsoon. Significant positive relationship of EC with RF and highest EC at Sites 1-9 during pre-monsoon and at Site 10, during monsoon indicated addition of pollutants in the system, along with surface runoff. Camargo and Esteves (1995) and Magrin and Senna (1997) found an increase in EC and nutrient concentrations during flooding, in two different oxbow lakes, of the River Mogi-Guaçu , Brasil. The range of TA (31.25 to 65 mg l^{-1}) in Baskandi *anua* indicated productive nature of water as natural waters with 40 mgl^{-1} or more TA was more productive (Manna and Das, 2004) and for fresh water aquaculture these value should range between 40-200 mg l^{-1} (Atobatale and Ugwumba, 2008).

Since phosphorus is believed to play a key role in eutrophication of water bodies, its presence is an important indicator of water quality (Koc and Skwierawski, 2004; Glinska-lewczuk, 2009). Highest concentration of phosphate was recorded in Baskandi *anua* (Site 7) closely followed by Site 6 of the same system and Site10 (Naga *anua*). Since all the three Sites (7, 6 and 10) were surrounded by paddy fields it can be said that fertilizers applied in the surrounding areas might have contributed to it. The highest nitrate concentration (4.94 mg l^{-1}) was also recorded at Site 7 and lowest at Site 4 (0.06 mg l^{-1}). All these facts were further supported by a significant positive relationship of phosphate only with nitrate, which is in agreement with the study made on the Mahi dam of Rajasthan (Sharma *et al.,* 2009). The range of nitrate concentration in the present study is comparable to the previous study made in Barak Valley (Bhuiyan and Gupta, 2007). Inverse relationship of pH with nitrate, as recorded in the present study, is in agreement with the previous study made in Barak Valley (Bhuiyan and Gupta, 2007). Computation of ANOVA (one way) on the basis of the physico-chemical parameters of water, revealed that the study Sites were significantly different (F-.263; significant at .984).

A six month survey made on the composition of both phyto- and zooplankton community at all the ten Sites revealed the presence of 30 phytoplankton taxa and 12 zooplankton taxa in the oxbow lake (Table 2). Among the phytoplankton taxa, 15 belonged to Chlorophyceae, 9 belonged to Cyanophyceae and 6 belonged to Bacillariophyceae. Euglenophyceae was not recorded in the system during the investigation period. The reason may be that the investigation period (premonsoon and monsoon) was not conducive for their propagation. Because euglenoid blooms are generally induced during post-monsoon and winter when evaporation results in increasing nutrient concentrations, after fresh nutrients are brought into the shallow systems via surface runoff (Duttagupta *et al.,* 2004).

Several studies in north eastern India have reported diverse nature of phytoplankton such as 75 species from Loktak Lake (a Ramsar Site), Manipur (Sharma, 2009), 62 species in Utra pat, 61 species in Waithou Pat of Manipur (Sharma, 2010a)

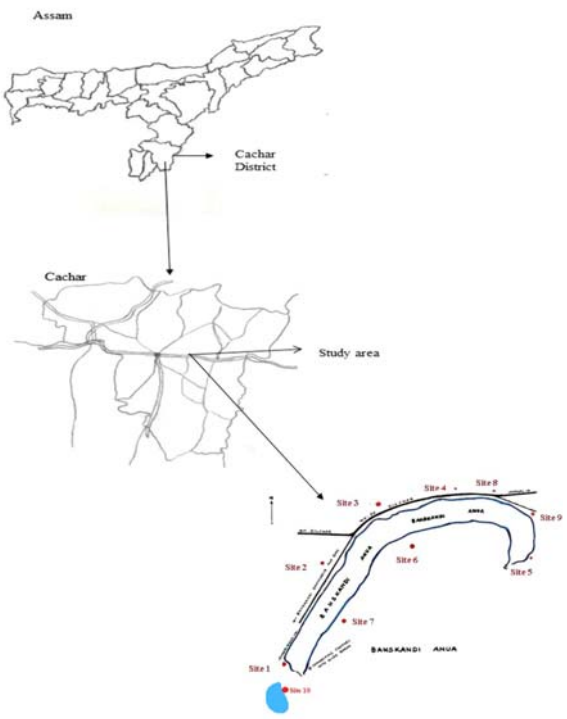


Fig. 1: Map of Baskandi *anua* showing its location and different study sites

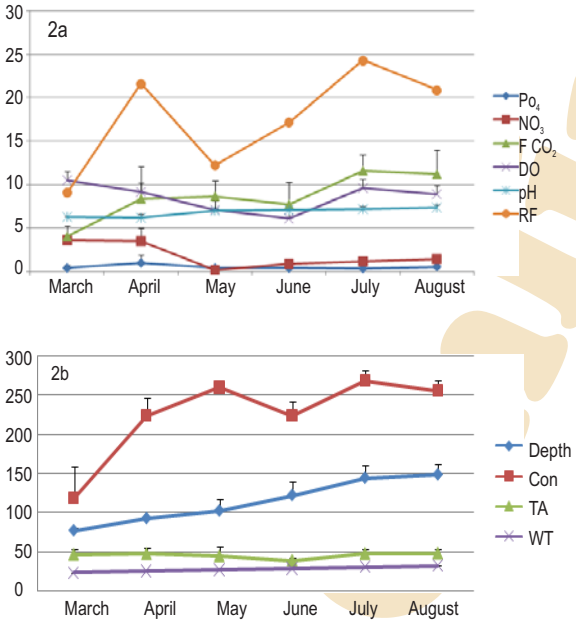
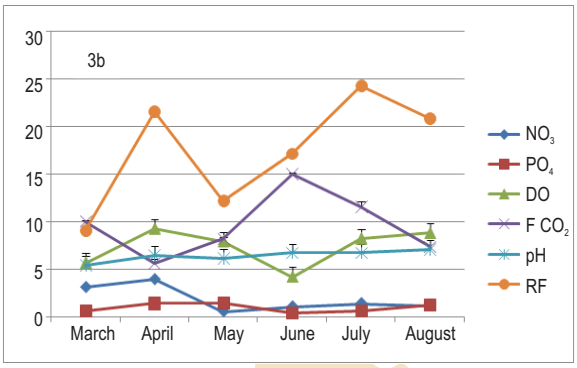


Fig. 2: (a) Variation in concentration of rainfall (RF mm), dissolved oxygen (DO ppm),pH, free CO_2(ppm), PO_4 (ppm) and NO_3(ppm) and **(b)** variation of water temperature (WT ^{0}C), depth (cm), total alkalinity (TA ppm) and conductivity (CON µ S cm^{-1}) of water of Baskandi *anua* (mean of Site 1 to 9) during March to August 2009



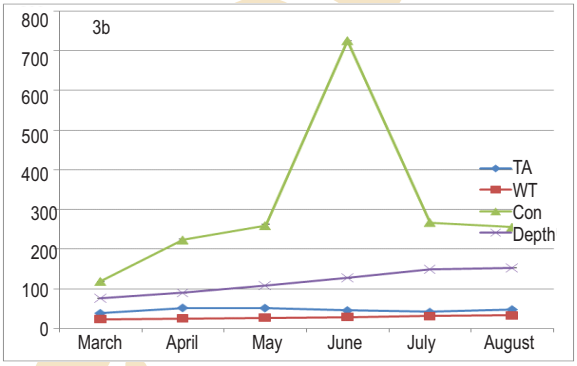


Fig. 3: (a) Variation in concentration of rainfall (RF mm), dissolved oxygen (DO ppm), pH, free CO_2(ppm), PO_4 (ppm) and NO_3(ppm) and **(b)** variation in water temperature (WT ^{0}C), depth (cm), total alkalinity (TA ppm) and conductivity (CON µs cm^{-1}) of water of Naga *anua* (Site 10) during March to August 2009

and 59 species from Deepor Beel-another Ramsar Site (Sharma, 2010b). Qualitative dominance of Chlorophyceae, as found in the present study, was also recorded in previous studies conducted in Barak Valley (Bhuyan and Gupta, 2007; Laskar and Gupta, 2009, 2010, 2013) and in the Brahmaputra valley, Assam (Goswami and Goswami,2001; Sharma, 2009). Among the 12 zooplankton taxa 6 belonged to Copepoda, 3 Cladocera, 2 Rotifera and only 1 belonged to Ostracoda (Table 2). A previous study carried out in a floodplain of Barak Valley encountered 14 zoopankton taxa (Laskar and Gupta, 2010). A study made in a 300 year old lake of Burdwan, West Bengal encountered 34 number of zooplankton taxa (Chattopadhyay and Barik, 2009). In North East India several studies carried out on zooplankton of floodplain lakes revealed the presence of 57 species of microcrustaceans in Loktak lake, Manipur (Sharma and Sharma, 2011) and 51 species from Deeporbeel, Guwahati, Assam (Sharma and Sharma, 2009).

The physico-chemical properties of water of Baskandi *anua* and Naga *anua* were found suitable for aquaculture and

diversity of plankton indicated productive nature of the water. The threats faced by the *anua* were encroachment, influx of nutrients from various anthropogenic sources like agricultural field, domestic waste and sewage from human settlement. Since oxbow lakes are very fragile ecosystems, the Lake Baskandi which harbour a variety of fishes should be given adequate protection.

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