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Dynamics of Euglena Bloom Growing in a Pond Ecosystem at Madhuraghat Floodplain area near Barak River, Southern Assam, North-East India

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Abstract

Floodplain ponds are common features of the river systems in North East India. In these ecosystems algae is of great importance as a major source of organic matter located at the base. Limnological characteristics of floodplain ponds in different seasons are related to the hydrological condition of the river. A study was conducted on a bloom acquiring floodplain pond near Barak River of Cachar district, North-East India. It showed a pattern of variation of physico-chemical parameters of water and their influence on the occurrence of Euglena bloom and the distribution of other algal species. The paper also focuses the impact of Euglena sp. on the growth and development of fish fauna.

Key words: Algae, Bloom, Dynamics, Euglena, Soil, Fauna, Floodplain, Limnology, Organic, Species

Introduction:

Algal bloom in the aquatic ecosystem is a natural process which is triggered by different anthropogenic activity and most of the blooms are beneficial to the ecosystem by boosting primary productivity. There is growing evidence that bloom- initiating mechanisms are diverse and controlled by several environmental and physiological factors (Paerl, 1996; Hyenstrand et al., 1998; Oliver and Ganf (2000). The phasing, duration and intensity of algal blooms can vary from year to year within a single ecosystem (Winder and Cloern, 2010). Algae can be considered to blooming when there concentrations reached from hundreds to thousands of cells per milliliter (Graneli and Turner, 2006). Freshwater blooms occur naturally and are seasonal occurrences. Human activity disturbs the ecosystems in the form of increased nutrient loadings and pollution modified the hydrology and introduced species which are linked to the increased occurrence of freshwater bloom events. In freshwater ecosystem, cyanobacteria are generally considered as major bloom-formers (Rengefors, 2001), Euglena and diatom rank second (Mun, 2003). Euglena is a motile, single celled, free swimming, cosmopolitan, green algae with an eye like photoreceptive structure freshwater form (Kim and Boo, 1998). Euglenophytes bloom is the common phenomenon in warmer shallow and eutrophic water bodies (Olaveson and Stokes, 1989; Xavier et al., 1991; Tripathi and Shukla, 1993). Euglenophyceae are generally seen to appear near sewage outfall (Pandit, 2002). Euglenoids are particularly associated with interfaces such as sediment-water and air-water boundaries (Walne and Kivic, 1990) and should probably not be regarded as open water truly planktonic algae (Lackey, 1968). Euglena species are found in organically polluted water (Goel et al., 1986 and More, 1997). The different kinds of pigments found in Euglena are chlorophyll a, chlorophyll b, chlorophyll c, carotene, euglenorhodone, β-carotene, zeaxanthin, flovoxanthin, flavicin, etc. The measurement of photosynthetic pigments that is chlorophyll a is an index of water quality and algal biomass (Desortova, 1981, Wetzel, 1984; Canfield et al., 1985; Voros and Padisak, 1991 and Papista et al., 2002). Generally, higher chlorophyll a concentration translates into higher individual cell counts and algal biomass (Felip and Catalan, 2000). Euglena made up more chlorophyll a than diatoms, chlorophytes and especially cyanobacteria (Reynolds, 1984; Pereira et al., 2001).The amount of biomass determines the extent of the photosynthetic activity in the water body (Ssanyu, 2003). Floodplain ponds are common features of the river systems in North East India. The floodplain ecosystem of Assam is highly productive producing around 100 kg ha -1 yr -1of fish in contrast to a meagre 6-7 kg ha-1yr-1 from Indian reservoirs (Jhingran, 1991).

This paper is an attempt to study the dynamics of Euglena bloom in a floodplain pond near Barak River and its correlations with the physico-chemical properties of water.

Materials and Methods

Study area

The work was conducted in a pond of Madhuraghat which is about 5 km west of Silchar town (Fig. 1). The area is located 3 km away from the highway of Silchar airport road. The area is basically a floodplain near river Barak and Madhura. The place is surrounded by paddy field where two cropping were done, one is boro and another is shile. It lies between latitude of 92□47' E and longitude of 24□43'N and an altitude of 13km above the sea level. The size of the pond is about 2.5 acre and the villagers use the pond for different household activity.

Water and soil analysis

The work was done for a period of one year (July 2009- May 2010). Collection of algae and water samples were done on monthly basis and collection time was from 11am-12 pm when sun rays fall straight with strong intensity. Physico- chemical analysis of water was done by standard methods (APHA, 2005). Identification of algal species was done by standard keys (Smith, 1950; Prescott, 1951; Desikachary, 1959). Chlorophyll estimation of algal samples was done by standard method (Wetzel and Likens, 1979). Statistical analyses were done by MS Excel 2007.

Soils sample were collected to a depth of 0-15cm using soil corer. After removing the debris samples were air-dried composite sample was made, sieved through 2mm mesh screen and used for all analysis except bulk density. Soil pH and conductivity were measured in1:2.5 soil-water (w/v) suspensions by "electrometric method" (Anderson and Ingram, 1993). Bulk density was determined by "soil core method" (Anderson & Ingram, 1993). Water holding capacity was measured by "Keen's Box method" (Piper, 1942). Soil organic carbon was determined by Walkley & Black's rapid titration method (Jackson, 1973). Soil colour was assessed with the help of Munsell Soil colour chart (1994). The texture of soil was studied by particle fractionation with Bouyoucas soil hydrometer (Allen, 1989).

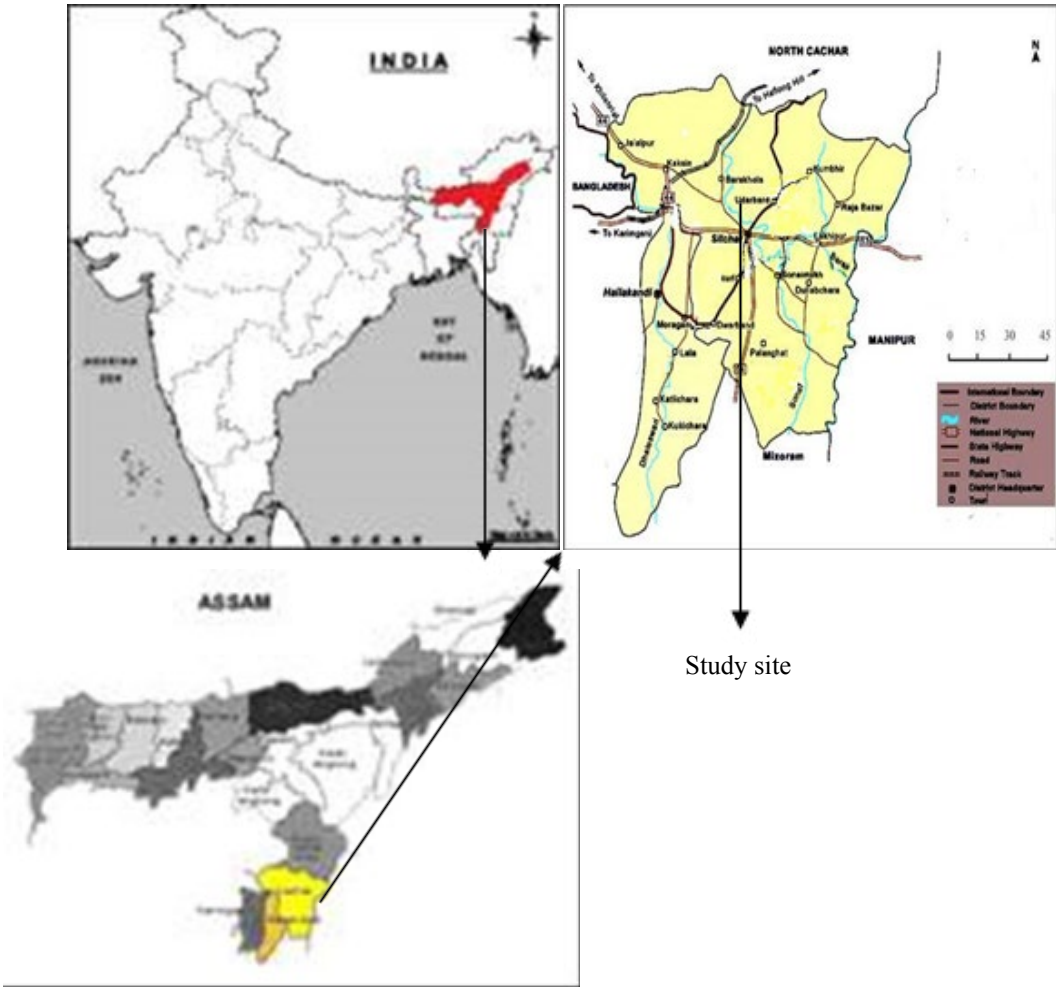

Table 1. Correlation matrix among the physico-chemical properties of water and Chlorophyll a concentration during July 2009 to May 2010.

Parametre	pH	DO(mg/ml)	FCO_2	TA	PO_4	Si	NO_3	Chl *a*
Temp(^{0}C)	-0.561*	-0.926**	0.932**	-0.925**	0.197	0.487	-0.676*	-0.802**
pH	-	0.503*	-0.269	0.230	0.180	-0.740**	0.698*	0.214
DO(mg/ml)		-	-0.833**	0.885**	0.942**	-0.267	0.421	0.630*
FCO_2(mg/ml)			-	-0.985**	0.375	0.279	-0.514*	-0.934**
TA(mg/ml)				-	-0.378	-0.174	0.415	0.876**
PO_4(mg/ml)					-	-0.156	0.202	-0.486
Si(mg/ml)						-	-0.942**	-0.278
$N0_3$(mg/ml)							-	0.711**

**= Correlation is significant at P<.01level, *= Correlation is significant at P<.05 level, Temp=Temperature, DO = Dissolved oxygen, FCO2= Free Carbon dioxide, TA= Total alkalinity, PO4=Phosphate, Si= Silica, N03= Nitrate.

pH	5.23
Conductivity(ms/cm)	1.03
Bulk density(g/cm^3)	1.45
Water holding capacity (%)	35.15
Organic carbon (%)	0.42
Moisture content (%)	15.2
Soil colour	Pale brown
Soil textural class	Loamy sand

Table 2. Soil physico-chemical properties of Madhuraghat area in Cachar District of Assam

Fish survey of the pond was done by questionnaire method (Saxena, 1995; Rastogi et al., 1998; Mendez et al., 2001; Vogl et al., 2004).

Result and Discussion

A variety of environmental factors are responsible for the distribution of a species. Temperature of the air and water and light intensity are among the key factors controlling the proliferation of algal bloom. The temperature affects the metabolic rate of living organisms (Gupta et al., 2008). Table -1 depicts the Pearson correlation matrix of different physico-chemical variables of water including chlorophyll a concentration of Euglena bloom. Temperature shows significant positive correlation with free carbon dioxide (r=0.932, P< 0.01). The pH of water is an important parameter that determines the suitability of water for various purposes. In the present work, pH shows significant positive correlation with dissolved oxygen (r=0.503, P< 0.05) and with nitrate (r=0.698, P< 0.05) but negatively correlated with silica (r=-0.74, P< 0.01). This finding are comparable with several workers in their studies on different water bodies (Petre, 1975; Rai and Gary, 1980; Shardendu and Ambashth, 1988 and Sinha, 1995).The higher dissolved oxygen concentration during the winter could be described to be the fact that oxygen is more soluble in colder water than of warmer water and the metabolic processes like respiration of aquatic organisms are slower in winter than in summer and therefore need less oxygen during the winter for biochemical reactions (Horne and Goldman, 1994).

Total alkalinity, nitrate and dissolved oxygen value shows significant correlation with chlorophyll a concentration, total alkalinity (r=0.876, P<0.01), nitrate (r=0.711, P<0.01) and dissolved oxygen (r=0.630, P<0.01). Alkalinity may also be caused due to evolution of CO2 during decomposition of organic matters. The high alkalinity is a function of ion exchange that is Ca ions are replaced by Na ions and later contributed to alkalinity (Sharma and John, 2009). Table- 2 shows the soil physico-chemical properties of study area. The texture of the soil was found to be loamy sand and acidic in nature. Bulk density of the pond soil was 1.45 g/cm 3 .

The bulk density tends to be lower in fine texture soils silt loams, clay and clay loams where adequate organic matter is present (Brady, 1990). Scholes et al., (1994) mentioned that increasing soil organic matter result in reduced bulk density. The water holding capacity and moisture content of soil were recorded as 35% and

Algal classes	Algal species
Chlorophyceae	*Spirogyra* sp.., *Pediastrum* sp., *Cosmarium* sp., *Scenedesmus* sp., *Ankistrodesmus* sp., *Zygnema* sp.
Cyanophyceae	*Oscillatoria* sp., *Spirulina* sp., *Anabaena* sp.
Bacillariophyceae	*Navicula* sp., *Gomphonema* sp., *Synedra* sp., *Gyrosigma* sp.
Euglenophyceae	*Euglena* sp., *Phacus* sp.

Table 3. Distribution of algal taxa of Madhuraghat floodplain area during study period.

15.2 %. Water holding capacity is more in clayey soil than loamy sand and sandy clay loam (Brady and Weil, 2004). Organic carbon content of soil was 0.42%. Brady (1990) pointed that soil with high silt and clay has higher organic carbon content and it indicate the fertility status of soils. The colour of the soil was found pale brown. Soil colour is an important indicator for classifying soils all over the world (Habarurema and Steiner, 1997; Bellon et al., 1999; Mango, 1999).

Colour in various types of soils is primarily due to the amount of organic matter and chemical state of the iron and other compound in the mineral fraction of the soil. Colour of the soil can reveal a great deal about the drainage conditions (Brady, 1990). Nutrients that are stored in the sediment can be introduced into the water-column by internal loading (Charboneau, 1999). A good amount of nitrate, dissolved oxygen, total alkalinity present in the system could be explained by the facts that the pond is located near the paddy field, where there is a continuous input of large amount of fertilizers and pesticides which might have increased the nutrient level of water (Isara and Chitchol, 2008).

Further it was observed that the villagers use the pond for taking bath and for other domestic use thus increasing NO3 concentration of the ponds (Minareci et al., 2009). The chlorophyll a concentration was also high because of photosynthesis and high temperature which also contributes oxygen concentration into the pond water. Present result is also supported by Vos and Roos, 2005. Distribution of other algal species was given in table 3. It shows that in Euglena bloom pond Chlorophyceae shows higher species as compared with Cyanophyceae and Bacillariophyceae.

According to the pond owner a mixture of fish species is good to use all the space and food in the pond. Local people use lime in their ponds to maintain the water pH because according to them acidic water is not good for the growth of their fish. Over hanging trees that shade out the sun and drop leaves are not good. Villagers fertilize the pond to increase the numbers of small plants and animals and can feed other material like rice bran and oil cakes to fish. Fish eat small plants, small animals and things which grow on leaves and on rock surfaces.

Commonly cultivated fish species were catla, japani, rohu, grass crap, common crap, silver crap, bracate, mrigal, tilapia, colisa, etc. But Catla, rohu and Mrigal were mostly preferred species because they live in different layers of the ponds and eat different thing, they can easily be grown together in the same body of water without competing with each other for space or food. Catla feeds mainly zooplankton, insect larvae, algae and aquatic weeds. It feed in the surface layers and swims in the upper layer of water. It is the fastest growing fish.

According to local people in Euglena growing ponds it can weight 700-800 g in one and about 1.0-1.5 kg when additional food are added. Rohu is a mid- water feeder, eating plankton, vegetable matter and debris. In Euglena growing ponds, it weight 400-500g but may even grow up to 1 kg when extra manure are used. Mrigal is a bottom-feeder that picks up large quantities of decaying things found in the bottom layers. After one year it weight 400-500 g in ponds rich in organic matter.

Conclusion

Present study revealed that factors that governed the growth of Euglena bloom are total alkalinity, nitrate, dissolved oxygen. As floodplain pond retaining their riverine connection for a reasonably long period of time are relatively free from weeds, Based on the variation of physico-chemical properties of water and algal population an integrated management approach combining capture and culture fishery during monsoon and dry spell in Madhuraghat floodplain area could be taken up for fish production to a great extent.

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