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Red Tide and Algal Bloom Hampering the Fish Production of the Ponds of Bankura Town of West Bengal, India

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ABSTRACT

Eutrophication, an anthropogenic nutrient enrichment is a common phenomenon in enclosed waterbodies like ponds which can be found in the maximum part of West Bengal, India. The Bankura district of West Bengal is full of static water bodies like pond, reservoir, water tank. But in Bankura town the pisciculture is less efficient due to various natural and anthropogenic causes. Light, temperature, inorganic and organic micro-nutrients are the key regulatory factors for the growth and succession of fishes and other species. But, sometimes water bodies are enriched with nutrients which leads to an excessive growth of plants that initially causes Eutrophication then ultimately end up with algal bloom formation and even a few of those ponds already turned into red tide condition which is very harmful for both aquatic animal and plant ecosystem so, the species diversity of planktons (mainly *Euglena* sp.) are hampered and cannot adapt with the abrupt changes in the physico-chemical parameters of the waterbody. This process may also lead to oxygen depletion in the water body. The effects of these conditions result in decreased fish production and species diversity a lot.

Keywords Red tide, Algal bloom, Eutrophication, Fish production, Bankura.

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INTRODUCTION

Natural surface water bodies like rivers and streams are subjected to pollution comprising of organic and inorganic constituents (Unnisa and Khalilullah 2004). The quality of water is usually determined by its physico-chemical characteristics. There is an intricate relationship between the metabolism of aquatic organisms and hydro-biological parameters in a freshwater body (Majumder and Dutta 2014). During the last several decades, the water quality of the Indian rivers has been deteriorating due to continuous discharge of industrial wastes and domestic sewages (Krishnan et al. 2007).

An important factor for economic development

of Bankura district is pisciculture. Bankura is one of the backward districts of West Bengal State. The village Ramsagar of Onda block (consisting of rural areas with 15 g panchayets; Ramsagar being one of them) of Bankura district is widely known for having more than 250 hatcheries. The fish-breeding industries of Ramsagar and its surrounding zone requires special attention as it provides a transaction of about Rs 6-7 crores per year through spawn production of about 50, 000 million in numbers. More than about 2,000 numbers of workers are directly and indirectly involved in this production system and many other enterprises have grown side by side to assist this production system. Bankura (for the Ramsagar village of Onda block) ranked first in pisciculture (particularly in spawn production) within West Bengal (according to the Office of the Additional Director of Fisheries, Bankura, West Bengal, India (www.bankura.org/SITE/Fisheries.htm). But, in Bankura town the pisciculture is less efficient although there are so many ponds located here. the reason behind it is, The ponds are not maintained properly. If we are able to involve most of these ponds for pisciculture, then Bankura will never be known as backward district.

At each level, the primary productivity can be further distinguished into gross primary production i.e., the total amount of organic matters produced and net primary production or the amount of organic matter produced at a particular level. Photosynthetic fixation of carbon in the inland aquatic system occurs in various plant communities such as phytoplankton, periphytic algae, benthic algae and macrophytes (Odum 1971). Production by the phytoplankton is the primary synthesis of food. It is the most important phenomenon and reflects the nature and the degree of productivity in the aquatic ecosystem.

A change in color of the water bodies or its intensity indicates the changes in growth of the planktons, flora and their densities. The factors regulating the growth and the succession of planktons are light, temperature, inorganic and organic micro-nutrients and the competition as well as the predatory characters among themselves (Gawande and Phadatare 2016). But, sometime water bodies are enriched with nutrients that leads to the excessive growth of plants and this ultimately results in Eutrophication (Sze 1998). Naumann (1919) described the term Eutrophication in a limnological sense and defined as an increase of the nutritional standards especially with respect to nitrogen and phosphorus. Since many biologists defined it in so may way, but all the definitions converge at one point; that is the enrichment of nutrients in the water bodies leading to the growth, specially the growth of plants (Mishra et al. 1988). The temperature affects the metabolic rate of living organisms (Gupta et al. 2008). The population of phytoplankton has a positive linear correlation with increase of phosphorus, and the redfield ratio can be particularly useful to determine whether nutrients are available in adequate levels for growth (Schindler et al. 2008). However, this relationship between phytoplankton biomass and nutrient concentration has been found to be less stronger in ponds, because of submerged vegetation and activity of large zooplankton (Teisser et al. 2008). Phytoplankton populations are directly influenced by the nutrient level because nutrient level generally exist in low concentrations in natural water bodies (Sze1998). If these nutrients are present in excess amount, the populations can increase rapidly. For example, the ecosystem health guidelines for an oligotrophic lake instructs that it should have less than 0.01mg/L of phosphorus and less than 2 mg/L of nitrogen, correlating with phytoplankton production levels of 7 to 25 (gC/m^2). But in contrast, an Eutrophic lake would have more than 0.03 mg/L of phosphorus and above 5 mg/L of nitrogen, correlating with 350—750 (gC/m^2) (Schindler and Fee 1974, Olem et al. 1990). The proliferation of bacteria that follows can lead to decrease in dissolved oxygen levels and a consequential drop in biodiversity (Carpenter et al. 1998).

Aquatic environment depicts ecological features that lead to the establishment of a very dynamic system in which the plankton community plays an important role. Among all these planktons *Euglena* play an important role. *Euglena* sp. is a motile, single celled, free swimming freshwater form of cosmopolitan green algae with an eye like photoreceptive structure (Kim et al. 2000). The common phenomenon in warmer shallow is euglenophytes bloom and eutrophic water bodies (Xavier et al. 1991). Euglenophyceae are generally seen to appear near sewage outfall (Pandit 2002). Euglenoids are particularly associated with interfaces such as sediment-water and air-water

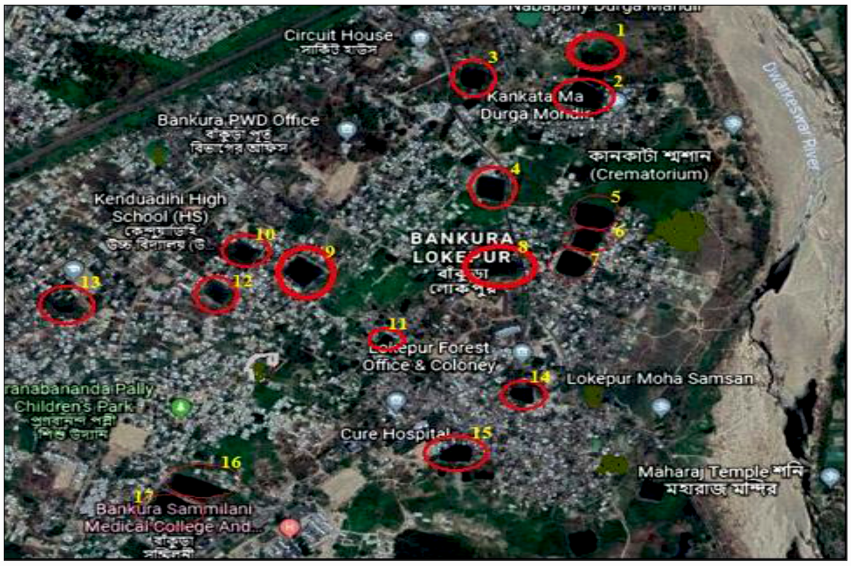

Fig. 1. The satellite view of different sampling sites of Bankura town.

boundaries and should be probably not regarded as open water truly planktonic algae. Euglena species are found in organically polluted water (Goel et al. 1986). The different kinds of pigments found in *Euglena* are chlorophyll a, chlorophyll b, chlorophyll c, carotene, ß-carotene, zeaxanthin, flovoxanthin, flavicin (Desortova 1981, Wetzel 1983, Canfield et al. 1985, Voros and Padisak 1991, Papista et al. 2002). The distribution of a particular species are influenced by the variety of environmental factors.

Eutrophication occurs when a water body becomes excessively enriched with minerals and nutrients which induce excessive growth of algae (Chislock et al. 2013). An algal bloom or algae bloom is a rapid increase or accumulation in the population of algae in freshwater or marine water systems, and is recognized by the discoloration of the water from their pigments (Cunningham and Cunningham 2008). Red tide is a common name of harmful algal blooms, which are large concentration of aquatic microorganisms, such as protozoans and unicellular algae mainly dinoflagellates and diatoms (Brand et al. 2012) . In certain species of phytoplankton and dinoflagellates, the photosynthetic pigments vary in color from brown to red, so the water can turn red, brown or pink (Brand et al. 2012). Here we have chosen three types of ponds to describe these three conditions.

The satellite view of sampling area (Fig. 1) of Bankura town shows that, it has a huge number of natural ponds. As fishes are mainly cultivated in pond water, and if the water quality of these ponds are maintained by us then obviously the fish production and species diversity could also be increased.

MATERIALS AND METHODS

For the measurement of surface water and air temperature the Mercury (Hg) thermometer of Ideal India was used (scale ranging from 0^oC to100^oC). For measuring intensity of light the Digital Lux meter (HTC, Model No.-LX-101A, Range -0 to 2,00,000) was used, and for measuring pH of the collected water sample, we used single electrode Digital pH meter of Systronics, India (Model No. SYS-335). To standardize the pH meter, 4.0, 7.0 and 10.0 pH tablets (Merck, India) were used. For measurement of dissolved oxygen (DO) we followed the standard Winkler's Iodometric method. Free and dissolved carbondioxide was measured by performing titration on the samples using mild (N/22) and (N/10) alkali (Na_2CO_3) solution respectively. Most of the chemicals (Merck, India) used were of highest purity available.

The total fieldwork was carried out consecutively for six months from October, 2018 to March, 2019

Table 1a. Name of the ponds.

1.	Kankata's no. 3 pond
2.	Kankata no. 1 pond
3.	Bhairav pond
4.	Leika pond
5.	Sol pond
6.	Majer gora
7.	Hod pond
8.	Lokepure's pond
9.	Sahanapally's no. 1 pond
10.	Sahanapally's no. 3 pond
11.	Thakur pond
12.	Sahanapally's no.1 pond
13.	Rammohan pally's pond
14.	Bakultola pond
15.	Kadma para's pond
16.	Kalindi bandh 1
17.	Kalindi bandh 2

Table 1b. Ponds under three categories.

Ponds with Red tides	
1.	Kankata's no. 3 pond
5.	Sol pond
Ponds with Algal Bloom	
3.	Bhairav pond
4.	Leika pond
6.	Majer gora
10.	Sahanapally's no. 3 pond
Ponds with Eutrophication	
2.	Kankata no. 1 pond
7.	Hod pond
8.	Likepure's pond
9.	Sahanapally's no. 1 pond
11.	Thakur pond
12.	Sahanapally's no. 1pond
13.	Rammohan pally's pond
14.	Bakultola pond
15.	Kadma para's pond
16.	Kalindi bandh 1
17.	Kalindi bandh 2

at 17 different sites (Table 1a) of Bankura town and here we have reported only three types of eutrified ponds (Table 1b) those are the represents of that 17 different ponds. The main three types of ponds here are Eutrophic pond-Pond of Lokepur, near Lokepur eye hospital, Bankura, algal bloom pond—Pond no. 3 of Sahanapally, Bankura and the red tide pond—Pond no. 3 of Kankata, Bankura. The main aim of this present study is to investigate the loss of species diversity and as a result the reduction in fish production due to Eutrophication in huge number of ponds of Bankura town of West Bengal, India. The physico-chemical data of the collected water sample were collected from three different ponds of Bankura town, these are pond near Lokepur eye hospital, pond in Sahanapally and pond in Kankata. These three ponds are used by the villagers for their household purposes and fishing. Lokepur eye hospital pond is situated in Lokepur, Bankura. In the surrounding sites of the pond, the huge dumps of garbages are found. Pond no. 3 in Sahana pally is situated in Kenduadihi and is used by the local people for their daily purposes. Pond no.3 of Kankata is situated in Kankata and used by the local residents for their household purposes.

The water samples for dissolved oxygen (DO) analysis were collected in sterile BOD glass bottles between 6.00 AM to 8.00 AM from each collection site. The standard methods of APHA were used to determine the hydrogen ion concentration (pH), dissolved oxygen (DO) (APHA-AWHA-WPCF 2005). The standard values of BIS (Bureau of Indian Standards 2003) were compared with the values (Khanna and Bhutiani 2008).

A modified plankton net (No. 25 mesh size 50 μ), filtering cone of it is made up of Nylon bolting silk, was taken with a round metallic frame of 0.625 sq m area for the plankton collection. Collected samples were transferred to labeled vials containing 5% formalin. Qualitative analysis and identification was done on a sedgwick Rafter Counter cell by taking 10 ml sample. The plankton was observed and documented using Olympus Trinocular Microscope (Model-MLX B) attached with Nikon Coolpix Camera.

RESULTS AND DISCUSSION

From Figs. 2—10 and Table 2, it is evident that the pond near Lokepur eye hospital is almost of trapezium shape. Planktons are found in large quantity (Fig. 11). The water is almost transparent but, at the bottom of the water body is filled with huge bunches of weeds (Fig. 2) and several weeds are present altogether throughout the pond. From the Fig. 5 it is quiet clear that there are some debries of organic nutrients just at the visible depth.These weeds are having their high level of nutrients from these heap of garbages

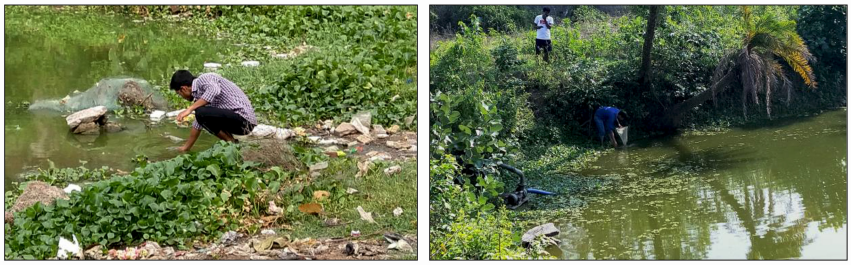

Fig. 2. Ponds with algal bloom.

Fig. 3. Ponds with red tide and algal bloom.

Fig. 4. Ponds with red tide.

of organic composts and inorganic fertilizers. High level of dissolved oxygen are consumed by the these weeds. This is not suitable for the survival of fishes.

From Fig. 8 and Table 2, it is also evident that the pond of Sahana pally is almost of square shaped. Water is moderately turbid. No remarkable number of planktons were noticed (Fig. 3). This pond is not well maintained for fishing point of view. The household activities are carried out here. As chemical wastes nutrients, primarily nitrogen and phosphorus are accumulated in the pond from the human wastes and fertilizers. As a result bacteria grows rapidly, most of the time they are cyanobacteria and causes algal bloom in the pond (Sharma et al. 2010). This cyanobacteria uses up the dissolve oxygen (DO), as a result the DO level declines. Therefore several fishes and aquatic organisms those are depending on oxygen may not survive and the outcomes are turned into dead zone.

From Fig. 9 and Table 2, we can see the Kankata pond is almost of trapezium shape. Fishing activities are very rare in this pond. Water is turbid. In this

Fig. 5. Eutrophic pond (several weeds are seen at the bottom layer of the pond).

Fig. 6. Very less production of fishes in Sahanapally, Bankura.

Fig. 7. Satellite view and physical view of Eutrophic pond beside Lokepur eye hospital, Bankura.

pond we can see it in a special condition called red tides or harmfull algal bloom. Algal blooms are in large concentration of aquatic microorganisms such protozoan and unicellular algae such as dianoflagellates and diatoms. The zooplanktons mainly *Euglena sanguinea* (Fig.12) which cause red tides in freshwater ecosystem like pond of Kankata. They contain photosynthetic pigments that vary in colors from brown to red and color of water depends upon these color pigments. They also produce toxic substances that affect both aquatic vertebrates (mainly fish) and invertebrates.

CONCLUSION

The effects of Eutrophication, algal bloom and red tide formation are directly correlated with fishery

Fig. 8. Satellite view and physical view of pond no. 3 at Sahanapally, Bankura (algal bloom pond).

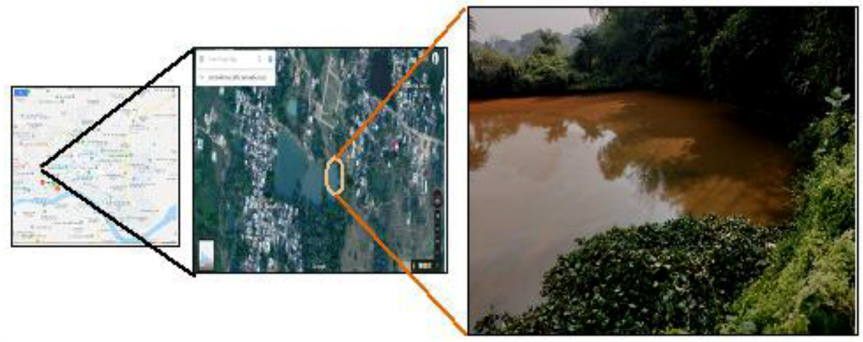

Fig. 9. Satellite view and physical view of algal bloom pond no. 3 in Kankata, Bankura (red tides).

potentiality. Due to this reasons the rate of fish production and species diversity both decreases. So it is necessary to maintain the ponds in proper way for fish production and species diversity.

Table 2. The physico-chemical and hydro-biological parameters of 17 different types of productive ponds of Bankura district of WB, India for six months from October, 2018 to March, 2019. The values of different physico-chemical parameters are Mean ±SE where N=12.

Sampling sites→ Parameters observed↓	Pond in Lokepur eye hospital (Eutriphied)	Pond in Sahanapally (algal bloom)	Pond in Kankata Bankura (red tides)	BSI standard
Shape of the pond	Almost of rectangular shape	Almost of square shape	Almost of trapezium shape	.....
Latitude	23°13′43.7′′N	23°23′56.3′′N	23°22′62′′N	.....
Longitude	87°02′41.1′′E	87°04′44.9′′E	87°05′19′′E	.....
Air temp (°C)	20 ± 1.2	21 ± 1.1	21 ± 1.4	.....
Water temp (°C)	16 ± 1.6	15 ± 1.8	16 ± 1.5	<40°C
pH	7.87 ± 0.68	7.33 ± 0.71	6.14 ± 0.54	6.5-8.2
Dissolved O_2 (mg/L)	4.60 ± 0.56	5.00 ± 0.25	2.64 ± 0.79	Up to 6.0
Free CO_2 (mg/L)	360 ± 26.5	365 ± 23.8	372 ± 28.1	.....
Dissolved CO_2 (mg /L)	355 ± 38.2	330 ± 34.6	405 ± 38.6	.....
Qualitative analysis of plankton	Zooplanktons observed there but not up to that mark	Phytoplankton huge in number and very little zooplankton observed	Protozoan and unicellular algae such as dianoflagellates and diatoms are observed	.....

Fig. 10. Clear and algal bloomed pond water collected in glass containers of plankton net.

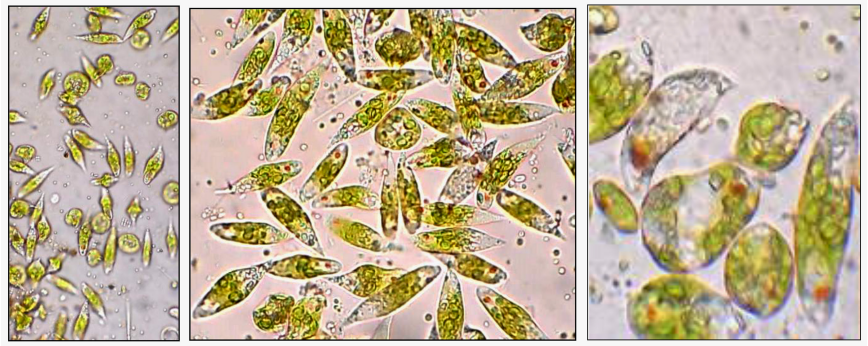

Figure 11a **Figure 11b** **Figure 11c**

Fig. 11. High density of *Euglena viridis* found in ponds with algal bloom (Figs. 11a,11b and 11c in 100x, 400x & 1000x zoom respectively).

The planktonic algal community is largely influenced by the interaction of a number of physico-chemical and biological factors. Moreover, the amount of organic matter in bottom soil of the pond strongly influences water quality and concentration of nutrients available to algae. Although, algal bloom and Eutrophication indicates high productivity of bacteria, weeds and plants in the water body concerned but excessive algal bloom causes serious economic loss to aquaculture. Algal bloom often create water quality problems, the most severe of which being the oxygen depletion leading to mass mortality of fish. Furthermore, bloom of these algae has a blanketing effect on the fish pond, thereby preventing the penetration of sunlight into water that affects the growth of beneficial algae through hampering their photosynthesis and continuously decreasing the diversity of the aquatic organism along with fishes.

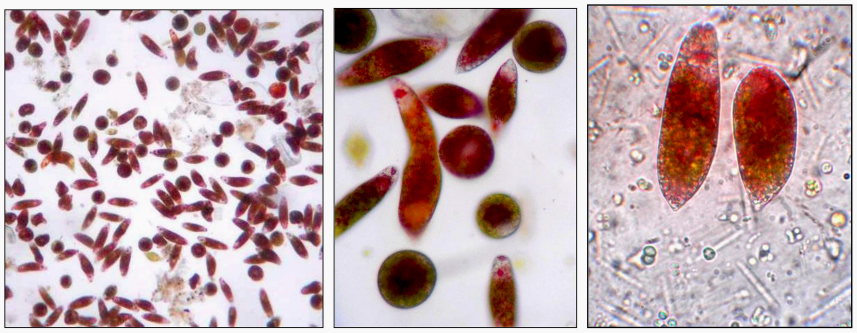

Figure 12a **Figure 12b** **Figure 12c**

Fig. 12. High density of *Euglena sanguinea* cause for the toxic effect in the red tide (Figs. 12a, 12b and 12c in 100x, 400x & 1000x zoom respectively).

Management of water bodies like ponds essentially requires an understanding of physico-chemical and biological conditions. The aquatic environment is an area controlled by the changes in factors such as light, heat, humidity and contamination of various effluents in the water body. It can also be said that the overall productivity of a water body is directly regulated by physico-chemical as well as by biological parameters. A healthy bloom also provides proper turbidity and subsequently stabilizes shrimp and reduces cannibalism. It decreases loss of temperature in winter and stabilizes water temperature. A suitable phytoplankton population enriches the systems with oxygen through photosynthesis during day light hours and lowers the levels of carbon dioxide, ammonia, nitrite, hydrogen sulfide, methane.

If the ponds are manured in a proper way by using sludge and other materials, the physico-chemical factors can be regulated which will ultimately lead to a positive change in hydro-biological factors . As a results Eutrophication, algal bloom and red tide formation can be controlled. Along with more intensive study is needed to make the ponds of Bankura town more productive.

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