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Fresh water planktonic algae from oligotrophic habitat of West Bengal with special remarks on taxonomy and ecology

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Abstract

Aim : Taxonomic analysis of fresh water phytoplankton based on bright field microscopy and SEM studies is yet to be done in depth that may elucidate a number of new taxa. The present study on the assemblage of fresh water phytoplankton is focused to interpret the ecological condition of the studied water body of Bankura District in West Bengal.

Methodology : Phytoplankton samples were collected from water bodies of Bankura District, West Bengal during the winter season. Planktonic algal taxa were analyzed using Scanning Electron Microscopy after preliminary observations made under Bright Field Microscopy. Qualitative and quantitative analyses of the phytoplankton were done for accurate taxonomic assignment of the taxa and interpretation of ecological perspectives.

Results : The qualitative analysis revealed an assemblage of phytoplankton that includes ten taxa. In the present assemblage, euglenophytes are represented by only one species, whereas, five species of desmids belonging to three genera and four species of diatoms belonging to four genera have been identified and illustrated. Quantitatively amongst the different groups of phytoplankton, desmids are dominant (57%) followed by diatoms (40%) with a minor representation of euglenophytes (3%).

Interpretation : The qualitative and quantitative analyses of the phytoplankton assemblage indicate an oligotrophic condition.

Introduction

Owing to the existence of a great variety of geological, topographical, ecological and micro-climatic conditions, the Indian sub-continent is remarkably rich in its water resources. In India, there are large number of natural pools and ponds at different geographical locations in different altitudes having variable climatic conditions. Studies on fresh water algae are mainly focused to the algal biodiversity. Extensive study concerning various aquatic habitats and its ecological perspectives has not been carried out in depth. Organisms living in aquatic habitats are one of the most reliable indicators of water quality. In view of this, observation on the algal flora in aquatic habitat are needed for the study of water quality because these organisms can be used as indicators of water pollution. Though studies on fresh water planktonic algae, specifically diatoms have been carried out from different regions of India (Senthikumar and Sivakumar, 2008; Karthick *et al.*, 2013), some areas are still unexplored. Planktonic algae viz., desmids and diatoms significantly contribute towards the maintenance of water quality. In recent years, biodiversity in freshwater environments are receiving unique attractions as the issues related to biodiversity in aquatic ecosystem has been incorporated in the programme of UNESCO and the International Union of Biological Sciences. Identification of the phytoplankton can be done by light microscopic study. However, for proper identification and Scanning Electron Microscopic (SEM) studies are essential. Otherwise, wrong identification of the taxa may lead to erroneous environmental interpretations. In India, SEM studies on fresh water phytoplankton have been done very sparingly (Vidyavati, 1995; Senthikumar and Sivakumar, 2008; Karthick and Kociolek, 2011; Keshri *et al.*, 2016; Roy and Keshri, 2016). During the present investigation, the authors recorded a number of fresh water planktonic algae from the Bankura District of West Bengal; those have been studied under SEM. Some of the reported taxa were not known earlier from India or as a new record from the state of West Bengal. The present study is aimed to interpret the habitat and ecological condition of fresh water planktonic algae with remarks on the taxonomic analysis.

Materials and Methods

Bankura District in the state of West Bengal is the connecting link between the plains of Bengal on the east and Chotanagpur plateau on the west. The district is situated between 22° 38' and 23° 38' N and between 86° 36' and 87° 46' E. The climate, especially in the upland tracts to the west is much drier than in eastern or southern Bengal. From the beginning of March to early June, hot westerly winds prevail, and the temperature rise around 45°C. The monsoon season (during June to September) is comparatively pleasant. It has been recorded that the total average rainfall is about 1,400 mm. During the winter months (*i.e.*, December to January) the temperature drops down to below 27°C.

The samples of phytoplankton were collected in the winter months (January-February) in two successive years from different ponds of Kotulpur area of Bankura District, West Bengal (Fig. 1). The techniques modified after Krammer and Lange-Bertalot (2000) was followed for processing of the samples. One part of the sample was preserved in 5% formalin prepared from paraformaldehyde crystals and another part was preserved in 70% ethanol for diatom preservation. Sub-samples (preserved in 70% ethanol) were cleaned using 30% hydrogen peroxide. The organic coating was removed and the clean samples were then repeatedly centrifuged at 3000-3200 rpm and alternatively rinsed with distilled water for 3-4 times. Using standard protocol, microscopic slides were prepared. Bright-field microscopic study was carried out for preliminary identification and qualitative analysis. Systematic descriptions and identification of the planktonic algae have been done using standard monographs and available literature. Phytoplankton cell counts from the composite samples were performed using a Sedgewick-Rafter cell counter for quantitative analysis. Phytoplankton abundance was deduced based on the counting of 200 specimens. Quantitative analysis of the recorded taxa was also carried out using Microsoft Excel 2007. For SEM studies the samples were fixed in 2.5% glutaraldehyde and 0.1% phosphate buffered saline (PBS) for 2 hours. Later on, the samples were rinsed with PBS for 10 minutes and dehydrated in a graded series of alcohols. Subsequently they were placed in 100% acetone and dried. Specimens were then coated with gold. Photographs of detailed morphological structures were taken using LEO 430 Scanning Electron Microscope (SEM) using accelerating voltage of 15 KV and a working distance of 24-34 nm at Birbal Sahni Institute of Palaeosciences, Lucknow.

Results and Discussion

Qualitative analysis of the phytoplankton under bright field microscopy and SEM reveals the occurrence of three important groups of phytoplankton *i.e.*, Euglenophyta, Chlorophyta and Bacillariophyta.

The Euglenophyta is represented by a solitary taxon *Trachelomonas klebsii* Deflandre (Fig. 2A). It is characterized by oval lorica, broadly rounded, punctate and densely covered with short spines, apical pore surrounded by a ring like thickening. It measures 24 µm in diameter and 40 µm in length. The taxon is distributed in Gujarat (Kamat, 1961) and Maharashtra (Kamat, 1968, 1975), however, it is reported for the first time from West Bengal.

The chlorophytes belonging to Order Zygnematales (Family Desmidiaceae) includes three species of the genus *Cosmarium* and one species each of the genera *Haplotaenium* and *Euastrum*.

The diagnostic features of *Cosmarium quadrum* Lundell var. *sublatum* (Nordstedt) West et. West (Fig. 3A) are: cells

Fig. 1 : Map showing the study area and sampling site in Bankura District of West Bengal State, India

slightly longer than broad, median constriction deep, sinus linear; semi-cells rectangular, apex slightly retuse; cell wall with densely and regularly arranged granules; in between the granules number of pores present, measuring 36-45 μm broad, 42-50 μm long and isthmus 10-12 μm . This is the first report of the taxon from India and it is common in the present assemblage.

Cosmarium pakistanicum Islam (Fig. 2F) is characterised by cells having dimension two times longer than broad, median constriction deep, semi-cells elliptic, apex round, wall with puncta, measuring 56-70 μm broad and 90-120 μm long, apex 30 μm , isthmus 42-45 μm . This species of the genus *Cosmarium* is reported here for the first time from India.

The significant taxonomic features of *Cosmarium connatum* (Bréb.) Ralfs (Fig. 2B) are: cell length greater than width; median constriction shallow, sinus widely open, semi-cells sub-elliptic, apex slightly flattened; poles rounded, smooth walled, dimension: 42-47 μm in breadth and 65-73 μm in length, isthmus 36-39 μm . This species is widely distributed in Maharashtra (Freitas and Kamat, 1979), Madhya Pradesh (Agarkar *et al.*, 1979), Andaman and Nicobar Islands (Prasad and Misra, 1992), Kerala (Sindhu and Panikkar, 1995), Sikkim and West Bengal (Santra and Pal, 2006).

The genus *Haplotaenium* of family Desmidiaceae is represented by *H. minutum* (Ralfs) Bando (Fig. 2H). Its important identifying characters are: cells cylindrical, straight, slender, more than eight times longer than breadth; median incision shallow, poles truncate, apices without tubercles; semi-cells with single basal inflation, chloroplast single, axial, pyrenoids many in linear pattern, cells measure 70-80 μm long and 3-6 μm broad, apex 4-5 μm in width. This is comparatively a rare taxon and this species of genus *Haplotaenium* is the first report from India.

Euastrum inerme (Ralfs) Lund. var. *depressum* Wolle (Fig. 2C) belonging to family Desmidiaceae possesses small cells, which are broadly oval in outline, semi-cells truncate, pyramidal to semi-oval in outline, converging lateral margins with conspicuous undulation halfway to the apex, apex more or less truncate with a very short median incision, cells 16-20 μm broad and 22-28 μm long. This species was not known earlier from India.

The diatoms (Bacillariophyta) belonging to the Order Pennales includes four species of the genera *Encyonema*, *Stenopterobia*, *Brachysira* and *Ulnaria*.

Encyonema neogratile Krammer (Fig. 2G) is characterized by asymmetrical valves, semi-lanceolate, strongly

Fig. 2 : SEM photomicrographs for morphological structure of fresh water phytoplankton (A) *Trachelomonas klebsii* Deflandre (B) *Cosmarium connatum* (Bréb.) Ralfs (C) *Euastrum inerme* (Ralfs) Lund. var. *depressum* Wolle (D-E) *Ulnaria ulna* (Nitzsch) Compère (F) *Cosmarium pakistanicum* Islam (G) *Encyonema neogracile* Krammer (H) *Haplotaenium minutum* (Ralfs) Bando

dorsiventral, dorsal margin convex and more or less straight ventral margin, apex of valve bluntly rounded, 27-33 μm long and 5.66-6.25 μm wide; raphe thin and straight, axial area narrow and linear, central area small, asymmetrical, larger on the dorsal side; striae parallel to somewhat radial. Its distribution is mainly confined to Maharashtra (Gandhi, 1960) and Assam (Phukan and

Bora, 2012; Buragohain *et al.*, 2012). This is the first report of the taxon from West Bengal as well as from eastern India.

Important taxonomic features of *Stenopterobia sigmatella* (Gregory) Ross (Fig. 3B-C) are: sigmoid solitary cells with elongated valves, end portion gradually becomes narrow

Fig. 3: SEM photomicrographs for morphological structure of fresh water phytoplankton- (A) *Cosmarium quadrum* Lundell var. *sublatum* (Nordstedt) West et. West (B-C) *Stenopterobia sigmatella* (Gregory) Ross (D-E) *Brachysira microcephala* (Grunow) Compère.

with bluntly rounded apex, 30-32 μm long and 3-4 μm wide, slight undulation found in valve face, fibulate raphe system found, fibulae are formed partially by the infolding and fusion of parts of valve face with mantle, striae delicate, multiseriate, pseudoraphe present. *Stenopterobia sigmatella* occurs in brackish water and epipelagic freshwater habitats, however, Desikachary (1989) reported this species from Indian Ocean. This species is hereby recorded for the first time from freshwater habitat of India.

The diatom taxon *Brachysira microcephala* (Grunow) Compère (Fig. 3D-E) is distinguishable by rhombic to lanceolate valves with protracted apices, measuring 15.6-19.17 μm long and 3.8-4.32 μm wide; axial area narrow and straight; central area small; striae are radiate near the central region and parallel near apices, stria density is 25-27 in 10 μm ; straight raphe was placed in between two ribs that lie on the external face of the valve. It is distributed in different parts of peninsular India (Karthick et al., 2013), though, it was not known earlier from eastern India as well as from West Bengal.

Distinguishing features of *Ulnaria ulna* (Nitzsch) Compère (Fig. 2D-E) are: valves solitary, linear, much elongated, gradually attenuated to the rostrate ends, pseudoraphe distinct, narrow, widening towards centre; central area quadrangular having small lineate striae on both margins, length 80-100 μm and width 5 to 6 μm , distribution of striae 12-15 in 10 μm . This is a commonly occurring species of diatom distributed in different regions of India (Roy and Keshri, 2016). Its presence in the presently analyzed phytoplankton assemblage is more or less common.

Quantitative analysis carried out in the present study reveals that amongst the different groups of phytoplankton desmids are dominant (57%), followed by diatoms (40%). The euglenophytes are very poorly represented (3%) by a solitary species i.e., *Trachelomonas klebsii*. The genus *Cosmarium* is most preponderant in the assemblage and is represented by three species, out of which *Cosmarium quadrum* var. *sublatum* that constitutes 13.65% of the total phytoplankton assemblage. However, frequency of occurrence of the desmid taxon *Euastrum inerme* var. *depressum* is most dominant (15.60%) amongst all the phytoplankton in the present assemblage. Diatoms are represented by four species out of which *Encyonema neogracile* is the most frequently occurring form (13.17%).

As evident from this study, desmids are the dominant group of phytoplankton followed by diatoms and euglenophytes. This signifies the oligotrophic condition, since desmids prefer to grow in oligotrophic waters (Shashikanth and Anand, 1978). Similarly, the presence of particular diatom taxa viz., *Stenopterobia sigmatella*, *Brachysira microcephala* is also indicative of an oligotrophic condition (Bellinger and Sigeo, 2015; Faustino et al., 2016). The euglenophyte taxon *Trachelomonas klebsii* recorded in the present assemblage is

found in low frequency. The species was reported for the first time from West Bengal and eastern India. Euglenophytes typically grow in eutrophic water and they are often considered as bioindicators of water contamination (Starmach, 1983; Wołowski, 2011), however, in the present study, a non-pollution indicating taxon *Trachelomonas klebsii* has been observed in oligotrophic waters with good cosmos of desmids and diatoms. Although this specific euglenophyte is unpolluted in nature, the presence of euglenophytes may lead to the mesotrophic condition.

In the present assemblage, some of the taxa are common to India and specifically from West Bengal. However, some of the taxa are new to this part of eastern India as well as West Bengal (e.g., *Trachelomonas klebsii* Deflandre, *Encyonema neogracile* Krammer and *Brachysira microcephala* (Grunow) Compère). From India *Cosmarium quadrum* Lundell var. *sublatum* (Nordstedt) West et. West, *Cosmarium pakistanicum* Islam, *Haplotaenium minutum* (Ralfs) Bando and *Euastrum inerme* (Ralfs) Lund. var. *depressum* Wolle have been recorded here for the first time. Quantitatively amongst the diatoms, *Encyonema neogracile* Krammer and *Ulnaria ulna* (Nitzsch) Compère are commonly occurring, whereas, *Brachysira microcephala* (Grunow) Compère is comparatively less in abundance. Amongst all the diatoms *Stenopterobia sigmatella* (Gregory) Ross is rare and reported for the first time from freshwater habitat. The desmids are represented by five taxa out of which, *Euastrum inerme* (Ralfs) Lund. var. *depressum* Wolle and *Cosmarium quadrum* Lundell var. *sublatum* (Nordstedt) West et. West are dominant, whereas, other taxa viz., *Cosmarium connatum* (Bréb.) Ralfs, *Cosmarium pakistanicum* Islam and *Haplotaenium minutum* (Ralfs) Bando are more or less common.

The species richness, as well as dominance of desmids is indicative of a low nutrient condition (Tiseer et al., 2008). In fresh water environments where the ionic composition is reduced, population of desmids becomes more preponderant (Kadiri, 1996, 1999; Nwankwo, 1996). In dry season when precipitation is low, the presence of more number of species of desmids and diatoms in a water body is common (Whitton et al., 1991). Samples for the present study were collected during the winter season, and apparently during this season dry condition prevails, and precipitation becomes weak. Thus, the present phytoplankton assemblage clearly indicates an oligotrophic state as it is dominated by desmids and some characteristic diatoms which prefer to grow in oligotrophic waters. The planktonic assemblage recovered in this study is very fascinating from both taxonomic and ecological point of view. It is very significant because many rare diatoms have been recorded in this analysis. It represents a long undistributed geological history of the area that is supported by suitable habitats for speciation.

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