First Report on the Cyanobacteria *Spirulina platensis* bloom and its effect on the physico-chemical parameters, at Muttukadu backwater, Southeast coast of India

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**Abstract**

Present study is the first registration of a bloom of the *Spirulina platensis* in the Muttukadu estuary, Tamilnadu, southeast coast of India. The plankton samples were collected from the Muttukadu estuary during January 2014 to June-2014 in three stations by phytoplankton net. The water samples were collected in the sterilized plastic bottles for the analysis of physico-chemical parameters. We confirmed the presence of *Spirulina platensis* bloom in Muttukadu estuary. The density of *Spirulina platensis* was reported an average of 4.1x10^7, 5.5x10^7 and 4.7x10^7 cells/l respectively. The pH ranged between 7.11 and 8.42 in all three stations. The dissolved oxygen ranged from 4.19 to 7.54 ml/l and salinity between 1.02 and 7.32 ppt. Silicate and nitrate levels were very high when compared to other nutrients. Muttukadu estuary is highly polluted due to discharges from the households, industries and tourism activity carried out on the bank of the Muttukadu backwater. This study showed the presence of *Spirulina platensis* bloom in the Muttukadu backwater.

**Keywords:** Muttukadu, Bloom, *Spirulina Platensis*, Nutrients, Phytoplankton

**Introduction**

Occurrence of cyanobacterial blooms is a worldwide phenomenon affecting the aquatic ecosystem (Sivonen 1996). *Spirulina* bloom typically thrives in the warm, turbid and slow moving waters. Blooms with the highest biomass occur in waters rich in nitrogen and phosphorous. The southeast coast of India is an important stretch of coastline, where many major rivers consume into the Bay of Bengal and they are also more affluent in marine fauna and flora (Rajkumar et al. 2011). Muttukadu backwater form a complex ecosystem of shallow estuarine network spread over an area of 217.98 acres (87.190 hectares) meant for fishing and boating activities. The backwater extends to north and southwards for about 15 Km and opens into the Bay of Bengal at its eastern end. The bar mouth acts as a barrier and the sea water infiltrates into the land which is the major resource for the prawn hatcheries mostly situated in this area (Bharathi and Ramanibai 2012). Estuaries, the major contributor of fisheries in India suffer from severe damage which receive large amount of contaminants due to enlarged industrialization and urbanization along the coastal areas by continuous discharge of domestic sewage and industrial effluents. Muttukadu backwaters are highly polluted by the household and industrial discharges. Overfilling of the estuaries with contaminants for a longer period of time has resulted in the significant buildup of pollutants with a resulting impact on water quality (Padmini et al. 2004). Santhanam et al. (2014), reported the first intensive *Microsystis aeruginosa* bloom in Muttukadu backwaters. Paramisivam and Kannan (2005) reported that factors similar to water quality such as temperature, pH, salinity, dissolved oxygen, total organic carbon and nutrients are particularly essential for determining the biota and ecosystem functions in coastal waters. Several reports are available on the occurrence of algal bloom in marine and brackish waters (Prescott 1954; Selvakumar and Sundararaman 2007; Reginald 2007; Velankar and Chaugule 2007). This paper documents the first occurrence of an algal bloom of *Spirulina platensis* in Muttukadu backwater, southeast coast of India.

**Materials and Methods:**

**Description of the study area**

Muttukadu backwater (near south Chennai/Tamil Nadu) (Lat. 12° 49’ N; Long. 80° 15’ E) extends for a distance of 20 km from the mouth of the estuary as shown in Figure. 1. The backwater runs at right angle to the coast for a distance of about 3 km and branches into southern and northern wings. The backwater is connected to the sea by a bar built mouth, the width of which is variable from a few meters to 200 m in different months. The backwater is normally cut off from the monsoon period and rest of the period sand bar is formed due to inundation by the fresh water from the upper reaches, the sand bar gets eroded and the connection with the sea is restored.
Collection of Plankton

Surface water was green with floating layers of green scum as shown in Figure 2. Plankton samples were collected using a Plankton net. The plankton net is made up of boiling silk cloth no 30, mesh size 48 µm and mouth diameter of 0.35 m. The net is submerged in the surface water and towed horizontally from a mechanized boat with an outboard engine at a speed of 01 – 02 knots/hour. The collected plankton samples were fixed with 5% formaldehyde solution in the field itself. For the identification of species, 1-2 drops of sample were put on a slide, covered with a cover glass and examined under light microscope followed by the method (Subrahmanyan1946; Venkataraman 1939; Steidinger 1970). Eukaryotic phytoplankton cell counter were performed on Sedgewick- rafter counting slide (Guillard 1978).

Analysis of water samples for physico-chemical properties

The temperature was measured using a standard Celsius Thermometer. Salinity was estimated with the help of a Hand Refractrometer. pH was measured by the ELICO grip pH meter. Dissolved Oxygen (DO) was estimated by the Winkler’s method. Water samples were collected in clean polyethylene bottles, which were kept immediately in an ice box and then transported to the laboratory for the analysis of nutrients. The collected water samples were filtered using a Millipore Vacuum Filtration system and analyzed for dissolved inorganic nitrate, nitrite,
Spirulina platensis bloom was observed in the water samples as shown in Figure 3. *Spirulina platensis* was dominated 98% of the total phytoplankton density during bloom (Figure 4). *Spirulina platensis* blooms were recorded in following months are January, February, March, April, May and June-2013 (Figure 5). During the study period, in station-I, the *Spirulina platensis* cell density varied between 4.1x10⁷ Cells/L to 2.7x10⁷ Cells/L. The Highest cell density of *Spirulina platensis* was recorded during the summer season (May) and the lowest cell density of *Spirulina platensis* was recorded during Post-monsoon season (February). In station-II, the *Spirulina platensis* cell density varied between 5.5x10⁷ Cells/L to 2.3x10⁷ Cells/L. Highest cell density was recorded during the summer season (May) and the lowest cell density was recorded during Post-monsoon (March). In station-III, *Spirulina platensis* cell density varied between 4.7x10⁷ Cells/L to 2.1x10⁷ Cells/L. Highest cell density was recorded during the summer season (May) and the lowest cell density were recorded during Post-monsoon (February). Physico-chemical variables were measured from surface water during the bloom occurrence were given in the Figure 6,7,8. Water in this region was green colored, slimy in nature with foul smell as shown in Figure 9 and 10. This coloration in Muttukadu backwater was established due to the presence of large concentration of *Spirulina platensis* bloom. The *Spirulina* bloom normally decreases the dissolved oxygen concentration of the water. The oxygen deficiency could lead to the fish mortality.
Spirulina platensis bloom at Muttukadu backwater, Southeast coast of India

Figure 6: During Study period the Physico-Chemical Parameter in the Muttukadu Backwater in Station-1

Figure 7: During Study period the Physico-Chemical Parameter in the Muttukadu Backwater in Station-2

Figure 8: During Study period the Physico-Chemical Parameter in the Muttukadu Backwater in Station-3
Atmospheric temperature was varied from 36.3°C to 27.5°C. A minimum (27.5°C) and maximum (36.3°C) was recorded in all three stations in January and May respectively. Surface water temperature was varied from 35.4°C to 26.5°C. A minimum (26.5°C) and maximum (35.4°C) was recorded in station 3 and station 2 in the months of January and May respectively.

Salinity varied from 1.02 to 7.32 ppt. The highest salinity of 7.32 ppt was observed in station 1 during the month of January and the lowest 1.02 ppt was observed in station 2 during the month of April in all the three stations.
pH was 8.42 at station 1 was recorded in the month of January and the lowest 7.11 at station 1 was recorded in the month of March. During the study period DO values varied between 4.19 mg L\(^{-1}\) to 7.54 mg L\(^{-1}\). Highest DO was recorded at station 2 in the month of June and the lowest was recorded at station 1 in the Nitrite. N was varied from 9.11 μ mol L\(^{-1}\) to 4.65 μ mol L\(^{-1}\). Maximum was recorded in station-1 (9.11 μ mol L\(^{-1}\)) in the month of May. Minimum was recorded in station-3 (4.65 μ mol L\(^{-1}\)) in the month of June. Nitrate - N was recorded from 20.11 to 8.95. Maximum 20.11 was observed in station-1 in the months of May. Minimum 8.95 was recorded in station-3 in the month of February. Phosphate- P was varied from 9.23 μ mol L\(^{-1}\) to 2.65 μ mol L\(^{-1}\). Maximum was recorded in station-2 (9.23 μ mol L\(^{-1}\)) in the month of May. Minimum was recorded in station-2 (2.65 μ mol L\(^{-1}\)) in the month of January. Silicate was varied from 121.54 μ mol L\(^{-1}\) to 54.26 μ mol L\(^{-1}\). Maximum was recorded in station-1 (121.54 μ mol L\(^{-1}\)) in the month of May. Minimum was recorded in station-3 (54.26 μ mol L\(^{-1}\)) in the month of January. Ammonia was recorded from 20.15 to 7.14 μ mol L\(^{-1}\). Maximum was recorded in station-1 (20.15 μ mol L\(^{-1}\)) in the month of May. Minimum was recorded at station-2 (7.14 μ mol L\(^{-1}\)) in the month of January.

Discussion

High level of urbanization and large amount of discharges from domestic and factories located along the bank of Muttukadu estuary affects the water quality of the Muttukadu backwater. Due to this, high level of nutrients accelerates the eutrophication process of this region. The nutrient concentration in surface water receiving high solar radiation can influence the abundance of phytoplankton. This is increase the phosphorous content of the surface water. This could be the reason for a bloom of the cyanobacterium *Spirulina platensis* during this period as proposed by earlier works (Yoshinaga 2006). In this present investigation, the *Spirulina* bloom was observed when the temperature was higher; this is supported by (Murrell & Lores 2004) who stated cyanobacteria dominance often occurs when temperature rises above 20°C. This pattern also occurs in subtropical waters, including coastal. During daylight hours the photosynthesis activities of the micro algae produces high level of oxygen of the highly dense algal bloom respiration. Thus the Dissolved oxygen concentrate was found to higher during the active bloom day. Salinity has been found to be another important factor influencing the cyanobacterial bloom (Blackburn 1996; Hobson 1999), although many species are also capable of grow and bloom over a wide range of salinities (Reed & Stewart, 1988). A standard Secchi Disc was used to determine water transparency. *Spirulina* bloom reduced water transparency through highly dense algal biomass. In this present study, inorganic nutrients, especially nitrate and phosphate, are key indicators of water quality in aquatic environment. Nitrate is highly soluble and leaches readily from the soil and when nitrate is readily available in waterways it can contribute to harmful algal bloom. Phosphate concentration also high in bloom days it may be due to the decomposition by microbial process as reported earlier (Raghuprasad and Jayaraman 1954; SubbaRao 1969; Sahayak et al. 2005). On the day of highest cell density, ammonia concentration was high which might be due to the high demineralization ability of Cyanobacteria to produce ammonia through the process of nitrogen fixation (Chang et al. 2000). Due to the presence of high ammonia or oxygen deficiency may result in fish mortality. The excessive nutrient load can cause rapid growth of algal populations called bloom, when we can easily see patches of algae in the water. Since the Muttukadu estuary is a bar built one, no seawater inundation has been recorded during the bloom time due to the bar mouth closing. In the present study, station-I got intensive bloom when compared to Station-II and Station-III during the Present study. This is because, the domestic and industrial sewages are routinely get discharged near to station-I and also the waters of Station-II and III get connected in Station-I. High level of nutrient loads naturally enhances the over-growth of Cyanobacteria to form bloom. It is well known that the stagnant condition resulting lack of flow of water and high level domestic and industrial discharges might have supported large density of *Spirulina platensis* which occupied around 98% of the biomass. Muttukadu backwater must be monitored regularly for biodiversity conservation and human health concern.

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References


