First report on the intense cyanobacteria *Microcystis aeruginosa* Kützing, 1846 bloom at Muttukkadu Backwater, Southeast coast of India

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Present study consists an intense *Microcystis aeruginosa* bloom was reported in Muttukadu backwater on 1st June 2012. Density of *M. aeruginosa* was reported an average of 6×10^8/L. Muttukadu backwater is highly polluted due to discharges from households and industries located along the banks of the estuary. The effect of pollution was reflected on microalgae abundance in the sewage-fed area. This study showed that the *M. aeruginosa* bloom has caused severe fish mass mortality attributed to the toxic effects exerted by this cyanobacteria bloom.

[**Key words:** Cyanobacteria, *Microcystis aeruginosa*, Bloom, Fish kill]

**Introduction**

The occurrence of blue green algae blooms is a global problem affecting the aquatic ecosystems\(^1\). *Microcystis aeruginosa* is one of the most cosmopolitan species among the planktonic cyanobacteria. *Microcystis* blooms typically thrive in warm, turbid, and slow-moving waters. Blooms with the highest biomass occur in waters that are high in nitrogen or phosphorus (eutrophic waters). *Microcystis* also requires sufficient light intensity to conduct photosynthesis, which results in blooms. This alga is capable of producing a hepatotoxin ‘microcystin’ which in high concentrations could be fatal to humans, finfish, shellfish, birds, and pets. Ingestion of significant levels of the toxin microcystin can cause liver damage and dysfunction in humans and animals. No deaths from ingestion of microcystins have been reported so far in humans. However, dogs, wildlife and livestock have died following exposure to this toxin. The growth of *Microcystis* produces bad odour and unsightly scum, preventing recreational use of water bodies, hampering the treatment of water for drinking, and clogging irrigation pipe\(^2\). *Microcystis aeruginosa* occur in fresh to moderately brackish water, often forming dense blooms in mid-to late summer and fall to the bottom sediments in autumn\(^3\). It is particularly problematic in large lakes and aquaculture ponds where it affects not only the aesthetic appearance, but also the fish production\(^4\). Under such conditions the productivity of zooplankton, and thereby fish, is reduced. Many studies have demonstrated the effect of *Microcystis* or its toxins on zooplankton growth and survival\(^5,6\). *Microcystis* can affect phytoplankton community composition through allelopathy\(^7\). Toxin producing cyanobacteria in lakes and reservoirs form a threat to humans, birds and fishes as well as various other forms of aquatic life. Freshwater systems have become serious water quality problems which also threaten human and animal health\(^8,9\).

A number of publications are available on the occurrence of algae in marine and brackish waters\(^10-13\). This paper documents the first occurrence of a harmful algal bloom of the colonial form of *Microcystis aeruginosa* in Muttukadu backwater, southeast coast of India on June 2012.

**Materials and Methods**

**Description of the study area**

Muttukadu backwater (Lat. 12° 49' N; Long. 80° 15' E) extends for a distance of 20 km from the mouth. This backwater is normally cut off from the sea during May-September when a sand bar is formed.
During October-December, due to inundation by the freshwater from the upper reaches, the sand bar gets eroded and the connection with the sea is restored. The width of the estuary ranges from 800 m to 1050 m. This estuary is shallow, the maximum depth being 2m, in the middle of the channel, while in most of the area; it is 1 m or less.

Temperature was measured using a standard Celsius Thermometer. Salinity was estimated with the help of a Hand Refractometer (ATAGO, Japan). pH was measured using a ELICO Grip pH meter. Dissolved Oxygen was estimated by the modified Winkler’s method and Chlorophyll-α were estimated using spectrophotometer followed by Acetone method and is expressed in mg m⁻³. Surface water samples were collected in clean polyethylene bottles for the analysis of nutrients, which were kept immediately in an ice box, and then transported to the laboratory. The collected water samples were filtered using a Millipore Vacuum Filtration system and analyzed for dissolved inorganic nitrate, nitrite, phosphate, reactive silicate and ammonia adopting the standard procedures and expressed in imol l⁻¹. Surface water was green with floating layers of green scum (Plate 2), spreading in an area of around 2 km² in the Muttukadu estuary. Plankton samples were collected using IOE standard plankton net (mesh size, 40ìm) at the surface layers. 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. Detailed analysis of the samples revealed that the discoloration was due to *Microcystis aeruginosa*. Eukaryotic phytoplankton cell counts were performed on Sedgewick-Rafter Counting Slide. Physico-chemical characteristics of the bloom area were given in Table 1. During the bloom the mass mortality of fin fishes was observed (Plate 2).

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### Table 1—Physico-chemical and biological characteristics of Muttukadu Backwater

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmospheric temperature (ºC)</td>
<td>32</td>
</tr>
<tr>
<td>Surface water temperature (ºC)</td>
<td>30</td>
</tr>
<tr>
<td>Salinity (ppt)</td>
<td>0</td>
</tr>
<tr>
<td>pH</td>
<td>8.7</td>
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<tr>
<td>Transparency (cm)</td>
<td>0</td>
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<tr>
<td>Dissolved Oxygen (mg l⁻¹)</td>
<td>6.28</td>
</tr>
<tr>
<td>Nitrate (imol l⁻¹)</td>
<td>3.55</td>
</tr>
<tr>
<td>Nitrite(imol l⁻¹)</td>
<td>9.9</td>
</tr>
<tr>
<td>phosphate(imol l⁻¹)</td>
<td>15.57</td>
</tr>
<tr>
<td>Silicate (imol l⁻¹)</td>
<td>39.14</td>
</tr>
<tr>
<td>Ammonia (imol l⁻¹)</td>
<td>54.97</td>
</tr>
<tr>
<td>Cell counts (cells/l)</td>
<td>6x10⁸</td>
</tr>
<tr>
<td>Chlorophyll ‘α’ (mg m⁻³)</td>
<td>84.7</td>
</tr>
</tbody>
</table>

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Results

The *Microcystis aeruginosa* bloom was observed as colonial, which means that the single cells can join together in groups as colonies which tend to float near the water surface (Plate 1a & 1b). The cell density of *M. aeruginosa* was encounter as 6 x 10⁸ cells l⁻¹. In the present study, *Microcystis aeruginosa* was dominated 95-98% of the total phytoplankton density during the bloom. *M. aeruginosa* populations accounted for significant proportions of total phytoplankton biomass in the surface water column (Table 1). Physico-chemical variables were measured from surface water during the bloom occurrence were given in Table 1. Silicate concentration was existed higher than other nutrients. Massive fishes were washed along the shore during the bloom. Water in the region was green coloured, slimy in nature with foul smell. This colouration in Muttukadu backwater was established due to the presence of large concentration of *Microcystis aeruginosa*. Toxic or oxygen deficiency could leads to the mortality of fishes during the *M. aeruginosa* bloom.
factories located along the bank of Muttukadu estuary. Moreover, pollution sources which accelerate to eutrophication process of these regions must be obstructed. Influence of nutrient content in surface water receiving high solar radiation can influence the abundance of phytoplankton. This is sure to increase the phosphorous content of the surface water where this nutrient will otherwise act as a limiting factor. This could be the reason for a bloom of the cyanobacteria *Microcystis aeruginosa* during this period as agreed by earlier workers. In the present investigation, the *M. aeruginosa* bloom was observed when the temperature was higher. This is supported by who stated cyanobacteria dominance often occurs when water temperature rises above 20°C this pattern also occurs in subtropical waters, including coastal systems. Salinity has been found to be another important factor influencing the production of cyanobacteria blooms, although many species are also capable of grow and bloom over a wide range of salinities from freshwater in lakes and rivers, transitional brackish environments, such as estuaries, to oceanic waters and even in hyper saline lakes. It is very clear in the present study where no salinity was reported as opined by earlier workers. During daylight hours micro algal photosynthesis produces oxygen in excess of highly dense algal biomass respiration, often resulting in dissolved oxygen concentration was found to higher during the active bloom day. A standard Secchi disk was used to determine water transparency. *Microcystis* bloom reduced water transparency through highly dense algal biomass. In 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. Because it is a limiting factor for plant growth, when nitrate is readily available in waterways it can contribute to harmful algal blooms. Phosphate concentration also high in bloom day it may be due to decomposition by microbial process as reported earlier. 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. Due to the presence of high ammonia, toxin (Mirocystin) or oxygen deficiency, *M. aeruginosa*

**Discussion**

Muttukadu backwater receives large quantities of effluents from domestic source and effluents from
bloom can leads to the mortality of fishes in Muttukadu backwater. While eutrophication is a natural process, it is enhanced and accelerated by increased nutrient run-off into waterways as a result of human agricultural practices. The excessive nutrient loads can cause rapid growth of algal populations, called ‘bloom’ when we can easily see patches of algae in the water. The large dominance of Microcystis aeruginosa were then maintained during all autumn and most of the winter. Since the Muttukadu estuary is a bar built one, no seawater inundation has been recorded during the bloom time due to bar mouth closing. It is well known that the stagnant condition resulting lack of flow of water might have resulted ‘dystrophic’ condition supporting large density of Microcystis aeruginosa which occupied around 98% of the biomass. Since Microcystis aeruginosa blooms reported as highly toxic species of the Muttukadu backwater must be monitored regularly for biodiversity conservation and human health in the future because the Muttukadu estuary is used by human for fisheries and also tourism activities.

Conclusion

Water quality of Muttukadu backwater was affected by M. aeruginosa bloom as evidenced by the analysis of water transparency, dissolved oxygen and other physico-chemical parameters. These blooms can rise to a film of oil forming on the surface of the water, decreases water clarity and prevent normal oxygenation of the water. These, in turn, cause the mortality of fishes. Pollution from various non-point sources are seen to trigger algal blooms and upset the normal phytoplankton composition of the study area. The pollution abatement facilities like the sewage and domestic waste treatment at Muttukadu area are inefficient, resulting in indiscriminate discharge of wastes into the backwaters. Present investigation highlights the need of regular monitoring of harmful algal blooms and the physico-chemical characteristics of the Muttukadu backwaters in order to conserve the fish stocks and safeguard the human beings.

Acknowledgement

Authors are thankful to Head, Department of Marine Science and authorities of Bharathidasan University, Tiruchirappalli, for facilities provided.

References


