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Fish Mortality due to Cyanobacterial Bloom in Freshwater Pond, Cochin, Kerala

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ABSTRACT

Present study revealed the cause of mass mortality of fishes and color variations of micro algal bloom observed in fresh water pond of Udayathumvathil Sreekrishna Swami Temple, Cochin, Kerala. Monitoring of water quality and phytoplankton abundance was carried out from selected stations during the period of study. Water quality parameters such as nitrate, phosphate and ammonia were observed in higher concentration that normal level directs towards phytoplankton bloom formation. Dissolved oxygen level below 4mg/l was observed which are lethal to aquatic fauna. Among the phytoplankton species, Cyanobacterial density dominated over other beneficial microalgae with a maximum cell density of 2.74×10^5 cells/ml. Two species of Cyanobacteria such as *Aphanocapsa* sp and *Microcystis* sp constituted 60.91 and 33.98 per cent of total phytoplankton abundance in the study area. The fish mortality was probably caused either by oxygen deficiency or toxins secreted by Cyanobacteria or by combination of both.

Key Words: Algal bloom, Cyanobacteria, Fish mortality, Phytoplankton, Toxins,Water quality.

INTRODUCTION

Freshwater ecosystems play a major role in regulating earth's climate with high socio-economic and ecological values as well as a crucial life giving resource for humanity. Phytoplankton communities are the part of pond microbial community forms essential component of aquaculture system. Most water quality problems in aquaculture ponds are the result of unmanaged growth of phytoplankton community dominated by noxious species of Cyanobacteria (Smith, 1991). Cyanobacterial blooms have become common phenomenon in ponds, lakes and reservoirs (Jewel, 2003). Cyanobacterial blooms in fresh water usually consist of both toxin and non toxin producing species (Baker and Humpage, 1994).It can rapidly overtake an aquaculture pond and give to unstable conditions. Cyanobacteria blooms lead to oxygen depletion in water leads to mass mortality of fishes in freshwater system (John, 2008). Factors includes intensity of light, temperature, nutrient availability, episodic hydrological events, bio-physiological and chemical characteristics and ecosystem structure are the main cause of cyanobacterial bloom (Moore *et al*, 2008). A critical time during bloom condition occurs when dense cell masses decompose naturally and this decomposed products plus toxic cellular materials released into the water when the cells lyses may cause death or illness of mammals, birds and fishes and may also reduce water quality for animal (including human) and recreational purpose (Plamer,1964; Schwimmer and Schwimmer,1964; Collins,1978). Several toxins produced by cyanobacteria are extremely toxic to warm blooded animals but there are little documentation of importance of cyanobacterial toxin in freshwater ponds is available. The objective of the study was to give base line information about the cause of fish mortality occurred in a fresh water pond during summer period.

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MATERIALS AND METHODS

Udayathumvathil temple is a pilgrim centre of Panangad,Kochi, Kerala,India. It is the worship centre for Hindus having ritual and sacred values. Mass mortality of fishes observed in the study area (Fig. 1) includes Silvercarp (*Hypophthalmichthys molitrix*), Catla (*Catla catla*), Common carp (*Cyprinus carpio*) were observed on 27th May 2019. Water samples were collected for the analysis of physico-chemical factors such as temperature, pH, Dissolved Oxygen, Nitrates, Nitrites, Phosphate and Ammonia following the Standard method of APHA (1998). Identification of phytoplankton was done with the Standard books (Prescott, 1962, 1978; Desikachary, 1959; Turner, 1982). Phytoplankton samples were taken in Sedgwick rafter cell counting chamberand the results are expressed as number of cells per ml of sample. Graphical representation of phytoplankton abundance and cluster diagram was done using PRIMER v7 software.

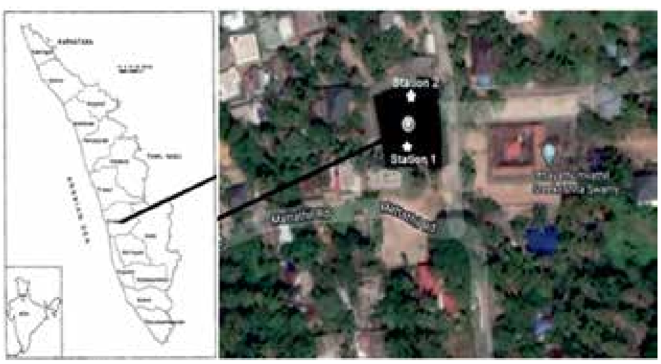
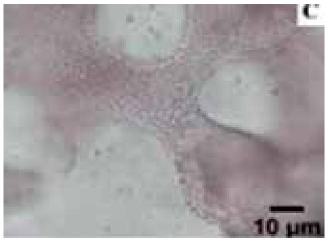


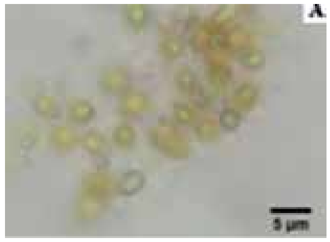
Fig. 1: Map indicating the sampling ponds in the study area

RESULTS AND DISCUSSION

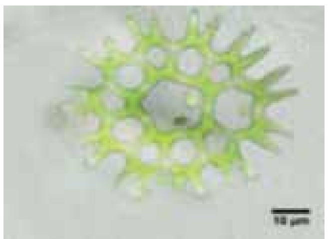
Cyanobacteria constituted a greater part of phytoplanktonic biomass during summer period in most of the fish ponds (Sevrin andPletikosic, 1990). During the present study,three species of Cyanobacteria namely *Aphanocapsa* sp., *Microcystis* sp., *Anabaena* sp. and one species of family Chlorophyceae namely *Pediastrum* sp. were dominatedas per their cell density (Fig. 2). Some of the microalgal species belonged to genera *Microcystis*, *Anabaena*, *Planktothrix*, *Aphanizomenon* and *Cylindrospermopsis* possessed gas vesicles provide buoyancy and vertical movement through water column and dominate over other pelagic microalgae for sunlight and nutrients leads to harmful effect to the ecosystem (Oliver and Walsby, 1984). It has been found that*Aphanocapsa* sp. and *Microcystis* sp. were dominant compared to other microalgal species.The microscopic study exposed that the cyanobacterial cell density was 2.74×10^5 cell/ml, constitute 98.25per cent of total phytoplankton abundance (2.94×10^5 cells ml^{-1}). The cell density of *Aphanocapsa* sp. and *Microcystis* sp. were 1.31×10^5 and 7.2×10^4 cells/ml, respectively which contributed 60.91 and 33.98% of total cyanobacterial abundance.Blue green algae played a major role in fish culture ponds, not only because of their prolific development, but also due to their effect on the environment and other aquatic organisms. In this study, water temperature, pH and DO observed at two stations varies from 28-29 ˚C,7.1-7.5 and2.03 to 3.7mg/l, respectively. Robarts and Zohary (1987) reported that water temperature of 25°C or above are favourable for the growth of *Anabaena*, *Aphanizomenon*, *Oscillatoria* and *Microcystis*. The increase in water temperature indirectly promoted better growth of cyanobacteria. The level of ammonia concentration in two stations (0.9 and 1.5mg/l)was higher than desired level showed an indication of fish mortality. Nitrate and phosphate concentration estimated a higher concentration that desired level during the sampling period (Fig 3).Among the abiotic factors, nutrients including inorganic nitrogen and phosphorus, temperature, light intensity hydrodynamic parameters of water body were the most important factors in the proliferation of cyanobacteria (Gobler *et al*, 2016). Phosphorus was the limiting nutrient in freshwater ecosystem and high concentration of phosphorus correlate to the occurrence of cyanobacterial blooms worldwide. Cluster diagram indicating that class Cyanophycea was dominating with less similarity in terms of abundance compared to other classes (Fig. 4).



a. ***Microcystis*** **sp.**



b. ***Aphanocapsa*** **sp.**



c.***Pediastrum*** **sp.**

d. ***Anabaena*** **sp.**

Fig. 2: Microscopic view of dominated phytoplankton species in the study area

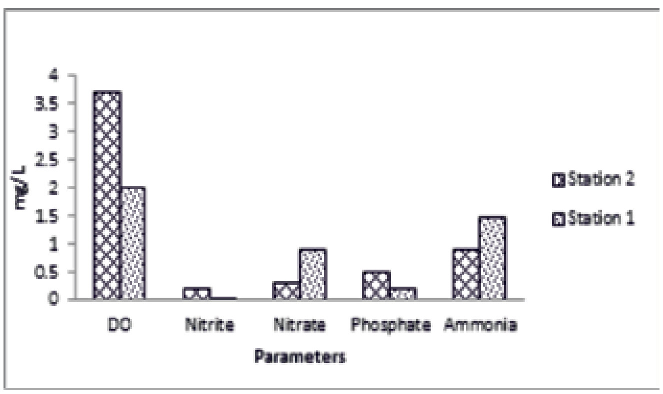


Fig. 3: Water quality parameters observed during the study period

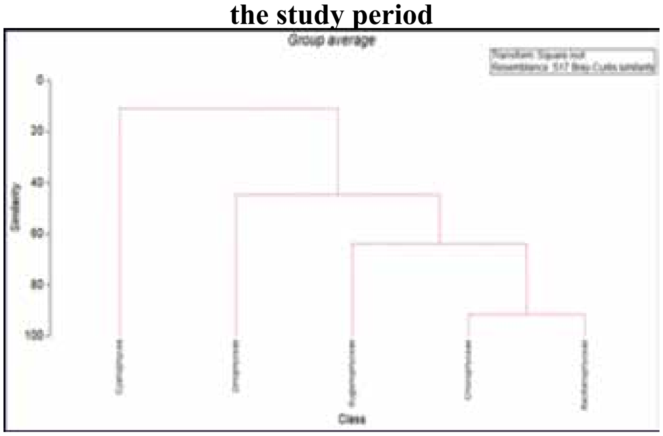


Fig. 4: Cluster diagram of various class of phytoplankton observed during the study

Mortality of fish in the studied pond may be associated with the bloom of *Aphanocapsa* sp. and *Microcystis* sp. The presence of higher density of Cyanobacterial cellsin both the stations (Fig. 5)resulted in clogging of gillsand leading to mortality of fishes.The production of potent toxins by *Aphanocapsa* and *Microcystis* which may be the cause of fish mortality. Sustaining evidences can also be drawn from other studies such as Collins (1978) who suggested that critical time bloom conditions occurred when dense cell mass of cyanobacteria decomposed naturally and this decomposed products plus toxic cellular materials released into the water during cell lysis might have caused death of fishes. A study conducted by Yamamoto and Nakahare (2009) elucidated the factor that trigger *Microcystis* bloom formation in a pond in Kyoto, Japan. A study by Vijayarani*et al*(2016) reported bloom formation of *Chrococcus turgidus*, *Oscillatoria limosa*, *Microcystis aeruginosa* and *Anabaena circularius* indicating organic pollution in a temple pond in Kanyakumari. Presence of pollution tolerant algae like *Melosira,Oscillatoria,Pediastrum* and *Scenedesmus* has been considered as indicative of enriched waters, thus providing evidence of pollution of water (Tessy and Sreekumar, 2008; Paul and Anu,2016).The runoff water increased the nutrient level of the pond water and provided a favorable condition for the Cyanobacterial bloom. Phytoplankton responds quickly to environmental changes and was used to assess the ecological status of water body. Phytoplankton diversity and successions in small man-made ponds were largely ignored.

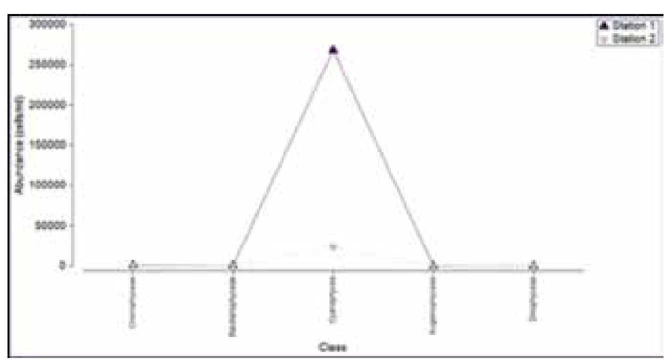


Fig. 5: Phytoplankton abundance (cells/ml) at Station 1 and 2

CONCLUSION

Cyanobacteria can be considered highly undesirable to fish culture pond. The cause of fish mortality in the present study may be caused due to the following reasons i.e. depletion of oxygen due to blue green algal blooms, runoff water increased nutrient levels of the pond, toxin secreted from the cells, the fish get intoxicated by bacteria associated with Cyanobacteria. The methods to control cyanobacterial blooms include maintain N: P at a level of 5 or above which facilitate growth of Chlorophycaea and reduce the number of cyanobacteria in the ponds or by installing aerators in the ponds to break vertical stratification of water and improve dissolved oxygen concentration make unfavorable to blue green algal growth.

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