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Occurrence of Cyanobacterial and Algal Blooms in Fish Culture Ponds

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abstract

The present study was conducted at Thayetkone Fish Culture Fram, Mandalay in Upper Myanmar, for a period of three years (July 2003 to December 2006). Seven genera of cyanobacteria namely, *Microcystis, Anabaena, Oscillatoria, aphonizomenon, Cylindrospermopsis, Arthrospira,* and *Spirlina* were also observed. Among these genera, *Microcystis, Anabaena, Oscillatoria, Aphanizomenon* and *Euglena* were dominant. Blooms of *Microcystis* in fish ponds composed of three species, *Microcystis* in fish ponds composed of three species, *Microcystis aeruginsosa, M.wesenbergii* and *M.navacekii*. Some cyanobacteria and algae are toxin producers, especially *Microcystis* spp. which often cause major problems in eutrophic freshwater by forming toxic blooms in hot seasons. Water quality of Thayetkone fish culture ponds revealed the eutrophication status due to cyanobacterial and algal blooms.

Key words : *Cyanobacteria, Microcystis, Euglena,* Toxin, Eutrophication

Introduction

The presence of cyanobacterial and algal blooms in natural and articicial water bodies has been frequently reported from different regions of the world. In many environment, cyanobacteria and algae are the primary producers at the base of the food web of an ecosystem such as freshwater, marine water, paddy fields, soils, deserts, hot springs and other extreme environments.

Moat War Dine Naw (2001) reported that cyanobacteria give positive and negative effects to the animals and environment. Some cyanobacteria are used as food and medicines, for example, *Spirulina* and *Nostoc*. However, some species of cyanobacteria are the main toxin producers in the freshwater environment. Some kinds of cyanobacteria produce toxins are produced inside the cells and stay there as long as the cells are alive. When cells die and breakdown, toxin can be released into the water. If aquatic animals are exposed to algae infested water, the position can possibly kill them (Chorus and Bartram., 1999).

Cyanobacterial blooms have been recorded in tropical regions. The conditions that favour excessive growth are high temperature, long sunny days, high level of nutrients in the water and calm conditions that permit the cells to migrate to the surface of storage. These conditions occur frequently in fish culture ponds associated with eutrophication (nutrient enrichment) which may increase the occurrence of cyanobacterial blooms. The cyanobacterial blooms are dominated by *Aphanizomenon, Anabaena, Microcystis, Oscillatoria, Nodularia, Arthrospira* and *Cylindrospermopsis*. Cyanobacterial blooms persist in freshwater that contain adequate levels of essential inorganic nutrients such as nitrogen and phosphorus, water temperature generally between 15ºC and 30ºC, and pH level between 7 and 9 (Robart *et al.,* 1987; Plinski *et al.,* 1996).

In East Africa, euglenoid algae, *Euglena sanguinea* was observed in fish pond. The red water bloom appeared regularly evey two or three weeks. *Euglena sanguinea* have their chlorophyll masked by red pigments so they may form a red blanket on ponds. *Euglena* was the most tolerant genus of organic pollution (Wurtz, 1964). Similar observations were reported by Bulent *et al* (2006).

Surface blooms formed by various filamentous genera of algae occur in fresh water. Filamentous algae included *Cladophora* sp., *Spirogyra* sp. and *Oedogonium* sp. *Spirogyra* sp. are usually regarded as an attaching green algae, yet it often forms huge colonies extending well toward the surface or even floating just beneath the surface.

Rahman *et al* (2004) also reported that organic and inorganic fertilizers and fish feed are the two major external sources of nutrient in ponds. Ponds are fertilized with both organic and inorganic fertilizers throughout the world to stimulate the growth of phytoplankton and thereby to increase fish yield. The animal manures is mostly used in many small scale fish farms in Asia. However, large amount of animal manures are applied in fish ponds, of which undissolved protions of fertilizers apparently settle and mix with pond sediment. This makes pond sediments rich in nutrients leading to eutrophication. Eutrophication is an accelerated growth of algae and undesirable disturbance to the balance of organisms present in the water and to the quality of the water concemend.

The cyanobacteira and algae which occur in fish production ponds are extremely important since they directly affect the properties of water quality such as colour, smell, taste, dissolved oxygen, turbidity. The present research was conducted at the Thayetkone Fish Culture Farm, Mandalay, Upper Myanmar. In this farm, cyanobacterial and algal blooms occur during hot season every year. For this research at Thayetkone fish culture ponds which need to be investigated for the eutrophication of cyanobacterial and algal bloom-froming condition was conducted with the following objectives.

- to identify the cyanobacteria and algae and study their monthly variations in fish ponds
- to examine the abundance of incidence of bloom-forming cyanbacteria and algae and their effects on fish health.

Materials and Methods

The present study was carried out for a period of three years (July 2003 to December 2006) at Thayetkone Fish Culture Farm, Mandalay. the area of Fish Farm is 20.62 hectares, in which 91 fish culture ponds are constructed. Each pond is 100' x 100' with a maximum water depth of 6 feet.

Water samples were taken once a month directly from the surface of fish ponds using a plastic bottle (one litre) during bloom formation. Water sample (0.1 ml) was examined and counted for the number of cells from at least 5 slides under light microscope. Cyanobacteria and algae were roughly recorded on each slide as abundance (n>20) and rare (n<5). Water samples were preserved with 4% formaldehyde solution. Taxonomic determination of algae and cyanobacteria was performed with a light microscope on living materials and potomicrographs were taken with Olympus digial camera. Identification of cyanobacteria and algae, was based on the work of Desikachary (1959) and Otsuka *et al* (2000). Crude protein contents in cyanobacteria and algae were analyzed at Soil and Water Utilization and Agricultural Engineering Division, Department of Agricultural Research, Yezin. Water temperature and pH were measured directly in the field by themomerter and pH meter. Air temperature was obtained from Department of Meteorology and Hydrology, Mandalay, Upper Myanmar.

Results

Bloom-formation of cyanobacteria and algae in fish ponds were observed and recorded (Figs. 1, 2, 3 and 4). During the bloom formation, pH values of the pond water ranged from 7.5 to 8.5. The pond water is highly alkaline. The air temperature varied from 13ºC to 40ºC (Department of Meteoroogy and Hydrology, Mandalay). Water temperature varied from 15ºC to 37ºC for each pond at the time of bloom formation.

During the present study, seven genera of cyanobacteria namely, *Microcystis, Anabaena, Oscillatoria, Aphonizomenon, Cylindrospermopsis, Arthrospira* and *Spirulina* were identified. Two genera of green algae, *Spirogyra* and *Euglena* were observed to be dominant. Blooms of *Microcystis* in fish ponds composed of three species, *Microcystis aeruginosa, M.wesenbergii* and *M.novacekii* (Gigs. 5-19).

In 2003, the genera *Microcystis, Anabaena, Oscillatoria, Aphanizomenon, Cylindrospermopsis* and *Euglena* occurred abundantly especially during July to December. In 2004, 2005 these genera were observed from April to the end of October. In breeder pond (Fig. 32), heavy surface blooms of cyanobacteria (mainly *Microcystis* spp.) associated with mass mortality of common carp, *(Cyprinus carpio),* were observed in September and October. *Microcystis* spp., *Anabaena* sp. and *Oscillatoria* sp. were dominant from March to the end of

October in 2006. Crude protein content of *Microcystis* spp. was 14% and that of *Euglena sanguinea* was 44%. The red water blooms of *Euglena sanguinea* covered the entire surface of fish ponds throughout the year. However, there was no mortality of culture fish during bloom formation. Filamentous green algae (*Spirogyra* sp.), *Arthrospira* sp. and *Spirulina* sp. were occasionally found in fish ponds.

Discussion and Conclusion

In the present study, cyanobacteria was the dominant phytoplankton in fish culture pond. Temperature and nutrient loading have been considered as important environmental factors that controls the dominance of forming cyanobacteria are optimal at around 25ºC and pH ranged from 7 to 9. In the present study, the water temperature (15ºC-36ºC) and pH (7.5-8.5) in fish ponds were observed to be within these range.

Plinski *et al*. (1996) reported that temperature is one of the important ecological parameters which influence the growth and biological activity of cyanobacteria. In the present study, genera of *Microcystis, Anabaena* and *Oscillatoria* were observed to be abundant during July to October, 2003 to 2006 with temperature varying from 24.3ºC to 36.4ºC. The result is in agreement with Robart *etal* (1987) who reported that cyanobacterial growth showed high temperature optima for species of the genera *Microcystis, Anabaena, Cylindrospermopsis* and *Oscilatoria* with maximum growth rate generally attained above 20ºC. Oudra *et al* (1998) also reported that cyanobacterial growth starts regularly in June and reaches its maximum generally in August- September. In the present study, similar occurrence of cyanobacteria were observed.

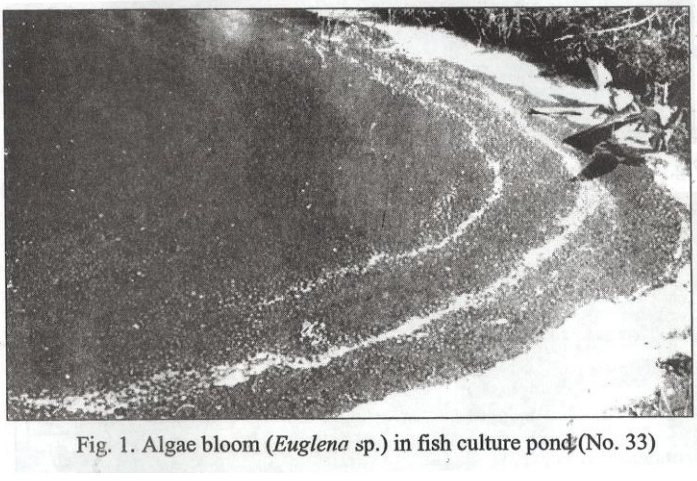

Fig. 1. Algae bloom (*Euglena* sp.) in fish culture pond (No. 33)

Fig. 3. Cyanobacteria bloom (*Microcystis* spp.) in fish culture pond (No. 32)

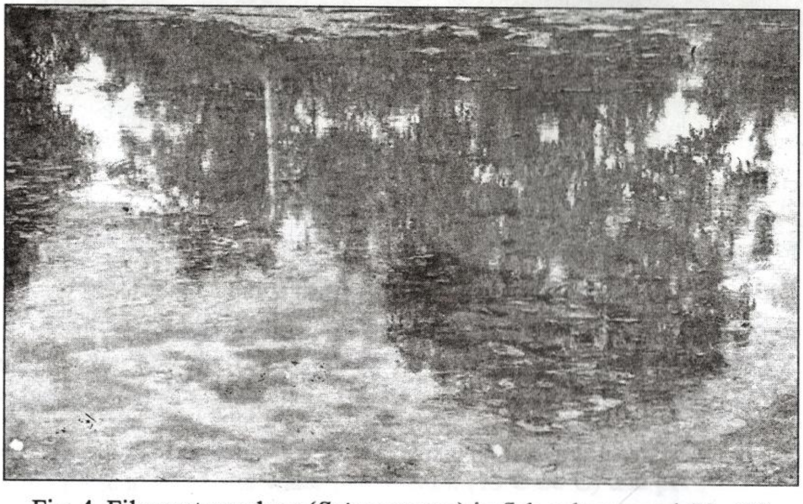

Fig. 4. Filamentous algae (*Spirogyra* sp.) in fish culture pond (No.63)

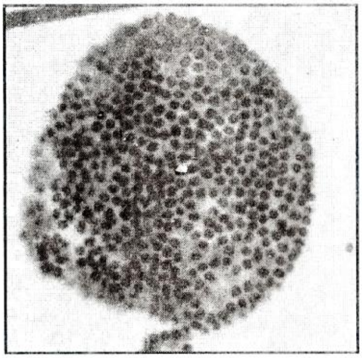

Fig. 5. *Microcystis* sp.

(x 400)

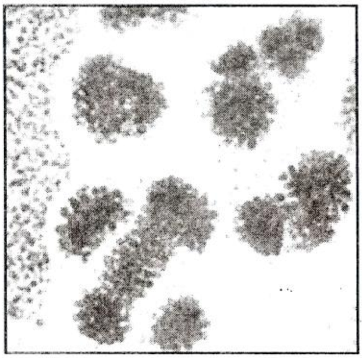

Fig. 6. *Microcystis novacerkii*

(x 400)

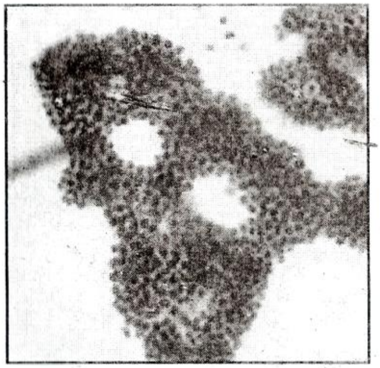

Fig. 7. *Microcystis aeruginosa*

(x 400)

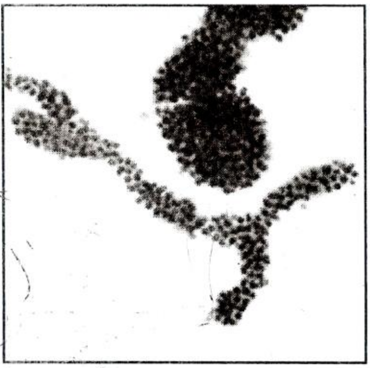

Fig. 8. *Microcystis aeruginosa*

(x 400)

Fig. 9. *Microcystis aeruginosa*
(x 400)

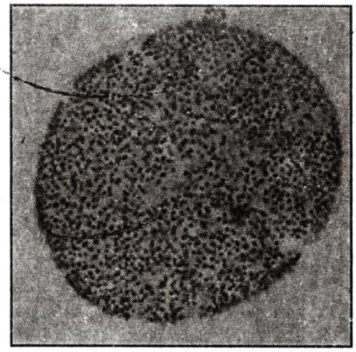

Fig. 10. *Microcystis wesenbergii*
(x 400)

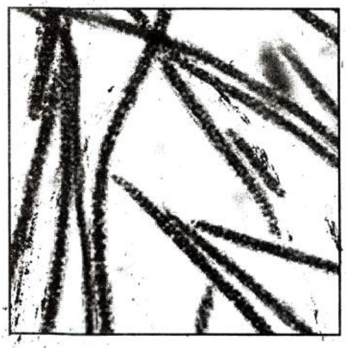

Fig 11. *Oscillatoria* sp.
(x 400)

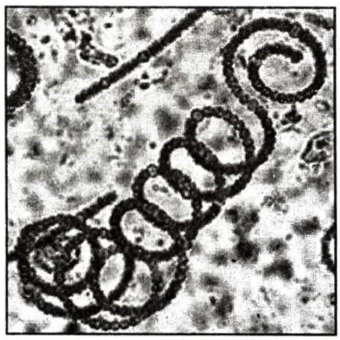

Fig 12. *Anabaena* sp.
(x 400)

Fig 13. *Arthrospira* sp.
(x 400)

Fig 14. *Spirogyra* sp.
(x 400)

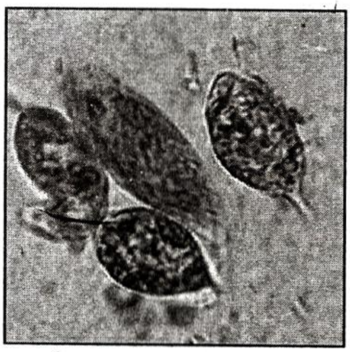

Fig 15. *Euglena* sp.
(x 400)

Fig 16. *Spirulina* sp.
(x 400)

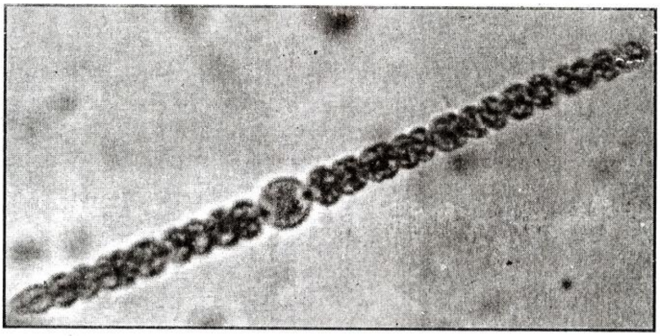

Fig 17. *Aphanizomenon* sp. (x 400)

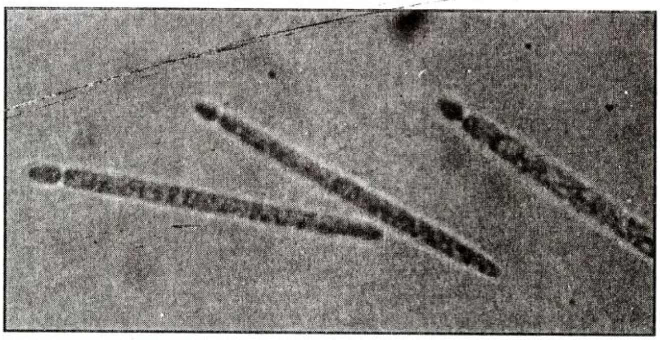

Fig 18. *Cylindrospermopsis* sp. (x 400)

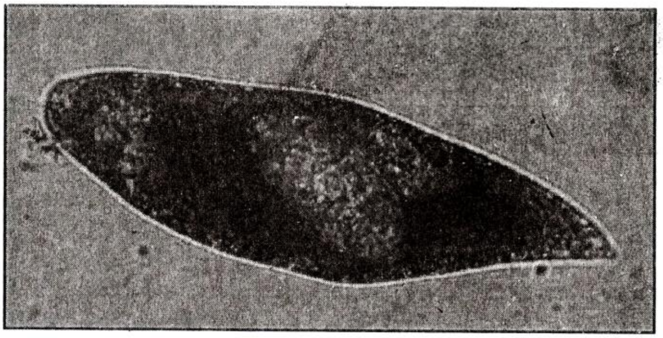

Fig 19. *Euglena sanguinea* (x 400)

Spirulina, Arthrospira and filamentous algae (*Spirogyra*) were occasionally observed in water samples during the study period. *Euglena* spp. were present in the fish ponds almost throughout the study period. According to the Bulent *et al* (2006), the existence of *Euglena spp*. in water was a proof for the richness of water with organic substances. Thus, the occurrence of organic matter in pond water was higher. There was no mortality of culture fish during *Euglena* bloom formation. The protein content of *Euglena sanguinea* was 44%. It is assumed that is a *Euglena sanguinea* natural food for fish.

Cyanobacteria and algae are also used as eutrophic indicators (Druvietis, 1998). Food is added daily to almost all ponds which represents the major source of nutrients in commercial fish production ponds. Uneaten feed and fish wastes are usually biologically degraded and reused by certain pond organisms. The heavy feed inputs needed for profitable commercial fish culture result in rapid nutrient accumulation leading to eutrophication. In Thayetkone Fish Culture Farm, fish pond sediments have become nutrient enrichment due to unconsumed feed, fish feces and fertilizers. Therefore, maintenance of pond volume and its environment by sediment removed should be made as a conductive practice for economical fish production.

In the present study, water quality of Thayetkone for culture ponds revealed the cutrophication due to cyanobacterial and algal blooms. Besides, water output from one pond was drained into a canal from which water was transferred to another pond. This water-reuse practice can cause dispersal of cyanobacteria and algae. Excessive inputs of nutrients including animal manure and supplementary feeding in fish ponds should therefore be limited.

Some of cyanobacteria have the property of secreting toxin, *Microcystis, Anataena, Aphanizomenon, Cylindrosperniopsis* and *Oscillatoria* are the known toxic genera of cyanobacteira. Some of these present study, heavy surface blooms of cyanobacteria, (mainly *Microcystis* spp.) associated with mass mortality of common carp, *Cyprinus carpio* were also fond in breeder pond (Fig.3), in September and October, 2004-2005. It may be suggested that, this finding show *Microcystis* spp. as nuisance cyanobacteria and growth of this cyanobacteria should be monitored regularly in the Thayetkone fish culture ponds.

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