# Morphology and Diversity Analysis of Cyanobacterial Blooms and its effects on Freshwater Biome in Virudhunagar And Thenkasi Districts, Tamil Nadu

**Vijayalakshmi. M[1*&2] and Ramanathan. G[3]**

[1]Ph.D Research scholar of Microbiology, Sri Paramakalyani College, Alwarkurichi, (Reg. No. 19221232102009 – Manonmaniam Sundaranar University, Tirunelveli)

[2] Assistant Professor of Microbiology, V.V.Vanniapermal College for Women, Virudhunagar
[3]Assistant Professor of Microbiology, Sri Paramakalyani College, Alwarkurichi, Tirunelveli,

**Corresponding author**

**Vijayalakshmi M, Assistant Professor of Microbiology, Virudhunagar.**

---

**ABSTRACT**

This study depicted the microalgal diversity in Virudhunagar and Thenkasi district, Tamil Nadu. The samples were collected from fifty sites like ponds, lakes and stagnant water bodies and its impacts on human beings. Almost 20 species were reported such as Oscillatoria sp., *O.salina, S.fusiformis, Chroococcus turgidus, N.communae, Phormidium sp., P. pachydermaticum, Lyngbya wollei, Calothrix elenkinii, Cylindrospermum muscicola, Microcystis wesenbergii, Chroococcus minutus, Gomphosphaeria aponina, Lyngbya majuscula, Stigonema hormoides* and *Microcystis panniformis*. Physio-chemical parameters of the water samples influenced the algal growth and reduced the growth of water borne insects. The suitable trophic condition and eutrophic nature of the lake favored the algal bloom formation. Taxonomically, the Cyanobacteria is very important because of its characteristic features among the algae forms, global distribution and occurrence.

The major threats to the aquatic bodies are bathing, cleaning vehicles, dumping of garbage, pesticides and other pollutant resources. This is only by the ignorance of illiterates and literates behave like illiterates.

**Keywords – Algal blooms, Diversity, Microcystis, Survey, Tropic conditions**

---

## INTRODUCTION

Bloom can be harmful to people, animals or the environment if it produces toxins, becomes too dense, uses up the oxygen in the water, or releases harmful gases (Mellisa *et al.* 2013). The routes of exposure by ingestion, inhalation, skin contact and eye contact. There are many factors that determine whether exposure to cyanobacterial blooms will cause adverse health effects such as toxin type and concentration, duration and route of exposure. Common cyanotoxins are Microcystins, Cylindrospermopsins, Anatoxin-a, Saxitoxins, Nodularins and Lyngbyatoxins. These are all called cyanotoxins (Archana 2013). We can determine the type of cyanotoxin, toxin exposure and its symptoms. Microcystins are the predominant one to cause abdominal pain, nausea, vomiting, headache, diarrhea, sore throat, blistering around the mouth, and pneumonia. Cylindrospermopsin are causing gastrointestinal symptoms, including vomiting and bloody diarrhea, as well as fever and headache. Anatoxin-a are also producing neurologic symptoms, including numbness, tingling, burning sensation, drowsiness, salivation, and speech disturbances. Singh, (2011) noted that the cyanobacteria from coastal regions of oceanic water used for the production of antibacterial substances against bacteria using solvent extracts of Diethyl ether, Ethyl acetate and Ethanol. Microcystins are most frequently occurring and widespread cyanotoxin. They are cyclic heptapeptides containing a specific amino acid (ADDA) side chain which has been found only in microcystin. Different structural analogues of microcystin have been identified. The seven amino acids that are involved in the structure of a microcystin include a unique β-amino acid (ADDA). The LR form of microcystin has leucine and arginine, RR form has arginine and arginine, YR form has tyrosine in R1 position and arginine in R2 position. For vertebrates, a lethal dose of microcystin (1µg<) causes death by liver necrosis within a few days. An acute dose response of microcystin may damage the liver in several ways. No diagnostic tests for cyanotoxins are clinically available. Electrolytes and liver enzymes, Renal function tests, serum glucose, and urine tests to check for proteinuria and glycosuria in severe toxicity and Chest radiograph tests can be used to evaluate the illnesses. Specialized laboratories can perform testing to identify cyanobacteria or cyanotoxins in feces, urine, stomach contents (if available), tissues, serum, or water specimens. In collection site level, we can also check the quality by basic strip test like cyanodec test.

## *MATERIALS AND METHODS*

Nearly 50 samples were collected from 4 different districts of southern Tamil Nadu. Sampling was carried out by using a sterilized container and also an identification or sample name for each sample (Table 1). By using a light microscope, the morphology of the sample, particularly microcystin producing algae, were identified and also immediately inoculated in BG11 broth (Lakshmi kumari 2008). These samples were kept in an algal incubator or wooden rack with the proper light source for 15-20 days. These were inoculated in BG 11 broth for later usage and stored in a refrigerator. The organisms were identified based on the Book entitled Cyanophyta and the author name Desikachary, 1959 and depicted in table 1 & figure 1.

**Table 1. Morphological identification of Cyanobacteria in Thenkasi and Virudhunagar districts**

| ORDER | FAMILY | GENUS & SPECIES | THENKASI DISTRICT | VIRUDHUNAGAR DISTRICT |
|---|---|---|---|---|
| Chroococcales | Chroococcaceae | Chroococcus minutus | + | + |
| Chroococcales | Chroococcaceae | Chroococcus turgidus | + | + |
| Chroococcales | Chroococcaceae | Gloeocapsa stegophila | + | - |
| Chroococcales | Gomphosphaeriaceae | Gomphosphaeria aponina | + | - |
| Chroococcales | Microcystaceae | Microcystis protocystis | - | + |
| Chroococcales | Microcystaceae | Microcystis pseudofilamentosa | - | + |
| Chroococcales | Microcystaceae | Microcystis aeruginosa | + | + |
| Chroococcales | Microcystaceae | Microcystis flos-quae | - | + |
| Chroococcales | Microcystaceae | Microcystis wesenbergii | + | + |
| Pleurocapsales | Pleurocapsaceae | Myxosarcina spectabilis | + | - |
| Nostocales | Oscillatoriaceae | Spirulina fusiformis | - | + |
| Oscillatoriales | Oscillatoriaceae | Oscillatoria salina | + | + |
| Oscillatoriales | Oscillatoriaceae | Phormidium pachydermaticum | + | - |
| Oscillatoriales | Oscillatoriaceae | Lyngbya wollei | + | + |
| Oscillatoriales | Oscillatoriaceae | Lyngbya aestuarii | + | + |
| Oscillatoriales | Oscillatoriaceae | Lyngbya majuscula | + | - |
| Nostocales | Nostocaceae | Cylindrospermum muscicola | - | + |
| Nostocales | Nostocaceae | Nostoc communae | + | + |
| Nostocales | Rivulariaceae | Calothrix elenkinii | + | + |
| Stigonematales | Stigonemataceae | Stigonema hormoides | - | - |


**Figure 2. Location of the study area: A satellite image of the study area of freshwater bodies in Tenkasi and Virudhunagar districts.**

***RESULTS***

**Chroococcus minutus (kutz) Nag.**

Geitler, Kryptogamenflora. 232, fig. 112a, 113c, 1932; Desikachari, 1959, pl - 114, figs – 5,6,11, p - 541. Desikachari, 1959, pl. 24, fig 4, p – 122 & pl. 26, fig. 4, 15, p – 129. Cells spherical or oblong, single or in groups of 2 -4, light blue –green, without sheath 4 -10 um diam., colonies 10 -13 x 15 -20um; sheath not lamellated, colorless.

**Chroococcus turgidus (kutz) Nag.**

Geitler, Kryptogamenflora. 228, fig. 109b, 110, 1932; Desikachari, 1959, pl. 26, fig 6, p – 122 Chroococcus is a large genus of cyanobacteria whose species are difficult to differentiate. However, they are typically characterized as living in small colonies of 2, 4, or 8 cells that are surrounded by a clear, mucus sheath and not distinctly lamellated.

**Gloeocapsa stegophila (Itzigs.) Rabenh.**

Geitler, Kryptogamenflora. 197, fig. 91b, 1932; Desikachari, 1959, pl. 25, fig 3, p – 126.

Cells spherical, 2 -8 in colonies, with a number of special envelopes. Cells with sheath 4.5 – 8 um in globose groups, 50 -140um diam., blue green; sheath golden to orange yellow to red, thin firm membrane. Occasionally with nannocystes.

**Gomphosphaeria aponina (Kutz.)**

Geitler, Kryptogamenflora. 245, figs. 117 a-c, 1932; Desikachary, 1959, pl. 28, firs 1- 3, p- 149.

Cells pyriform or radially arranged, heart shaped cells, mucilaginous envelope at longitudinal cell division. Colonies are spherical, crustaceous and yellowish. Cells spherical to oval, sheath vesicular, yellowish to colour less, and lamellated. Cells 6µm-9µm in diameter.

**Microcystis**

Microcystis are harmful bloom forming cyanobacteria and can produce neurotoxins (cyanopeptolin) and hepatotoxins (microcystin). Microcystin is a potent liver toxin and possible human carcinogen. Fish and bird mortalities have also been reported in water bodies with persistent cyanobacteria blooms.

**Microcystis aeruginosa (Kutz)**

Geitler, Kryptogamenflora. 137, fig. 59d, 1932; Desikachary, 1959, pl. 17, figs. 1,2,6 & pl.18, fig. 10, p- 86.

An ovate, spherical, or irregularly lobed, clathrate and mucilaginous colony of numerous spherical cells much crowded within a gelatinous matrix; mucilage colourless, structure less, diffluent, sometimes forming distinct cell contents blue-green, highly granular with gas vacuoles.

**Microcystis protocystis (Crow)**

Geitler, Kryptogamenflora. 140, fig. 62b, 1932; Desikachari, 1959, pl. 20, fig. 4, p- 92.

Colonies irregular, mostly diffuse with the limits of colonial mucilage, not clearly restricted; cells spherical, many varying in the mode of aggregation from closely packed to generally dissociate. Spherical, 3.5 -6.5 um diam., with gas vacuoles.

**Microcystis pseudofilamentosa**

Geitler, Kryptogamenflora. 138, fig. 61, 1932; Desikachary, 1959, pl. 18, fig. 9 & pl. 20, fig. 1, p- 88 & 92.

Colonies vary in size, usually 220 - 290 µm long; margins of the colonial mucilage indistinct; mostly partial colonies; cells spherical with gas-vacuoles.

**Microcystis panniformis**

Komárek, Komárk.-Legn., C.L. Sant" Anna, M.T.P. Azevedo & Senna, Crypto. Algol. 23: 165, figs. 14-28. 2002; Komárek & Anagn., Cyanoprokaryota Part 1: Chroococcales, 19(1): 226, fig. 297. 1998. (Fig. 2E).

Colony flat, irregular with small holes; margins of the colonies smooth or irregular; cells regularly densely and smoothly accumulated.

**Microcystis wesenbergii**

Colony irregular, spheroidal to lobate or elongate with holes when old; mostly composed with connected spheroidal subcolonies; cells sparsely to densely accumulate often near the surface of subcolonies (Maya et al., 2021).

**Microcystis flos-aquae (Wittr.) Kirchner**

Geitler, Kryptogamenflora. 138, fig. 59e & f, 1932; Desikachari, 1959, pl. 17, fig. 11, & pl. 18, fig 11, p- 86 & 88.

Colony ellipsoidal or more or less elongate or roughly spherical, not clathrate; colonial mucilage indistinct; cells spherical with gas-vacuoles. Nannocyst present.

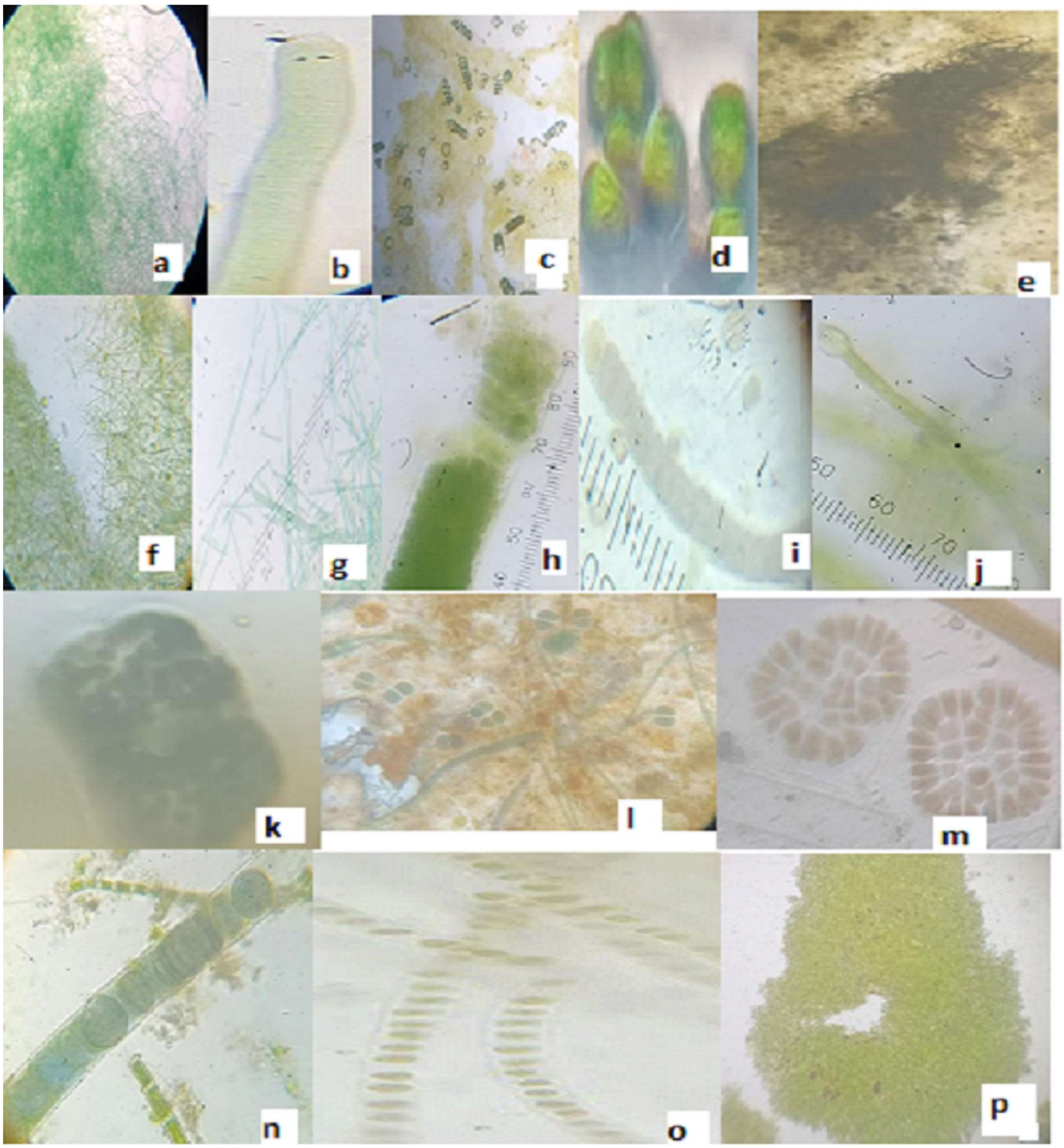
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
p

Figure 1: Morphology of Cyanobacteria; a. *Oscillatoria sp.* b. *O.salina,* c. *S.fusiformis* d. *Chroococcus turgidus* e. *N.communae* f. *Phormidium sp*. g. *P. pachydermaticum* h. *Lyngbya wollei* i. *Calothrix elenkinii* j. *Cylindrospermum musicola* k. *Microcystis wesenbergii* l. *Chroococcus minutus* m. *Gomphosphaeria aponina* n. *Lyngbya majuscula* o. S*tigonema hormoides* p. *Microcystis panniformis*

**Myxosarcina spectabilis**

Desikachari, 1959, pl. 30, figs. 1-5, & pl. 31, figs. 17 – 22, p – 153 & 161.

Cyanobacteria that undergo repeated binary fission in three planes to form more or less cubical aggregates of cells. Multiple fission occurs simultaneously in most cells of the aggregate and is followed by the massive release of motile baeocytes. The baeocyte initiates growth by enlarging symmetrically into a spherical vegetative cell that, just prior to the onset of binary fission, attains a size that is characteristic and constant for any given strain. Cells in three dimensional colonies, 6.5 – 10 um broad; colonical sheath thin, distinct, hyaline, individual sheaths, blue green endospores.

**Spirulina fusiformis (Arthrospira fusiformis)**

Spirulina is commonly used as a dietary supplement. Free-floating, filamentous cyanobacteria. Filaments unbranched, always without sheaths, rarely solitary, usually in clusters or in fine mats which can cover the substrate. Screw-like coils of cells are common. Cells are pale blue-green, olive-green or pinkish. Cell size: Length 4mm, width 6-9mm, spiral diameter 45-45mm and microcystin producers (Angelina, *et al.*, 2019.)

**Oscillatoria salina (Biswar)**

Geitler, Kryptogamenflora. 978, figs. 624, 1932; Desikachari, pl. 37, figs. 16, 17, p- 204.

Oscillatoria is a genus of unbranched filamentous cyanobacteria with mucilaginous sheaths. The genus is named for its oscillating movement; filaments can slide back and forth in order to orient the colony towards a light source. Apices of trichome straight, briefly tapering end with sharp point, not capitate, apical cell mucronate hyaline, calyptra absent, cells shorter than broad. Oscillatoria can produce both anatoxin-a and microcystins. filamentous found in freshwater environments. Naturally produce BHT (butylated hydroxytoluene) an antioxidant, food additive.

**Phormidium pachydermaticum (Fremy)**

Geitler, Kryptogamenflora. 1014, figs. 648 b -c, 1932; Desikachari, pl. 43, figs. 8 -10, p- 260.

Thallus outer surface dull blue green, sheath at first thin, later thick, irregularly lamellated, lamellae short, irregularly disposed, not attenuated, not capitate; end cell slightly convex. Filaments usually in expanded thallus, growing attached to substrate (secondarily floating in masses); texture varies (from thin to thick, fine to leathery). Filaments sometimes form tufts or clusters, and are rarely solitary. Filaments without any branching; slightly waved to loosely, irregularly coiled. Sheaths may occur facultatively to almost obligately, depending on environmental conditions. Gas vesicles are not present. *Phormidium* mats do not dissociate as easily as those of *Oscillatoria*, and the sheaths on *Phormidium* filaments are looser than the rigid sheaths of *Lyngbya*. The mats are usually attached to benthic substrates, and can detach and float to the surface.

**Lyngbya aestuarii**

Geitler, Kryptogamenflora. 1052, fig. 666, 1932; Desikachari, pl. 51, fig. 9, p – 300 & pl. 52, fig. 8, p- 304.

Lyngbya is a genus of cyanobacteria, unicellular autotrophs and form long unbranching filaments inside a rigid mucilaginous sheath. They reproduce asexually. Filamentous, non-heterocystous, an important contributor to marine microbial mats system worldwide. Short, sheath-less, motile filamentous (hormogonia) are also formed. Their filaments break apart and each cell forms a new filament. This type of species can temporarily form dense, floating mats in water. Ingestion of Lyngbya is potentially lethal, Ciguatera like poisoning is caused by eating fish which have been fed on Lynbya and cause skin irritation.

**Lyngbya majuscula**

Geitler, Kryptogamenflora. 1060, fig. 672c, 1932; Desikachari, pl. 48, fig. 7, p – 288, pl -49, fig. 12, p- 292 & pl. 52, fig. 10, p- 304.

Lyngbya majuscula (Gomont) is a toxic, filamentous, trichiome with round ends, Often after periods of high light, warm temperatures and calm weather, eventually float to the water's surface to form large surface aggregations. Unbranched filamentous cyanobacteria termed 'mermaid hair or fireweed'. Cyanobacteria produce a large number of anticancer compounds that inhibit development of several types of cancer cells. Curacin – A (cyclopropyl-substituted thiazoline heterocyclic ring) is isolated from this majuscule and acts as an anticancer compound.

**Lyngbya wollei**

*Lyngbya* species form long, unbranching filaments inside a rigid mucilaginous sheath. Sheaths may form tangles or mats, intermixed with other phytoplankton species. They reproduce asexually. Their filaments break apart and each cell forms a new filament. Saxitoxin produces cyanobacteria. The mats grow around fresh water. (Meagan, *et al.,* 2020).

**Cylindrospermum muscicola (Kutzing ex Born. Et Flah.)**

Geitler, Kryptogamenflora. 822, fig. 520d, 1932; Desikachari, 1959, pl. 65, fig 3, p – 365.

Cylindrospermum has curved or slightly coiled cylindrical or barrel shaped filaments composed of rectangular cells. The cells are joined together end to end to form long, unbranched, untappered, straight or slightly curved filaments. They lack gas vesicles that have visible granules. The trichomes are enclosed in loose, colorless, homogeneous mucilage. Heterocysts are terminal at one end only and spores are next to heterocyst as well as bigger.

**Nostoc communae (Voucher)**

Geitler, Kryptogamenflora. 845, figs. 536, 537, 1932; Desikachari, 1959, pl. 68, fig. 3, p – 378.

Nostoc also known as star jelly, troll's butter, spit of moon, fallen star, witch's butter, and witch's jelly, is the most common genus of cyanobacteria found in various environments that may form colonies composed of filaments of moniliform cells in a gelatinous sheath of polysaccharides. Thallus firm, gelatinous, membranous or leathery, blue green, olivacous or brown, filamentous, entangled, thick, yellowish brown, short barrel shaped, heterocysts nearly spherical, spores only once observed, as big as vegetative cells epispore smooth colorless.

**Calothrix elenkinii Kossinskaja**

Not. Syst. Crypt. Inst. Horti Bot. Petropol., 3: 11, 1924; Geitler, Kryptogamenflora. 609, fig. 383 (5-6), 1932; Desikachari, 1959, pl. 114, figs – 5,6,11, p - 541.

Calothrix is a genus of cyanobacteria found in freshwater and trichome long attenuated gradually. They are heteropolar, tapered at one end, expressing heterocyst, sheath, akinetes formed in few species and confused with Homeothrix.

**Stigonema hormoides (Kutz.) Born. Et Flah.**

Geitler, Kryptogamenflora. 499, fig. 302, 1932; Desikachari, pl.134, fig. - 1 – 4, P- 605.

Filamentous prostate, dense interwined, long, forming a thin blackish brown thallus, irregularly and sparsely branched, erect, curved; colorless or yellow to yellowish brown single rowed, heterocysts sparse chroococcoid conidia present.

**CONCLUSION**

Environmental shifts due to human activities or introduction of biological elements can result in major changes in the ecosystem. Algae contaminations in water resources are not suitable for drinking and the algal toxins pollutants also induce health issues. Swallowing of algal contaminated water or taking nutritional supplements, inhalation, direct contact with skin and eye contact are the risk inducing factors. Even though it is safe for consumption after boiling, we have to avoid such risky places from direct and indirect contact (pets). Water soluble toxins of algae have allelochemical properties like plant-plant, plant-soil, plant-insect, plant-microbial and plant-animal interactions. These resources or the raw materials are kept for agricultural production in future.

**BIBLIOGRAPHY**

1. Angelina Michael., Margareth Serapio Kyewalyanga and Charles Venance Luomela, 2019. Biomass and nutritive value of Spirulina cultivated in a cost effective medium, Annals of Microbiology, 69, 1387 -1395.

2. Archana Tiwari and Deepika Sharma., 2013. Antibacterial activity of bloom forming Cyanobacteria against clinically isolated Human Pathogenic Microbes, Journal of Algal Biomass Utilization, 4:1, 83-89.

3. Barry H. Rosen and Ann St. Amand., 2015. Field and laboratory guide to freshwater cyanobacteria Harmful Algal Blooms for Native American and Alaska Native Communities, USGS science for a changing world, open file report 2015 – 1164, 1- 54.

4. Cecile Bernard., Andreas Ballor., Solene Thomazeaau., Selma Maloufi., Ambrose Furey., Joanna Manikiewicz., Barbara Pawlik- Skowronska., Camilla Capelli., and Nico Salmaso., 2017. Handbook of Cyanobacterial Monitoring and Cyanotoxin Analysis, 1 ed, 1-25.

5. Cyanobacteria and cyanotoxins: Information for drinking water systems, EPA United States Environmental Protection agency, 2014. http://water.epa.gov/scitech/drinkingwater/dws/ccl/

6. David A. Caron., Avery O. Tatters., and Eric A. Wwbb., Documenting multiple phycotoxins in coastal ecosystems of California coast, University of Southern Claifornia Sea Grant Proposal,

7. Edward G. Bellinger and David C. Sigee., 2010. Introduction to freshwater Algae, Freshwater Algae: Identification and use as Bioindicators, 1-40.

8. Ingrid Chorus and Jamie Bartram., 1999. Toxic cyanobacteria in water: A Guide to their public health consequences, monitoring and management, WHO, ISBN- 0-419-23930-8, 1-400.

9. Lakshmi Kumari., Samad and Siba Prasad Adhikary., 2008. Diversity of Micro-algae and Cyanobacteria on Building Facades and Monuments in India, Algae, 23:2, 91-114,

10. Maya Stoyneva Gartner., Katerina Stefanova., Jean Pierre Descy., Blagoy Uzunov., Mariana Radkova., Vera Pavlova., Mariya Mitreva and George Gartner., 2021. *Microcystis aeruginosa* and *M.wesenbergii* were the primary planktonic Microcystin producers in several Bulgarian waterbodies, Applied Sciences, 1 -19.

11. Meagan L. Smith., Danielle C. Westerman., Samuel P. Putnam., Susan D. Richardson., and John L. Ferry., 2019. Emerging *Lyngbya wollei* toxins: A new high resolution mass spectrometry method to elucidate a potential environment threat, Harmful Algae, doi: 10.1016/j.hal.2019.101700.

12. Melissa, Y., Cheung, L., Song Liang and Ji young Lee, 2013. Toxin-producing Cyanobacteria in Freshwater: A Review of the Problems, Impact on Drinking Water Safety, and Efforts for Protecting Public Health, Journal of Microbiology, The Microbiological Society of Korea, 1:51, 1–10.

13. Occurrence of cyanobacterial toxins (microcystins) in surface waters of rural Bangladesh – pilot study, 2004. WHO, 1-24.

14. Odelu, G., 2015. Phytoplankton Comparative Studies of Polluted And Non Polluted Ponds of Jammikunta & Huzrabad Mandals, Karimnagar, Telugana State, India. Journal of Applied Science And Research, 3:6, 16 – 24.

15. Paul A. Broady., Faradina Merican., Phylum Cyanobacteria: blue green bacteria, blue green algae, 2012. Research gate, 1 -21. : https://www.researchgate.net/publication/281600202

16. Pratibha Gupta, 2019. Occurrence of Genus Microcystis Lemmerm. From water bodies of Maldah district, West Bengal, India, The Journal of Tropical Plant research, 6:2, 233 -240.

17. Richa Tandon., Sarika Kesarwani., Arti Mishra., Anupam Dikshit and Tiwari, G. L., 2016. Genus Microcystis Kuetzing ex Lemmermann (Chroococcales, Cyanoprokaryota) from India, Phycological Society, India, 46:2, 4 - 13

18. Singh R.K., Tiwari S.P., Rai A.K., and Mohapatra T.M., 2011. Cyanobacteria: An emerging source for drug discovery. Journal of Antibiotics, 64, 401–412.

19. Victor Vasconcelos., 2006. Eutrophication, toxic cyanobacteria and cyanotoxins when ecosystems cry for help, Limnetica, 25(1-2), 425 -432.

20. Vijayan, D., Manivannan, K., Santhoshkumar, S., Pandiaraj, D., Mohamedimran, M., Thajuddin, N., Kala, K and Muhammad Ilyas, M. H., 2014, Depiction of Microalgal diversity in Gundar Lake, Tiruchirappalli District, Tamil Nadu, India, Asian Journal of Biological Sciences, 7:3, 111- 121.

21. Vincent, W.F., 2009. Cyanobacteria, Elsevier, 226 – 232.

22. Water Treatment Optimization for Cyanotoxins, EPA United States Environmental Protection agency,2016.https://www.epa.gov/dwstandardsregulations/optimization-programdrinking-water-systems