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MORPHOLOGY & ECOLOGY OF SELECTED BGA (*AULOSIRA, TOLYPOTHRIX, ANABAENA, NOSTOC)*

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ABSTRACT

The cyanobacteria are an ancient group of prokaryotic organisms that are found all over the world in environments as diverse as Antarctic soils and volcanic hot springs, and often where no other vegetation can exist. Being prokaryotes they share with others of their type the lack of a nucleus and a laminated extracellular wall. Unlike photosynthetic bacteria however, cyanobacteria possess chlorophyll-a in common with photosynthetic eukaryotes, and they liberate oxygen during photosynthesis. Cyanobacteria are ubiquitous in waters of a great range of salinity and temperature, and they occur in and on the soil as well as on rocks and in their fissures. As well, they form symbiotic and commensal relationships with a number of other organisms. In general, they are most abundant from waters with a neutral or slightly alkaline pH and can exhibit diurnal variation in abundance in waters with low buffering capacity. The name "blue-green algae" derives from the fact that the first species to be recognised and named were blue-green in colour, and although most species are in fact blue-green many are not.

KEYWORDS: Cyanobacteria, Prokaryotic, Antarctic Soils, Volcanic Hot Springs, Chlorophyll-A, Symbiotic etc

INTRODUCTION

Irrespective of the form of any particular species however, all the vegetative cells are more or less alike. Each is surrounded by a cell wall composed of peptidoglycan and lipopolysaccharide layers which is in turn surrounded by a gelatinous or mucilaginous sheath. Interior to the cell wall lies the plasma membrane which encloses the cytoplasm (*Lang, 1968; Bold & Wynne, 1985)*. Being prokaryotic, cyanobacteria lack a nucleus or distinct intracellular organelles *(Fuhs, 1968; Lang, 1968)* and are characterised by the presence of phycobiliprotein *(Ganf et al., 1991).*

MORPHOLOGY

Aulosira trichomes is uniserate and enclosed in the firm individual sheaths, found mostly single but sometimes in clusters but never occurs in mats. Heterocysts occurs occasionally along with the trichomes at regular intervals and they are little larger than the vegetative cells. Found in benthos region of unpolluted ponds and lakes, among stick cells and plants are attached to form string of beads or un-branched filaments that may be appear coiled and twisted randomly, entangled with so many other filaments or sometimes springs like coiled. Vegetative cells may be 4-14 mm diameter and 6-12 mm long with conspicuous, granular contents and refractive pseudo vacuoles. Within a filament of vegetative cells two types of spherical cells in various numbers may be present. Akinete may appear spherical to sausage shaped having 6-13 mm diameter and 20-50 mm long. Heterocyst are somewhat spherical, 7-9 mm diameter, 6-10 mm long and which is also appear empty.

Morphology of *Tolypothrix tenuis* Culture bluish-green; trichome pale blue in colour; sheath around the trichome visible; some of the filaments were tapered. *Tolypothrix* are found filamentous, heteropolar filaments, wooly mats or clusters or united in fasciculate, basal parts are with free apical ends and heterocytes, branches are rarely geminate but mainly in cultures, commonly false branching; branches initiate usually at originally intercalar heterocytes (commonly unipored), waved, long, diverging from the main filaments or for a minimum distance joined to the essential filament and later diverging. Sheaths thick or thin, merged to the trichome, commonly lamellated, yellow-brown or colourless, apex open. Trichomes and branches uniserial, with several or one basal heterocytes, cylindrical, not attenuated at the end, unconstricted or constricted or at the cross walls. Akinetes rarely in some species *(Komarek, 1992)*.

Morphology of *Anabaena* sp. Culture bluish-green; mostly short filaments, but some rather longer; trichome straight or entangled, vegetative cell barrel-shaped or cylindrical. The BGA *Anabaena azollae* consists of unbranched trichomes having bead-like, much pigmented vegetative cells, near about 6 µm in diameter and 10 µm in length, and lightly pigmented, intercalary heterocysts which are little larger and have thicker cell walls *(Van Hove, 1989)*. In very new leaves, trichomes lack heterocysts. Heterocysts gradually enhance in frequency until they comprise 30 to 40 percent of the BGA cells *(Van Hove, 1989)*. Hill (1977) stated that the frequency of heterocyst to reach upto 15^{th} leaf from the apex is about 30% in the cell. Akinetes (spores) are also contained by the mature trichomes and as per stated by *Peters (1975)* trichomes consist on average of 23.1% heterocyst, 60.9% vegetative cells and 16% of akinetes.

Morphology of *Nostoc commune* Culture bluish-green in colour; Morphology of *Nostoc ellipsosporum* Culture bluish-green; trichome longg healthylooking, some short; a few degenerated vegetative cells; heterocyst bigger than the vegetative cell, a few heterocyst-like cells, rather longer than others, but the same pale yellow-green in colour. *Nostoc muscorum* Culture bluish-green; trichome bright in colour, straight or entangled; heterocyst more or less rounded. *Nostoc punctiforme* Culture bluish-green; thallus forming; filamentous filaments contorted and entangled; small irregular young colonies with a sheath and a heterocyst present. Cells more or less rounded, deeply constricted at their septa.

ECOLOGY

Different genera of cyanobacteria vary in their response to temperature. Cyanobacteria can be found growing on rocks in the Antarctic and in hot volcanic springs. These however represent the exceptions. Most cyanobacteria forming nuisance blooms in fresh or brackish waters are from five genera: *Anabaena, Apkanizomenon, Microcystis, Noddaria* and *Oscillatoria*. In marine environments *Trickodesmizm* also forms toxic blooms. The photosynthetic capacity, specific respiration rate and growth rate of *Anabaena* genera are optimised at temperatures of 25^0C or greater. However, different genera and species vary in their responses to low temperatures, with *Microcystis* being most severely limited at temperatures below 15^0C *(Robarts & Zohary, 1987)*.

Cyanobacteria refer from the order Chrococcales, family of Osillatoriaceae and Nostacaceae and normally found in planktonic forms. Various species get grow in abidance and whole body of water coloured and also form water blooms. So many genera as 41 of 251 species of cyanobacteria has listed by Hurber – Pestalozzi which is found in freshwater planktons *(Desikachary, 1959)*. Microcyst is associated in tropical fresh water with permanent blooms that are constant to sunshine, nitrates, silicate, warmth or nutrients like phosphate, lime & CO_2 and it shows dominancy of microsyst organisms *(Frankelin, 1972).*

From the surrounding areas the source of nitrogen for fresh water includes drainage, and free ammonia dissolve through precipitation from atmosphere and from the dead populations release nitrates. Nitrates combine nitrogen from a preferred source of non – toxic and high rate of nitrification produce as a result under water logged conditions *(Cristofir, et.al., 1981).* Due to buoyant nature of cyanobacteria, formation of cyanobacterial blooms is necessary. The surface accumulation rate of these organisms depends within their cells upon the numbers of gas vacuoles and also buoyancy is necessary by the gas vacuoles. On the water surface of ponds, lakes and reservoirs gas vacuoles containing cyanobacteria form dense growth and also cause production of toxins *(Carmichael, 1994)* and, a serious nuisance due to visual appearance, and unpleasant odour such as geomin produced by the *(Juttner, 1987).*

Komarek (1992) reported that *Tolypothrix* are mainly submerse and growing in not polluted water littorals, among other algae or reservoirs on stones and water plants, pools, in springs, streams, mineral springs but various species are limited as ecologically and they grow in alkalic swamps in some areas of lime stones. Some species need taxonomic revision mostly but they are only known from tropical biotopes. Various species are described from bark of trees, wet sandy soils, wet stones, sand stone walls or calcareous walls (aerophytic habitats)

ANABAENA and azolla lives together as a symbiotic complex in which the endophytic BGA *Anabaena* azolla strasburger resides within the cavities of leaf of water fern Azolla Lain. The nitrogen fixing endosymbiont provides sufficient nitrogen for itself as well as for host *(Peters, 1978)*. On the other hand for the algae the water fern provides a protected environment and also supplies it with a settled carbon source *(Peters, 1976).*

It has also been little success to transferring of one species of Azolla to another species in *Anabaena (Watanabe & Liu, 1992)*. Transferring *Anabaena* from temperature-tolerant *Anabaena* microphylla to *Anabaena*-free *Anabaena filiculoides*, resulted in high-temperature tolerance may be partially controlled by the symbiont.

Nostoc can form microscopic and macroscopic colonies and it is common in aquatic and terrestrial both type of habitat because of its belonging to genus of filamentous cyanobacteria. Full of the success of *Nostoc* in terrestrial habitats is associated to its capability to remain desiccated for years or months and entirely recover metabolic activity within hours to days after re-hydration with liquid water. *Nostoc* has adoptability to repeated cycles of freezing and thawing and, thus, shows is an important component of intense terrestrial habitats in the stress Antarctic and Arctic *(Walter, et.al., 1995).*

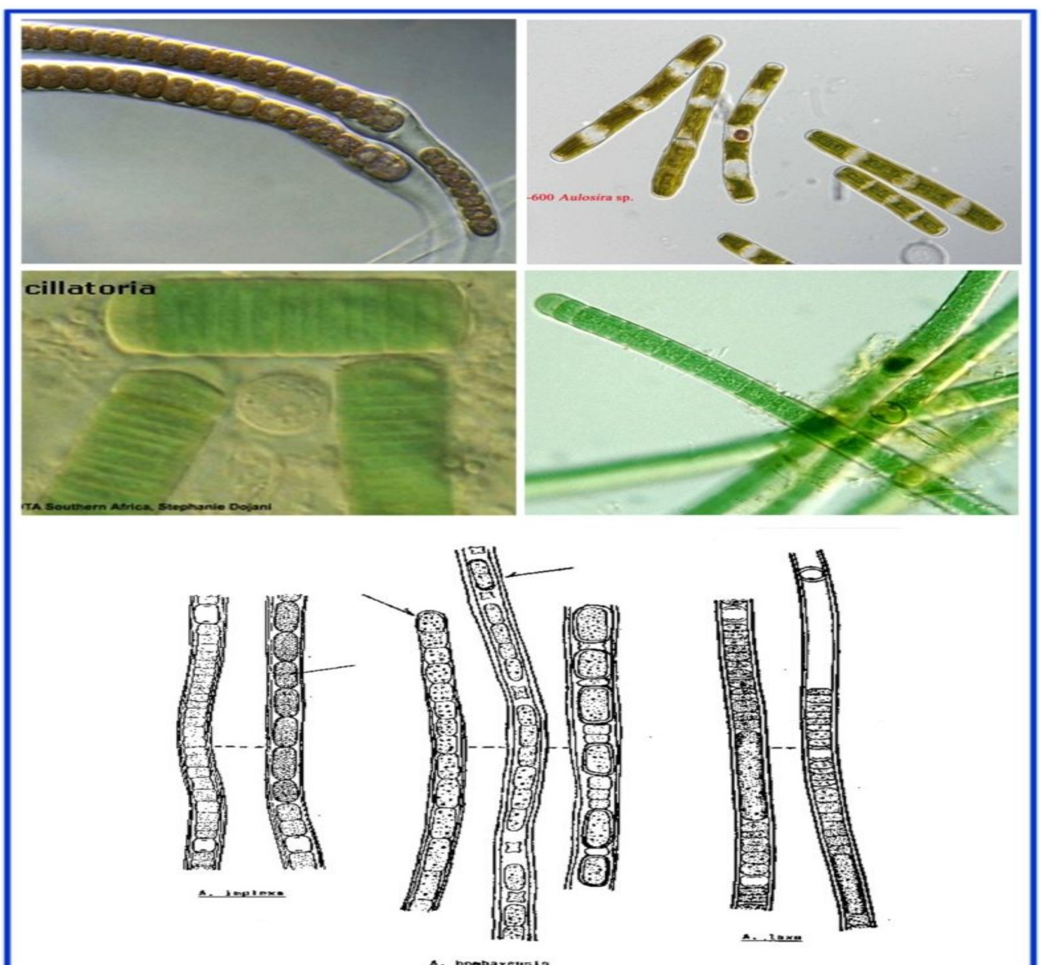
MATERIALS AND METHODS

The soil used in this study was taken at 0 - 20 cm depth supplied from Village Mawai nearby 10 km from Churhat, District-Sidhi (M.P.) Soil samples were air dried to be used for isolation of microalgae and other samples were autoclaved for undergoing Pot experiment. Some mechanical, physical and chemical properties of soil were analysed before conducting the Pot experiment. The four nitrogen fixing cyanobacteria *Aulosira, Tolypothrix, Anabaena* and *Nostoc* which were isolated from the soil experimented. These cyanobacterial species were selected on the basis of their wide occurrence, fast growth and high nitrogen fixing ability. All organisms were used as biofertilizers. Isolation of the organisms in axenic cultures is essential to the study of heterotrophic growth. Different methods have been tried to obtain axenic cultures in the course of the present study, including repeated sub culturing on agar plates, repeatedly washing cells in sterile medium *(Pringsheiem, 1946),* and treatment of the algae with dilute chlorine water *(Fogg, 1942).*

The use of antibiotics seemed to offer a possible method for freeing blue-green algae of bacterial contaminants. Therefore various antibiotics were employed, and a bacteria free culture of *Aulosira*, *Tolypothrix*, *Anabaena*, *Nostoc* was found after treatment with neomycin and the alga.

RESULTS

The four BGA member's morphology and ecology were noted. These species popularly known as nitrogen fixer enhance the overall parameters of physico-chemical properties of the habitat of system. Perhaps, these species improve the macronutrients status of soil. To improve the physical status of the habitat through which many nutrient which are enable to participate in the system through breakage of the limitation barrier extend possibility of enhancing crop production of the whole area. These species used as such for large production of bio-fertiliser. This is clearly evident from the morphology and other characteristics of these algae. These four species and related isolate were taken from the IARI, New Delhi. To assess their role in improving the overall strata of edaphic habitat. Many works proves the significant contribution of these algae which are main contributor in the habitat of paddy field. Many algolist contributions are evident for enhancing the greater role for improving the status directly or indirectly.



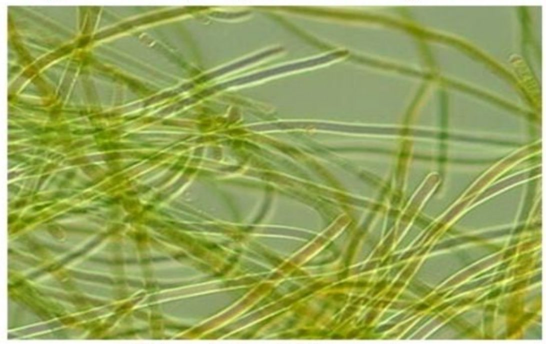
MORPHOLOGY OF AULOSIRA

* Photograph were compared, verified & taken from the text referred photograph available on the internet for clear identification

Tolypothrix tenuis photographed at higher magnification right

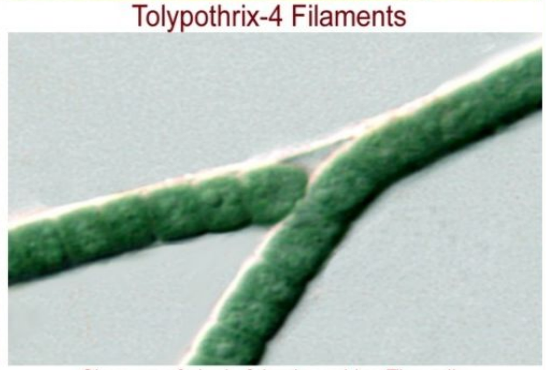
Tolypothrix tenuis photographed at low magnification Left

Tolypothrix-3 Junction

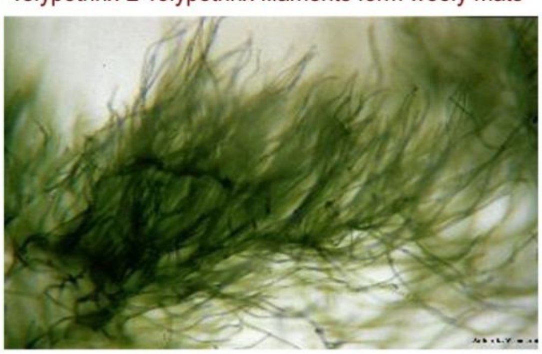


Tolypothrix-4 Filaments

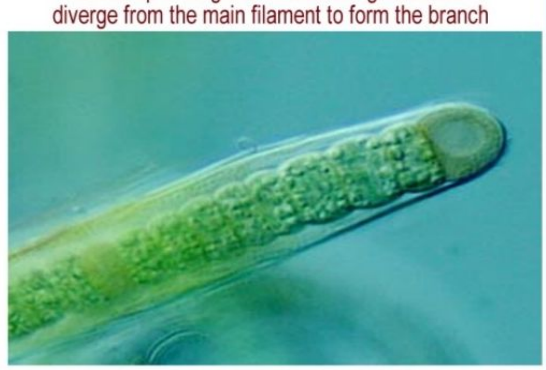
Tolypothrix-2 Tolypothrix filaments form wooly mats



Close-up of single false branching The cells diverge from the main filament to form the branch



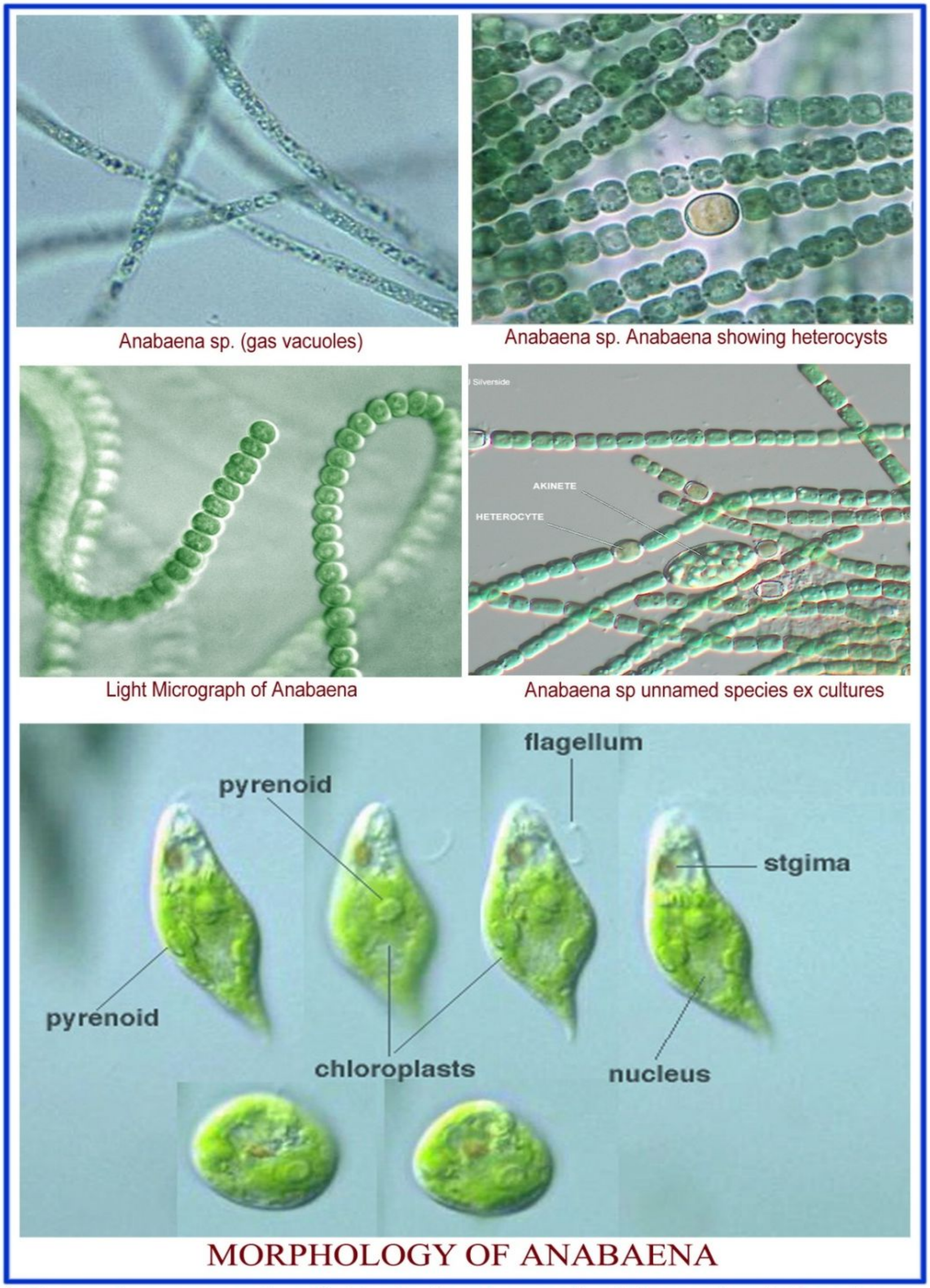
Tolipothrix sp. (overview)



Tolypothrix-2 Filament Tip

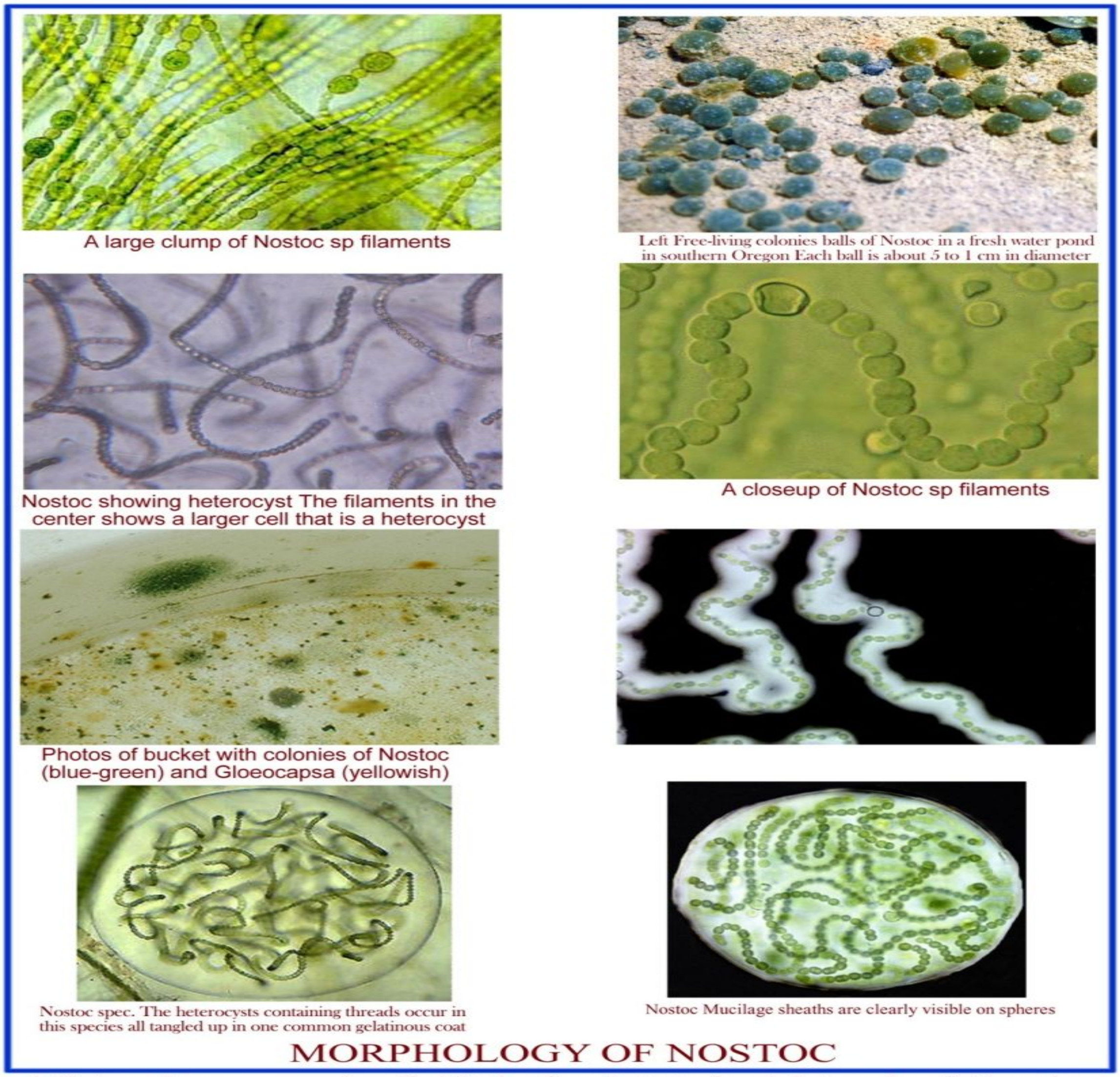
MORPHOLOGY OF TOLYPOTHRIX

* Photograph were compared, verified & taken from the text referred photograph available on the internet for clear identification



MORPHOLOGY OF ANABAENA

* Photograph were compared, verified & taken from the text referred photograph available on the internet for clear identification



* Photograph were compared, verified & taken from the text referred photograph available on the internet for clear identification

DISCUSSIONS

BGA occupy a unique position and posses metabolic system like bacteria, an autotrophic mode like eukaryotic plant cells. They have chlorophyll 'a' for carry out photosynthesis and exhibit great diversity of morphology with their broader spectrum of physiological properties shows their widely distribution and tolerance of environmental stress *(Tandeau and Howard, 1993).* The detail studies of BGA in the various geographical part of India reported interesting results *(Venkataraman, 1975; Kolte and Goyal, 1985; Singh, 1985)*. Various reports have already been published on widly distribution of forms like Nostoc, *Oscillatoria, Anabaena, Aphanothece and Phormidium (Gupta, 1975; Sinha and Mukherjee, 1975; Garcia-Pichel and Belnap, 1996).* Some species reported from soil of cuttack and Orissa, those are dominating heterocutous N2 fixing Blue green algae species of *Nostoc, Anabaena, Tolipothrix, Aulosira, Calothrix*, and Cylindrospermum *(Singh, 1961).* Distribution of isolated cyanobacteria in the soil of Howrah, Cuttack and Bhuwaneshwar, indicated that heterocytous strains are predominance in the natural habitat *(Saxena, et.al., 2007).*

Saadatnia & Riahi (2009) has shown experimental work on germination of rice seeds treated with cyanobacteria compare than control. The more germination was reported with blue-green algae.BGA are uses as a major component for the nitrogen fixation in the paddy fields. In the cultivation of rice the agricultural importance of cyanobacteria is related directly with the nitrogen fixing ability and some other positive effect for soil and paddy plants. Nitrogen is the second limiting factor after the water for growth of plants in various fields and deficiency of this element is met by biofertilizer (*Malik, et.al, 2001).*

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REFERENCES

1. Lang, N.J. 1968. Ultra structure of the blue-green algae. In: Algae, man and the environment. (ed. D.F. Jackson). Syracuse University Press, New York. pp. 235-248.
2. Bold, H.C. and Wynne, M.J. 1985. Introduction 2nd to the algae. Structure and reproduction. ed. Prentice-Hall Inc., Eaglewood Cliffs, N.J.
3. Fuhs, G.W. 1968. Cytology of blue-green algae: light microscopical aspects. In: Algae, man and the environment. (ed. D.F. Jackson). Syracuse University Press, New York. pp. 213-233.
4. Ganf, G.G., Heaney, S.I. and Corry J. 1991. Light absorption and pigment content in natural populations and cultures of a non-gas vacuolate cyanobacterium Oscillatoria bourrellyi (= Tyckomema bowrellyi). J. Plank. Res. 13(5), 1101-1121.
5. Komarek J. 1992. http://www.cyanodb.cz/Aulosira.
6. Van Hove, C. 1989. Azolla and its multiple uses with emphasis on Africa. Food and Agriculture Organization, Rome. State University Press, Pullman.
7. Hill, D.J. 1977. The role of Anabaena in the Azolla-Anabaena symbiosis. New Phytol. 78:611-616.
8. Peters, G.A. 1975. The Azolla-Anabaena azollae relationship III. Studies on metabolic capacities and a further characterization of the symbiont. Arch. Microbiol. 103:113-122.
9. Robarts, R.D. and Zohary, T. 1987. Temperature effects on photosynthetic capacity, respiration, and growth rates of bloom-forming cyanobacteria. N.Z.J. Marine Freshzoat. Res. 21,391-399.
10. Desikachary, T.V. 1959. Cyanophyta: I.C.A.R. monograph on algae, New Delhi, India, 686pp.
11. Frankelin, T. 1972. Blue–green algae of some Tropical reservoirs of South India. In Taxonomy and Biology of Blue–Green Algae (ed. Desikachary, T. V.), University of Madras, Chennai, pp. 442–447.
12. Peters, G.A. 1978. Blue-green algae and algal associations. BioScience 28: 580-585.
13. Cristofir, N., Preston, T. and Stewart, W. D. P. 1981. Endogenous nitrate production in an experimental enclosure during summer stratification. Water Res.,15, 343–349.
14. Carmichael, W.W. 1994. The toxins of Cyanobacteria. Scientific American 270 (1): 78-86.

15. Juttner, F. 1987. Volatile organic substances. In The Cyanobacteria (eds Fay, P. and Van Bealen, C.), Elsevier, Amsterdam, pp.453–469.
16. Peters, G.A. 1976. Studies on the Azolla-Anabaena azollae symbiosis. Pages 592-610 in W. E. Newton & C. L Nyman (ed.), Proceedings of the First International Symposium on Nitrogen Fixation. Vol. 2. Washington.
17. Watanabe I. and Liu, C.C. 1992. Improving nitrogen-fixing systems and integrating them into sustainable rice farming. P1. & Soil 141: 57-67.
18. Walter K.D., Gudder D.A. and Dieter M. 1995. The Ecology of Nostoc, Journal of Phycology; Volume 31, Issue 1, pages 2–18, DOI: 10.1111/j.0022-3646.00002.x.
19. Pringsheiem, G. 1946. Pure Cultures of Algae. Cambridge University Press.
20. Fogg, G.E. 1942. Studies on nitrogen fixation by blue-green algae. I. Nitrogen fixation by Anabaena cylindricu Lemm. J. exp. Biol. 19, 78.
21. Tandeau de Marsac and Houward, J. 1993. Adaptation of cyanobacteria to environmental stimuli: new steps to the world's molecular mechanism. FEMS. Microbiological review. 104: 119-190.
22. Venkataraman, G.S. 1975. The role of blue green algae in tropical paddy cultivation. In: W. D. P. Stewart (ed.), Nitrogen fixation by free living microorganisms. 207-218. Cambridge University Press, London.
23. Kolte, S. O. and Goel, S. K. 1985. Distribution pattern of blue green algae in paddy field soils of Vidharb region of Maharashtra state. Phykos. 24: 156-162.
24. Singh, P.K. 1985. Nitrogen fixation by blue green algae in paddy soils. In: Paddy Research in India. ICAR Publication, New Delhi.
25. Gupta, D. 1975. Some new records of blue green algae from West Bengal. Bulletin of Botanical Society of Bengal. 19: 1-2.
26. Sinha, J.P. and Mukherjee D. 1975. Blue green algae from the paddy fields of Bankura District of West Bengal. Phykos. 14: 117-118. 338.
27. Garcia-Pichel, F. and Belnap J. 1996. Microenvironments and micro scale productivity of cyanobacterial desert crusts. Phykos. 32: 774-778.
28. Singh, R.N. 1961. *Role* of *Blue-green Alpe in Nirrogen Econoin? of hdian .4griculriire.* Indian Council of Agricultural Research. New Delhi.
29. Saxena, S., Singh, B.V., Tiwari S. and Dhar D.W. 2007. Physiological characterization of cyanobacterial isolates from Orissa and West Bengal. Indian Journal of Plant Physiology.12 (2): 181-185.
30. Saadatnia, H. and Riahi, H. 2009. Cyanobacteria from paddy-fields in Iran as a biofertilizer in rice plants. Plant Soil Environment 55(5): 207–212.
31. Malik, F.R., Ahmed, S. and Rizki, Y.M. 2001. Utilization of lignocellulosic waste for the preparation of nitrogenous biofertilizer. Pakistan Journal of Biological Sciences, 4: 1217–1220.