DISTRIBUTION OF BLUE GREEN ALGAE FROM PADDY FIELD IN BO TAUG KONE VILLAGE OF PATHEINGYI TOWNSHIP, MANDALAY REGION

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Abstract

Blue Green Algae perform as a bioindicator for paddy field and play the important roles in agricultural soils. The algae specimens and soil samples were collected from paddy field of Bo taug kone village, Patheingyi Township during the months from June 2022 to January 2023. A total of twenty-four species belonging to eleven genera of division Cyanophyta were identified according to their morphological characteristics. The soil pH, electrical conductivity, nitrogen, phosphorus, potassium, moisture and soil texture were measured. Nitrogen fixation blue green algae such as *Anabaena ambigua, A. orientalis, A. variabilis, Cylindrospermum muscicola, Nostoc ellipsosporum, N. microscopicum, N. commune, N. paludosum, N. spongiforme, Gloeotrichia raciborskii* and others blue green algae species were found in the paddy field soil. The present study concludes that the blue green algae enhances soil fertility and is capable of nitrogen fixation for agriculture soil.

Keywords: Bo Taug Kone village, Blue Green Algae, Morphological characteristics

Introduction

Blue green algae are autotrophic which are capable of nitrogen fixation. It has ability to convert nitrogen into nitrate and nitrites, which are easily absorbed by the plant. Thus, blue green algae enhance growth and productivity of the crop plant by providing usable nitrogen through soil and improving the fertility of soil (Jadhav & Talekar, 2019). Blue green algae are the main components of the microbiota in rice fields and play an important role in the maintenance and build-up of soil fertility, consequently increasing rice production (Thajamanbi *et al*., 2016).

Rice field ecosystem provides favorable environment for the growth of various groups of algae with respect to their requirement of light, water, temperature and nutrient availability (Venkataraman, 1981). Blue green algae are extremely important to fix atmospheric nitrogen in rice fields. They can contribute to the natural fertility of the soils through nitrogen-fixation in their heterocysts.

Kamat (1975) stated that the nitrogen fixing algae not only fix atmospheric nitrogen when they grow in paddy fields but they also enrich the soil with nitrogen and thereby make nitrogen available to the plants growing in these areas. Blue green algae such as *Aulosira, Porphyrosiphon, Scytonema, Lyngbya, Microcoleus, Anabaena, Nostoc, Cylindrospermum* and *Aphanothece* grow extensively in the cultivated soils.

In Myanmar, Khin Mya Mya and Than Tun (1976) examined the nitrogen fixing of blue green algae in Patheingyi of Mandalay area. Khin Nilar Than (1994) investigated that the blue green algae in Patheingyi of Mandalay area. The study of blue green algae is relatively scarce for Myanmar. So, this study emphasized on the blue green algae from paddy field of Bo taug Kone village, Patheingyi Township. The soils in Bo taug kone village are mainly used for rice cultivation. Bo taug kone paddy field is irrigated by the water from the irrigation supply channel, Setawgyi Dam. The aim of the study is to identify the blue green algae from paddy field soils, to investigate physico-chemical features of the soil and to reveal beneficial blue green algae for agriculture.

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Materials and Methods

Study area

Bo taug kone village is one of the 140 villages of Patheingyi Township and it is situated in the North-East of Mandalay City. It lies between the latitude of 21º 51'- 22º 09' N and the longitude of 96º 01'- 96º 22' E. Locationally, Patheingyi is 5 miles far from Mandalay and in the North-East of Mandalay City. This area is characterized by a mean temperature of 29°C. The annual rainfall is 33.77 inches and the mean humidity is 71%. The elevation is 250 m above sea level.

Identification of algae

The algae specimens were collected at random during the months from June 2022 to January 2023. The soil samples were collected on sunny days having temperature 28-35°C, at 10:00 am-11:30 am. The collected specimens were added to the plastic bottles and brought to the laboratory of Botany, Yadanabon University. In culture, 3 g of soil sample was put into 100 ml capacity conical flask containing 50 ml BG 11 medium. These cultures were incubated under sunlight to promote the growth of algae. They were examined for ten days. The morphological characters of algae specimens were analyzed by using Olympus microscope. Then, the cell shapes were measured by using ocular meter. The morphological characteristics were taxonomically identified with the help of literature by Desikachary (1959), Komarek and Anagnostids (1985), Prescott (1962), Shameel (2012). And then, the soil samples were taken randomly from different places and combined together for subsequent analysis. Soil analyses of soil sample were done by the Department of Agriculture (Land use division), Mandalay Region.

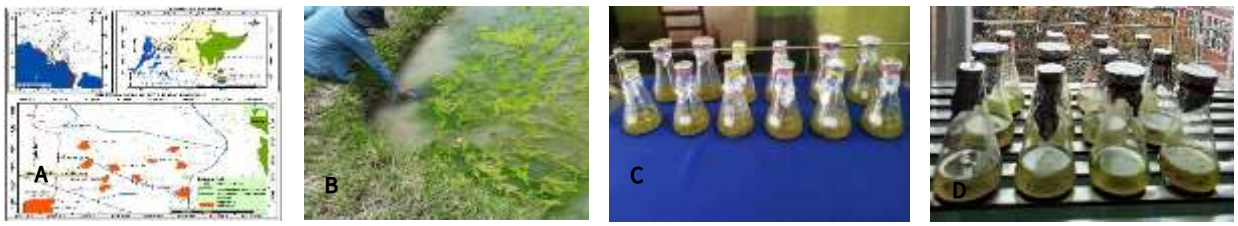


Figure 1. A. Map of study area, B. Algae specimens collect with plastic bottle, C. 3 g of soil inoculated in 50 ml BG 11 Medium, D. Formation of algae after 7 days in BG 11 medium

Results

In the present study, blue green algae 24 species from paddy field of the Bo taug kone village, which belong to 2 classes, 2 order, 4 families and 11 genera were recorded and are described on the following table 1. Cyanophyta (blue green algae) included that unicellular, heterocyst and non- heterocyst filamentous forms. Five different parameters such as pH, EC and concentration of N, P, and K, soil type, moisture and texture were analyzed. The key of the genera and their morphological characteristics of blue green algae are described as follow.

Key to the Genera:

1. Non-filamentous forms ---------- 2
1. Filamentous forms ---------- 4
   2. Sheath present ---------- *Chroococcus*
   2. Sheath absent ---------- 3
3. Cells forming packet-like colonies ---------- *Cyanosarcina*
3. Cells without forming packet-like colonies ---------- *Aphanocapsa*

4. Heterocysts present ---------- 5
4. Heterocysts absent ---------- 8
5. Heterocysts terminal ---------- 6
5. Heterocysts intercalary ---------- 7
6. Trichomes hair present ---------- *Gloeotrichia*
6. Trichomes hair absent ---------- *Cylindrospermum*
7. Trichomes solitary or in a tangled ---------- *Anabaena*
7. Trichomes embedded in obvious and extended firm mucilage ---------- *Nostoc*
8. Trichomes sheath present ---------- *Lyngbya*
8. Trichomes sheath absent ---------- 9
9. Trichomes straight ---------- *Oscillatoria*
9. Trichomes spirally coiled ---------- 10
10. Multicellular, cross wall distinct ---------- *Arthrospira*
10. Unicellular, cross wall indistinct ---------- *Spirulina*

Table 1. Species of Blue Green Algae occurred from paddy field of Bo Taug Kone village.

Phylum	Class	Order	Family	Genus	Species
Cyanophyta	Chroocophyceae	Chroococcales	Chroococcaceae	1. *Aphanocapsa*	*intertexta*
				2. *Chroococcus*	*turgidus* var. *maximus*
				3. *Chroococcus*	*minutus*
				4. *Cyanosarcina*	*burmensis*
	Nostocophyceae	Nostocales	Oscillatoriaceae	5. *Arthrospira*	*khannae*
				6. *Spirulina*	*princeps*
				7. *Spirulina*	*subsalsa*
				8. *Oscillatoria*	*chlorina*
				9. *Oscillatoria*	*rubescens*
				10. *Oscillatoria*	*proboscidea*
				11. *Oscillatoria*	*subbrevis*
				12. *Oscillatoria*	*vizagapatensis*
				13. *Lyngbya*	*martensiana*
				14. *Lyngbya*	*truncicola*
			Nostocaceae	15.*Nostoc*	*ellipsosporum*
				16.*Nostoc*	*microscopicum*
				17.*Nostoc*	*commune*
				18.*Nostoc*	*paludosum*
				19.*Nostoc*	*spongiforme*
				20.*Anabaena*	*ambigua*
				21.*Anabaena*	*variabilis*

Phylum	Class	Order	Family	Genus	Species
			Rivulariaceae	22. *Cylindrospermum*	*muscicola*
				23. *Gloeotrichia*	*raciborskii*
				24. *Gloeotrichia*	*raciborskii* var. *conica*

1. *Aphanocapsa intertexta* Gardner

Colony with no definite, cells agglomerations with up to 50 cells, surrounded by a thin mucilage, cells sub-spherical, light green, with small granules; cells 7.5µm in diameter.

2. *Chroococcus turgidus* var. *maximus* Nygaard

Cells hemispherical, sheath colorless; much lamellate in the inner portion, two-celled colonies, cells 42.5µm in diameter and long, colony 45µm in diameter, 62.5µm in long.

3. *Chroococcus minutus* (Kuetzing) Naegeli

Cells spherical, groups of 4, covered mucilaginous sheath; granule present; cells 25µm in diameter and long, colony 50µm in diameter, 75µm in long.

4. *Cyanosarcina burmensis* (Skuja) Kovacik

Cells irregular, cells join to mucilaginous colonies, cells divide successively in three or more different places, forming small packet-like colonies; cells 8.5µm in diameter, 15.5µm long.

5. *Arthrospira khannae* Drouet et Strickland

Trichome planktonic, multicellular, forming loose spirals, not constricted at the cross walls, ends slightly attenuated, cross walls granulated; cells 5.0µm in diameter, spiral about 20.0µm distant.

6. *Spirulina princeps* W.et G. S West

Trichome loosely spiralled, unicellular, regularly coiled, blue green; distance between spiral 12.5µm in diameter.

7. *Spirulina subsalsa* Oersted ex Gomont

Trichome tightly spiralled, blue green, regularly coiled, tightly coiled, no space between cells; cells 2.5µm in diameter.

8. *Oscillatoria chlorina* Gomont

Trichome straight, not constricted at the cross walls, granules present, apical cell broadly rounded, not capitate, yellow; cells 12.0µm in diameter, 7.5µm in long.

9. *Oscillatoria rubescens* (Kutz.) Gomont

Trichome straight, not constricted at the cross walls, apical cell conical, granule present, ends gradually attenuated, calyptra present, blue green, forming black spot; cells 7.5µm in diameter, 2.5µm long.

10. *Oscillatoria proboscidea* Gomont

Trichome straight, not constricted at the cross walls, apical cells capitate, granule absent at the septa, at the end gradually attenuated and bent, blue green; cells 12.5µm in diameter, 7.5µm in long.

11. ***Oscillatoria subbrevis*** Schmidle

Trichome straight, slightly constricted at the cross walls, granule absent at the septa, slightly curved at the apex, apical cells rounded, yellowish green; cells 7.5µm in diameter, 2.5µm in long.

12. ***Oscillatoria vizagapatensis*** Rao, C.B

Trichome straight, not constricted at the cross wall, apical cell broadly rounded forming a cap with a slightly thickened outer membrane, granules present, blue green; cells 8.0µm in diameter, 9.5µm long.

13. ***Lyngbya martensiana*** Menegh ex Gomont

Filaments caespitose, filament more or less flexible, sheath thin, not constricted at the cross-walls, end cell round, blue green; cells 10.0µm in diameter, 3.0µm in long.

14. ***Lyngbya truncicola*** Ghose

Filaments straight, sheath thin, not constricted at the cross-walls, cells short, apical cell rotund, not attenuated, blue green; cells 10.0µm in diameter, 3.0µm in long.

15. ***Nostoc ellipsosporum*** (Desm.) Rabenhorst

Thallus colonial, gelatinous, irregularly loosely entangled, brownish green; cells cylindrical; 6.5µm in diameter, 14.0µm long; heterocyst sub-spherical, 7.5µm in diameter, 14.0µm long; gonidia ellipsoid; 7.5µm in diameter; 17.5µm long.

16. ***Nostoc microscopicum*** Carmichael

Thallus loosely entangled in mucilage colonial, cells barrel-shaped, 7.5□m in diameter, heterocyst subspherical, 7.5µm in diameter; gonidia barrel-shaped.

17. ***Nostoc commune*** Vaucher ex Bornet & Flahault

Thallus gelatinous mass, colonial, filaments very coiled, densely entangled and interwined, cells sub-spherical, 6.25µm in diameter and 7.5µm long, heterocyst globose, intercalary.

18. ***Nostoc paludosum*** Kutzing ex Born et Flah.

Thallus microscopic, loosely or tightly coiled in gelatinous sheath, yellowish-green; cells barrel-shaped, 5.5µm in diameter, 6.5µm long, heterocyst ovate, 5.0µm in diameter and 7.5µm long; akinetes ovate.

19. ***Nostoc spongiforme*** C.A Agardh

Colony globular of loosely entangled trichome, expanded; cells cylindrical; 5.0µm in diameter; 7.5µm long, the colour changing blue-green to brownish green; heterocysts oblong or ovate, 6.5µm in diameter, 7.5µm long.

20. ***Anabaena ambigua*** Rao, C.B.

Trichome straight or slightly bent, dense clusters, cells barrel-shaped, with deep constriction at the joint, apical cell rounded, granular present; cells 7.5µm in diameter, 5.0µm long, heterocyst spherical, 7.5µm in diameter, 10.5µm long, akinetes ellipsoid, continguous to heterocysts, 12.5µm in diameter, 15µm long, attaching at one both side of the heterocysts.

21. ***Anabaena variabilis*** Kutzing ex Born. et Flah

Trichomes single, flexuous, cells spherical, end cell rounded, heterocyst intercalary, spherical, blue green; cells 6.5µm in diameter, heterocysts 6.5µm in diameter, akinetes not continguous with the heterocysts.

22. *Cylindrospermum muscicola* Kutzing ex Born. et Flah

Thallus mucilagenous, trichome broad, constricted at the cross walls, light blue green; cells quadrate, 4.5- 5.0µm in diameter, heterocysts oblong; 5µm in diameter and 7.5µm long.

23. *Gloeotrichia raciborskii* Woloszynska

Filaments free floating; trichomes heteropolar, ending in a long hair, sheath at the base lamellated, dull brown; cells at the base of the trichome shorter than broad, higher up as long as broad, pale blue green; basal heterocyst spherical, 7.5µm in diameter, cells 2.5µm in diameter and 55µm long.

24. *Gloeotrichia raciborskii* var. *conica* Woloszynska

Filaments free floating; taper towards the end, with a basal heterocyst, with a sheath which often covers the basal heterocyst, sheath thinning out from the base to apex, giving a more or less conical shape, trichomes 7.5µm in diameter, heterocyst 7.5µm long and diameter, cells 55µm long.

Table 2. Soil analytical data of Paddy field in Bo Taug Kone Village

No.	pH (1:25)	Electro Conductivity (mS/cm)	Total Nitrogen (%)	Available Phosphorus (ppm)	Available Potassium (mg/100g)	Soil type	Moisture (%)	Soil texture
1.	7.56	0.17	0.22	5.40	19.47	moderately alkaline	4.40	Sandy loam

Discussion

In this present study, the distribution of blue green algae in the paddy fields from Bo taug kone village in Patheingyi Township, Mandalay region has been studied from June 2022 to January 2023. A total 24 species of blue green algae were identified from paddy field soil. 1 species of *Aphanocapsa intertexta, Arthrospira khannae, Cyanosarcina burmensis* and *Cylindrospermum muscicola*; 2 species of *Anabaena ambigua, A. variabilis, Chroococcus turgidus* var. *maximus, C. minutus, Gloeotrichia raciborskii, G. raciborskii* var. *conica, Lyngbya martensiana, L. truncicola* and *Spirulina princeps, S. subsalsa* and 5 species of *Nostoc* and *Oscillatoria* were recorded. Heterocystous containing cell such as *Anabaena, Cylindrospermum, Gloeotrichia* and *Nostoc* were found in paddy field. *Anabaena* and *Nostoc* species were abundant because akinetes cells are resting spores to withstand adverse environmental conditions in the paddy field. *Cylindrospermum* and *Gloeotrichia* play an important role in the soil nutrients cycling, improvement of plant growth, and development. Singh (1950) reported that *Nostoc* and *Anabaena* can be used in the reclamation of the 'usar' lands. Nitrogen fixation blue green algae are present on paddy field soil to increases the soil fertility and nitrogen fixation will be improved.

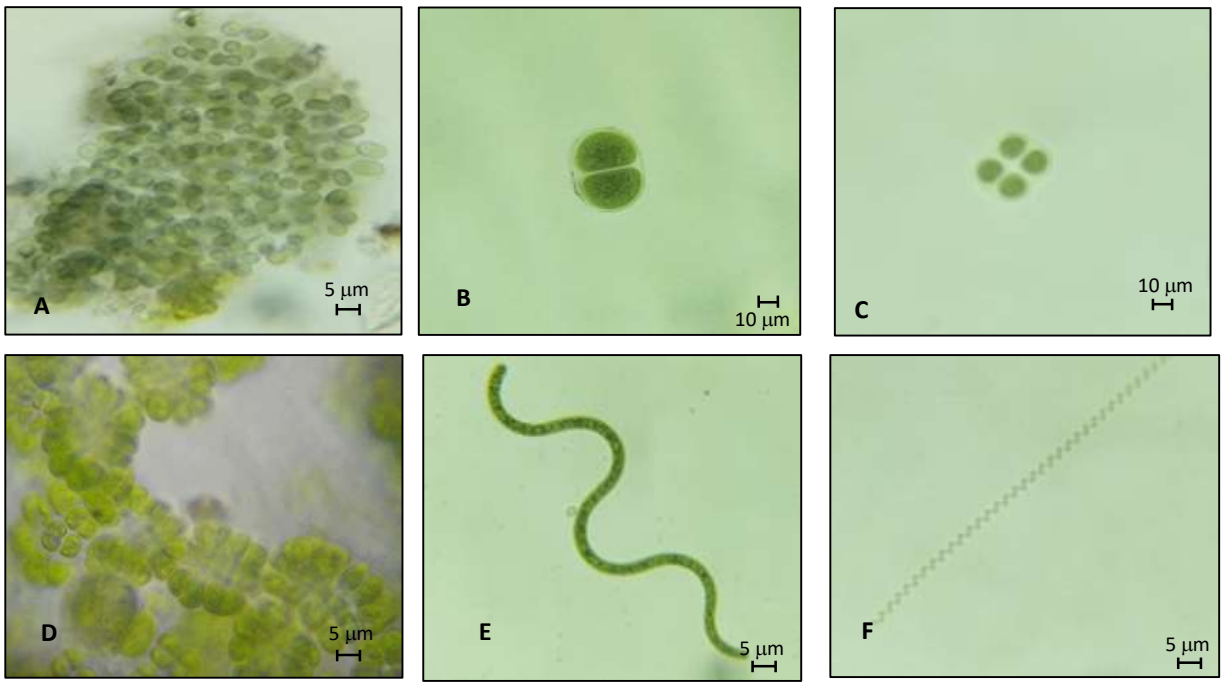
Non heterocystous cells such as *Aphanocapsa intertexta, Chroococcus turgidus var. maximus, C. minutus, Cyanosarcina burmensis, Lyngbya martensiana, L. truncicola Oscillatoria chlorina, O. rubescens, C. proboscidea, O. subbrevis, O. vizagapatensis, Arthrospira khannae, Spirulina princeps* and *S. subsalsa* were observed in this field. The genus of *Anabaena, Nostoc, Oscillatoria, Cylindrospermum* and other genus were commonly found in culture. The genus of *Cyanosarcina* was only found in culture and this genus was not observed on the surface of paddy field. *Oscillatoria* species is not only a source of nitrogen, but also used as organic matter and growth promoting substances for rice cultivation. It can reduce ecological and biochemical imbalance in a rice field. *Spirulina* species is associated with symbiotic bacteria that fix nitrogen which is needed for the growth of plants. Other algae species are able to increase nitrogen in soils.

In this results, the soil of Bo taug kone village was found moderate alkaline and having the pH of 7.56. The alkaline soil is responsible for the growing population of Cyanophyceae. Soil pH affects nutrient solubility in the soil. (Kumari *et al*., 2011) reported that soil pH level of near 7 is optimal for overall nutrient availability, crop tolerance and soil microorganism activity. Blue green algae prefer a slightly alkaline pH 7.5. So, this results agreed with Kumari *et al*., 2011. pH is the most important factor in determining the algal flora composition. Ghadage and Karande (2019) observed an abundant growth of blue green algae in fields with pH ranges from 6.5 to 7.5. In Cultures, optimal pH for growth of cyanobacteria ranges from 7.5 to 10. This result was agreed with Ghadage and Karande. The concentration of total nitrogen, available phosphorus and available potassium have 0.22%, 5.40 ppm and 19.47 in this field. Banakar *et al*., (2020) reported that influences of nutrients especially nitrate and phosphate have in the regulation of Cyanophyceae growth.

The content of the nitrogen, phosphorus and potassium are important factor determining the growth of algae. The moisture of soil and electrical conductivity have 4.40 and 0.17. The Bo taug kone soil texture is sandy loam. Soil texture is also important in agriculture. It was agreed with that of Kamaromy and Padisak (1999) who stated that sandy loam soil has rich algal flora and high algal density. (Jadhav & Talekar., 2019) represented pH and electrical conductivity had a direct influence with the development of algal forms. Rani and Narasimha (2021) stated that a correlation between the composition of the algal flora and soil characters. Blue green algae are economically important both directly and indirectly. The growth of blue green algae depends not only the nutrition in the soil but also their physico-chemical parameters and its environments.

Conclusion

It was concluded that the blue green algae were richly observed from Bo taug kone paddy fields. The blue green algae are beneficial in various ways and its potential application for valuable benefits of human beings as well as other organisms. The blue green algae are present in paddy fields and are helping to maintain soil fertility and to improve the crop production.



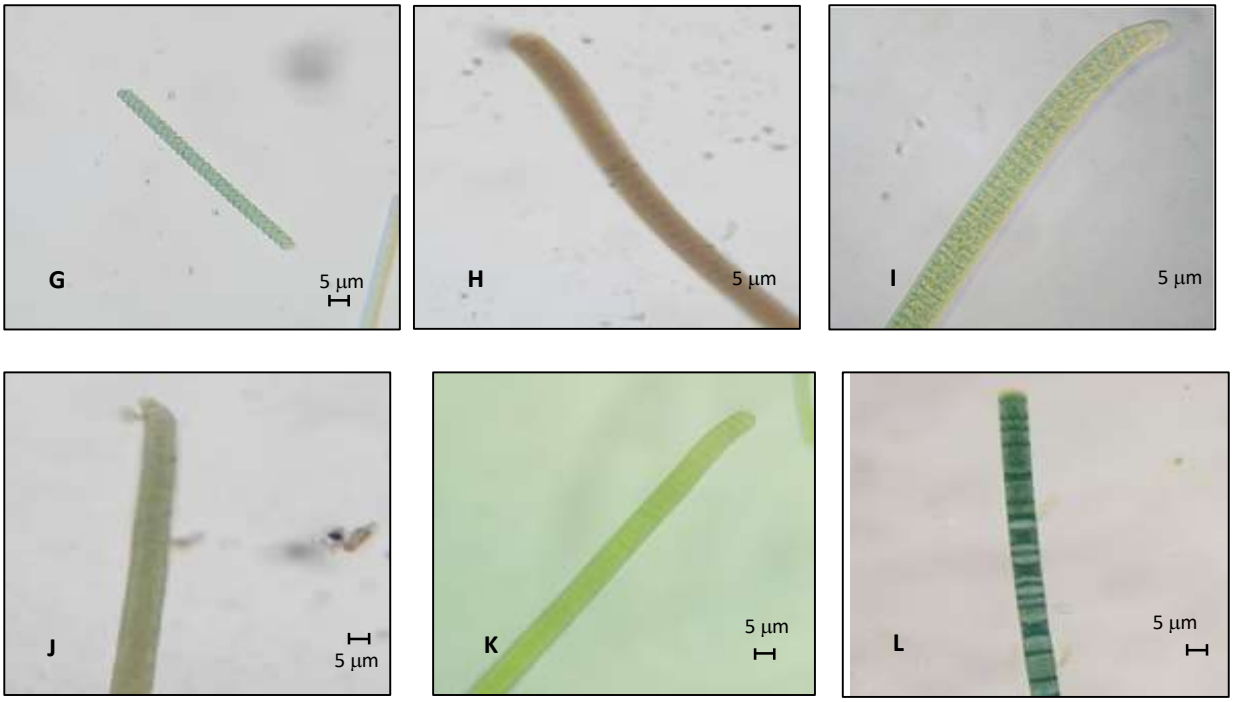


Figure 2. A. *Aphanocapsa intertexta* Gardner

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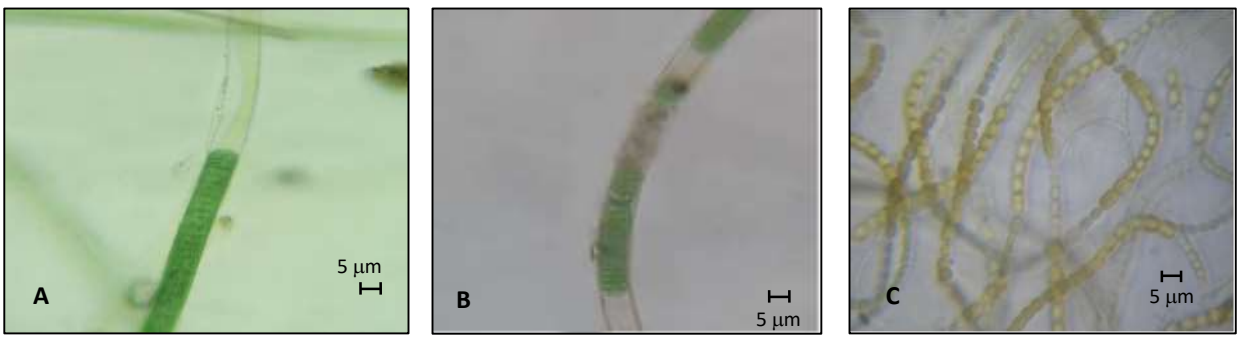

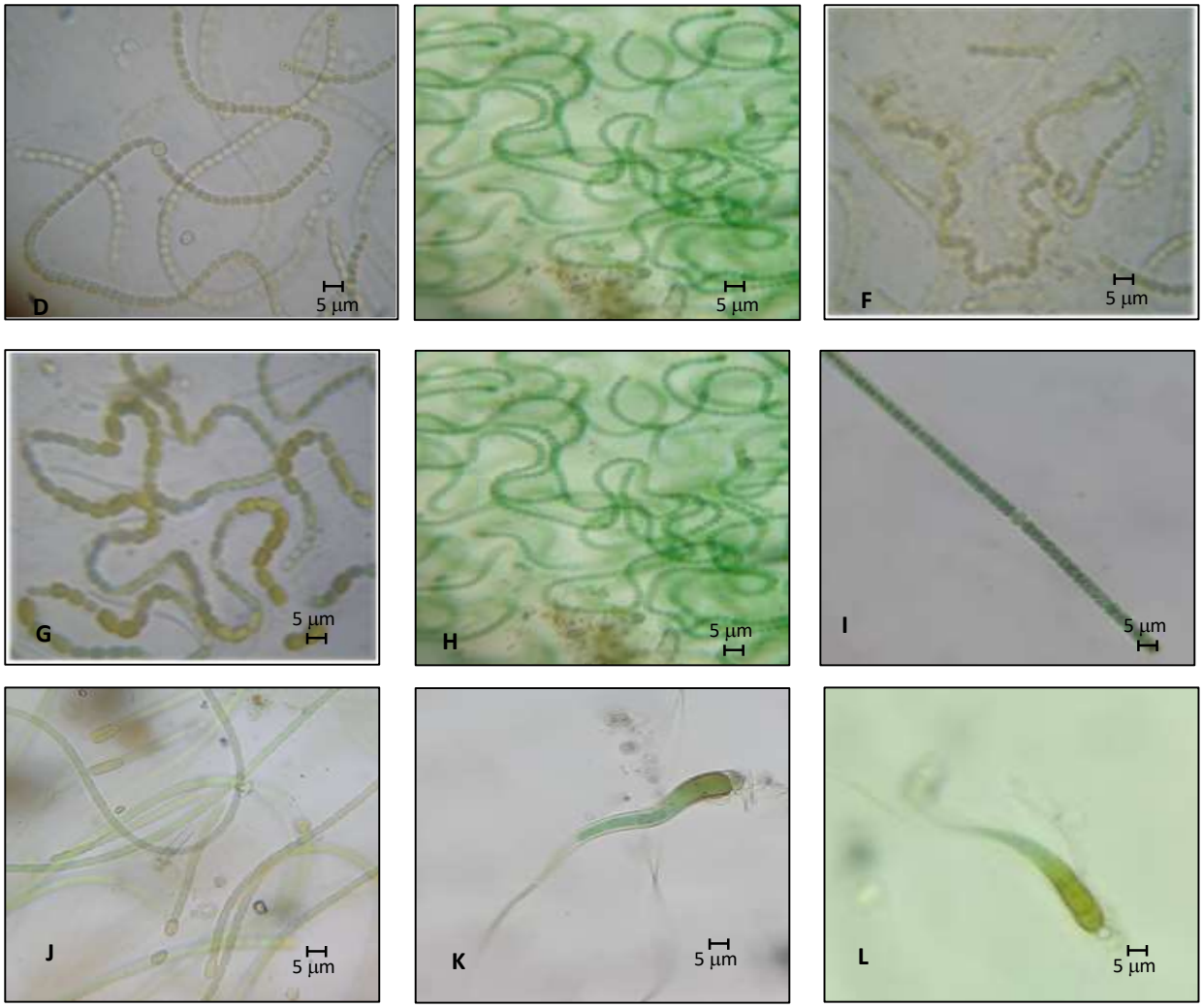

Figure 3. A. *Lyngbya martensiana* Menegh ex Gomont

B. *Lyngbya truncicola* Ghose

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