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Research Article

AN ECOLOGICAL ASSESSMENT OF ALGAL GROWTH WITH PARTICULAR REFERENCE TO BLUE-GREEN ALGAE FROM UPPER BRAHMAPUTRA VALLEY OF ASSAM

***Dilip Hazarika[1], Ipsita Duarah[2] and Jayanta Barukial[1]**
[1]Dept of Botany, D. R. College, Golaghat
[2]Biotech Hub, D. R. College, Golaghat
**Author of Correspondence*

ABSTRACT
The ecological assessment of algal growth of the present study area i.e. Upper Brahmaputra Valley, Assam is very infancy. The present study revealed that the algal growth depends mainly upon the water holding capacity of the soil and abundance of water which is correlated with the initiation of rainfall. It has also revealed that the rainfall and abundance of water is not the only factor for optimum growth of BGA. Temperature may also play a vital role for the luxuriant growth of BGA along with the abundance of water. Besides, we have noticed that BGA diversity is more in virgin low lying area than other areas. It has seen that in most of the rice fields situated nearby tea garden of the study area has significantly less species diversity of BGA. It is perhaps due to indiscriminately used of chemical fertilizers as well as other chemical herbicides and pesticides in the tea gardens. And also notice that there are no any BGA in the crude oil contaminated paddy fields as well as in other low lying areas near by it. In such area the surface of the water bodies and soil surface is covered completely by crude oil, released from oil digs and Gas Gathering Station (GGS). However, abundance of BGA has gradually increased with the increasing of distances from the point of oil digs and GGS.

Key Words: *BGA, Crude Oil Contamination, Paddy Field, Rainfall, Tea Garden, Chemical Fertilizers, Pesticides, Herbicides, Oil Digs, Gas Gathering Station (GGS)*

INTRODUCTION

The present study area includes of three districts viz., Sivasagar, Jorhat, Golaghat only. Blue-green algae (BGA) are prokaryotes that play an important role in nitrogen economy particularly, in rice fields. *Calothrix indica* was the first recorded BGA in India and this was reported by *Kirtikar* in 1886 from Assam (*Anand,* 1993b). BGA flora was studied by many workers in some restricted area of Assam. This ample works have been done by different algologists covering different localities (*Bruhl and Biswas*, Deka & Bordoloi, 1991; 1922; *Parukkuty*, 1939; *Bordoloi*, 1974; *Devi*, 1981; *Devi and Boissya*, 1981; *Hazarika*, 1988; *Saikia and Bordoloi*, 1994; *Hazarika et al.*, 1990; *Ahmed and Kalita*, 2002*; Hazarika and Barukial*, 2012). Most of the area of upper Brahamaputra valley is covered by paddy fields, tea gardens and oil fields. Besides, there are several ditches, springs, ponds and other low lying areas. A numbers of hot springs are located in the Nambor Reserve Forest, Golaghat and in these springs were also reported to be rich in BGA (*Hazarika and Gogoi,* 1985). In Sivasagar district there are a number of oil fields which are very adjacent to cultivated rice fields where crude oil effluent is a common feature and they contaminated and polluted the soil as well as the environment (Deka *et al*., 1994). The crude oil drastically changes the physico-chemical properties of the soil and crop growth (Baruah, 1995).

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The crude oil contaminated cultivated rice fields and other low lying area drastically influences the growth and distribution of BGA. However, there are no previous report on distribution pattern and abundance of BGA with seasonal variation and their growth periodicity.

MATERIALS AND METHODS

Study Area and Location

The upper Brahmaputra valley, Assam included 5 districts which comprises Sivasagar, Jorhat, Golaghat, Dibrugarh and Tinsukia with an area of 16,192 km^2. However, the present study area includes of three districts viz., Sivasagar, Jorhat, Golaghat only. The study area situated in between 25.9º - 27.1º latitude and 93.8º - 96.3 º longitudes and 100 – 150 meters above sea level. The total study area comprising the districts Sivasagar, Jorhat and Golaghat is covering 8989 km^2 which is 55.52% of the total area of the Upper Brahmaputra Valley, Assam.

Collection and Identification

The collection of algae have been made randomly from different habitats *viz*. moist soil surface, paddy field, oil fields, and other low lying area of study area in every month of a year during last decade i.e. 2001-2010 and identified them by standard published literatures (Desikachary, 1959, 1972; Anand, 1990, 1993a & b). The soil samples have also collected from the same selected localities to evaluate the different ecological parameters related to the abundance of BGA. Soil and water samples from oil digs and Gas Gathering Station (GGS) were also collected. The different ecological parameters such as physico-chemical properties were also studied by the method of Jackson (1973). The duly identified taxa of BGA and other green algae have been deposited in the Botany department.

OBSERVATIONS AND RESULTS

Soil Texture and Physicochemical Factors

The table No- II shows the physico-chemical data revealed that the soil texture is loamy to sandy loamy. The soils of upper Brahmaputra valley, except Rudrasagar are found to be mostly acidic which ranges from 4.0 – 7.8. The percentage of organic carbon ranging from 0.35 – 1.12; available P_2O_5 from trace to 62.25 Kg/ha and available K_2O were 225.4 – 463.1 Kg/ha. Blue-green algae generally preferred loamy soils. A critical analysis indicates that certain forms of algae are found to occur strictly in certain pH while others tolerate a wide range of pH (both in acidic and alkaline). The algae which fall under later categories are *Aphanothece bullosa, Gleocapsa pleurocapside, Chloroglea microcystoides, Spirulina subsalsa, Lyngbya martensiana, L. putealis, Oscillatoria acuminata, O. chlorina, O. fremii, O. proboscidea, O. subtillisima, Phormidium subincursatum.*

Ecology and Distribution of Blue-Green Algae

An ecological study of the available algae growing naturally in the paddy fields, uncultivated soil surface, low lying areas and different oil fields of the selected region was done. The study had revealed that this region is rich in algal flora. The heavy rainfall associated with high humidity favoured luxurious growth of not only BGA but the other groups of algae also. With the advent of rainy season, in the month of March-April algae made their appearance on the soil surface. The first one to appear is *Microcoleus chthonoplastes* that admixed with *Oedogonium* spp. in sparse patches followed by *Oscillatoria* spp., *Lyngbya* spp. and *Spirulina subsalsa*. In the month of June or July, after a few showers, mostly continuous, pale brown or blackish brown gelatinous mass of *Aphanotheace* spp. and yellowish brown or yellowish blue-green mass of *Nostoc* spp. was appeared in a colonial form. During the period from July to September the species of *Anabaena, Cylindrospermum, Calothrix, Hapalosiphon, Phormidium* showed abundant growth in stagnant water, rice field and low lying areas. *Scytonema* spp., *Aulsira* spp. and *Symploca muscorum* appeared on moist soil surface in patches or form cushions or grew intermixed with other algae in rice fields. The species of *Anabaena* appear when the rice field or low land was covered with water. *A. variabilis* var. *ellipsospora* was commonly associated with *Nostoc microscopicum*. On moist soil surface *Oscillatoria laete-virens* var. *minimus* and *O. tenuis*, formed a bluish-green thin layer

on moist soil surface. Similarly, the *Cylindospermum stagnalae f. variabilis* formed a ball or a mate either being attached to aquatic plant or remain floating. Green algae like *Spirogyra* spp. And the members of *Chloroccocale*s and *Chaetophorale*s were mostly associated with blue-green algae. The spp. of *Calothrix*, and *Hapalosiphon* appeared in the last part of the season. On moist soil surface *Scytonema* spp., appeard as thick brown coloured cushion or formed carpets. Most of the species of *Lyngbya*, *Oscillatoria*, *Microcolous* and *Spirulina* were found to remain mixed with each other. The environmental factors (like rainfall, temperature, humidity etc.) physico-chemical properties of the soil, water logged condition of the soil, agricultural chemicals (fertilizers and pesticides) in-organic and organic nutrients are the main important factors to determine the abundance, distribution and type of BGA species in a particular area. In this region, non-heterocystous BGA are more abundant (about 60%) than the heterocystous forms (Table-I). When high level of combined nitrogen is present in a particular ecosystem, non-heterocystous BGA, green algae and diatoms are predominant (Stewart, 1972).

Table I: Occurrence of Different Taxa at Different pH Range

Name of the Genus	No. of Species	Soil pH range
Non - Heterocystous BGA		
Aphanothece	4	5.1-7.0
Chroococcus	2	5.1-7.0
Gloeocapsa	2	5.1-7.0
Microcystis	1	4.1-6.0
Chlorogloea	1	6.1-7.0
Lyngbya	10	4.1-7.0
Microcoleu	3	4.1-7.6
Oscillatoria	17	4.1-7.6
Phormidium	3	5.1-7.0
Schizothrix	1	7.0-7.6
Spirulina	2	4.1-7.0
Symploca	1	5.1-6.0
Heterocystous BGA		
Anabaena	10	4.1-7.0
Aulosira	2	4.1-5.0
Cylindrospermum	5	4.1-7.0
Nostoc	6	5.1-7.0
Calothrix	3	4.1-6.0
Camptylonemopsis	1	6.1-7.0
Scytonema	5	6.1-7.0
Haplosiphon	2	4.1-6.0

Generally, in this region pre-monsoon starts from early March and continues up to late May. This is a transitional season between dry winter and wet monsoon. The temperature gradually rises during this season from 26^0 C to 36^0 C and casual showers occur. Monsoon period generally starts from the middle part of May up to month of September. Towards the beginning of October, the rainfall gradually declines and the temperature begins to lower down gradually. After long term observation, it was found that the initiation of rainfall in this area is varied. Basing on the initiation of rainfall we have categorized three types of rainfall in this study area. In the first type, Pre-monsoon and monsoon start normally; in the second type, pre-monsoon followed by drought condition and monsoon appear lately after about 15 to 20

days; in the third type, both pre-monsoon and monsoon appear late. The graphs (Figure 2A, B and C) show three different patterns of algal growth in a particular year of the study area.

Abundance of BGA Genera-

It has been noticed that in this region, the genus *Oscillatoria* is the most dominant among the BGA and occur throughout the year. The period from June to October *Oscillatoria* shows abundance after which it begins to decline gradually. Other dominant genera, *viz*., *Aphanothece* spp., *Nostoc* spp., *Cylindrospermum* spp., and *Anabaena* spp. begin to grow at the onset of Monsoon; optimum growth being in the month of June to September and their growth begin to decline with the approach of winter season. *Hapalosiphon* is also one of the dominant genera which begins to grow in the month of August when the temperature is highest (Figure 1). *Microcystis flos-aquae*, *Anabaena flos-aquae*, and *Oscillatoria limosa* were found quite abundantly in pure form, but they also found to occur intermixed with other mucilaginous algae or were found attached to aquatic angiosperms. Most of the BGA species admixed with the species of green algae and diatoms.

Table No II: Showing Soil Analysis from Different experimental site of Upper Brahmaputra Valley

District	Study Site	Soil pH	Soil Texture	Organic C (%)	Available P_2O_5 Kg/ha	Available K_2O Kg/ha
Golaghat	KB Ali	4.0	Sandy Loamy	1.12 (H)	Trace	351.9(H)
	Borpathar	4.5	Sandy Loamy	0.96	Trace	463.1
	Chinatoli	4.5	Loamy	0.96	Trace	540.3
	Kuralguri	4.7	Loamy	0.75	6.25(H)	463.1
	Golaghat	5.1	Sandy Loamy	0.72	Trace	262.4
Jorhat	Nambor	6.2	Loamy	1.07	Trace	293.3
	Moriani	4.7	Loamy	0.70	6.25	353.1
	Titabor	5.1	Sandy Loamy	0.78	Trace	281.4
	Selenghat	6.2	Loamy	1.00	Trace	320.5
Sivasagar	Borhula	6.5	Loamy	0.90	7.4	232.7
	Nimati	6.8	Sandy Loamy	0.43	Trace	240.6
	Gelaki	4.9	Sandy Loamy	1.33	12.6	87.4
	Lakowa	4.63	Sandy Loamy	1.74	17.67	137.45
	Rudrasagar	7.8	Sandy Loamy	2.03	19.23	329.82
	Demow	6.3	Loamy	1.98	10.3	97.0
	Sonari	5.9	Sandy Loamy	0.68	11.2	78.4

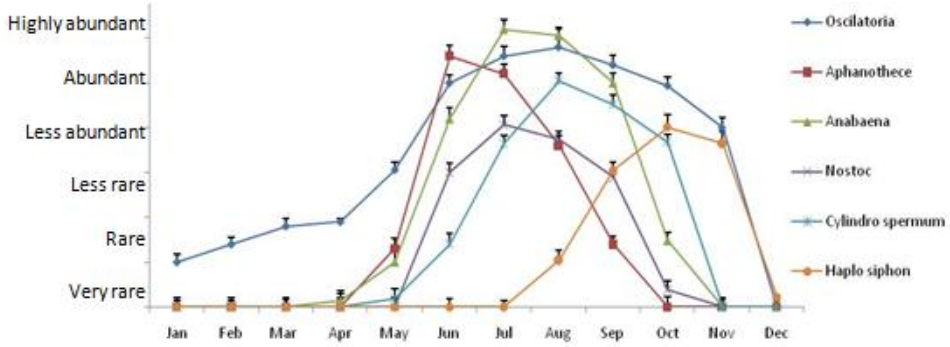

Figure 1: Abundance of Blue Green Algal genera in the upper Brahmaputra valley throughout the year

The Effect on that Herbaceous Community, Especially on the Component Herbaceous Annuals

Oscillatorioid forms BGA are the most widely distributed and found throughout the year. Water logged situation under natural condition is necessary for the abundance of algal flora (Subba Raju, 1972). The application of chemical fertilizer and pesticides in paddy field nearby tea garden, GGS and oil fields drastically inhabit the growth of BGA. The inhibition of BGA through the application of herbicides and pesticides was also reported by many workers (Venkataraman, 1972; Hazarika and Barukial, 2012). The paddy fields lying near to tea gardens, oil fields and GGS, BGA and other algae are totally absent. At least 80-90 per cent of angiospermic plant species were absent in the affected areas in comparison to nearby unaffected areas.

Some Abnormalities of Growth of Abundance of Different Algae

With the advent of rainy season of summer, BGA sooner or later make their appearance and show their maximum number and growth Figure 2(A). Growth periodicity of BGA in relation to rainfall and temperature reveals a very interesting finding. If monsoon starts late and is disrupted by prolonged dry days the growth of BGA becomes very much restricted or inhibited Figure 2(B). When the monsoon starts late the growth of BGA is suppressed by the green algae namely, *Oedogonium* spp., *Chaetophora* spp., *Cladophora* spp., *Trentipohlia* spp., *Chara* spp., *Nitella* spp., *Spirogyra* spp., *Zygnema* spp., *Chlorococcales* and the members of diatoms as their growth is maximum. *Oscillatoria* and *Hapalosiphon* able to compete equally with other algae. Diatoms perhaps do not play any major role on the growth suppression of BGA, as their (diatoms) optimum growth starts from late September, during which period the BGA and green algae begin to decline Figure 2(A), 2(B) and 2(C).

Figure 2: Abundance of Algae in the upper Brahmaputra valley basing on rainfall initiations

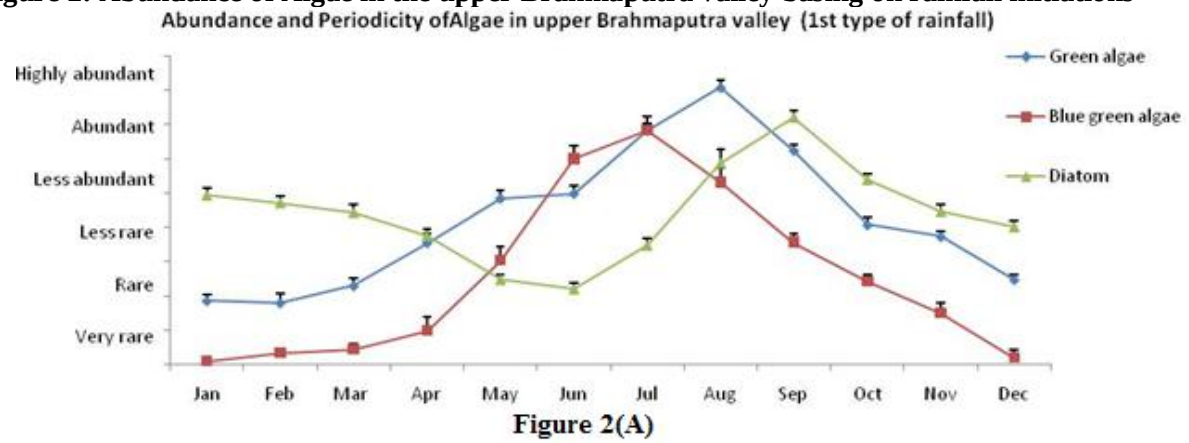

Figure 2(A)

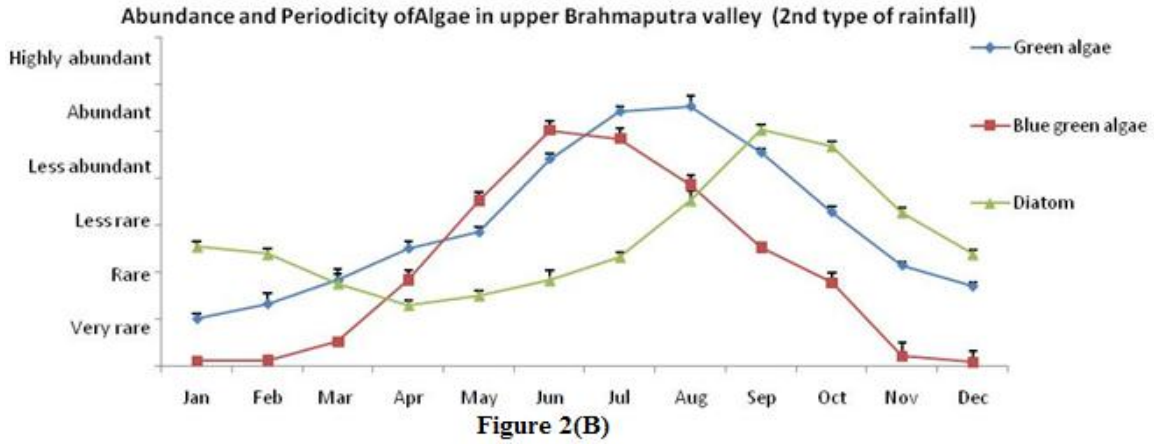

Figure 2(B)

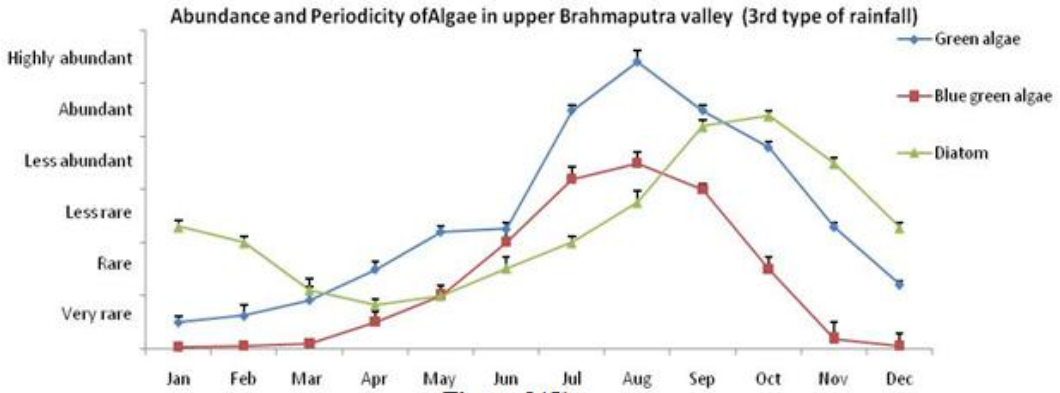

Figure 2(C)

CONCLUSIONS

From the Figure 2(A), 2(B) and 2(C) it is clear that in the experimental localities, the algal flora i.e., BGA and green algae depend mainly upon the water holding capacity of the soil and abundance of water which remain logged in the rice fields and other low-lying areas. Similar observations had been reported from Andra Pradesh soils by Subba Raju (1972). Therefore, it may be possible that so far the luxuriant growth of BGA like *Anabaena* spp., *Cylindrosperum* spp., *Calothrix* spp are concerned, the rainfall play a very important role. Besides it has been recorded that during winter season when paddy fields are flooded with river water by irrigation, algae exhibit a very poor growth. During winter, the temperature decline to about to 10^0 C. However, in hot water springs, different BGA are found in bloom throughout the year. Therefore, it is revealed that the rainfall and abundance of water is not the only factor for optimum growth of BGA. Temperature may also play a vital role for the luxuriant growth of BGA along with the abundance of water. Seasonal changes of temperature tend to lag behind corresponding changes in illumination so that a combination of supposed light and temperature tolerance exists as has been suggested to determine seasonal occurrence (Talling, 1962). Growth of soil BGA is best on damp soil surface having exposure to light which prove that light is essential for growth and development.

Blue-green algal diversity is more in virgin low lying area than other areas. During the field study it was seen that in most of the rice fields shows significantly less species diversity. No BGA was found in the crude oil contaminated paddy fields as well as in other low lying areas. Because, the upper surface of the water bodies and soil surface is covered completely by crude oil released from oil digs and Gas Gathering Station (GGS). The presence BGA gradually found to be increased with the increasing distance from the oil drill and GGS.

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REFERENCES

Ahmed SU and Kalita MC (2002). Nitrogen fixing potential of BGA isolated from rice field soils of Hojai sub-division, Nagaon, Assam. *Phykos* **41**(1 and 2) 17-20.

Anand N (1990). *A hand book of blue-green algae*. Bishen Singh Mahendra pal Singh, Dehradun 1-79.

Anand N (1993a). Blue Green Algae (Cyanophyta/Cyanobacteria) A Preamble in *Indian Phyco Rev Cyanophyta* **2.**

Anand N (1993b). *Morphology, Classification and Taxonomic Studies. In Indian Phyco Rev Cyanophyta* **2**.

Baruah TC (1995). Enviromental pollution in oil fields. Seminar on Environmental Education and Society. DCB Girls College, Jorhat, Assam.
Bordoloi RPM (1974). Ph. D. Thesis on Studies on algal flora of Assam. Gauhati University, Guwahati (Unpublished).
Bruhl P and Biswas K (1922). The algae of Bengal filter beds. *Journal Department of Science* (Calcutta University) **4** 6-10.
Deka M and Bordoloi RPM (1991). Studies on the blue-green algae from rice field of Assam. *Phykos* **30** 175-180.
Deka S, Devi A, Barthakur HP and Kagti LC (1994). Impact of gas flaring on physico-chemical properties and occurrence of micro flora in rice field soil at Rudrasagar oil field of Assam. *Environment and Ecology* **12**(3) 523-531.
Desikachary TV (1959). *Cyanophyta Monograph*. ICAR, New Delhi.
Desikachary TV (1972). *Taxonomy and Biology of Blue-Green Algae. Centre for Advance Study in Botany* (Madras).
Devi P (1981). Algal Flora of Darrang District, Assam. Ph. D. Thesis, Gauhati University, Guwahati. (Unpublished)
Devi P and Boissya CL (1981). Addition to algal flora of Assam II. A few Formidium species from the Paddy fields of Assam. *Proc National Academy of Sciences* **4**(2) 65-67.
Hazarika D (1988). A Study of the Blue Green Algae in the Paddy Field of Golaghat Sub-Division, Assam. Ph.D Thesis Gauhati University, Guwahati. (Unpublished)
Hazarika D and Barukial J (2012). Occurance and Distribution of Blue-Green Algae in Paddy fields of Golaghat District, Assam, India. *Advanced Journal of Plant Science* **25**(1) 341-344.
Hazarika D and Gogoi P (1985). Thermal algae from Hot Springs of Nambor Forest, Assam. *Geobios News Report* **4** 187-190.
Hazarika D, Gogoi P and Boissay CL (1990). Few species of *Anabaena* Bory from Assam, India. *Advanced Journal of Plant Science* **3**(1) 151-152.
Jackson ML (1973). *Soil Chemical Analysis,* (Prentice Hall, New Delhi) 239-241.
Parukutty PR (1939). Collection of Algae from Assam. *Proc. Indian Academy Science* B **IX**(5) 229-235.
Saikia P and Bordoloi RPM (1994). Blue-green algal flora from the rice fields of Assam. *Phykos* **33** 53-57.
Subba Raju N (1972). The blue green algae from the soils of India. *Taxonomy of Bluegreen Algae (Ed) Desikachary,* TV, (Madras University) 332-352.
Stewart WDP (1972). Heterocysts of Blue-green algae. *In taxonomy and Biology of Blue-green Algae(ed) Desikachary TV,* (Madras University, Madras) 227-235.
Talling JF (1962). *In Physiology and Biochemistry of Algae,* (Ed.) Ralph A. Lewin, Academic Press, (New Yourk and London) 742.
Venkataraman GS (1972). *Algae bio-fertilizers and Rice Cultivation* (IAAR, New Delhi).