

Observations on certain Blue-green Algae from Polluted Environments

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The present paper deals with certain Cyanophyceean (algal) forms recorded from the apparently polluted course of River Gomati at Lucknow. A possible correlation between such algae and selected physico-chemicals has been attempted at.

Key-words—Blue-Green Algae, Pollution, Gomati River, Lucknow

INTRODUCTION

WATER constitutes most important and vital component of biosphere, and human needs largely depend upon the availability of potable and clean water. Most of the municipal water supplies in our country are met by perennial rivers for the urban population (Tripathi & Pandey 1990). In Lucknow the main source of drinking water is fulfilled by river Gomati which is highly polluted (Singh, 1979, Prasad & Saxena 1980, Verma *et al.* 1996). The blue-green algae of river Gomati at Lucknow was studied by Saxena (1978) which was followed by the studies on diatoms (Singh 1979, Verma 1990). The work on the pollution and allied aspects of various rivers of our country and their algal flora has been done chiefly by Chacko and Ganapati (1949) on river Adyar, Roy (1955) on Hooghly, Motwani *et al.* (1956) and Philipose (1960) on Sone, Philipose (1960) on Mahanadi, Prasad (1964) on river Varuna, Gupte (1964) on Ajee, Lakshminarayana (1965), Pahwa and Mehrotra (1966) and Agarwal *et al.* (1976) on Ganga, Olaniya *et al.* (1976) on Chambal, while Chakravarty *et al.* (1959) and Rai (1974) have worked on other various aspects of river Yamuna.

MATERIAL AND METHOD

The course of river in Lucknow city covers approximately 11 kilometers. The four stations (Collection and analytical points) were selected

namely Gaughat upstream as station I, six kilometers downstream from Gaughat was station II as Shaheed-Smarak, three kilometers downstream from station II was Papermill as station III and the last station Gomati Barrage as station IV, nearly two kilometers from station III. Thus covering the total stretch of 11 kilometers.

The algal samples were collected from the immediate vicinity from where the water samples had been taken in clean plastic containers to ensure that the algae actually grew in the water which was taken for analyses at monthly intervals from May, 1990 to February, 1991.

Total alkalinity, Total Hardness, Calcium, Magnesium and Dissolved oxygen were analysed following I.S. 3025 (1964) while pH was recorded with the help of narrow range pH paper and later on confirmed in the laboratory by pH meter.

OBSERVATION

A. Physico-chemical

Water temperature : The water had shown a regular rise and fall in temperature at all the four stations and any marked fluctuation was absent, the minimum temp. 16.5°C was recorded at both the stations I & II during the month of December and the maximum temp. 34°C was recorded at station II during May. A linear decrease in the temperature was clearly observed from May onwards to

December and thereafter a rise was observed (Fig.A).

pH : At all the four stations pH of the water was nearly neutral with a slight variation. The minimum pH 6.5 was recorded at all the four stations and maximum pH 7.5 at stations I & IV. The maximum pH 7.5 at station I during May, 1990 and at station IV during January, 1991 was observed (Fig.B).

Total Alkalinity : The maximum total alkalinity (328.00 mg/l) was recorded at station III during February, 1991 and minimum (84.00 mg/l) was recorded at stations II & III during the month of July, 1990. At station I the total alkalinity ranged from (120.00 to 318.00 mg/l) minimum during July and August, 1990 and maximum was observed during February, 1991. At station II the maximum (316.00mg/l) was recorded during the month of January, 1991 and at station IV the minimum (96.00 mg/l) was observed during July, 1990 and maximum (324.00 mg/l) during February, 1991. The total alkalinity showed marked increase from October, 1990 till February, 1991 (Fig.C).

Total Hardness : Total Hardness of the water at all the four stations ranged from (68.00 to 280.00 mg/l). At station I, the minimum was recorded during August and maximum during May, 1990. The minimum values of (100.00 mg/l) during August and maximum of (264.00 mg/l) during May, 1990 at station II were recorded. At the station III the values varied from (78.00 to 202.00 mg/l) while the minimum during the month of August and maximum during June was observed. At station IV the minimum (86.00 mg/l) during August and maximum value (212.00 mg/l) was recorded during June, 1990. The maximum values were observed during summer months May and June and minimum value was recorded during the rainy month of August, 1990 (Fig.D).

Calcium : The calcium content had shown a regular fluctuation at all the four stations. At station I the minimum (16.00 mg/l) during May while maximum (56.00 mg/l) was recorded during June, 1990. At station II the minimum value of (17.60 mg/l) during May and maximum (44.80 mg/l) during Oc-

tober and November were recorded. The values at station III varied from (24.00 to 42.40 mg/l). The minimum (24.00 mg/l) during July and August and maximum (42.40 mg/l) during January was recorded. At station IV the minimum value (22.40 mg/l) was recorded during the month of July and maximum (44.80 mg/l) during the months of October and November (Fig. E).

Magnesium : A perceptible change in magnesium content was observed throughout the period of the observation. The minimum magnesium (4.32 mg/l) was recorded during August at stations I & III and maximum (57.60 mg/l) was observed at station I during May. At station II the values varied from (4.80 to 52.80 mg/l), the maximum was recorded during May and minimum 4.80 mg/l during December. The maximum (31.68 mg/l) was observed during June at station III and at station IV while the minimum (2.40 mg/l) was recorded during December and maximum (30.72 mg/l) during June, 1990. (Fig. F).

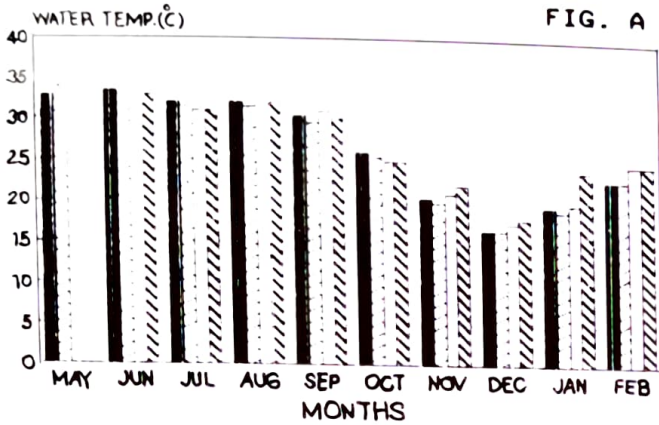
Dissolved Oxygen : The range of dissolved oxygen of water at all the four stations was (1.60 to 17.20 mg/l). At station I the minimum dissolved oxygen (6.00 mg/l) during July and maximum of (17.20 mg/l) was recorded during December. At station II the minimum (3.00 mg/l) during May and maximum (12.80 mg/l) during December was recorded. The dissolved oxygen had shown an increase from the month of May onwards. At station III the maximum dissolved oxygen (10.00 mg/l) was observed during the month of December and the minimum of (2.00mg/l) during November and January was recorded (Fig.G).

B. Taxonomical consideration

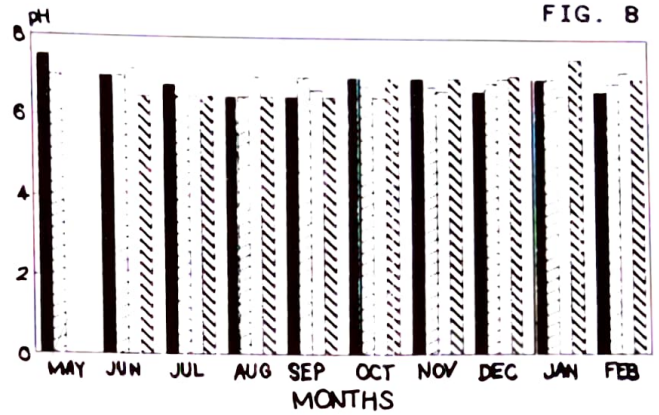
Oscillatoria acuta Bruhl et Biswas, orth, mut Geitler, Fig.1 : Trichomes straight, blue-green in colour, not constricted, end cell bent; without calyptra, not capitate. Lat. Trich., 4.5-5.5 μm ; Long. cells, 2.5-4.0 μm . Habitat : Attached on the stones at bank of river Gomati at stations II & III coll. 26. 5. 90 and 26. 6. 90.

O. annae Van Goor, Fig.2 : Trichomes straight, constricted at the septa, blue-green, cross-walls

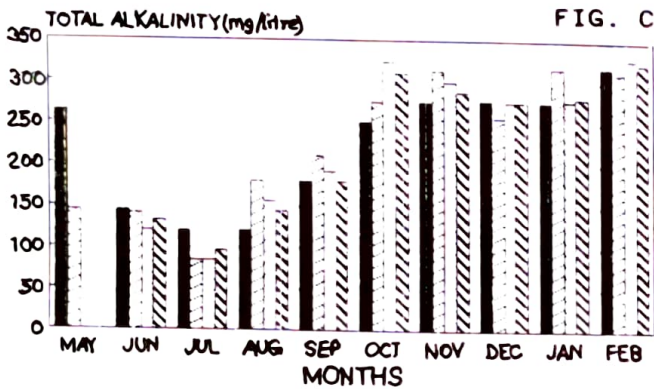
MONTHLY VALUE OF WATER TEMP. FIG. A



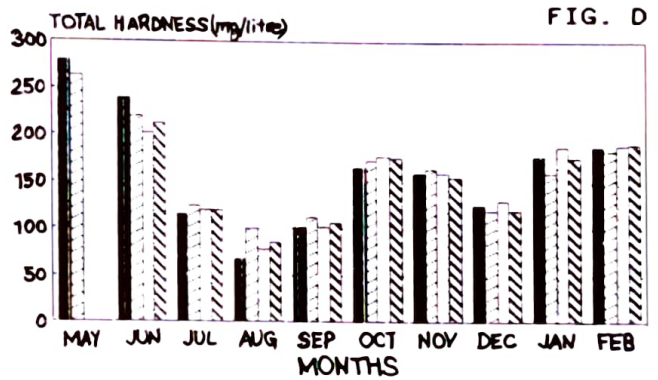
MONTHLY VALUES OF pH FIG. B



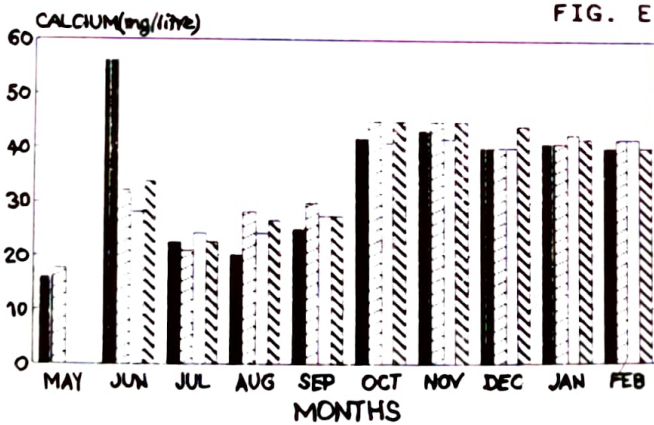
MONTHLY VALUES OF TOTAL ALKALINITY FIG. C



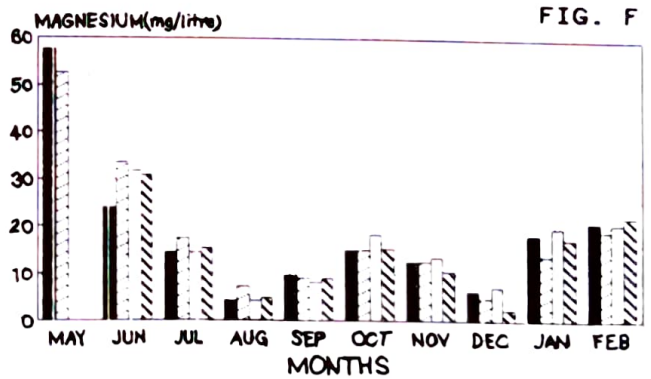
MONTHLY VALUES OF TOTAL HARDNESS FIG. D



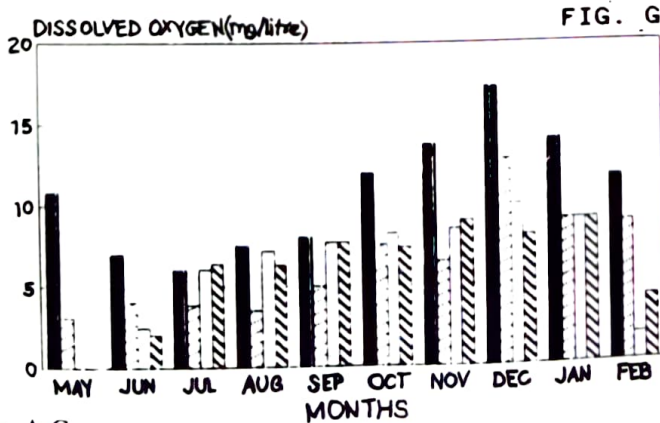
MONTHLY VALUES OF CALCIUM FIG. E



MONTHLY VALUES OF MAGNESIUM FIG. F



MONTHLY VALUES OF DISSOLVED OXYGEN FIG. G



- GAUGHAT
- SHAHEED SMARAK
- PAPER MILL
- BARRAGE

Figs A-G

without granulation, end cells hemispherical, without calyptra. Lat. Trich., 6.0 μm ; Long. cells, 1.5 - 2.0 μm . Habitat : Attached on the stones at the bank of river Gomati at stations II & III coll. 26.6.90 and 13.11.90.

O. chalybea var. *insularis* Gardner, Fig.3 : Trichomes straight but slightly bent upward, blue-green, slightly constricted at the cross-wall, cross-wall not granulated, end cell bent obtuse; without calyptra. Lat. Trich., 8.0 μm ; Long cells, 3.0-3.6 μm . Habitat : On damp soil on the river bank at stations II & III coll. 28.8.90 and 24.10.90.

O. curviceps Ag. ex Gomont, Fig. 4: Trichomes straight, blue-green in colour, without constriction at the septa, cross-wall granulated, end cells attenuated. Lat. Trich., 5.0 μm ; Long. cells, 1.5-2.0 μm . Habitat : On the muddy soil on the river bank at stations II & III coll. 25.5.90, 26.6.90, 27.8.90 and 24.10.90.

O. formosa Bory ex Gomont, Fig.5 : Trichomes straight, slightly constricted at the septa, blue-green, cross-wall slightly granulated, end cells obtuse, without calyptra. Lat. Trich., 4.0-5.0 μm ; Long. cells., 2.5-3.0 μm . Habitat : Attached on the stones at station II coll. 13.11.90.

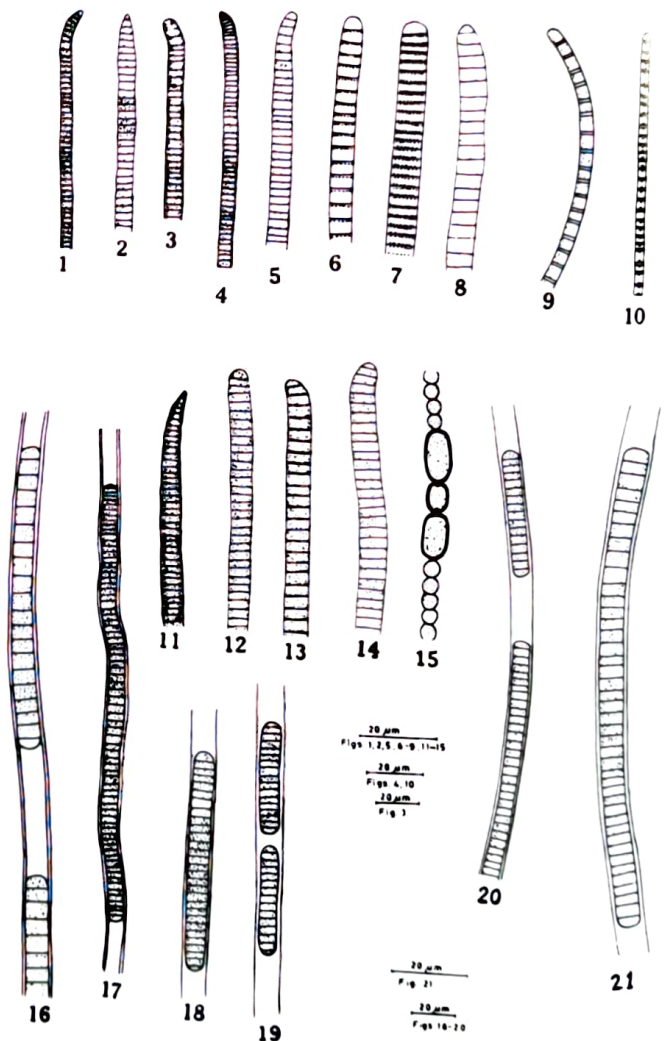
O. formosa var. *loktakensis* Bruhl. et Biswas, Fig.14 : Trichomes straight or slightly bent, flexible, blue-green, slightly constricted at the septa, end cell obtuse and bent, without calyptra. Lat. Trich., 5.0-6.0 μm ; Long. cells., 2.0-3.0 μm . Habitat : Attached on the stones at station II coll. 13.11.90.

O. granulata Gardner, Fig. 6 : Trichomes straight, slightly curved, end cells without capitate, calyptra absent, end cells rounded. Lat. Trich., 5.0 μm , Long cells., 3.0-4.0 μm . Habitat: Mixed with other algae in river water at stations III & IV coll. 17.10.90 and 24.11.90.

O. nigra Vaucher, Fig. 7 : Trichomes straight, dark blue-green, cells shorter than broad, trichomes slightly constricted at the septa, end cells rounded without calyptra. Lat Trich., 8.0 μm , Long. cells. 2.0-3.0 μm . Habitat : On muddy soil at station III coll. 29.6.90.

O. okeni Ag. ex Gomont, Fig.8 : Trichomes straight slightly bent at apex, constricted at the septa, end cells obtuse, without calyptra. Lat. Trich., 7.0-8.0 μm . Long. cells, 2.0-3.0 μm . Habitat : Attached on the stones at stations I, II & III coll. 13.11.90 and 14.11.90.

O. pseudogeminata G. Schmid, Fig.9 : Trichomes straight pale blue-green, cells constricted. cross-wall ungranulated, end cells rounded, without calyptra. Lat. Trich., 2.0-2.5 μm , Long. cells, 2.0-3.0 μm . Habitat : On the bank of river on moist soil station III col. 29.6.90.



Figs 1-21. *Oscillatoria acuta*, 2. *O. annae*, 3. *O. chalybea* var. *insularis*, 4. *O. curviceps*, 5. *O. formosa*, 6. *O. granulata*, 7. *O. nigra*, 8. *O. okeni*, 9. *O. pseudogeminata*, 10. *O. pseudogeminata* var. *unigranulata*, 11. *O. salina* f. *major*, 12. *O. subbrevis*, 13. *O. tenuis*, 14. *O. formosa* var. *loktakensis*, 15. *Anabaena ossicallarioides*, 16. *Lyngbya ceylanica*, 17. *L. spirulenoides*, 18. and 19. *L. truncicoal*, 20. *Phormidium ambiguum* var. *major*, 21. *P. calcicola*.

O. pseudogeminata var. *unigranulata* Biswas, Fig. 10 : Trichomes tenuous, straight, unstricted at the septa, apical cells rounded or truncate, uncapitate, not attenuated, cell-wall thick, distinct with one large granule situated at the centre of the cross-wall on either side, blue-green. Lat. Trich., 3.0 μm , Long. cells, 2.5-4.0 μm . Habitat : On the boat of river with other algae near the point of collection of water samples at station IV coll. 28.8.90.

O. salina f. *major* Biswas, Fig. 11 : Trichomes straight, tapering end, occasionally pointed or hooked without any distinct cap, without calyptra, transverse septa ungranulated, blue-green trichomes straight, elongate, erect, scarcely curved, Lat. Trich., 6.0 μm , Long. Cells, 1.5-2.0 μm . Habitat : On the muddy soil at stations II & III coll. 24.10.90 and 13.11.90.

O. subbrevis Schmidle, Fig. 12 : Trichomes straight, not attenuated at the apices, septa not granulated, end cells rounded, without calyptra. Lat. Trich., 6.0 μm , Long. cells, 2.0 μm . Habitat. Attached on the stones at all the stations coll. 26.6.90, 17.10.90 and 13.11.90.

O. tenuis Ag. ex Gomont, Fig. 13 : Trichomes straight, blue-green, slightly constricted at the septa, bent at the ends, without any attenuation and cap, end cells hemispherical. Lat. Trich., 6.0-7.0 μm , Long. cells, 2.5-3.0 μm . Hemispherical. Lat. Trich., 6.0-7.0 μm , Long. cells, 2.5-3.0 μm . Habitat : Attached on stones at stations II & III coll. 24.10.90 and 13.11.90.

Phormidium ambiguum var. *major* Lemmermann, Fig. 20 : Trichomes straight, blue-green, slightly constricted at the septa, septa without granulations, sheath thin, end cells rounded calyptra absent. Lat. Trich., 7.0 μm , Lat. filament, 10.0 μm ; Long. cells, 4.0 μm . Habitat : Attached on the boat at stations II & IV coll. 27.10.90.

P. calcicola Gardner, Fig. 21 : Thallus thick colourless, filament unstricted at septa, not attenuated and blue cells green, end-rounded, with a slightly thickened outer membrane. Lat. trich., 6.4 μm , Lat filaments, 8.0 μm , Long. cells, 2.5-3.0 μm . Habitat : On the muddy soil at station IV coll. 27.10.90.

Lyngbya ceylanica Wille, Fig. 16 : Filaments blue-green, not constricted at the cross-walls without attenuation at the ends, septa ungranulated cells quadrate, end cells rotund, calyptra absent. Lat. Trich., 9.0 μm , Lat. filament, 10.0 μm ; Long. cells, 5.0 μm . Habitat : Attached on the boat near collection point at station IV coll. 28.8.90.

L. spirulenoidea Gomont, Fig. 17 : Filaments slightly spirally coiled, trichomes not constricted at septa, sheath prominent, end cells rounded without calyptra. Lat. Trich., 10.0-12.0 μm ; Long. cells, 2.0-3.0 μm . Habitat : Attached on the stones at station IV coll. 17.8.90.

L. truncicola Ghose, Figs 18, 19. : Trichomes blue-green without constrictions at the septa, septa ungranulated, filaments more or less straight, apical cells rounded, unattenuated calyptra absent. Lat. Trich., 12.0-14.0 μm ; Long. cells, 3.0-4.0 μm . Habitat : Attached on an old boat near collection point at station IV coll. 17.8.90.

Anabaena oscillarioides Bory ex Born. et Flah., Fig. 15 : Trichomes dark green, cells barrel shaped as long as broad, heterocyst spherical or oval, akinete long cylindrical. Lat. Trich., 4.5 μm ; Diam. Het., 6.0 μm ; Long. Akinetes, 11.5 μm , Lat. Akinetes, 7.0 μm . Habitat: On muddy soil at station I coll. 26.10.90.

RESULTS AND DISCUSSION

Twenty different taxa of Cyanophyceae were recorded from the river Gomati during the period of study. Most of them were recorded from the stations I & III. Out of twenty taxa, fourteen of *Oscillatoria*, two of *Phormidium*, three of *Lyngbya* and only one species of *Anabaena* were recorded. Only three species of cyanophyceae, *Oscillatoria okeni*, *O. subbrevis* and *Anabaena oscillarioides* were recorded at station I. *O. okeni* was present at the first three stations. At first three stations the average water temperature was about 21°C and pH was 6.7 during the month of November. *Anabaena oscillarioides* was present during the month of October at station I, water temperature was 26°C, pH 7.0, total alkalinity 252.00 mg/l, total hardness

166.00mg/l, calcium 41.60mg/l, magnesium 14.88 mg/l and dissolved oxygen 12.00 mg/l. *O. subbrevis* was present during June at Gaughat station (station-I) but interestingly it was growing at Shaheed-Smarak (Station-II) during August, at Papermill (station-III) during October and at the Barrage station (station-IV) during November in the present course of study.

The dissolved oxygen was quite appreciable at station I as compared to remaining three stations. The maximum dissolved oxygen was 17.20 mg/l during the month of December and 1.60 mg/l at Papermill station during month of February. Dissolved oxygen increased from the month of June till January without any fluctuation. Luxuriant growth of blue-green algae was observed during months of December, January and February. During the month of July no taxon of cyanophyceae was observed. The floral composition was quite variable while the chemical picture was more or less consistent during the present study.

O. formosa and *O. formosa* var. *loktakensis* was recorded at Shaheed-Smarak station during the month of November. At this station the dissolved oxygen was 6.50 mg/l, total hardness 120.00 mg/l, total alkalinity 256.00 mg/l, calcium 44.80 mg/l and magnesium was 4.80 mg/l. This station receives sewage effluents from older parts of Lucknow and water appears to be highly contaminated. Venkateswarlu (1976) also reported *O. formosa* only from the most polluted station of river Moosi at Hyderabad, A.P. Palmer (1963) had also listed *O. formosa* among the most pollution tolerant species. *Oscillatoria* spp. are known to be pollution tolerant (Palmer 1963, Prasad & Saxena 1980).

A marked fluctuation was observed in the magnesium content which was maximum 576.60 mg/l at station I during the month of May and minimum 2.40 mg/l at station IV during December. Total hardness is also highly variable at different stations.

The two taxa of *Phormidium*, viz. *P. ambiguum* var. *major* was present at stations II & IV during

August and *P. calcicola* at station IV during October, when pH was 7.0 and total alkalinity 288.00 mg/l. Singh *et al.* (1970) also reported *Phormidium* from sewage under almost similar conditions. All the three species of *Lyngbya* were present at station IV during the month of August.

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