

Some Fresh Water Algae of Oil Refinery Effluent Drains of Assam, India

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Abstract

The present paper deals with the morpho-taxonomic account of some hitherto unknown fresh water algal species of hydrocarbon polluted refinery drains of Assam. Twenty two taxa of class Chlorophyceae, Bacillariophyceae, Euglenineae and Cyanophyceae were identified from three effluent drains of Guwahati Oil Refinery. Cyanophyceae with 11 species was the dominant algal group in the study sites and *Oscillatoria* was the dominant genus with 8 species.

Key words: Fresh water algae, *Oscillatoria*, oil refinery effluent, Assam

Introduction

The Guwahati oil refinery is located at Latitude 26°10' N and Longitude 92°49' E in the state of Assam (India) at an elevation of 55 m msl. The oil refinery was established in the year 1962 and is situated in the eastern part of the city itself. There are as many as three drains coming out from the refinery campus carrying sludge waste. The drains either flow towards the mighty Brahmaputra River or to Bharalu River, a perennial tributary of Brahmaputra. The drains are perennial in nature and hardly dry up. These drains often have very low water levels during winter season and that is too high during summer. The area has a subtropical monsoonal climate with 29°C/19°C average maximum /minimum temperature and 1600 mm average annual rainfall. The hot and humid climate and slightly polluted habitats influence the growth of few algae in the drains of the area.

Information pertaining to diversity of algal flora of Assam (India) is meager (Parukutty, 1939; Bordoloi, 1974; Devi, 1981; Devi and Boissya, 1981; Talukder, 1997; Choudhury, 2004). Since there has been no report on algae from any refinery sites of Assam, an attempt has therefore been made to describe the algae reported to be present in the water drains flowing through the Guwahati oil refinery site.

Materials and methods

The study was conducted for a year from May, 2008 to April, 2009. Algal samples were collected in two months intervals. The samples were collected in plastic tubes from three different effluent drains flowing through the Guwahati oil refinery with the help of plankton mesh net (size 0.5 mm) and by scrubbing the slippery pebbles. The collection timings were set between 9-12 am.

All the samples were preserved in 4% formaldehyde solution on the spot. Geographical position, sample no., date of collection etc. of each locality was also noted on the field diary. They were brought to the laboratory of the Department of Botany, Gauhati University for further investigation. Chlorophycean algae were stained with iodine and mounted in glycerin. Bacillariophycean taxa were studied after clearing the frustules by concentrated sulphuric acid and potassium dichromate method of Patrick and Reimer (1966). Cyanophycean algae were stained with dilute safranin and mounted in glycerin. Identification was confirmed by cross checking each specimen with literature and monographs (Kützing, 1895; Gomont, 1892a, b; Hustedt, 1930; Fritsch, 1935, 1961; Smith 1950; Desikachary, 1959; Islam and Haroon, 1975; Prescott, 1975; Hirose *et al.*, 1977; Islam and Chaudhary, 1979; Germain, 1981; Sarode and Kamat, 1984). All the samples have been deposited in the repository of Department of Botany, Gauhati University.

Morpho-taxonomic descriptions

Class: Chlorophyceae
Order: Volvocales
Family: Chlorellaceae
Genus: *Chlorella* Beijernick. 1890

1. *Chlorella vulgaris* Beij. (Fig. 7)
Fritsch 1961, P. 146, Fig. 37
Solitary spherical cell, cell membrane thin. Cup shaped parietal chloroplast, very prominent. Cell diameter varies from 7.8-9.3 μm .

Class: Bacillariophyceae
Order: Pinnales

Family: Fragillarioideae
Genus: *Fragillaria* Lyngbye. 1819;
Emend. Rabenhorst. 1864

2. *Fragillaria virescens* Ralf. (Fig. 16)
Hustedt 1930, P. 142, Fig. 144
Frustules attached together to form chains, broadly linear, valves 64.2 μm long and 8.7 μm broad, pseudoraphe, striae marginal, thin, central area unilateral, valves elliptic, striae 12-19 in 10 μm .

3. *Fragillaria crotonensis* var. *praelonga*
Grun. (Fig. 12)
Smith 1950, P. 479, Fig. 386
Frustules 127 μm long and 9 μm broad at the tip. Valves mostly straight, rod shaped or lenceolata, only a pseudo-raphe present.

Genus: *Synedra* Ehrenberg. 1830

4. *Synedra ulna* (Nitz) Her. (Fig. 11)
Hustedt 1930, P. 151, Fig. 159.
Valves 122 μm long and 10 μm broad, linear to lenceolate and tapering at the ends, ends rounded pseudoraphe narrow, linear, central area absent or present. Striae 9-11 in 10 μm . Coarse.

Genus : *Pinnularia* Ehrenberg. 1838

5. *Pinnularia gibba* Ehr. Var.
mesogongyla (Ehr.) Hust. (Fig. 8)
Islam and Haroon 1975, P. 32, Pl. 3, Fig. 56.
Frustules 50.49 μm long and 13.2 μm broad, have the general form of an oblong box, isobilateral with 2 planes of symmetry, both valve with a fully differentiated raphe.

Family: Naviculoideae
Genus: *Nevicula* Bory

6. *Nevicula rhynchocephala* Kuetz. (Fig. 17)

Hustedt 1930, P. 296, Fig. 501.

Valves 50.24 μm long and 12.2 μm broad, oblong slender, with slightly dilated capitates ends, raphe thin and straight, axial area narrow, linear, central and rounded, somewhat rhombic, striae 14-16 in 10 μm . Denser towards the ends, radial in the middle and convergent at the ends.

7. *Nevicula cryptocephala* Kutz. (Fig. 13)

Germain 1981, P. 188, Pl. 72, Fig. 2.

Frustules 29.7 μm long and 5.95 μm broad at the middle, raphe occupying the apical axis, both polar and central nodules are elongated at the apical direction and enclosed along the raphe, both valve with a fully differentiated raphe.

Genus: *Gomphonema* Agardh 1824

8. *Gomphonema lenceolatum* Her. (Fig. 9)

Sarode and Kamat 1984, P. 190, Pl. 22, Fig. 514.

Valves 86 μm long and 22 μm broad, lanceolate, clevate with distinctly rounded apex and base, base somewhat narrow, linear central area slightly unilateral with an isolated stigma on the opposite sides, striae 11-12 in 10 μm . Radial and lineate.

9. *Gomphonema parvulum* (Kg.) Grun. (Fig. 10)

Islam and Chaudhary 1979, Pl. 7, Fig. 63.

Frustules 33 μm long and 11.55 μm broad at the middle, has only a single often deep incised chromatophore, the median portion of which lies against one of the girdle, while the rest spread over on to the valve faces and most of the other girdle. The central area is asymmetrical with a single long stria on one side terminating in a distinct stigma,

and a single short stria on the other side. Striae are almost perpendicular to the raphe.

Class: Euglenineae

Family: Euglenaceae

Genus: *Euglena* Ehrenberg 1838

10. *Euglena acus* Her. (Fig. 15)

Fritsch 1935, P. 725, Fig. 239.

Planktonic, unicellular, uniflagellate, cell elongated and the posterior end more pointed. Cell has a gullet at the anterior end and one contractile vacuole. Eyespot present at the anterior end. Chloroplast numerous and discoid. Cells 2-4 μm in breadth and 7-9 times longer than the breadth.

Genus : *Phacus* Dujardin 1841

11. *Phacus acuminatus* a. Stokes. (Fig. 14)

Cell body 23-40 μm long, 20-30 μm wide, dorsal view nearly spherical; cauda short V-shaped and slightly curved or straight, striae also straight; a locomotive flagellum nearly the same as the cell body in length; paramylon bodies disc-shaped with a hole at the center.

Class: Cyanophyceae

Order: Nostocales

Family: Oscillatoriaceae

Genus: *Oscillatoria* Voucher, 1803

12. *Oscillatoria Formosa* Bory (Fig 1)

Hirose 1977, P. 102, Pl. 44, Fig. 33; Prescott 1975, P. 489, Pl. 109, Figs. 10-11.

Trichomes straight and rather firm, curved and slightly tapering towards the apex. Apical cell conical, not capitates, without a calyptras. Trichomes constricted at the cross walls, which contains micro-granulars. Cells

4-6 μm in diameter, 2.5-6 μm long. Dark blue-green in colour.

13. *Oscillatoria nigra* Vaucher. (Fig. 2)

Hirose 1977, P. 110, Pl. 45, Fig. 12; Prescott 1975, P. 489, Pl. 109, Fig. 18.

Trichomes straight or slightly twisted, not tapering towards the apex, straight or curved. Apical cell rounded or capitate. Trichomes constricted at the cross walls, which contains micro-granules. Cells 7.5-9 μm in diameter, 3.5-7 μm long. Trichomes aggregates to form a mucilaginous blackish green plant mass.

14. *Oscillatoria limnosa* Agardh. (Fig. 3)

Hirose 1977, P. 102, Pl. 44, Fig. 15; Prescott 1975, P. 489, Pl. 109, Fig. 17.

Trichomes straight, not constricted at the crosswalls which are granular. Apical cell round, Cells 10-12 μm in diameter, 2-4 μm long. Dark blue green in colour.

15. *Oscillatoria anguina* (Bory) Gomont. (Fig. 6)

Hirose 1977, P. 102, Pl. 44, Fig. 28.

Trichomes straight for most of their lengths but bent and sometimes twist in the apical regions, slightly tapering towards the apex. Apical cell with capitate. Cells not constricted at the crosswalls, which are granular. Cells 7.5 μm in diameter, 2 μm long. Dark blue green in colour.

16. *Oscillatoria articulata* Gardner (Fig. 5)

Prescott 1975, P. 486, Pl. 107, Fig. 22.

Trichomes with a thickened outer membrane, not tapering at the apices, Apical cell rounded, not capitate, without a calyptra. Cells 2.5-3.5 μm in diameter, 1.2-3.5 μm long. Blue green in colour. Not constricted.

17. *Oscillatoria princeps* Vaucher ex. Gomont. (Fig. 4)

Desikachary 1959, P. 210, Pl. 37, Figs. 1, 10, 11, 13, 14.

Trichomes blue green to dirty green, mostly forming a thallus, mostly straight not constricted at the cross walls, slightly or briefly attenuated at the apices and bent. Cells 13.3 μm broad and 2.6 μm long, granulated end cell flatly rounded, slightly capitate with slightly thickened membrane.

18. *Oscillatoria subbrevis* Schmidle (Fig. 22)

Desikachary 1959, P. 207, Pl. 37, Fig. 2; Pl. 40, Fig. 7.

Trichomes single, light blue green, nearly straight, apices not attenuated, septa not granulated, indistinct, cells 5.76-6.2 μm broad and 0.96-1.9 μm long, granulated end cell rounded, calyptras absent.

19. *Oscillatoria tenuis* Agardh. (Fig. 18)

Hirose 1977, P. 102, Pl. 44, Fig. 25.

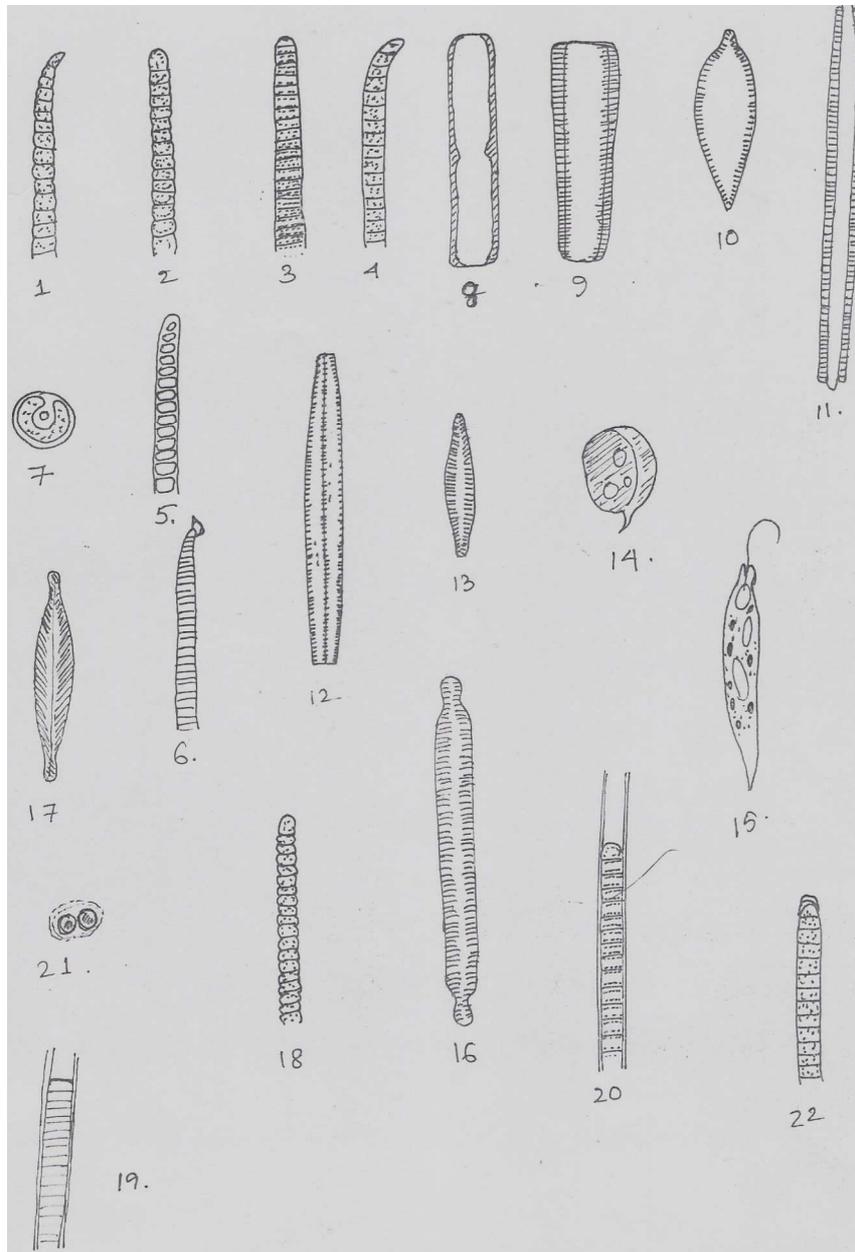
Trichomes straight or slightly flexuous at the anterior end, which does not taper, homogenous sheath frequently present. Apical cell round and not capitate. Trichomes only slightly constricted at the cross walls, which are granular. Cells 5-10 μm in diameter, 2.5-4 μm long. Trichomes aggregates to form a blue green mass.

Genus: *Phormidium* Kutz.

20. *Phormidium inuatum* Kutz. Ex. Gomont. (Fig. 19)

Kützing 1895, P. 251; Gomont 1892, P. 172, Pl 4, Figs. 31-32,

Thallus blue green, membranous, filament sub erect, when dry fragile, sheath thin, becoming diffluent, trichomes blue green,



Figures: 1. *Oscillatoria formosa* Bory 2. *O. nigra* Vaucher 3. *O. limnosa* Agardh, 4. *O. princeps* Vaucher ex. Gomont, 5. *O. articulata* Gardner 6. *O. anguina* (Bory) Gomont 7. *Chlorella vulgaris* Beij. 8. *Pinnularia gibba* Ehr. var. *mesogongyla* (Ehr.) Hust. 9. *Gomphonema lenceolatum* Her. 10. *G. parvulum* (Kg.) Grun. 11. *Synedra ulna* (Nitz.) Her. 12. *Fragillaria crotonensis* var. *praelonga* Grun. 13. *Nevicula cryptocephala* Kütz. 14. *Phacus acuminatus* a. Stokes 15. *Euglena acus* Her. 16. *Fragillaria virescens* Ralf. 17. *Nevicula rhynchocephala* Kütz. 18. *Oscillatoria tenuis* Agardh 19. *Phormidium inuatum* Kütz. ex. Gomont 20. *Lyngbya birgei* Smith 21. *Chroococcus montanus* Hansging 22. *Oscillatoria subbrevis* Schmidle

straight or bent, not constricted at the cross walls, ends straight, briefly attenuated, not capitate, 3-5 µm broad cells nearly quadrate or longer than broad, 4-8 µm long, granulate at the septa, calyptras absent.

Genus: *Lyngbya* Agardh 1824

21. *Lyngbya birgei* Smith. (Fig. 20)

Gomont 1892, P. 91-264, Pl. 7; Smith 1950, P. 577, Fig. 492.

Filamentous straight, seldom coiled, free floating, 20-25 µm broad sheath firm, colorless, trichomes not constricted at the cross walls, 18-23 µm broad, ends rounded, not attenuated, not capitate. Cells 2-2.5 µm long, hormogonia are 22-25 µm broad, 5-7 celled.

Order : Chroococcales

Family: Chroocaceae

Genus: *Chroococcus* Nageli 1849

22. *Chroococcus montanus* Hansging. (Fig. 21)

Desikachary 1959, P. 108, Pl. 26, Fig. 12

Thallus slimy, gelatinous, brownish or blackish brown, cells 4.9-6.5 µm, seldom 9.9 µm diameter, single or 2-4, seldom more in irregular groups, 19-25 µm in diameter, sheath is lamellate.

Results and discussion

Taxonomic investigations on the algal flora of North Eastern region of India in general and Assam in particular are still very limited and most studies were performed in ponds, Ditches and in rice fields (Parukutty, 1939; Bordoloi, 1974; Devi, 1981; Devi and Boissya, 1981; Talukder, 1997; Choudhury, 2004). In the present study, altogether 22 algal species have been reported to be present in the hydrocarbon polluted drains

that have been passing through the Guwahati oil refinery. Cyanophyceae was represented by eleven species in the study sites followed by Bacillariophyceae with eight species. Euglenineae and Chlorophyceae were represented two and one species respectively. *Chlorella vulgaris* Beij. was the lone genus that belongs to Chlorophyceae. *Oscillatoria* was found to be the dominant genus with eight species and widely available throughout the study period. All the species have for the first time morpho-taxonomically described from the hydrocarbon contaminated sites of the region and, thus opens up a new area of research in the region. The oil refinery effluent drains therefore, need more attention and require a more extensive exploration and documentation of its algal flora. The establishment of an algal database in those hydrocarbon polluted sites would be an essential contribution to the conservation of hydrocarbon resistant and hydrocarbon tolerant aquatic biodiversity.

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