



A study on green algal flora of Indian Sundarbans mangrove forest with special reference to morphotaxonomy

Gour Gopal Satpati, Nirupam Barman and Ruma Pal*

Phycology laboratory, Department of Botany, University of Calcutta, 35, Ballygunge Circular Road, Kolkata – 700019

*Corresponding author: rpalcu@rediffmail.com.

Abstract

In the present communication a detail morphotaxonomic description of 32 algal taxa from Indian Sundarbans (between 21°31' to 22°53' N and 88°37' to 89°09' E) was studied. Dense algal association was recorded from the forest floor, tree bark, pneumatophores, knee roots and stilt roots of the mangrove plants like *Avicinnia alba*, *Bruguiera gymnorrhiza* and *Heritiera fomes* etc. A number of epiphytic and epixylic algae were also recorded from these plants. An endozoic unicellular alga *Chlorococcum infusionum* was recorded inside the body of Slugs- the shell less molluscs. Among the filamentous microalgal flora, *Rhizoclonium* and associated genus *Lola* appeared as the most dominant genus with 9 species all together viz. *R. riparium*, *R. pachydermum*, *R. africanum*, *R. tortuosum*, *R. hieroglyphicum*, *R. fontinale*, *R. crassipellitum*, *Lola capillaris* and *L. tortuosa*. *Cladophora* with three species (*C. glomerata*, *C. crystallina* , *C. nitellopsis*) and *Chaetomorpha gracilis* are the other dominant green algal genera of Sundarbans flora along with two species of *Pithophora* (*P. cleveana* and *P. polymorpha*). Four species of *Spirogyra* were recorded from the study area among which only *S. pseudoreticulata* was recorded from brackish water zone, whereas *S. jaoense*, *S. hymerae* and *S. punctulata* were collected from the fresh water pond of these islands. Tree barks and the pneumatophores of mangrove forest remain covered with *Rhizoclonium* at the marine region of the estuary exposed to daily tidal cycle. But the aerial portion of the mangrove plants remains covered by orange thallus of *Trentepohlia*. The abundance of the individual taxa in different salinity level is also discussed in the present communication.

Key words- Abundance; Green algae; Morphotaxonomy; Salinity; Seasonal variation.

Introduction

The members of Chlorophyta or green algae are abundantly found in fresh water, brackish water and marine water environments. The water body harboring them may be lentic (stagnant) or lotic (continuously flowing). The lentic environment may be characterized by a static ponds, more stable permanent pools, ponds and lakes in the form of natural and man-made sources. Lotic systems comprise all kinds of flowing water from a small stream to huge rivers. Besides these, any moist surface such as wet soil, rocks, tree trunks, walls of old buildings can also support growth of algae. The algal thallus ranges from unicellular mucilaginous colonies to multicellular compact forms which show considerable diversity in form and adaptation to their distinctive environment (Krishnamurthy, 2000).

Sundarbans is the largest mangrove forest comprises more than 400 islands interconnected with small rivers, creeks and canals, mud banks or sandy beaches and dunes along the coast of each island. The land is constantly molded and altered by tidal action, with erosion along

estuaries and deposition silt from seawater (Sanyal and Bal, 1986). Prain (1903) described the algal flora of the mangrove forest of the Ganges-Brahmaputra delta. A more recent examination of the composition and structure of the mangrove vegetation including algal flora and fauna of the Indian Sundarbans have been made by Sen *et al.* (1994, 2003) and Mandal and Naskar (1994). Algal flora of Bangladesh Sundarbans mangrove forest, estuaries, lagoons, marine water and benthic marine habitats has been studied extensively by Islam *et al.* (Islam and Aziz, 1975; Islam, 1973, 1976; Islam and Aziz, 1977, 1979, 1987). The genus *Enteromorpha tubulosa* in brackish sewage fed fisheries of Sundarbans was studied by Naskar and Santra, 1986. Algal flora of saline habitat of Sundarbans was studied by Maity *et al.*, 1987. Some benthic forms of marine algae from Sundarbans were recorded by Santra and Pal (1988). A checklist of algae of Sundarbans was reported by Pal *et al.*, 1988. A study on marine phytoplankton of Sundarbans was carried out by Santra *et al.*, 1991. Phytoplankton and filamentous algal diversity varied to a greater extent with salinity gradient. The present

group also reported the coastal diversity of West Bengal including part of Sundarban and southern coast (Mukhopadhyay and Pal, 2002; Chowdhury and Pal, 2008). In a recent survey Satpati *et al.* (2011) reported some green algae from Indian Sundarbans away from their usual habitat. Some common seaweed from Indian Sundarbans also reported by Satpati *et al.*, 2012.

Our work attempted to explore the green algae of Sundarbans ecosystem to develop a database of Sundarbans algae as potential bioresource with their respective habitat and taxonomic description. Investigation was mainly

carried out in terms of collection, preservation, identification and strain maintenance of the algal flora collected from different parts of Sundarbans together with germplasm preservation.

Materials and Methods

Sampling sites

The study area lies between 21°31' to 22°53' N and 88°37' to 89° 09' E of the south-eastern part of Bay of Bengal. The study area covers 14 islands with dense mangrove forest and inner island area (Figure 1).

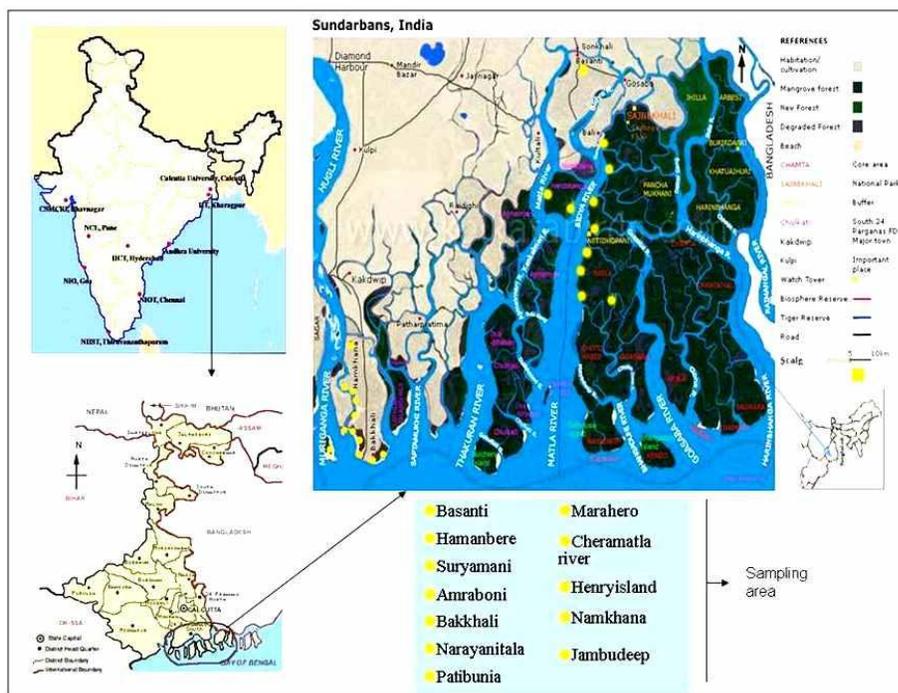


Figure 1: Showing the algal sampling sites from Indian Sundarbans mangrove forest.

Collection of algal samples

The samples were mainly collected in three different season's viz. Summer (March-June), Monsoon (July-October) and Winter (November-February) from the forest floor, bark of mangrove plants, pneumatophores, other aerial root systems, wooden and bamboo poles, mud plain (exposed in low tide), concrete jetties, on the sides of boat and launches, from shells of different animals etc. Samples were collected from their natural sources and man made areas. The phytoplanktons were collected from the rivers, creeks and canals during both the tidal phases and also from the brackish water areas with the help of truncated

plankton net of 25 μ mesh size. Samples were also collected in plastics pouches and were brought to the laboratory for further examinations. The samples thus collected were thoroughly washed with running tap water or saline water and then with double distilled water to remove soil particles and other materials. After washing the samples were preserved in 4% (v/v) formalin for further study. The slides were prepared and digital photographs were taken in Carl Zeiss Axiostar plus Microscope by Cannon Power Shot 500D camera. Identification of taxa was done by standard monographs of Prescott (1951); Randhawa (1969); Gonzalves (1981); Anand (1998); Kargupta *et al* (1998) and Krishnamurthy (2000). The unialgal cultures were

ISSN: 2229- 6905

raised using different culture media to induce the reproductive structures for proper identification.

Results and Discussion

The pH level varied from 2 to 8 and the variation in temperature from winter to summer season were from 12°C to 40°C. Rainfall is heavy and the humidity averages 70-90% at the sea coast of the Bay of Bengal. The phosphate and nitrate level fluctuated from 0.04 to 0.08ppm and 0.26 to 0.32ppm respectively throughout the year. The most important factor for controlling the algal diversity of Indian Sundarbans is the salinity variation due to the diurnal tidal cycle (low and high tide twice a day). The upstream rivers and the monsoon rain bring huge amount of freshwater and the saline water is carried inside by tidal cycle. The area has three main hydrological zones based on salinity level of habitat water viz, brackish, moderately

saline and saline which influence the flora to a greater extent. As a result freshwater, marine and a number of estuarine algae grow luxuriantly in this tiger inhabiting undisturbed ecosystem.

Diversity of green algal flora has been listed in table 1 and their abundance on generic basis is also represented in three different seasons. From table 1 it is evident that a total 32 algal species have been recorded in the first phase of exploration of different area of Sundarban. They belong to the different family viz. Chlorococcaceae, Chlorellaceae, Hydrodictyaceae, Scenedesmaceae, Desmidiaceae, Cladophoraceae, Oedogoniaceae, Zygnemataceae, Ulvaceae, Chaetophoraceae and Trentepohliaceae. The morphotaxonomic description of the algal genera are given below:

Table 1: Showing abundance and seasonal variation of green algal genera collected from Indian Sundarbans mangrove forest.

GENERA RECORDED	SAMPLING SITE	ABUNDANCE			SALINITY (%)
		SUMMER	MONSOON	WINTER	
<i>Rhizoclonium riparium</i>	Jharkhali	+	+	++	4.2
<i>R. fontinale</i>	Basanti	+	+	++	0.6
<i>R. hieroglyphicum</i>	Lothian Island	+	-	++	7.5
<i>R. tortuosum</i>	Morahero	-	+	+	12.6
<i>R. pachydermum</i>	Narayanitala Island	-	+	+	20.1
<i>R. africanum</i>	Cheramatta	-	+	+	25.5
<i>R. crassipellitum</i>	Basanti	+	-	++	2.1
<i>Pithophora polymorpha</i>	Suryamani Island	+	-	++	23.3
<i>P. cleveana</i>	Sushni Island	-	+	+	21.5
<i>Cladophora crystallina</i>	Jharkhali Island	++	+	-	4.9
<i>C. glomerata</i>	Jai gopalpur	+	-	++	2
<i>C. nitellopsis</i>	Cheramatta	-	+	++	23.5
<i>S. variable</i>	Kala jangal	+	-	+	15.4
<i>Trentepohlia thevalliensis</i>	Suryamani Island	+	+	-	12.1
<i>T. abietina</i>	Morahero	-	+	+	22.4
<i>T. torulosa</i>	Lothian Island	+	-	+	9.2
<i>Chlorococcum infusionum</i>	Jharkhali Eco-Park	+	-	+	3.9

- Absent, + Present, ++ Luxuriant growth

GENERA RECORDED	SAMPLING SITE	ABUNDANCE			SALINITY (%)
		SUMMER	MONSOON	WINTER	
<i>Spirogyra orientalis</i>	Jaigopalpur	+	-	++	1.6
<i>S. hymerae</i>	Bhagabatpur	+	-	+	2.1
<i>S. occidentalis</i>	Jharkhali Jetty	+	+	-	12.5
<i>S. punctulata</i>	Lothian Island	-	+	++	7.6
<i>Scenedesmus quadricauda</i>	Matla river	-	+	+	14.8
<i>S. dimorphus</i>	Matla river	+	-	++	15.6
<i>S. bijuga</i>	Matla river	++	+	-	16.2
<i>Pediastrum tetras</i>	Bidya river	+	-	++	18.5
<i>Crucigenia tetrapedia</i>	Bidya river	-	+	++	18.6
<i>Chaetomorpha gracilis</i>	Bakkhali sea beach	+	-	++	20.8
<i>Lola capillaris</i>	Kala jangal Suryamoni Island	-	+	+	16.2
<i>L. tortuosa</i>	Island	-	+	+	12.5
<i>Closterium tumidium</i>	Matla canal Jaigopalpur pond	-	+	++	20.6
<i>Chlorella vulgaris</i>	pond	+	-	++	2.9
<i>Oedocladim prescottii</i>	Jharkhali Island	+	-	++	1.8

- Absent, + Present, ++ Luxuriant growth

Table 1(Continued): Showing abundance and seasonal variation of green algal genera collected from Indian Sundarbans mangrove forest.

Taxonomic description of the genera recorded-

DIVISION: CHLOROPHYTA

CLASS: CHLOROPHYCEAE

ORDER: CHLOROCOCCALES

FAMILY: CHLOROCOCCACEAE

1. *Chlorococcum infusionum* (Schrank) Menegh (Pl. 1, Fig. 2; Pl. 5, Fig. 8)

Smith, 1950, p 224; Komárek and Fott, 1983, p 36, fig 3.

Free living, unicellular, green, cells are solitary or sometimes in colonial form; striking variation in size shows between various cells when the alga grows in an expanded stratum, young cells are thin walled and spherical or somewhat compressed, old cells have thick walls that are often irregular in outline, chloroplasts of young cells are parietal massive cups, completely filling the cell except for

a small hyaline region at one side, they contain one pyrenoid, as a cell increases in size, the chloroplast usually becomes diffuse and contains several pyrenoids, young cells are 50-125 μ in diameter and mature cells are 120-210 μ in diameter.

Occurrence- Jharkhali Eco-Park (N 22°01.143', E 088°41.886'), fresh water.

2. *Crucigenia tetrapedia* (Kirch.) West & West (Pl. 1, Fig. 7; Pl. 5, Fig. 4)

Anand, 1998, p 34.

Cells forming compact colonies, cells arranged otherwise, colonies flat plate like, cells in groups of variable shapes, colonies in groups of four cells, angular, mother cell wall absent, and cells 2-4 μ in diameter.

ISSN: 2229- 6905

Occurrence- Bidya river (N 21°42.696', E 088°42. 924'), brackish water.

FAMILY: CHLORELLACEAE

3. *Chlorella vulgaris* Beijerinck (Pl. 1, Fig. 1; Pl. 5, Fig. 2)

Prescott, 1982, p 237, pl 53, fig 13; Sen & Naskar, 2003, p 138, pl XIII, fig 84.

Unicellular, free floating planktonic, single or aggregated form, cells small spherical, single prominent, cup shaped parietal chloroplast, cells 4-8 μ in diameter.

Occurrence- Jaigopalpur pond (N 22°12.463', E 088°42.432'), fresh water.

FAMILY: HYDRODICTYACEAE

4. *Pediastrum tetras* (Her.) Ralf (Pl. 1, Fig. 6; Pl. 5, Fig. 3)

Prescott, 1982, p 227, pl 50, figs 3, 6; Anand, 1998, p 32.

Cells forming compact colonies, cells arranged forming radiating flat spherical or cylindrical colonies, colonies microscopic, colony plate like with 7 cells, cells multinucleate, cells are 20-30 μ in diameter.

Occurrence- Bidya river (N 21°42.696', E 088°42. 924'), brackish water.

FAMILY: SCENEDESMACEAE

5. *Scenedesmus quadricauda* (Turp.) Breb (Pl. 1, Fig. 4; Pl. 5, Fig. 6)

Prescott, 1982, p 280, pl 64, fig 2; Anand, 1998, p 34, fig 105.

Cells forming compact colonies, cells arranged otherwise, colonies flat plate like, cells in groups of variable shapes, colonies irregular, cells are ellipsoidal, fusiform, cells arranged in longitudinal axis, colonies are with 4 cells, cells parallel with setae, cells are of 4-12 μ long and 2-5 μ broad.

Occurrence- Matla river (N 22°06.598', E 088°38.560'), brackish water.

6. *S. bijuga* (Turp.) Lagerheim (Pl. 1, Fig. 3; Pl. 5, Fig. 5)

Prescott, 1982, p 276, pl 63, figs 2, 7; Sen & Naskar, 2003, p 139, pl XIV, fig 86.

Cells 4, arranged in a single row, cells rarely oblong, similar in shape, apices rounded, closely appeared to each other, wall smooth, cells 4-6 μ in diameter and 8-12 μ long.

Occurrence- Matla river (N 22°10.489', E 088°39.623'), brackish water.

7. *S. dimorphus* (Turp.) Kuetzing (Pl. 1, Fig. 5; Pl. 5, Fig. 7)

Prescott, 1982, p 277, pl 63, figs 8, 9; Anand, 1998, p 34, Fig 103.

Colony composed of 4-8 fusiform cells arranged in a single or alternative series; the inner cells with straight, sharp apices; the outer cells lunate, strongly curved, with acute apices; cells 2-6 μ in diameter, 10-22 μ long.

Occurrence- Matla river (N 22°05.589', E 088°39.610'), brackish water.

FAMILY: DESMIDACEAE

8. *Closterium tumidium* Johnson (Pl. 1, Fig. 8; Pl. 5, Fig. 1)

Anand, 1998, p 55, fig 177.

Cell wall segmented with constriction forming semi cells, cells cylindrical, elongated with central constriction, cells elongate curved attenuated towards each end with two chloroplasts, cells are 48-60 μ long and 8-10 μ broad.

Occurrence- Matla canal (N 22°05.588', E 088°39.612'), marine water.

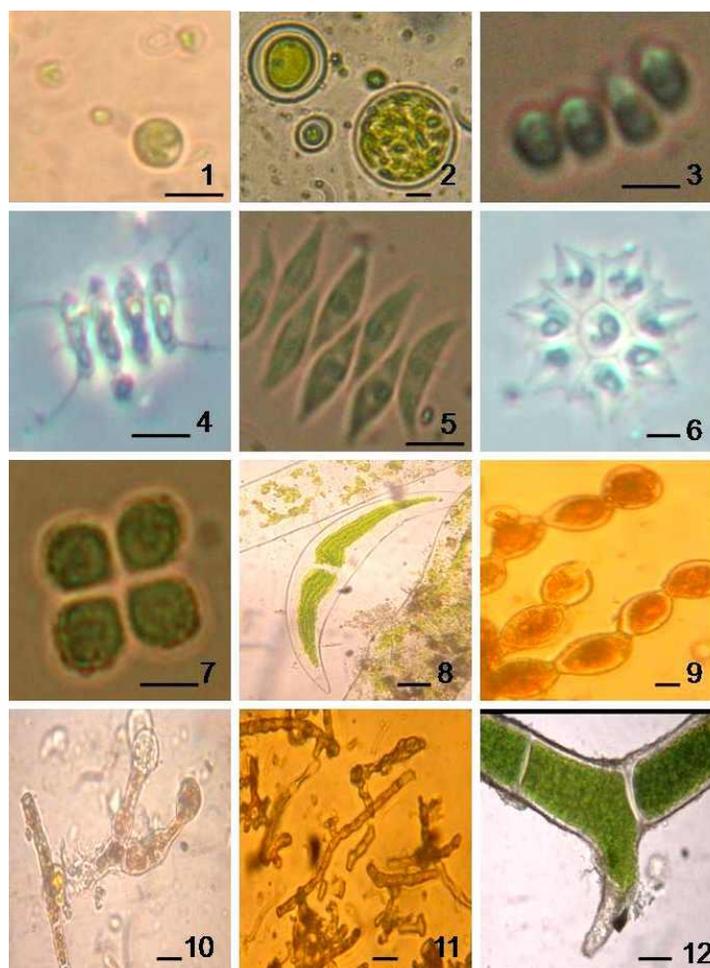


Plate 1 (Scale bar 10 μ): Showing microphotographs of Fig. 1. *Chlorella vulgaris*, Fig. 2. *Chlorococcum infusionum*, Fig. 3. *Scenedesmus bijuga*, Fig. 4. *S. quadricauda*, Fig. 5. *S. dimorphus*, Fig. 6. *Pediastrum tetras*, Fig. 7. *Crucigenia tetrapedia*, Fig. 8. *Closterium tumidium*, Fig. 9. *Trentepohlia torulosa*, Fig. 10. *T. thevalliensis*, Fig. 11. *T. abietina*, Fig. 12. *Rhizoclonium africanum*.

ORDER: CLADOPHORALES

FAMILY: CLADOPHORACEAE

9. *Rhizoclonium fontinale* Kutzing (Pl. 2, Figs. 2-4; Pl. 5, Figs. 17-18)

Kutzing, 1849, p 386; Murray, 1887, p 42; Krishnamurthy, 2000, p 123.

Fresh water, thallus bright green, twice as long as broad, cells are 10-15 μ in diameter, cells just before division four times as long as broad, cell wall thin almost homogeneous, rhizoid like branches sparse, reproduction is by akinete.

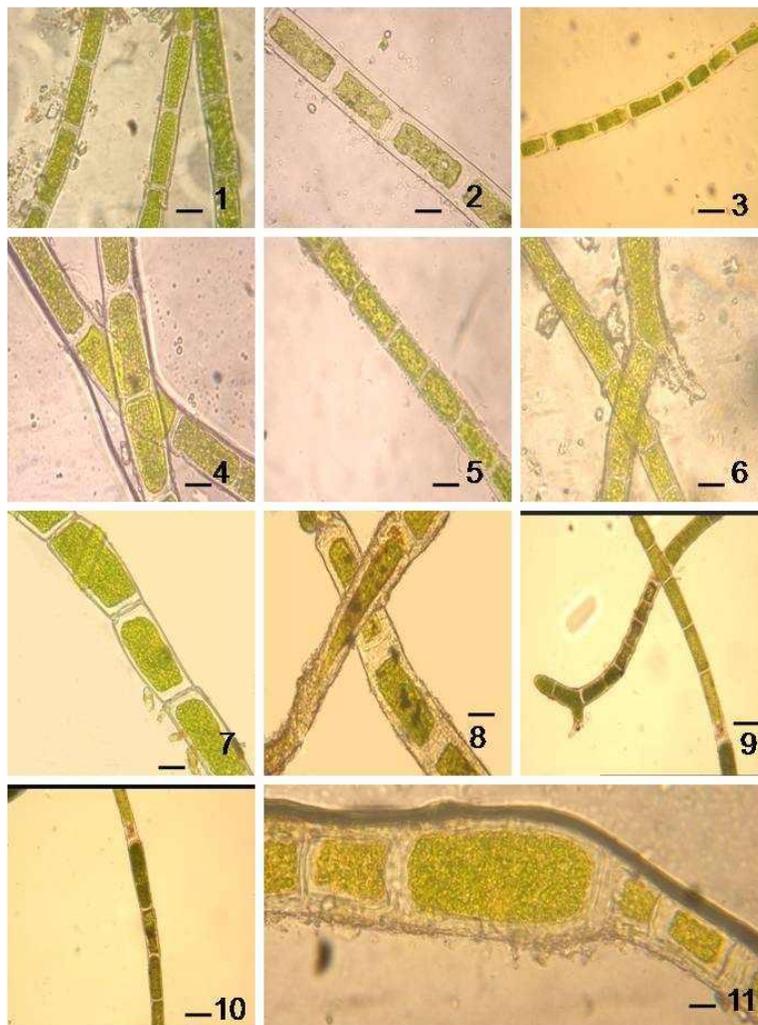


Plate 2 (Scale bar 10 μ): Showing microphotographs of Figs. 1, 7. *Rhizoclonium pachydermum*, Figs. 2-4. *R. fontinale*. Figs. 5-6. *R. hieroglyphicum*, Figs. 8. *R. riparium*, Figs. 9-10. *R. tortuosum*. Fig. 11. *R. riparium*.

Occurrence- Basanti (N 22°12.022', E 088°43.822'), fresh water.

10. *R. crassipellitum* West and West (Pl. 3, Fig. 1; Pl. 5, Figs. 11-12)

Sarma & Keshri, 1993, p 43, figs 3 & 4; Krishnamurthy, 2000, p 123, figs 26A & B.

Thallus consists of very coarse and wiry unbranched filaments, entangled in floating mass, rhizoidal

branches rare, cells cylindrical, 20-35 μ in diameter, 2-3 times as long as broad, cell wall is thick.

Occurrence- Basanti (N 22°12.022', E 088°43.822'), brackish water.

11. *R. pachydermum* Kjellmann (Pl. 2, Fig. 1; Pl. 3, Fig. 2; Pl. 5, Figs. 9-10)

Prasad & Vijaykumari, 1979, p 128, fig 4; Krishnamurthy, 2000, p 123, fig 26F.

Thallus branched, the principal axes becoming indistinct, 95 μ broad, filaments with frequent rhizoidal branches, short filaments with 3 or more cells, cells are 30-40 μ in diameter, frequently longer than broad, with thin cell wall, branches crowded in lower part of the thallus, cells of branches 40-60 μ in diameter, cylindrical, twice as long as broad.

Occurrence- Narayanitala Island (N 20°00.107', E 088°40.608'), marine water.

12. *R. tortuosum* (Dillwyn) Kutzing (Pl. 2, Figs. 9-10; Pl. 5, Figs. 13-14)

Kutzing, 1845, p 205; Martens, 1868; Krishnamurthy, 2000, p 124.

Epiphytic on mangrove plant, filaments slender, contorted, forming mats, cells of filaments are 18-30 μ in diameter almost equal or one and a half times as long as broad, just before divisions 2-3 times as long, cell wall fairly thick, distinctly stratified.

Occurrence- Morahero Island (N 22°03.097', E 088°40.310'), brackish water.

13. *R. africanum* Kutzing (Pl. 1, Fig. 12; Pl. 5, Fig. 15)

Kutzing, 1849, p 21; Krishnamurthy, 2000, p 124.

Deep green, filaments stiff, entangled, branched, branches held out at right angles with the main axis, cells cylindrical, swollen, 12-50 μ in diameter of almost equal length, cell wall lamellated, rhizoids numerous.

Occurrence- Chermatla (N 22°00.116', E 088°42.610'), marine water.

14. *R. hieroglyphicum* (G. Agardh) Kutzing (Pl. 2, Fig. 6; Pl. 5, Fig. 16)

Kutzing, 1845, p 205; Biswas, 1949, pl V, fig 47; Krishnamurthy, 2000, p 125.

Pale green, somewhat caespitose, filaments with frequent rhizoidal branches, short and produced laterally, cells 10-20 μ broad, 2 times as long as broad, constricted at septa.

Occurrence- Lothian Island (N 21°42.341', E 088°18.890'), brackish water.

15. *R. riparium* (Roth) Harvey (Pl. 2, Figs. 8,11; Pl. 3, Fig. 3; Pl. 5, Figs. 19-20)

Biswas, 1949, pl V, fig 48; Durairatnam, 1961, p 19; Islam, 1976, p 15, pl 1, figs 5 & 6; Krishnamurthy, 2000, p 125.

Thallus yellowish green, crisp, caespitose, intricately interwoven into mats, cells 14-16 μ in diameter, as long as broad, 2-5 times as long as broad before cell division, rhizoid like branches sparse, short.

Occurrence- Jharkhali (N 22°01.141', E 088°41.175'), brackish water.

Plate 3 (Scale bar 10 μ): Showing microphotographs of Fig. 1. *Rhizoclonium crassipellitum*, Fig. 2. *R. pachydermum*, Figs. 3-4. *R. riparium*, Fig. 5. *Lola tortuosa*, Fig. 6. *L. capillaries*, Figs. 7-8. *Chaetomorpha gracilis*, Figs. 9-10. *Stigeoclonium variable*, Fig. 11. *Cladophora crystallina*, Figs. 12-13. *C. glomerata*, Figs. 14-15. *C. nitellopsis*.

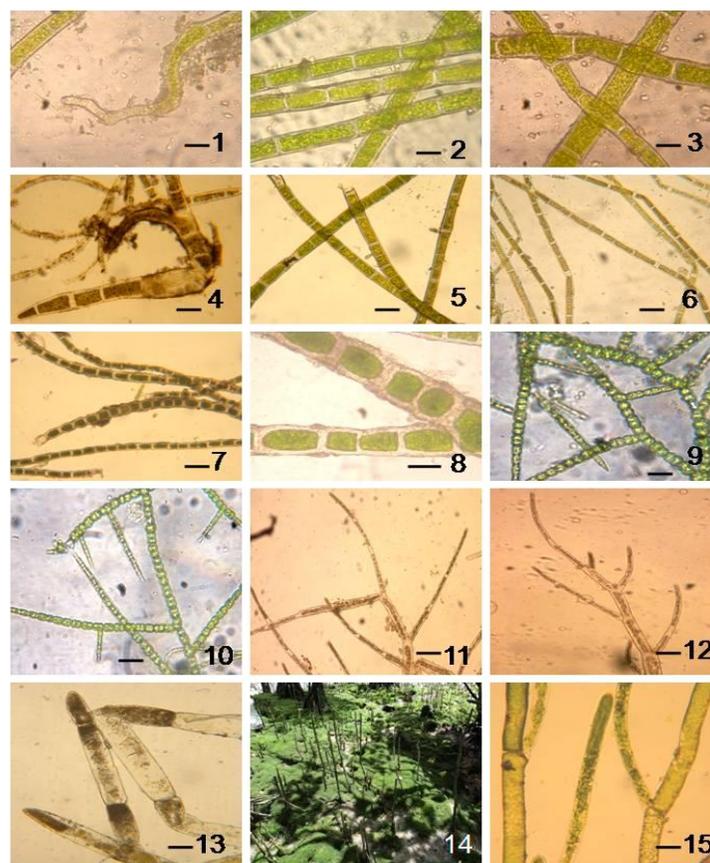


Plate 3 (Scale bar 10 μ): Showing microphotographs of Fig. 1. *Rhizoclonium crassipellitum*, Fig. 2. *R. pachydermum*, Figs. 3-4. *R. riparium*, Fig. 5. *Lola tortuosa*, Fig. 6. *L. capillaries*, Figs. 7-8. *Chaetomorpha gracilis*, Figs. 9-10. *Stigeoclonium variable*, Fig. 11. *Cladophora crystallina*, Figs. 12-13. *C. glomerata*, Figs. 14-15. *C. nitellopsis*.

16. *Pithophora polymorpha* wittrock (Pl. 4, Figs. 2-3; Pl. 6, Figs. 6-7)

Ramanathan, 1939, fig 1-8; Krishnamurthy, 2000, p 130, fig 26.

Thallus pale green, filamentous, branched, stiff, branches up to second order, primary branches solitary or rarely in opposite pairs, secondary branches solitary, cells are 10-15 μ broad and 30-50 μ long, akinetes single (rarely double), either intercalary or terminal, akinetes in primary branches intercalary, cylindrical, cylindrical akinetes up to 60-80 μ long and 20-40 μ broad, terminal akinetes often subconical with rounded apex, usually shortly acuminate with somewhat rounded apex, terminal akinetes 20-25 μ broad and 30-35 μ long.

Occurrence- Jaigopalpur (N 22°12.424', E 088°41.909'), fresh water.

17. *P. cleveana* Wittrock (Pl. 4, Figs. 4-5; Pl. 6, Figs. 8-9)

Wittrock, 1877, p 48; Krishnamurthy, 2000, p 128.

Thallus yellowish green, filaments branched, primary branches in lower portions of the thallus giving out secondary branches up to 4 times as long, primary branches alternate, often consisting of a single cell, cells of primary branches 20-60 μ in diameter and 2-5 times as long, cells of secondary branches 10-40 μ in diameter, 2-4 times as long, akinetes both intercalary and terminal, intercalary akinetes both barrel shaped and cylindrical, barrel shaped akinetes 30-60 μ in diameter and 60-120 μ long, cylindrical akinetes 35 μ in diameter and 63 μ long.

ISSN: 2229- 6905

Occurrence- Sushni Island (N 21°42.802', E 088°18.028'), marine water.

18. *Cladophora crystallina* (Roth) Kutzing (Pl. 3, Fig. 11; Pl. 5, Fig. 23)

Kale, 1966, p 180, pl 2, figs 1-4; Verma, 1991, p 46; Krishnamurthy, 2000, p 143.

Thallus yellowish green, soft, branches lateral, dichotomous, further branching unilateral, branches spreading above, cells of main filaments 20-50 μ in diameter, 3-9 times as long as broad, cells of branches 25-35 μ in diameter and 60-80 μ long.

Occurrence- Jharkhali Island (N 22°01.142', E 088°41.168'), fresh water.

19. *C. glomerata* (L.) Kutzing (Pl. 3, Figs. 12-13; Pl. 6, Figs. 1-2)

Biswas, 1949, p 76, pl V, fig 48; Nizamuddin & Begum, 1973, figs 26-28; Sarma et al, 1993, p 41, fig 1; Krishnamurthy, 2000, p 139, figs 18B & H.

Thallus dark green, filaments branched, branches making an acute angle with the axes, verticillate in lower portions, solitary above, crowded, apical cell slightly attenuate, ending in bluntly pointed tip, cells of main axis 20-45 μ in diameter and 40-80 μ long, cells in branches 10-15 μ in diameter and 50-70 μ in length.

Occurrence- Jaigopalpur (N 22°12.466', E 088°42.444'), fresh water.

20. *C. nitellopsis* Boergesen (Pl. 3, Figs. 14-15; Pl. 4, Fig. 1; Pl. 6, Figs. 3-5)

Boergesen, 1939, figs 11-13; Dixit, 1970, p 106; Nizamuddin & Begum, 1973, figs 38-39; Krishnamurthy, 2000, p 146, fig 21H.

Filaments sub dichotomous in the lower parts, alternately branched above, cells of main axis cylindrical, 35-45 μ in diameter, 2-3 times as long as broad, branches in lower parts at long intervals but in upper parts frequent, almost

one branch from each cell, cells of branches 30-40 μ in diameter and 80-120 μ long.

Occurrence- Sushni Island (N 22°00.117', E 088°42.608'), marine water.

21. *Chaetomorpha gracilis* Kutzing (Pl. 3, Figs. 7-8; Pl. 6, Fig. 10)

Collins & Harvey, 1917; Taylor, 1933, pl 26; Islam, 1976, pl 2, figs 15-17; Santra & Pal, 1988, Pl. III, figs 28 & 29; Sen & Naskar, 2003, p 127, pl X, fig 68.

Plants entangled, thallus filamentous, filaments not straight, cells cylindrical, short and long, wall thin, cross walls slightly inflated, constricted at septum, cells 45-65 μ diameters, 57-142 μ long.

Occurrence- Bakkhali sea beach (N 20°00.017', E 088°40.612'), marine water.

22. *Lola capillaris* (Kutzing) Hamel (Pl. 3, Fig. 6; Pl. 5, Fig. 21)

Islam, 1976, Pl 2, figs 11-14; Santra & Pal, 1988, Pl III, figs 30 & 31; Sen & Naskar, 2003, p 129, pl X, fig 64.

Filaments cylindrical, not straight, vegetative cells 25-50 μ broad and 80-140 μ long, cells cylindrical, some long, some short, slightly swollen at septum, basal rhizoid like growth present.

Occurrence- Kala Jangal (N 21°42.545', E 088°19.218'), brackish water.

23. *L. tortuosa* (Dulw.) Chapman (Pl. 3, Fig. 5; Pl. 5, Fig. 22)

Islam, 1976, pl 2, fig 13; Sen & Naskar, 2003, p 126, pl X fig 66.

Free floating filaments, contorted, rhizoidal outgrowth absent, and cells 15-23 μ broad and 25-35 μ long.

Occurrence- Suryamoni Island (N 22°12.486', E 088°41.901'), brackish water.

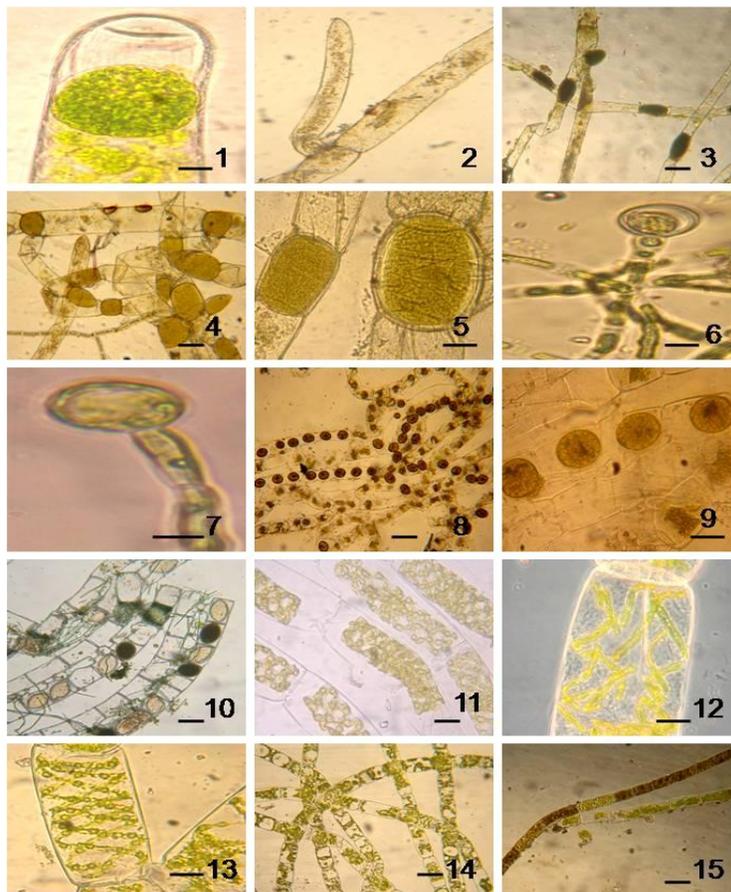


Plate 4 (Scale bar 10 μ): Showing microphotographs of Fig. 1. *Cladophora nitellopsis*, Figs. 2-3. *Pithophora polymorpha*, Figs. 4-5. *P. cleveana*, Figs. 6-7. *Oedocladium prescottii*, Figs. 8-9. *Spirogyra jaoense*, Fig. 10. *S. pseudoreticulata*, Figs. 11-13. *S. punctulata*, Figs. 14-15. *S. hymerae*.

ORDER: OEDOGONIALES

FAMILY: OEDOGONIACEAE

24. *Oedocladium prescottii* Islam (Pl. 4, Figs. 6-7; Pl. 6, Fig. 11)

Islam, 1973; Anand, 1998, p 50 & 53, fig 159.

Filaments branched; cells without setae, vegetative cells are 40-50 μ long and 10-12 μ broad, oospore about 26-40 μ in diameter.

Occurrence- Jharkhali Island (N 22°01.355', E 088°41.167'), fresh water.

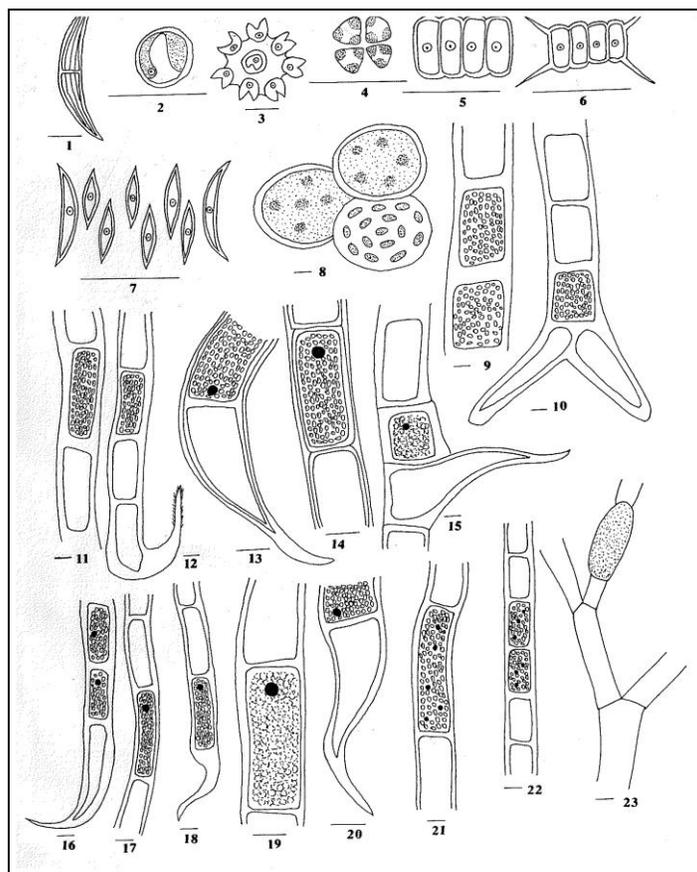


Plate 5 (Scale bar 10 μ): Showing line drawings of Fig. 1. *Closterium tumidium*, Fig. 2. *Chlorella vulgaris*, Fig. 3. *Pediastrum tetras*, Fig. 4. *Crucigenia tetrapedia*, Fig. 5. *Scenedesmus bijuga*, Fig. 6. *S. quadricauda*, Fig. 7. *S. dimorphus*, Fig. 8. *Chlorococcum infusionum*, Figs. 9-10. *Rhizoclonium pachydermum*, Figs. 11-12. *R. crassipellitum*, Figs. 13-14. *R. tortuosum*, Fig. 15. *R. africanum*, Fig. 16. *R. hieroglyphicum*, Figs. 17-18. *R. fontinale*, Figs. 19-20. *R. riparium*, Fig. 21. *Lola capillaries*, Fig. 22. *L. tortuosa*, Fig. 23. *Cladophora crystallina*.

FAMILY: ZYGNEMATACEAE

25. *Spirogyra jaoense* Randhawa (Pl. 4, Figs. 8-9; Pl. 7, Figs. 2-3)

Randhawa, 1959, p 327, figs 314a-b.

Vegetative cells are 40-56 μ broad and 2-3 times as long; 2-5 chloroplasts in each cell, the septa of the cells are plane; conjugation scalariform, the zygospores are oval to elliptical in shape and are 30-54 μ broad and 50-72 μ long.

Occurrence- Jaigopalpur (N 22°12.463', E 088°42.442'), fresh water.

26. *S. hymerae* Britton & Smith (Pl. 4, Figs. 14-15; Pl. 7, Fig. 1)

Britton & Smith, 1942, p 70; Transeau, 1951 p 171, pl XXVII, fig 3; Randhawa, 1959, p 321, fig 300.

Vegetative cells 48-80 \times 42-250 μ ; end walls plane; chloroplasts 2, making 0.5-2 turns in the cell, conjugation scalariform.

Occurrence- Bhagabatpur (N 21°43.482', E 088°18.562'), fresh water.

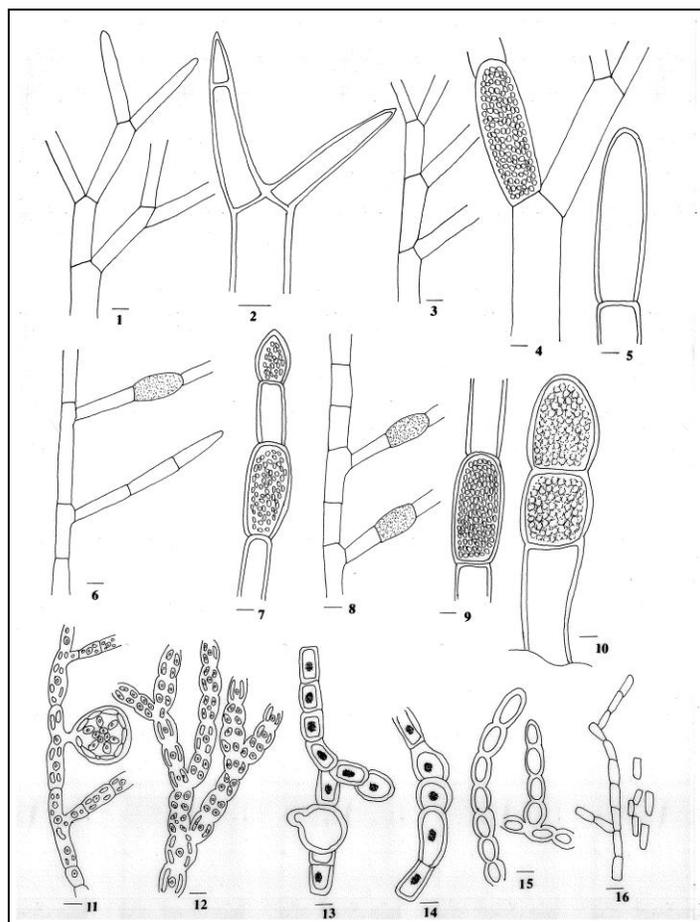


Plate 6 (Scale bar 10 μ): Showing line drawings of Figs. 1-2. *Cladophora glomerata*, Figs. 3-5. *C. nitellopsis*, Figs. 6-7. *Pithophora polymorpha*, Figs. 8-9. *P. cleveana*, Figs. 10. *Chaetomorpha gracilis*, Fig. 11. *Oedocladium prescottii*, Fig. 12. *Stigeoclonium variable*, Figs. 13-14. *Trentepohlia thevalliensis*, Fig. 15. *T. torulosa*, Fig. 16. *T. abietina*.

27. *S. pseudoreticulata* Krieger (Pl. 4, Fig. 10; Pl. 7, Figs. 4-5)

Randhawa, 1959, p 391, figs 471a-c.

Vegetative cells 20-25 \times 75-170 μ , with plane end walls and 2 chloroplasts; conjugation scalariform and lateral, tubes formed by both cells, zygospores ellipsoid, 25-33 \times 48-68 μ .

Occurrence- Jharkhali Jetty (N 22°01.144', E 088°41.955'), brackish water.

28. *S. punctulata* Jao (Pl. 4, Figs. 11-13; Pl. 7, Fig. 6)

Jao, 1936, p 57, figs 13-14; Transeau, 1951, p 187, pl XXX, figs 11-13; Randhawa, 1959, p 341, figs 342a-b.

Vegetative cells 40-80 \times 105-305 μ ; end walls plane; chloroplasts 3, making 1-2 turns, conjugation scalariform.

Occurrence- Lothian Island (N 21°42.342', E 088°18.892'), fresh water.

ORDER: CHAETOPHORALES

FAMILY: CHAETOPHORACEAE

29. *Stigeoclonium variable* Naegeli in Kutzing (Pl. 3, Figs. 9-10; Pl. 6, Fig. 12)

Kutzing, 1849, p 352; Krishnamurthy, 2000, p 46.

Plants bright green, usually small, sparsely branched, branches very rarely opposite, at base mostly alternately branched, branches long, slender and spine like, branch apex usually sharply pointed, cells of prostrate system rounded or angular, 17-20 μ in diameter, cells of erect filaments cylindrical or slightly inflated, 10-15 μ in diameter, usually as long as broad, cell wall usually thin.

Occurrence- Kala jangal (N 21°42.544', E 088°19.217'), brackish water.

ORDER: TRENTEPOHLIALES

FAMILY: TRENTEPOHLIACEAE

30. *Trentepohlia thevalliensis* Panikkar and Sindhu (Pl. 1, Fig. 10; Pl. 6, Figs. 13-14)

Krishnamurthy, 2000, p 188, fig 30: E-G.

Thallus saxicolous, forming small dark brown cushions on the bark of mangrove plants, filaments long, bearing primary and secondary branches, cells of primary branches large, 15-21 μ long and 10-15 μ broad, cells of secondary branches 14-18 μ long and 10-14 μ broad, sporangia sessile, produced on both primary and secondary branches, lateral, terminal or intercalary, 16-30 μ in diameter.

Occurrence- Suryamoni Island (N 22°12.424', E 088°41.901'), on tree bark at brackish water region.

31. *T. torulosa* de Wildeman (Pl. 1, Fig. 9; Pl. 6, Fig. 15)

Krishnamurthy, 2000, p 190, figs 29D-E.

Filaments in small compact tufts or spreading to form a soft cushion, yellowish-green, brown when dry; filaments loosely branched; cells ellipsoid, rarely sub spherical, distinctly constricted at septa, 17-35 μ long and 10-16 μ broad.

Occurrence- Lothian Island (N 21°42.341', E 088°18.890'), on tree bark at brackish water region.

32. *T. abietina* (Flotow) Hansg (Pl. 1, Fig. 11; Pl. 6, Fig. 16)

Jose & Choudhury, 1980; Islam, 1960; Krishnamurthy, 2000, p 187, fig 29C.

Filaments copiously branched, forming green cottony layers on bark of trees, not clearly differentiated into prostrate and erect systems, cells cylindrical, 12-50 μ in length and 5-12 μ in breadth; apical cell without a cap.

Occurrence- Morahero Island (N 22°03.098', E 088°40.325'), on tree bark at marine water region.

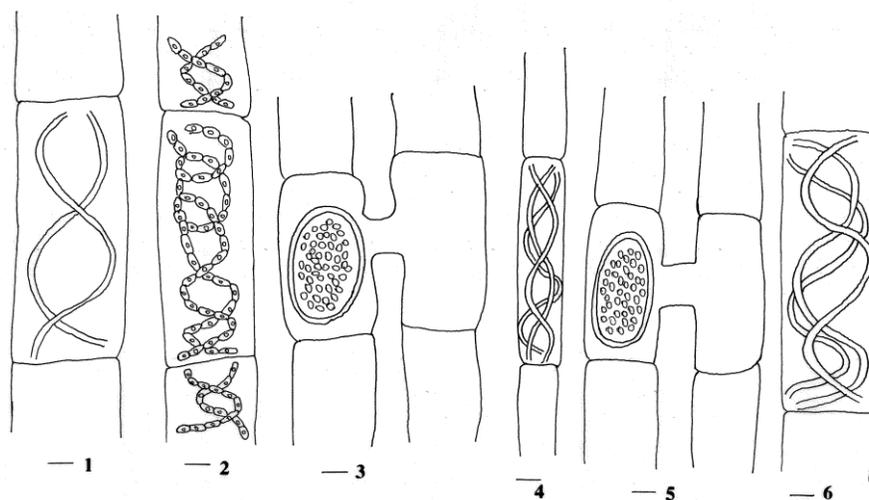


Plate 7 (Scale bar 10 μ): Showing line drawings of Fig. 1. *Spirogyra hymerae*, Figs. 2-3. *S. jaoense*, Figs. 4-5. *S. pseudoreticulata*, Fig. 6. *S. punctulata*.

Acknowledgement

Authors express their heartiest thanks to NMITLI-CSIR for their financial assistance and to Mr. Sujit Kar for his help in sample collection.

References

Anand, N. 1998 Indian freshwater microalgae 50 & 53 pp. Bishen Singh Mahendra Pal Singh, 23A, Dehra Dun, India.

Biswas, K. 1949 Common fresh and brackish water algal flora of India and Burma- Records from Bot. Surv. Ind. **15**(1): 75.

Boergesen, F. 1939 Marine algae from the Iranian Gulf, especially from the innermost part near Bushire and the Island Kharg- In K. Jessen and R. Sparck (eds) 69-71 pp. Danish Scientific investigations in Iran, Part I. Copenhagen.

Britton, J. M. and Smith, M. S. 1942 Ohio Jour. Sci. **42**: 70.

Chowdhury, A. K. and Pal, R. 2008 Diversity of planktonic diatoms from West Bengal coast with special reference to taxonomic accounts Phytomorphology. **58**(1 & 2): 29-40.

Collins, F. S. and Hervey, A. B. 1917 The algae of Bermuda- Proc. Ame. 1976r. Acad. Arts and Sci. **53**: 1-195.

Dixit, S. C. 1970 Species list of Indian marine algae III- J. Univ. Bombay. **39**: 106.

Durairatnam, M. 1961 Contribution to the study of the marine algae of Ceylon- Fisheries Res. Station, Ceylon, Bull. **10**: 19.

Islam, A. K. M. N. 1972 Subaerial algae of Bangladesh- Bangladesh J. Bot. **1**: 13-64.

Islam, A. K. M. N. 1973 The algal flora of Sundarban Mangrove forest. Bangladesh J. Bot. **2**(2): 11-36.

Islam, A. K. M. N. and Aziz, A. 1975 Studies of Marine phytoplankton from the North Eastern Bay of Bengal, Bangladesh. Bangladesh J. Bot. **4**(1-2): 1-32.

Islam, A. K. M. N. 1976 Contribution to the study of the marine algae of Bangladesh. Bibliotheca Phycologia. 19, pp. 15.

Islam, A. K. M. N. and Aziz, A. 1977 Studies on the Phytoplankton of the Karnaphuli river estuary. Bangladesh Acad. Sci. **1**(2): 141-154.

Islam, A. K. M. N. and Khair, A. 1978 Addition to the list of marine algae of St. Martins Island. I. Genus *Codium* Stackhouse. J. Asiatic Soc. Bangladesh. **4**(1): 123-126.

Islam, A. K. M. N. and Aziz, A. 1979 Algal flora of Moheshkhali Island, Bangladesh. Dacca Univ. Stud. **27**(2): 105-122.

Islam, A. K. M. N. and Alam, R. J. M. S. 1980 Members of Cladophoraceae of Dacca District, Bangladesh. Dacca Univ. Stud, B. **28**(1): 61-70.

Islam, A. K. M. N. and Mannan, M. A. 1986 Algal flora of some brackish water shrimp culture ponds at Satkhira. Dacca Univ. Stud. **1**: 7-18.

Jao, C.C. 1936 Amer. Jour. Bot. figs. 13-14. **23**: 57.

Jose, B. and Choudhury, Y. B. K. 1980 New records of *Trentepohlia* from India, Nova Hedwigia. **32**: 725-731.

Kale, S. R. 1966 On some green algae from the channels and reservoirs of Saurashtra Salt Works, Porbandar. Curr. Sci. **35**: 180.

Krishnamurthy, V. 2000 Algae of India neighbouring Countries I. Chlorophycota- Oxford and IBH Publishing Co. Pvt. Ltd.

Kutzing, F.T. 1845 Phycologia Germanica 205 pp. Nordhausen.

Kutzing, F. T. 1845. Phycologia Generalis 266 pp. Lipsiae,

Kutzing, F. T. 1849. Species Algarum 386 pp.

Maity, H., Bandopadhyay, G. and Santra, S. C. 1987 Algal flora of Saline habitats of Sunderbans, West Bengal and its possible role in reclamation of soil. J. Indian Soc. Coastal Agric. Res. **5** (1): 325-331.

Mandal, R.N. and Naskar, K. R. 1994 Studies on the periphytic algae on the aerial roots of the mangrove swamps of Sundarban in West Bengal- In Environmental Pollution & Impact of Technology on life. Malabika Roy (Ed.). Recent researches in Ecology, Environment and pollution, (Viswabharati, santiniketan, Birbhum). **9**: 91-104.

ISSN: 2229- 6905

Martens, G. V. 1868 Die Tange, In Die Preussische Expedition nach Ost-Asien. Nach Amptlichen quellen- Bot. Theil, Berlin **22**: 58-59.

Mukhopadhyay, A. and Pal, R. 2002 A report on biodiversity of algae from coastal West Bengal (South & North 24-parganas) and their cultural behavior in relation to mass cultivation programme. *Indian Hydrobiol.* **5**(2): 97-107.

Murray, G. 1887 Catalogue of Ceylon algae in the Herbarium of the British Museum. *Annals and Magazine of Natural history, Ser., 5*, **20**: 42.

Naskar, K. R. and Santra, S. C. 1986 Studies on *Enteromorpha tubulosa* in brackish mixed sewage fed fisheries from Sunderbans. *West Bengal, Sci. and Cult.* **32** (6): 210.

Nizamuddin, M. and Begum, M. 1973 Revision of the marine Cladophorales from Karachi. *Bot. Mar.* **16**: 6-8.

Pal, U. C., Naskar, K. R. and Santra, S. C. 1988 A check list of algal flora of Sundarban delta of West Bengal, India. *Phykos* **27**: 48-53.

Prain, D. 1903 Flora of Sundarbans. Records of the Botanical Survey of India, **2**: 231-390.

Prasad, B. and Vijaykumari, N. 1979 On four species of Cladophorales new to Indian flora. *J. Indian Bot. Soc.* **58**: 28.

Presscott, G. W. 1962 Algae of the Western Great Lakes area, 2nd ed. Wm Brown Co. Dubuque, Iowa.

Ramanathan, K. R. 1939 On the mechanism of spore liberation in *Pithophora polymorpha* Wittrock. *J. Indian Bot. Soc.* **18**(1): 25-29.

Randhawa, M. S. 1959 Zygnemaceae. ICAR. New Delhi.

Saha, L.C. 1985 Ulotrichales, Cladophorales, Chaetophorales and Oedogoniales of Bhagulpur, India. *J. Ecol. Tax. Bot.* **7**(8): 676-679.

Santra, S. C. and Pal, U. C. 1988 Marine algae of Mangrove delta region of West Bengal, India: Benthic forms. *Indian Biologists* **20** (2), 31-41.

Santra, S. C. and Pal, U. C. 1989 Phytoplanktons of Bhagirathi-Hugli estuary: An illustrative account. *Indian Biologist.* **27**(1): 1-27.

Santra, S. C. and Pal, U. C. and Choudhury, A. 1991 Marine phytoplankton of the mangrove delta region of West Bengal, India. *J. Mar. Biol. Ass. India.* **33** (1 & 2): 292 - 307.

Sanyal, P. and Bal, A. 1986 Some observations on abnormal adaptations of mangrove in Indian Sundarbans. *Indian Soc. Coastal Agric. Res.* **4**: 9-15.

Sarma, P. and Keshri, J. P. 1993 New records of Cladophorales from West Bengal- *Phykos.* **32**: 43.

Satpati, G. G., Barman, N., Chakraborty, T. and Pal, R. 2011 Unusual habitat of algae, *J. Algal Biomass Utln.* **2** (4): 50-52.

Satpati, G. G., Barman, N. and Pal, R. 2012 Morphotaxonomic account of some common seaweeds from Indian Sundarbans mangrove forest and inner island area, *J. Algal Biomass Utln.* **3**(4): 45-51.

Sen, N., Naskar, K. R., Chakraborty, S. and Santra, S. C. 2003 New Benthic algae from Indian Sunderbans, *Phykos.* IARI Delhi.

Taylor, W. R. 1933 Notes on algae from the Tropical Atlantic Ocean, II. *Papers Mich. Acad. Sci., arts & Lett.* **17**: 395-407.

Transeau, E. N. 1951 The Zygnemataceae. Ohio State Univ. Press. Columbus, 327 pp.

Verma, B. N. 1991 New records of Cladophora Kutz. From Bihar. *Phykos.* **20**: 46.

Wittrock, V. B. 1877 On the development and systematic arrangement of the Pithophoraceae, a new order of the algae. *Nova Acta Reg. Soc. Sci. Upsaliensis, III. Vol. extord.* 62 pp.