An investigation on Morphotaxonomy and Diversity of Planktonic Chlorophytes from fresh water Eutrophic Wetland of Indian Ramsar Site

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Abstract
In first inter-governmental conservation convention at Ramsar, it was decided to designate the important ecosystem throughout the world as 'Ramsar Site'. Presently in India 26 such sites have been identified. One of which is East Calcutta Wetland (88°27' E and 22°27' N), principally used for sewage stabilization and fish production. This wetland had been found to harbor planktonic chlorophytes as the dominating flora controlling the productivity of the ecosystem (more than 90% of total population). Floristic pattern is an important indicator of an ecosystem as any change in plankton flora indicates the altered environmental condition. In the present investigation a thorough survey was carried out for 2 years (January 2012 to January 2014) for documentation and taxonomic identification of cholorophyte population of this important site. A total number of 61 taxa belonging to 17 different genera had been recorded. Among these 13 taxa belonging to 7 different genera such as, *Scenedesmus* (2 spp.), *Desmodesmus* (3 spp.) *Tetraedron* (3 spp.), *Pediastrum* (1 sp.), *Stauridium* (2 spp.), *Chlorococcum* and *Kirchneriella*, (1 spp. each) were designated as major taxa showing maximum variation in species diversity. Detail morphological studies of dominant taxa were also done with the help of Scanning Electron Microscopy (SEM).
Key words: Chlorophytes, Eutrophic tropical Wetlands, Phytoplankton, SEM, Taxonomy.

Introduction

Phytoplankton are vital components of both freshwater and marine aquatic ecosystems (Perez *et al.*, 2002). They are the primary producers being at the base of aquatic food chain and are also important biological indicators assessing the water quality (Ariyadej *et al*., 2004). Therefore diversity and ecological studies of phytoplankton population are quite popular (Ray Chaudhuri *et al.*, 2007; Pradhan *et al*., 2008; Mukherjee *et al.,* 2010) . Chlorophytes compose the largest and the most varied phylum of algae (Perez *et al*., 2002) and are ubiquitous in aquatic and some terrestrial habitats. Being closely related to the higher plants, they have a crucial role in the global ecosystem for hundreds of millions of years (Happey- Wood, 1988; Perez *et al.*, 2002; Falkowski *et al.*, 2004; O'Kelly, 2007; Leliaert *et al.*, 2011).

The Ramsar convention has defined wetlands as, "areas of marsh, peat land, fen or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meter" (Murthy *et al.,* 2013). The Ramsar list of Internationally Important Wetlands presently includes 2186 Ramsar Sites, with the highest number of sites in the country, United Kingdom (170 Ramsar sites) and with the greatest area of listed wetlands in the country Bolivia. India is known to include 26 Ramsar sites, while neighbouring country like Bangladesh includes 2 Ramsar sites, viz. Tanguar Haor, Sunderbans Reserved Forest which is partly in common with India. Works of Ali (2000), Khan (1993) and others gave a detail account on Bangladesh Wetland ecology.

For proper documentation, taxonomic identification of algal flora is essential and Chlorophyte members are difficult to describe taxonomically because many of them exhibit phenotypic plasticity (Shubert and Wozniak, 2003). Cell wall ornamentation has also been used as taxonomic characters by many authors (Nielson, 2000; Shubert and Massalski, 2002), therefore SEM observation is sometimes inevitable. Shubert and Wozniak (2003) did SEM studies on morphology of some non-motile coccoid chlorophytes from aquatic habitats of Poland. Prasertsin and Peerapornpisal (2012) did an extensive SEM study on the diversity of *Pediastrum* sp. Other authors like, Kowalska and Wolowski (2010), Kyung and Kim (1997), Kim and Chang (1997) and An *et al*. (1999) also did SEM studies of plankton population.

In India, out of the 26 sites, Eastern India is well renowned for East Kolkata Wetlands. The East Kolkata Wetland is a complex of natural and human made wetland, lying in the eastern fringes of Kolkata city, India. This pond serves the dual purpose of recycling sewage water of Kolkata metropolitan city and for extensive fish cultivation. This wetland is declared as a

"Wetland of International Importance" by Government of India and the Ramsar Convention had declared this wetland as "Ramsar Site" in 19th August 2002 .Very few works on plankton ecology have been done from this area (Ray Chaudhuri, 2006; Kundu *et al.,* 2008; Pradhan *et. al*., 2008; Mukherjee *et al.,* 2010). But total documentation of floristic pattern of green microalgal flora along with their taxonomic descriptions is still lacking.

In the present investigation, a thorough survey of this wetland of Eastern India designated as Ramsar site had been done for two years with the aim of documentation of planktonic chlorophyte flora along with their taxonomical description including SEM studies.

Materials and Methods

Study area

Captain Bheri, a part of East Calcutta Wetland is an example of wisely used wetland where usage of city sewage for fisheries is practiced by traditional methods. The geographic coordinates of the water body under study area was found to be situated between the 88°27' east latitude and 22°27' north latitude. It covers an area of almost 450 m² having a depth of 3–4 ft. The sewage water includes municipal waste, agriculture run off and industrial effluents of urban and semi urban areas. The sampling spots were selected along transects of the Bheri and samples were collected from surface and subsurface water level of the wetlands. No epipelic or benthic flora was recorded.

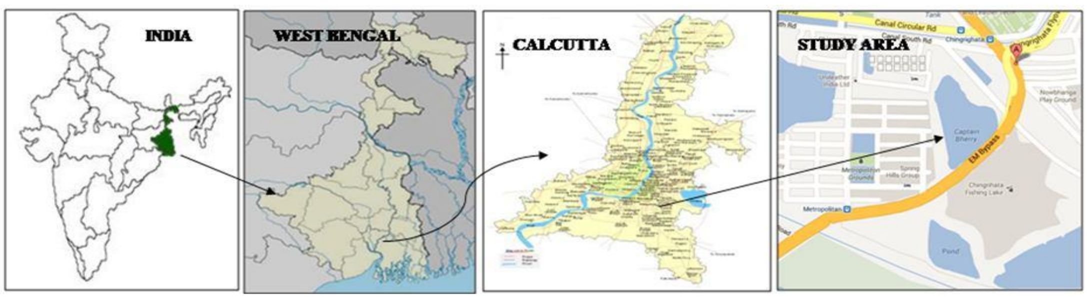

Fig. 1 Site map showing the study area

Sampling and diversity analysis

Monthly samplings were done from January 2012 to January 2014, at morning hours between 7.00 am to 9.00 am and concentrated using standard plankton net having pore size of 20µm from the selected sampling stations. Phytoplankton samples were observed in fresh and preserved conditions. Preservation was done in Lugol's solution (w/v) or 4% formaldehyde solution (v/v) separately for detail study. For taxonomic identifications, prism drawings were performed and microphotographs were taken using Carl Zeiss Axiostar phase-contrast microscope with the help of Cannon Power shot A80 digital camera. Identification of algal forms was done with the help of standard keys using monograph and relevant available literature viz. Prescott (1982), Anand (1998), Jaiswal and Tiwari (2003) and Rath and Adhikari (2005) and confirmed from Algaebase (http://www.algaebase.org.).

Scanning Electron Microscopic study

Major taxa of the planktonic chlorophytes (7 genera) were maintained in active culture and their detail morphology was studied with the help of Scanning Electron Microscope. The sample materials were washed with saline phosphate buffer for 2-3 times and precipitated by ultra centrifuge at 8000 rpm. One drop of washed material was put on a glass cover slip (Blue Star) and dried at 20°C in culture room. The samples were repeatedly washed with ethanol grade and dried at room temperature. After complete dehydration the cover slips were placed on carbon tape and put in Quorum (Q 150 TES) gold coater to coat the samples with gold. The photographs were taken at different magnification. Images have been taken with the use of Carl Zeiss EVO 18 (EDS 8100) microscope with Zeiss Inca Penta FETX 3 (Oxford instruments) attachment.

Results

A total of 61 taxa of planktonic chlorophytes have been recorded. Identification, taxonomic description and systematic enumeration of all the taxa have been documented according to Lee's classification (2008). Among these 13 taxa like, *Stauridium tetras*, *S. tetras* var. *apiculatum*, *Pediastrum duplex* var. *duplex*, *Chlorococcum humicola*, *Tetraedron caudatum*, *T. caudatum* var. *longispinum*, *T. minimum*, *Scenedesmus denticulatus*, *S. quadricauda*, *Desmodesmus abundans*, *D. opoliensis*, *D. armatus* var. *bicaudatus* and *Kirchneriella lunaris* were recorded as major taxa for the first time whose detailed morphological study was carried out using scanning electron microscopy. The taxonomic description along with systematic enumeration is given below-

1. *Chlamydomonas mucicola* Schmidle (Fig. 2a)
(Prescott, 1982, pl. 46, fig. 20)
Cells narrowly ovoid, flagella one and half times the body in length, cells 3-4 μm wide, 6-12 μm long.

2. *Chlorococcum humicola* (Naeg.) Rabenhorst (Fig. 2b)
(Prescott, 1982, pl. 45, fig. 1)
Cells spherical 8-20 μm in diameter.
SEM observation- Cellular morphology became more prominent showing wavy undulating margin and wrinkled surface. (Fig. 5a)

3. *Stauridium tetras* (Ehrenberg) Hegewald (Fig. 2c)
(Hegewald in Buccheim *et al.*, 2005, p. 105)
Basionym: *Pediastrum tetras* (Ehrenberg) Ralfs
Coenobia oval or circular, 4-8-16 celled, without intercellular space, inner cells 4-6 sided with a single linear or cuneate incision; cells 5-9 μm in diameter, eight celled colonies 24-30 μm in diameter.
SEM observation: Cell wall morphology became more prominent which appeared to be undulating with net-like to short warty processes, warts or granules dispersed throughout, appearing like wrinkled surface. (Fig. 5b)

4. *S. tetras* (Ehrenberg) Hegewald var. *apiculatum* (Fritsch) Keshri et Mallick comb. nov. (Fig. 2d)
(Keshri and Mallick, 2013, pl. 4, figs. 21-22)
Basionym: *Pediastrum tetras* (Ehrenberg) Ralfs var. *apiculatum* Fritsch
Colony 4 celled, cells 12-15 μm in diameter and colony of 4 cells upto 20-28 μm in diameter.
SEM observation: Colony structures became more prominent with detail cell wall morphology. Cell wall undulating with warty processes, ultrastructure appearing in form of net- like pattern with warts or granules densely dispersed throughout, lobes formed from cuneate incision end up with distinct nodular processes. (Fig. 5c)

5. *Pediastrum privum* (Printz) Hegewald (Fig. 2e)
(Hegewald in Buccheim *et al*., 2000)
Coenobia were up to 20 μm in diameter, cell length ranged from 5-7 μm in length and from 3-5 μm in width. Cells contained pyrenoid.

6. *P. duplex var. clathratum* (A. Braun) Lagerheim (Fig. 2f)
(Prescott, 1982, pl. 48, fig. 6)
Coenobia with larger perforations peripheral cells truncate; cells 12-20 μm in diameter.

7. *P. boryanum* var. *brevicorne* A. Braun (Fig. 2g)
(Chang, 1997, fig. 3)
Coenobia 4-32 cells, 18- 20 μm diameter with peripheral cells 6-18 μm long, 5-13 lain wide, inner cells 5-14 μm long, 5-13 μm wide.

8. *P. duplex* Meyen var. *duplex* (Fig. 2h)
(Philipose, 1967, p. 123, figs. 43d; Komarek and Jankovska, 2001, p. 8, fig. 32)
Colony made of 16-32 cells, upto 40-50 μm in diameter cells 8-10 μm.
SEM observation: Cell wall morphology distinctly visible with fine granules on the wall, surface of the wall wrinkled with irregularly dispersed granules, tiny depression or pore arranged in oblique decussate series. (Fig. 5d)

9. *Pseudopediastrum boryanum* (Turpin) E. Hegewald (Fig. 2i)
(Hegewald in Buccheim *et al*., 2005)
Basionym: *Pediastrum boryanum* (Turpin) Menegh.

Colony36 celled 85-90 µm wide, cells 5-6 sided , cells upto 14 µm in diameter , 21 µm long;
10. *Pediastrum subgranulatum* (Raciborski) Komárek et Jankovská (Fig. 2j-2k)
(Komarek and Jankovska, 2001, p. 53, fig. 29)
Basionym: *Pediastrum duplex* Meyen var. *subgranulatum* Raciborski.
Colony 8-16 celled, 80-105µm in diameter, cells 18-24 µm in diameter;
11. *P. sarmae* Keshri et Mallick *sp. nov*. (Fig. 2l)
(Keshri and Mallick, 2013, pl. 2, figs. 9-11)
Colony of 32-128 cells circular to elliptical, 14-24 µm in diameter, 12-22 µm long.
12. *Tetraedron caudatum* (Corda) Hansgirg (Fig. 2m)
(Prescott, 1982, pl. 59, figs. 17, 24, 25)
Cells flat 5-sided, cells in their longest dimension 8-15 µm.
SEM observation: More prominent cell wall morphology visible with sculptures on the wall, forming network or reticulate pattern of arrangement. Cell wall undulating which end up forming short sharp spiny apices. (Fig. 5e)
13. *T. caudatum* var. *longispinum* Lemmermann (Fig. 2n)
(Prescott, 1982, pl. 59, figs. 20-22)
Cells 8-12µm in diameter; spines 1-3 µm long.
SEM observation: Prominent cell wall morphology visible with geometric sculptures on the wall, forming network or reticulate pattern of arrangement. Cell wall undulating which end up forming sharp spiny apices. (Fig. 5f)
14. *T. minimum* (A. Braun) Hansgirg (Fig. 2o)
(Prescott, 1982, pl. 60, figs. 12-15)
Cells small flat tetragonal, cells 6-20µm diameter.
SEM observation: Structure became more prominent on cell wall showing distinct ridges in net like pattern, dispersed throughout irregularly, cell wall not undulating. (Fig. 5g)
15. *T. muticum* (A. Braun) Hansgirg (Fig. 2p)
(Prescott, 1982, pl. 60, figs.16,17).
Cells flat triangular, 6-18µm in diameter.
16. *T. trigonum* (Naeg.) Hansgirg (Fig. 2q)
(Prescott, 1982, pl. 61, figs. 11, 12)
Cells 3-angled, 19-25 µm in diameter.
17. *T. trigonum* var. *gracile* (Reinsch) DeToni (Fig. 2r)
(Prescott, 1982, pl. 61, figs. 14-16)
Cells flat, 20-25 µm in diameter.
18. *Scenedesmus dimorphus* (Turp.) Kuetzing (Fig. 3a-3b)
(Philipose, 1967, p. 249, fig. 160 (a-b); Prescott, 1982, pl. 63, figs.8, 9)
Colony composed of 4 or 8 fusiform cells, cells 3-6 µm in diameter, 16-22 µm long.
19. *S. incrassatulus* Bohlin (Fig. 3c)
(Prescott, 1982, pl. 63, fig. 14.)
Colony of 4 (2-8) fusiform subacuate cells, 3-5 µm in diameter, 10-15µm long.
20. *S. Bernardii* G.M.Smith (Fig. 3d)
(Prescott, 1982, pl. 63, fig. 1)
Colony of 2-8 fusiform, luneate, sigmoid cells, 3-4 µm in diameter, 8-12 µm long.
21. *S. disciformis* (Chodat) Fott & Komarek (Fig. 3e)
(Jaiswal and Tiwari, 2003, p. 98, pl. 14, figs. 2-3.)
Colony 8 celled, 9-10 µm long, 3-5 µm wide.
22. *S. acuminatus* (Lag.) Chodat (Fig. 3f)
(Prescott, 1982, pl. 62, fig. 16)
Cells arranged in a curved series of 4 - 8 cells, lunate, cells 3-7 µm in diameter, 30-40 µm long.

23. *S. ecornis* (Ehrenb.) Chodat (Fig. 3g)
(Chodat, 1902, p.211)
Colonies of 4 cells 7-20 µm long, 4-10 µm in diameter.
24. *S. acutus* Meyen (Fig. 3h)

(Jaiswal and Tiwari, 2003,p. 95 pl. 13, fig. 12)
Colony 4 celled, length 20-24 µm and breadth 5-7µm.
25. *S. bijuga* (Turp.) Lagerheim (Fig. 3i-3j)
(Prescott, 1982, pl. 63, figs. 2, 7)
Colony of 2-8 cells, cells 4-8 µm in diameter, 8-16µm long.
26. *S. brasiliensis* Bohlin (Fig. 3k)
(Prescott, 1982, pl. 63, figs. 5, 6)
Colony of 2-8 subcylindric cells, 3-5 µm in diameter, 10-15 µm long.
27. *S. denticulatus* Lagerheim (Fig. 3l)
(Prescott, 1982, pl. 63, figs. 10, 11)
Colony of 2-8 ovate cells, cells 4-5 µm in diameter, upto 15µm long.
SEM observation: Undulating cell wall with granules sparsely dispersed thoughout, pole of each cells with short dentate spines. (Fig.5j-5m)
28. *S. antillarum* Comas Gonzalez (Fig. 3m)
(Jaiswal and Tiwari, 2003,p. 95 pl. 14, fig. 8)
Colony 4-8 celled, cells 2-3µm wide, 5-10µm long.
29. *S. obliquus* (Turp.) Kuetzing (Fig. 3n)
(Prescott, 1982, pl. 63, fig. 17)
Colony of 4 or 8 fusiform cells, cells 4.2 - 9µm in diameter, 14 - 21µm long.
30. *Desmodesmus plieomorphus* (F.Hindak) Hegewald (Fig. 3o)
(Hegewald, 2000, pg. 96, fig. 16)
Coenobia of 4-8 cells, cells cylindrical 8-14 µm long, 3-5µm wide.
31. *D. itascaensis* Fawley, Fawley *et.* Hegewald (Fig. 3p)
(Fawley, Fawley et Hegewald, 2011, p. 23-56, fig. 123)
Colony 4-8 celled, cells 2-3µm wide, 7-12µm long.
32. *D. bicaudatus* (Dedusenko) Tsarenko (Fig. 3q-3r)
(Tsarenko, 2000, p. 18)
Basionym: *Scenedesmus bicaudatus* (Dedusenko)
Coenobium 2-8 celled, length 10-12 µm , width 4-6µm.
33. *D. armatus* var. *bicaudatus* (Guglielmetti) Hegewald (Fig. 3s)
(Hegewald, 2000, p. 4)
Basionym: *Scenedesmus armatus* var. *bicaudatus* (Gugielmetti) Chodat.
Colonies of 2-4 cells, cells 8-15 µm long, 2-5 µm in diameter.
SEM observation: Cell wall with fine warty processes dispersed throughout without undulations. Cells exhibit a binary ridge, passing the entire cell length forming two cauda at opposite corner. Ridge development more vigorous in older cultures the younger ones. (Fig. 5h)
34. *D. abundans* (Kirchn.) Hegewald (Fig. 3t)
(Hegewald, 2000, p. 96, fig. 1)
Basionym: *Scenedesmus abundans* (Kirchn.) Chodat.
Cells oblong or ovate, 4-7µm in diameter, 7-12 µm long.
SEM observation: Binary ridge absent in cell wall, spines or cauda appearing from both inner and outer cells of the colony. Wall surface wavy granulated. (Fig. 5i)
35. *D. opoliensis* (P. Richter) Hegewald (Fig. 3u)
(Hegewald, 2000, p. 96, fig. 13)
Basionym: *Scenedesmus opoliensis* P. Richter.
Colony composed of 2-4 naviculoid cells, cells 8-15µm long, 3-5µm wide.
SEM observation: Fine bristles like structures visible on cell wall. Inner cells of the colony are with oppositely arranged single cauda, whereas the outer cells are with more than two cauda. (Fig. 5m)
36. *Scenedesmus pseudoopliensis* Hortob (Fig. 3v)
(Jaiswal and Tiwari, 2003, pl. 13, fig. 4)
Colony consisting of 2 cells, cells11-18 µm long and 5-6 µm wide; spines 5-6 µm long.
37. S. *quadricauda* (Turp.) de Brebisson (Fig. 3w-3x)

(Prescott, 1982, pl. 64, fig. 2)

Colony consisting of 2-4-8 oblong-cylindric cells, cells variable in size, 3-18 µm in diameter, 9-35 µm long.

SEM observation: Cell wall surface undulating with fine granules. Cells exhibit binary ridges traversing the entire cell length; ridges on inner cells are short and less conspicuous, while those of outer cells are expanded. Rossets (structures bigger than warts) are visible, poles on the outer cells emerging out in form of cauda or spines. (Fig. 5k-5l)

38. *Tetrastrum* sp. (Norsted) Chodat (Fig. 4a)
(Chodat, 1902, p. 114)
4-celled coenobia, 5-13 µm in one plane, cells 2-5 µm long, with longitudinal axis in plane of coenobium.

39. *T. heteracanthum* (Nordstedt) Chodat (Fig. 4b)
(Rosini *et al.*, 2013, fig. 4i)
Colony of 4 crucially arranged cells, cells triangular4-5µm in diameter, spines 2-4 µm long.

40. *T. triangulare* (Chodat) Komarek (Fig. 4c)
(Rosini *et al.*, 2013, fig. 4 j-l)
Colony of four trapezoidal cells, cells 3-5 µm in diameter, 5-6 µm long.

41. *T. staurogeniaeforme* (Schroeder) Lemmermann (Fig. 4d)
(Prescott, 1982, pl. 66, fig. 3)
Colony of 4 triangular cells, cells 3-6 µm in diameter , colony 7-14 µm wide, setae 4-5 µm long.

42. *Coelastrum microporum* Naegeli (Fig. 4e)
(Prescott, 1982, pl. 53, fig. 3)
Coenobium spherical of 8-68 sheathed globose cells cells 8-20 µm in diameter including the sheath.

43.*C. proboscideum* Bohlin (Fig. 4f)
(Prescott, 1982, pl. 53, figs. 4, 5, 8).
Coenobium pyramidal of 4-32 cone shaped cells, cells 8-15 µm in diameter; 4-celled colony 35 µm in diameter.

44. *S. bibraianum* Reinsch (Fig. 4g)
(Prescott, 1982, pl. 57, fig. 9)
Colony composed of 4-16 lunate cells cells 5-8 µm in diameter, 20-30 µm long.

45. *S. gracile* Reinsch (Fig. 4h)
(Prescott, 1982, pl. 57, fig. 11)
Colonies composed of 4-16, cells 3-4 µm in diameter, 15-20 µm long.

46. *S. Westii* G.M.Smith (Fig. 4i)
(Prescott, 1982, pl. 57, fig. 10)
Colony small of 2-8 slender,arcuate cells, cells 1-2 µm in diameter, 10-15 µm long.

47. *Ankistrodesmus convolutus* Corda (Fig. 4j)
(Prescott, 1982, pl. 55, fig. 3)
Solitary or in groups of 2-4 cells, fusiform in shape, twisted and sigmoid; apices sharply pointed and often twisted in opposite directions; cells 3-4.5µm in diameter, 10-20 µm long.

48. *A. falcatus* (Corda) Ralfs (Fig. 4k)
(Prescott, 1982, pl. 56, figs. 5)
Cells needle- like to somewhat spindle- shaped, cells 2-6 µm in diameter, 10-15µm long.

49. *A. falcatus var. acicularis* (A.Braun) G. S. West (Fig. 4l)
(Prescott, 1982 pl. 56, fig. 16)
Cells solitary 2-3µm in diameter, 15-20µm long.

50.*A. falcatus var. tumidus* (West and West) G. S. West (Fig. 4m)
(Prescott, 1982, pl. 56, fig. 9)
Cells lunate or fusiformis 4.5-6.5 µm in diameter, 30-50 µm long.

51. *A. falcatus var. stipitatus* (Chodat) Lemmermann (Fig. 4n)
(Prescott, 1982, pl. 56, figs.14, 15)
Cells lunateforming clusters of 2-8; cells 2-3 µm in diameter, 18-20 µm long.

52. *Kirchneriella lunaris* (Kirchner) Moebius (Fig. 4o)
(Prescott, 1982, pl. 58, fig. 2)
Colony composed in groups of 4-16 cells 3-8 µ in diameter, 6.5-10µm long.

SEM observation: Structure more clearly visible, cell wall smooth with undulating surface. (Fig. 5n)

53. *K. obesa* (W.West) Schmidle (Fig. 4p)
(Prescott, 1982 pl. 58, fig. 5)
Colony of many irregularly arranged cells, cells 4-6 µm in diameter, 5-10µm long.

54. *K. contorta* (Schmidle) Bohlin (Fig. 4q)
(Prescott, 1982, pl. 57, figs. 7, 8).
Free floating colonies of 16 twisted, arcuate, cylindrical cells 1-2µm in diameter, 5.8-10µm long.

55. *K. elongata* G. M. Smith (Fig. 4v)
(Prescott, 1982, pl. 58, fig. 1)
Colonies of 4-16 elongate cylindrical, spirally twisted cells, cells 2-3 µm in diameter, 15-20 µm long.

56. *Oocystis Borgei* Snow (Fig. 4r)
(Prescott, 1982, pl. 51, fig. 10)
Cells in groups of 2-8, 5-7 µm in diameter, 8-10 µm long, colony upto 15 µm in diameter.

57. *Crucigeniella crucifera* (Wolle) Komarek (Fig. 4u)
(Komarek, 1974, p. 38, figs. 13, 14)
Basionym: *Crucigenia crucifera* (Wolle) Collins.
Colony of 4-sided cells, cells 3.5-5 µm in diameter, 5-7 µm long.

58. *C. apiculata* (Lemmermann.) Komarek (Fig. 4y-4z)
(Komarek, 1974)
Basionym: *Crucigenia apiculata* (Lemmermann.) Schmidle
Colony of 4 ovate rhomboidal or somewhat triangular cells, cells 3-7 µm in diameter, 5-10 µm long; colony 5-6 µm wide, 9-10 µm long.

59. *Actinastrum gracillum* G. W. Smith (Fig. 4w)
(Prescott, 1982, pl. 64, fig.5)
Cells cylindrical 1-2 µm in diameter, 10-15 µm long.

60. *Crucigenia tetrapedia* (Kirchner) West&West (Fig. 4s-4t)
(Prescott, 1982, pl. 65, fig. 9; pl. 66, fig. 1)
Colony free-floating consisting 4 triangular cells, cells 4.5-9 µm in diameter, frequently forming a rectangular plate of 16 cells.

61. *C. quadrata* Morren (Fig. 4x)
(Prescott, 1982, pl. 65, fig. 10)
Colony consisting of a circular plate of 4 triangular cells, cells 2.5-6 µm in diameter, 3.7 µm long;

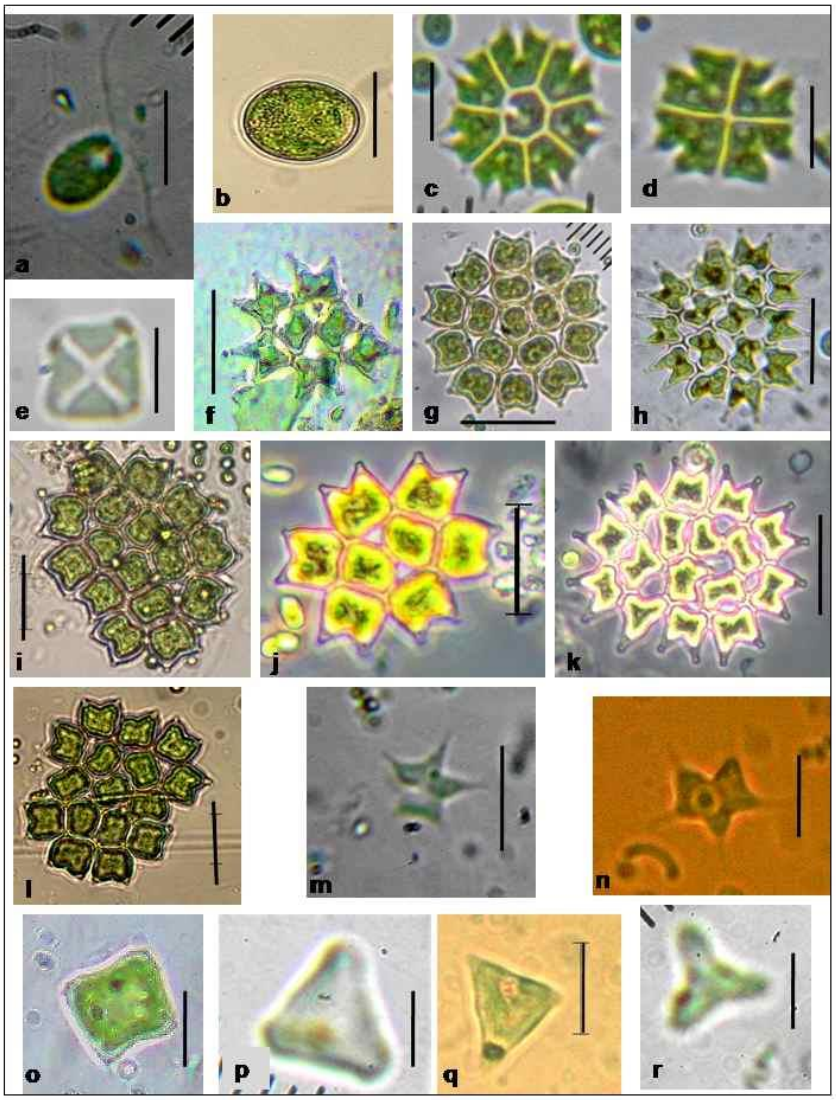

Fig. 2 (10 µm scale): Microphotographs of a. *Chlamydomonas mucicola,* b. *Chlorococcum humicola,* c. *Stauridium tetras*, d. *S. tetras var. apiculatum*, e. *Pediastrum privum*, f. *P.duplex* var. *clathratum*, g. *P.boryanum* var. *brevicorne*, h. *P. duplex* var. *duplex*, i. *P. boryanum*, j,k. *P. subgranulatum*, l. *P. sarmae*, m. *Tetraedron caudatum*, n. *T. caudatum* var. *longispinum*, o. *T. minimum*, p.*T. muticum*, q. *T. trigonum*, r. *T. trigonum* var. *gracile*.

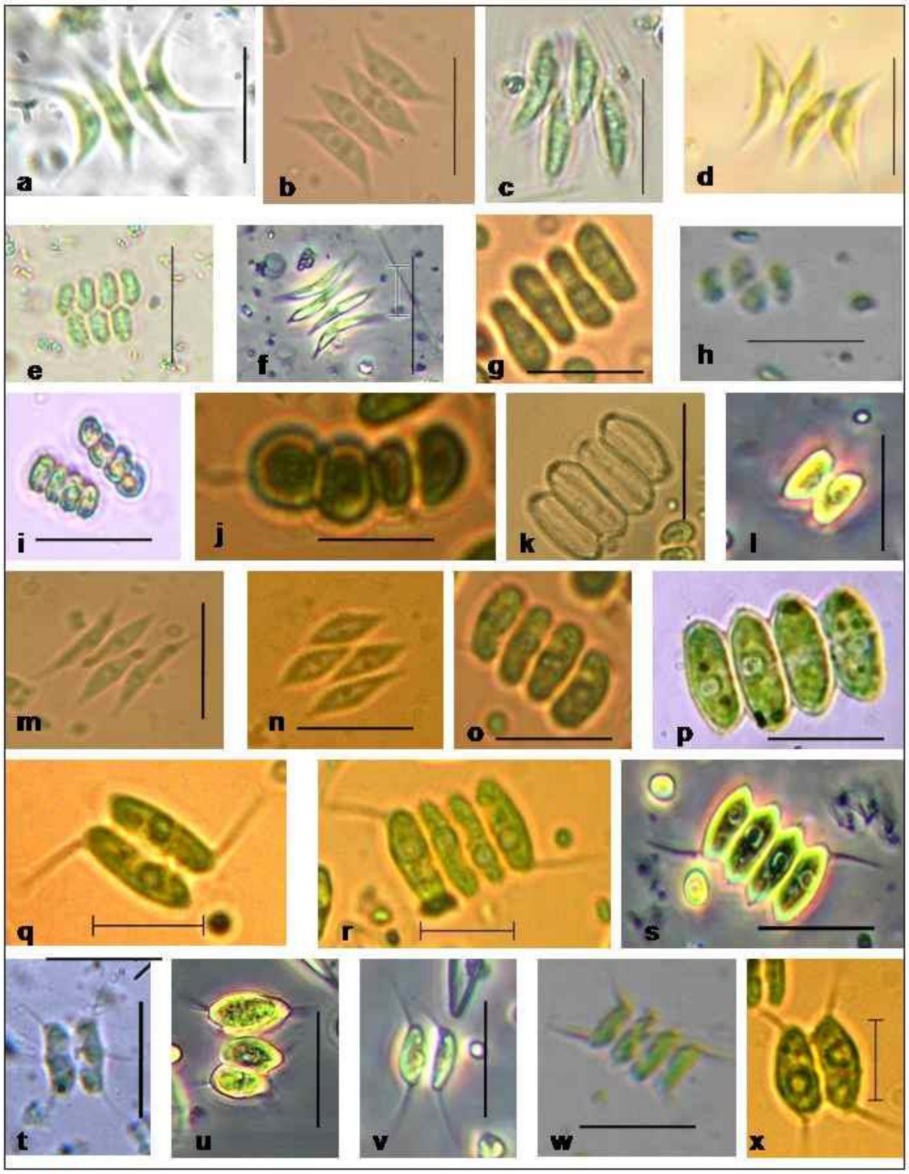

Fig. 3 (10µm scale): Microphotographs of a-b. *Scenedesmus dimorphus*, c. *S. incrassatulus*, d. *S. Bernardii*, e. *S. disciformis*, f. *S. acuminatus*, g. *S. ecornis*, h. *S. acutus*, i-j. *S. bijuga*, k. *S.brasiliensis*, l. *S. denticulatus*, m. *S. antillarum*, n. *S. obliquus*, o. *Desmodesmus pleiomorphus*, p. *D. itascaensis*, q-r. *D. bicaudatus*, s. *D. armatus* var. *bicaudatus*, t. *D. abundans*, u. *D opoliensis*, v. *Scenedesmus Psuedoopliensis*, w,x. *Desmodesmus quadricuada*

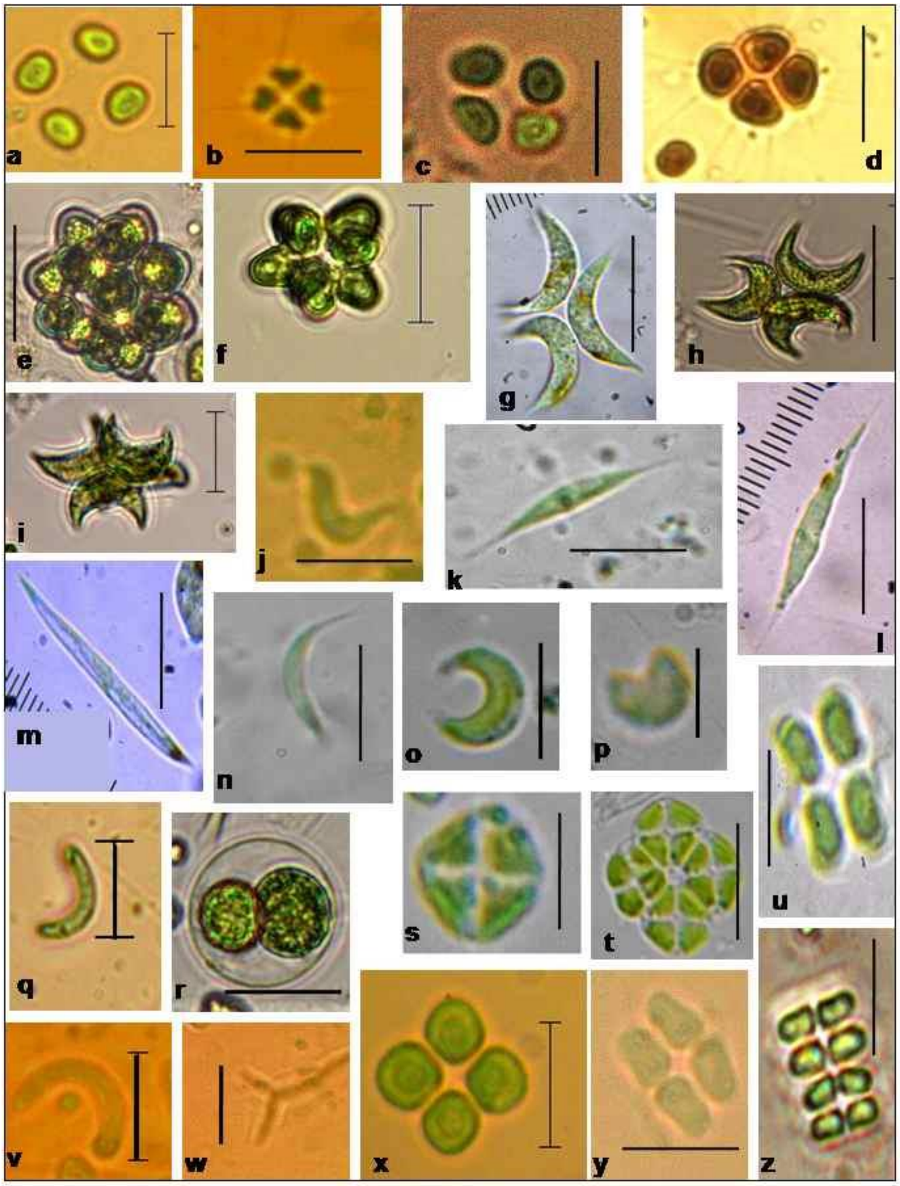

Fig. 4 (10µm scale): Microphotographs of a.*Tetrastrum* sp., b. *T. heteracanthum*, c. *T. triangulare*, d. *T. staurogeniaforme*, e. *Coelastrum microporum*, f. *C. prpboscideum*, g. *Selenastrum bibraianum*, h. *S. gracile*, i. *S. Westii*, j. *Ankistrodesmus convolutus*, k. *A. falcatus*, l. *A. falcatus* var. *acicularis*, m. *A. falcatus* var. *tumidus*, n. *A. falcatus* var. *stipitatus*, o. *Kirchneriella lunaris*, p. *K. obesa*, q. *K. contorta*, r. *Oocystis Borgei*, s. *Crucigenia tetrapedia*, t. *C. tetrapedia* (dividing stage), u. *Crucigeniella crucifera*, v. *Kirchneriella elongate*, w. *Actinastrum gracillum*, x. *Crucigenia quadrata*, y-z. *Crucigeniella apiculata*.

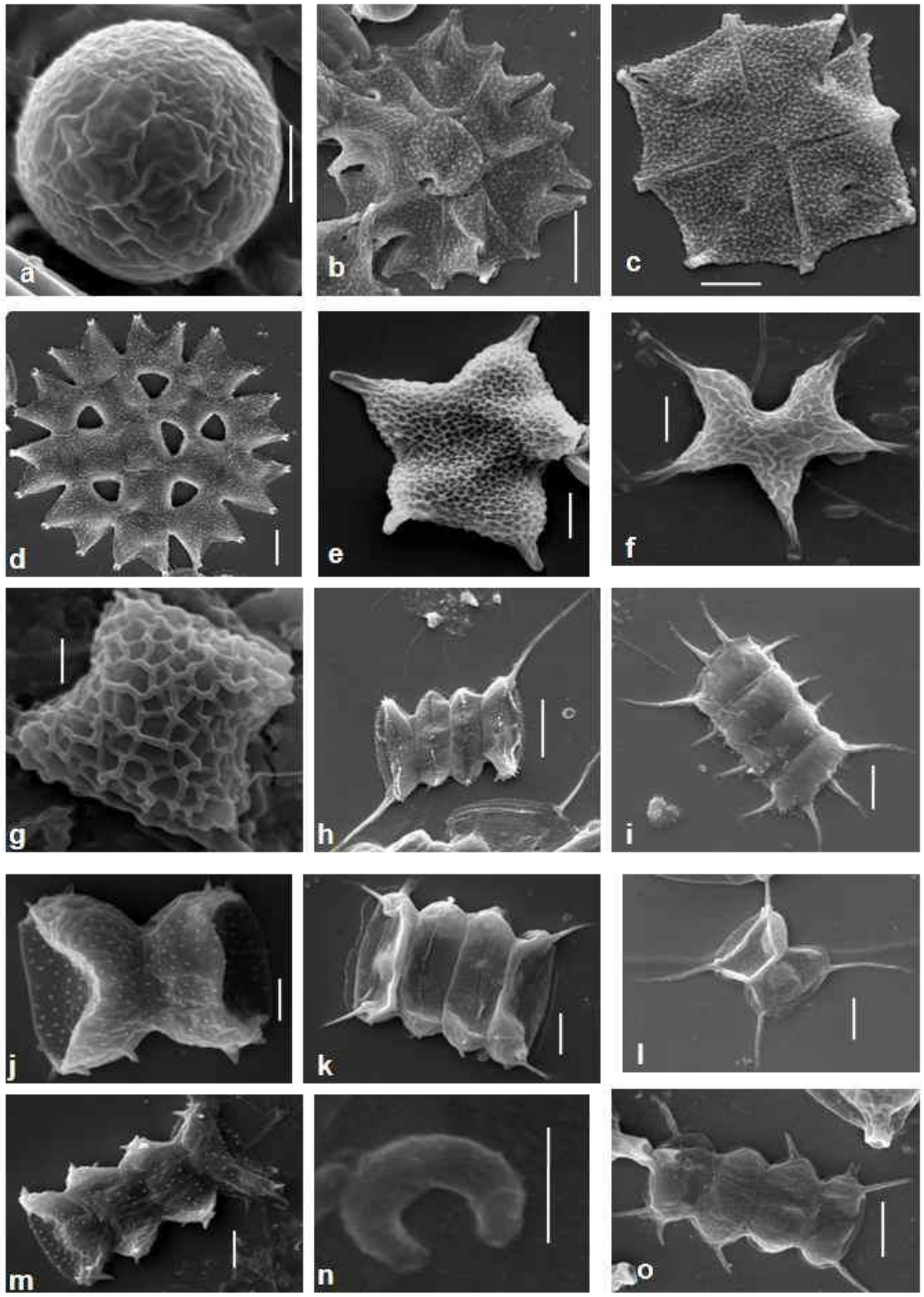

Fig. 5 (2µm scale): SEM micrographs of a. *Chlorococcum humicola*, b. *Stauridium tetras*, c.*S. tetras var. apiculatum*, d. *Pediastrum duplex* var. *duplex*, e. *Tetraedron caudatum*, f. *T. caudatum* var. *longispinum*, g. *T. minimum*, h. *Desmodesmus armatus* var. *bicaudatus*, i. *D. abundans*, j, m. *Scenedesmus denticulatus*, k-l. *D. quadricuada*, n. *Kirchneriella lunaris*, o. *D. opoliensis*.

Discussion

Algal assemblages in wetlands all over the world comprises of epipelon, which includes mobile algae inhabiting soft sediments, epiphyton, composed of algae growing on plants and phytoplankton or the free-floaters .Therefore different wetlands throughout the world are characterized by the presence of algal population of different categories. This particular eutrophic (data unpublished) tropical wetland of the study area, is comprised only of phytoplanktons. Brown (1972) studied short-lived blooms of *Aphanizomenon* and *Stephanodiscus* in Delta Marsh, a large freshwater wetland, Lake Manitoba, Canada. Another freshwater wetland of temperate regions was found to include pennate diatom as dominant algal group (Pip and Robinson, 1984; Hann, 1991). However, our sampling sites were found to harbor a wide diversification of planktonic chlorophytes with *Scenedesmus* being maximum to populate it. A total 14 species of *Scenedesmus* had been recorded from the study pond as identified by early authors (Philipose 1967; Komarek 1974; Prescott 1982). But recently in algal classification a polyphasic approach is being taken for identification, considering morphology, ultrastructure, biochemistry and molecular characters. Following this Hegewald (2000) and Tsarenko (2000) separated out the genus D*esmodesmus* from *Scenedesmus*. Accordingly, we also recorded additional 6 *Desmodesmus* spp.viz. *D. opoliensis, D. plieomorphus, D. itascaensis, D.abundans, D. armatus var. bicaudatus, D. bicaudatus* from the study area. Besides these 6 spp. of Pediastrum, 6 taxa belonging to genus *Tetraedron*, 5 *Ankistrodesmus* spp. and 4 spp. of *Tetrastrum* and *Kirchneriella* each had also been recorded.

Therefore from our study it can be concluded that in tropical eutrophic shallow wetlands the algal population is mostly dominated by members of chlorophytes generally and the classes Chlorophyceae and Trebouxiophyceae particularly.

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