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A TAXONOMIC ACCOUNT ON THE PHYTOPLANKTON OF A POND RECEIVING TEXTILE INDUSTRIAL EFFLUENTS

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Abstract

Phytoplankton from four stations of a large pond receiving effluents from two textile industries have been investigated. A total of 69 taxa were identified out of which 48 belonged to Chlorophyceae followed by 17 to Cyanophyceae. One species from each of Chrysophyceae, Xanthophyceae, Cryptophyceae and Dinophyceae were also recorded. *Oscillatoria limnetica* Lemm., *Anabaena circinalis* Rabenh. *ex* Born. *et* Flah., *Nostoc commune* Vaucher *ex* Born. *et* Flah. *Ankistrodesmus falcatus* var. *mirabilis* (West & West) Lemm. and *Scendesmus* spp. were found dominant in all the stations.

Introduction

The effluents, discharged in rivers, ponds, lakes, etc., are as varied as the human activities which produce them. According to Hynes and Pentelow (1978) six categories of effluents exist, namely (i) inert suspensions, (ii) poisons, (iii) inorganic reducing agents, (iv) oils, (v) organic residues, and (vi) hot water. The degree of pollution can often be measured most easily by a biological analysis in which phytoplankton are important indicators. For the assessment of water quality biological indicators are better than chemical and physical features (Round 1985). In India, aspects of biology of industrial wastewater have been studied by Mohan and Kumar (1990) and Baliarsingh *et al.* (1991).

In Bangladesh, a number of research works have been carried out on phytoplankton from a range of habitats and localities (Islam and Begum 1970, 1987, Islam and Irfanullah 2005a, b, c, 2006, Khondker *et al.* 2007a, b). Phytoplankton from organically polluted ponds were worked out by Islam and Khatun (1966), Islam and Nahar (1967), and Khondker *et al.* (1990), but there exists very little information on qualitative aspects of phytoplankton from the polluted habitats contaminated by industrial wastes. The present work has therefore been undertaken to study qualitative account of phytoplankton (excluding members of Bacillariophyceae and Euglenophyceae) from a pond receiving wastewater from two textile industries in Dhaka.

Materials and Methods

The investigation was carried out in a large permanent pond near Deilla, Demra, Dhaka during 1990-1991. The pond is an open drainage type having one inlet and is regularly charged with effluent wastewater released from the nearby textile and dyeing

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industries. Four stations or sampling points, namely S-1, S-2, S-3 and S-4, were selected in the pond for sampling.

Samples were collected at fortnight intervals at a depth of about 25 cm below the surface of water. A rafter was used for this purpose. Air and water temperatures were recorded by a mercury (centigrade) thermometer. pH and redox potential (RP) were measured by CD-300 digital portable pH meter with the help of the electrode (PHM-HBA-220U, 24:760/6). Dissolved oxygen (DO) and free carbon dioxide were analyzed according to APHA (1976). The bicarbonate alkalinity was measured after Gerrath and Denny (1979).

Collection and preservation of samples for biological analysis were done according to Johansen (1940) and Khondker *et al.* (1990). Phytoplankton were identified with the help of a Nikon compound microscope (Japan) at magnifications ranging from ×150 - × 1500. Desikachary (1959), Islam and Begum (1970), Prescott (1982), Huber-Pestalozzi (1983), Bold and Wynne (1985), Islam and Irfanullah (2005a, b, c) and Khondker *et al.* (2006, 2007a, b) were consulted for the identification of phytoplankton species.

Results and Discussion

Table 1 shows annual ranges of some physicochemical variables from the studied pond. Except S-1 no significant variation was observed in case of air and water temperatures. Annual maximum water temperature recorded at this station was about 6-7°C higher compared to the maximum temperature recorded in other stations. Might be this station was receiving some hot water discharge from the industries. A minimum pH value has been recorded at this station and S-4. Anoxia was observed in all the stations. Carbon dioxide was occasionally undetectable at S-1 and S-3. Similarly bicarbonate alkalinity was also undetectable at different times in all the stations.

Table 1. Range of some physical and chemical variables from four stations of the pond in Dhaka, 1990-1991.

Sampling station	Air temperature (^oC)	Water temperature (^oC)	pH	Dissolved oxygen (mg/l)	Free CO_2 (mg/l)	Bicarbonate alkalinity (meq/l)	Redox potential
S-1	23-38	20-39	5-7	0-5	0-8	0-19	-0.43-0.29
S-2	23-36	20-32	6-7	0-6	1-6	0-8	-0.21-0.29
S-3	22-36	20-33	6-7	0-5	0-9	0-19	-0.19-0.29
S-4	23-36	18-32	5-7	0-5	1-9	0-5	-0.22-0.27

A total of 69 phytoplankton taxa were recorded from the pond. The taxa which were found to be dominant were also previously reported to be dominant in different aquatic habitats in Bangladesh. The taxa belonged to the classes Cyanophyceae, Chlorophyceae, Chrysophyceae, Xanthophyceae, Cryptophyceae and Dinophyceae. A brief account on each taxon has been provided below including its abundance in station(s).

Class: Cyanophyceae; Order: Chroococcales; Family: Chroococcaceae

1. **Aphanothece pallida** Kütz. (Rebenh.), Fl. Eur. Alg. 2: 64 (1865). Colony 4-6 µm broad; cells 7-9 broad, 14-16 µm long with sheath, without sheath 6.5 broad, 6.5-10.0 µm long. Stations: 1-4; common.

Order: Oscillatoriales; Family: Oscillatoriaceae

2. **Oscillatoria agardhii** Gomont, Monogr. Oscillariées, 205 (1892). Filamentous; cells 2.0-6.6 broad, 1-3 µm long; calyptra 2.5 broad, 1.8 µm long. Stations: 2-4; few.
3. **Oscillatoria amphibia** Ag. *ex* Gomont, Monogr. Oscillariées, 221, pl. 7, figs 4-5 (1892). Tip cell 3 µm broad, 13 µm long; individual cell 5 µm broad, 3 µm long. Station: 3; rare.
4. **Oscillatoria homogenea** Frémy, Myxo. d' Afr. Équat. Franc. 215, fig.184 (1929). Trichomes long; cells 5.7-8.5 µm broad, 4-7 µm long. Stations: 1-4; common.
5. **Oscillatoria limnetica** Lemm., Ber. dtsch. Bot. Ges. 18: 310 (1900). [Syn.: *O. splendida* var. *limnetica* (Lemm.) Playfair]. Trichomes straight or bent; cells 1.5-2.0 µm broad, 2.5-5.0 µm long. Stations: 1-4; very common.
6. **Oscillatoria pseudogeminata** G. Schmid., Ber. dtsch. Bot. Ges. 32: 124, fig. 4 (1914). Trichomes straight; individual cell 3 µm broad, 8 µm long; terminal cell 2-3 µm broad, 4-8 µm long. Stations: 1-4; common.
7. **Oscillatoria sancta** (Kütz.) Gomont, Monogr. Oscillariées, 209, pl. 6, fig. 12 (1892). Thallus composed of many trichomes; cells 9.2-16.0 µm broad, 2.3-6.1 µm long. Stations: 1, 3, 4; few.
8. **Oscillatoria subbrevis** Schmidle., Engler's Bot. Jahrb. 30; 243, pl. 4, fig. 7 (1901). Trichomes single, 5-6 µm broad; cells 1-2 µm long. Stations: 1-3; few.
9. **Spirulina gigantea** Schmidle., Engler's Bot. Jahrb. 32: 59, pl. 1, fig. 5 (1902). Trichomes 2.7-4.0 µm broad, regularly spirally coiled, spirals 8-16 µm broad. Station: 1; rare.

Family: Nostocaceae

10. **Anabaena affinis** Lemm., Zeit. f. Fisch. 1897: 177-188 (1897). Filaments long; cells 6.0-7.5 µm broad, 4.0-4.5 µm long; heterocysts 6.5-8.5 µm broad, 5.5-6.2 µm long. Stations: 1-4; common.
11. **Anabaena circinalis** Rabenh. *ex* Born. *et* Flah., Algen Eur. Exs. no. 209 (1852). [Syn.: *A. flos-aquae* var. *circinalis* Kirchner]. Trichome 5-8 µm broad; cells 7-10 µm

long, 5-6 µm broad; heterocysts sub-spherical, 7-11 µm broad. Stations: 1-4; very common.

12. **Anabaena flos-aquae** (Lyngb.) Bréb. *ex* Born. *et* Flah. in Bréb. *et* Godey, Algues des environs de Falaise, 36 (1835). Filamentous; cells 5-6 µm broad; heterocysts 6-7 µm broad, 7.8 µm long. Stations: 1-4; common.
13. **Anabaena naviculoides** Fritsch, J. Indian Bot. Soc. 28: 138, figs 17-39 (1949). Trichomes elongate, coiled; cells 3.5-5.0 µm broad. Station: 1; very rare.
14. **Anabaena orientalis** Dixit, Proc. Indian Acad. Sci. B, 3: 101, fig. 3 D, E (1936). Trichomes single, 6.5 µm broad; cells 3.6-7.0 µm broad, 5-7 µm long; heterocysts 5-7 µm broad, 7.0-11.2 µm long; akinetes 11-14 µm broad, 18.1-21.5 µm long. Stations: 3, 4; not very common.
15. **Anabaena volzii** Lemm., Abh. Nat. Ver. Bremen, 18: 153, pl. 9, figs 4, 5, 20 (1906). [Syn.: *Anabaena unispora* Gardner]. Filamentous; cells 3.6-4.8 µm broad, 7-10 µm long; heterocysts 3.6-8.0 µm broad, 7-16 µm long; akinetes 9.6-20.0 µm broad, 20-34 µm long. Stations: 1-4; few.
16. **Anabaenopsis raciborskii** Wolosz., Bull. Int. Acad. Sci. Cracovie, B, 6: 684, fig. 10 (1913). Filaments 40-130 µm long; cells 2-3 µm broad, 4.5-11.0 µm long; heterocysts 3.0-3.5 µm broad, 5.5-7.5 µm long; akinete-like structure 4.0-4.3 µm broad, 7-9 µm long. Station: 2; very rare.
17. **Nostoc commune** Vaucher *ex* Born. *et* Flah., Historoie des conferves d'eau douce, 222, pl. 16, fig. 1 (1803). Colony 84 µm broad, 183 µm long; cells 4-5 µm broad, 5-7 µm long; heterocysts 5 µm broad, 3 µm long. Stations: 1-4; very common.

Class: Chlorophyceae; Order: Volvocales; Family: Volvocaceae

18. **Eudorina elegans** Ehrenberg, Monatsber. Akad. Wiss. Berlin 183: 78, 152 (1833). Colony 32-celled (also 16-celled), 69-96 µm broad, c 60-200 µm long; cells 7.0-11.7-(25.0) µm broad; pyrenoids 3 to many. Station: 1; rare.
19. **Pandorina morum** (Müller) Bory, Encycl. Meth. Diet. Hist. Nat., p. 600 (1824). Colony 8-16-(rarely-32)-celled, 20-33(-42) µm broad, 30-41(-60) µm long (may be longer); cells 6.6-10.0(-17.0) µm broad, 9-13(-17) µm long; flagella 2, 2.0-2.5 times body length; contractile vacuole 2. Stations: 2, 3; few.

Order: Chlorococcales; Family: Chlorococcaceae

20. **Schroederia setigera** (Schröd.) Lemmermann, Hedwigia, Dresden, 37: 303-312 (1898). [Syn.: *Reinschiella setigera* Schröd., *Ankistrodesmus setigerus* (Schröd.) G.S.

West, *Characium setigerum* (Schröd.) Bour.]. Cells 4.4 µm broad, 105.6 µm long with spines. Stations: 2-4; rare.

Family: Hydrodictyaceae

21. **Pediastrum duplex** Meyen, Nova Acta Loep. Carol., Norimberge, 14(2): 768-778 (1829). [Syn.: *P. napoleonis* Ralfs, *P. pertusum* Kützing]. Colony 8-128-celled, up to 182 µm broad; cells 10.0-16.2 µm broad, 13.5-21.78 µm long. Stations: 1, 2; few.
22. **Pediastrum duplex** var. **gracillimum** West & West, J. Roy. Microsc. Soc., London, 14: 1-17 (1894). [Syn.: *P. gracile* A. Br., *P. gracillimum* Thun.]. Colony 4-32-celled; cells 2.3-13.2 µm broad, 5.5-13.2 µm long. Station: 2; rare.
23. **Pediastrum duplex** var. **reticulatum** Lagerheim, Ofv. Kgl. Sv. Vet.-Akad. Forh. 39: 47-81 (1882). [Syn.: *P. duplex* var. *clathratum* (Ag. Br.) Lagerheim]. Colony 8-32-celled; outer cells 4.4-20.0 µm broad, 8.8-27.0 µm long; inner cells 2.3-17.6 µm broad, 6.6-20.55 µm long. Stations: 2-4; few.
24. **Pediastrum tetras** (Ehrenberg) Ralfs, Ann. & Mag. Nat. Hist. 14: 469 (1844). [Syn.: *P. rotula* Kütz., *P. ehrenbergii* (Chodat) A. Braun, *P. incavatum* Turn.]. Colony 4-8-celled; inner cells with 4-6 straight sides, cells 4.4-6.6 µm broad, 5.5-9.0 µm long. Stations: 2-4; common.
25. **Pediastrum tetras** var. **tetraedron** (Corda) Hansgirg, Prod. Algen. Böhmen-1. Teil, 288 pp. Prag (1886). Colony 4-celled, 21.3-40.0 µm long; cells 2.2-13.3 µm broad, 7.26-14.2 µm long. Stations: 1, 4; very rare.

Family: Oocystaceae

26. **Ankistrodesmus falcatus** (Corda) Ralfs, Ann. Bot. 34: 49, 74, fig. 2 (1848). [Syn.: *Micrasterias falcata* Corda, *A. biplex* (Reinsch) G.S. West, *A. lundbergii* Kors.]. Cells 1.1-2.0 µm broad, 30.2-66.0 µm long, solitary or in clusters of 2-32 individuals. Stations: 1-4; very common.
27. **Ankistrodesmus falcatus** var. **mirabilis** (West and West) Lemmermann (1908). Cells 2 µm broad, 19.8-37.4 µm long; autospores 4-8 in number. Stations: 1-4; very common.
28. **Ankistrodesmus spiralis** (Turner) Lemmerman, Ark. Bot. Kristiania 2: 1-209 (1904). [Syn.: *Raphidium spirale* Turn., *Raphidium polymorphum* Fres., *Raphidium turneri* Bern.]. Colony 2-8 or more celled; cells 1.1-2.2 µm broad, 25.8-30.8 µm long; autospores 4-8 in number. Stations: 2, 4; rare.

Family: Scenedesmaceae

29. **Crucigenia lauterbornii** (Schmidle) Schmidle, Allg. Bot. Z., Karlsruhe, 5: 2-4 (1900). [Syn.: *Hofmannia lauterbornii* (Schmidle) Wille, *Komarenkia lauterbornii* (Schmidle) Fott, *Staurogenia lauterbornii* Schmidle]. Colony 4-celled; cells 4.4-6.6 µm broad, 6.6-6.7 µm long. Station: 1; rare.

30. **Crucigenia quadrata** Morren, Ann. Sci. Nat. (a). Paris, 20: 404-426 (1830). [Syn.: *Micrasterias crucigenia* Kütz., *Staurogenia quadrata* (Morr.) Kütz.]. Colony 4-celled, forming 16-celled multiple coenobia; colony 13.2-36.0 µm in diameter; cells 3.3-6.6 µm broad, 3.3-9.9 µm long; chloroplasts as many as 4 in a cell. Stations: 1, 2; few.

31. **Crucigenia tetrapedia** (Kirchner) West and West, Trans-Roy. Irish Acad. 32 (B): 1-100 (1902). [Syn.: *Staurogenia tetrapedia* Kirchner, *Tetrapedia kirchneri* Lemm., *Lemmermannia tetrapedia* (Kirchn.) Lemm.]. Colony 4-celled, forming 16-celled multiple coenobia; colony 6.6 µm in diameter; cells triangular, 2.2-4.4 µm broad, 6.4-6.7 µm long. Stations: 1, 2; few.

32. **Crucigeniella crucifera** (Wolle) Komárek, Arch. Protistenk., Jena, 116: 1-75 (1974). [Syn.: *Staurogenia crucifera* Wolle, *Crucigenia cruciata* Schmidle, *C. crucifera* (Wolle) Collins]. Colony 4-16-celled, 8.8-11.0 µm broad, 8.8-14.2 µm long, cells 2.2-6.6 µm broad, 4.4-10.0 µm long. Station: 2; rare.

33. **Crucigeniella rectangularis** (Näg.) Komárek, Arch. Protistenk., Jena, 116: 1-75 (1974). [Syn.: *Staurogenia rectangularis* Nägeli in *ex* Braun, *Crucigenia rectangularis* (Nägeli) Gay]. Colony 4-32-celled; cells 2.2-3.5 µm broad, 2.4-6.6 µm long; chloroplasts 1-4 parietal discs. Stations: 1-4; common.

34. **Scenedesmus acutiformis** Schöder, Ber. Dt. Bot. Ges., Stuttgart 15: 372-373 (1897). [Syn.: *S. quadricauda* var. *acutiformis* (B. Schröder) Schmidle, *S. hystrix* var. *acutiformis* (B. Schröder) R. Chodat, *S. hystrix* f. *acutiformis* (B. Schröder) R. Volk]. Colony 4-celled; cell 6 µm long. Stations: 1, 2, 4; few.

35. **Scenedesmus arcuatus** Lemmermann, Forschungsber. Biol. Stat. Plön 7: 96-135 (1899). Colony 4-16-celled; cells 4.4-8.8 µm broad, 6.6-14.3 µm long. Stations: 1-4; very common.

36. **Scenedesmus arcuatus** var. **platydiscus** G.M. Smith, Trans. Wisc. Acad. Sci. Arts and Letters, Madison, 18: 422-539 (1916). Colony 4-8-celled, 11.0 µm long; cells oblong-elliptic, 2.2-6.6 µm broad, 6.8-8.8 µm long. Stations: 1, 3; few.

37. **Scenedesmus bijuga** (Turp.) Lagerheim, Nuora Notarisia 2: 153-191 (1893). [Syn.: *S. helveticus* Chodat]. Colony 2-4-8-celled, 13.5 µm long; cells 3.3-10.0 µm broad, 8.8-20.0 µm long. Stations: 1-4; common.

38. **Scenedesmus bijuga** var. **irregularis** (Wille) G.M. Smith, Trans. Wisc. Acad. Sci. Arts and Letters, Madison 18: 422-539 (1916). Colonial; cells 3.3-6.6 µm broad, 6.6-8.8 µm long. Stations: 1, 3, 4; common.

39. **Scenedesmus brasiliensis** Bohlin, Bih. K. Svenska Vet.-Akad. Handl. 23, Afd. 3, No. 7: 3-47 (1897). Colony 2-4-8-celled, arranged in a single series, 21-27 µm long; poles with 1-2 small teeth; cells 4.4-7.4 µm broad, 11.0-22.3 µm long. Stations: 1, 4; rare.

40. **Scenedesmus denticulatus** Lagerheim, Öfv. Kongl. [Svenska] Vet.-Akad. Förh. 39(2): 47-81 (1882). Colony 4-8-celled, arranged in a single series; cells 3.3-10.0 µm broad, 11.0-20.9 µm long; 1-4 short teeth/spines at cell apices; spines 3.3 µm long. Stations: 1-4; common.

41. **Scenedesmus dimorphus** (Turp.) Kütz., Linnaea 8: 604-609 (1833). [Syn.: *Achnanthes dimorpha* Turp., *S. pectinatus* Meyen, S. *acutus* var. *dimorphus* (Turp.) Rabenh.]. Colony 4-8-celled; cells 2.2-10.0 µm broad, 11-23 µm long. Stations: 1-4; common.

42. **Scenedesmus incrassatulus** Bohlin, K. Svenska Vet.- Akad. Handl. Stockholm, Afd. 3, 23 (7): 3-47 (1897). Colony 2-4-8-celled; cells 2.2-4.4 µm broad, 13.4-17.6 µm long. Stations: 2-4; few.

43. **Scenedesmus magnus** Meyen, Nova Acta Leop. Carol., Norimbergae 14(2): 768-778 (1829). [Syn.: *S. longus* var. *naegelli* Bréb., *S. longus* Meyen, *S. quadricauda* Bréb. var. *maximus* (West & West) Chodat.]. Colony flat, 2-4-8-celled; cells 3.0-8.8 µm broad, 7-23 µm long. Stations: 1, 2, 4; few.

44. **Scenedesmus longus** var. **brevispina** G.M. Smith, Trans. Wisc. Acad. Sci. Arts. Lett., Madison 18: 422-530 (1916). Colonial; cells 4.5-6.6 µm wide, 15.4-17.4 µm long; setae 2.2 µm long. Stations: 3, 4; rare.

45. **Scenedesmus perforatus** Lemmermann, Forschungsber. Biol. Stat. Plön 11: 289-311 (1904). Colony 2-8-celled; cells 3.0-8.8 µm broad, 9.9-26.4 µm long; setae 2.2-15.4 µm long. Station: 1; very rare.

46. **Dictyosphaerium ehrenbergianum** Nägeli, Gattungen einzelliger Algen. pp. 137, Zürich (1849). Colony 85 µm in diameter; individual cells 3.3-6.6 µm broad, 6.6-9.9 µm long. Stations: 1-4; very common.

47. **Hyaloraphidium contortum** Pascher & Korsikov, Arch. Protistenk. 74: 249, figs 1-6 (1931). Cells 2.2-2.5 µm broad, 19.8-28.6 µm long. Stations: 1-4; common.

48. **Kirchneriella lunaris** (Kirch.) Moebius, Abh. Senck. Natur. Ges. Frankfurt A.M. 18: 309-350 (1894). [Syn.: *Raphidium convolutum* var. *lunare* Kirchn., *K. lunata*

Schmidle]. Colony 4-16-celled, up to 48.4 µm in diameter; cells 4.4-6.6 µm broad, 3.3-9.9 µm long. Station: 2; rare.

49. **Trochiscia reticularis** (Reinsch) Hansgirg, Hedwigia, 27: 126-132 (1888). Cells usually in clumps, 26.4-33.0 µm in diameter; autospores 4, 8 or 16. Stations: 1, 2; not very common.

50. **Tetraedron regulare** Kützing, Phycologia germanica, d.i. Deutschlants Algen in bündigen Beschreibungen, pp. 340. Nordhausen (1845). [Syn.: *T. tumidulum* (Reinsch) Hansgirg, *T. quadrilobum* G.M. Smith]. Cells tetragonal, 50.7 µm broad (with spine), 15.5-57.4 µm long. Stations: 1, 2; rare.

51. **Tetraedron trigonum** (Nägeli) Hansgirg, Hedwigia, 27: 126-132 (1888). Cells 8.6-22.0 µm broad, 11.2-22.0 µm long. Stations: 1-4; common.

52. **Tetraedron constrictum** G.M. Smith, Wis. Geol. and Nat. Hist. Surv., Bull. 57: 1-243 (1920). Cells 28.6 µm in diameter with processes. Station: 2; very rare.

53. **Tetraedron caudatum** (Corda) Hansgirg, Hedwigia, Dresden, 27 (516): 126-132 (1888). [Syn.: *Polyedrium pentagonum* Reinsch]. Cell diameter 8.8 µm; autospores 2-4-8 per cell. Stations: 1, 2, 4; few.

Family: Coelastraceae

54. **Actinastrum hantzschii** Lagerheim, Öfv. Kongl. Sv. Vet.–Akad. Förhandl, 39 (2): 47-81 (1882). [Syn.: *Ourococcus bicaudatus* (A. Braun) Grobety]. Colony 4- or 8-celled; cells 2.2-4.2 µm broad, 8.8-19.6 µm long. Stations: 1-4; very rare.

Order: Zygnematales; Family: Desmidiaceae

55. **Closterium moniliferum** (Bory) Ehrenberg, Infusions. Volkomm. Organism. p. 91, pl. 5, fig. 16; *ex* Ralfs 1848, Brit. Desm. 166, pl. 28: 3 (1838). [Syn.: *C. leibleinii* Kg. *ex* Ralfs proparte, *C. malinvernianiforme* Groenblad, *C. moniliferum* (Bory) Her. *ex* Ralfs var. *malinvernianiforme* (Groenb.) Kosinsk.]. Cells solitary, 166-261 µm long, median diameter 29-45 µm, apex (3)-6-9 µm, 50º-133º arc; chloroplast 5-10, pyrenoids 4-10; terminal vacuole with c 10 granules. Station: 2; very rare.

56. **Closterium ralfsii** Bréb. *ex* Ralfs var. **gracilius** (Maskell) Krieger, Rabenhorst's Kryptog. Flora 13: 346, pl. 31, fig. 6 (1937). [Syn.: *C. decorum* Bréb. var. *gracilius* Maskell]. Cell length 210 µm, median diameter 11 µm, apex 3 µm, curvature less, c 30º arc; striation 5-14 in 10 µm. Station: 4; very rare.

57. **Cosmarium caelatum** Ralfs, Brit. Desmid.: 103 (1848). Cells 18.2 µm broad, 21.8-23.2 µm long, isthmus 3.6-5.4 µm, apex 10 µm. Station: 2; rare.

58. **Cosmarium impressulum** Elfving, Acta Soc. Fauna Flora Fenn. 2 (2): 13, pl.1, fig. 9 (1881). [Syn.: *C. meneghinii* var. *simplicissimum* f. *reinschii* Istvanfy]. Cells 18-26 µm long, 12.6-18.5 µm broad, isthmus 3.6-7.4 µm, apex 5.5-7.3 µm. Station: 3; rare.

59. **Cosmarium laeve** Rab., F1. Eur. Aig. 3: 161 (1858). Cells 25.4 µm long, median diameter at the base of semicell 7.5-14.5 µm, isthmus 3.3-6.9 µm. Stations: 2-4; common.

60. **Staurastrum galeatum** Turner, Alg. Ind. Orient.: 122, pl. 14, figs 3, 9-10 (1893). Cells 29.6-30.0 µm long, median diameter with processes 37-39 µm, isthmus 11 µm. Station: 4; rare.

61. **Staurastrum lapponicum** (Schmidle) Grönblad, Soc. Sc. Fenn., cimment. Biol. 2(5): 29 (1926). [Syn.: *S. punctulatum* var. *muricatiforma* fa. *lapponica* Schmidle]. Cells 25 µm long, median diameter 23-24 µm, isthmus 8.3 µm. Station: 4; rare.

62. **Staurastrum longibrachiatum** West & West, Nova Hedwigia pl. 17, figs 8, 9 (1905). [Syn.: *S. bicorne* var. *longebrachiatum* Borge]. Cell length without processes 26-46 µm, median diameter with processes 60-90 µm, isthmus 8-10 µm. Station: 4; rare.

63. **Staurastrum manfeldtii** Delponte, Hirano, Mem. R. Accad. Sc. Torino, ser. 2, 30: 64 (1878). Cell length 35 µm, median diameter without spines 13.6 µm, isthmus 8.3 µm. Stations: 1, 2, 4; few.

64. **Pleurotaenium trabecula** (Her.) Nägeli., Gattung einz. Algen, 104, pl. 6, fig. A (1849). Cells 576 µm long, median diameter at the base of semicell 50 µm, isthmus 42 µm, cell apex 25.0-33.4 µm. Stations: 3, 4; rare.

65. **Euastrum spinulosum** Delponte var. **inermius** (Nordstedt) Bernard, p. 126, pl. 8, figs 207, 208 in Protococcácées *et* Desmidiées d'eau douce, recoltees á Java, pp. 230, Batavia (1908). [Syn.: *E. spinulosum* Delp. subsp. *inermius* Nordstedt]. Cells 49-59-(81) µm long, median diameter 42-51-(67) µm, isthmus 8.5-11-(18) µm, apex 12.5-17-(27) µm. Station: 4; rare.

Class: Chrysophyceae; Sub-class: Chrysophycidae;
Order: Ochromonadales; Family: Dinobryaceae

66. **Dinobryon sertularia** Ehrenberg, Abh. K. Aked. Wiss. Berlin, Physik. K1. 1833: 280 (1834). Lorica 9.4 µm broad, 32.4-36.4 µm long, opening diameter 10.8 µm; zygospore diameter 14.8 µm. Stations: 2-4; not so common.

Class: Xanthophyceae; Order: Mischococcales; Family: Pleurochloridaceae

67. **Isthmochloron gracile** (Reinsch) Skuja var. **dacchense** Islam, Dacca Univ. Stud. 21, pt. B. (1973). Cells solitary, with arms 22-34 µm broad, 28.8-34.0 µm long. Stations: 2-4; not so common.

Class: Dinophyceae; Order: Peridiniales; Family: Peridiniaceae

68. **Ceratium hirundinella** (Müller) Dujardin, Infusoires: 377 (l84l). [Syn.: *Bursarja hirundinella* Müller]. Cell proper 41 µm broad, 150 µm long; epicone with horn 95 µm long; hypocone with posterior horn 64 µm long. Stations: 1, 2; not so common.

Class: Cryptophyceae; Order: Cryptomonadales; Family: Cryptomonadaceae

69. **Cryptomonas obovata** Skuja, Acta Horti Bot. Univ. Latv. 11-12: 41-169 (1939). Cells 13 µm broad, 25 µm long; flagella 2, equal or unequal, 12 µm long. Stations: 2-4; common.

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