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Phytoplankton diversity in the coastal waters of Port Blair, South Andaman, India

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ABSTRACT

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The present study deals with the diversity of phytoplankton from two selected stations, (Station 1: Junglighat and Station 2: Science Centre) during December 2010 to February 2011 in the coastal waters of Port Blair, South Andaman. Special emphasis was given to visualise the phytoplankton assemblages of the selected stations during low tide and high tide. Qualitative analysis reveals occurrence of 114 species belonging to 42 genera of diatoms, 16 genera of dinoflagellates and 4 genera of Cyanobacteria. Quantitatively, diatoms are dominant (56.8−95.6%) followed by dinoflagellates (1.5−32.2%) and Cyanobacteria (1.2−14.6%) respectively. It has been interpreted that the variation in tides and other environmental factors have influence on the species diversity and representation of specific micro-algal groups at different times. However, the study indicates rather low phytoplankton productivity in the study area.

Key-words: Phytoplankton, species diversity, tidal variation, Port Blair, South Andaman, India.

INTRODUCTION

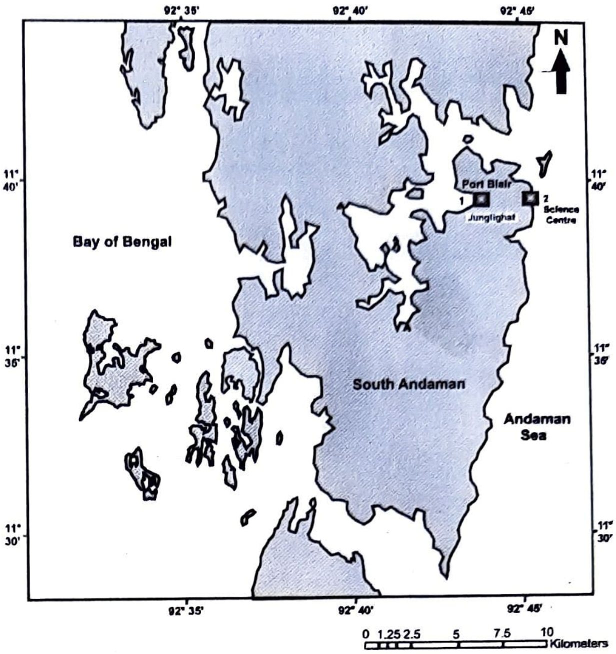
Andaman and Nicobar islands are considered as an important biosphere in terms of species diversity and endemism (Prasad et al. 2007). However, little efforts have been made for estimating the diversity of phytoplankton of these islands (Devassy & Bhattathiri 1981, Sarojini & Sarma 2001, Karthik et al. 2012, Siva Sankar & Padmavati 2012). From, the ecological point of view, determination of biodiversity within various communities has long been a pivotal point. In the coastal seas and estuaries, where the mixing of fresh and marine waters takes place, considerable changes in physico-chemical and biological processes lead to diverse life forms. The significant diversity of these organisms is essential for the ecology and biogeochemistry of the oceanic system (Tilman et al. 1997, Ptacnik et al. 2008). Marine phytoplankton includes various groups of organisms. However, the most common and significant are the diatoms and the dinoflagellates in microplankton size range and cyanobacteria in picoplankton size range (Ptacnik et al. 2008). The objectives of the present study are to understand the species composition and their differences between the two selected stations during low tide and high tide, the assemblage pattern and the temporal variation.

MATERIAL AND METHOD

Coastal water samples were collected for the study of phytoplankton diversity from Port Blair, South Andaman. For this purpose, two stations were selected, Station 1 at Junglighat and Station 2 at Science Centre (Text-figure 1). Water samples were collected at lowest low tide and highest high tide at these stations at monthly intervals during December 2010, January-February 2011 by using a phytoplankton scoop net (30 μm). For each sampling, 50 litres of water was passed through the phytoplankton net. The phytoplankton were preserved in 1% Lugol's solution for quantitative analyses. The species were identified using relevant taxonomic literatures (Venkataraman 1939, Cupp 1943, Desikachary & Ranjitha Devi 1986, Santhanam et al. 1987, Tomas 1997). Photomicrographs were taken by phase contrast microscope (Carl-Zeiss Axiostar) attached with a digital camera (Canon Powershot A80). Phytoplankton cell counts from the composite samples were performed using a Sedgewick–Rafter cell counter. The total number of phytoplankton present in one litre of water sample was calculated using the following formula: N = n.v.100/V where N = total number of phytoplankton cells per litre of water filtered; n = average number of phytoplankton cells in 1 ml of sample; v = volume of phytoplankton concentrates in ml and V = volume of total water filtered in litre. Phytoplankton abundance was estimated (modified after Olschesky & Laws 2002) as D = dominant (>30%), A = abundant (10-30%), F = few (5-10%), R = rare (1-5%) and P = present (<1%).

PHYTOPLANKTON ASSEMBLAGE

In the present study, 114 phytoplankton species belonging to 3 groups, viz. Bacillariophyceae



Text-figure 1. Map showing location of Station 1 (Junglighat) and Station 2 (Science Centre) in Port Blair, South Andaman.

(diatoms), Dinophyceae (dinoflagellates) and Cyanobacteria have been recorded (Table 1, Plates 1-4).

At Station 1, the percentage of diatoms varies from 56.80 to 89.10%, dinoflagellates from 1.90 to 28.60% and cyanobacteria from 1.20 to 14.60% respectively. At Station 2, diatoms vary from 66.10 to 95.60%, dinoflagellates from 1.50 to 32.20% and cyanobacteria from 1.30 to 3.10% respectively. Frequency of occurrence of the phytoplankton in two stations during the study period in low tide and high tide has been illustrated in Text-figure 2. Quantitative analysis reveals that diatoms are the most dominant phytoplankton group. Cyanobacteria are better represented at Station 1 than at Station 2. Phytoplankton density varies from 4,500 to 11,790 cells/litre at Station 1 and from 827 to 3450 cells/litre at Station 2. At Station 1, during the month of December 2010, *Coscinodiscus* spp. were dominant whereas, in January and February 2011 dominance of *Rhizosolenia* sp. was observed (Table 1).

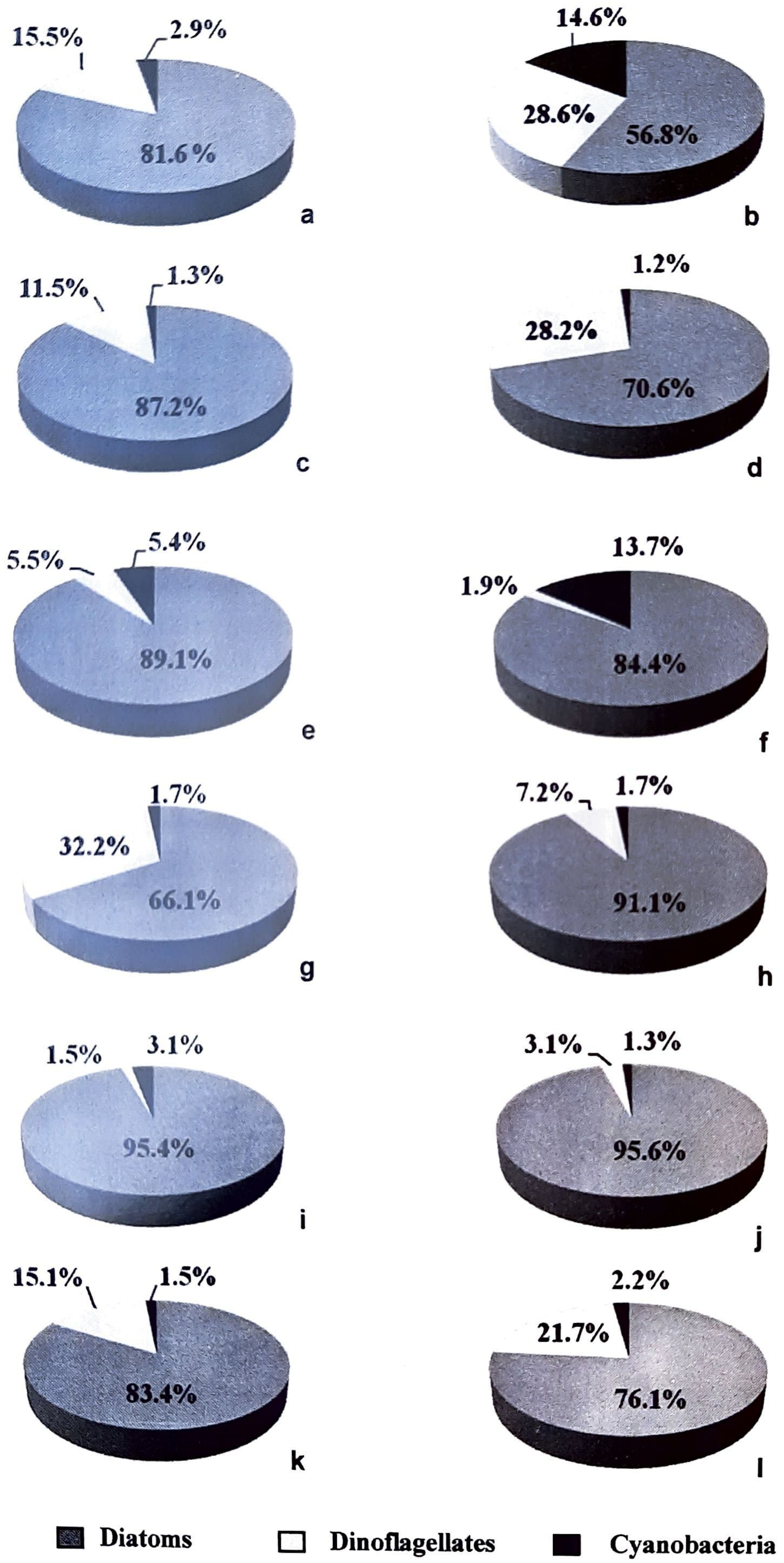
Amongst the diatoms, *Rhizosolenia* sp., *Coscinodiscus* sp., *Navicula* sp., *Nitzschia longissima*, *Pseudonitzschia* sp., *Pleurosigma*

Table 1. Distribution of phytoplankton in the study area (cells/ml).

Phytoplankton taxa	December				January				February			
	JG		SC		JG		SC		JG		SC	
	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT	LT	HT
Diatoms												
Actinoptychus senarius Ehrenberg 1843	R	-	-	-	-	R	R	-	-	-	-	-
Asterionellopsis glacialis (Castracane) Round 1990	R	-	R	-	-	-	-	R	-	-	R	-
**Bacillaria paxillifera* (O. F. Müller) T. Marsson 1901	-	-	R	R	-	-	-	-	P	P	-	R
Bacillaria sp. J. F. Gmelin 1791	R	P	-	-	-	-	-	F	-	-	-	-
Chaetoceros danicus Cleve 1889	-	-	-	-	-	-	-	-	-	-	R	-
**Chaetoceros peruvianus* Brightwell 1856	-	-	-	-	-	-	-	-	-	-	-	R
**Chaetoceros* sp. Ehrenberg 1844	R	R	P	F	-	-	-	-	F	-	-	F
Climacosphenia elongata Mereschkowsky 1902	-	-	-	R	-	-	F	F	-	-	-	-
Climacosphenia moniligera Ehrenberg 1843	F	P	-	-	-	-	-	-	-	-	-	-
Climacosphenia sp. Ehrenberg 1843	R	-	R	-	-	-	-	-	-	-	-	-
**Coscinodiscus granii* Gough 1905	-	-	-	-	-	-	-	-	-	R	-	-
**Coscinodiscus* sp. Ehrenberg 1839	D	D	R	A	R	R	F	F	F	F	A	F
Cyclotella sp. (Kützing) Brébisson 1838	R	-	-	-	-	-	-	-	-	-	-	-
Cylindrotheca closterium (Ehrenberg) Reimann & Lewin 1964	-	-	-	-	-	-	R	-	R	-	-	R
Cylindrotheca sp. Rabenhorst 1859	-	-	-	R	-	-	-	-	-	R	-	R
Detonula pumila (Castracane) Gran 1900	-	-	-	-	-	-	-	-	-	-	-	R
Diatoma vulgare Bory de St-Vincent 1824	-	-	A	-	-	-	-	-	-	-	-	-
Ditylum sp. J. W. Bailey 1861	-	-	-	-	-	-	-	-	-	P	-	-
**Eucampia* sp. Ehrenberg 1839	-	-	-	-	P	-	-	-	-	-	-	-
**Fragilariopsis cylindrus* Hustedt in Schmidt 1913	-	-	R	A	-	-	-	-	-	-	-	-
Gossleriella tropica F. Schütt 1892	P	-	-	-	-	-	-	-	-	-	-	-
Grammatophora sp. Ehrenberg 1839	-	-	P	-	-	-	-	-	-	-	-	-
Guinardia delicatula (Cleve) Hasle 1997	-	-	-	R	-	-	-	-	-	-	-	-
**Guinardia flaccida* (Castarcane) H. Peragallo 1892	-	-	R	-	-	P	-	-	P	P	-	R
**Guinardia striata* (Stolterfoth) Hasle 1996	-	-	R	-	-	-	R	-	-	-	-	-
**Guinardia* sp. Peragallo 1892	-	-	-	-	P	-	-	-	-	-	-	-
**Hemialus membranaceus* Cleve 1873	-	-	-	-	-	-	-	-	R	-	-	R
Hemidiscus hardmanianus (Greville) Mann 1907	P	P	-	-	-	-	-	-	-	-	-	-
Hemidiscus sp. Wallich 1860	-	R	P	R	-	P	-	-	R	R	-	-
Lauderia sp. Gran 1900	-	-	-	-	R	-	-	-	-	-	-	-
Leptocylindrus minimus Gran 1915	-	-	-	R	-	-	-	-	-	-	-	-
**Leptocylindrus* sp. Cleve 1889	R	P	P	A	-	-	R	A	-	-	-	A
Licmophora abbreviata C. Agardh 1831	-	-	F	-	-	-	-	-	-	-	-	-
Licmophora sp. C. Agardh 1827	-	-	-	-	-	P	-	-	-	-	-	-
Lithodesmium undulatum Ehrenberg 1839	-	P	-	-	-	-	-	-	-	P	-	-
**Melosira* sp. C. Agardh 1824	-	-	-	-	-	-	P	-	-	-	-	-
Navicula distans (W. Smith) Ralfs 1861	-	-	-	-	-	-	-	-	R	P	F	-
Navicula transitrans (Grunow) Cleve 1883	-	-	-	-	-	-	-	-	R	R	-	-
**Navicula* sp. Bory de St-Vincent 1822	R	R	F	R	-	P	F	F	-	-	-	-
Neodenticula sp. Akiba et Yanagisawa 1986	-	-	-	-	-	-	-	R	-	-	-	-
Neostreptotheca subindica von Stosch 1977	-	-	-	R	-	-	-	-	-	-	-	-
Nitzschia braarudii G. R. Hasle 1960	-	-	R	-	-	-	-	-	-	-	-	-
**Nitzschia longissima* (Brébisson) Ralfs 1861	P	R	F	R	-	-	-	R	R	-	-	R
Nitzschia panduformis Gregory 1857	P	-	-	-	-	-	-	-	-	-	-	-
Nitzschia sigma (Kützing) W. Smith 1853	-	-	R	-	-	-	-	-	-	-	-	-
**Nitzschia* sp. 1 Hassall 1845	P	P	-	R	-	-	-	-	-	-	-	-
**Nitzschia* sp. 2 Hassall 1845	-	-	-	-	-	-	-	-	-	P	-	-
**Nitzschia* sp. 3 Hassall 1845	-	P	-	-	-	-	-	-	-	-	-	-
**Odontella* sp. C. Agardh 1832	-	-	R	-	P	-	R	R	R	P	-	R
**Phaeodactylum tricornutum* Bohlin 1897	-	-	R	-	R	-	R	-	P	-	R	R
Pleurosigma angulatum (Queckett) W. Smith 1852	-	-	-	-	-	-	-	-	-	R	-	-
Pleurosigma directum Smith 1852	-	-	-	-	-	-	R	-	P	-	-	R
Pleurosigma elongatum Smith 1852	R	-	-	-	-	-	-	-	-	R	-	-
Pleurosigma normanii Ralfs 1861	-	-	-	-	-	-	-	-	P	-	-	-
**Pleurosigma* sp. 1 Smith 1852	F	-	R	R	P	R	R	F	-	R	R	R
**Pleurosigma* sp. 2 Smith 1852	-	-	-	-	-	-	-	-	P	-	-	-
Pseudonitzschia delicatissima (Cleve) Heiden 1928	-	-	A	-	-	-	-	-	-	-	-	-

Pseudonitzschia lineola (Cleve) Hasle 1965	-	-	-	-	-	-	-	-	-	-	R	-
Pseudonitzschia subcurvata (Hasle) Fryxell 1993	-	P	R	-	-	-	-	-	R	-	-	-
Pseudonitzschia turgidula (Hustedt) Hasle 1993	-	-	-	-	-	-	-	-	P	-	-	-
Pseudonitzschia sp. 1 Peragallo 1900	P	-	A	R	R	-	-	-	R	R	D	R
Pseudonitzschia sp. 2 Peragallo 1900	-	-	-	-	-	-	-	-	P	-	-	-
Pseudoguinardia recta von Stosch 1986	-	-	-	-	-	-	-	-	-	-	-	R
Rhabdonema arcuatum (Lyngbye) Kützing 1844	-	-	P	-	-	-	-	-	-	-	-	-
Rhabdonema sp. Kützing 1844	P	-	-	-	-	-	-	-	-	-	-	-
Rhizosolenia alata (Cleve) Gran 1908	-	-	-	-	-	-	-	-	-	D	-	-
**Rhizosolenia hebetata* Bailey 1856	-	-	-	-	-	-	-	-	R	-	R	-
Rhizosolenia temperei Peragallo 1888	-	-	-	-	-	-	-	-	-	R	-	-
**Rhizosolenia* sp. Brightwell 1858	-	P	R	R	D	D	D	A	D	-	A	D
Skeletonema costatum (Greville) Cleve 1873	R	-	-	-	-	-	-	-	-	-	-	-
Skeletonema sp. Greville 1865	-	-	-	R	P	-	-	R	-	-	-	R
**Stephanopyxis* sp. (Ehrenberg) Ehrenberg 1845	R	-	-	-	-	-	-	-	-	-	-	-
**Thalassionema nitzschioides* (Grunow) Mereschkowsky, 1902	-	-	-	-	-	-	-	-	R	-	-	-
Thalassionema sp. Grunow ex Mereschkowsky 1902	-	-	F	-	-	-	-	-	-	-	-	-
Thalassiosira subtilis (Ostenfeld) Gran 1900	-	-	-	-	-	P	-	-	-	-	-	-
**Thalassiosira* sp. Cleve 1873	-	-	-	R	-	-	-	F	-	-	-	-
**Thallasiothrix frauenfeldii* Cleve & Grunow 1880	-	-	-	-	-	-	-	-	-	R	-	-
**Thallasiothrix longissima* Cleve & Grunow 1880	-	-	R	A	-	-	F	A	-	-	-	-
Thallasiothrix sp. Cleve & Grunow 1880	R	-	-	-	-	P	-	-	-	-	-	-
Toxarium undulatum Bailey 1854	P	-	-	-	-	-	-	-	P	-	-	-
**Triceratium* sp. Ehrenberg 1839	R	P	-	-	P	-	R	-	-	P	R	-
Trichotoxon reinboldii (Van Heurck) Reid & Round 1988	-	-	-	R	-	-	-	-	-	-	-	-
Dinoflagellates												
Alexandrium sp. Halim 1960	-	-	-	F	-	-	A	F	R	R	D	-
Ceratium extensum (Gourret) Cleve-Euler 1900	-	-	-	-	-	-	-	-	-	D	-	-
**Ceratium furca* (Ehrenberg) Claparède & Lachmann 1859	-	-	-	-	-	F	-	F	-	R	-	-
**Ceratium fusus* (Ehrenberg) Dujardin 1841	-	F	-	-	-	-	-	-	-	-	-	-
Ceratium kofoidii Jørgensen 1911	-	-	-	-	-	F	-	-	R	-	-	-
**Ceratium tripos* (Miller) Nitzsch 1817	-	-	-	-	-	-	A	-	-	R	-	-
**Ceratium* sp. Schrank 1793	F	A	A	A	A	D	-	A	A	-	-	-
Centrodinium sp. Kofoid 1907	-	-	-	-	-	-	D	F	-	-	-	-
Cochlodinium sp. Schütt 1896	-	-	-	-	-	-	-	-	-	R	-	-
**Dinophysis caudata* Saville-Kent 1881	F	F	-	A	-	F	-	-	A	F	D	-
Dinophysis sp. Ehrenberg 1839	-	F	R	-	-	-	-	A	R	-	-	-
Gonyaulax polygramma Stein 1883	-	-	-	-	-	-	-	-	-	R	-	-
Gonyaulax spinifera (Claparède & Lachmann) Diesing 1866	-	F	-	-	-	-	-	-	-	-	-	-
Gonyaulax sp. Deising 1886	-	-	-	-	-	-	-	F	F	-	-	-
Gymnodinium catenatum Graham 1943	-	F	-	-	-	-	-	-	-	-	-	-
Gymnodinium sp. Stein 1878	A	A	D	A	-	F	A	A	R	R	-	D
Gyrodinium spirale (Bergh) Kofoid & Swezy 1921	F	-	-	-	-	-	-	-	-	-	-	-
**Noctiluca scintillans* (Macartney) Kofoid & Swezy 1921	-	F	-	-	D	-	A	-	A	R	-	-
Peridinium leonis Pavillard 1916	-	-	-	-	-	-	-	-	-	R	-	-
Peridinium oceanicum Vanttöffen 1897	-	A	-	-	-	-	-	-	-	-	-	-
**Peridinium* sp. Ehrenberg 1830	F	-	-	-	-	-	-	-	-	-	-	-
Phalacroma argus Stein 1883	-	-	-	-	-	-	-	-	-	R	-	-
Preperidinium sp. Mangin 1913	-	-	F	-	-	-	-	-	-	-	-	-
Prorocentrum sp. Ehrenberg 1834	F	R	F	A	-	-	-	A	-	-	-	-
**Protoperidinium depressum* (Bailey) Balech 1974	D	F	A	F	-	A	A	A	F	F	-	-
**Pyrophacus horologium* Stein 1883	-	-	-	-	-	-	-	-	-	R	-	-
Warnowia sp. Lindemann 1928	-	-	-	-	-	-	-	F	-	-	-	-
Cyanobacteria												
Agmenellum quadruplicatum (Meneghini) Brébissont 1839	-	-	D	R	-	-	-	-	-	-	-	-
Lyngbya sp. C. Agardh ex Gomont 1892	-	-	-	-	-	-	-	-	-	-	D	-
**Oscillatoria limosa* C. Agardh ex Gomont 1892	-	-	-	-	-	-	D	-	-	-	-	-
Oscillatoria sp. Vaucher ex Gomont 1892	-	-	-	D	-	-	-	-	-	-	-	A
**Trichodesmium* sp. Ehrenberg ex Gomont 1892	-	-	-	F	D	-	-	-	D	D	D	D

- = Absent, R = Rare, P = Present, F = Frequent, D = Dominant, A = Abundant, LT = Low tide, HT = High tide, JG = Junglighat, SC = Science Centre; Figured taxa are marked with asterisk.



Text-figure 2. a-f. Pie diagrams showing diversity of phytoplankton in Station 1. a. December 2010: low tide. b. December 2010: high tide. c. January 2011: low tide. d. January 2011: high tide. e. February 2011: low tide. f. February 2011: high tide. **g-l.** Pie diagrams showing diversity of phytoplankton in Station 2. g. December 2010: low tide. h. December 2010: high tide. i. January 2011: low tide. j. January 2011: high tide. k. February 2011: low tide. l. February 2011: high tide.

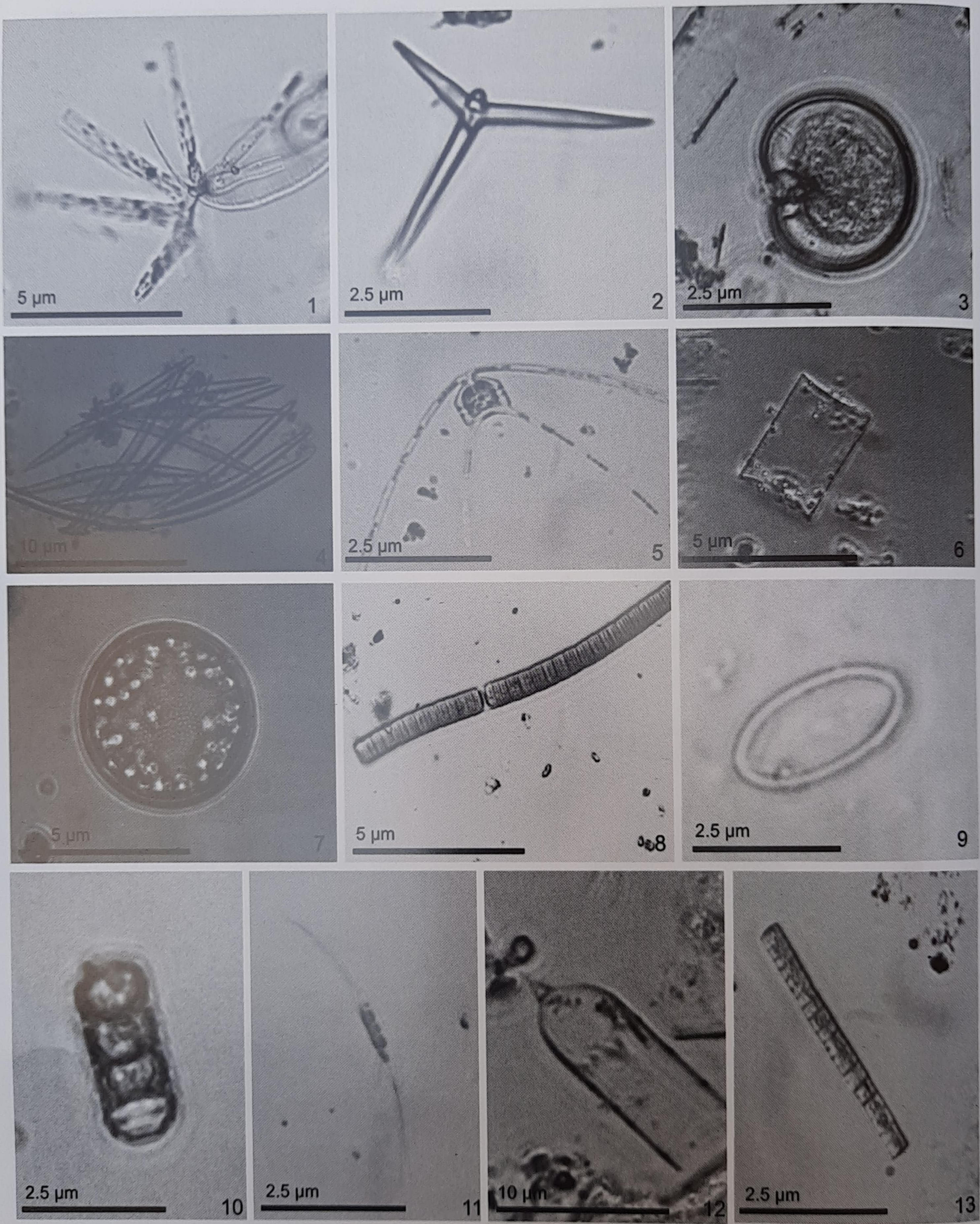


Plate 1

1. *Thallasiothrix nitzschiodes*. 2. *Phaeodactylum tricornutum*. 3. *Noctiluca scintillans*. 4. *Thallasiothrix longissima*. 5. *Chaetoceros peruvianus*. 6. *Guinardia flaccida*. 7. *Coscinodiscus* sp. 8. ?*Trichodesmium* sp. 9. *Coscinodiscus* sp. 10. ?*Melosira* sp. 11. *Nitzschia longissima*. 12. *Rhizosolenia* sp. 13. *Leptocylindrus* sp.

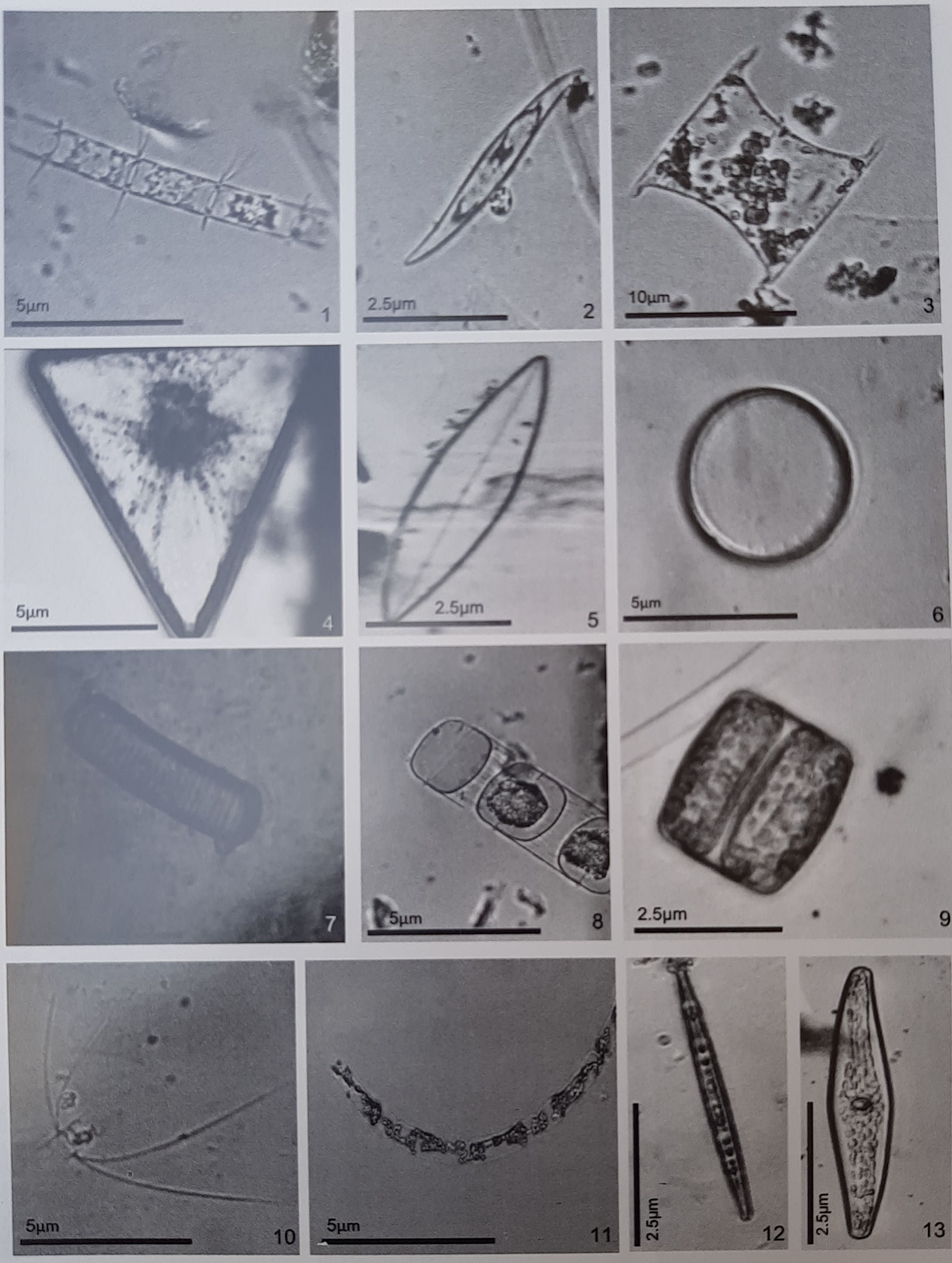


Plate 2

1. *Chaetoceros* sp. 2. *Pleurosigma* sp. 3. *Hemialus membranaceus*. 4. *Triceratium* sp. 5. *Navicula* sp. 6. ?*Thalassiosira* sp. 7. *Fragilliriopsis cylindrus*. 8. *Stephanopyxis* sp. 9. *Coscinodiscus* sp. 10. *Chaetoceros* sp. 11. *Guinardia striata*. 12. *Nitzschia* sp. 13. *Pleurosigma* sp.

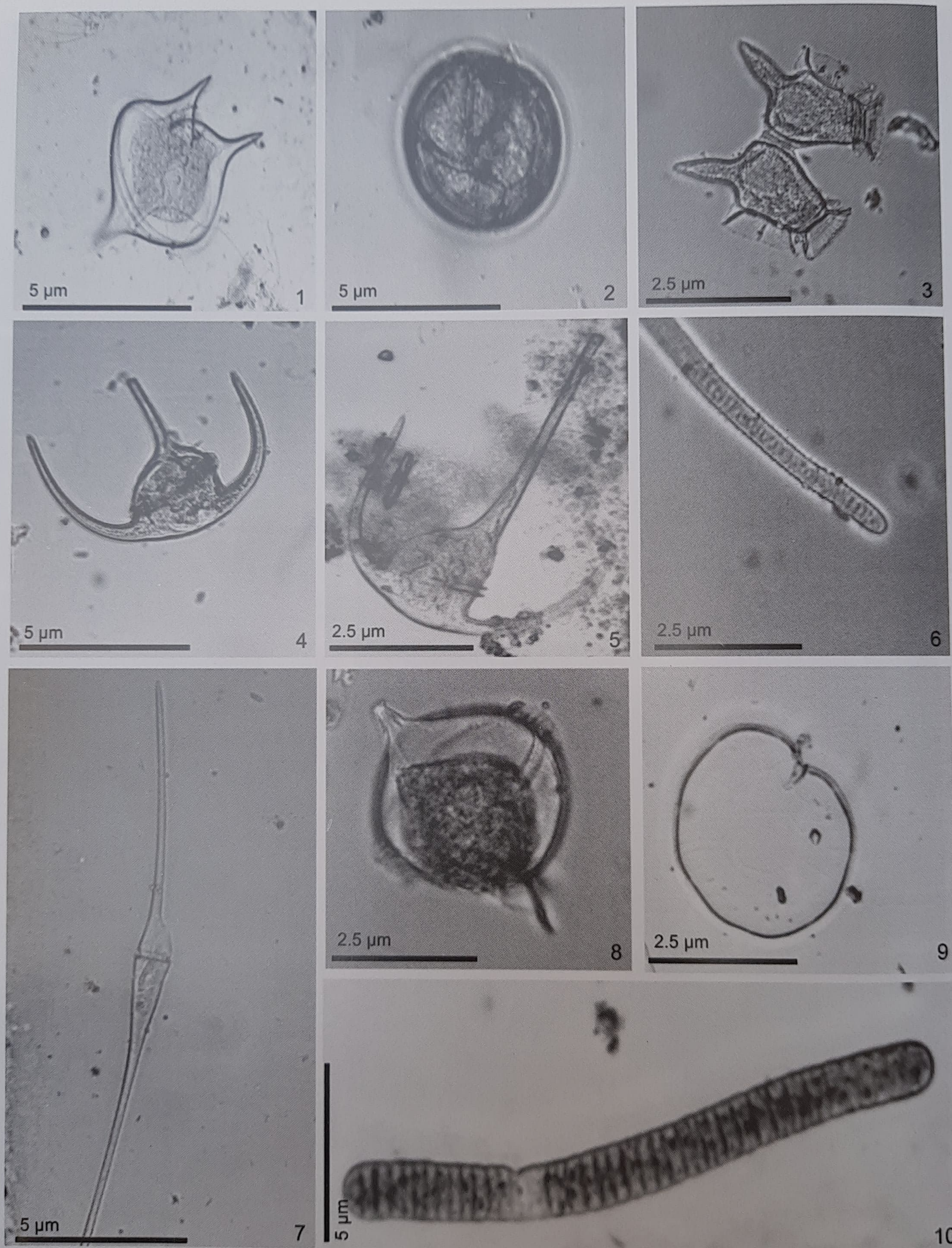


Plate 3

1. *Protoperidinium depressum*. 2. *Peridinium* sp. 3. *Dinophysis caudata*. 4. *Ceratium tripos*. 5. *Ceratium* sp. 6. *Trichodesmium* sp. 7. *Ceratium fusus*. 8. *Protoperidinium depressum*. 9. *Pyrophacus horologium*. 10. *Oscillatoria limosa*.

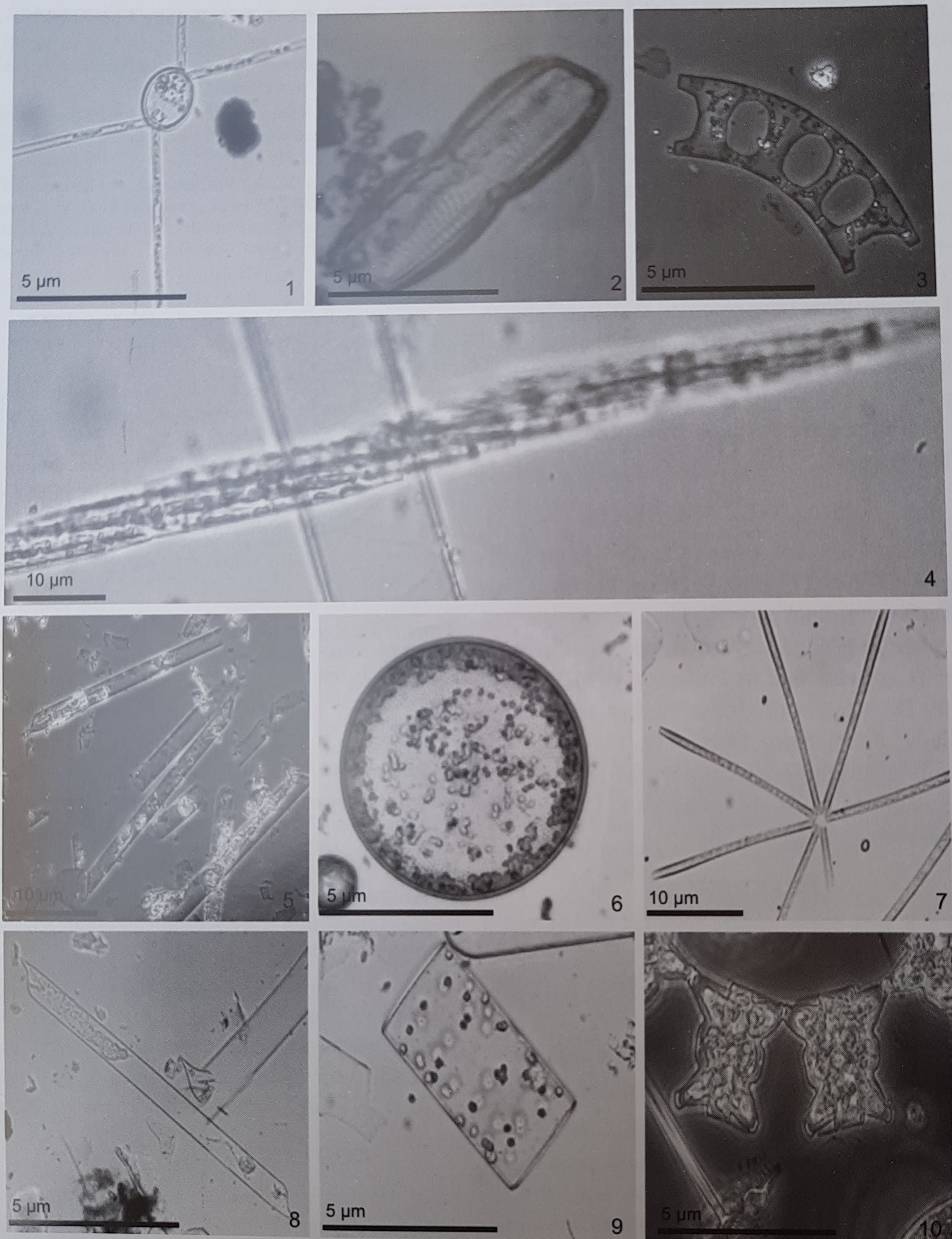


Plate 4

1. *Chaetoceros danicus*. 2. *Ceratium furca*. 3. *Eucampia* sp. 4. *Bacillaria paxillifera*. 5. *Rhizosolenia* sp. 6. *Coscinodiscus granii* 7. *Thalassiothrix frauenfeldii* 8. *Rhizosolenia hebetata* 9. *Guinardia* sp. 10. *Odontella* sp.

sp., *Leptocylindrus* sp. and *Thalassiothrix* sp., while amongst the dinoflagellates *Ceratium* sp., *Gymnodinium* sp., *Protoperidinium* sp., *Dinophysis caudata* and *Prorocentrum* sp. are commonly occurring forms. *Trichodesmium* sp., a cyanobacterium has been found preponderant in the studied samples (Table 1). The dominance of *Coscinodiscus* sp. and *Rhizosolenia* sp. has been observed in the post-monsoon period (Siva Sankar & Padmavati 2012). Maximum population density (11,790 cells/litre) was recorded at station 2 due to abundance of *Rhizosolenia* sp. It can be interpreted that various environmental parameters, such as temperature, salinity, and pH, are responsible for the dominance of these particular species in different time.

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