

## ON NEW DISTRIBUTIONAL RECORDS OF PLANKTON DIATOMS FROM THE INDIAN SEAS

C. P. GOPINATHAN

Central Marine Fisheries Research Institute, Cochin-682 018

### ABSTRACT

In this account 34 species of plankton diatoms identified from the collections made during the cruises of R. V. *Varuna* and from the collections of Cochin Backwater are described. Except one species, others are new distributional records from the Indian Seas. A brief remark on the distributional records of some of these diatoms is also presented.

### INTRODUCTION

QUALITATIVE studies of the phytoplankton of the oceanic regions of the west coast of India, based on the collections of R. V. *Varuna* and from the samples of the Cochin Backwater revealed some hitherto unrecorded planktonic diatoms from the Indian Seas. The marine collections were obtained from the area between latitude 07°00' to 16°00'N and longitude 71°00' to 77°00'E along the west coast of India during the period 1962-64. The estuarine samples were obtained from the Cochin Backwater, mainly from two stations; first at the 4-berth channel and the second away from the bar-mouth, during the year 1971. The collections were made by using a half metre bolting nylon net (No. 21, mesh size 0.069 mm) for the qualitative studies of phytoplankton.

Earlier taxonomic accounts on marine diatoms of the Indian Seas were Subrahmanyam (1946) for the east coast and Nair (1959) for the Trivandrum Coast. Subrahmanyam (1958) has published a checklist of 226 species from the Indian Seas. The 34 species belonging to 21 genera described here form a supplement to the above accounts. Except one species, all others have however, been checklisted by Wood (1963) from the Indian Ocean.

The author is grateful to Dr. S. Z. Qasim, former Director, for encouragement. He also wishes to express his sincere gratitude to Dr. E. G. Silas, Director, Central Marine Fisheries Research Institute, and Dr. P. V. Ramachandran Nair for going through the manuscript critically and offering advice and suggestions for improving this paper.

### LIST OF SPECIES

ORDER: CENTRALES  
SUB ORDER: DISCOIDEAE  
FAMILY: COSCINODISCEAE  
SUB FAMILY: MELOSIRINEAE

Genus *Melosira* Agardh  
*Melosira moniliformis* (Muller) Agardh  
Genus *Stephanopyxis* Ehrenberg  
*Stephanopyxis nipponica* Gran and Yendo

- SUB FAMILY: COSCINODISCINEAE  
 Genus *Coscinodiscus* Ehrenberg  
*Coscinodiscus nitidus* Gregory  
*Coscinodiscus reniformis* Castracane
- FAMILY: ACTINODISCEAE  
 SUB FAMILY: ASTEROLAMPRINEAE  
 Genus *Asteromphalus* Ehrenberg  
*Asteromphalus arachne* Brebisson  
 Genus *Asterolampra* Ehrenberg  
*Asterolampra dallassiana* Greville  
*Asterolampra marylandica* Ehrenberg  
*Asterolampra marylandica* var. *major* Peragallo
- FAMILY: EUPODISCEAE  
 SUB FAMILY: EUPODISCINEAE  
 Genus *Actinocyclus* Ehrenberg  
*Actinocyclus ralfsii* (Smith) Ralfs
- FAMILY: EUODIEAE  
 Genus *Hemidiscus* Wallich  
*Hemidiscus cuneiformis* Wallich
- SUB ORDER: SOLENOIDEAE  
 FAMILY: SOLENIEAE  
 SUB FAMILY: LAUDERINEAE  
 Genus *Lauderia* Cleve  
*Lauderia borealis* Gran
- FAMILY: LEPTOCYLINDRACEAE  
 Genus *Dactyliosolen* Castracane  
*Dactyliosolen mediterraneus* Peragallo
- SUB ORDER: BIDDULPHIOIDEAE  
 FAMILY: CHAETOCERAE  
 Genus *Chaetoceros* Ehrenberg  
*Chaetoceros concavicornis* Mangin  
*Chaetoceros pendulum* Karsten
- FAMILY: BIDDULPHIEAE  
 SUB FAMILY: BIDDULPHINEAE  
 Genus *Biddulphia* Gray  
*Biddulphia tridens* Ehrenberg
- SUB FAMILY: TRICERATOIDEAE  
 Genus *Hydrosera* Wallich  
*Hydrocera triquetra* Wallich
- ORDER: PENNALES  
 SUB ORDER: ARAPHIDINEAE  
 FAMILY: FRAGILARIOIDEAE  
 SUB FAMILY: TABELLARIEAE  
 Genus *Rhabdonema* Kützing  
*Rhabdonema adriaticum* Kützing  
 Genus *Thalassiothrix* Cleve and Grunow  
*Thalassiothrix mediterranea* Pavillard  
 Genus *Grammatophora* Ehrenberg  
*Grammatophora marina* (Lyngbye) Kützing  
*Grammatophora oceanica* Grunow
- SUB FAMILY: FRAGILARIEAE  
 Genus *Pseudoeunotia* Grunow  
*Pseudoeunotia doliofus* (Wallich) Grunow  
 Genus *Synedra* Ehrenberg  
*Synedra undulata* Gregory

SUB ORDER: BIRAPHIDEAE  
 FAMILY: NAVICULOIDEAE  
 SUB FAMILY: AMPHIPROROIDEAE

Genus *Amphiprora* (Ehrenberg) Cleve  
*Amphiprora alata* (Ehrenberg) Kützing  
 Genus *Tropidoneis* Cleve  
*Tropidoneis elegans* (W. Smith) Cleve

FAMILY: NITZSCHIACEAE  
 SUB FAMILY: NITZSCHIOIDEAE  
 Genus *Nitzschia* Hassall  
*Nitzschia linearis* (Agardh) W. Smith  
*Nitzschia vermicularis* (Kützing) Hantzsch

FAMILY: SURIRELLACEAE  
 SUB FAMILY: SURIRELLOIDEAE  
 Genus *Surirella* Turpin  
*Surirella recedens* A. Schmidt  
*Surirella splendida* (Ehrenberg) Kützing  
*Surirella gemma* (Ehrenberg) Kützing  
*Surirella tenera* Gregory  
*Surirella ovata* Kützing  
*Surirella linearis* W. Smith

SUB FAMILY: CAMPYLODISCOIDEAE  
 Genus *Campylodiscus* Ehrenberg  
*Campylodiscus echeneis* Ehrenberg  
*Campylodiscus clypeus* Ehrenberg

#### DESCRIPTIONS OF SPECIES

##### **Melosira moniliformis** (Müller) Agardh (Fig. 1c)

*Conferva moniliformis* Muller, 1783, p. 83, pl. 3, figs. 1-5.

*Melosira moniliformis* Agardh, 1824, p. 8; W. Smith, p. 56, pl. 50, fig. 330; Cupp, 1943, p. 39, fig. 1, Brunel, 1962, p. 31, pl. 8, fig. 5; Wood, 1963a, p. 162-163; Hendeby, 1964, p. 72, pl. 1, fig. 2.

Occurrence: *Varuna* st. No. 2097 (11°02'N and 75°13'E during February 1964).

Cells short and forms a small chain, valves circular, almost sub-hemispherical, girdles punctated; in valve view, puncta radiating from a small central hyaline area in short irregular lines; in girdle view, puncta on girdle arranged in transverse rows; in valve view, puncta on valve 20 in 10 $\mu$  and 14 in girdle view; chromatophores numerous; length of cell 124 $\mu$  and breadth 104 $\mu$ .

Distribution: Antarctic, N. America, British Coast, Java Sea, S. Africa, Australian waters and west coast of India.

##### **Stephanopyxis nipponica** Gran and Yendo (Fig. 1h)

*Stephanopyxis nipponica* Gran and Yendo, 1914, p. 43, fig. 5; Wood, 1963a, p. 273.

Occurrence: *Varuna* st. No. 1815 (15°50'N and 73°32'E during May 1963).

Cells oblong to spherical, united to form short chains; 6 to 8 spines present arising from top of cell and connecting adjacent cell forming a chain, with no line

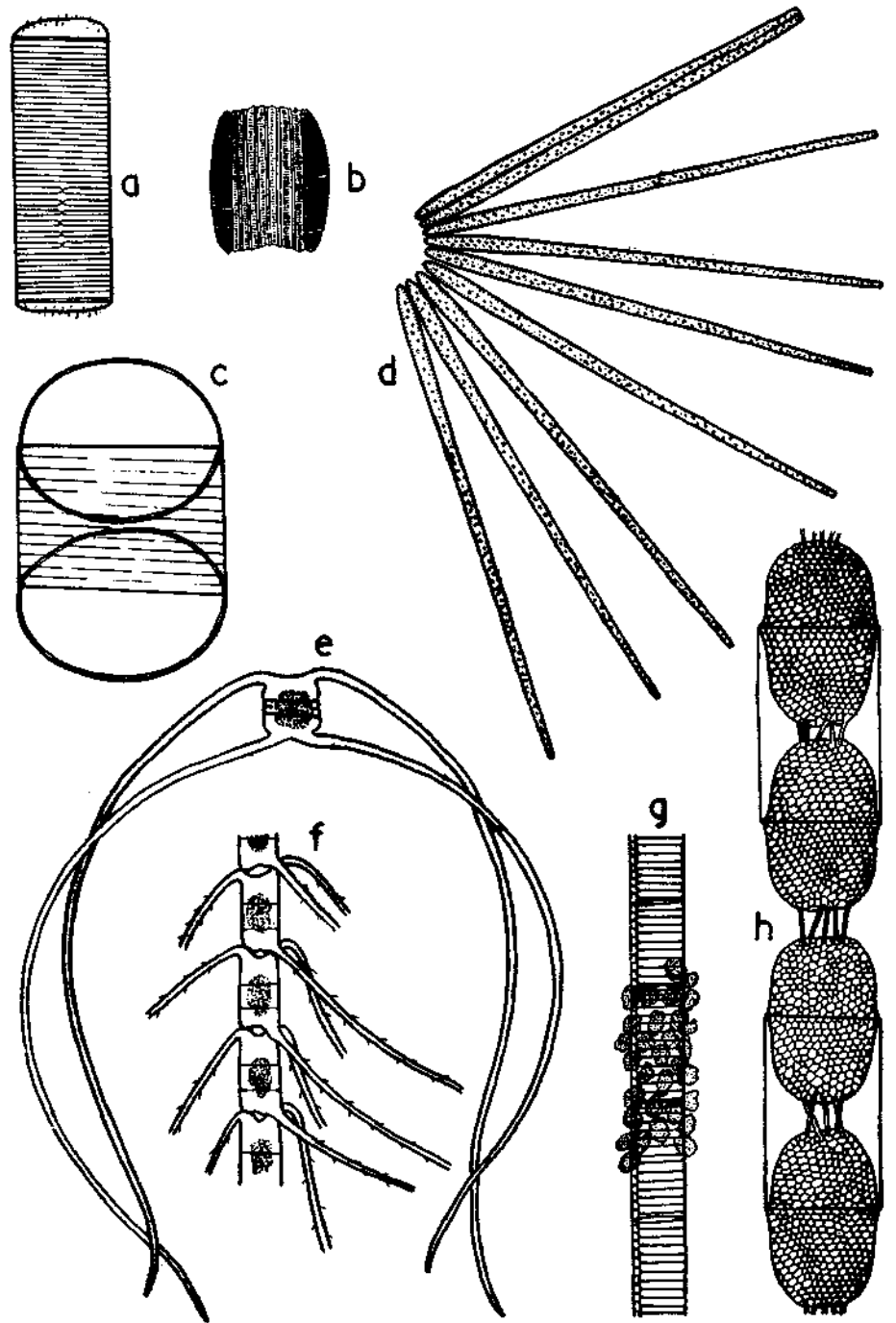


Fig. 1. a. *Lauderia borealis*; b. *Pseudoeunotia doliolus*; c. *Melosira moniliformis*; d. *Thalassiothrix mediterranea*; e. *Chaetoceros pendulum*; f. *Chaetoceros concavicornis*; g. *Dactyliosolen mediterraneus* and h. *Stephanopyxis nipponica*.

of fusion as in *S. palmariana*; valves with hexagonal or pentagonal areolae; areolae 6-8 in  $10\mu$ ; chromatophores numerous, small rounded bodies; length of cell  $185\mu$  and breadth  $54\mu$ .

Distribution: Arctic, west coast of N. America, British Coast, Japanese and Australian waters, Java Sea and west coast of India.

***Coscinodiscus nitidus* Gregory (Fig. 2e)**

*Coscinodiscus nitidus* Gregory, 1857, p. 27, pl. 2, fig. 45; A. Schmidt, 1878, pl. 58, figs. 17-19; Van Heurck, 1899, p. 532, pl. 23, fig. 667; Hustedt, 1927-30, p. 414, fig. 221; Cupp, 1943, p. 55, fig. 18; Wood, 1963 a, p. 86; Hendey, 1964, p. 76, pl. 23, fig. 12.

Occurrence: *Varuna* st. No. 2285 ( $08^{\circ}10'N$  and  $76^{\circ}55'E$  during May 1964).

Cells small and discoid, valves flat, covered with small granule-like structures in irregular radial arrangement; granules are large and rounded in centre and decrease in size at periphery; at margin of valve furnished with radial lines formed due to the small punctae, 2 to 3 punctae in each line; chromatophores numerous, present as plate-like bodies; diameter of the valve  $98\mu$ .

Distribution: Antarctic, N. America, British Coast, Mozambique Channel, Australian waters and west coast of India.

***Coscinodiscus reniformis* Castracane (Pl. II B, H and I)**

*Coscinodiscus reniformis* Castracane, 1886, p. 160, pl. 12, fig. 12.  
*Coscinodiscus stoschi* Witt in A. Schmidt, 1889, pl. 140, fig. 17.  
*Stoschia admirabilis* Janisch, 1890, pl. 1, figs. 1-5.  
*Stoschia janisch* Van Heurck, 1899, p. 537, fig. 283.  
*Stoschia reniformis* (Ratray) Heiden and Kolbe, 1928, p. 476.  
*Coscinodiscus reniformis* Wood, 1963b, p. 190, pl. 1, fig. 10; Sournia, 1970, p. 684.

Occurrence: *Varuna* st. Nos. 1815 to 2275 covering the region  $07^{\circ}00'$  to  $16^{\circ}00'N$  and  $70^{\circ}40'$  to  $76^{\circ}50'E$ ,

Cells kidney-shaped, valves flat, sculpture very distinct with strong meshes about same size from centre to margin; polygonal punctae radiate from centre to periphery; chromatophores numerous, rounded small bodies; length  $220-280\mu$  and breadth at centre  $104-120\mu$ .

Distribution: Arctic, Atlantic, Mediterranean Sea, Java Sea, British Coast, Australian waters and west coast of India.

***Asteromphalus arachne* Brebisson (Pl. II G)**

*Asteromphalus arachne* Brebisson, 1857, p. 296, pl. 3, fig. 1; Pritchard, 1861, p. 837, pl. 5, fig. 66; A. Schmidt, 1876, pl. 38, figs. 3-4.  
*Spatangidium arachne* Pavillard, 1925, p. 20, fig. 29.  
*Asteromphalus arachne* Wood, 1963 a, p. 31; Sournia, 1968, p. 547, pl. 9, fig. 60.

Occurrence: *Varuna* st. No. 2275 ( $07^{\circ}30'N$  and  $70^{\circ}35'E$  during May 1964).

Cells discoid, with circular or slightly ovoid outline; valves flat, areolated with five fine subequal distinct rays; narrow ray somewhat longer than others;

central field slightly excentric, one fourth to one third diameter of cell; diameter of cell  $115\mu$ , areolae rather large, compare to other *Asteromphalus* species, 6 in  $10\mu$ .

Distribution: Antarctic, Mediterranean Sea, Danish waters, N. America, S. Africa, Mozambique Channel, Sri Lanka, Australian waters and west coast of India.

***Asterolampra dallassiana* Greville (Pl. II A)**

*Asterolampra dallassiana* Greville, 1860, p. 115, pl. 4, fig. 10; A. Schmidt, 1890, pl. 137, fig. 18; Wood, 1963a, p. 31.

Occurrence: *Varuna* st. No. 2278 ( $08^{\circ}10'N$  and  $75^{\circ}20'E$  during May 1964).

Cells discoid, sharply divided into 10 definite sections by broad hyaline rays running from hyaline centre towards margin, all rays are of same width and inter-connected by straight lines into 10 parts as number of rays; segments between rays regularly areolated, with areolae in three line system; striae in middle 14 in  $10\mu$  and at margin 16 in  $10\mu$ ; diameter of cell  $85\mu$ .

Distribution: North Sea, Mediterranean Sea, N. America, Australian waters and west coast of India.

***Asterolampra marylandica* Ehrenberg (Fig. 2c)**

*Asterolampra marylandica* Ehrenberg, 1844, p. 76, fig. 10; A. Schmidt, 1886, pl. 137, figs. 19-21; Karsten, 1907, p. 151, pl. 38, fig. 1; Pavillard, 1925, p. 17, fig. 24; Cupp, 1943, p. 68, fig. 31; Wood, 1963a, p. 31; Sournia, 1970, p. 681.

Occurrence: *Varuna* st. No. 2282 ( $08^{\circ}10'N$  and  $76^{\circ}33'E$  during May 1964).

Cells disc-shaped with hourglass like arched valves and large hyaline middle region; at least one third diameter of valve divided into six or seven rays, same size and structure running from central region almost to edge of valve; segments between rays regularly areolated, areolae 16 in  $10\mu$ ; diameter of valve  $155\mu$ .

Distribution: Mediterranean Sea, Danish waters, Java Sea, N. America, British Coast, Mozambique Channel, Australian waters and west coast of India.

***Asterolampra marylandica* Ehrenberg var. *major* Peragallo (Fig. 2g)**

*A. marylandica* Ehrenberg var. *major* Peragallo, 1888, p. 7; Karsten, 1907, p. 151, pl. 53, fig. 10; Pavillard, 1925, p. 17, fig. 25.

Occurrence: *Varuna* st. No. 2278 ( $08^{\circ}10'N$  and  $75^{\circ}20'E$  during May 1964).

Cells disc shaped, sharply divided into seven sections by broad hyaline lines running from centre towards margin, rays all of same width and size; from forma *typica* it differs in its larger size and having always seven sectors; diameter of cell  $195-215\mu$ .

Distribution: Mediterranean Sea, Danish and Australian waters and west coast of India.

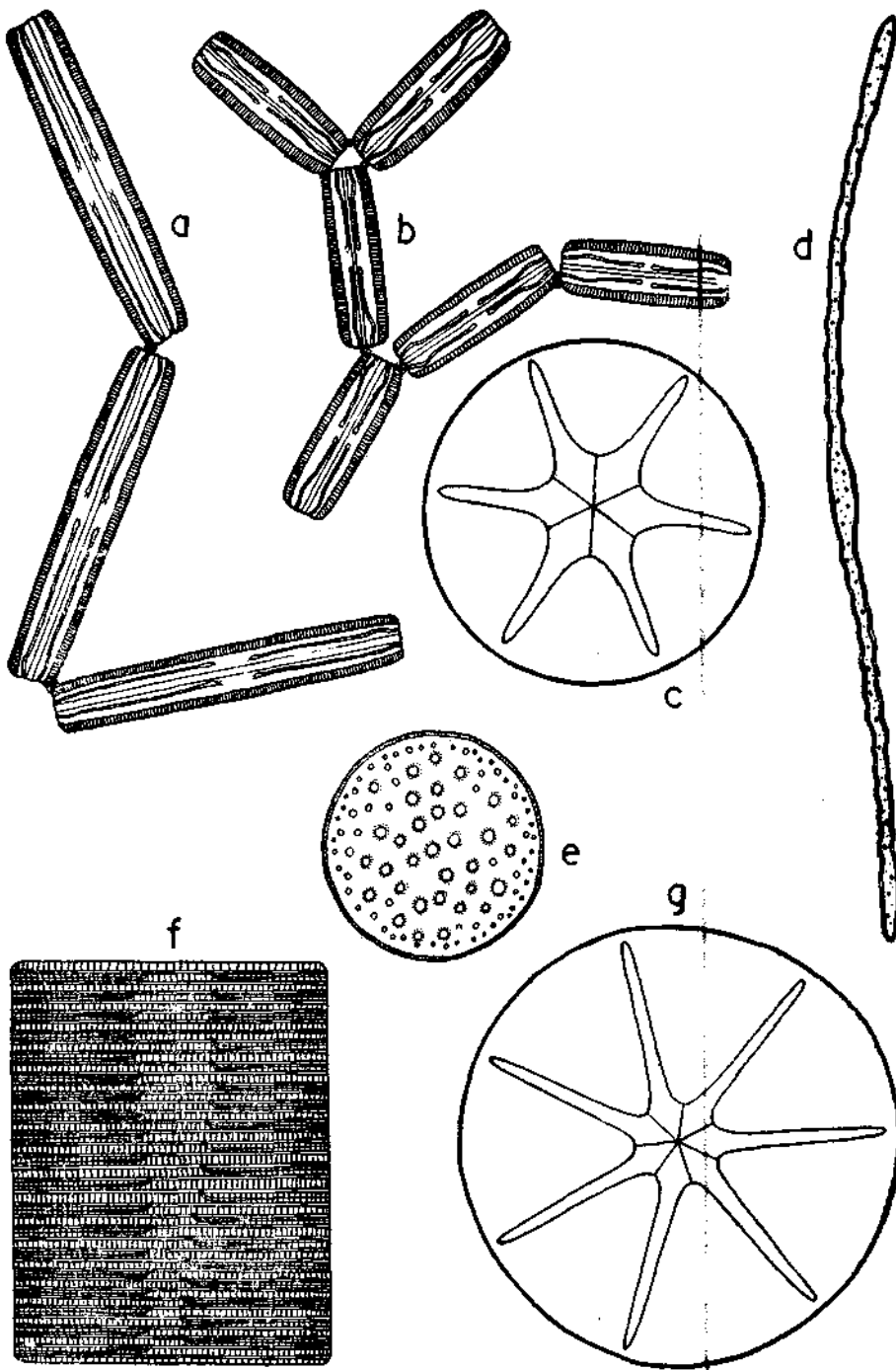


Fig. 2. a. *Grammatophora oceanica*; b. *Grammatophora marina*; c. *Asterolampra marylandica*; d. *Synedra undulata*; e. *Coscinodiscus nitidus*; f. *Rhabdonema adriaticum*; and g. *Asterolampra marylandica* var. *major*.

**Actinocyclus ralfsii** (W. Smith) Ralfs (Pl. II C)

*Eupodiscus ralfsii* W. Smith, 1856, p. 86.

*Actinocyclus ralfsii* Ralfs in Pritchard, 1861, p. 835; Van Heurck, 1899, p. 523, pl. 23, fig. 658; Karsten, 1928, p. 226, fig. 251b; Lebour, 1930, p. 54, pl. 2, fig. 2; Wood, 1963a, p. 11.

*Actinocyclus ehrenbergii* var. *ralfsii* (W. Smith) Hustedt, 1927-30, p. 528.

*Actinocyclus octanarius* var. *ralfsii* Hendey, 1964, p. 83, pl. 24, fig. 4.

Occurrence: *Varuna* st. No. 2211 (08°00'N and 77°00'E during April 1964).

Cells solitary, circular, walls thick with flat central part, valve surface punctate, central space small and filled with a few scattered punctae; valve surface divided by numerous radial striae and clearly marked fascicules of striae, in middle part with rather wide intervals forming a concentric zone, marginal zone with radial striations; diameter of cell 188 $\mu$ .

Distribution: North Sea, Mediterranean Sea, Norwegian Sea, Pacific Ocean, Java Sea, Australian waters and west coast of India.

**Hemidiscus cuneiformis** Wallich (Pl. II D-F)

*Hemidiscus cuneiformis* Wallich, 1860, p. 42, pl. 2, figs. 3-4; Cupp, 1943, p. 170, fig. 121; Wood, 1963a, p. 148-49; Hendey, 1964, p. 94, pl. 22, fig. 9; Sournia, 1970, p. 685.

*Euodia gibba* Van Heurck, 1899, p. 538, fig. 285.

*Euodia cuneiformis* (Wallich) Schütt, 1896, p. 100.

*Euodia radiata* Castracane, 1886, p. 150, pl. 12, fig. 4.

*Euodia gibba* (Bailey) Ralfs in Pritchard, 1861, p. 852.

*Euodia cuneiformis* Lebour, 1930, p. 55, pl. 2, fig. 4.

Occurrence: *Varuna* st. No. 1815 to 2275 covering the region 08°10' to 15°00'N and 70°40'E to 77°10'E during October to December 1963 and May 1964.

Valves semicircular, dorsal margin strongly convex and ventral margin almost straight or with a slight median inflation; sculpture on valve fine and hexagonal, arranged irregularly, radiating from centre to periphery; whole cell in girdle view appears as a sector of an orange; length of cell 115-180  $\mu$  and breadth 60-85  $\mu$ .

Distribution: Atlantic, Mediterranean Sea, North Sea, British Coast, Mozambique Channel, Australian waters, Java Sea and west coast of India.

**Lauderia borealis** Gran (Fig. 1a)

*Lauderia borealis* Gran, 1900, p. 110, pl. 9, figs. 5-9; 1905, p. 23, fig. 22; Karsten, 1928, p. 150, fig. 141; Lebour, 1930, p. 66, fig. 38; Cupp, 1943, p. 74, fig. 35; Wood, 1963, p. 152; Hendey, 1964, p. 143.

Occurrence: *Varuna* st. No. 2070 (09°30'N and 74°19'E during December 1963).

Cells situated close together to form small chains touching by their valve surface; cells cylindrical, valve surface with a slight central depression, but rounded at margin; valve surfaces with numerous small spinulae, marginal ones extending into straight gelatinous threads; longer reaching the adjacent cell; entire cell wall having intercalary bands; length of cell 133  $\mu$  and breadth 45 $\mu$ .



**Distribution:** North Atlantic, Mediterranean Sea, North Sea, Norwegian Sea, Java Sea, Australian waters and west coast of India.

***Dactyliosolen mediterraneus* Peragallo (Fig. 1g)**

*Dactyliosolen mediterraneus* Peragallo, 1892, p. 104, pl. 13, figs. 8-9; Pavillard, 1925, p. 23, fig. 34; Lebour, 1930, p. 76, fig. 51; Cupp, 1943, p. 77, fig. 38; Wood, 1963a, p. 105; Hendey, 1964, p. 142; Sournia, 1970, p. 684.

**Occurrence:** *Varuna* st. No. 2095 (11°28'N and 74°44'E during February 1964).

Cells cylindrical, united to form chains and with numerous intercalary bands; valves having irregular areolae, intercalary bands 4-5 in 10 $\mu$  on valve, also having fine sub-rectangular areolation; chromatophores numerous. Cells with an epiphytic flagellate, *Solenicola setigera* attached on chains in girdle band zone; length of cell 50  $\mu$  and breadth 23  $\mu$ .

**Distribution:** North Atlantic, Mediterranean Sea, North Sea, N. America, Danish waters, British Coast, Java Sea, Australian waters and west coast of India.

***Chaetoceros concavicornis* Mangin (Fig. 1f)**

*Chaetoceros concavicornis* Mangin, 1917, pp. 704, 770, figs. 5-7; Hustedt, 1927-30, p. 665, fig. 376; Lebour, 1930, p. 122, fig. 88; Cupp, 1943, p. 109, fig. 66a-c; Wood, 1963a, p. 59; Hendey 1964, p. 122, pl. 9, fig. 1.

**Occurrence:** *Varuna* st. 2008 (09°04'N and 74°40'E during November 1963).

Cells united to form straight chains; valves elliptical to circular, upper valve rounded with higher cylindrical valve mantle and setae emerging from the centre of valve, lower having a flat surface, with setae emerging from valve margin; setae of both valves divided in sweeping concave curves to lower end of chain, curving inward; length of cell 30  $\mu$  and breadth 18  $\mu$ .

**Distribution:** Arctic, Norwegian Sea, North Sea, N. America, British Coast, Australian waters and west coast of India.

***Chaetoceros pendulum* Karsten (Fig. 1e)**

*Chaetoceros pendulum* Karsten, 1905, p. 118, pl. 15, figs. 7, 7a; Wood, 1963a, p. 65.  
*Chaetoceros pendulus* Cupp, 1943, p. 114, fig. 69.

**Occurrence:** *Varuna* st. No. 2260 (10°00'N and 75°40'E during May 1964).

Cells solitary, valves somewhat dissimilar, upper with deep depression in centre, lower with projecting corners; setae large, entirely smooth, running from valve diagonally to basal part, curving, crossing two setae of one side; chromatophores small, numerous; length of cell excluding setae 32  $\mu$  breadth 25  $\mu$ . This species easily confused with *C. peruvianus*.

**Distribution:** Antarctic, Danish waters, N. America, Mozambique Channel, Australian waters and west coast of India.

***Biddulphia tridens* Ehrenberg (Pl. I E)**

*Biddulphia tridens* Ehrenberg, 1840, p. 205; Wood, 1963a, p. 45; Sournia, 1968, p. 27, pl. 5, fig. 33 et pl. 12, fig. 83.

*Biddulphia tuomeyi* Roper, 1859, p. 8, pl. 1, figs. 1-2; A. Schmidt, 1886, pl. 119, fig. 1; Van Heurck, 1899, p. 471, pl. 34, fig. 895.

*Biddulphia tuomeyi* var. *pacifica* Castracane, 1886, p. 106, pl. 30, fig. 6.

Occurrence: Cochin Backwater.

Valves elliptical with three globular processes besides two linear side processes; middle large process has got a short horn on each valve; chromatophores numerous rounded bodies. Cells usually in chains formed by attachment of individual cells with mucilage pads at blunt end of their side processes; surface of valve finely striated; length of individual valve 180 $\mu$  and breadth 93 $\mu$ .

Distribution: Antarctic, Mediterranean Sea, North Sea, Java Sea, S. Africa, Australian waters and Cochin Backwater, India.

#### ***Hydrosera triquetra* Wallich (Pl. IF)**

*Hydrosera triquetra* Wallich, 1858, p. 247; A. Schmidt, 1882, pl. 78, fig. 38; Wood, 1963a, p. 151.

Occurrence: Cochin Backwater.

Frustule six cornered, appearing as two *Triceratium* valves overlapping but not in juxtaposition; corners rounded, cell walls areolated, areolae polygonal, 12-14 in 10  $\mu$ ; length and breadth of valve 162 to 168  $\mu$ .

Distribution: Atlantic, North Sea, Mediterranean Sea, Java Sea, Australian waters and Cochin Backwater, India.

#### ***Rhabdonema adriaticum* Kutzing (Fig. 2f)**

*Rhabdonema adriaticum* Kutzing, 1844, p. 126, pl. 18, fig. 7; W. Smith, 1856, p. 35, pl. 38, fig. 305b; Van Heurck, 1899, p. 360, pl. 12, fig. 486a; Karsten, 1928, p. 252, figs. 318 a-d; Lebour, 1930, p. 202, fig. 164; Wood, 1963a, p. 252; Hendey, 1964, p. 172.

Occurrence: *Varuna* st. No. 2283 (08°10'N and 76°41'E during May 1964).

Cells conical, united to form flat ribbon-like bands, lying in girdle view: cells rectangular, with rounded corners, valves linear, elliptical, surface striate with transverse striae, 6 in 10 $\mu$ ; length of colony 186  $\mu$  and breadth 142  $\mu$ .

Distribution: Atlantic, Pacific, N. America, British Coast, North Sea, Australian waters and west coast of India.

#### ***Thalassiothrix mediterranea* Pavillard (Fig. 1d)**

*Thalassiothrix mediterranea* Pavillard, 1916, p. 39, pl. 2, fig. 3; Cupp, 1943, p. 185, fig. 136; Wood, 1963a, p. 296.

Occurrence: *Varuna* st. No. 1902 (08°29'N and 76°52'E during September 1963).

Cells are slender and long, united into a star or fan-shaped colonies by valve surfaces of wedge-shaped point; cells very linear, basal part slightly wedge-shaped, but pointed; valve surface and mantle delicately striated; pseudoraphe very faint, chromatophores numerous small rounded bodies. Differs from *T. longissima*

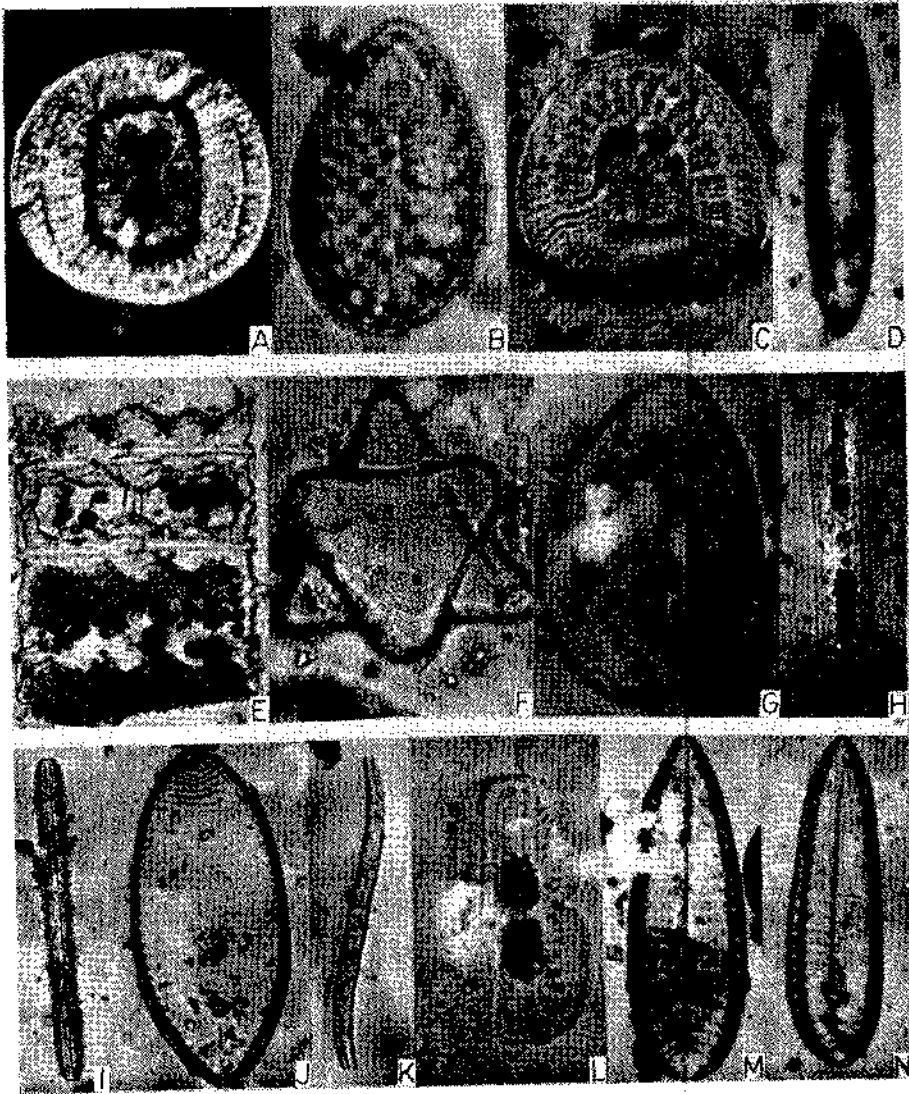


Plate I. A. *Campylodiscus elypeus*; B. *Sarirella recedens*; C. *Campylodiscus echenis*; D. *Sarirella linearis*; E. *Biddulphia tridens*; F. *Hydrosera triquetra*; G. *Sarirella ovata*; H. *Tropidoneis elegans*; I. *Nitzschia linearis*; J. *Sarirella gemma*; K. *Nitzschia vesiculata*; L. *Amphiprora alata*; M. *Sarirella splendida* and N. *Sarirella tenera*.

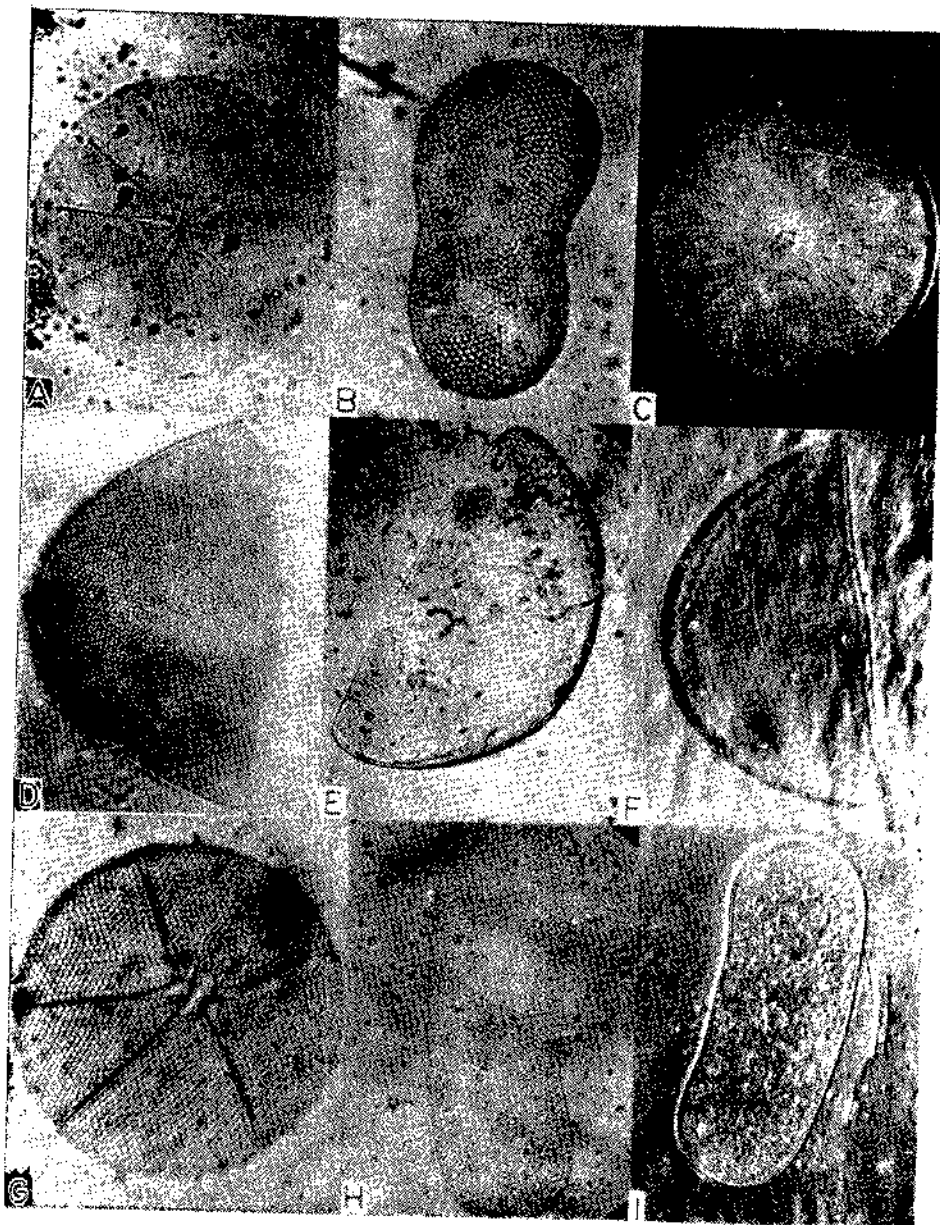


Plate II. A. *Asterolampra dallasiensis*; B, H and I, *Coscinodiscus reniformis*; C. *Actinoevelus ralfsii*; D, E and F, *Hemidiscus sinuiformis*; and G, *Asteromphalus arachne*.

mainly by coarse striation and large size; striae 18 in 10  $\mu$ , length of one cell 215  $\mu$  and breadth 6-8  $\mu$ .

Distribution: Arctic, North Sea, N. America, British Coast, Australian waters and west coast of India.

**Grammatophora marina** (Lyngbye) Kutzing (Fig. 2b)

*Diatoma marinum* Lyngbye, 1819, p. 180.

*Grammatophora marina* Kutzing, 1844, p. 128, pl. 17, fig. 24, pl. 18, fig. 1, 1-5; Van Heurck, 1899, p. 354, pl. 11, fig. 479; Karsten, 1928, p. 256, fig. 323 a-b; Lebour, 1930, p. 202, fig. 163a; Cupp, 1943, p. 174, fig. 125 a-b; Wood, 1963a, p. 144; Hendey, 1964, p. 170.

Occurrence: *Varuna* st. No. 2210 (08°00'N and 77°12'E during April 1964).

Cells in girdle view oblong, united by their opposite and alternate edges to form a zig-zag chains; valves relatively broad, linear, ends broadly widened, slightly inflated in middle; valve surface striate, striae 16 in 10  $\mu$ ; girdle view show septa which have a single undulation close to girdle; frustules usually lie in girdle view; chromatophores numerous small rounded bodies; length of cell 80  $\mu$  and breadth 20  $\mu$ .

Distribution: North Atlantic Coast, British Coast, North Sea, Mediterranean Sea, N. America, Australian waters and west coast of India.

**Grammatophora oceanica** Grunow (Fig. 2a)

*Grammatophora oceanica* Grunow, 1881, p. 9; Cupp, 1943, p. 176, fig. 126; Wood, 1963, p. 145.

Occurrence: *Varuna* st. No. 2601 (09°00'N and 76°09'E during September 1964).

Cells in girdle view similar to *G. marina*, but slightly wider at centre than at ends, valve narrow linear to linear-lanceolate with blunt-rounded ends; valves punctated, 18 in 10  $\mu$ ; pseudoraphe very narrow, central area of valve with hyaline lines; length of cell 155  $\mu$  and breadth 28  $\mu$ .

Distribution: Antarctic, North Sea, N. Atlantic, Mediterranean Sea, N. America, Australian waters and west coast of India.

**Pseudoeunotia doliolus** (Wallich) Grunow (Fig. 1b)

*Synedra doliolus* Wallich, 1860, p. 48, pl. 2, fig. 19.

*Pseudoeunotia doliolus* Grunow, 1884, pl. 35, fig. 140; Cupp, 1943, p. 190, fig. 140; Wood, 1963a, p. 251; Sournia, 1970, p. 686.

Occurrence: *Varuna* st. No. 1990 (12°38'N and 74°06'E during October 1963).

Cells cylindrical, united by their valve surfaces to form barrel-shaped colony; cells in ventral view linear, dorsal, with slightly convex margins; valve surface with transapical ribs with membrane lying between ribs and delicately areolated; pseudoraphe and central area absent; length of cell 65  $\mu$  and breadth 60  $\mu$ .

Distribution: Antarctic, Far East, west coast of N. America, Danish waters, Java Sea, Mozambique Channel, Australian waters and west coast of India.

*Synedra undulata* Gregory (Fig. 2d)

*Synedra undulata* Gregory, 1877, p. 53, pl. 14, fig. 107; Van Heurck, 1899, p. 317, pl. 10, fig. 437; Karsten, 1928, p. 285, fig. 347; Capp, 1943, p. 181, fig. 132; Wood, 1963a, p. 296; Sourin, 1970, p. 188.

Occurrence: *Varuna* st. No. 1483 (07° 30'N and 77° 03'E during October 1964).

Cells very slender, long and narrow, solitary, with undulating or wavy margins on valve, prominent in middle but ends somewhat bulging; transapical striae short, distinctly punctated, pseudotaxial indistinct; central area hyaline; length of cell 415  $\mu$  and breadth 5.8  $\mu$ .

Distribution: Atlantic, North Sea, Pacific, Mediterranean Sea, Java Sea, N. America, Mozambique Channel, Australian waters and west coast of India.

*Amphiprora alata* (Ehrenberg) Kutzing (Pl. I L)

*Navicula alata* Ehrenberg, 1861, p. 237.

*Amphiprora alata* Kutzing, 1842, p. 197, pl. 3, fig. 63; W. Smith, 1853, p. 44, pl. 15, fig. 124; Van Heurck, 1899, p. 292, pl. 5, fig. 289; Karsten, 1928, p. 283, fig. 383c; Hustedt, 1930, p. 339, fig. 625; Wood, 1963a, p. 15; Hovey, 1964, p. 253, pl. 39, fig. 14-16.

Occurrence: Cochin Backwater during June-July 1971.

Cells broad and elliptical, spirally twisted in the pattern of '8'; frustule ends broad and round, striae on cells curved and connecting zone with numerous longitudinal hyaline lines, girdle composed of numerous narrow bands; chromatophores present as two small bodies; striae on cell 7 in 10 $\mu$ ; length of valve 131  $\mu$  and breadth 87  $\mu$ .

Distribution: Sumatra, Java, Western Bass Strait, Antarctic, S. Africa and Cochin Backwater, India.

*Tropidoneis elegans* (W. Smith) Cleve (Pl. IH)

*Amphiprora elegans* W. Smith, 1856, p. 96.

*Plagiogramma elegans* Grunow, Van Heurck, 1899, p. 265, fig. 54.

*Tropidoneis elegans* Cleve, 1874, p. 27; Wood, 1963a, p. 303; Hovey, 1964, p. 255.

Occurrence: Cochin Backwater during July-August 1971.

Frustule valve cylindrical, rectangular, broad and rounded ends with a median narrow constriction; median connecting zone has longitudinal hyaline parallel lines reaching both ends. The marginal striae transverse, very distinct about 16 in 10 $\mu$ , not reaching central connecting zone; no true keel punctae; chromatophores present as two rounded bodies; length of valve 212  $\mu$ , breadth 50  $\mu$ .

Distribution: North Sea, Norway and British Coast, Java Sea, Australian waters and Cochin Backwater, India.

***Nitzschia linearis* (Agardh) W. Smith (Pl. I 1)**

*Frustulia linearis* Agardh in W. Smith, 1853, p. 39, pl. 13, fig. 110.

*Nitzschia linearis* Van Heurck, 1899, p. 399, pl. 16, fig. 542; Hustedt, 1930, p. 410, fig. 784; Wood, 1963a, p. 213.

Occurrence: Cochin Backwater during June 1971.

Valves linear, cylindrical, straight with parallel sides and rounded ends; ends of cell in valve view extended into long beaks, slightly curved; keel punctae and transapical striae present on the margins; keel punctae 7-8 in 10 $\mu$ ; transapical striae 18 in 10 $\mu$ ; length of valve 690  $\mu$ , breadth 58  $\mu$ .

Distribution: Atlantic, North Sea, Mediterranean waters, British Coast, Java Sea, Sri Lanka, Australian waters and Cochin Backwater, India.

***Nitzschia vermicularis* (Kützing) Hantzsch (Pl. I K)**

*Synedra vermicularis* Kützing, 1844, p. 67.

*Nitzschia vermicularis* Hantzsch in Rabenhorst, 1864, pl. 1, fig. 155; Van Heurck, 1899, pl. 395, p. 16, fig. 529; Hustedt, 1930, p. 419, fig. 811; Wood, 1963a, p. 224.

Occurrence: Cochin Backwater, during July-August 1971.

Frustule long and cylindrical, slightly curved on both sides in opposite directions in valve view; central area having parallel lines all along valve; transverse striae present on two sides of valve intermingled with keeled punctae; keel punctae 8 in 10 $\mu$ ; transapical striae 20 in 10 $\mu$ ; length of valve 325 to 425  $\mu$ , breadth 19 to 22  $\mu$ .

Distribution: Arctic, North Sea, British Coast, Java Sea, East coast of S. Africa, Burmese and Australian waters and Cochin Backwater, India.

***Surirella recedens* A. Schmidt (Pl. IB)**

*Surirella recedens* A. Schmidt, 1875, pl. 19, fig. 2-4; pl. 24, fig. 28.

*Surirella fastuosa* var. *recedens* (A. Schmidt) Cleve, Cupp, 1943, p. 208, fig. 160; Wood, 1963b, p. 281, pl. 12, fig. 237.

Occurrence: Cochin Backwater, during June 1971.

Frustule in valve view ovate to broadly elliptical, valves with costae inflated at margins, tapering to a central area which is lanceolate and hyaline, faintly striated; striae more evident on margins where costae starts but towards centre not well defined; 27 costae present on valve; girdle view shows a distinct median zone; length of valve 118 $\mu$  and breadth 57  $\mu$ .

Distribution: New record for the Indian Ocean. Other records: N. America, Philadelphia and Texas Bay.

***Surirella splendida* (Ehrenberg) Kutzing (Pl. I M)***Navicula splendida* Ehrenberg, 1845, p. 156.*Surirella splendida* Kutzing, 1845, p. 62; Kützinger, 1858, p. 298, fig. 409a; Wood, 1963a, p. 284.*Surirella tenera* var. *spendida* A. Schmidt, 1875, pl. 23, fig. 5.*Surirella robusta* var. *spendida* A. H. Heurck, 1899, p. 371, pl. 12, fig. 578; Hustedit, 1930, p. 437, fig. 851-852.

Occurrence: Cochin Backwater, during April-June 1971.

Valves elliptical, linearly rounded extremities, costae numerous, central space cylindrical; all costae are projecting towards central space, which is linear and cylindrical, attenuated towards ends; marginal punctae distinct; length of valve 181  $\mu$ , breadth 56  $\mu$ .

Distribution: North Sea, Mediterranean Sea, Java Sea, Danish waters, British coast, Australian waters and Cochin Backwater, India.

***Surirella gemma* (Ehrenberg) Kutzing (Pl. I J)***Navicula gemma* Ehrenberg, 1845, p. 156, pl. 4, fig. 6.*Surirella gemma* Kutzing, 1845, p. 62, fig. 11; W. Smith, 1853, p. 32, pl. 9, fig. 65; Van Heurck, 1899, p. 372, pl. 12, fig. 582; Pavillard, 1925, p. 63, fig. 115; Wood, 1963a, p. 280; Hendey, 1967, p. 26, pl. 40, fig. 5; pl. 42, fig. 4.

Occurrence: Cochin Backwater, during April-May 1971.

Valves elliptical, oval, costae numerous projecting from margin, more or less alternate and at irregular intervals; axial area very narrow; marginal striae visible; length of valve 182  $\mu$ , breadth 93  $\mu$ .

Distribution: North Sea, Mediterranean Sea, Java Sea, Danish waters, British Coast, Australian waters and Cochin Backwater, India.

***Surirella tenera* Gregory (Pl. I N)***Surirella tenera* Gregory, 1876, p. 11; A. Schmidt, 1875, pl. 23, fig. 9; Hustedit, 1930, p. 438, fig. 853.

Occurrence: Cochin Backwater, during August 1971.

Valves narrowly elliptical, rounded at one end and acute at the other; central space narrow, costae indistinct or faint, touching central space; marginal striae also visible; length of valve 187  $\mu$ , breadth 62  $\mu$ .

Distribution: Antarctic, Mediterranean Sea, Java Sea, British Coast, Australian waters and Cochin Backwater, India.

***Surirella ovata* Kutzing (Pl. I G)***Surirella ovata* Kutzing, 1845, p. 62; A. Schmidt, 1875, pl. 23, figs. 49-55; Hustedit, 1930, p. 442, fig. 864; Wood, 1963b, p. 281, pl. 12, fig. 239; Hendey, 1964, p. 287, pl. 40, figs. 7-9.*Surirella ovalis* var. *ovata* A. H. Heurck, 1899, p. 373, pl. 13, fig. 587.



Occurrence: Cochin Backwater, during July 1971.

Valves ovate, one end broad and the other acute, costae short, marginal, radial and unequal, central space rather indistinct; striations in between costae fine and arranged parallel to costae; length of valve 118  $\mu$ , breadth 75  $\mu$ , costae 34 in number, striae 15 in 10  $\mu$ .

Distribution: Antarctic, North Sea, Mediterranean Sea, British Coast, Java Sea, Australian waters and Cochin Backwater, India.

***Suirella linearis* W. Smith (Pl. ID)**

*Suirella linearis* W. Smith, 1853, p. 31, pl. 8, fig. 58a; Van Heurck, 1899, p. 370, pl. 31, fig. 864; Hustedt, 1930, p. 434, fig. 837.

Occurrence: Cochin Backwater, during July 1971.

Frustule elliptical, linear, apical ends acute and equal middle portion of valve margin straight; costae numerous arising from margin transverse to central space which is linear and hyaline; length of valve 430  $\mu$ , breadth 81  $\mu$ .

Distribution: Antarctic, Mediterranean Sea, British Coast, Java Sea, Australian waters and Cochin Backwater, India.

***Campylodiscus echeneis* Ehrenberg (Pl. IC)**

*Campylodiscus echeneis* Ehrenberg, 1840, p. 206; Van Heurck, 1899, p. 377, pl. 14, fig. 60; Karsten, 1928, p. 299, fig. 411a; Wood, 1963a, p. 51; Hendeby, 1964, p. 291, pl. 40, fig. 14.

*Campylodiscus cribrus* W. Smith, 1853, p. 29, pl. 9, fig. 50.

Occurrence: Cochin Backwater, during June-July 1971.

Cells solitary, valves partially circular, one side slightly broad, costae indistinct, short and marginal; punctae are in rows radiating from margin towards centre, rounded or elongated, unequal at irregular intervals, marginal punctae closely arranged than inner ones; central hyaline area present with a few scattered punctae; chromatophores two large irregularly shaped bodies; length of valve 120  $\mu$ , breadth 125  $\mu$ .

Distribution: Atlantic, Mediterranean Sea, North Sea, British Coast, Java Sea, Australian waters, Mozambique Channel and Cochin Backwater, India.

***Campylodiscus clypeus* Ehrenberg (Pl. IA)**

*Campylodiscus clypeus* Ehrenberg, 1840, p. 205; Van Heurck, 1899, p. 377, pl. 14, fig. 598; Wood, 1963a, p. 50.

Occurrence: Cochin Backwater, during July 1971.

Valves in this species more or less circular; cellular disc converges towards centre, but leave space as a ring, after projecting from margin; characteristic of this species is a centrally placed non-cellular hyaline area; striae loosely arranged towards

centre, while at margins they are closely arranged. *C. clypeus* closely resembles *C. echeneis*. Diameter of valve 106  $\mu$ .

Distribution: Antarctic, Atlantic, Mediterranean Sea, British Coast, Java Sea, S. African Coast, Australian waters and Cochin Backwater, India.

#### REMARKS

One noteworthy feature of this account is the record of *Surirella recedens*, a brackish water species from the Cochin Backwater, as it is a new record for the Indian Ocean. Previous records of *S. recedens* were those of Boyer (1916) from the vicinity of Philadelphia, Cupp (1943) from the west coast of N. America and Wood (1963b) from the sediments of Texas Bays in Pacific Ocean. Similarly *Asterolampra marylandica* and *A. marylandica* var. *major* are rare records for the Indian Ocean. Previous records of these diatoms were by Karsten (1907) from the western Indian Ocean and Pavillard (1925) from the Mediterranean Sea. The records of *Stephanopyxis nipponica*, *Pseudoeunotia doliolus*, *Thalassiothrix mediterranea*, *Coscinodiscus reniformis* and *Asterolampra dallassiana* are also significant, because they have been observed previously only from the Australian waters (Wood, 1963 a). The records of *Hydrosera triquetra* and *Surirella ovata* from the Cochin Backwater are also of interest, because the previous records were those of Hustedt (1938) from the Indonesian waters and Wood (1963 a) from the southern Indian Ocean for the former species and Leuduger-Fortmorel (1893) for the latter from the Java Sea.

#### REFERENCES

- AGARDH, C. A. 1824. *Systema algarum*, Lund. Literis Berlingianis, 38: 1-312.
- BREISSON, A. DE. 1857. Description de quelques nouvelles diatomées observées dans le guano de Pérou, et formant le genre *Spatangidium*. *Bull. Soc. Linn. Normandie*, 2 : 296-298.
- BOYER, C. S. 1916. *The diatomaceae of Philadelphia and vicinity*. Philadelphia.
- BRUNEL, J. 1962. Le phytoplankton de la Baie des Chaleurs. *Contrib. Inst. Bot. Univ. Montral*, 77: 1-365.
- CASTRACANE, A. F. 1886. Report on the Diatomaceae. Report on the scientific results of the voyage of *H. M. S. Challenger* during the years 1873-76. *Challenger Reports*, Botany, 2.
- CLEVE, P. T. 1894. Planktonundersökningar. Cilioflagellater og Diatomaceer. *Bih. svensk. Vetensk Akad. Handl.*, 20 (3, 2).
- CUPP, E. E. 1943. Marine plankton diatoms of the west coast of North America. *Bull. Scripps. Inst. Oceanogr. Univ. Calif.*, 5 (1); 1-238.
- Ehrenberg, C. G. 1840. Hr. E. legte hierauf 274 Blätter von ihm selbst ausgeführter Zeichnungen von eben so vielen Arten. *Ber. Akad. Wiss. Berlin*, 197-219.
- 1844. Über 2 neue Lager von Gebirgsmassen aus Infusorien als Meeres-Absatz in Nord-Amerika und eine Vergleichung derselben mit den organischen Kreide-Gebilden in Europa und Afrika. *Ber. Akad. Wiss. Berlin*, 57-97.
- GRAN, H. H. 1900. Bemerkungen über einige Planktondiatomeen. *Nyt. Mag. Naturv.*, 38(2): 103-128.
- AND K. YENDO 1914. Japanese diatoms. 1. *Chaetoceros*. 2. On *Stephanopyxis*. *Vidensk. Skrifter. Mat-Naturv.* 8 : 1-29.

- GREGORY, W. 1856. On the post-tertiary diatomaceous sand of Gt. Shira. *Trans. Soc. London*, 4 : 1-48.
- 1857. On new forms of marine Diatomaceae found in the Firth of Clyde and in Loch Fine. *Trans. roy. Soc. Edinb.*, 21: 473-542.
- GREVILLE, R. K. 1860. A monograph of the genus *Asterolampra* including *Asteromphalus* and *Spatangidium*. *Trans. micr. Soc.*, 8 : 102-124.
- GRUNOW, A. 1881. Ueber die Arten der Gattung *Grammatophora* mit Bezug auf die Tafeln 53 and 53b, in Van Heurcks synopsis der belgischen Diatomeen. *Bull. Bot. Centralbl.*, 7 : 1-15.
- 1884. Die diatomeen von Franz Josefs-land. *Denkschr. Akad. Wien.*, 48: 53-112.
- HEIDEN, H. ET KOLBE, R. W. 1928. Die marinen Diatomeen der deutschen sudpolar Expedition. *Dt. Sudpol. Exped.*, 8 (5): 447-714.
- HENDY, N. I. 1964. An introductory account of the smaller algae of British coastal waters Part V. Bacillariophyceae (Diatoms). *Fish. Invest. Ser.*, 4: 1-317.
- HUSTEDT, F. 1927-30. Die Kieselalgen Deutschlands, in Rabenhorst L. Kryptogamen-Flora, 7, Pt. I, 1-925.
- 1930. Bacillariophyta (Diatomeae) in A. Pascher's die Süswasser-Flora Mitteleuropas, 10: 1-466.
- 1937-1939. Systematische und Ökologische untersuchungen über die Diatomeen-Flora von Java, Bali und Sumatra. *Arch. Hydrobiol. Suppl.*, 15 : 131-177; 187-295; 16: 393-506; 638-790.
- JANISCH, C. 1890. The diatoms of the 'Gazelle' expedition, in Keesalgen des 'Gazelle' Expedition. Travail von public: distribue directement par l' auteur sous forme manuscrite; repris en grande partie dans l'atlas de Schmidt.
- KARSTEN, G. 1905. Das Indische Phytoplankton nach dem Material der deutschen Tiefsee-Expedition, 1898-99. *Wiss. Engebn. Dtsch. Tiefsee-Exped. 'Valdivia' 1898-99*, 2 (2): 1-136.
- 1907. Das Indische Phytoplankton nach dem Material der deutschen Tiefsee-Expedition, 1898-99. *Wiss. Engebn. Dtsch. Tiefsee-Exped. 'Valdivia', 1898-99*, 2 (2): 221-548.
- 1928. Bacillariophyta (Diatomeae). Die Natürlichen Pflanzenfamilien, Zweite Auflage, 2 : 105-303.
- KUTZING, F. T. 1844. *Die Kieselschaligen Bacillarien oder Diatomeen*. Nordhausen.
- LEBOUR, M. V. 1930. The planktonic diatoms of Northern Seas. *Ray Soc. Publ.*, 116 : 1-244.
- LEUDUGER-Fortmorel, G. M. D. 1893. Diatomees de la Malaisie. *Ann. Jard. Bot. Buiten.*, 11.
- LYNGBYE, H. C. 1819. *Tentamen Hydrophytologiae Danicae*, Copenhagen.
- MANGIN, L. 1917. Sur le *Chaetoceros criophilus* Castracane espece caracteristique des mers antarctiques. *Acad. Sci., C. R.*, 164: 704-709.
- MÜLLER, O. F. 1783. Strand-Parle bandit och Armbandet tranne Microscopika straidvaseter. *K. Vetensk Akad. nye Handl.*, 4: 80-85.
- NAIR, P. V. R. 1959. The marine planktonic diatoms of the Trivandrum Coast. *Bull. Cent. Res. Inst. Univ. Kerala*, Ser. C, 7 (1): 1-63.

- PAVILLARD, J. 1916. Recherches sur les Diatomees pelagiques du Golfe du Lion. *Trav. Inst. bot. Univ. Montpellier, Ser. Mixte, Mem.*, 5 : 1-63.
- 1925. Bacillariales. Rep. Danish Oceanogr. Exped. 1908-1910 to the Mediterranean and adjacent seas, 2, *Biology*, J 4.
- PERAGALLO, H. 1888. Diatomees de la baie de Villefranche, in Diatomees du Midi de la France. *Bull. Soc. Hist. nat. Toulouse*, 22 : 1-92.
- 1892. Monographie du genre *Rhizosolenia* et de quelques genres voisins. *Le Diatomeiste.*, 1 : 79-82, 99-117.
- PRITCHARD, A. 1861. A history of the infusoria, including the Desmidiaceae and Diatomaceae, British and Foreign. London 4th Edit. *Diatoms* by J. Ralfs., 756-947.
- RABENHORST, L. 1864. Flora europea Algarum. 1. Algae, Diatomaceae.
- ROPER, F. C. S. 1859. On the genus *Biddulphia* and its affinities. *Trans. micr. Soc. Lond.*, 7:1-24.
- SCHMIDT, A. 1874-1944. *Atlas der Diatomaceenkunde*, Leipzig., pls. 1-460.
- SCHÜTT, F. 1896. Bacillariales. *Natürlichen Pflanzenfamilien*, 1 (1): 31-150.
- SMITH, W. M. 1853. *Synopsis of the British Diatomaceae*. vol. 1. London.
- 1856. *Ibid.*, vol. 2 London.
- SOURNIA, A. 1968. Diatomees Planctoniques du canal de Mozambique et de l'île Maurice. *Mem. O. R. S. T. O. M.*, 31 : 1-120.
- 1970. A checklist of planktonic diatoms and dinoflagellates from the Mozambique Channel. *Bull. mar. Sci.*, 24 : 85-197.
- SUBRAHMANYAN, R. 1946. A systematic account of the marine plankton diatoms of the Madras Coast. *Proc. Indian Acad. Sci.*, 24 : 85-197.
- 1958. Phytoplankton organisms of the Arabian Sea off the west coast of India. *J. Ind. Bot. Soc.*, 37 (4): 435-441.
- VAN HEURCK, H. 1899. *Traité des Diatomees*, Anvers, 1-572.
- WALLICH, G. C. 1858. On *Triceratium* and some new allied forms, with figures of the same. *Quart. J. micr. Sci.*, 6 : 242-253.
- 1860. On the siliceous organisms found in the digestive cavities of the salpae and their relation to find nodules of the chalk formation. *J. Roy. micr. Soc. Trans.*, 8 : 36-55.
- WOOD, E. J. F. 1963a. Checklist of diatoms recorded from the Indian Ocean. *Rep. Div. Fish. Commonw. Sci. Ind. Res. Org. Austr.*, 36: 1-311.
- 1963b. A study of the diatom flora from the sediments of south Texas Bay and adjacent waters. *Publ. Inst. mar. Sci., Texas*, 9: 237-310.