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A SYSTEMATIC ACCOUNT OF THE LITTORAL DIATOMS OF THE SOUTHWEST COAST OF INDIA

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ABSTRACT

In this account, a systematic enumeration of 109 littoral and epiphytic diatoms of the south west coast of India is presented. This work forms a supplement to the available information regarding the diatom flora of the Indian Seas.

INTRODUCTION

ALTHOUGH some work has been done on the taxonomy of the plankton diatoms of the Indian Seas (Venkataraman, 1939; Menon, 1945; Subrahmanyan, 1946; Nair, 1959; Gopinathan, 1975) very little information is available on the littoral and epiphytic diatoms of our coastal waters. Gandhi (1965, 1967) reported on several species of freshwater littoral forms from the North Indian waters. Apart from the studies by Misra (1956) on the littoral diatoms of the west coast of India, no systematic study has been made hitherto on the littoral marine forms from the Indian waters. In view of this fact, an attempt was made to enumerate the littoral diatoms of the south west coast of India, especially from the estuarine and inshore area of Cochin.

The present work forms a supplement to the available information regarding the diatom flora of the Indian Seas, particularly from the west coast. The diatoms enumerated here were found to occur either as attached ones on seaweeds, rocks, dead shells and in the sediments of the estuarine area as well as from the inshore environment of Cochin.

Altogether 109 diatoms have been described including 10 varieties and a new species, representing 40 genera. Out of these 8 genera and 17 species belong to the group Centrales and 32 genera and 92 species to the Pennales. The diatoms showed a good deal of resemblance to those of the British coast (Hendey, 1964). Many of the diatoms described here have been recorded previously from the east coast (Subrahmanyan, 1946) and a few forms from the Trivandrum coast (Nair, 1959), yet 49 species are found to be new distributional records from the Indian waters. The classification followed is that of Schutt (1896) as later modified by Hustedt (1930).

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Taxonomy

Order : CENTRALES

Sub Order : DISCOIDEAE

Family : *Coscinodisceae*

Sub-Family : *Melosirineae*

Genus **Podosira Ehrenberg**

Podosira montagnei Kutzing (Fig. 1 a)

Podosira montagnei Kutzing, 1844, p. 52, pl. 29; fig. 85; Smith, 1856, p. 53, pl. 59, fig. 326, Hustedt, 1930, p. 281, fig. 122; Subrahmanyan 1946, p. 87, figs. 5, 6, 10; Misra, 1956, p. 538, fig. 4; Hendey, 1964, p. 90.

Podosira laevis Gregory, Greville, 1859, p. 85, pl. 6. figs. 15-17; *Melosira montagnei* Lagerstedt, 1876, p. 9.

Cells round cylindrical, united to form short chains, attached to higher algae. Cell wall areolated, areolae 22 in 10μ. In valve view the areolae arranged in straight oblique lines. Girdle composed of intercalary bands. Length of valve 46 μ.

Distribution : Atlantic Coast, coastal areas of Britain, Caspian Sea and coasts of India.

Genus **Cyclotella** Kutzing

Cyclotella striata (Kutzing) Grunow (Fig. 1 b)

Cyclotella striata (Kutzing) Grunow, 1880, p. 119; Van Heurck, 1899, p. 444, pl. 22, fig. 651; Boyer, 1926, p. 37; Hustedt, 1930, p. 744, fig. 176; Wood, 1963, p. 256, pl. 6, fig. 98; Subrahmanyan, 1946, p. 92, fig. 31; Hendey, 1964, p. 131, pl. 1, fig. 8; Foged, 1975, p. 20; Huang, 1979, p. 198, pl. 1, fig. 1.

Coscinodiscus striatus Kutzing 1844, p. 131, pl. 1, fig. 8.

Cyclotella dallassiana Smith, 1856, p. 87.

Cyclotella radiata Brightwell, 1860, pl. 6, fig.11.

Cells discoid, rectangular, valves with two distinct surface areas, the central portion coarsely punctate, valve surface striate, striae 12 in 10μ. Diameter of valve 45 μ.

Distribution : Estuaries of Atlantic Coast, North Sea Coast and coasts of India.

Family : *Actinodisceae*

Sub-Family : *Actinoptychinece*

Genus **Actynoptychus** Ehrenberg

Actinoptychus senarius (Ehrenberg) Ehrenberg, (Pl. I A)

Actinoptychus senarius Ehrenberg, 1843, p. 6, pl. 1. fig. 27; Hendey, 1937, p. 271; 1951, p. 32, pl. 8, fig. 11; 1964, p. 95, pl. 23, fig. 1-2; Wood, 1963, p. 241, pl. 1, fig. 14; Huang, 1979, p. 196, pl. 1. fig. 11.

Actinoptychus undulatus (Bailey) Ralfs, Hustedt, 1930, p. 475; Lebour, 1930. p. 51, fig. 27; Allen and Cupp, 1935, p. 121, fig. 20.

Cells discoid, valves divided into 6 sectors, alternately raised and depressed. Central area hexagonal, hyaline. The raised sectors possess a short blunt process in the middle near the margin. Valve surface strongly areolated, areolae 6 in 10μ. Depressed sectors without processes, areolae not so prominent. Diameter of valve 56μ.

Distribution : European coastal waters, Atlantic and Pacific Coasts, coastal waters of Australia and India.

Actinoptychus splendens (Shadbolt) Pritchard (Pl. I B)

Actinoptychus splendens Pritchard, 1861, p. 840; Van Heurck, 1899, p. 497, pl. 22, fig. 649; Lebour, 1930, p. 51, pl. 1. fig. 6; Nair, 1959, p. 10, fig. 25; Hendey, 1964, p. 95, pl. 22, fig. 1.

Actinosphenia splendens Shadbolt, 1854, p. 116;

Actinoptychus quatuordenarius Ehrenberg, 1854, pl. 18, fiig. 25.

Actinoptychus halionyx Grunow, 1860, p. 25.

Valves circular, divided into 18 sectors that are alternately raised and depressed. Valve structure complex, alternate sectors differ in structure with coarse hexagonal areolae and are of fine areolae. Central space large, stellate, valve margin narrow. Diameter of valve 85μ.

Distribution : Atlantic and Pacific Coasts, coastal regions of Mediterranean, Java Seas and west coast of India.

Sub Order : BIDDULPHIOIDEAE

Sub-Family : *Anauleae*

Genus **Terpsinoe** Ehrenberg

Terpsinoe musica Ehrenberg (Fig. 1 c)

Terpsinoe musica Ehrenberg in De Toni, 1894, p. 894; Van Heurck, 1899, p. 452, fig. 176, Boyer, 1927, p. 144; Hustedt, 1930, p. 898, fig. 540; Venkataraman, 1939, p. 301, fig. 15; 18-21.

Valves quadrangular in girdle view, united to form zig-zag chains. The septa of the frustules thickened to form a structure resembling the musical notes. Valves linear, elliptical with undulating sides, slightly knobbed at the ends. The septa divides the inner side into 5-6 chambers. Surface of valve coarsely punctate. Length of valve 112μ and breadth 64μ.

Distribution : Estuaries in Europe, British coastal waters, east coast of India.

Family : *Eupodisceae*

Sub-Family : *Eupodiscineae*

Genus **Auliscus** Ehrenberg

Auliscus sculptus (Smith) Ralfs (Fig. 1 d)

Auliscus sculptus Ralfs in Pritchard, 1861, p. 845, pl. 6, fig. 3; Schmidt, 1875, pl. 32, figs. 21-22 Van Heurck, 1899, p. 482, pl. 21, fig. 646; Subrahmanyan, 1946, p. 109, figs. 93, 97; Hendey 1964. p. 98, pl. 23, fig. 4.

Eupodiscus sculptus Smith, 1853, p. 25, pl. 4, fig 42.

Auliscus caelatus Bailey, 1854, p. 6, pl. 1, figs. 3-4.

Cells discoid, broadly elliptical, median area clear and distinct. Valves furnished with two large slightly produced ocelli which are situated near the margin, termed as 'eyes' facing opposite each other. Valves sculptured strongly radial ribs, which are faint towards the centre. Valves radially striated, striae 26 in 10μ. Diameter of valve 62μ in long axis and 56μ in short axis.

Distribution : North Sea Coast, West Indies, coastal waters of Australia and India.

Family : *Biddulphieae*

Sub-Family : *Triceratineae*

Genus **Triceratium** Ehrenberg

Triceratium dubium Brightwell (Fig. 1 e)

Triceratium dubium Brightwell, 1859, p. 180, pl. 9, fig. 12; Hustedt, 1930, p. 806, fig. 469; Subrahmanyan, 1946, p. 151, figs. 274-276; Misra, 1956, p. 542 fig. 14; Huang, 1979, p. 201, pl. 2, fig. 3.

Triceratium bicorne Cleve, 1878, p. 17, pl. 6, fig. 30.

Amphitetras bicornis De Toni, 1891, p. 902.

Biddulphia dubia Cleve in Boyer, 1900, p. 707; Allen and Cupp, 1935, p. 148, fig. 84.

Cells rhomboid, lanceolate and four sided. In side view of the valve, two angles, each with a stout horn-like process, and the other angle with short blunt process. Valves strongly sculptured, irregularly areolated, valve margin striated. Length of apical axis, 65 μ.

Distribution : European coastal waters, Atlantic and Pacific Coasts, coasts of Australia and India.

Triceratium reticulatum Ehrenberg (Fig. 1 f)

Triceratium reticulatum Ehrenberg, 1844, p. 88, pl. 18 fig 50; Hustedt, 1930, p. 823, figs. 485-486; Subrahmanyan, 1946, p. 151, figs. 274, 280.

Triceratium sculptum Shadbolt, 1854, p. 15, pl. 1 fig. 4.

Triceratium punctatum Brightwell, 1856, p. 275, pl. 9, fig. 18.

Biddulphia sculpta Van Heurck, 1899, p. 476, pl. 21, fig. 645.

Biddulphia reticulum Boyer, 1926, p. 138.

Cells with triangular valves and rounded corners. Valves punctate, small at the periferal region and larger at centre, scattered and of different sizes, groups of areolae seen separated by a hyaline ring. Length of valve 115μ.

Distribution : Coastal waters of Europe, Mediterranean and Scandinavian Coasts, Texas Bay, coasts of India.

Triceratium robertsianum Greville (Fig. 1 g)

Triceratium robertsianum Greville, 1863, p. 231 pl. 9, fig. 9; Hustedt, 1930, p. 803, fig. 466; Subrahmanyan, 1946, p. 150, figs. 272-273.

Biddulphia robertsianum Boyer, 1927, p. 134.

Valves triangular with convex sides, angles rounded, strongly sculptured. Valve corners with hollow cylindrical process. Length of valve 135μ.

Distribution : Mediterranean Coast, Texas Bay, east coast of Africa, coasts of Australia and India.

Sub-Family : Biddulphineae

Genus **Biddulphia** Gray

Biddulphia pulchella Gray (Fig. 1 h-j)

Biddulphia pulchella Gray, 1821, p. 1, fig. 294; Smith, 1856, pl. 44, fig. 321; Van Heurck, 1899, p. 470, pl. 20, fig. 630; Subrahmanyan, 1946, p. 154, figs. 283-284; Misra, 1956, p. 544, fig. 17; Hendey, 1964, p. 101, pl. 25, fig. 1; Huang, 1979, p. 196, pl. 2, fig. 1.

Biddulphia pulchella var. *major* Castracane, 1876, p. 102, pl. 23, fig. 6.

Biddulphia biddulphiana Boyer, 1900, p. 694; Lebour 1930, p. 172.

Cells colonial, united by their angles to form short chains, valves elliptic, swollen margin, strongly sculptured, divided into 3 sections by strong costae. Ends of the valve furnished with large globular process covered with fine pores, areolae arranged in longitudinal and transverse rows, girdle punctate in longitudinal lines. Length of valve 98μ.

Distribution : European coastal waters, coasts of Atlantic and Pacific, coasts of Australia and India.

Biddulphia alternans (Bailey) Van Heurck (Fig. 1 k)

Biddulphia alternans Van Heurck, 1899, p. 208, pl. 21, fig. 644; Boyer, 1923, p. 137; Lebour, 1930, p. 181; Hendey, 1951, p. 34, pl. 7, fig. 10; 1964, p. 102, pl. 25, fig. 5.

Triceratium alternans Bailey, 1851, p. 40; Subrahmanyan, 1946, p. 153, figs. 277, 282.

Cells box shaped, valves triangular with straight concave sides, corners rounded. Valve surface areolated, rows in the margin, but irregular at the centre, 9 in 10 μ. Usually forms short chains by attaching at the angles of the cells by means of mucous. Length of valve 65μ.

Distribution : Coastal waters of Europe, British Coast, North Sea, coasts of India.

Biddulphia aurita (Lyngbye) Brebisson (Fig. 1 l)

Biddulphia aurita Brebisson, 1838, pl. 12; Smith, 1856, p. 49, pl. 45, fig. 319; Van Heurck, 1899, p. 471, pl. 20, fig. 631; Lebour, 1930, p. 173, fig. 133; Misra, 1956, p. 544, fig. 19; Wood, 1963, p. 247, pl. 3, fig. 48; Hendey, 1964, p. 103, pl. 24, fig. 6.

Diatoma aurita Lyngbye, 1819, p. 182, pl. 62, D.

Cells quandrangular, valves elliptical, with cornuate process, united by their processes to form short chains. Valves slightly swollen at the centre and furnished with radiating punctae. Length of valve 62μ.

Distribution : Coasts of Atlantic and Pacific, North Sea, coasts of Australia and India.

Biddulphia laevis Ehrenberg (Fig. 1 m)

Biddulphia laevis Ehrenberg, 1843, p. 410; Van Heurck, 1899, p. 474, pl. 20, fig. 639; Hustedt, 1930 p. 852, figs. 506-507; Misra, 1956, p. 546, fig. 20; Wood, 1953, p. 247, pl. 3, fig. 49; Hendey, 1964, p. 105, pl. 25, fig. 7.

Cells sub-circular, valve surface flat, finely punctate. Valve mantle deep, occupying one third of the pervalvar length. On the major axis of the valve surface two large processes and on a line almost at right angles, two short spines present. In girdle view, the valves appear rectangular with straight sides. Diameter of valve 82μ.

Distribution : Estuaries of Europe, coastal areas of Australia and west coast of India.

Biddulphia granulata Roper (Fig. 1 n)

Biddulphia granulata Roper, 1859, p. 13, pl. 1, figs. 10-11; Van Heurck, 1899, p. 473, pl. 21, fig. 638; Gran, 1905, p. 107, fig. 140; Lebour, 1930, p. 177, fig. 137; Hendey, 1964, p. 105.

Cells elliptic lanceolate, bearing two spines alternate with the terminal process. Valve surface punctate, arranged oblique rows. Girdle rectangular, punctate, arranged in decussate rows. Length of valve 74μ.

Distribution : Coasts of Atlantic, North Sea, British Coast, coasts of Australia and west coast of India.

Genus **Lithodesmium** Ehrenberg

Lithodesmium undulatum Ehrenberg (Fig. 1 o-p)

Lithodesmium undulatum Ehrenberg, 1840, p. 155, pl. 4, fig. 13; Lebour, 1930, p. 185, fig. 145; Subrahmanyan, 1946, p. 149, figs. 268-70; Hendey, 1964, p. 111, pl. 6, fig. 6.

Triceratium undulatum Brightwell, 1858, p. 154.

Triceratium intricatum West, 1860, p. 148, pl. 7, fig. 5.

Ditylum intricatum Grunow, Van Heurck, 1899, p. 424, pl. 17, fig. 607.

Lithodesmium victorioe Karsten, 1907, p. 171, pl. 28, fig. 6.

Cells united to form a colony. Valves rectangular in girdle view, triangular in valve view with a median inflation, finely areolate. A small spine present from a conical base at the centre. Length of valve 56μ.

Distribution : Coastal areas of Europe, North Sea, coasts of Australia and India.

Family : *Isthemineae*

Genus **Isthmia** Agardh

Isthmia enervis Ehrenberg (Fig. 1 r)

Isthmia enervis Ehrenberg, 1838, p. 209, pl. 16, fig. 6; Kutzing, 1844, p. 137, pl. 19, fig. 4, Smith, 1856, p. 52, pl. 48; Hustedt, 1930, p. 866, fig. 516; Subrahmanyan, 1946, p. 157; fig. 297; Hendey, 1964, p. 110, pl. 25, fig. 2.

Isthmiella enervis Cleve, 1873, p. 10.

Isthmiella obliquata (Smith) Boyer, 1900, p. 689.

Cells are united to form short chains, valves elongate, without costae, but well developed girdle with two distinct poles, one short and other slightly big. Valve surface and girdle areolated, 7 in 10μ. Length of cell 72μ.

Distribution : Epiphytic form found in the coasts of Atlantic, British Coast, coasts of Australia and India.

Isthmia nervosa Kutzing (Fig. 1 q)

Isthmia nervosa Kutzing, 1844, p. 137, pl. 19, fig. 5; Smith, 1856, p. 52, pl. 47; Hustedt, 1930, p. 865, fig. 515; Cupp, 1943, p. 166, fig. 116; Hendey, 1964, p. 110, pl. 25, fig. 3.

Cells trapizoidal in girdle view, 2-3 cells united to form short chains. The girdle is large, rectangular valve mantle strongly costate, irregularly arranged. Cells showing two poles, somewhat equal and rounded, not elongate as in *I. enervis*. Valve surface and girdle areolated, the areolae on the border of the girdle longer than the others. Length of valve 120μ.

Distribution : European coastal waters, British Coast and Australian waters. New record to the Indian Coasts.

Order : PENNALES

Sub Order : ARAPHIDINEAE

Family : *Fragilarioideae*

Sub-Family : *Tabellarieae*

Genus **Rhabdonema** Kutzing

Rhabdonema mirificum Smith (Fig. 1 s)

Rhabdonema mirificum Smith, 1856, p. 36, pl. 38, figs. 305 a-b; Brightwell, 1859, p. 180, pl. 9, fig. 11; Subrahmanyan, 1946, p. 161, figs. 316, 318-319.

Climacosira mirifica (Smith) Grunow, De Toni, 1891-94, p. 765; Van Heurck, 1899, p. 361, fig. 112.

Rhabdonema punctatum Stoddar, Boyer, 1926, p. 150.

Cells in girdle view ribbon-shaped with hyaline rounded corners forming more or less long bands. Valves linear with numerous intercalary bands, transversely striated, 15 in 10 μ. Length of cell 46 μ.

Distribution : Coastal areas of Pacific, Red Sea, British Coast, Sri Lanka Coast, coasts of India.

Genus **Striatella** Agardh

Striatella unipunctata (Lyngbye) Agardh (Fig. 1 t)

Striatella unipunctata (Lyngbye) Agardh, 1832, p. 61; Van Heurck, 1899, p. 363, pl. 12, fig. 485 a; Lebour, 1930, p. 200, fig. 162; Cupp, 1943, p. 173, fig. 122; Hendey, 1964, p. 161, pl. 26, figs. 17-18.

Fragilaria unipunctata Lyngbye, 1819, p. 183, pl. 62, fig. 6.

Cells colonial, united by their corners by small mucuous pads, to form zig-zag chains. Cells rectangular in girdle view, composed of numerous intercalary bands, alternate with short septa. Valve surface striate, undulating pseudoraphe, the striae crossing each other in curved oblique lines. Length of valve 118μ and breadth 45μ.

Distribution : Coastal waters of Europe, British Coast, west Coast of America. New record to the Indian Coasts.

Genus **Grammatophora** Ehrenberg

Grammatophora undulata Ehrenberg (Fig. 1 u)

Grammatophora undulata Ehrenberg, Kutzing, 1849, p. 121; Boyer, 1926, p. 156; Hustedt, 1931-32 p. 48, fig. 576; Subrahmanyan, 1946, p. 163, figs. 320, 324, 326.

Cells united to form short colonies, valves quandrangular, rounded corners and undulate septa. Valves linear, oblong, broad, widened in the middle, ends capitulate. Striae not visible on the valve. Length of valve 52μ.

Distribution : European coastal waters, Mediterranean Coast, West Indies, coasts of India.

Family : *Licmophorineae*

Genus **Licmophora** Agardh

Licmophora abbreviata Agardh (Fig. 1 v)

Licmophora abbreviata Agardh, 1831, p. 42; Hustedt, 1931-32, p. 66, fig. 590; Cupp, 1943, p. 177, fig. 127; Subrahmanyan, 1946, p. 163, figs. 330-32; Misra, 1956, p. 550, fig. 31; Nair, 1959, p. 36, fig. 105.

Podosphenia lyngbyei Kutzing, 1849, p. 110.

Licmophora lyngbyei Grunow, Van Heurck, 1899, p. 344, pl. 11; fig. 460; Lebour, 1930, p. 203, fig. 165.

Licmophora lyngbyei var. *abbreviata* Grunow, De Toni, 1891-94, p. 735.

Cells colonial, united by means of short mucuous stipes to form dense tufts, valves clavate, short with broad rounded bands. Cells in girdle view broadly cuneate, triangular, septa projecting into the cell, peseudoraph

distinct. Numerous internal septa projecting into the cell in girdle view. Valve surface striate, 12 in 10μ. Length of valve 65μ.

Distribution : Coasts of Atlantic and Pacific, North Sea Coast, English channel, coasts of India.

Licmophora ehrenbergii (Kutzing) Grunow
(Fig. 1 w)

Licmophoro ehrenbergii (Kutzing) Grunow, 1867, p. 36; Van Heurck, 1899, p. 344, pl. 31, fig. 853; Cleve-Euler, 1953, p. 18, fig. 319 a, b; Hendey, 1964, p. 168.

Podosphenia ehrenbergii Kutzing, 1844, p. 121, pl. 9, fig. B.

Cells in girdle view cuneate, deep septa at the upper end, valves broadly clavate, with broad cuneate upper apex and rounded lower apex. Valve surface striate 8 in 10μ, arranged in transverse lines upon either side of a well marked pseudoraphe. Length of valve 110μ and breadth 22μ.

Distribution : Coastal waters of Europe, British Coast, coasts of Australia. New record for the Indian Coasts.

Licmophora flabellata (Greville) Agardh
(Fig. 1 x)

Licmophora flabellata (Greville) Agardh, 1830-32, p. 41; Smith, 1853, p. 86, pl. 26, fig. 234; Van Heurck, 1899, p. 342, pl. 31. fig. 852; Boyer, 1927, p. 165; Hustedt, 1931-32, p. 58, fig. 581; Misra, 1956, p. 549, fig. 28 a-c; Hendey, 1964, p. 168, pl. 26, fig 5.

Exilaria flabellata Greville, 1823-28, pl. 289.

Cells in girdle view, narrow, elongate and cuneate, valves join to form a 'fan' shaped appearance, supported upon a branching mucuous stipe. Valves clavate, inflated at the base, faintly striated. Internal septa appear in girdle view as line penetrating the cell from the broad end. Length of valve 86μ.

Distribution : Coastal areas of Europe, British Coast, coasts of Australia and India.

Licmophora gracilis (Ehrenberg) Grunow
(Fig. 1 y)

Licmophora gracilis (Ehrenberg) Grunow, 1867, p. 34; Van Heurck, 1899, p. 343, pl. 31, fig. 851; Hendey, 1964, p. 167.

Podosphenia gracilis Ehrenberg, 1838. p. 214, pl. 17, fig. 6.

Cells in fan shaped colonies, supported upon a simple stipe, valves cuneate, broadly rounded, tapering to a narrow slender lower end with a truncate base. Valves obovate inflated with internal septa, appear in girdle view as lines, pseudoraphe present with faint transverse striation. Striae 18 in 10 μ. Length of valve 82 μ.

Distribution : Coastal waters of Europe, Mediterranean Goast, British Coast and Australian waters. New record to the Indian Coasts.

Licmophora juergensii Agardh (Fig 1 z, aa)

Licmophora juergensii Agardh, 1830-32, p. 42; Vau Heurck, 1899, p. 343, pl. 31, fig 850; Cleve, Euler, 1953, p. 19, fig. 325 b, d; Hendey-1964, p. 168, pl. 26, fig. 14.

Podosphenia juergensii (Agardh) Kutzing, 1844, p. 121, pl. 9, fig. 12.

Colonial form, attached to the substratum by means of stipes, fan shaped appearance, being smaller than the other species. Valves cuneate, truncate at the upper end, slightly rounded, clavate, sides straight, surface striate, striation transverse, 10 in 10 μ. Length of valve 58 μ.

Distribution : Coasts of Britain, Mediterranean Coast, coasts of Atlantic and Australian Coasts. New record for the Indian Coast.

Licmophora paradoxa (Lyngbye) Agardh
(Fig. 1 ad)

Licmophora paradoxa (Lyngbye) Agardh. 1825-35 p. 32; Van Heurck 1899, p. 344, pl. 31, fig. 855; Boyer, 1927, p. 167; Lebour, 1930, p. 203, fig. 165; Hendey, 1951, p. 40; 1964, p. 168.

Echinella paradoxa Lyngbye, 1819, p. 211.

Licmophora paradoxa (Lyngbye) Agardh var. *media* Misra, 1956. p. 550, figs. 32-33.

Cells in fan shaped colonies, supported by a mucuous stipe, valves obovate, rounded at both sides, broad at the posterior portion in girdle view, valve mantle faintly striate, well distinct pseudoraphe. Striae 22 in 10 μ, length of valve 78 μ.

Genus **Climacosphenia** Ehrenberg

Climacosphenia moniligera Ehrenberg (Fig. 1 ae-af)

Climacosphenia moniligera Ehrenberg, 1841, p 411, pl. 2, fig. 6; Boyer, 1926, p 171; Hustedt, 1931-32, p. 89, fig. 625; Cupp, 1943, p. 178, fig. 128; Subhrahmanyan, 1946, p. 164, figs. 322, 325, 333-34; Nair, 1959, p. 37, fig. 106-108.

Climacosphenia australis Kutzing, 1849, p. 114.

Climacosphenia catena Shadbolt, 1854, p. 17, pl. 1, fig. 15.

Climacosphenia monilifera Van Heurck, 1899, p. 346, fig. 100.

Epiphytic form, cells are borne on short stalked mucilage colonies, cells wedge shaped in girdle view, valves clavate, rounded at the apex, elongate below, traversed longitudinally by two parallel lines. Valves striated, 16 in 10 μ, length of valve 268 μ and breadth 32 μ at the tip and 12 μ at the base.

Distribution : Coasts of Europe, Atlantic Coast, Gulf of Mexico, West Indies, coasts of Australia and India.

Climacosphenia elongata Bailey (Fig. 1 ag-ah)

Climacosphenia elongata Bailey, De Toni, 1891, p. 739, Boyer, 1926, p. 172; Hustedt, 1931-32, p. 90, fig. 626; Subrahmanyan, 1946, p. 164, figs. 323, 327-329, 335.

Cells very slender and narrow, slightly rounded at angles with truncate bases, valves are more elongate than *C. moniligera*. Valves clavate, rounded at the apex and very much elongate below, traversed by two parallel ongitudinal lines. Upper broader part short, 28μ broad and rather suddenly diminish in breadth lower down and becoming linear, lower part 12μ broad. Length of valve 820μ.

Distribution : Coasts of Atlantic, North Sea, Florida Coast, coasts of India.

Genus **Rhaphoneis** Ehrenberg

Rhaphoneis amphiceros Ehrenberg (Fig. 1 ai)

Rhaphoneis amphiceros Ehrenberg, 1844, p. 87; Boyer, 1926, p. 190; Hustedt, 1931-32, p. 174, fig. 680; Allen and Cupp, 1935, p. 153, fig. 93; Subrahmanyan, 1946, p. 165, figs. 340-41; Hendey, 1951, p. 37, pl. 15, fig. 4; 1964, p. 154, pl.26, figs. 1-4.

Cocconeis amphiceros Ehrenberg, 1840, p. 206.

Rhaphoneis lusitanica Rabenhorst, 1864, p. 126.

Doryphora amphiceros Kutzing, 1849, p. 50.

Rhaphoneis amphiceros var. *rhombica* Grunow, Van Heurck, 1899, p. 330, pl. 10, fig. 394.

Cells solitary, lanceolate or boat shaped, inflated at the centre, valve surface punctate, punctae in curved radiating lines, 6 in 10 μ. Length of valve 55 μ.

Distribution : European coastal waters, North Sea Coast, west coast of N. America, coasts of India.

Genus **Synedra** Ehrenberg

Synedra superba Kutzing (Fig. 1 aj)

Synedra superba Kutzing, 1844, p. 69, pl. 15, fig. 13; Smith, 1853, p. 74, pl. 12, fig. 102; Van Heurck, 1899, p. 316, pl. 30, fig. 835; Hendey, 1964, p. 163.

Cells solitary, often in fan shaped clustures, supported on short mucuous pads. Valves broadly linear, slightly rounded at the apices. Valves striate, crossed by three equidistant longitudinal lines, transverse except at the apices, 10 in 10 μ. Length of valve 360 μ, breadth 15 μ.

Distribution : Coasts of Europe, North Sea Coast, coasts of Britain. New record for the Indian Coasts.

Synedra pulchella Kutzing (Fig. 1 ak-al)

Synedra pulchella Kutzing, 1844, p. 68, pl. 29, fig. 87; Van Heurck, 1899, p. 309, pl. 10, fig. 402; Hendey, 1964, p. 163.

Cells in fan shaped colonies, valves linear, lanceolate in girdle view with rounded apices. Valves with a distinct narrow pseudoraphe in the axial area, central area large. Valve striate, 15 in 10 μ. Length of valve 78 μ.

Distribution : Estuaries in Europe, North Sea Coast and coasts of Britain. New record for the Indian Coasts.

Synedra crystallina (Agardh) Kutzing (Fig. 1 ab)

Synedra crystallina (Agardh) Kutzing, 1844, p. 69, pl. 16, fig. 1; Smith, 1853, p. 74, pl. 12, fig. 101; Van Heurck, 1899, p. 315, pl. 10, fig. 435; Boyer, 1927, p. 208; Hendey, 1964, p. 264.

Diatoma crystallina Agardh, 1824, p. 3.

Valves very long, linear lanceolate, slightly tapering from the middle towards the weakly inflated rounded apices. Valve surface striate, 9 in 10 μ, finely punctate, arranged either side a thin, but distinct pseudoraphe. Striae transverse, slightly radiate near the apices. Length of valve 760 μ and breadth 22 μ.

Distribution : Coastal areas of Europe, Atlantic and North Sea Coasts. New record for the Indian Coasts.

Synedra ulna Ehrenberg (Fig. 1 ac)

Synedra ulna Ehrenberg, De Toni, 1891, p. 653; Van Heurck, 1899, p. 310, pl. 10, fig. 409; Boyer, 1926, p. 198; Hustedt, 1930, p. 151, figs. 158-59; Venkataraman, 1939, p. 105, figs. 37, 39, 43.

Valves narrowly linear, somewhat broadened at the ends, rounded, pseudoraphe narrow, linear, central area rectangular, striae coarse, 12 in 10 μ. Length of valve 145 μ and breadth 10μ.

Distribution : Estuaries and coastal areas of Atlantic, Pacific and North Sea, coasts of India.

Genus **Podocystis** Bailey

Podocystis adriatica (Kutzing) Ralfs (Fig. 1 am)

Podocystisa driatica (Kutzing) Ralfs in Pritchard, 1861, p. 772; Smith, 1856, p. 101; Van Heurck, 1899, p. 365, fig. 117; Hendey, 1964, p. 169, pl. 27, fig. 4.

Surirella adriatica Kutzing, 1844, p. 62, pl. 30, fig. 80.

Podocystis americana Bailey, 1854, p. 11, fig. 38.

Podocystis spathulata Foged, 1975, p. 50, pl. 8, fig. 14.

Epiphytic diatom, attached to higher algae by means of short mucuous stipe or pad. Valves broadly ovate or baloon shaped, having the lower end slightly flattened. Valve surface with a median pseudoraphe and transverse costae, between which are two rows of areolae, alternately arranged. Striae 14 in 10μ. Length of valve 105 μ and breadth 65 μ.

Distribution : North Sea Coast, coasts of Britain, Australia and Sri Lanka. New record for the Indian Coasts.

Sub Order : MONORAPHIDEAE

Family : *Achnanthoideae*

Sub-Family : *Cocconeideae*

Genus **Cocconeis** Ehrenberg

Cocconeis scutellum Ehrenberg (Fig. 1 an)

Cocconeis scutellum Ehrenberg, 1838, p. 194; Van Heurck, 1899, p. 287, pl. 8, fig. 338; Boyer, 1927, p. 245; Hustedt, 1930, p. 191, fig. 267; 1931, p. 337, fig. 790; Wood, 1963, p. 252, pl. 4, fig. 73a; Hendey, 1964, p. 180, pl. 27, fig. 8.

Cells broadly elliptical, flat, upper valve with pseudoraphe, coarse punctate, arranged

in transverse lines, equidistant rows. The lower valve with a broad, marginal loculiferous rim and a small rounded central area, radiately striate, 9 in 10μ, raphe straight. Length of valve 65μ and breadth 38μ.

Distribution : European coastal waters, British Coast and coasts of Sri Lanka. New record for the Indian Coasts.

Cocconeis placentula Ehrenberg
(Fig. 1 ao-ap)

Cocconeis placentula Ehrenberg, 1838, p. 194; Van Heurck, 1899, p. 288, pl. 8, fig 341; Boyer, 1916, p. 57, pl. 16, fig. 29; Hustedt, 1930, p. 189, fig. 260.

Valves elliptical, plain, median hyaline zone of the upper valve enlarged at the centre and showing feeble traces of raphe and nodules, punctae distinct, separated by a hyaline zone. Striae 35 in 10μ. Length of valve 65μ and breadth 35μ.

Distribution : British Coast, mud flats in the North Sea, coastal areas of N. America, Pacific Coasts. New record for the Indian Coasts.

Cocconeis littoralis Subrahmanyan
(Fig. 1 aq)

Cocconeis littoralis Subrahmanyan, 1946, p. 171, figs. 368-70.

Epiphytic form, broadly elliptical, rapheless, with three well defined hyaline areas, demarcated by striated bands, striae unequal in length, dot like thickening at the centre. Valve with raphe with somewhat radial punctate, alternating with those of the adjacent one, raphe sigmoid, axial area narrow dilating into a very small central area. Striae 18 in 10μ. Length of valve 55μ and breadth 35μ.

Distribution : Coasts of India.

Cocconeis pseudomarginata Gregory (Fig. 1 ar)

Cocconeis pseudomarginata Gregory, 1857, p. 492, pl. 9, fig. 27; Boyer, 1927, p. 248; Hustedt, 1931, p. 359, fig. 813; Hendey, 1964, p. 179, pl. 28, fig. 20.

Valves broadly elliptical, upper valve with a narrow lanceolate axial area and several longitudinal curved folds, lower valve with a narrow area, raphe terminating at a distance from the ends of the valve, central area small, valve surface striated, 18 in 10 μ. Length of valve 68μ, breadth 45μ.

Distribution : Atlantic and North Sea Coasts, British Coast. New record for the Indian Coasts.

Sub-Family : Achnanthaceae

Genus **Achnanthes** Bory

Achnanthes brevipes Agardh (Fig. 2 a)

Achnanthes brevipes Agardh, 1824, p. 1; Smith, 1856, p. 27, pl. 37, fig. 301; Van Heurck, 1899, p. 279, pl. 8, fig. 324; Hustedt, 1955, p. 18; Wood, 1963, p. 239, pl. 1, fig. 2; Hendey, 1964, p. 174, pl. 28, figs. 7-8.

Cells united to form short chains by mucuous pads, valves linear elliptical, slightly constricted in the middle with broad obtuse ends. Valve structure punctate, 8 in 10μ. Valves dissimilar, lower one with a marked raphe enclosed in a stout rib, while the upper one bearing eccentric pseudoraphe. Girdle structure composed of annular segments. Length of valve 76μ and breadth 27μ.

Distribution : Estuarine and coastal areas of Atlantic and Pacific, coasts of Britain. New record for the Indian Coasts.

Achnanthes longipes Agardh (Fig. 2 b, c)

Achnanthes longipes Agardh, 1824, p. 1; Smith, 1856, p. 26, pl. 35, fig. 300; Van Heurck, 1899, p. 279, pl. 8, fig. 323; Boyer, 1927, p. 231; Lebour, 1930, p. 205, fig. 166; Cupp. 1943, p. 192, fig. 141; Hustedt, 1955, p. 18; Wood, 1963, p. 240, pl. 1. fig. 9; Hendey, 1964, p. 174, pl. 28, figs. 1-6, pl. 42, fig. 2.

Cells united by mucuous pads to form short chains. Valves variable, elongate, elliptical, constricted in the middle, apices obtuse, valve punctate, in double rows, alternating with strong costae 6 in 10μ, girdle with annular segments, upper valve with a narrow pseudoraphe, lower one a distinct raphe, dilated to form a narrow stauros. Length of valve 92μ and breadth 28μ.

Distribution : Coastal areas of Atlantic, Pacific, North Sea, west coast of N. America, Texas Bay and coasts of Australia. New record for the Indian Coasts.

Sub Order : BIRAPHIDEAE

Family : *Naviculoideae*

Sub-Family : *Naviculeae*

Genus **Mastogloia** Thwaites

Mastogloia pumula (Grunow) Cleve (Fig. 2 d)

Mastogloia pumula (Grunow) Cleve, 1895, p. 157; Hustedt, 1931, p. 553, fig. 983; Wood, 1963, p. 266, pl. 8, fig. 154 a-c; Hendey, 1964, p. 238.

Mastogloia braunii var. *pumula* Grunow, Van Heurck, 1880, pl. 4, fig. 23.

Valves linear elliptical, broadly rounded apices, raphe straight, axial area very narrow, central area rectangular with longitudinal extensions on either side of the raphe in the form of an 'H', valve surface striate, radial, 22 in 10μ. Septate plate marginal, composed of one or two large loculi and two or three smaller ones either side. Length of valve 77μ and breadth 32μ.

Distribution : Coastal areas of Atlantic, North Sea, British Coast, Texas Bay, west coast of N. America. New record for the Indian Coasts.

Mastogloia braunii Grunow (Fig. 2 e)

Mastogloia braunii Grunow, 1863, p. 156, pl. 4, fig. 2; Van Heurck, 1899, p. 156, pl. 2, fig. 320; Venkataraman, 1939, p. 317. figs. 57, 62; Hendey, 1964, p. 239.

Valves lanceolate, obtuse, raphe not straight but deviate at about middle, axial area narrow, central area large, rectangular and form two horns like 'H'. Valve surface striated, 16 in 10μ, inner septate plate marginal composed of small numerous rectangular loculi bigger in the middle than at the ends. Length of valve 76μ and breadth 34μ.

Distribution : Coastal areas of Europe, North Sea and Atlantic Coasts, coasts of Australia and India.

Mastogloia exigua Lewis (Fig. 2 f)

Mastogloia exigua Lewis, 1861, pl. 2, fig. 5; Van Heurck, 1899, p. 155, pl. 2, fig. 63; Hustedt, 1931-32, p. 569, fig. 1003; Venkataraman, 1939, p. 317, figs. 44-45.

Valves elliptical, raphe straight, axial area narrow, central area square, striations radial, loculi 5 in number, bigger at the middle and smaller at the ends, striae 18 in 10μ. Length of valve 45μ and breadth 17μ.

Distribution : Coastal waters of Europe, North Sea, coasts of India.

Mastogloia lanceolata Thwaites (Fig. 2 g)

Mastogloia lanceolata Thwaites, Smith, 1856, p. 64, pl. 54, fig. 340; Van Heurck, 1899, p. 154, pl. 2, fig. 62; Hustedt 1931-33, p. 493, fig. 922; Wood, 1963, p. 266, pl. 8, fig. 152 a-b.

Valves lanceolate with bluntly rounded ends, raphe curved slightly in the middle, axial area very narrow, central area small, circular in form. Valve surface with transverse and irregular striae, loculi numerous, but not reaching the ends. Striae 14 in 10μ. Length of valve 74μ and breadth 32μ.

Distribution : Coastal areas of North Sea, British Coast, west coast of N. America, Texas Bay. New record for the Indian Coasts.

Mastogloia dolosa Venkataraman (Fig. 2 h)

Mastogloia dolosa Venkataraman, 1939, p. 316, fig. 49.

Valves elliptical, lanceolate, sub rostrate, axial area narrow, central area large, rectangular, widened to form a 'H' shape. The furrows on either side of raphe seem to meet at the tip. Striations radial, 24 in 10μ, loculi 10 on either side, ending at a distance from the apices. Length of valve 52μ, breadth 18μ.

Distribution : Estuaries in the east and south west coasts of India.

Mastogloia exilis Hustedt (Fig. 2 i)

Mastogloia exilis Hustedt, 1931-32, p. 553, fig. 985; Subrahmanyan, 1946, p. 172, fig. 366, 367.

Valves lanceolate, constricted, bluntly rounded, raphe straight, axial area narrow, central area widened and connected to two small half lanceolate areas forming an 'H' shape, loculi bigger 4 in number, bigger in the middle and outermost smaller, transapical striae fine, 22 in 10μ. Length of valve 36μ and breadth 14μ.

Distribution : Coastal areas of Indo-Malayan Archipelago, European coastal waters, Texas Bay, east and southwest coast of India.

Mastogloia cochinensis sp. nov. (Pl. IV D)

Valves broadly elliptical, raphe straight, axial area narrow, central area small, valve surface evenly areolated, forming radiate and concentric system, areolae 16 in 10μ, loculi marginal, big, striated, 6 in either side, reaching the apices. Length of cell 68μ and breadth 52μ.

This diatom shows a close resemblance to *Mastogloia crucicula* (Grunow) Cleve and *M. hovarthiana* Grunow in the broadly elliptical shape of the cell and in the arrangement of the areolae. However, the distinguishing characteristic features of these two species are: in *M. crucicula*, the loculi are 4 in each side, uniform and not reaching the apex and in *M. hovarthiana*, numerous small loculi are present on either side.

Distribution : Estuarine area of Cochin, southwest coast of India.

Family : *Naviculoideae*

Sub-Family : *Naviculeae*

Genus **Navicula** Bory

Navicula forcipata Greville (Fig. 2 j)

Navicula forcipata Greville, 1859, p. 83, pl. 6, figs. 10-11; Van Heurck, 1899, p. 203, pl. 4, fig. 163; Boyer, 1927, p. 416; Subrahmanyan, 1946, p. 182, fig. 405; Nair, 1959, p. 44, fig. 126; Hendey, 1964, p. 211, pl. 33, figs. 8-9.

Valves elliptical with broad, rounded ends, lateral areas narrow, constricted in the middle of the valve with convergent ends towards the pole, valve surface striated, 12 in 10 μ, transverse. Length of valve 78μ and breadth 34μ.

Distribution : Adriatic Sea, coasts of Britain, Belgium, Atlantic and Pacific Coasts, coasts of India.

Navicula permagna Bailey (Fig. 2 k)

Navicula permagna Bailey, 1850, p. 40, pl. 2, fig. 28; Van Heurck, 1899, p. 218, pl. 5, fig. 202.

Cells solitary, broadly lanceolate, sub-acute apices, raphe distinct, surrounded by a broad hyaline zone, dialated into a round area, striae distinct, finely divided transversely and interrupted near the margin of the valve by a broad depression. Length of valve 82μ and breadth 24μ.

Distribution : Atlantic and Pacific Coasts, coasts of Britain, west coast of N. America. New record for the Indian Coasts.

Navicula lyra Ehrenberg (Fig. 2 l)

Navicula lyra Ehrenberg, 1843, p. 419; Van Heurck, 1899, p. 202, pl. 4, fig. 161; Hendey, 1964, p. 209, pl. 33, fig. 2.

Navicula lyra var. *ehrenbergi* Cleve, 1895, p. 63.

Valves elliptical, rostrate apices, striated, slightly radial, 12 in 10μ, interrupted by lateral hyaline areas upon either side of the narrow axial area, forming a central area. Some striae lie in between the lateral area and the valve margin, while others form a band between the bowlshaped area and the raphe. Length of valve 85μ.

Distribution : Coastal areas of Europe, Pacific and Atlantic Coasts, British Coast. New record for the Indian Coasts.

Navicula gracilis Kutzing (Fig. 2 m)

Navicula gracilis Kutzing, 1844, p. 91, pl. 3, fig. 48; Van Heurck, 1899, p. 179, pl. 3, fig. 109.

Cells elongate, lanceolate, acute at the extremeties. Valve surface striate, striae robust, central nodule short, the median ones scarcely radiant, all the striae are reaching to the raphe. Striae 12 in 10μ. Length of valve 65μ and breadth 15μ.

Distribution : Atlantic and Pacific Coasts, coastal waters of Europe. New record for the Indian Coasts.

Navicula gracilis var. **schizonemoides** Van Heurck (Fig. 2 n)

Navicula gracilis var. *schizonemoides* Van Heurck, 1899, p. 179, pl. 3, fig. 110.

Cells are endophytic, elongated and very narrow, striate, median striae longer and of unequal length, 9 in 10μ. Length of valve 68μ, breadth 15μ. Cells usually embeded in mucilage tubes or in decayed a gal pieces.

Distribution : Coastal areas of Atlantic, North Sea. New record for the Indian Coasts.

Navicula hasta Pantocsek (Fig. 2 o)

Navicula hasta Pantocsek in Cleve, 1895, p. 25; Boyer, 1923, p. 399; Hustedt, 1930, p. 306, fig. 541; Venkataraman, 1939, p. 331, fig. 98.

Valves lanceolate, broad in the middle, tapering to sub acute ends. Axial area narrow, slightly widened in the middle, radial striae, coarse and slightly wide apart in the centre. Striae 9 in 10μ. Length of valve 65μ, breadth 17μ.

Distribution : Estuaries and coastal areas of Europe, coasts of Britain and India.

Navicula pygmoea Kutzing (Fig. 2 p)

Navicula pygmoea Kutzing, 1849, p. 77; Cleve, 1895, p. 65; Van Heurck, 1899, p. 203, pl. 4, fig. 164; Boyer, 1927, p. 416; Hustedt, 1930, p. 312, fig. 561.

Valves hyaline, elliptical, with broadly rounded ends. Axial area indistinct, lateral area constricted in the middle and converged at the ends, delicate striations, 22 in 10μ. Length of valve 36μ and breadth 14μ.

Distribution : Estuaries, coastal areas of Europe, coasts of India.

Navicula bicapitata Lagerstedt (Fig. 2 q)

Navicula bicapitata Lagerstedt in Van Heurck, 1899, p. 172, pl. 2, fig.90.

Valves narrow, linear with apices attenuated, rostrate, valve surface costate, 8 in 10μ, radiate in the middle of the valve, convergent at the apices, leaving round the raphe a narrow hyaline zone which expands into a sub-quandrangular area, round the central nodule. Length of valve 62μ.

Distribution : Coastal waters of Europe, North Sea Coast, estuaries in Britain, Ireland. New record for the Indian Coasts.

Navicula granulata Bailey (Fig. 2 r)

Navicula granulata Bailey, 1854, p. 10, fig. 16; Cleve, 1895, p. 48; Van Heurck, 1899, p. 211, pl. 4, fig. 183; Hendey, 1964, p. 208, pl. 31, fig. 6.

Valves elliptical, rounded apices, axial area widened, central area round, surface striated, striae punctate, 16 in 10μ, transverse at

the centre, radiate at the poles. Length of valve 62μ and breadth 26μ.

Distribution : Esturies and coastal areas of Europe, North Sea, coasts of Britain. New record for the Indian Coasts.

Navicula monilifera Cleve (Fig. 2 s)

Navicula monilifera Cleve, 1895, p. 43; Hendey, 1964, p. 206, pl. 31, fig. 4-5.

Valves broadly elliptical, sides parallel with rostrate apices, axial area clear, narrow and central area orbicular, moderately large, raphe straight, valve surface coarsely striated, 8 in 10μ. Length of valve 85μ, breadth 35μ.

Distribution : North Sea Coast, coasts of N. America, British Coast. New record for the Indian Coasts.

Navicula notabilis Greville (Fig. 2 t)

Navicula notabilis Greville, 1863, p. 18, pl. 1, fig. 9; Cleve, 1894, p. 93; Schmidt, 1875, pl. 8, figs. 46-52; Van Heurck, 1899, p. 200, pl. 26, fig. 750.

Diploneis notabilis (Greville) Cleve, Hendey, 1964, p. 224.

Valves elliptical, broadly rounded apices, central nodule moderately large, raphe narrow, straight, lying between strongly silicified parallel horns, lateral areas small, narrow, valve surface costate, transverse, between the costae are elongated alveoli of different lengths. Costae 7 in 10μ, length of valve 82μ and breadth 32μ.

Distribution : Coastal waters of Europe, coasts of Britian. New record for the Indian Coasts.

Navicula plicata Donkin (Fig. 2 u)

Navicula plicata Donkin, 1870-73, p. 59, pl. 9, figs. 2a-b; Cleve, 1894, p. 154; Van Heurck, 1899, p. 235, pl. 27, fig. 787; Hendey, 1964, p. 193.

Valves in girdle view rectangular, rounded angles, girdle composed of numerous bands, valves linear, lanceolate, with tapering obtusely rounded ends in valve view, axial area narrow, central area small, valve surface more or less convex, fine parallel striae, 17 in 10μ. Length of valve 85μ, breadth 28μ.

Distribution : Coastal waters of Europe, British Coast. New record for the Indian Coasts.

Navicula hennedyei var. **neapolitana** Cleve (Fig. 2 v)

Navicula hennedyei var. *neapolitana* Cleve, 1895, p. 58.

Valve elliptical, middle region wide and broad, axial area narrow, raphe straight, surface of valve straight, striae in two bands, the axial striae forming a narrow band about 3-5 punctae, wide open either side of the raphe. Length of valve 110μ and breadth 62μ.

Distribution : Coasts of Scotland, North Sea and Java Seas. New record for the Indian Coasts.

Navicula hennedyei var. **nebulosa** Cleve (Fig. 2 w)

Navicula hennedyei var. *nebulosa* Cleve, 1895, p. 58; Van Heurck, 1899, p. 204, pl. 27, fig. 755; Boyer, 1927, p. 413; Subrahmanyan, 1946, p. 181, fig. 404.

Navicula nebulosa Gregory, 1857, p. 480, pl. 9, fig. 8; Hendey, 1964, p. 213.

Valves elliptical, angular margin, apices note fully round, axial area narrow, raphe straight, axial striae transverse, very short, marginal striae in a narrow band of approximately equal length, hyaline lateral area. Striae 18 in 10μ. Length of valve 55μ and breadth 26μ.

Distribution : North Sea Coast, coasts of Scotland, English channel and coasts of India.

Genus **Dictyoneis** Cleve

Dictyoneis marginata Cleve (Fig. 2 x)

Dictyoneis marginata Cleve in Van Heurck, 1899, p. 157, fig. 29; Wood, 1963, p. 108.

Navicula strangulata Leuduger-Fortmorel, Lagerstedt, 1876, p. 42.

Valve elongated, broad and round apex, median part of valve constricted, raphe straight, surrounded by a narrow hyaline zone, surface of valve striated, marginal striae broad and large, resembling the loculi of the genus *Mastogloia*. Length of valve 68μ.

Distribution : Coasts of Atlantic, Mediterranean, East Indies, Tasmania, Madagascar and Sri Lanka. New record for the Indian Coasts.

Genus **Caloneis** Cleve

Caloneis liber (Smith) Cleve (Fig. 2 y)

Caloneis liber (Smith) Cleve, 1894, p. 54; Boyer, 1927, p. 310; Hendey, 1964, p. 229, pl. 29, fig. 2.

Navicula liber Smith, 1853, p. 48 pl. 16, fig. 133; Van Heurck, 1899, p. 222, fig. 219.

Valves elliptical, oblong, with rounded apices. Axial area very narrow, developing into a small, orbicular centre area, valve surface striate, striae parallel 8 in 10 μ. Longitudinal lines median, about half way between the raphe and the valve margin. Length of valve 65 μ and breadth 18 μ.

Distribution : North Sea Coast, coasts of Britain and Australia. New record for the Indian Coasts.

Genus **Diploneis** Ehrenberg

Diploneis smithii Cleve (Fig. 2 ac)

Diploneis smithii Cleve, 1894, p. 96; Boyer, 1927, p. 354; Hustedt, 1930, p. 253, fig. 402, Subrahmanyan, 1946, p. 180, fig. 399; Wood, 1963, p. 259, pl. 6, fig. 112; Hendey, 1964; p. 225, pl. 32, fig. 10.

Navicula elliptica Smith, 1853, p. 48, pl. 17, fig. 152a.

Navicula smithii Van Heurck, 1899, p. 192, pl. 4. fig. 151 a, b

Cells small, elliptical, oval, central nodule, small, produce two horns, enclosing the raphe furrows narrow, punctate, close to the horns. Surface of valve costate, alternating with double rows of areolae. Length 72μ and breadth 38 μ.

Distribution : Coasts of Atlantic, North Sea, Mediterranean Sea, Texas Bay, Australian waters and coasts of India.

Diploneis dydima (Ehrenberg) Cleve (Fig. 2 z)

Diploneis dydima (Ehrenberg) Cleve, 1894, p. 90; Hustedt, 1931, p. 685, fig. 1075; Smith, 1853, p. 53, pl. 17, fig. 154; Boyer, 1925, p. 352; Hendey, 1964, p. 226, pl. 32, fig. 12.

Navicula didymus Ehrenberg, 1840, p. 155; Van Heurck, 1899, p. 193, pl. 3, fig. 147.

Cells slightly constricted in the middle, ovoid, valves divided into two tongue-shaped segments. The central nodule is subquadrate or almost circular. Valve surface costate, transverse in the middle, slightly curving radiating lines towards the apices and crossed by numerous undulating longitudinal lines. Costae 6 in 10 μ, length of valve 85 μ and breadth 35 μ.

Distribution : European coastal waters, North Sea Coast. New record for the Indian Coasts.

Diploneis subovalis Cleve (Fig. 2 aa)

Diploneis subovalis Cleve, 1894, p. 96, pl. 1, fig. 27; Venkataraman, 1939, p. 322.

Cells oval, valves elliptical, central nodule large, rounded, furrows narrow, closely following the central nodule and its horns. Costae strong, and far apart alternating with double rows of alveoli, costae 12 in 10 μ. Length of valve 62 μ and breadth 36 μ.

Distribution : Coastal waters of Europe, North Sea Coast, Coasts of India.

Diploneis splendida (Gregory) Cleve
(Fig. 2 ab)

Diploneis splendida (Gregory) Cleve, 1894, p. 87; Hustedt, 1931, p. 712, fig. 1089; Hendey, 1964, p. 227.

Navicula splendida Gregory, 1856, p. 44, pl. 5, fig. 14.

Navicula entomon Donkin, 1870-73, pl. 7, fig. 5.

Valves linear elliptical, constricted in the middle, dividing the valve into two tongue-shaped broadly cuneate segments, furrows somewhat wide and linear, inner margin straight, horns strong, linear and parallel. Beyond the furrows, the valve surface costate, 8 in 10 μ. Length of valve 110 μ and breadth 45 μ.

Distribution : Coastal waters of Europe, British Coast. New record for the Indian Coasts.

Diploneis elliptica (Kutzing) Cleve
(Fig. 2 ad)

Diploneis elliptica (Kutzing) Cleve, 1894, p. 92; Boyer, 1927, p. 355; Wood, 1963, p. 175; Hendey, 1964, p. 226.

Navicula elliptica Kutzing, 1844, p. 98, pl. 30, fig. 55; Van Heurck, 1899, p. 201, pl. 4, fig. 156.

Cells elliptical, valves with broad and rounded apices, central nodule medium in size, furrows narrow, close to the slender horn, uniform breadth throughout. Valve surface punctate, 12 in 10 μ, transverse in the middle, slightly radiate towards the apices. Length of valve 45 μ and breadth 18 μ.

Distribution : Estuaries in North Sea Coast, British Coast, coasts of Australia. New record for the Indian Coasts.

Diploneis chersonensis (Grunow) Cleve
(Fig. 2 ae)

Diploneis chersonensis (Grunow) Cleve, 1894, p. 91; Hustedt, 1931, p. 709, fig. 1088; Hendey, 1964, p. 227, pl. 32, figs. 7-8.

Navicula chersonensis Grunow in Schmidt, 1875, pl. 12, fig. 40; Venkataraman, 1939, p. 196, pl. 26, fig. 738.

Navicula opis Schmidt, 1874, pl. 1, fig. 9.

Valves linear, elliptic, with a deep trans-apical constriction, opposite the central nodule to form ovoid outline, with two tongue shaped segment having round apices. Central nodule small, horns narrow, linear, flanked by narrow linear furrows, having longitudinal lines of punctae and transverse striae, 12 in 10 μ. Length of valve 88 μ and breadth 24 μ.

Distribution : Coasts of Atlantic, North Sea, west coast of Britain, Wales and coasts of Australia. New record for the Indian Coasts.

Genus **Anomoeoneis** Cleve

Anomoeoneis sculpta (Ehrenberg) Cleve
(Fig. 2 af)

Anomoeoneis sculpta (Ehrenberg) Cleve, 1895, p. 6; Boyer, 1928, p. 324; Hendey, 1964, p. 218, pl. 37, fig. 12.

Navicula sculpta Ehrenberg, 1854, pl. 10, figs. 1, 5; Van Heurck, 1899, p. 216, pl. 4, fig. 194.

Cells lanceolate, obtuse apices, axial area narrow, linear, bordered upon each side with a single row of punctae, valve surface striate, 15 in 10 μ, radiate, irregular towards the lateral sides, closely packed near the margin. Length of valve 95 μ and breadth 28 μ.

Distribution : Coastal areas of Britain, France, English Channel, coasts of Australia. New record for the Indian Coasts.

Genus **Trachyneis** Cleve

Trachyneis aspera (Ehrenberg) Cleve
(Fig. 2 ag)

Trachyneis aspera (Ehrenberg) Cleve, 1894, p. 191; Boyer, 1927, p. 428; Subrahmanyan, 1946, p. 183, fig. 408; Hendey, 1964, p. 236, pl. 29, fig. 13.

Navicula aspera Ehrenberg, 1840, p. 213; Van Heurck, 1899, pl. 10, fig. 13.

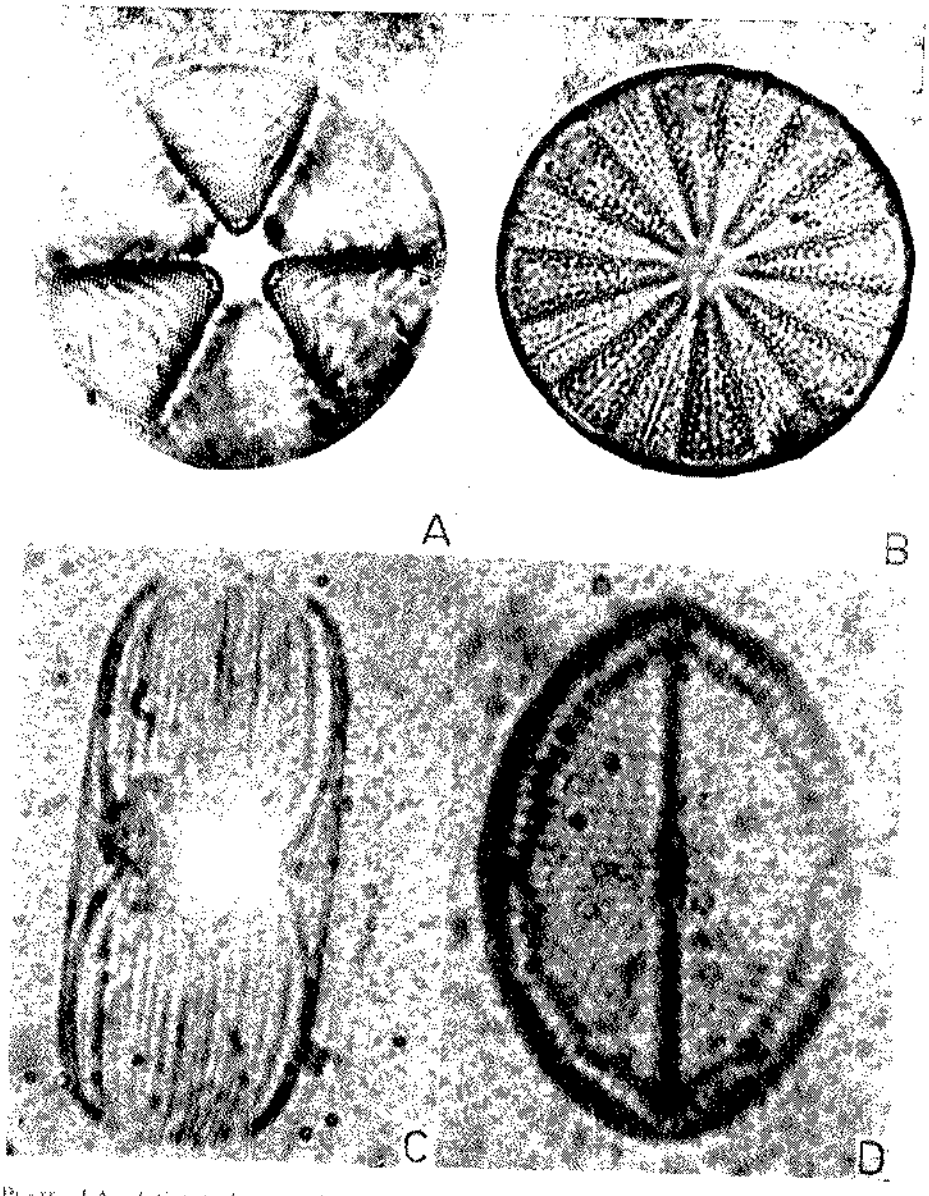

PLATE I A. *Actinoptychus senarius* - valve view; B. *A. splendens* - valve view; *coscinodiscus* - girdle view and D. *Mastogloia cochinsis* sp. nov. - valve view.

Stauroneis pulchella Smith, 1853, p. 61, pl. 19, fig. 194.

Trachyneis aspera var. *pulchella* Cleve 1894, p. 191.

Valves linear-lanceolate, obtuse ends, axial area narrow, central area chilated to form a transverse staurose, slightly widening towards the margin, transapical striae alveolate, 9 in 10 μ, longitudinal striae 22 in 10 μ. Length of valve 145 μ and breadth 35 μ.

Distribution : North Atlantic Coast, Mediterranean Sea Coast, coasts of North Sea, Adriatic Sea and coasts of India.

Trachyneis antillarum Cleve (Fig. 2 ah)

Trachyneis antillarum Cleve, 1894, p. 193; Boyer, 1927, p. 429; Subrahmanyan, 1946, p. 183, fig. 409.

Alloneis antillarum Cleve and Grunow, Cleve, 1878, p. 8, pl. 2, fig. 11.

Scoliopleura antillarum De Toni, 1891-94, p. 265.

Valves linear, elliptical, with obtuse ends. Raphe eccentric, axial area broad, irregularly linear, transverse striae in radial rows alveolate, alveolae 9 rows in 10 μ. Length of valve 118 μ and breadth 45 μ. The main difference between *T. aspera* is the broad nature of the cell and the alveolar arrangement on the surface of the valve.

Distribution : Coastal areas of Britain, Belgium, West Indies, coasts of Sri Lanka and India.

Sub-Family : Amphiproroideae

Genus **Amphiprora** Ehrenberg

Amphiprora gigantea Grunow var. **sulcata** (O'Meara) Cleve (Fig. 2 ap)

Amphiprora gigantea Grunow var. *sulcata* (O'Meara) Cleve, 1894, p. 18; Allen and Cupp, 1935, p. 160, fig. 113; Cupp, 1943, p. 198, fig. 151; Subrahmanyan, 1946, p. 184, figs. 410-413.

Amphiprora sulcata O'Meara, 1871, p. 22, pl. 3, fig. 3.

Cells strongly constricted and sides resemble 'bow' like appearance. Keel with hyaline margin, keel punctate, forming obliquely decussating rows, 15 rows in 10 μ, striae curved, connecting zone with numerous longitudinal divisions, striae on the connecting zone 16 in 10 μ. Length of valve 86 μ and breadth 38 μ.

Distribution : Coasts of North Sea, Java Sea, west coast of N. America, coasts of Australia and India.

Genus **Pleurosigma** Smith

Pleurosigma formosum Smith (Fig. 2 aq)

Pleurosigma formosum Smith, 1853, p. 63, pl. 20, fig. 195; Boyer, 1916, p. 73, pl. 22, fig. 5; Wood, 1963, p. 277, pl. 11, fig. 220; Hendey, 1964, p. 242.

Valves elongated, sigmoid and linear with sub-acute apices. Raphe strongly sigmoid, sweeping across the valve at about middle distance and becoming almost coincident with the convex margin as it approaches the apices. Valve surface, striate, arranged in oblique lines, 14 in 10 μ and in transverse lines 16 in 10 μ. Length of valve 380 μ and breadth 45 μ.

This species is often confused with *P. decorum* Smith, but it is less lanceolate and the apices are a little more obtuse. The striations are more coarse than in *P. decorum*.

Distribution : European coastal waters, coasts of North Sea, Australia and Sri Lanka. New record for the Indian Coasts.

Genus **Gyrosigma** Hassel

Gyrosigma balticum (Ehrenberg) Cleve (Fig. 2 as)

Gyrosigma balticum (Ehrenberg) Cleve, 1894, p. 118 Boyer, 1927, p. 456; Hustedt, 1930, p. 224; fig. 331; Venkataraman, 1939, p. 318, fig. 71; Subrahmanyan, 1946, p. 173, figs. 373-375; Hendey, 1964, p. 248, pl. 35, fig. 9.

Navicula baltica Ehrenberg 1838, p. 180, pl. 13, fig. 10.

Pleurosigma balticum Smith, 1853, p. 66, pl. 22, fig. 207.

Valves linear, sides parallel, sigmoid towards the ends with obtuse apices. Raphe slightly eccentric, sigmoid, having the same sigmoid curvature as the valve margin, central area small, oblique, transverse and longitudinal striae equi-distant, 14 in 10 μ. Length of valve 310 μ and breadth 42 μ.

Distribution : Coasts of Atlantic, North Sea, Britain and Sri Lanka, east and south west coast of India.

Gyrosigma scalproides var. **eximia** (Thwaites) Cleve (Fig. 2 ar)

Gyrosigma scalproides var. *eximia* (Thwaites) Cleve, 1894, p. 118; Hustedt, 1930, p. 226, fig. 339; Venkataraman, 1939, p. 319, fig. 76.

Colletonema eximium Thwaites, 1848, pl. 12, fig. F.

Pleurosigma eximium (Thwaites) Van Heurck, 1899, p. 259, pl. 7, fig. 283.

Valves short, linear, parallel sides and obliquely rounded ends. Raphe slightly sigmoid at the ends, rarely central, transverse striae finely punctate, longitudinal striae very faint. Transverse striae 22 in 10 μ. Length of valve 55 μ and breadth 18 μ.

Distribution : Atlantic Coast, British Coast, west coast of North America, coasts of India.

Sub Order : RAPHIDIODINEAE

Family : *Eunotiaceae*

Sub-Family : *Eunotioideae*

Genus **Eunotia** Ehrenberg

Eunotia monodon Ehrenberg (Fig. 2 aj)

Eunotia monodon Ehrenberg, Smith, 1853, p. 16, pl. 11, fig. 16; Boyer, 1927, p. 221; Hustedt, 1930, p. 185, fig. 254; Venkataraman, 1939, p. 310, fig. 40.

Valves arcuate with the dorsal side well bent, narrow towards the ends, rounded, structures coarse, narrower near ends. Striae 9 in 10 μ. Length of valve 65 μ and breadth 15 μ.

Distribution : Estuaries and coastal waters of Europe, North Sea Coast, coasts of India.

Eunotia diodon Ehrenberg (Fig. 2 ak)

Eunotia diodon Ehrenberg, 1856, p. 192, pl. 21, fig. 23; Van Heurck, 1899, pl. 30, fig. 829; Hustedt, 1930, p. 173, fig. 207.

Valves with ventral margin, concave, dorsal margin showing two slight rounded ridges, apices obtuse, rounded, valves finely punctate, punctae 5 in 10 μ. Length of valve 26 μ and breadth 12 μ.

Distribution : Estuaries of European countries, North Sea Coast, British Coast, coasts of Ireland and Sweden. New record for the Indian Coasts.

Family : *Epithemiaceae*

Sub-Family : *Epithemoideae*

Genus **Epithemia** Brebisson

Epithemia turgida Kutzing (Fig. 2 al)

Epithemia turgida Kutzing, 1856, pl. 5, fig. 14; Van Heurck, 1899, p. 294, pl. 9, fig. 346; Hustedt, 1930, p. 387, fig. 733.

Valves arcuate, apices more or less rostrate, capitate, dorsal margin rather flexed, costate radiant, 4 in 10 μ about 8 radiant rows of coarse elongated beads in the same space, girdle view more or less strongly inflated in the median portion. Length of valve 77 μ and breadth 18 μ.

Distribution : Coastal waters of Europe, North Sea Coast, Japanese waters and Sri Lanka Coast. New record for the Indian Coasts.

Epithemia musculus Kutzing (Fig. 2 an)

Epithemia musculus Kutzing, 1844, p. 33, pl. 30, fig. 6; Smith, 1853, p. 14, pl. 1, fig. 10; Van Heurck, 1899, p. 297, pl. 9, fig. 350; Hendey, 1964, p. 271.

Cells broadly elliptical, sub-orbicular, with dorsal margin strongly arcuate and ventral

margin concave, apices acute, valve complex, consisting of an inner plate, costae radiant, variable in number, moniliform striae, 15 in 10 μ. Length of valve 45 μ and breadth 18 μ.

Distribution : Estuarine waters of Europe, North Sea Coast and coasts of Britain. New record for the Indian Coasts.

Genus **Encyonema** Kutzing

Encyonema prostratum Ralfs (Fig. 2 am)

Encyonema prostratum Ralfs, Van Heurck, 1899, p. 149, pl. 1, fig. 44.

Valves large, dorsal side considerably inflated, ventral side with slight curvature, apices abruptly produced, obtuse and rounded, raphe straight with its median ends slightly arcuate towards the dorsal margin, surrounded by a hyaline zone. Valve surface striated, 7 in 10 μ. Length of valve 75 μ and breadth 22 μ.

Distribution : Estuaries and coastal areas of Europe, North Sea and British Coasts. New record for the Indian Coasts.

Sub-Family : Gomphocymbelloideae

Genus **Amphora** Ehrenberg

Amphora ovalis Kutzing (Fig. 2 ai; 3 c)

Amphora ovalis Kutzing, 1844, p. 107, pl. 5, figs. 35, 39; Van Heurck, 1899, p. 127, pl. 1, fig. 15; Wood, 1963, p. 24.

Cells oval, inflated at the median portion, then slightly attenuate, apices broadly truncate, valves arcuate, at dorsal margin, concave at internal margin, raphe inflexed, striae strongly marked with coarse punctae, 12 in 10 μ. Length of valve 62 μ and breadth 28 μ.

Distribution : Coasts of Atlantic and Pacific, North Sea coast, Coasts of Sri Lanka. New record for the Indian Coasts.

Amphora laevissima Gregory (Fig. 2 ao)

Amphora laevissima Gregory, 1857, p. 41, pl. 4, fig. 72; Schmidt, 1874, pl. 26, fig. 3, 13-14; Van Heurck, 1899, p. 139, pl. 24, fig. 694.

Valves linear, oblong, extremities hyaline, raphe abruptly inflexed towards the median portion, with a broad stauros, striae invisible. Length of valve 62 μ and breadth 28 μ.

Distribution : European coastal waters and North Sea Coast. New record for the Indian Coasts.

Amphora lineolata Ehrenberg (Fig. 3 a)

Amphora lineolata Ehrenberg, 1856, p. 188, pl. 14, fig. 4; Van Heurck, 1899, p. 138, pl. 1, fig. 10; Subrahmanyan, 1946, p. 184, fig. 407; Wood, 1963, p. 22.

Amphora tenera Smith, 1853, p. 20; pl. 30, fig. 252.

Amphora plicata Gregory, 1857, p. 70, pl. 1, fig. 31.

Valves weakly silicified, hyaline, in girdle view rectangular, elliptical, with slightly convex sides. Intercalary bands numerous, 10 in 10μ, raphe with straight branches, axial area narrow, central area absent, transapical striae slightly radial, finely punctate, 18 in 10 μ. Length of valve 92 μ and breadth 44 μ.

Distribution : Coastal waters of Europe, North Sea Coast, west coast of N. America and coasts of India.

Amphora decussata Grunow (Fig. 3 b)

Amphora decussata Grunow, 1877, p. 178; Cleve, 1895, p. 128, pl. 4, fig. 10; Boyer, 1927, p. 267; Allen and Cupp, 1935, p. 161, fig. 116; Subrahmanyan, 1946, p. 185, figs. 414-15; Hendey, 1964, p. 266, pl. 37, fig. 9.

Cells elliptical, valves flat with straight ventral margin and truncate ends, arcuate dorsal margin with somewhat flatenned side from the sub-arcuate apices, giving the valve the appearance of an equilateral triangle. Raphe along the ventral margin, central nodule dilated to form a narrow staurose, striated, 16 in 10μ. Length of valve 98 μ and breadth 46 μ.

Distribution : European coastal waters, North Sea Coast, west coast of N. America and coasts of India.

Amphora ostrearia (Brebisson) Kutzing

(Fig. 3 d; Pl. IV C)

Amphora ostrearia (Brebisson) Kutzing, 1849, p. 94; Van Heurck, 1899, p. 139, pl. 1, fig. 1; Boyer, 1927, p. 265; Subrahmanyan, 1946, p. 185, figs. 418-419; Hendey, 1964, p. 266, pl. 38, fig. 5.

Amphora quadrata Brebisson, Kutzing, 1849, p. 95.

Amphora membranaceae Smith, 1853, p. 20, pl. 11, fig. 29.

Amphora littoralis Donkin, 1858, p. 30, pl. 111, fig. 15.

Valves elliptic-oblong, extremities narrow, rounded ends, arcuate dorsal margin and straight ventral margin, striae well marked on the dorsal side, central nodule dilated transversely to produce a staurose, girdle composed of numerous longitudinal narrow bands which appear as lines, striae 14 in 10 μ. Length of valve 82 μ and breadth 22 μ.

Distribution : Coasts of Pacific, North Sea, British Coast, west coast of N. America and coasts of India.

Amphora laevis Gregory (Fig. 3 h)

Amphora laevis Gregory, 1857, p. 42, pl. 4, fig. 74; Van Heurck, 1899, p. 139, pl. 24, fig. 693; Boyer, 1927, p. 268; Hendey, 1964, p. 267.

Cells rectangular, slightly constricted in the middle, rounded or truncate ends, weakly silicified cell walls, valves narrow, straight ventral margin, surface striated, 22 in 10 μ, crossed by a well-defined staurose, girdle composed of numerous segments and marked with parallel lines. Length of valve 78 μ and breadth 45 μ.

Distribution : Coasts of Atlantic and Pacific, west coast of N. America, Texas Bay, Australian Coasts. New record for the Indian Coasts.

Amphora proteus Gregory (Fig. 3 e)

Amphora proteus Gregory, 1857, p. 518, pl. 13, fig. 81; Van Heurck, 1899, p. 129, pl. 24, fig. 671; Wood, 1963, p. 245, pl. 2, figs. 36a-c; Hendey, 1964, p. 262.

Cells in girdle view elliptic to oblong, parallel sides and rounded ends, valves lunate, surface striate, raphe biarcuate, central area variable. Length of valve 82 μ and breadth 36 μ.

Distribution : Coasts of Atlantic, North Sea, English Channel, Texas and Galvastone Bays, Western Indian Ocean. New record for the Indian Coasts.

Sub-Family : Amphiproroideae

Genus **Tropidoneis** Cleve

Tropidoneis lepidoptera (Gregory) Cleve

(Fig. 3 f)

Tropidoneis lepidoptera (Gregory) Cleve, 1894, p. 25; Boyer, 1916, p. 69, pl. 4, figs. 8-8; Venkataraman, 1939, p. 340, figs. 101, 106; Wood, 1963, p. 284, pl. 12, figs. 251 a, b; Hendey, 1964, p. 256, pl. 36, figs. 2-4.

Amphiprora lepidoptera Gregory, 1857, p. 505, pl. 12, fig. 59b.

Orthotropis lepidoptera Van Heurck, 1899, p. 263, pl. 5, fig. 287.

Cells rectangular, linear oblong, constricted in the middle, valves lanceolate, acute central area small, transversely lanceolate, wing unilateral, projecting above the median line, striae transverse, 18 in 10 μ. Length of valve 245 μ and breadth 35 μ.

Distribution : North Sea Coasts, west coast of N. America, coasts of Australia and India.

Tropidoneis semistriata Grunow (Fig. 3 i)

Tropidoneis semistriata Grunow, Cleve, 1894, p. 27, pl. 3, figs. 9-11; Subrahmanyan, 1946, p. 184, figs. 411-12.

Valves membranaceous, lanceolate, acute and in girdle view slightly constricted in the middle. Keel somewhat eccentric, surface

striated, 16 in 10 μ, not reaching the margin of the valve. Length of valve 128 μ and breadth 22 μ.

Distribution : Coasts of North Sea, Java Sea, N. America, Australia and India.

Tropidoneis antarctica var. **polyplasta** Gran and Angst (Fig. 3 g)

Tropidoneis antarctica var. *poiyplasta* Gran and Angst, 1931, p. 501, fig. 90; Cupp, 1943, p. 198, fig. 150.

Cells elliptical in girdle view, slightly constricted at the central nodule, in valve view lanceolate, with broad ends. Keel median, long, valves with two transverse rod-like thickening at both sides of the central nodule. Cell wall thin, weakly silicified, both transverse and longitudinal striae present, striae 22 in 10 μ.

Distribution : West coast of N. America and North Sea Coast. New record for the Indian Coasts.

Genus **Cymbella** Agardh

Cymbella marina Castracane (Fig. 3 k)

Cymbella marina Castracane, 1886, p. 21, pl. 27, fig. 13; De Toni, 1891-94, p. 359; Subrahmanyan, 1946, p. 187, fig. 416.

Valves linear, elliptical, convex sides and obtuse ends, raphe straight, somewhat broad, axial area narrow, central area slightly dilated, striae radiate 9 in 10 μ. Length of valve 74 μ and breadth 21 μ.

Distribution : West coast of N. America, Japanese coastal waters, coasts of Australia and India.

Cymbella cistula (Hemprich) Van Heurck (Fig. 3 j)

Cymbella cistula (Hemprich) Van Heurck, 1899, p. 147, pl. 1, fig. 41; Boyer, 1927, p. 280; Venkataraman, 1939, p. 344, fig. 136; Wood, 1963, p, 256, pl. 6, fig. 100a.

Cocconema cistula Hemprich in Ehrenberg, 1838, p. 224.

Valves asymetrical, ventral margin swollen, ends rounded, central area dilated on dorsal side, distinct row of punctae on ventral side, striae radial. Length 82 μ.

Distribution : Estuarine regions of North Sea, Texas Bay, coasts of Australia and India.

Family : Nitzschiaceae

Sub-Family : Nitzschioideae

Genus **Nitzschia** Hassal

Nitzschia panduriformis Gregory (Pl. III, Fig. h)

Nitzschia panduriformis Gregory, 1875, p. 529, pl. 14, fig. 102; Grunow, 1880, p. 71; Van Heurck, 1899, p. 386, pl. 15, fig. 500; Boyer, 1927, p. 497; Subrahmanyan, 1946, p. 188, fig. 425; Hendey, 1964, p. 279.

Cells elliptical, slightly constricted in the middle, with pointed extremities. Margin with strongly marked keel, punctae 8 in 10 μ; valve finely punctae, 24 in 10 μ arranged in transverse and oblique lines. Length of valve 85 μ and breadth 24 μ.

Distribution : Coasts of Europe, North Sea Coast, coasts of Britain and India.

Nitzschia sigma (Kutzing) Smith var. **indica** Karsten (Fig. 3 o - p)

Nitzschia sigma (Kutzing) Smith var. *indica* Karsten, 1907, p. 400, pl. 44, figs. 11a-b; Allen and Cupp, 1935, p. 163, fig. 120; Subrahmanyan, 1946, p. 189, figs. 423-24, 430-431.

Synedra sigma Kutzing, 1844, p. 67, pl. 30, fig. 14.

Nitzschia sigma Smith var. *sigma*. Hendey, 1964, pl. 42, fig. 1.

Valves linear, with weakly truncate ends, slightly sigmoid in girdle view, in valve view almost straight, considerably diminish in size at the extremities, elongated, keel distinct, punctae 8 in 10 μ, valve surface striate, striae transverse 16 in 10 μ. Length of valve 285 μ, breadth at the middle 18 μ.

EXPLANATION TO FIGS. 1 TO 3

Fig. 1 a. *Podosira montagnei* - two cells in girdle view; b. *Cyclotella striata* - valve view; c. *Terspinoe musica*- girdle view; d. *Aulicus sculptus* - valve view; e. *Triceratium dubium* - valve view; f. *Triceratium reticulatum* - valve view; g. *Triceratium roberstianum* - valve view; h-j. *Biddulphia pulchella* - girdle views; k. *Biddulphia alternans* - girdle view; l. *Biddulphia aurita* - girdle view; m. *Biddulphia laevis* - girdle view; n. *Biddulphia granulata* - girdle view; o, p. *Lithodesmium undulatum:* o. valve view, p. girdle view; q. *Isthmia nervosa* girdle view; r. *Isthmia enervis* - girdle view; s. *Rhabdonema mirificum* - valve view; t. *Striatella unipunctata* - valve view of two cells; u. *Grammatophora undulata* - cells in girdle view; v. *Licmophora abbreviata* - girdle view; w. *Licmophora ehrenbergii* - girdle view; x. *Licmophora flabellata* - girdle view; y. *Licmophora gracilis* - girdle view; z, aa: *Licmophora juergensii* - z. girdle view, aa. valve view; ab. *Synedra crystallina* - girdle view; ac. *Synedra ulna* - valve view; ad. *Licmophora paradoxa* - girdle view; ae, af. *Climacosphenia moniligera* - girdle and valve views; ag, ah. *Climacosphenia elongata* - girdle and valve views; ai. *Rhaphoneis amphiceros* - valve view; aj. *Synedra superba* - valve view; ak, al. *synedra pulchella* : ak. valve view of a cell and al. colonial habit; am. *Podocystis adriatica* - valve view; an. *Cocconeis scutelum* - valve view; ao, ap. *Cocconeis placentula* - ventral and dorsal valve views; aq. *Cocconeis littoralis* - ventral valve view and ar. *Cocconeis pseudomarginata* - valve view.

Fig. 2 a. *Achnanthes brevipes* - girdle view; b - c. *Achnanthes longipes* - girdle and side view; d. *Mastogloia pumula* - valve view; e. *Mastogloia braunii* - valve view; f. *Mastogloia exigua* - valve view; g. *Mastogloia lanceolata* - valve view; h. *Mastogloia dolosa* - valve view; i. *Mastogloia exili* - valve view; j. *Navicula permagna* - valve view; l. *Navicula lyra* - valve view; m. *Navicula gracilis* - valve view; n. *Navicula gracilis* var. *schizonema* - valve view shows division; o. *Navicula hasta* - valve view; p. *Navicula pygmoea* - valve view; q. *Navicula bicapitata* - valve view; r. *Navicula granulata* - valve view; s. *Navicula monilifera* - valve view; t. *Navicula notabilis* - valve view; u. *Navicula plicata* - valve view; v. *Navicula hennedyei* var. *neopolitana* - valve view; w. *Navicula hennedyei* var. *nebulosa* - valve view; x. *Dictyoneis marginata* - valve view; y. *Caloneis liber* - valve view; z. *Diploneis dydima* - valve view; aa. *Diploneis subovalis* - valve view; ab. *Diploneis splendida* - valve view; ac. *Diploneis smithii* - valve view; ad. *Diploneis elliptica* - valve view; ae. *Diploneis chersonensis* - valve view; af. *Anomoeneis sculpta*- valve view; ag. *Trachyneis aspera* - valve view; ah. *Trachyneis antillarum* - valve view; ai. *Amphora ovalis* - valve view; aj. *Eunotia monodon* - valve view; ak. *Eunotia diodon* - valve view; al. *Epithemia turgida* - valve view; am. *Encyonema prostratum* - valve view; an. *Epithemia musculus* - valve view; ao. *Amphora laevissima* - girdle view; ap. *Amphiprora gigantea* var. *sulcata* - girdle view; aq. *Pleurosigma formosum* - valve view ar. *Gyrosigma scalproides* var. *eximia* - valve view; and as. *Gyrosigma balticum* - valve view;

Fig. 3 a. *Amphora lineolata* - girdle view; b. *Amphora decussata* - girdle view; c. *Amphora ovalis* - girdle view; d. *Amphora ostrearia* - girdle view; e. *Amphora proteus* - girdle view; f. *Tropidoneis lepidoptera* - girdle view; g. *Tropidoneis antarctica* var. *polyplasta* - girdle view; h. *Amphora laevis* - valve view; i. *Tropidoneis semistriata* - valve view; j. *Cymbella cystula* - valve view; k. *Cymbella marina* - valve view; l. *Nitzschia panduriformis* valve view; m. *Nitzschia sigma* - middle portion of the valve enlarged; n. *Nitzschia acuminata* - valve view; o, p. *Nitzschia sigma* var. *indica* : o. entire cell and p. middle portion enlarged; q. *Nitzschia obtusa* - valve view; r. *Nitzschia longissima* - valve view; s- u. *Bacillaria paradoxa* : s and u. two cells in girdle view and t. shows the colonial habit; v. *Hantzschia amphioxys* - valve view; w. *Hantzschia amphioxys* var. *major* - valve view; x. *Hantzschia amphioxys* var. *intermedia* - valve view; y. *Hantzschia amphioxys* var. *vivax* - valve view; z. *Surirella neumeyeri* - valve view; aa. *Surirella fastuosa* - valve view; ab. *Surirella fluminensis* - valve view; ac. *Surirella eximia* - valve view; ad. *Campylodiscus hodgsonii* - valve view; and ae. *Campylodiscus biangulatus* - valve view.

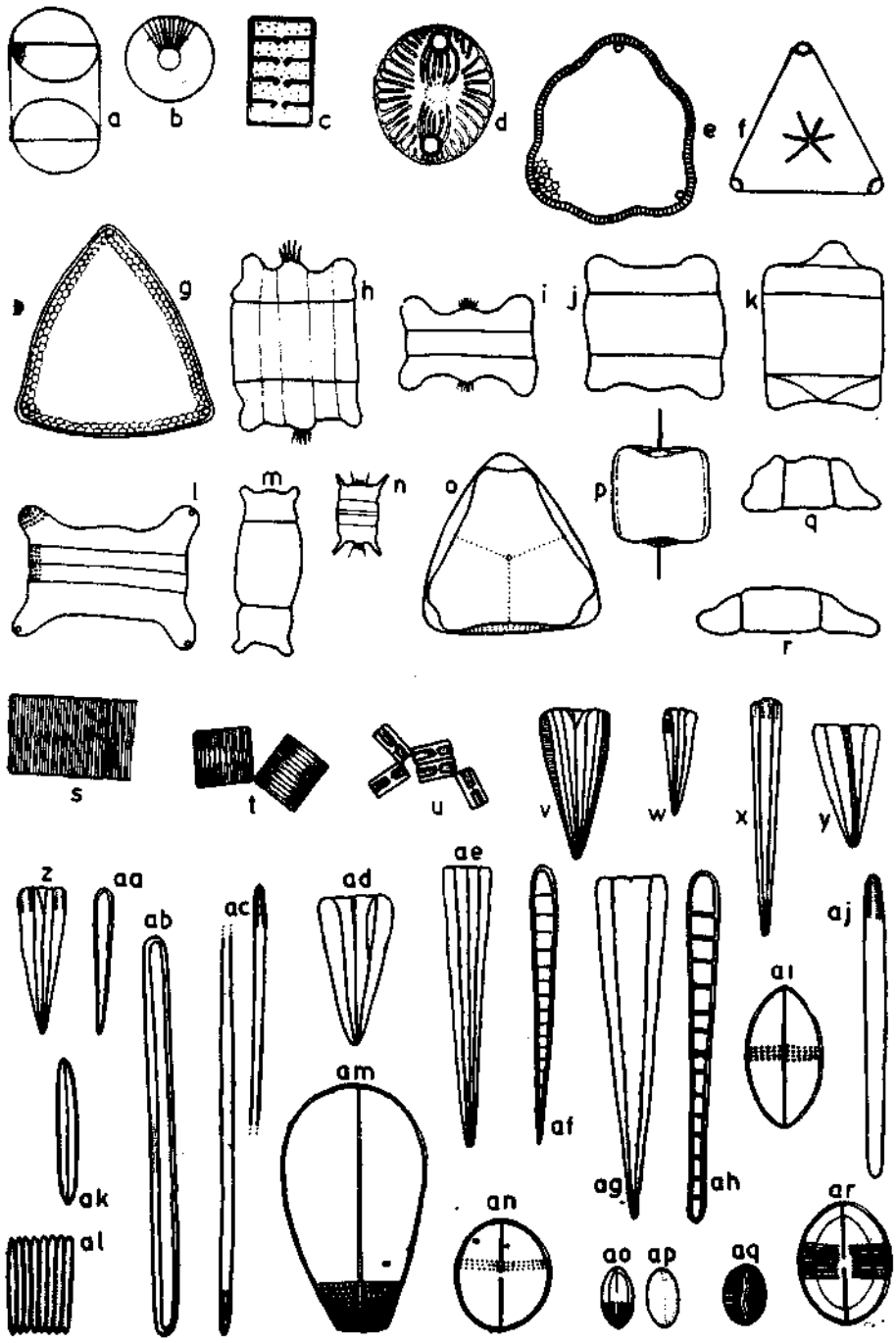

Fig. 1. For explanation, see page 22.

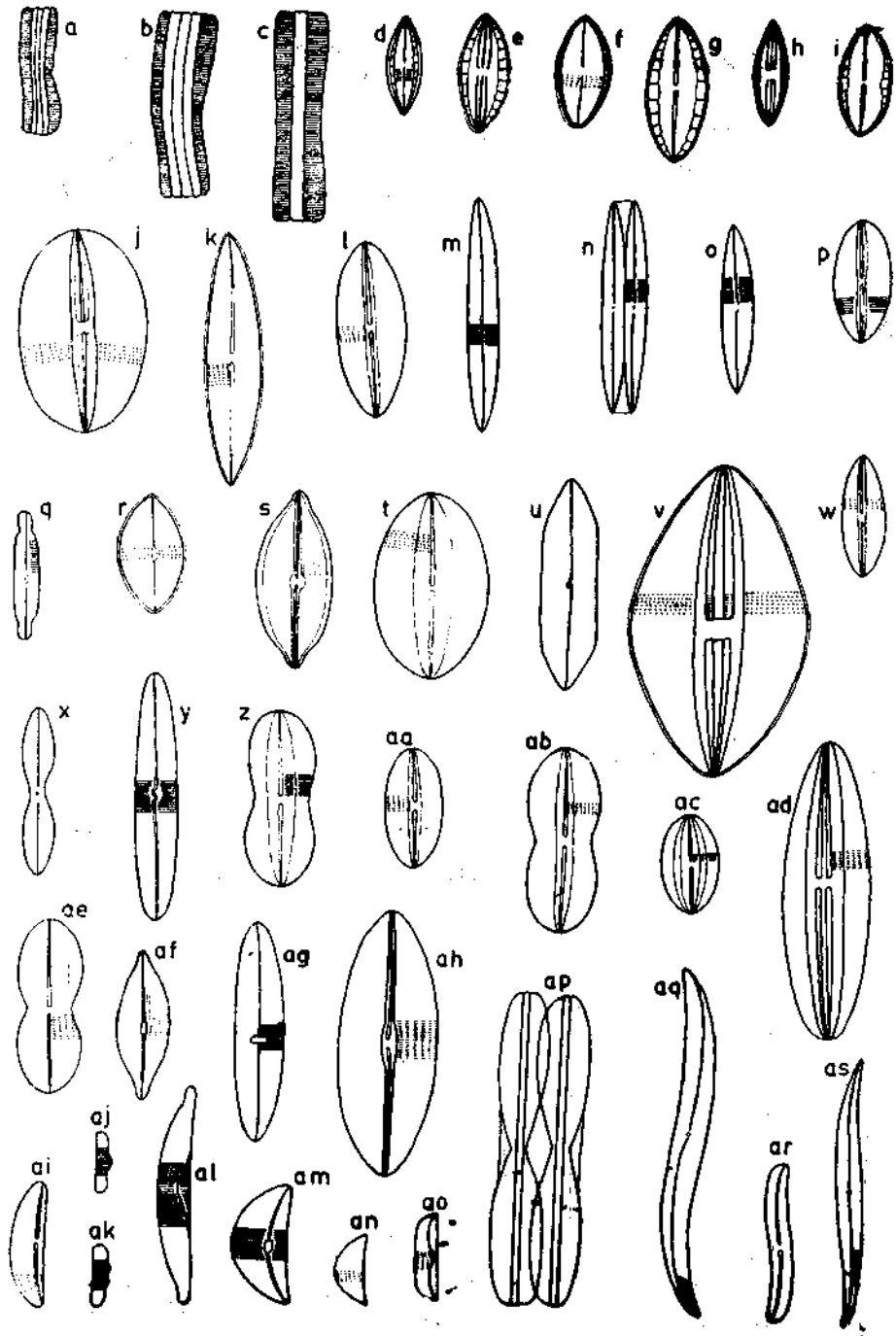

Fig. 2. For explanation, see page 22.

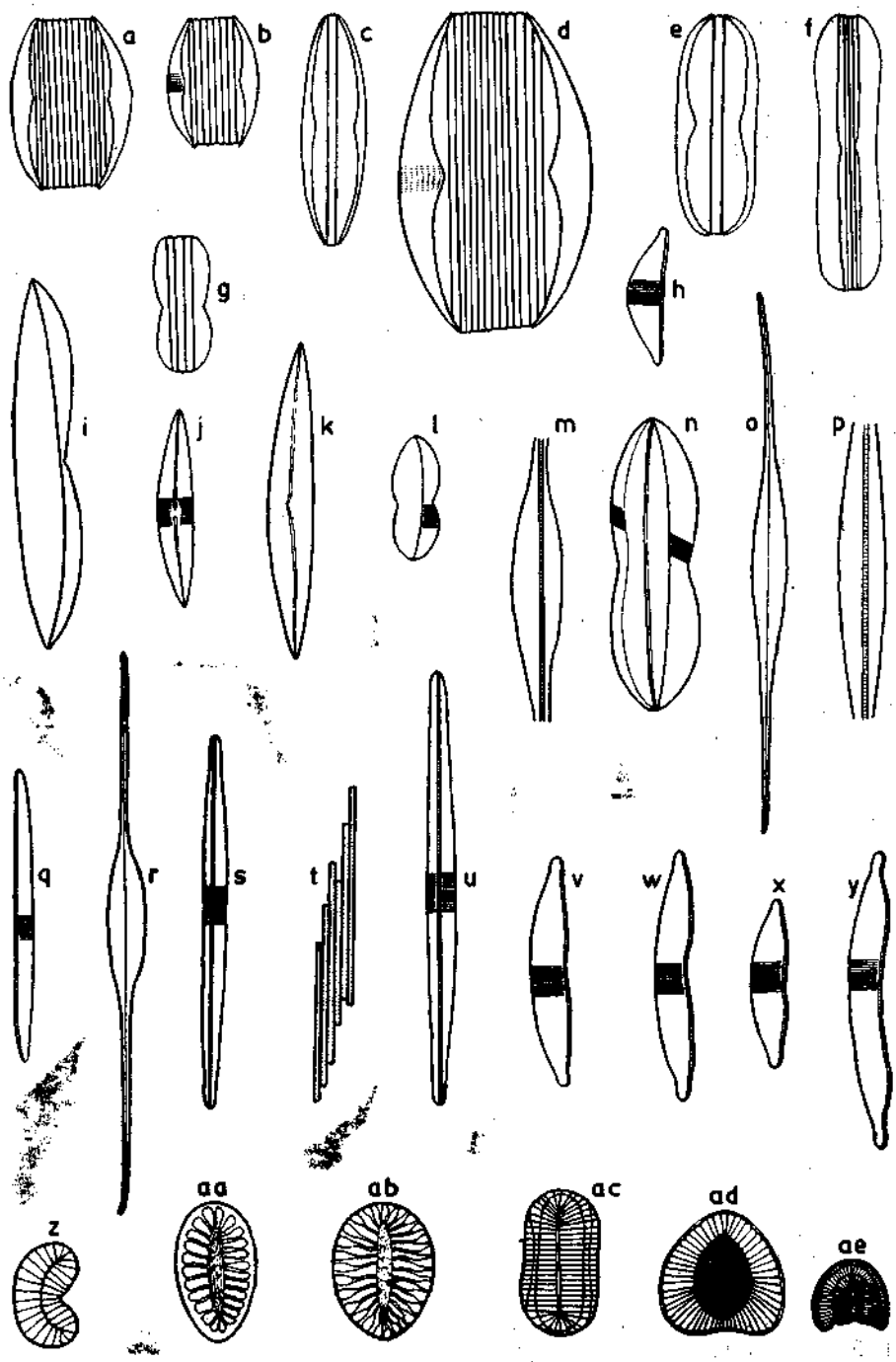

Fig. 3. For explanation, see page 22.

Distribution : Estuaries in Europe, coasts of North Sea, Java Sea, N. America, coasts of India.

Nitzschia acuminata (Smith) Grunow (Fig. 3 n)

Nitzschia acuminata (Smith) Grunow, Cleve and Grunow, 1880, p. 73; Van Heurck, 1899, p. 388, pl. 15, fig. 506; Hendey, 1964, p. 280, pl. 39, fig. 10.

Tryblionella acuminata Smith, 1853, p. 36, pl. 10, fig. 77.

Valves broad and linear, with apiculate apices, valve margin straight, slightly concave, keel marginal, valve surface striate, striae transverse, 7 in 10 μ, interrupted by a longitudinal fold which is hyaline. Length of valve 76μ and breadth 16 μ.

Distribution : Coasts of Europe, North Sea and British Coasts. New record for the Indian Coasts.

Nitzschia longissima (Brebisson) Ralfs (Fig. 3 r)

Nitzschia longissima (Brebisson) Ralfs, Pritchard, 1861, p. 783; Van Heurck, 1899, p. 404, pl. 17, fig. 568; Boyer, 1927, p. 526; Subrahmanyan, 1946, p. 191, figs. 435-437; Hendey, 1964, p. 283.

Ceratoneis longissima Brebisson, Kutzing, 1849, p. 891.

Nitzschia birostrata Smith, 1853, p. 42, pl. 14, fig. 119.

Nitzschiella longissima Rabenhorst, 1864, p. 164.

Valves linear lanceolate, tapering to very long apical extremities, valves straight over the whole length, extremities not curved, marginal keel strong, keel punctae definite, valve surface faintly striate, keel punctae 12 in 10 μ. Length of valve 768 μ.

Distribution : Coastal and estuarine regions of France, Britain, Denmark, North Sea Coast, west coast of N. America, coasts of India.

Nitzschia obtusa Smith (Fig. 3 q)

Nitzschia obtusa Smith, 1853, p. 39, pl. 13, fig. 109; Van Heurck, 1899, p. 397, pl. 16, fig. 539; Wood, 1963, p. 273, pl. 10, fig. 200 a-b; Hendey, 1964, p. 282.

Cells linear, slightly sigmoid at the ends, valves with obtuse apices, keel central, slightly turned in at the margin, keel punctae 6 in 10 μ, the 3 median ones more distant, giving the impression of central nodule, valve surface striate, 22 in 10 μ. Length of valve 182 μ and breadth 18 μ.

Distribution : Coasts of North Sea, North America, Britain, Australia and Texas Bay. New record for the Indian Coasts.

Genus **Bacillaria** Gmelin

Bacillaria paradoxa Gmelin (Fig. 3 s-u)

Bacillaria paradoxa Gmelin, 1788, p. 3903; Smith, 1856, p. 10, pl. 32, fig. 279; Lebour, 1930, p. 211, fig. 175; Venkataraman, 1939, p. 351, figs. 144-45; Subrahmanyan, 1946, p. 187, figs. 417, 421, 427.

Vibrio paxillifer Muller, 1786, p. 54.

Nitzschia paxillifer Huberg in Boyer, 1927, p. 509.

Nitzschia paradoxa Grunow in Cleve and Grunow, 1880, p. 85; Van Heurck, 1899, p. 392, pl. 16, fig. 518.

Bacillaria paxillifer Hendey, 1964, pl. 21, fig. 5.

Cells united by their valves to form a mat-like colony, valves linear, lanceolate with squarish apices, spindle shaped in appearance, keel punctae strong, central valve striate, transverse 18 in 10 μ. Length of valve 115 μ and breadth 12 μ.

Distribution : Coasts of Europe, North Sea, west coast of N. America, Japanese Coast, coasts of Australia and India.

Genus **Hantzschia** Grunow

Hantzschia amphioxys (Ehrenberg) Grunow (Fig. 3 v)

Hantzschia amphioxys (Ehrenberg) Grunow, 1863, p. 103; Van Heurck, 1899, p. 381, pl. 15, fig. 438b; Wood, 1963, p. 263; Hustedt, 1930, p. 345, fig. 11.

Eunotia amphioxys Ehrenberg, 1840, p. 25, pl. 1, fig. 26.

Nitzschia amphioxys Smith, 1853, p. 41, pl. 13, fig. 105.

Cells narrowly rectangular, in girdle view, elongated, narrow and slightly bent in valve view, sides almost straight, keel punctae irregular, striated, 16 in 10 μ. Length of valve 72 μ and breadth 18 μ.

Distribution : Atlantic Coast, west coast of N. America, Texas Bay, coasts of Australia. New record for the Indian Coasts.

Hantzschia amphioxys var. **major** Van Heurck (Fig. 3 w)

Hantzschia amphioxys var. *major* Van Heurck, 1899, p. 381, pl. 15, fig. 484b.

Cells rectangular, much linear and longer than the type species, with 6 carinal dots, valve striate 12 in 10 μ. Length of valve 120μ and breadth 18 μ.

Hantzschia amphioxys var. **intermedia** Van Heurck (Fig. 3 x)

Hantzschia amphioxys var. *intermedia* Van Heurck, 1899, p. 381, pl. 15, fig. 485b.

Cells rectangular in girdle view, linear and longer, slightly constricted in the middle, with 4 carinal dots, striated valve with 11 in 10 μ. Cells similar to the type species except its slightly bigger size and shape. Length of valve 85 μ and breadth 16 μ in the middle.

Hantzschia amphioxys var. **vivax** Van Heurck (Fig. 3 y)

Hantzschia amphioxys var. *vivax* Van Heurck, 1899, p. 381, pl. 15, fig. 486b.

Valves slender, long, rostrate, 5 carinal dots and 13 striae in 10 μ., slightly squarish at the apices in girdle view, much bigger than the type species. Length of valve 92 μ and breadth 14 μ.

Distribution : Estuaries in Britain, coastal areas of North Sea. New record for the Indian Coasts.

Family : *Surirellaceae*

Sub-Family : *Surirelloideae*

Genus **Surirella** Turpin

Surirella neumeyeri Janish (Fig. 3 z)

Surirella neumeyeri Janish, 1862, pl. 31, fig. 33; Schmidt, 1886, pl. 56, fig. 1; Wood, 1963, p. 210, pl. 4, fig. 100.

Surirella nervatus Grunow, Lefe'bre, 1947, pl. 31 fig. 6.

Valves reniform, radiating septa, reniform axial area, surface of valve hyaline, striae indistinct. Length of valve 62 μ, breadth 28 μ.

Distribution : Coasts of North Sea, Britain and Australia. New record for the Indian Coasts.

Surirella fastuosa (Ehrenberg) Kutzing (Fig. 3 aa)

Surirella fastuosa (Ehrenberg) Kutzing, 1844, p. 69, pl. 28, fig. 19; Smith, 1853, p. 32, pl. 2, fig. 66; Van Heurck, 1899, p. 372, pl. 13, fig. 583; Hendey, 1951, p. 75, pl. 9, fig. 7; Huang, 1979, p. 201, pl. 6, fig. 5.

Navicula fastuosa Ehrenberg, 1840, p. 214.

Valves broadly oval, costae robust, directed towards the margin, become narrow to the central space, lanceolate and hyaline. Valve surface striate, delicate, 20 in 10 μ. Length of valve 65 μ and breadth 42 μ.

Distribution : Estuaries of the coasts of North Sea, British Coast, west coast of N. America and Texas Bay. New record for the Indian Coasts.

Surirella fluminensis Grunow (Fig. 3 ab)

Surirella fluminensis Grunow, 1862, p. 463; Schmidt, 1875, pl. 5, fig. 6; Allen and Cupp, 1935, p. 164, fig. 126; Subrahmanyan, 1946, p. 102, fig. 438.

Suriraya fluminensis Grunow in Rabenhorst, 1864, p. 58.

Valve ovate, broad, ribs or canaliculi few on the valve surface, inflated towards the

margin, except 2 pairs at the ends. Central region linear and large, marginal striae 18 in 10 μ. Length of valve 55 μ and breadth 35 μ.

Distribution : Coasts of North Sea, Java Sea, N. America, Adriatic Sea and coasts of India.

Surirella eximia Greville (Fig. 3 ac)

Surirella eximia Greville, 1857, p. 10, pl. 3, fig 6; Subrahmanyan, 1946, p. 192, fig. 439; Nair, 1959, p. 48.

Suriraya eximia (Greville) De Toni, 1891-94, p. 585.

Valves linear oblong, rounded ends, slightly constricted in the middle, canaliculate delicate, 18 in each side, reaching the narrow linear space and attenuate from ring-like space near the margin. Length of valve 92 μ and breadth 43 μ.

Distribution : North Sea Coast, British Coast, West Indies, coasts of India.

Sub-Family : Campylodiscoideae

Genus **Campylodiscus** Ehrenberg

Campylodiscus hodgsonii Smith (Fig. 3 ad)

Campylodiscus hodgsonii Smith, 1853, p. 29, pl. 6, fig. 63; Van Heurck, 1899, p. 376, pl. 32, fig. 868; Boyer. 1927, p. 549: Hendey, 1964, p. 291.

Valves sub-orbicular, nearly circular, canaliculi numerous, 3 in 10 μ, equal in length, about one third of the radius of the valve, central area punctate, arranged in radiating lines, interrupted by a linear median space. Length of valve 85 μ and breadth 78 μ.

Distribution : Estuaries in west coast of N. America, North Sea Coast and coasts of Britain. New record for the Indian Coasts.

Campylodiscus biangulatus Greville (Fig. 3 ae)

Campylodiscus biangulatus Greville, 1863, p. 4, fig. 2; Schmidt, 1895, pl. 14, figs. 18-22; Wood, 1963, p. 249, pl. 4. fig. 60.

Valve heart-shaped, strongly concolute, costae strong, bifurcate near margin, reaching linear ovate median space, coastae strong in valve view than girdle view, 3 in 10 μ. Length of valve 65 μ and breadth 35 μ.

Distribution : Estuarine and coastal waters of Europe, west coast of N. America, sediments of Texas Bay. New record for the Indian Coasts.

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