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MANGROVE ECOSYSTEMS

A MANUAL FOR THE ASSESSMENT OF BIODIVERSITY

A follow up of the
National Agricultural Technology Project
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Mangrove Ecosystem Biodiversity :
Its Influence on the Natural Recruitment of
Selected Commercially Important Finfish and Shellfish
Species in Fisheries

Edited by :
Dr. George J. Parayannilam

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Micro Algae

C. P. Gopinathan, P. K. Jayasurya, M. Kaliamoorthy and Sunirmal Giri

The present work pertains to the micro flora of selected mangroves of India. The littoral diatoms are found to occur in the sediment as well as attached to the decaying leaves of mangrove plants. Few of them are true plankton, which are brought to the mangroves during high tide.

Altogether 48 genera and 2 general of blue green have been described under which 80 species have been found in the Indian mangroves. The systematic position of the common littoral diatoms is given below (genera only):

Class	Bacillariophyceae
Order	Centrales
Sub order	Discoideae
Family	Coscinodiscae
Subfamily	Melosirineae

1. Genus : *Melosira* Agardh

Cells forming closely fitting long chains, disc shaped, papilla like structures at the border of the valve, those of the neighbouring cell fitting into the depression between this papillae and thus helps to hold together. Chromatophores numerous, disc shaped. Length of valve 20-30µ.

2. Genus: *Stephanopyxis* Ehrenberg

Cells cylindrical with arched end faces; valves convex, number of cells joined together by their spines to form chain, spines numerous arranged in a ring and enlarged at the base. Diameter of the cell 50-110µ.

3. Genus *Podosira* Ehrenberg

Cells round cylindrical, united to form short chains, attached to decaying leaves. Cell wall areolated, in valve view the areolate arranged in straight oblique lines. Girdle composed of inter-calary bands. Length 42-50 µ.

4. Genus *Cyclotella* Kutzing

Cells discoid, rectangular, valve with two distinct surface areas, the central portion coarsely punctate,valve surface striated. Diameter of the valves 40-45µ.

Family	Actinodisceae
Subfamily	Actinoptichineae.

5. Genus : *Skeletonema* Greville

Frustules weakly silicified, lens shaped with rounded ends, forming long slender chains with the aid of marginal spines which run parallel to the axis of the chain. Chromatophores two plates which are at times dissected. No visible structures on the valve. Diameter of the cell 10-15µ.

6. Genus: *Thalassiosira* Clev

Cells disc shaped forming a colony enclosed in muscilage. Valves weakly silicified, chromatophores numerous disc shaped. Structure on the valve not visible. Diameter of the cell 30-55 µ.

Family	Actinodisceae
Sub Family	Asterolamprineae

7. Genus: *Asteromphalus* Ehrenberg

Cells slightly convexed, valves ovate, middle field exentric, sector lines of middle unbranched, hyaline rays 7-8, one slightly narrower reaching margin of the valve. Rays slightly corved. Border segments aerolated in 3 line system. Length of valve 35-60 and breadth 30-50 µ.

Family	Eupodisceae
Sub Family	Aulicodiscineae

8. Genus *Actinoptychus* Ehrenberg

Cells discoid, valves divided into 6 sectors, alternatively raised and depressed. Central area hexagonal, hyaline. The raised sectors posses a short blunt process in the middle near the margin. Valve surface strongly areolated. Depressed sectors without processes. Diameter of valve 50-60µ.

Family Biddulphieae

Subfamily Biddulphineae

9. Genus *Biddulphia* Gray

Valves elliptical with swollen margins, strongly sculptured with a few ribs inside. Two blunt, rounded processes at the corners, areolations both valve and girdle. Cells forming long or short chains, by attachment with mucilage pads at blunt end of their processes. One of the common forms found in mangrove habitats when salinity is high. Cell length from 60-90µ.

Sub Family Triceratineae

10.Genus *Lithodesmium* Ehrenberg

Cells forming long chains. Valve plane triangular, corners rounded. Valve with a small spine at the center. Sides of valve measuring 40-50µ, membrane punctate.

11.Genus *Triceratium* Ehrenberg

Cells box like with three-cornered valve plane and short per valve axis. Sides of valve slightly convex, the corners rounded. Blunt processes present. Cell wall strongly sculptured, areolate. Areolae in regular rows, almost of the same size. Chamber openings clear, girdle band areolated, punctate. Length of valve 65-150µ.

Order Pennales

Suborder Araphideae

Family Fragilarioideae

12.Genus: *Bellerochea* Van Heurck

Cells flat, forming ribbon-like chains, weakly silicified, valve with a rudimentary central knob and punctate in the margin. Apertures slit-like, closed in the middle by rounded valves. Chromatophores numerous, disc shaped, Length of the cell 50-78 µ.

Family Hemiaulineae

13.Genus : *Cerataulina* Paragalle

Cells cylindrical, elongated along per valvar axis, forming long chains. At the margin of the valve two short cylindrical processes with hair like spines on them. Apertures small. Structures on valve not clear. Apical valve measuring 12-26µ.

14.Genus *Aulicodiscus* Ehrenberg

Cells disc shaped, valves without radial elevations, three distinct processes of the valve, knob like, placed equally apart. A number of pore canals a little within the border. Chromotophores several lobed disc with a central pyramid. Diameter of the cell 74-114 µ.

Sub order Solenoideae

Family Solenieae

15.Genus : *Shroederella* Pavillard

Cells cylindrical with more or less slightly convex, valves depressed in the middle, cells bound in chains. Valves with a crown of spines in the center, a spine-like pore canal present. Diameter of the cell 14-39µ.

16.Genus: *Chaetoceros* Ehrenberg

Cells cylindrical forming straight chains. Tiny spines at the center of the valve. Terminal setae strongly divergent, thicker than the rest. Outer setae of the end cells different. Chromatophores numerous. Length may vary from 35-75 µ.

17.Genus *Rhabdonema* Kutzing

Cells in girdle view ribbon shaped with hyaline rounded corners forming more or less long bands. Intercalary bands numerous, valves linear, transversely striate, valve view not observed. Length of valve 80-120µ.

18.Genus *Grammatophora* Ehrenberg

Frustules quadrangular with rounded angles, septa slightly undulate, valves linear-oblong, several times constricted in longer individuals, broad and widened in the middle, ends capitulate 20-70µ long and 10-15µ broad, striae not clearly visible.

19.Genus *Licmophora* Agardh

Frustules in girdle view cuneate with strongly rounded angles. Lower end attached to mucous stalk, cells forming colonies. Septa projecting into the cell. Valves lanceolate with margins, sub-parallel towards the apex, narrowed and elongated towards the base. Pseudoraphe distinct. Length of the cell 30-75µ and breadth 12-15µ.

20. Genus *Climacosphenia* Ehrenberg

Frustules on short branched mucilage stalks, epiphytic forming colonies, narrow with upper margin rounded at the angles, or sub-quadrate. valves clavate, rounded at the apex, elongated below transversed longitudinally by two parallel lines, cell length 90-800µ and breadth 20µ at the top and 7-10µ at the base.

21. Genus: *Climacodium* Grunow

Cells even, flat, forming very long ribbon-shaped chains, in girdle view with small linear middle part at

the poles of the apical axis with more or less slender processes. Intercalary ban absent. Membrane structures not visible. Apical axis 100-160µ in length.

22.Genus: *Streptotheca* Shrubsole

Cells square to rectangular, membranaceous forming long chains, which are at time twisted on its own axis. Chromotaphores numerous, disc shaped.

Order	Pennales
Sub Order	Araphidineae
Family	Fragilarioideae

23.Genus: *Thallassiothrix* Cleve and Grunow

Frustules free, thread like often slightly curved, valves linear cells forming zig- zag chains, slender, both tendency in the same chain. Length: 90-210 µ.

24.Genus *Rhaphoneis* Ehrenberg

Frustles lanceolate, inflated at the center, 20-40µ long, valve areolated, close together. Pseudoraphe narrow in the center and slightly dilated at the pole. The cells grow attached to particles or dirt on other algae.

25.Genus *Synedra* Ehrenberg

Valves linear, gradually attenuate to the rounded ends,140-300µ long, 20-35µ broad, cell wall porous, pores enclosed inside and appearing as small openings. Valves with 3 longitudinal ribs hence as four series of openings. Outer membrane finely areolate-punctate. Between two ribs double series of areolae.

Suborder	Monoraphideae
Family	Acanthoideae
Subfamily	Coconeideae

26.Genus *Cocconeis* Ehrenberg

Cells elliptic, 20-40µ long and 15-20µ broad, raphe less valve with three well defined hyaline areas demarcated by striated bands. Valve with raphe, the striae are radial, raphe sigmoid, axial area narrow dilating into a very small central areas.

Sub Family *Achnanthaceae*

27.Genus *Achnanthes* Bory

Valves lanceolate with scarcely drawn out rounded ends. The cells35-45µ and 1-16µ broad. Raphe-less valve with robust transapical ribs, perpendicular to the middle lines, crossed by delicate longitudinal ribs. Pseudoraphe long, linear. Valve with raphe thread-like, axial area narrow, widened in the middle a little. Central area having a small cross band about half the valve breadth. Transapical strea radial and throughout.

Sub Order	Biraphidea
Family	Naviculoidae
Sub Family	Naviculeae

28.Genus *Mastogloia* Thwaites

Valves lanceolate with more or less constricted bluntly rounded ends, 20-22µ long and 10µ broad. Raphe straight, axial area very narrow, central area widened and connected to two small half lanceolate areas, together forming an ”H“ shaped figure. Transapical strreae fine, radial, 20-24µ. Loculi bigger in the middle, the outermost ones slightly smaller.

29.Genus *Gyrosigma* Hassal

Valves linear with slightly truncate and obtuse ends, 300-340µ long, 30-38µ broad. Raphe slightly excentric and somewhat flexciose. Central area small, oblique, with transverse and longitudinal striae equidistant.

30.Genus *Pleurosigma* Smith

Valves scarcely sigmoid, lanceolate, tapering from the middle to the sub-acute ends, 75-140µ long and 15-30µ broad, raphe slightly sigmoid and central.

31.Genus *Diploneis* Ehrenberg

Valves strongly with sub-elliptical ends,30-55µ long and 12-20µ broad and at the constriction 8-14µ broad. Central nodule with approximate horns. Transverse costa 9 in 10µ,crossed by equidistant longitudinal costae curved outwards in the middle of the valve.

32.Genus *Navicula* Bory

Valves elliptic, rhombic, elongated with acute ends,35-90µ long,axial area narrow, central area small, striated, radial. Widely distributed form in coastal and mangrove ecosystem.

33.Genus *Trachyneis* Cleve

Valves linear, lanceolate with obtuse ends, 55-220µ long and 12-22µ broad, axial area broad,truncate, not reaching the site. Transapical striae alveolate, longitudinal striae very fine.

34.Genus *Amphiprora* Ehrenberg

Cells strongly constricted, keel with hyaline margin. Junction line curved like a box. Cells 65-90µ long. Keel punctae forming obliquely decussating

rows, striae curved, connecting zone with numerous longitudinal divisions.

35.Genus *Tropidoneis* Cleve

Valves membranaceous, lanceolate, acute, in girdle view slightly constricted, 125µ long and 20µ broad. Keel somewhat excentric striae not reaching the margin of the valve.

36.Genus *Amphora* Ehreberg

Frustules hyaline, weakly silicified, in girdle view rectangular, elliptical with slightly convex sides 70-95µ long, 32-55µ broad, intercalary bands numerous. Raphe with straight branches which run back from the central dorsal-ward. Axial area narrow, central area absent. Trasapical striae slightly radial, finely punctate.

37.Genus *Cymbella* Agardh

Cells linear, ventral margin straight, dorsal arcuate, raphe somewhat broad, axial area narrow, central area slightly dilated,striae radial, common form in littoral zone.

38.Genus *Bacillaria* Gmelin

Cells in girdle view linear and rectangular, united by their valves to form a mat like colony, the individual cells of which exhibit gliding movements in the living conditions. Valves linear. Spindle shaped in outline 112-120µ long and 7-10µ broad. Keel punctate and transapical striae fine.

39.Genus *Nitzchia* Hassal

Cells elliptical, linear. Slightly constricted to the middle extremities somewhat pointed, in valve view almost straight considerably diminished in size at the extremities and elongated, 80-300µ long, 15-20µ broad, keel punctate.

40.Genus *Hantzschia* Grunow

Cells narrowly rectangular in girdle view, elongated, narrow and slightly bent in valve view, sides almost straight, keel punctate, irregular, striated. Length of valve 70-78µ and breadth 18-20µ.

Sub Order Raphidiodineae
Family Eunotiaceae

41.Genus *Eunotia* Ehrenberg

Valves arcuate with the dorsal side well bent, narrow towards the ends, rounded striated, coarse, striated. Length of valve 60-70µ and breadth 15-18µ.

Family Epithemiaceae

42.Genus *Epithemia* Brebisson

Valves arcuate, apices more or less rostrate, capitate, dorsal margin rather flexed, coste, radiant, girdle view more or less strongly inflated in the median portion. Length of valve 75-60µ and breadth 15-20µ.

43.Genus *Podocystis* Bailey

Epiphytic diatom, attached to higher algae or decaying leaves of mangroves by means of short mucous stipe or pad. Valves broadly ovate or balloon shaped, having the lower end slightly flattened. Valve surface with a median pseudoraphe and transverse costae between which are two rows of areolae, alternatively arranged. Length of valve 100-110µ and breadth 60-65µ.

44.Genus *Isthmia* Agardh

Cells are united to form short chains, epiphytic form, valves elliptic without costae, but well developed girdle with two distinct poles, one short and other slightly big. Valve surface and girdle areolated. Length of cell 70-75µ.

Family Surirellaceae

45.Genus *Surirella* Turpin

Valves oval and reniform, radiating septa, reniform axial area, surface of valve hyaline, striae indistinct, length of valve 60-65µ and breadth 25-40µ.

46.Genus *Campylodiscus* Ehrenberg

Valves sub-orbicular, nearly circular, cannaliculate, 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 85µ and breadth 75µ.

47. Genus *Aulicus* Ehrenberg

Cells disc shaped with broadly elliptic valvar plane,long axis 45-50µ and short axis 40-42µ. Two hyaline 'eye' of 12µ in diameter present opposite to each other. Valves sculptured with strong radial ribs which became faint, towards the center. Valves radially striated, central area hyaline, more or less oblong with round structures.

48.Genus *Encyonema* Kutzing

Valves large, dorsal considerably inflated, ventral side with slight curvature, apices abruptly produced, obtuse and rounded, raphe straight with the medium ends, slightly areolated towards the dorsal margin surrounded by a hyaline zone. Valve surface striated. Length of valve 75µ and breadth 25µ.

Phylum	Cyanophyceae
Class	Nostocales
Family	Oscillatoriaceae

49.Genus : *Oscillatoria* Vaucher

Trichome single or forming a flat or spongy free. Swimming thallus, sheath absent, end of trichome pointed, bend like a sickle or coiled. Present in stagnant water bodies.

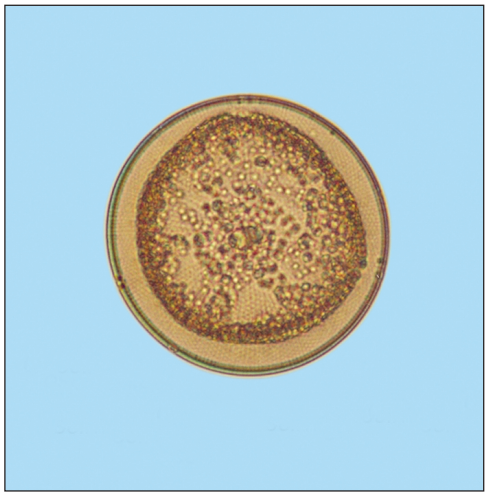
50.Genus: *Phormidium* Kutzing

Filaments forming a gelatinus or leathery stratum, sheath present, thin and colourless, trichomes cylindrical, apices attenuated, spirally coiled, apices with calyptra: Present in stagnant water bodies.

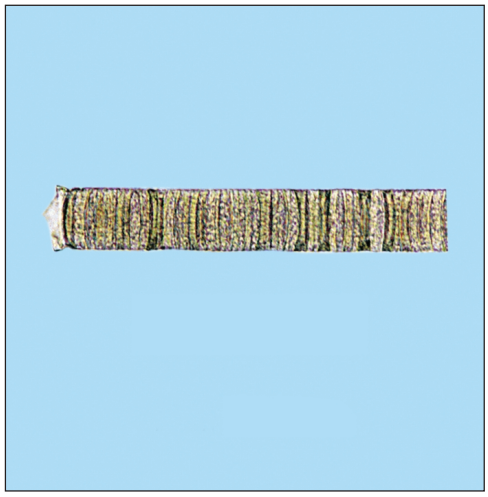
Common green algae, blue green and macro algae occurring in Mangroves

Due to the tidal influence and mixing of fresh and marine water in the mangrove ecosystem, several species of green, blue green algae and seaweeds enter in the mangrove waters. The common forms seen in mangrove areas are species of *Scenedesmus, Oocystis, Chlorella, Ulothrix, Cladophora, Oedogonion,* and *Chara*(all are Green micro algae) and species of *Spirulina, Anabaena, Nostoc, Oscillatoria* and *Lyngbya*(all are blue green algae) and species of macro algae are seaweeds comprises *Chaetomorpha, Enteromorpha* and *Ulva*.

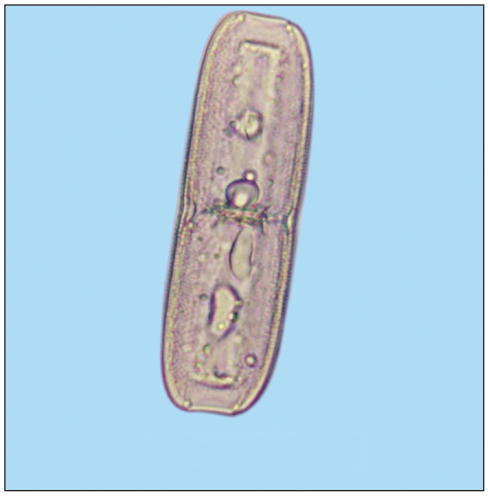
Very common species of micro algae in the mangroves



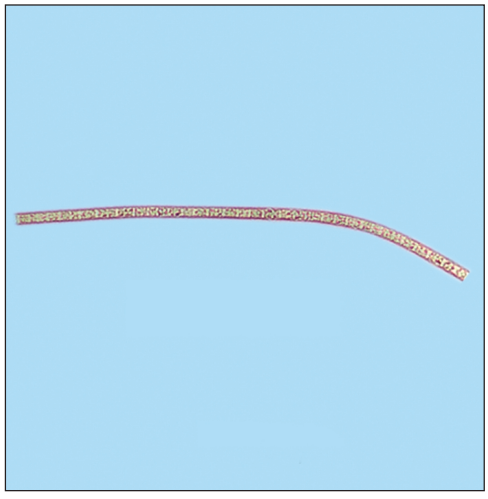
Coscinodiscus excentricus (valve view)



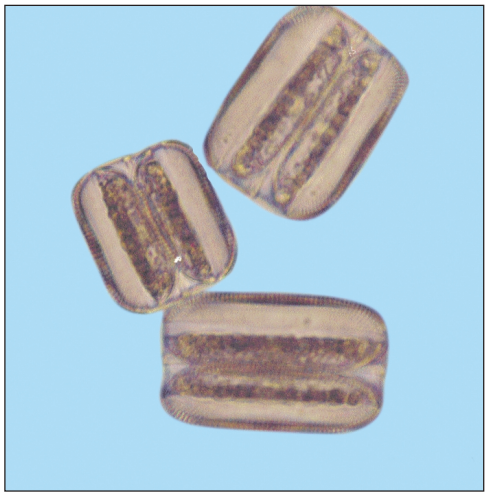
Phormidium sp.



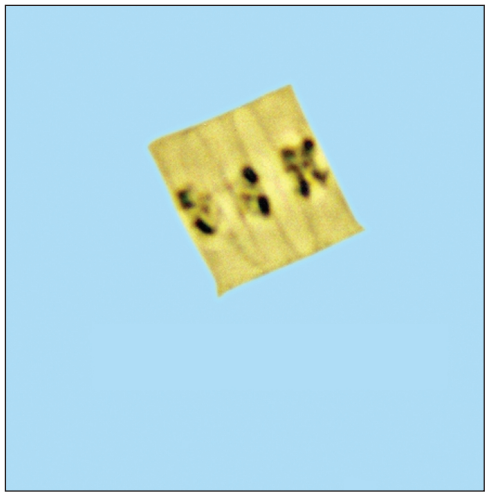
Amphora decussata



Oscillatoria sp.



Coscinodiscus excentricus (girdle view)



Chaetoceros lorenzianus

Fig. I

1. *Podosira montagni* - two cells in girdle view
2. *Cyclotella striata* - valve view
3. *Terspinoe musica* - gridle view
4. *Aulicus sculptus* - valve view
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l2. *Biddulphia aurita* - girdle view
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39. *Podocystis adriatica* - valve view
40. *Cocconeis scutelum* - valve view
41-42. *Cocconeis placentual* - ventral and dorsal valve views
43. *Cocconeis littoralis* - ventral valve view
44. *Cocconeis pseudomarginata* - valve view

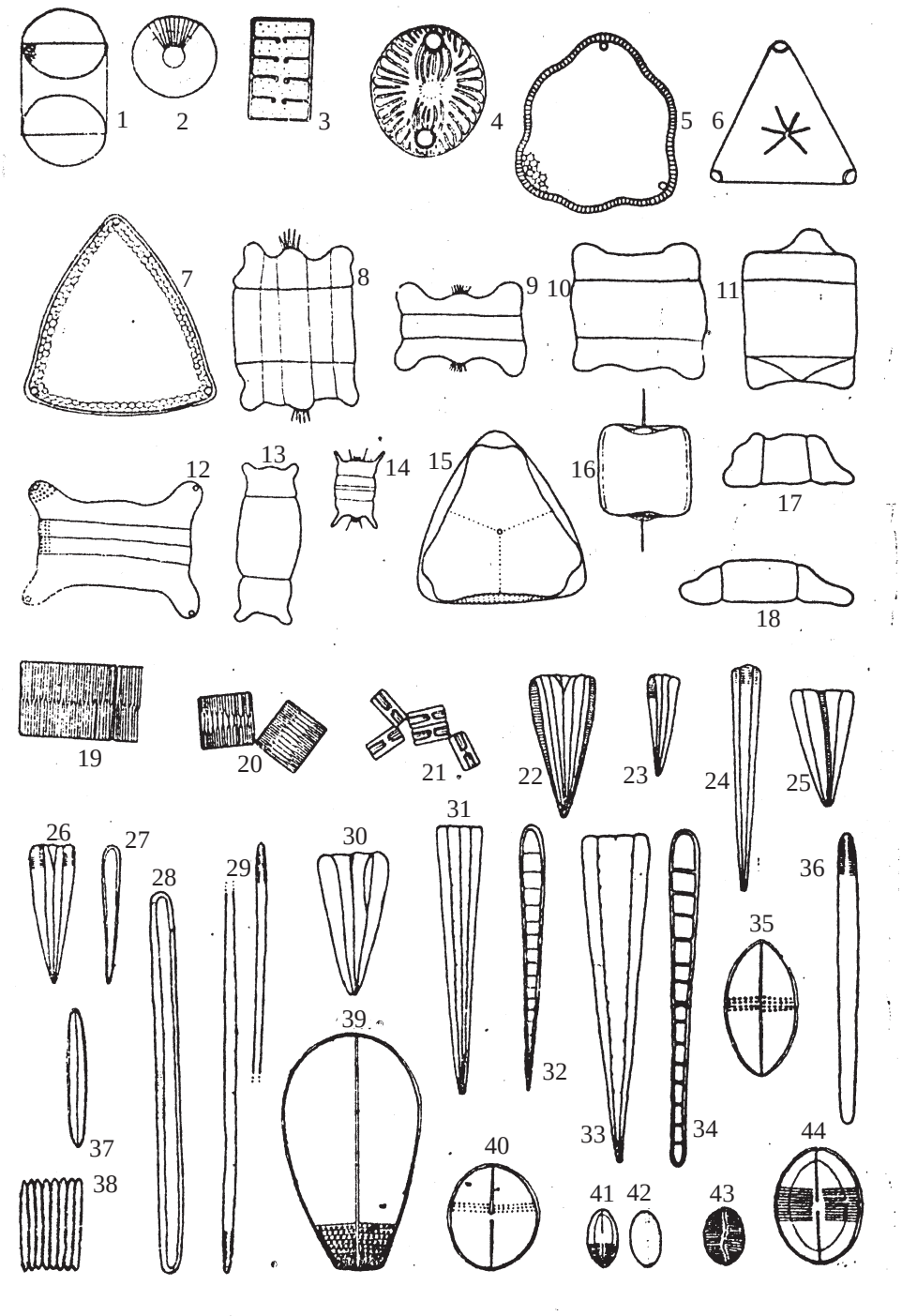
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Fig. I

Fig. II

1.	*Achnanthes brevipes*	-	girdle view
2-3.	*Achnanthes longipes*	-	girdle and side view
4.	*Mastogloia pumula*	-	valve view
5.	*Mastogloia braunii*	-	valve view
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7.	*Mastogloia lanceolata*	-	valve view
8.	*Mastogloia dolosa*	-	valve view
9.	*Mastogloia exili*	-	valve view
10.	*Navicula permagna*	-	valve view
11.	*Navicula forcipata*	-	valve view
12.	*Navicula lyra*	-	valve view
13.	*Navicula gracilis*	-	valve view
14.	*Navicula gracilis* var. *schizonema*	-	valve view shows division
15.	*Navicula hasta*	-	valve view
16.	*Navicula pygmoea*	-	valve view
17.	*Navicula bicapitata*	-	valve view
18.	*Navicula granulata*	-	valve view
19.	*Navicula moniligera*	-	valve view
20.	*Navicula notabilis*	-	valve view
21.	*Navicula plicata*	-	valve view
22.	*Navicula hennedyel* var. *neopolitana*	-	valve view
23.	*Navicula hennedyei* var,. *nebulosa*	-	valve view
24.	*Dictyoneis marginata*	-	valve view
25.	*Caloneis liber*	-	valve view
26.	*Diploneis dydima*	-	valve view
27.	*Diploneis subovalis*	-	valve view
28.	*Diploneis splendida*	-	valve view
29.	*Diploneis smithii*	-	valve view
30.	*Diploneis elliptica*	-	valve view
31.	*Diploneis chersonensis*	-	valve view
32.	*Anomoeneis sculpta*	-	valve view
33.	*Trachyneis aspera*	-	valve view
34.	*Trachyneis antillarum*	-	valve view
35.	*Amphiphora gigantea* var. *sulcata*	-	valve view
36.	*Pleurosigma formosum*	-	valve view
37.	*Gyrosigma scalprodies* var. *eximia*	-	valve view
38.	*Gyrosigma balticum*	-	valve view
39.	*Amphora ovalis*	-	valve view
40.	*Eunotia monodon*	-	valve view
41.	*Eunotia diodon*	-	valve view
42.	*Epithemia turgida*	-	valve view
43.	*Encyonema prostratum*	-	valve view
44.	*Epithemia musculus*	-	valve view
45.	*Amphora laevissima*	-	girdle view

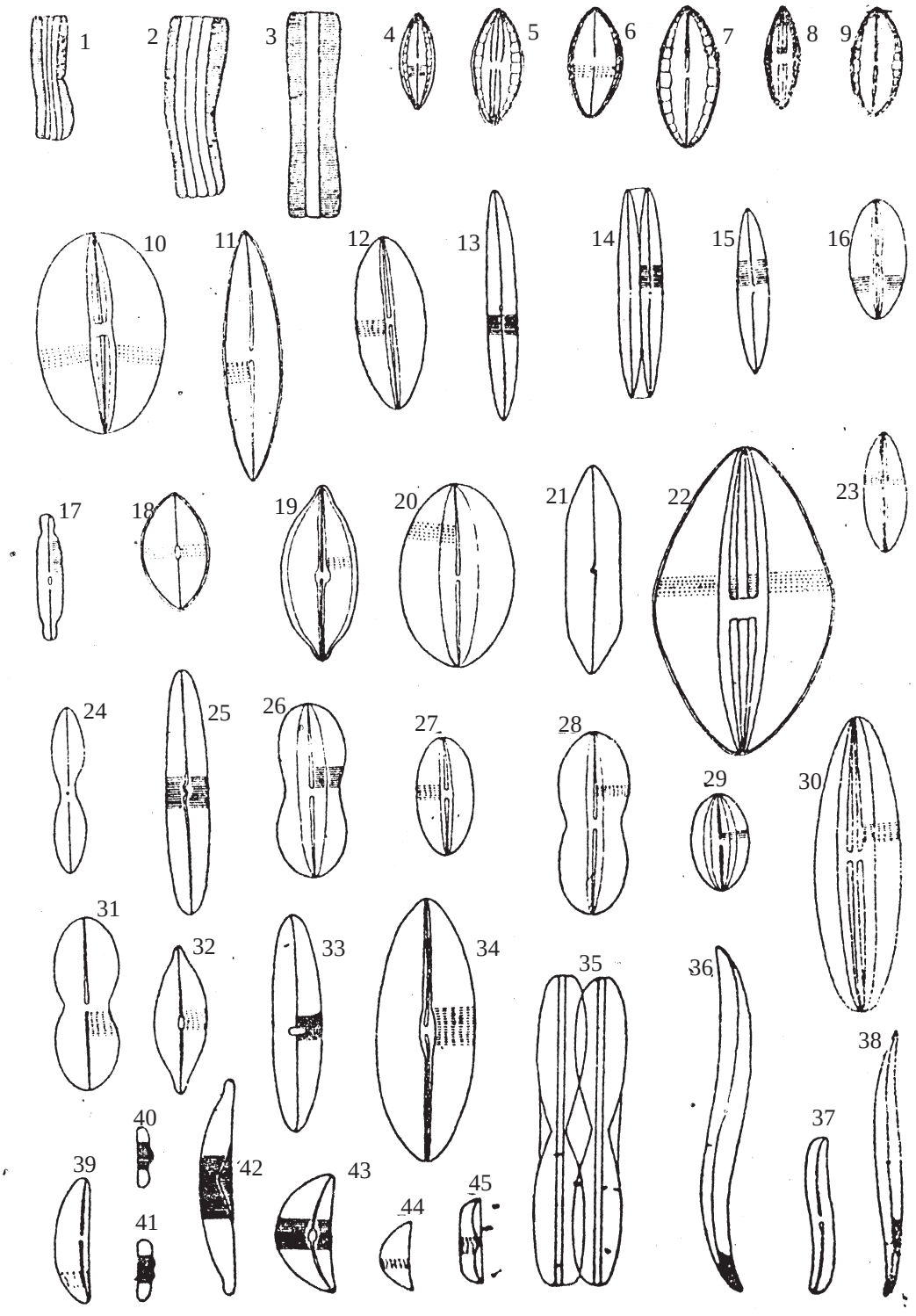
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Fig.II

Fig. III 1. *Amphora lineolata* - girdle view
2. *Amphora decussata* - girdle view
3. *Amphora ovalis* - girdle view
4. *Amphora ostrearia* - girdle view
5. *Amphora proteus* - girdle view
6. *Tropidoneis lepidoptera* - girdle view
7. *Tropidoneis antarctica* var. *polyplasta* - girdle view
8. *Amphora laevis* - valve view
9. *Tropidoneis semistriata* - valve view
10. *Cymbella cystula* - valve view
11. *Cymbella marina* - valve view
12. *Nitzschia panduriformis* - valve view
13. *Nitzschia sigma* - middle portion of the valve
14. *Nitzschia acuminata* - valve view
15-16. *Nitzschia sigma* var. *indica* - entire cell and middle portion
17. *Nitzschia obtusa* - valve view
18. *Nitzschia longissima* - valve view
19-21. *Bacillaria paradoxa* - 19, 21 two cells in girdle view and 20 shows the colony
22-24. *Hantzschia amphioxys* var. - valve view
25. *Surirella neumeyeri* - valve view
26. *Surirella fastuosa* - valve view
27. *Surirella fluminensis* - valve view
28. *Surirella eximia* - valve view
29. *Campylodiscus hodgsoni* - valve view
30. *Campylodiscus biangulatus* - valve view

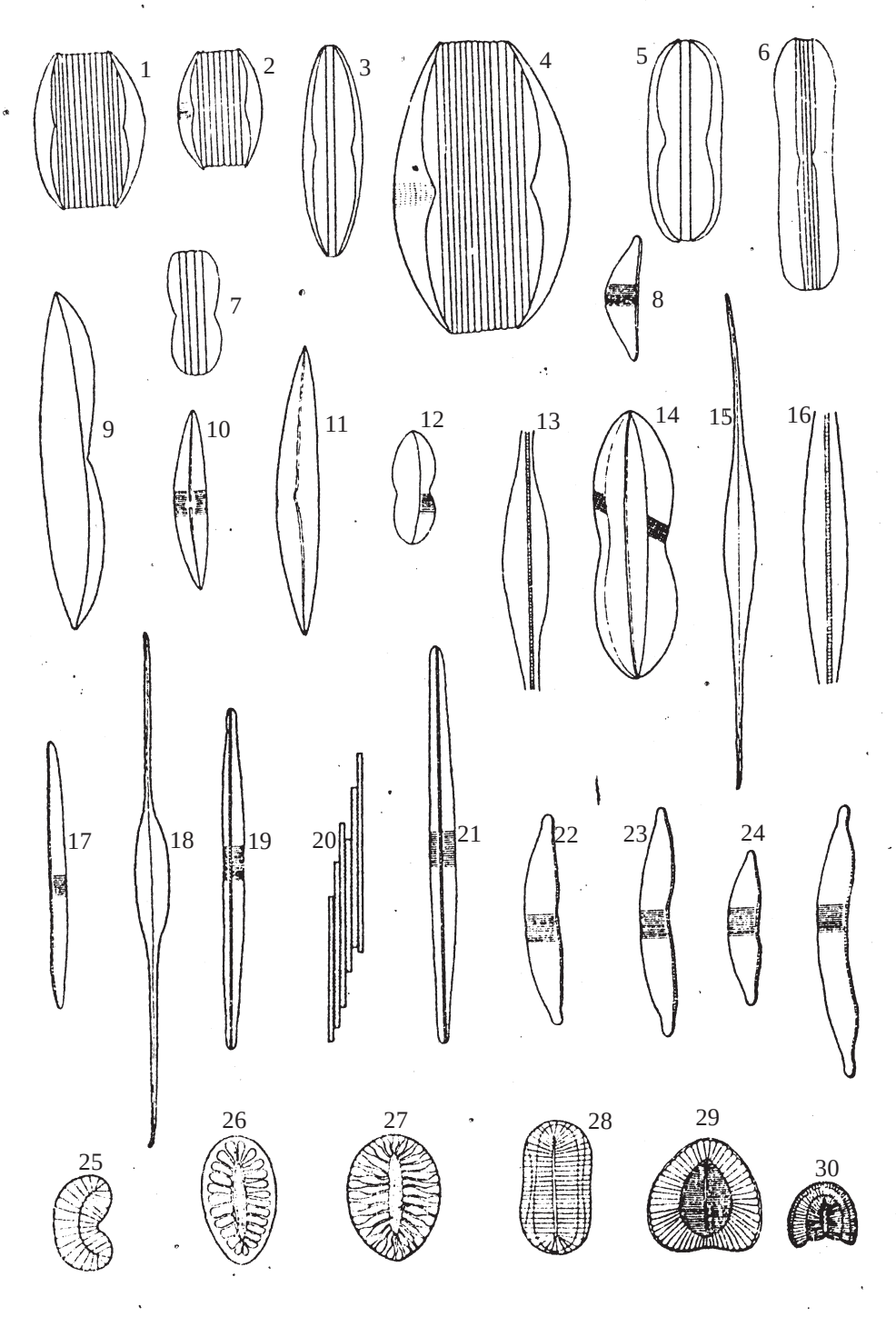
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Fig.III

Fig. IV 1. *Scenedesmus* sp.

2. *Oocystis* sp.

3. *Tetrahedron* sp.

4. *Chlorella* sp.

5. *Ulothrix* sp.

6. *Oedogonium* sp.

7. *Cladophora* sp.

8. *Chara* sp.

9. *Spirulina* sp.

10. *Anabaena* sp.

11. *Nostoc* sp.

12. *Oscillatoria* sp.

13. *Ulva reticulata*

14. *Enteromorpha* sp.

15. *Chaetomorpha* sp.

16. *Lyngbya* sp.

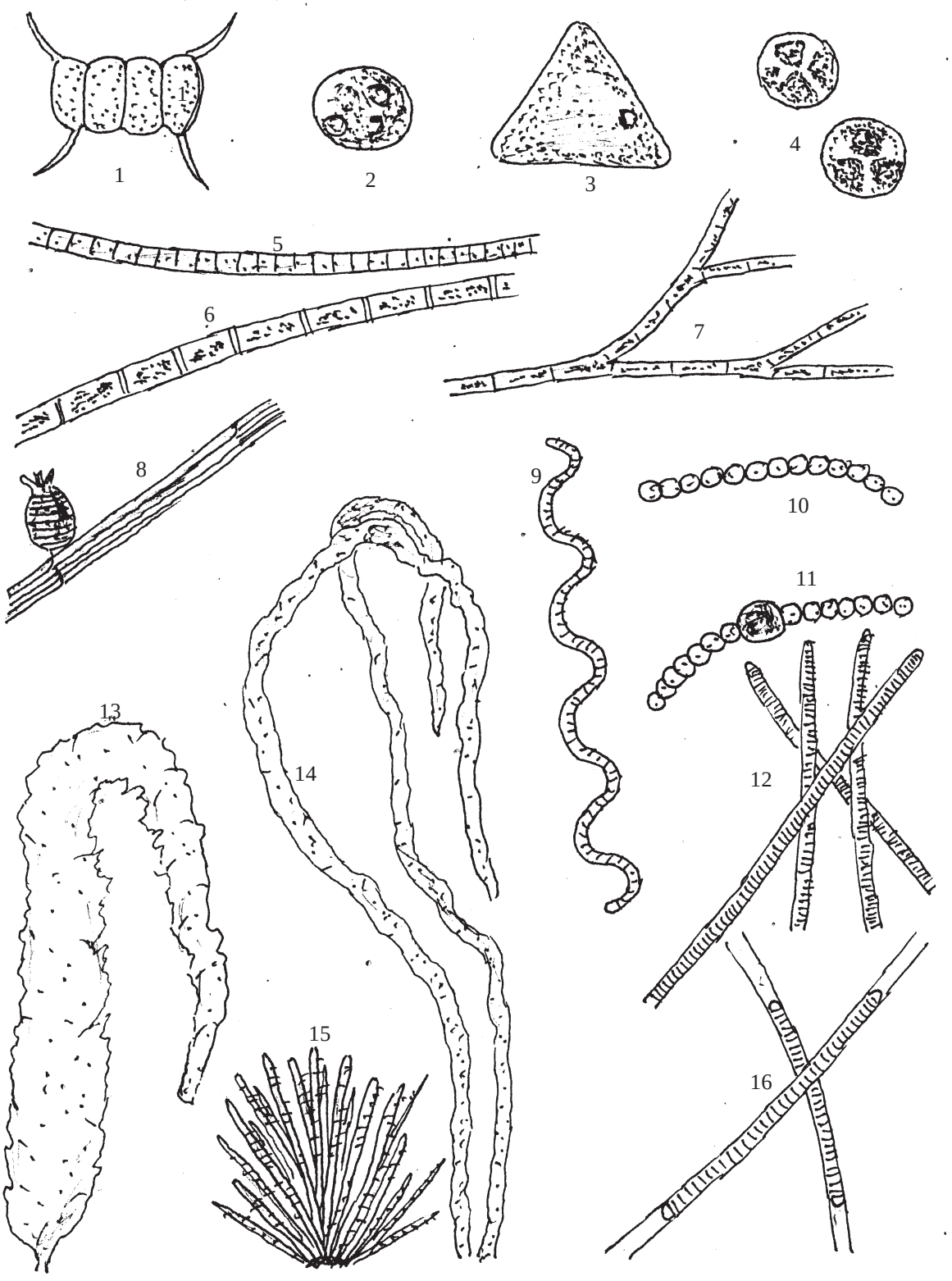
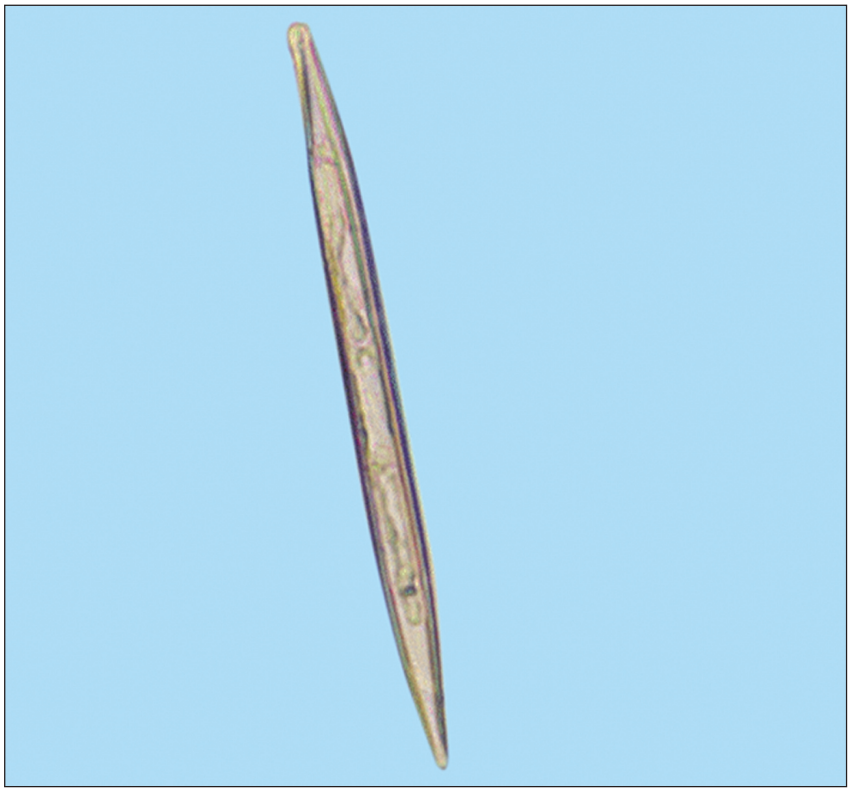
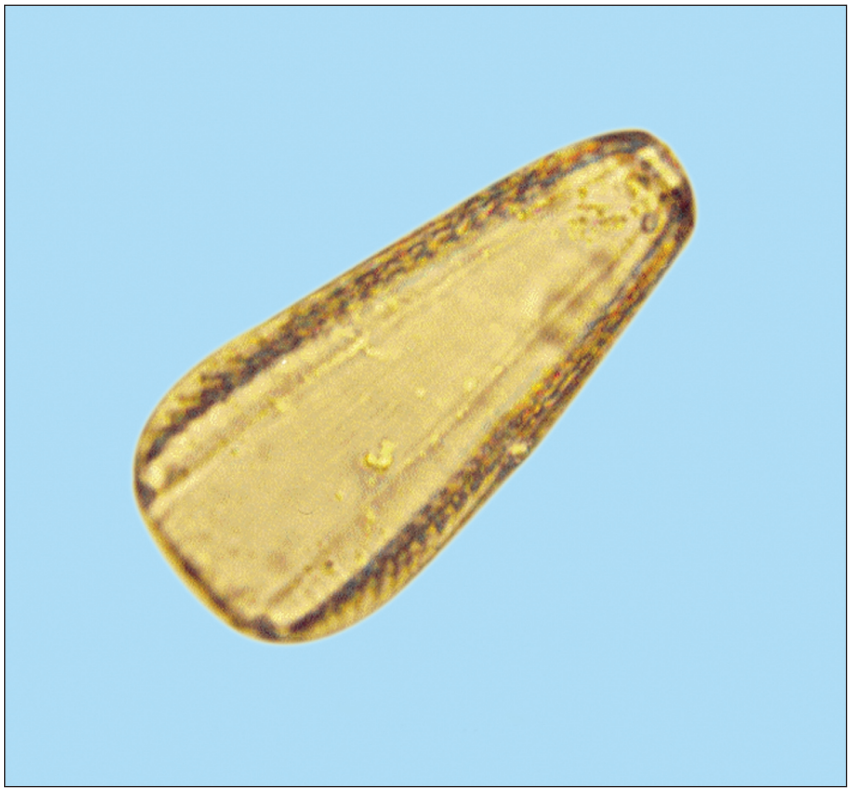


Fig.IV

Very common species of micro algae in the mangroves

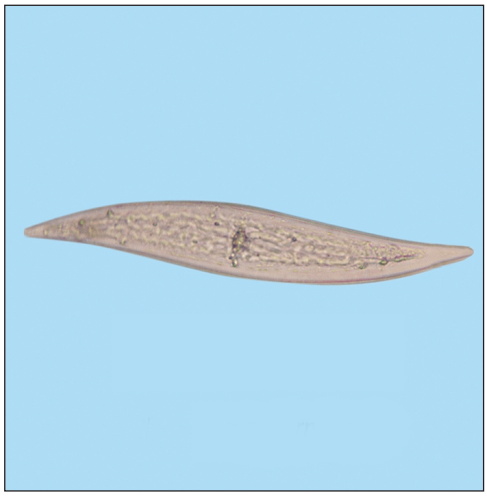


Bacillaria paradoxa



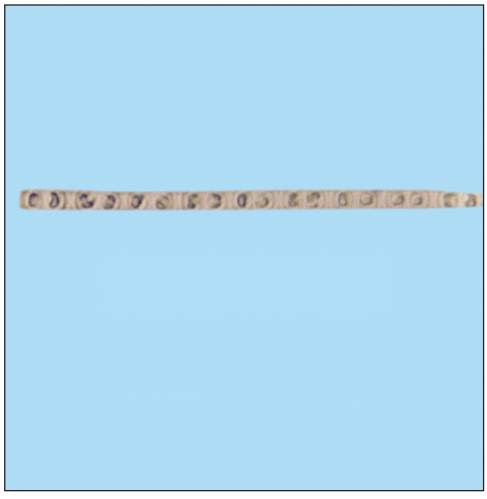
Surirella splendida

Very common species of micro algae in the mangroves



Pleurosigma normannii

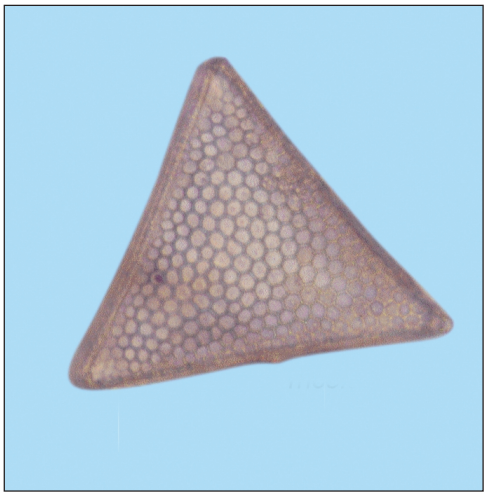
Surirella residense



Skeletonema costatum

Campylodiscus clypeuas

Nitzschia longissima



Triceratium favus