

# Phytoplankton Identification Catalogue

APRIL 2001

*Saldanha Bay, South Africa*

Lizeth Botes



**GloBallast Monograph Series No. 7**

# **Phytoplankton Identification Catalogue**

***Saldanha Bay, South Africa  
April 2001***

**Botes, L.<sup>1</sup>**



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The Global Ballast Water Management Programme (GloBallast) is a cooperative initiative of the Global Environment Facility (GEF), United Nations Development Programme (UNDP) and International Maritime Organization (IMO) to assist developing countries to reduce the transfer of harmful organisms in ships' ballast water.

The GloBallast Monograph Series is published to disseminate information about and results from the programme, as part of the programme's global information clearing-house functions.  
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## Introduction

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The International Maritime Organization (IMO), with funding provided by the Global Environment Facility (GEF) through the United Nations Development Programme (UNDP), has initiated the Global Ballast Water Management Programme (GloBallast).

The programme is aimed at reducing the transfer of harmful marine species in ships' ballast water, by assisting developing countries to implement existing IMO voluntary guidelines on ballast water management (IMO Assembly Resolution A.868(20)), and to prepare for the new international convention on ballast water management currently being developed by IMO member countries.

The programme aims to achieve this by providing technical assistance, capacity building and institutional strengthening to remove barriers to effective ballast water management arrangements in developing countries, through six initial demonstration sites. These six sites are Sepetiba (Brazil); Dalian (China); Mumbai (India); Kharg Island (Iran); Saldanha (South Africa) and Odessa (Ukraine). The initial demonstration sites are intended to be representative of the six main developing regions of the world; South America, East Asia, South Asia, Arab Countries/Persian Gulf, Africa and Eastern Europe respectively. As the programme proceeds, it is intended to replicate these initial demonstration sites throughout each region.

One of many technical activities being implemented by GloBallast at each demonstration site is the instigation of port biological baseline surveys. These surveys utilise standardised methodologies (Hewitt & Martin 2001) and are designed to provide baseline data on native marine biodiversity in and around the port, and on the presence/absence of invasive aquatic species across all habitat types and from all taxonomic groups. The surveys also provide the basis for long term monitoring of invasive aquatic species in and around the port. This allows any existing invasions to be monitored and managed, any new invasion to be detected and responded to, and also assists port States to comply with section 10.3 of IMO Assembly Resolution A.868(20) and relevant sections of the draft ballast water Convention, which, among other things, require port States to notify outbreaks of harmful species.

This catalogue contains various phytoplankton species (investigated and photographed by means of a light microscope) found in Saldanha Bay during the April 2001 port biological baseline survey. Micrographs were taken with an Olympus B201 light microscope, equipped with an Olympus DO10 digital camera but without a micro-ocular vernier. Scale bars on micrographs are therefore unfortunately absent.

Eighteen sampling sites within Saldanha Bay were sampled by means of net tows (20µm mesh). Each sample was preserved in 5% formaldehyde buffered with CaCO<sub>3</sub> AR grade, pH ≥ 7. A map of the site and tables of diatom, dinoflagellates and flagellates species present/absent at each site are included at the end of the catalogue. All species were typical to the area except for a *Spatulodinium* sp. (page 46 of catalogue, sp.1 in the Sample Location tables) and a *Proto-peridinium* sp. (page 55 of catalogue, sp.2 in the Sample Location tables).

Morphological features of species belonging to genera such as *Chaetoseros*, *Thalassiosira*, *Coscinodiscus*, *Navicula* and *Pseudo-nitzschia* need to be investigated with electron microscopy in order to be accurately identified. Unarmoured species, such as those belonging to the genus *Gyrodinium*, need to be investigated live in order to be accurately identified (cells are deformed when preserved with formaldehyde).



# Diatoms

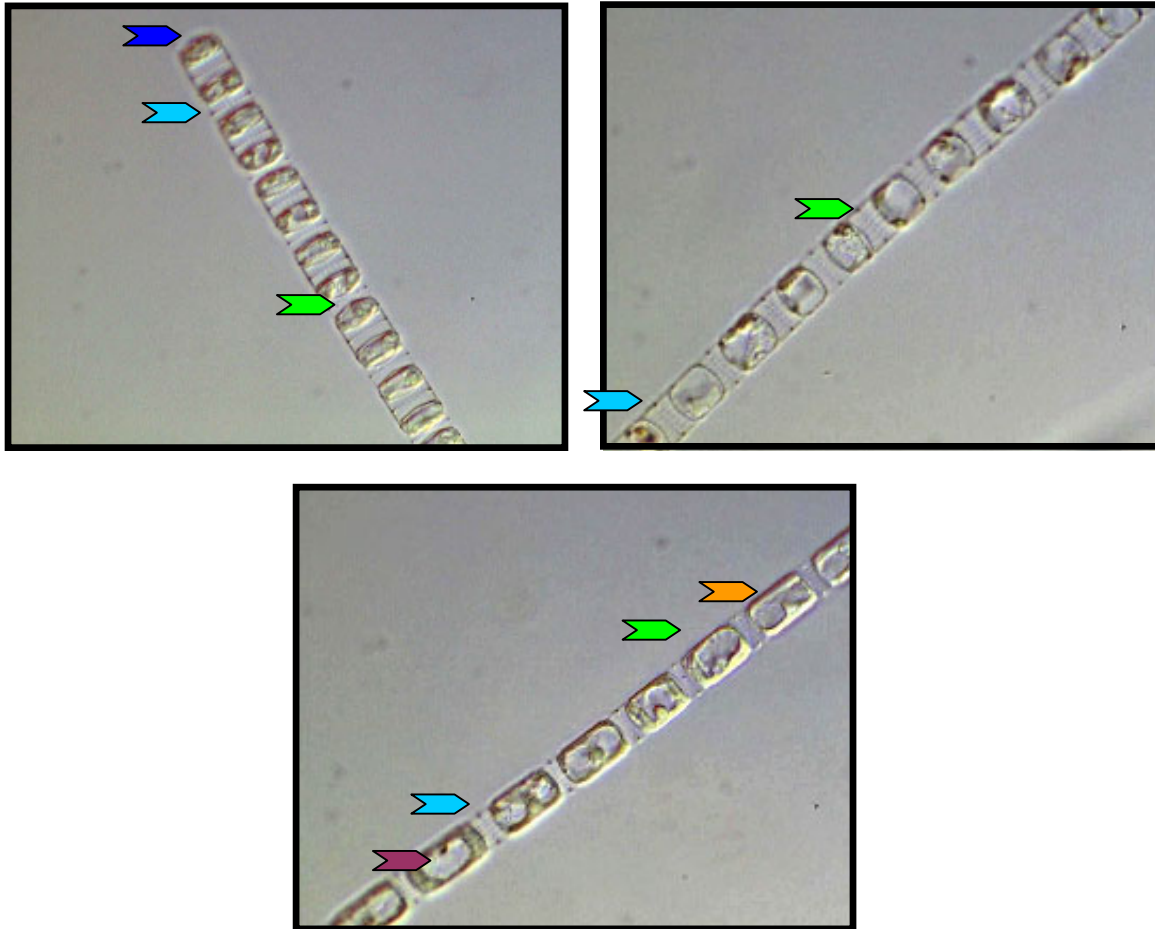
Diatom species encountered in the study area are ordered according to Hasle and Syvertsen (1997)






## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Thalassiosiraceae

### *Skeletonema costatum*

---

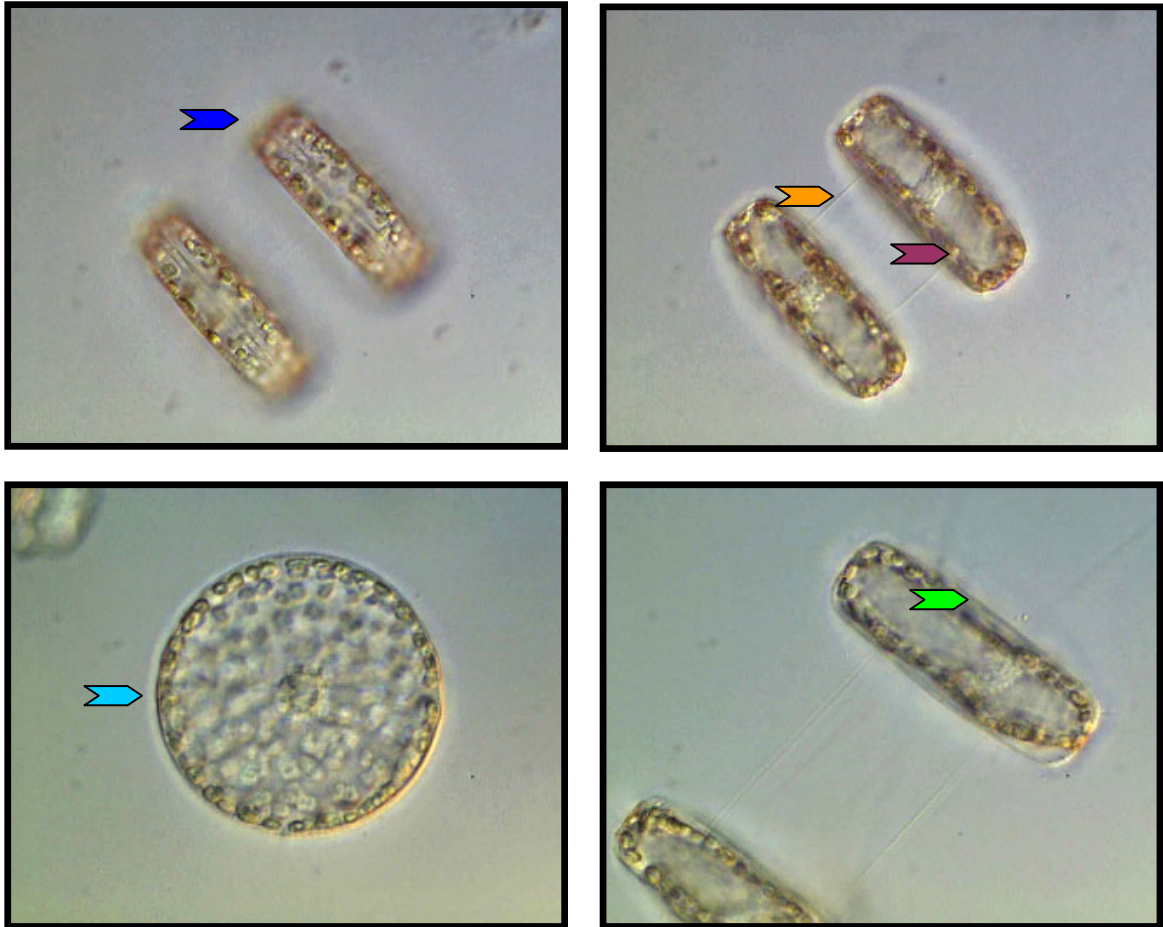






-  Cells cylindrical with rounded ends.
-  Cells form long straight chains, held together by fine marginal process, parallel with longitudinal axis.
-  Spines are straight and slender and unite with the spines of the next cell to form a junction.
-  Two chromatophores per cell.
-  Nucleus is central.

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Thalassiosiraceae

### *Thalassiosira anguste-lineata*



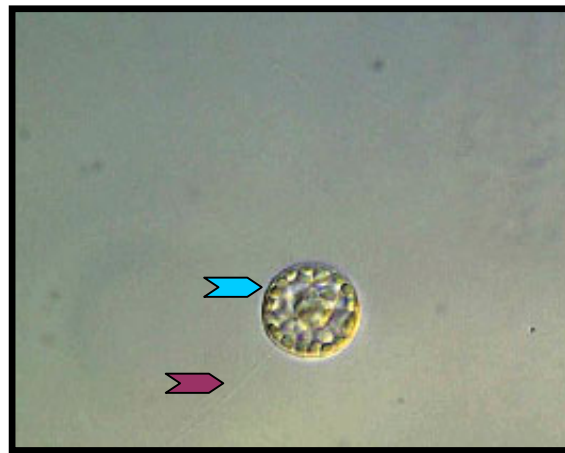
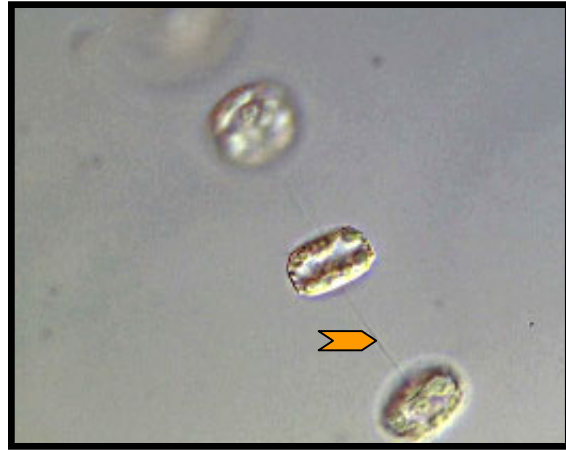
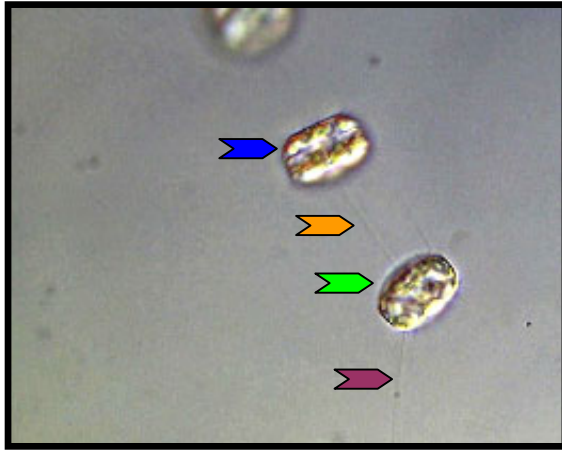
-  Cells in girdle view are rectangular with the valve face flat or slightly curved.
-  Valves are disc-shaped.
-  Cells connected by many connecting threads at some distance from the valve centre.
-  Cells connected by many connecting threads at some distance from the valve centre.






## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Thalassiosiraceae

### *Thalassiosira decipiens*

---



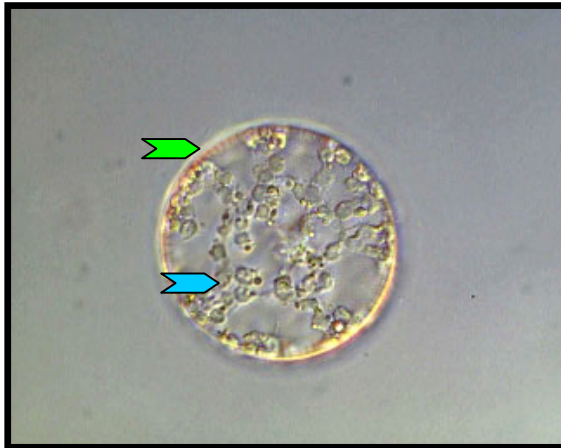
-  Cells in girdle view are rectangular to drum-shaped with the
-  valve face slightly curved/rounded.
-  Valves are disc-shaped.
-  Cells connected in a loose chain with one connecting thread.
-  Organic threads emerge from the marginal strutted processes.





Note: *Thalassiosira condensata* somewhat similar but valves are slightly depressed in the middle (*T. decipiens* has curved valves).

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Thalassiosiraceae

### *Thalassiosira eccentrica*



-  Cells discoid, united in chains by a thick thread.
-  Cells furnished with short but fairly well pronounced marginal spinulae.
-  Chromatophores proportionally large, biscuit-formed, with a
-  single pyrenoid.

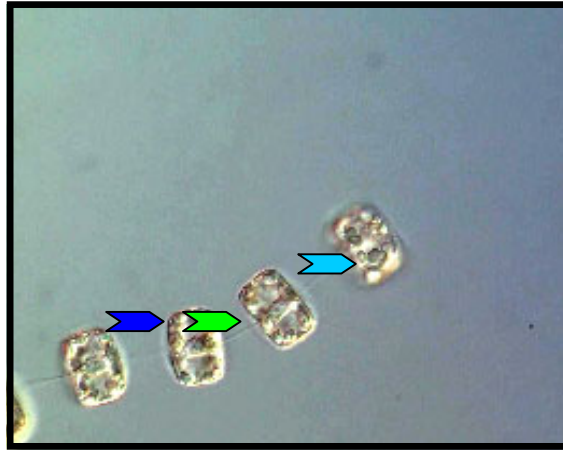


## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Thalassiosiraceae

### *Thalassiosira hyalina*

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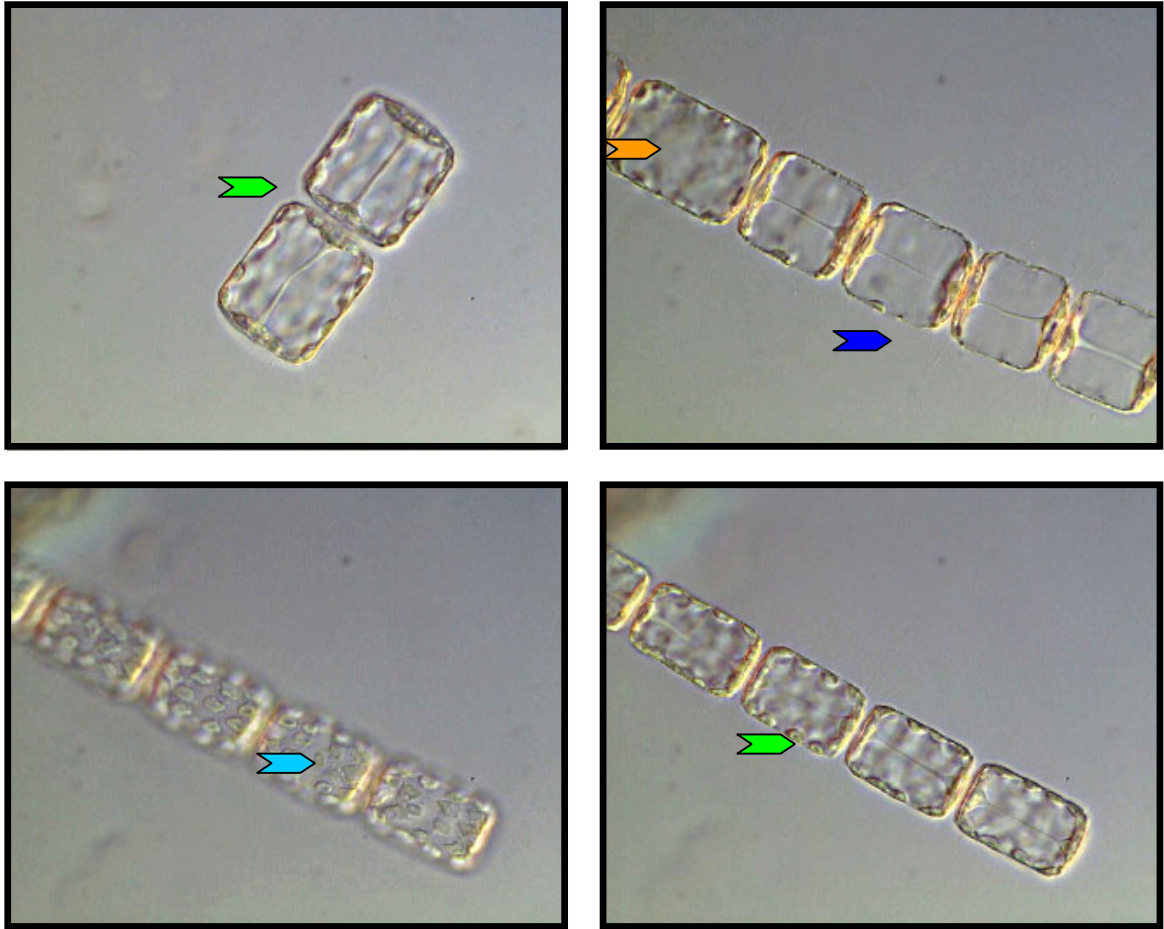






- Girdle view of cells is rectangular, valve face round and flat.
- One thick connecting thread.
- Chromatophores 8-10 small plates.

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Melosiraceae

### *Melosira cf. spaerica*



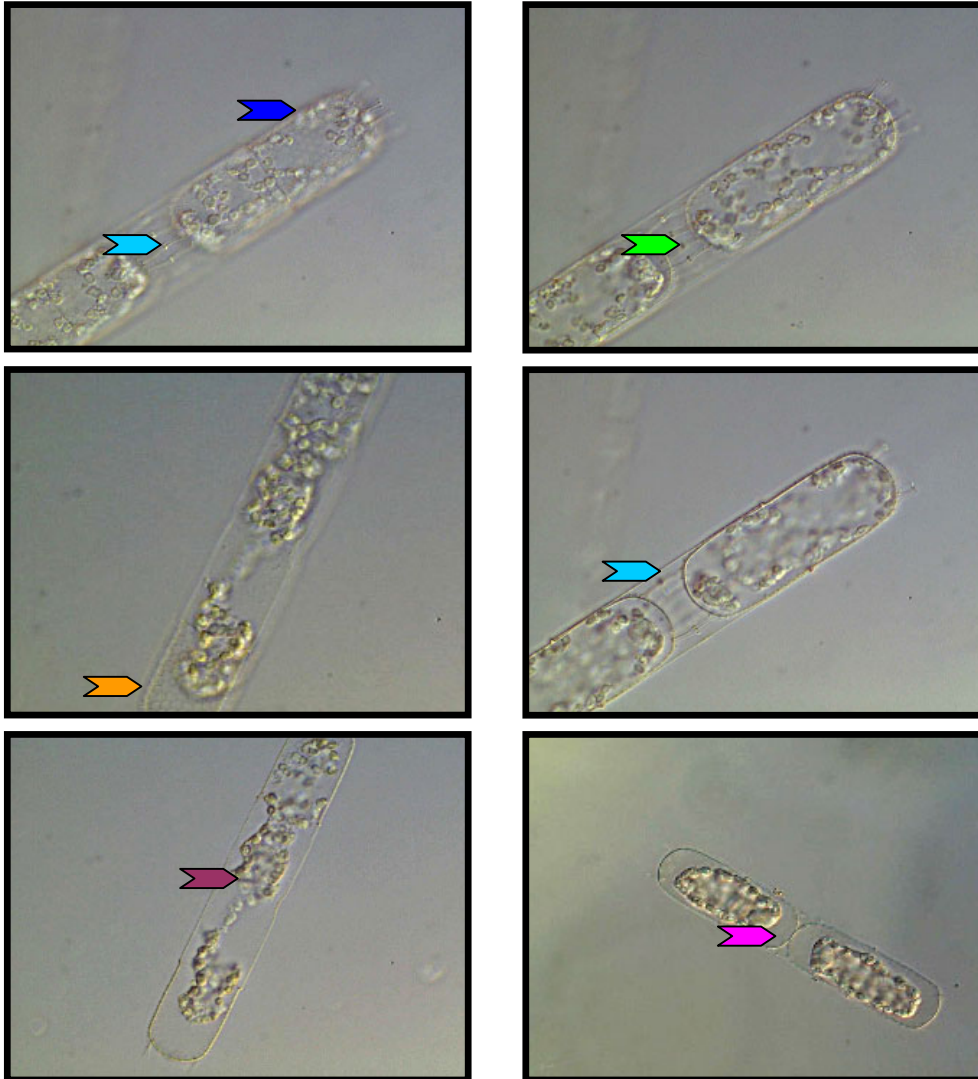
-  Connected to form long chains,
-  looking like a string of beads.
-  Several plate-like chromatophores.
-  Nucleus is central.







## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Melosiraceae

### *Stephanopyxis turris*

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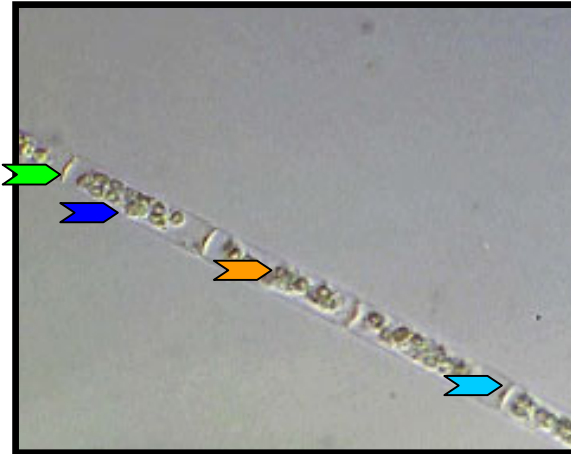
-  Cells are cylindrical with convex valves.
-  Number of spines at the end of each cell with slightly thickened tips.
-  Spines attach with adjoining cells to form short chains, line of fusion midway between cells.
-  Hexagonal areolations.
-  Dividing cell
-  Recently divided cell





## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Leptocylindraceae

### *Leptocylindricus danicus*

---



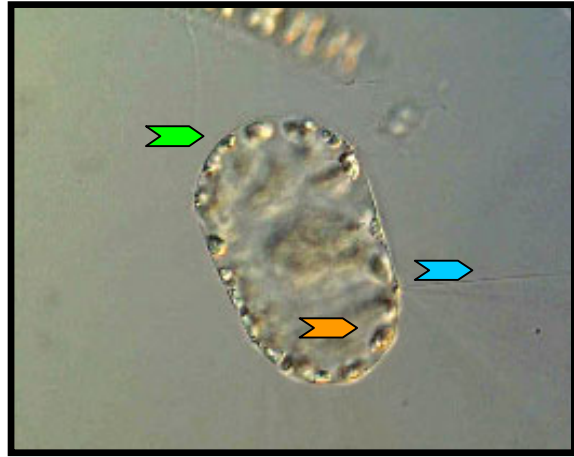
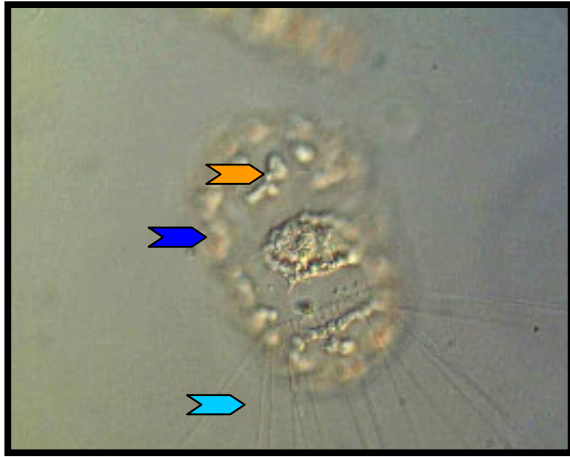
-  Cells cylindrical and slender.
-  Forms long stiff straight chains with only one cell wall between the two adjacent cells.
-  One cell is slightly concave and one cell slightly convex.
-  Numerous small rounded chloroplasts.





## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Leptocylindraceae

### *Corethron criophilum*

---

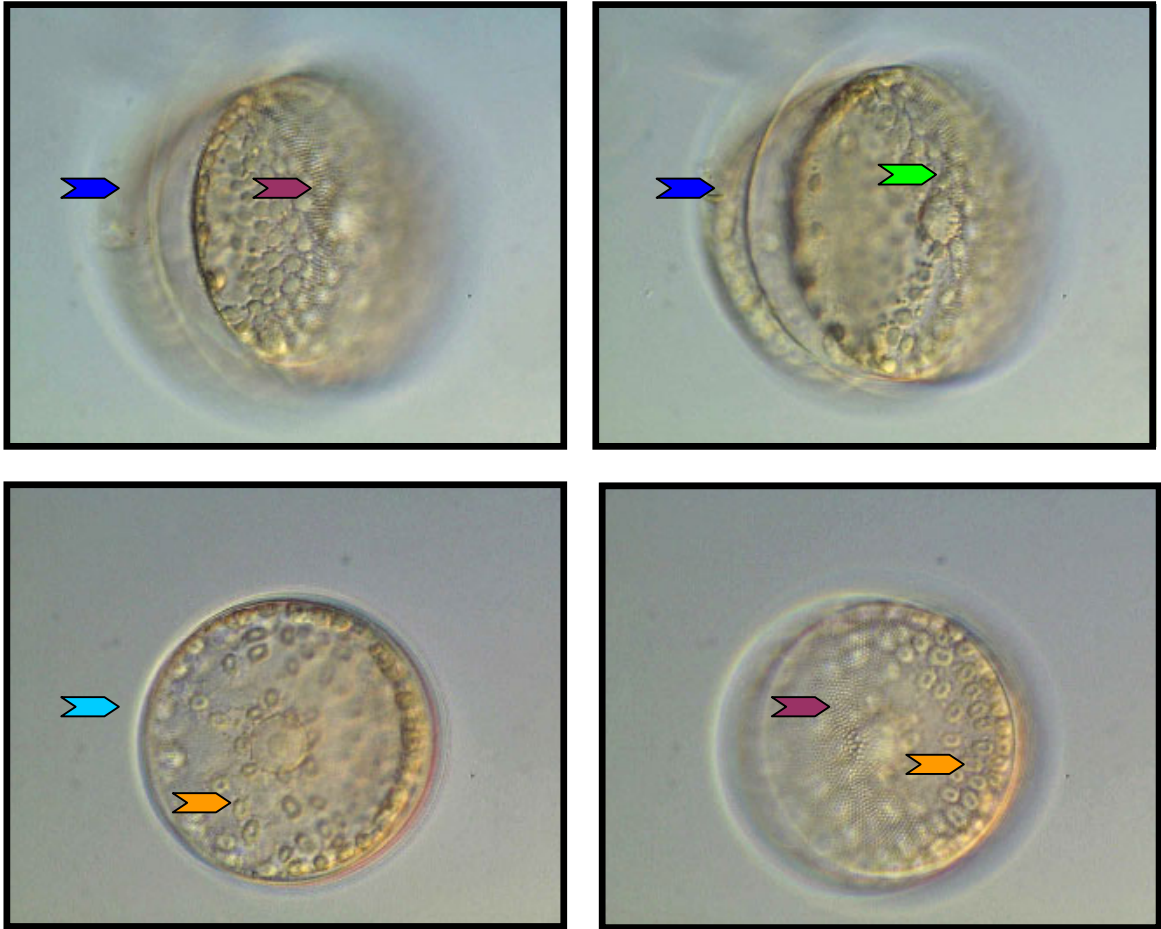







-  Cells solitary and cylindrical.
-  Valves are strongly convex
-  and furnished with a marginal crown of well developed slender spines directed outwards at an angle.
-  Numerous plate-like chromatophores.

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Coscinodisceae

### *Coscinodiscus granii*



-  Cell is asymmetric, one side much higher than the other.
-  Cell is wedge shaped in girdle view, valves are arched.
-  Cells are solitary.
-  Chloroplasts discoid and smooth in outline.
-  Mesh consists of fine lines radiating from a definite central rosette.




## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Coscinodisceaceae

### *Coscinodiscus stellaris*

---



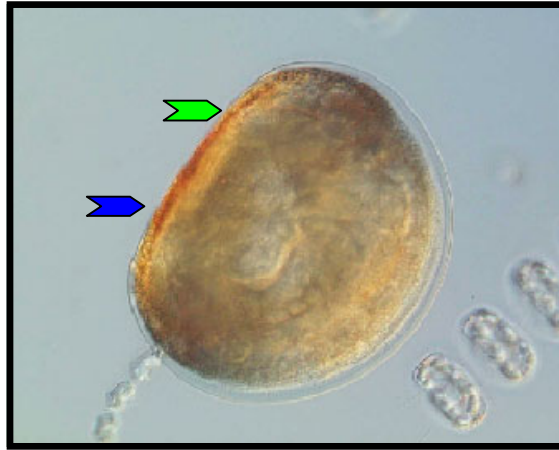
-  Cells discoid, solitary.
-  Valves almost flat, areolated.
-  Meshes arranged in curved sectors, first curved line of each sector radiates from centre.

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Hemidiscaceae

### *Hemidiscus cuneiformis*

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➤ Cells cuneiform and solitary.

➤ Valves semicircular, dorsal margin strongly convex, ventral margin weakly so.

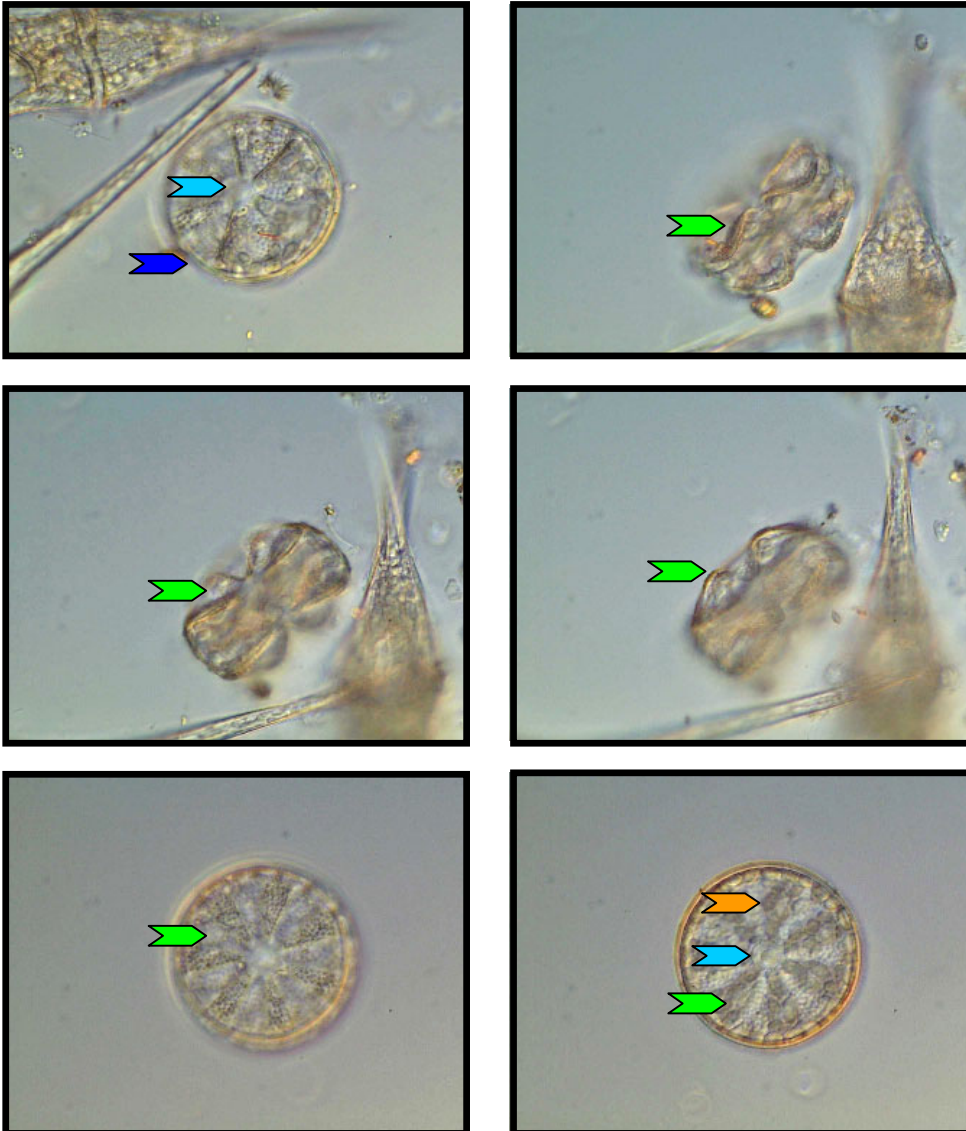






## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	COSCINODISCINEAE
Family:	Heliopeltaceae

### *Actinoptychus splendens*

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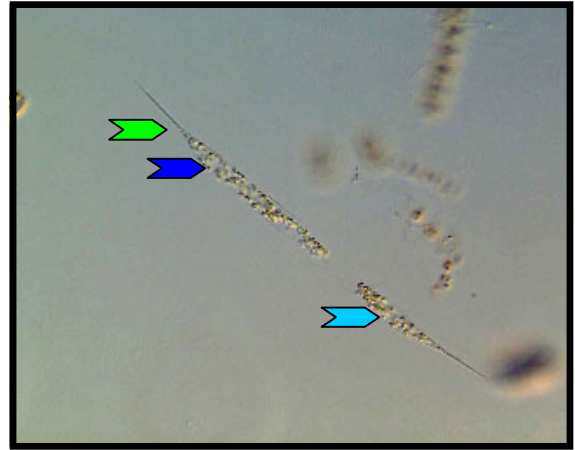
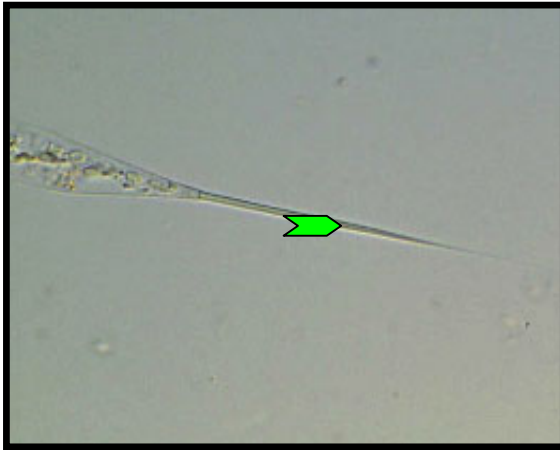
-  Cells are discoid and solitary.
-  Valves radially undulate, divided into 10-20 sections, polygonal and areolated.
-  Nearly circular central area present.
-  Numerous chromatophores with plate-like bodies.




## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	RHIZOLENIICEAE
Family:	Rhizoleniaceae

### *Rhizosolenia hebetata*

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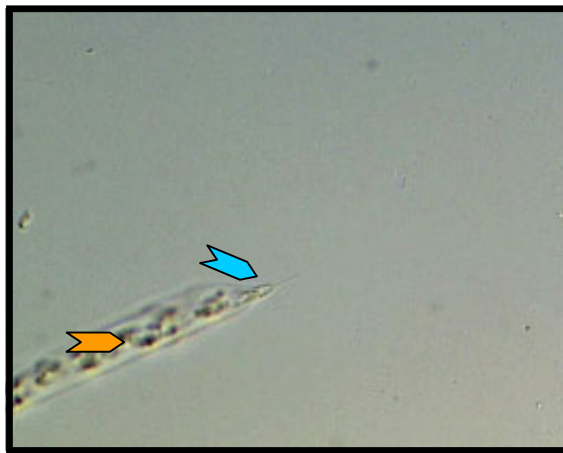
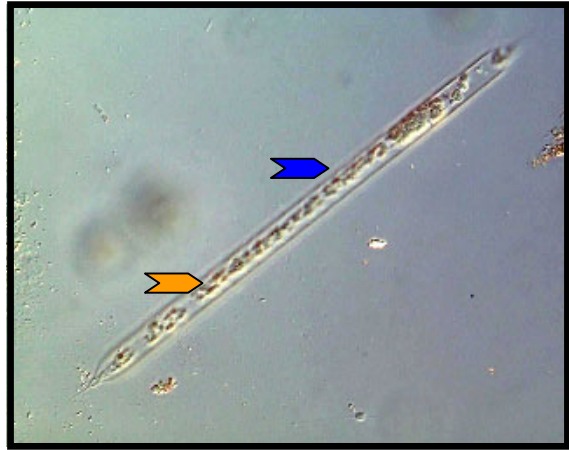
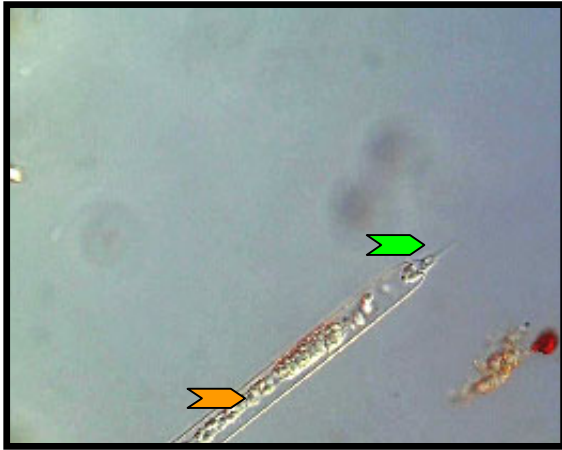
-  Cells are cylindrical and long.
-  Valves drawn out, armed with a long, hair-like spine.
-  Numerous small chromatophores.





## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	RHIZOLENIICEAE
Family:	Rhizosoleniaceae

### *Rhizosolenia imbricata*

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-  Cells cylindrical.
-  Valves oblique and pointed.
-  Apical process hollow nearly all the way, with small wings at the base which run up to about a third of the spine.
-  Chromatophores are numerous and small.




## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	RHIZOLENIICEAE
Family:	Rhizosoleniaceae

### *Guinardia delicatula*

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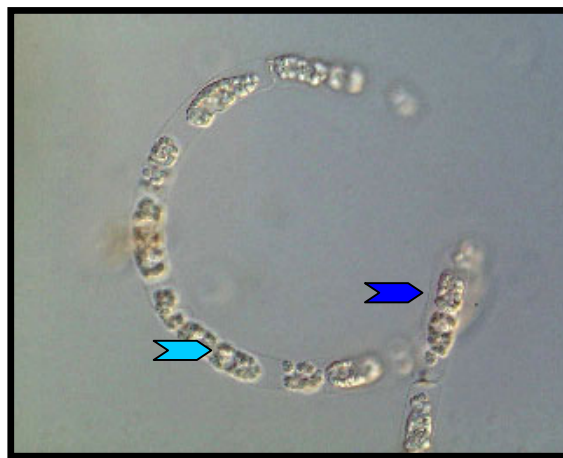
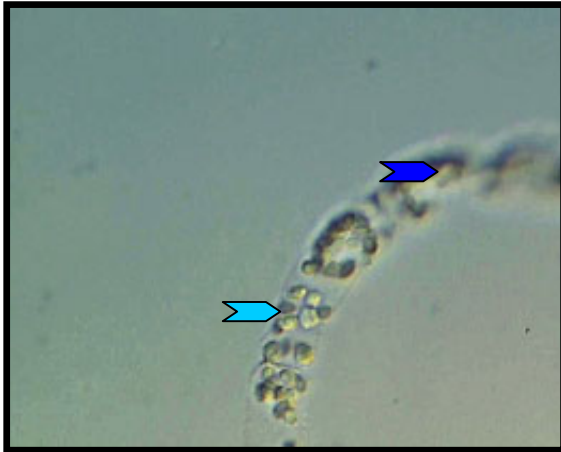
-  Cells cylindrical, longer than broad, in close-set straight chains.
-  Valves flat and only slightly rounded at the edges.
-  Spike-like attachment to next cell.




## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	RHIZOLENIIACEAE
Family:	Rhizosoleniaceae

### *Guinardia striata*

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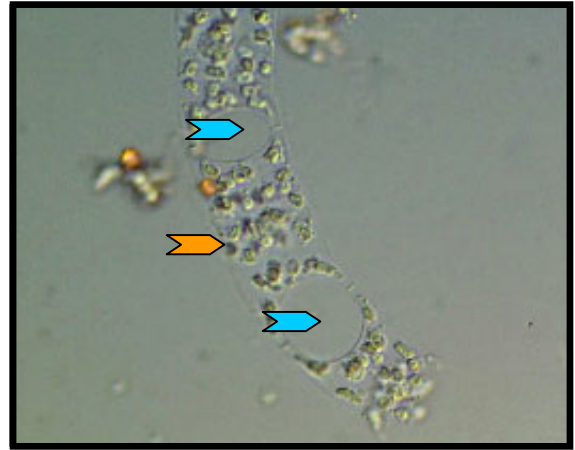
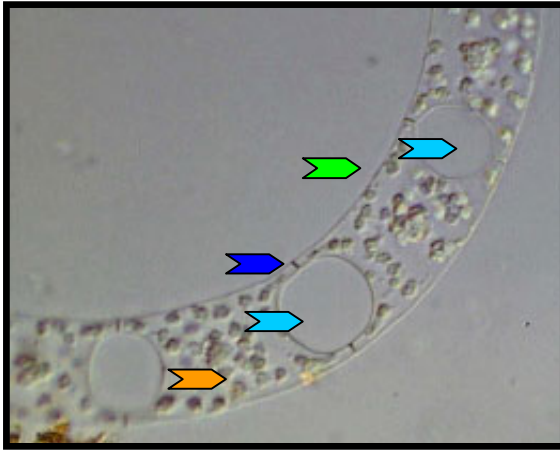






-  Cells in close set curved, often spiralling chains
-  Valves flat and rounded at the edges.
-  Chromatophores small and numerous.

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	BIDDULPHIINEAE
Family:	Hemiaulaceae

### *Eucampia zoodiacus*



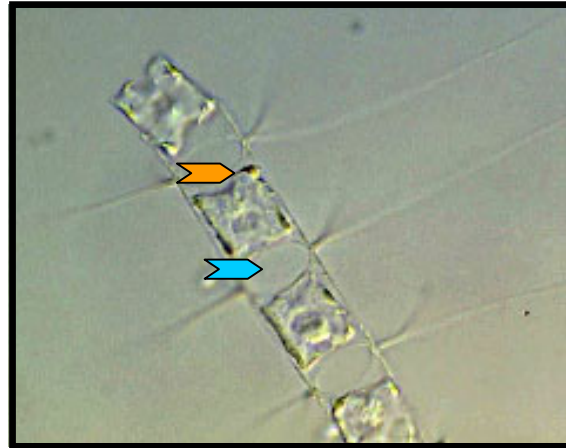
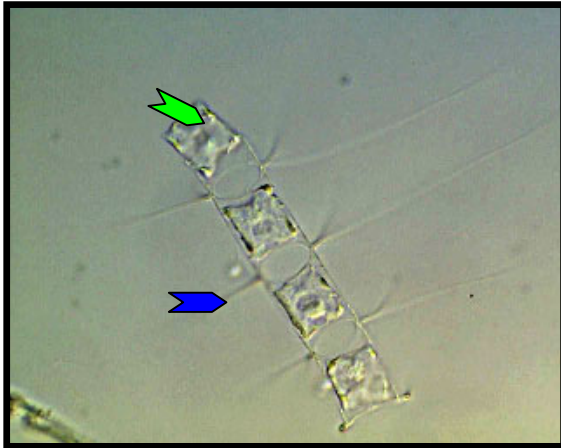
-  Cells flattened united by two blunt processes.
-  Chains helically coiled.
-  Apertures between two cells are circular in small cells and more elongated in larger cells.
-  Chromatophores small, numerous and scattered.





## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	BIDDULPHIINEAE
Family:	Chaetocerotaceae

### *Chaetoceros capense*

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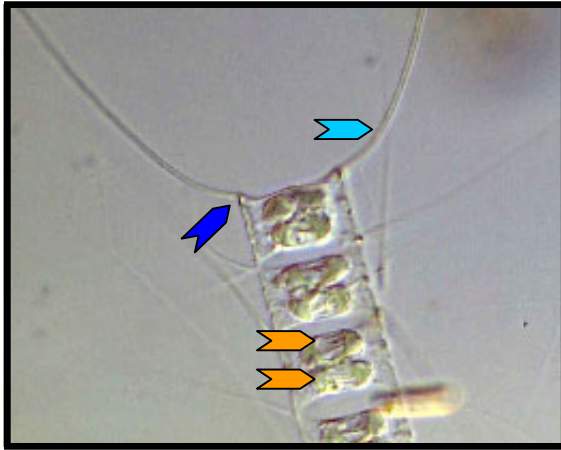






-  Long thin setae originate at corners,
-  united to form 4-8 cells per chain.
-  Valve surface concave and apertures elliptical.
-  Chromatophores irregularly shaped.

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	BIDDULPHIINEAE
Family:	Chaetocerotaceae

### *Chaetoceros constrictus*



-  Valves with sharp corners and
-  concave but slightly raised in the centre.
-  Terminal setae acutely divergent.
-  Two chromatophores per cell.

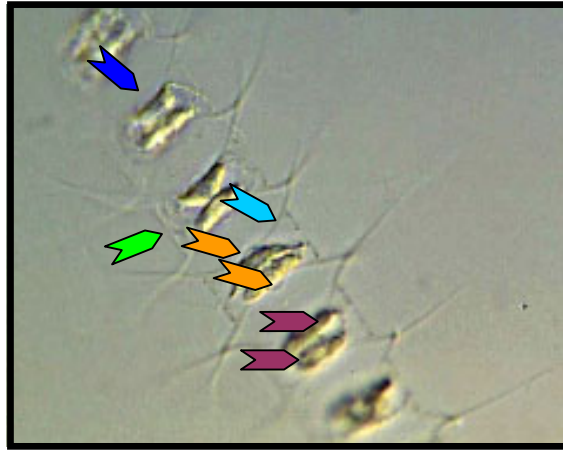


## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	BIDDULPHIINEAE
Family:	Chaetocerotaceae

### *Chaetoceros didymus*

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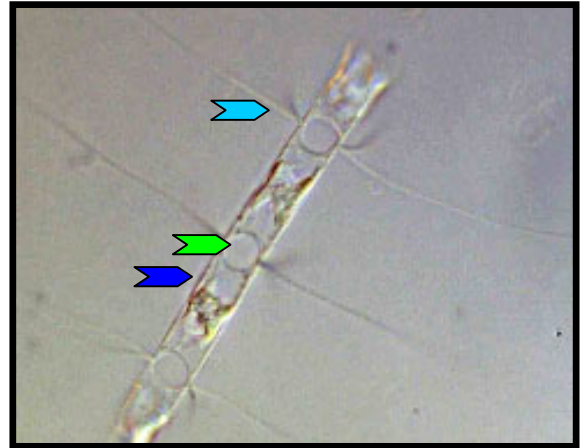
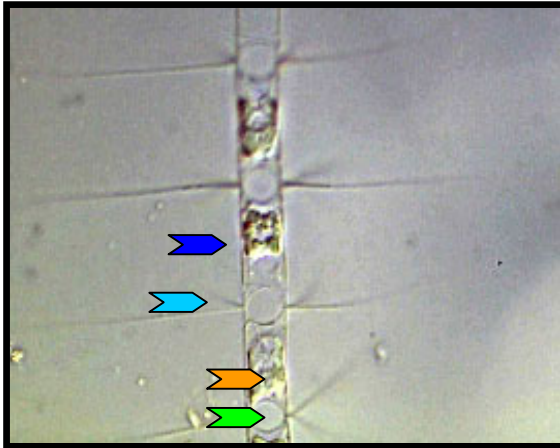
- Chains straight,
- cells compressed in broad girdle view,
- with concave end surfaces,
- and a semicircular knob in the centre.
- Two chromatophores present.





Note: The inner setae of *Chaetoceros didymus* var. *protuberens* cross further out than in the type species (as in this case).

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	BIDDULPHIINEAE
Family:	Chaetocerotaceae

### *Chaetoceros cf. lorenzianus*



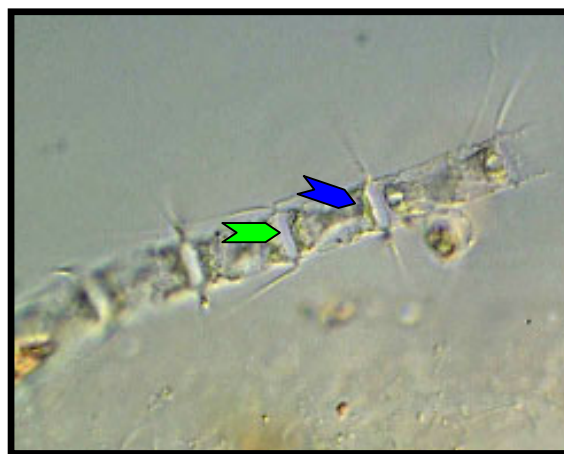
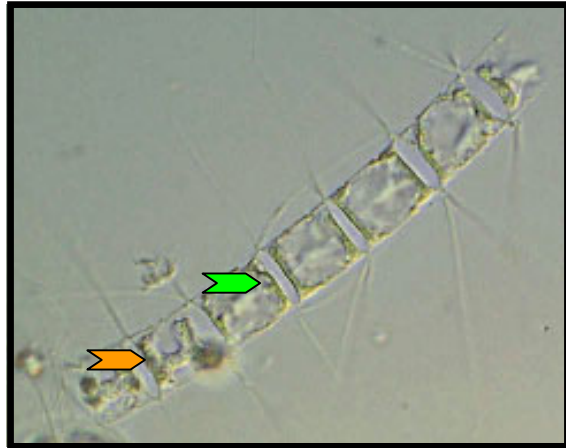
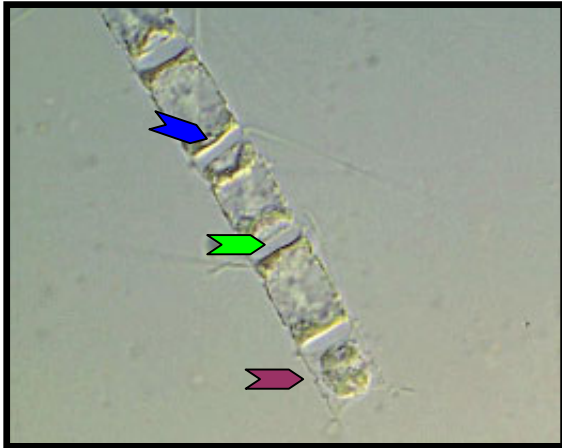
-  Cells rectangular in girdle view.
-  Apertures polygonal to elliptical.
-  Setae fused only at point of exit from margin.
-  Chromatophores large and plate-like.






Note: *Chaetoceros lorenzianus* have coarse setae.

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	BIDDULPHIINEAE
Family:	Chaetocerotaceae

### Chaetoceros sp.

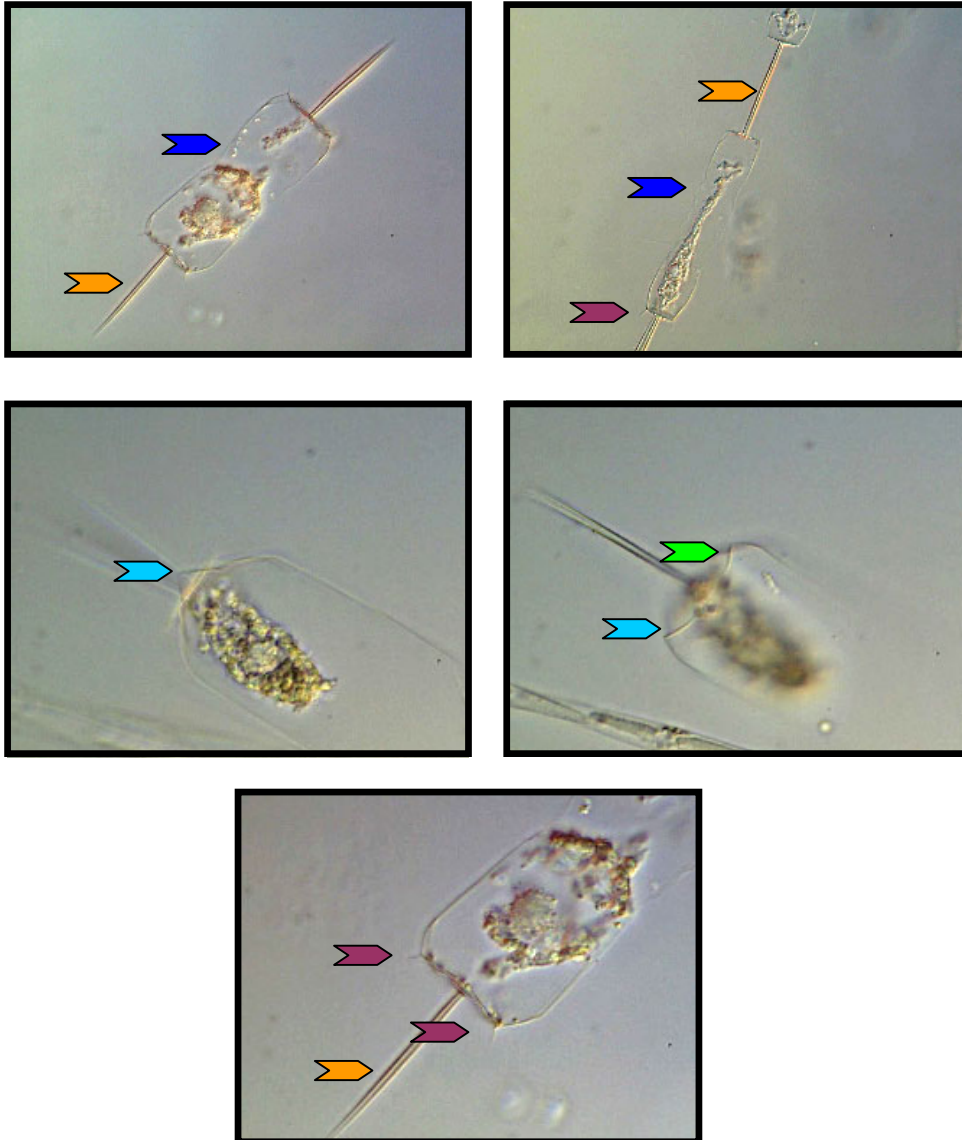







-  Cell surface concave, slightly raised in the centre.
-  Aperture narrow.
-  Setae originate at cell corners but are directed in different directions.
-  Chromatophores large.
-  Resting spore.

## A. Centric Diatoms

Division:	BACILLARIOPHYTA
Order:	BIDDULPHIALES
Sub-order:	BIDDULPHIINEAE
Family:	Lithodesmisceae

### *Ditylum brightwelli*



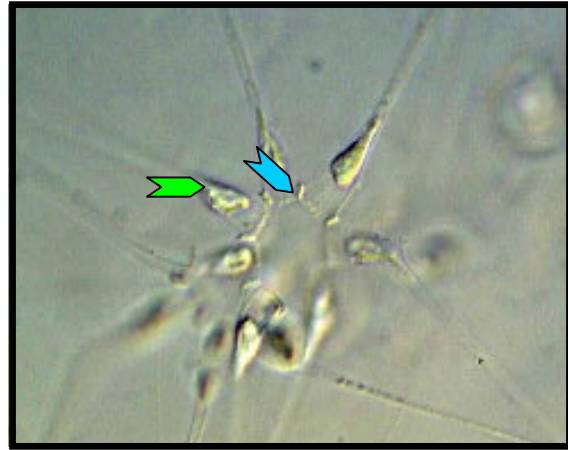
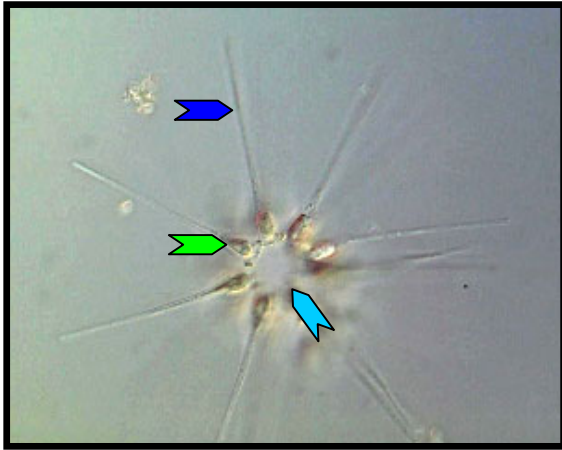
-  Weakly siliceous cell walls.
-  Cells prism-shaped with strongly rounded angles.
-  Valves triangular with
-  central hollow labiale process.
-  Triangular marginal ridge present on the valve face.

## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Fragilariaceae

### *Asterionellopsis glacialis*

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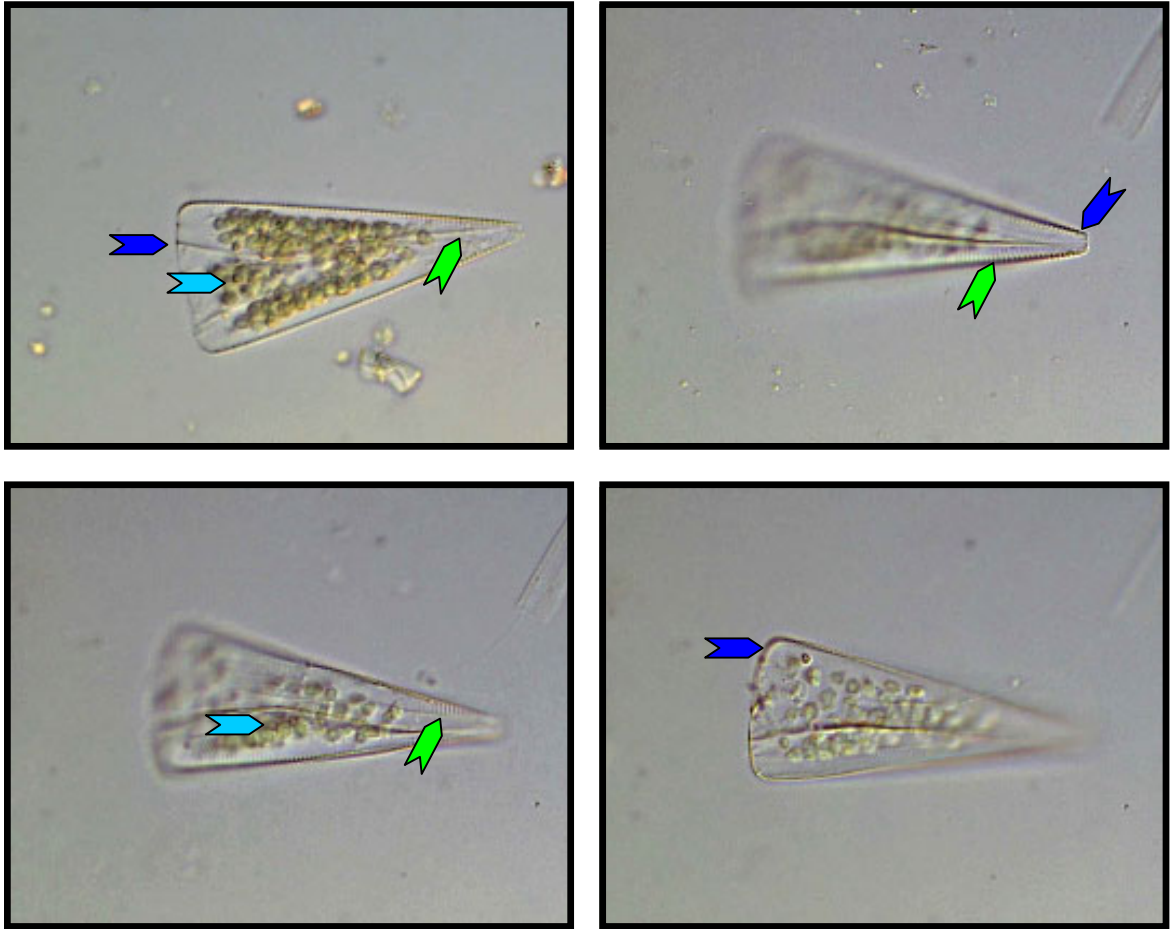





- Cells rod-like with distinctly dissimilar ends,
- one end enlarged.
- Larger ends united into star-like spiral colonies.

## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Fragilariaceae

### *Licmophora ehrenbergii*



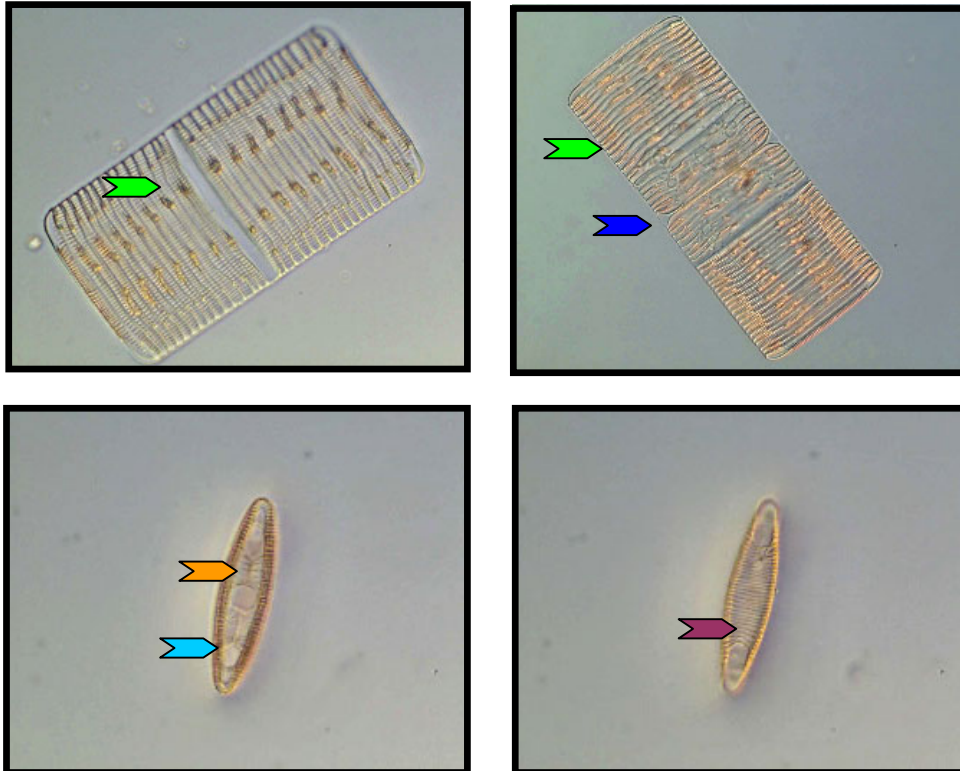
-  Cells in girdle view are wedge-shaped with rounded corners.
-  Strong clear striations.
-  Chromatophores are granular.






## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Fragilariaceae

### *Striatella unipunctata*

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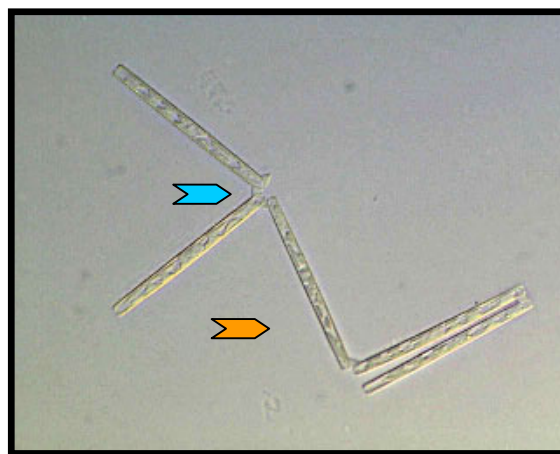
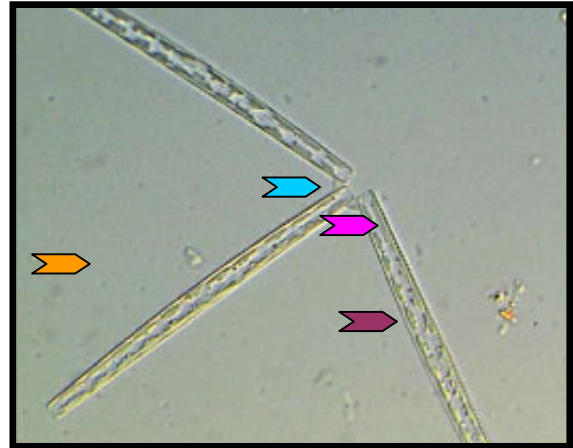
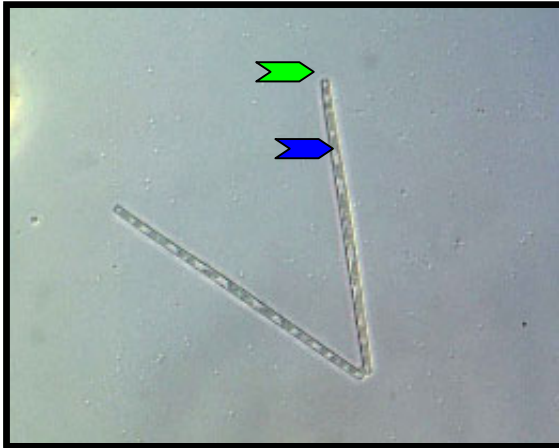
-  Tabular with corners appearing as being cut off.
-  Numerous open bands with narrow septa.
-  Valve view is lanceolate with distinct apical pore fields.
-  Sternum narrow.
-  Areolae in line systems.







Note: Can be confused with *Cerataulina dentata*, which in valve view is circular.

## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Thalassionemataceae

### *Thalassionema nitzschioides*



-  Cells linear and narrow in girdle view with
-  bluntly rounded ends.
-  Cells united by a gelatinous cushion at one end into
-  zig-zag or star-shaped colonies.
-  Numerous small granular chromatophores present.
-  Along the margin of the valve face are a row of sawtooth-like spinulae.



## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Naviculaceae

### *Navicula* sp.

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➤ Two plate-like chloroplasts.

### *Navicula* sp.

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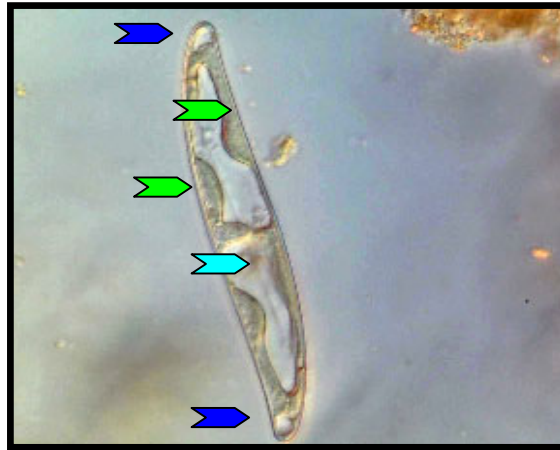
➤ Two chloroplasts, each covering the girdle from end to end.




## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Naviculaceae

### *Pleurosigma capense*

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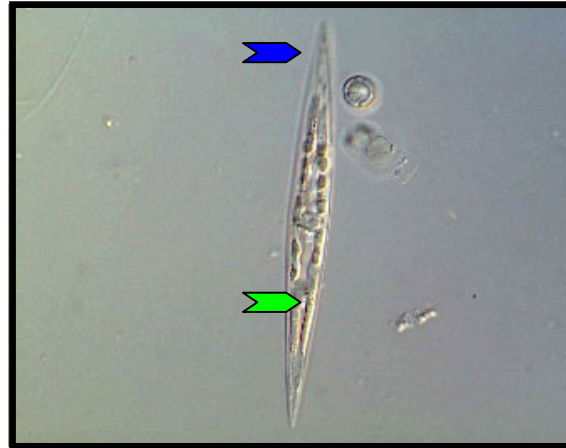
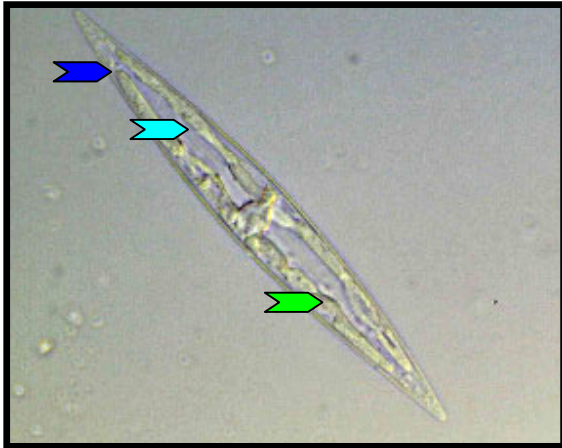
-  Cells elongated and sigmoid.
-  Chromatophore two bands, one to each valve.
-  Raphe more or less sigmoid and central.

## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINIEAE
Family:	Naviculaceae

### *Pleurosigma directum*

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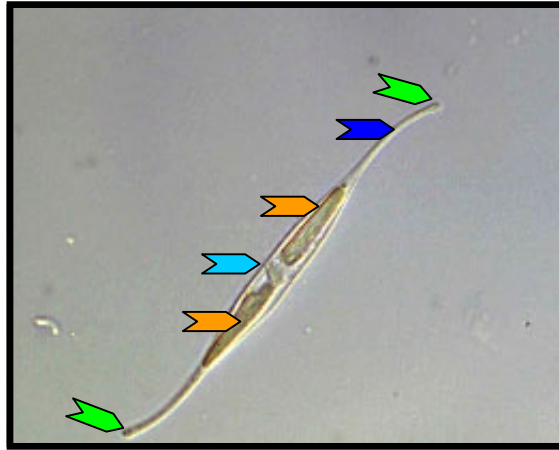
- Cells elliptic-lanceolate.
- Chromatophores present.
- Raphe almost straight.





## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Bacillariaceae

### *Nitzschia closterium*

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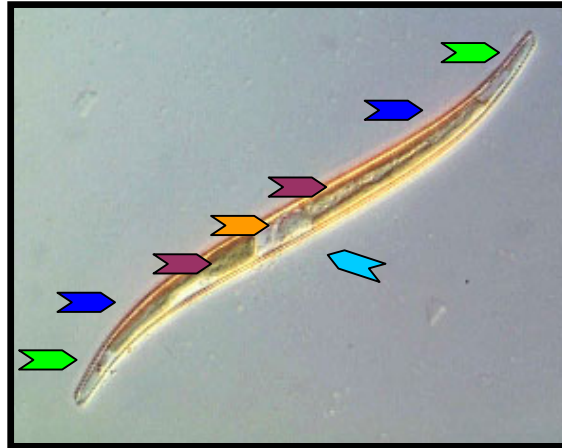
-  Cells solitary and slightly bend.
-  Ends of bent horns are hair-like.
-  Central nucleus and
-  two chromatophores.

## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Bacillariaceae

### *Nitzschia sigma*

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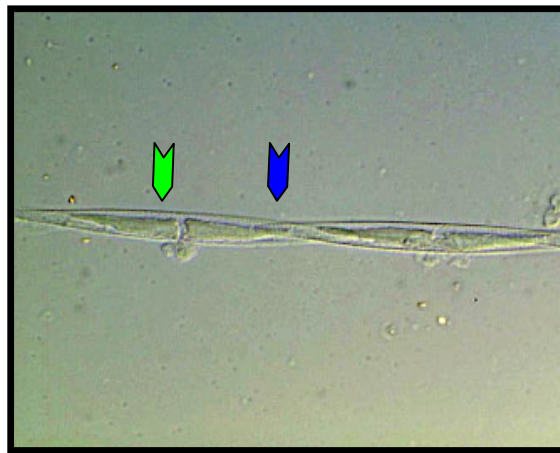
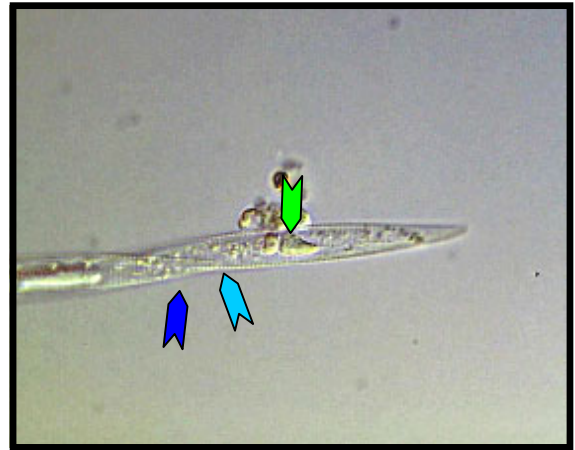
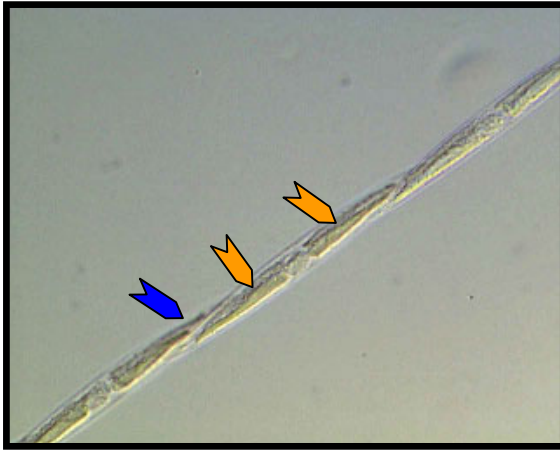






- Valves linear and somewhat sigmoid.
- Valve is finely striated.
- Cells are fairly long.
- Central nucleus and two chromatophores.

## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Bacillariaceae

### *Pseudo-nitzschia australis*



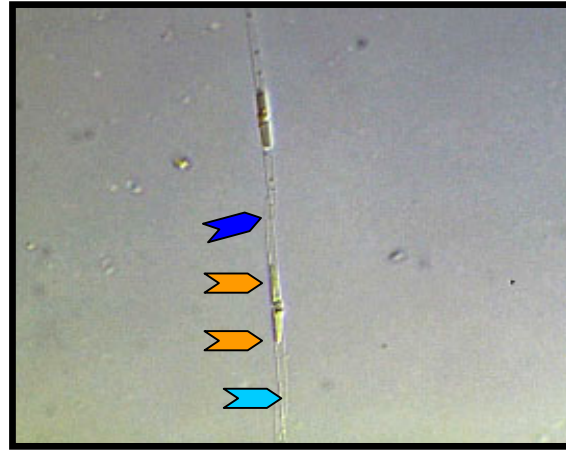
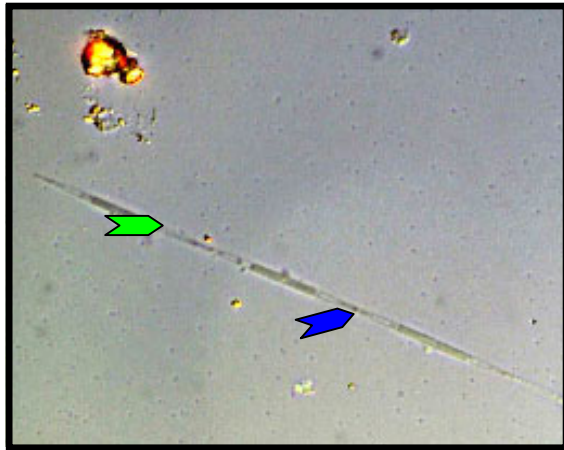
-  Cells joined at tips (overlap is 1/4 of cell).
-  Cells very wide.
-  Striations visible with light microscope.
-  Two chromatophores are present.





## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Bacillariaceae

### *Pseudo-nitzschia delicatissima*

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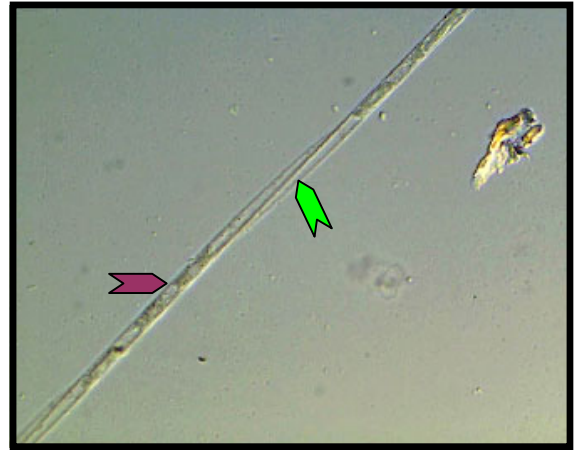
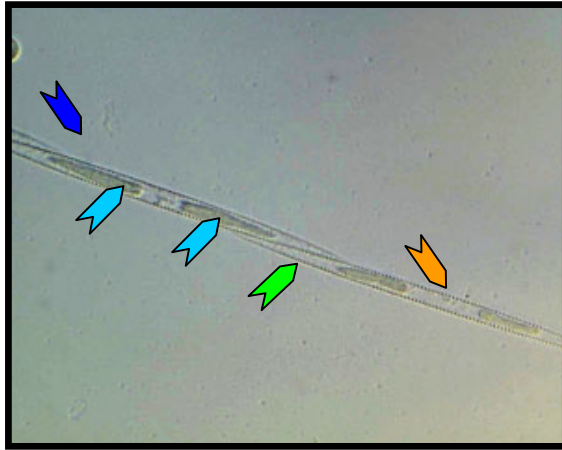







-  Cells joined in short chains tip to tip (tip to tip overlap is 1/9 of cell).
-  Cells not very wide.
-  Striations not visible with light microscope.
-  Two chromatophores are present.

## B. Pennate Diatoms

Division:	BACILLARIOPHYTA
Order:	BACILLARIALES
Sub-order:	FRAGILARIINEAE
Family:	Bacillariaceae

### *Pseudo-nitzschia pungens*



-  Valves linear lanceolate and strongly tapered with pointed ends
-  Cell tips overlap with 1/3 of the cell.
-  Two chromatophores present.
-  Striations visible with light microscope.
-  Cell narrower than that of *Pseudo-nitzschia seriata*.





# Dinoflagellates

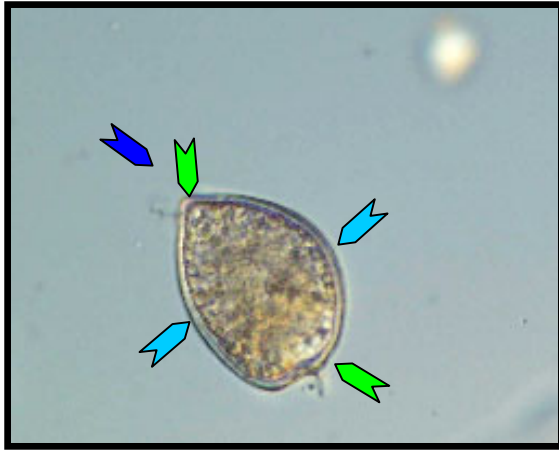
Dinoflagellate species encountered in the study area are ordered according to Steidinger and Tangen (1997)






# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PROROCENTRALES
Family:	Prorocentraceae

## *Prorocentrum micans*

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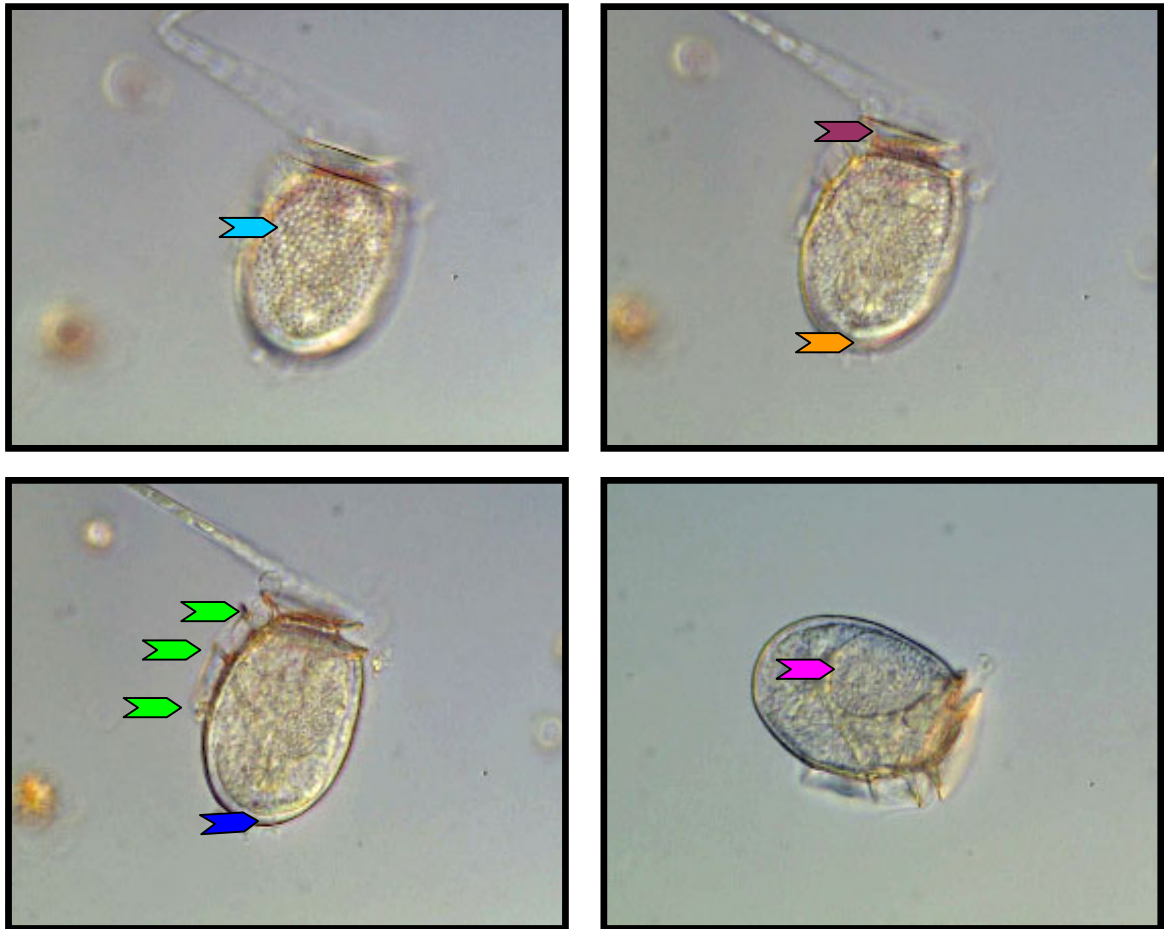








-  Cells are tear-drop shaped to heart shaped.
-  Rounded anterior end and a pointed posterior end.
-  In valve view have one convex side and one arched side.
-  The convex arch profile is typically in the middle of the cell where the cell is the broadest.
-  Prominent spine with a triangular wing is present.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	DINOPHYSIALES
Family:	Dinophysiaceae

### *Dinophysis acuminata*










-  Cell oval or elliptical in shape.
-  Left sulcal list is well developed, supported by 3 ribs and extends beyond the midpoint of the cell.
-  Surface covered with areolae, each with a pore.
-  Posterior profile of hypotheca is rounded.
-  Epitheca is dorsoventrally reduced.
-  Nucleus.

# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	DINOPHYSIALES
Family:	Dinophysiaceae

## *Dinophysis fortii*

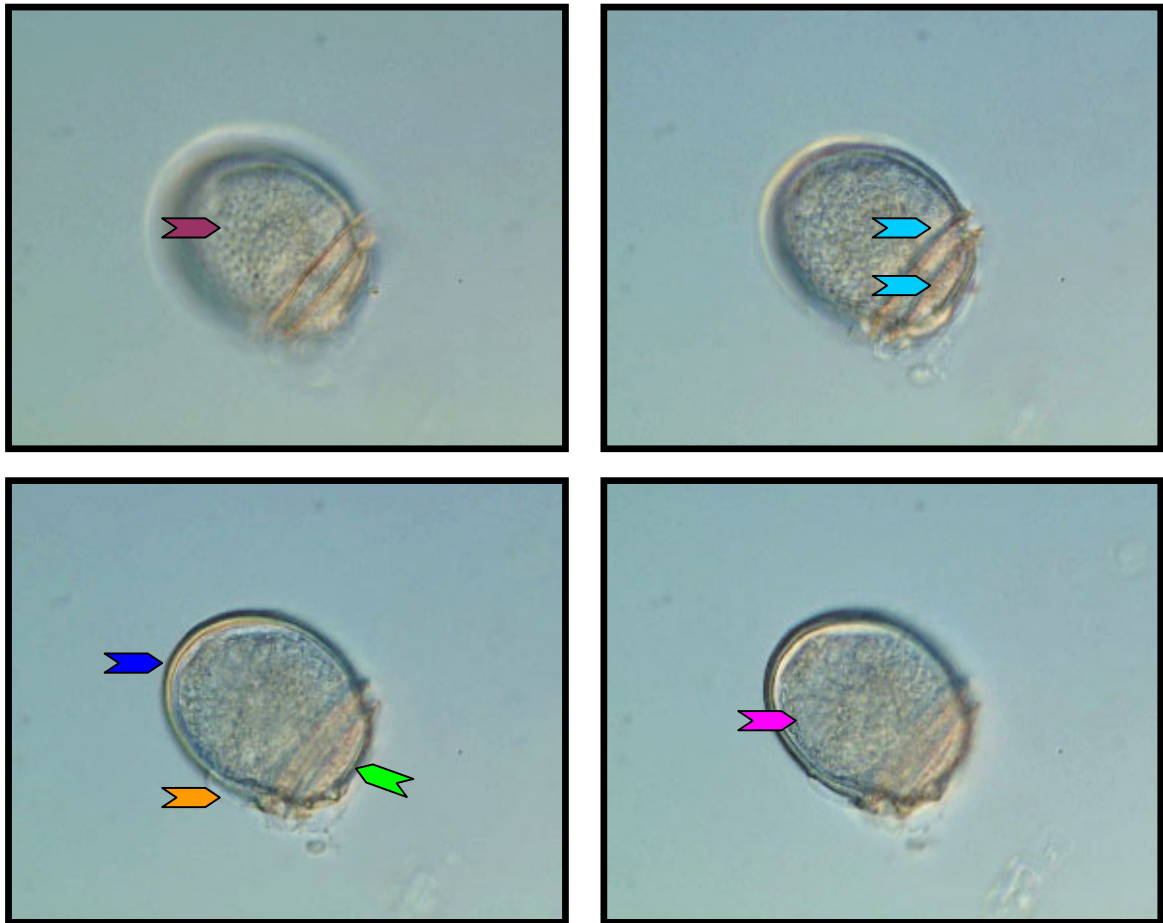








-  Cells are broadly sub-ovoid shaped.
-  Cell widest posteriorly.
-  Dorsal margin curved and ventral margin almost straight.
-  Left sulcul list long and can be up to 4/5 of the cell length.
-  Right sulcul list also well developed and can extend beyond the 2nd rib.
-  Surface of the valves have deep poroids, each with a pore.
-  Nucleus.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	DINOPHYSIALES
Family:	Dinophysiaceae

### *Dinophysis rotundata*



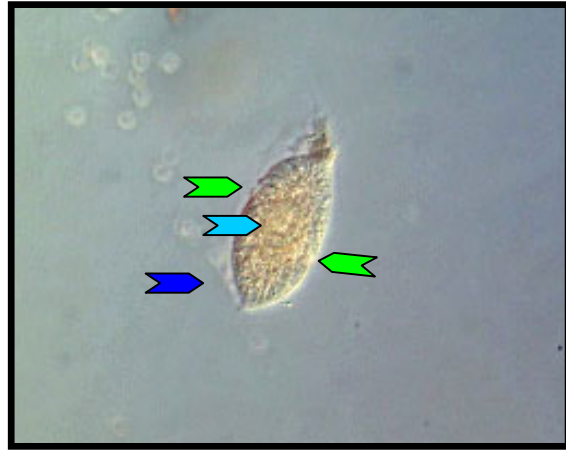
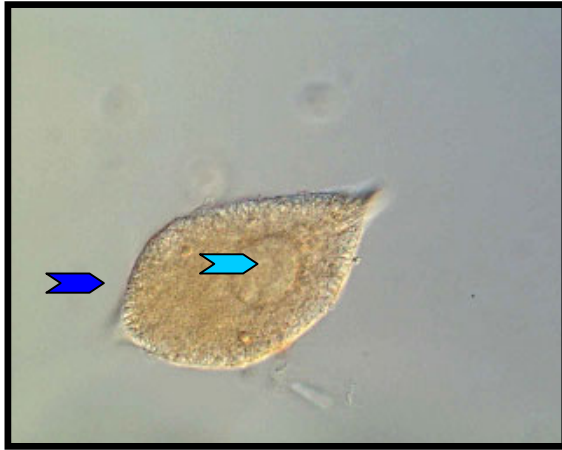
-  In lateral view, cells are asymmetrically rounded to oval.
-  Epitheca is low and fairly evenly rounded and convex
-  Both anterior and posterior cingular lists are narrow and lack any ridges.
-  Sulcul lists extend about half the total length
-  The thecal plates are thin and finely areolated.
-  Nucleus.




# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	GYMNODINIALES
Family:	Gymnodiniaceae

## *Gyrodinium* sp.

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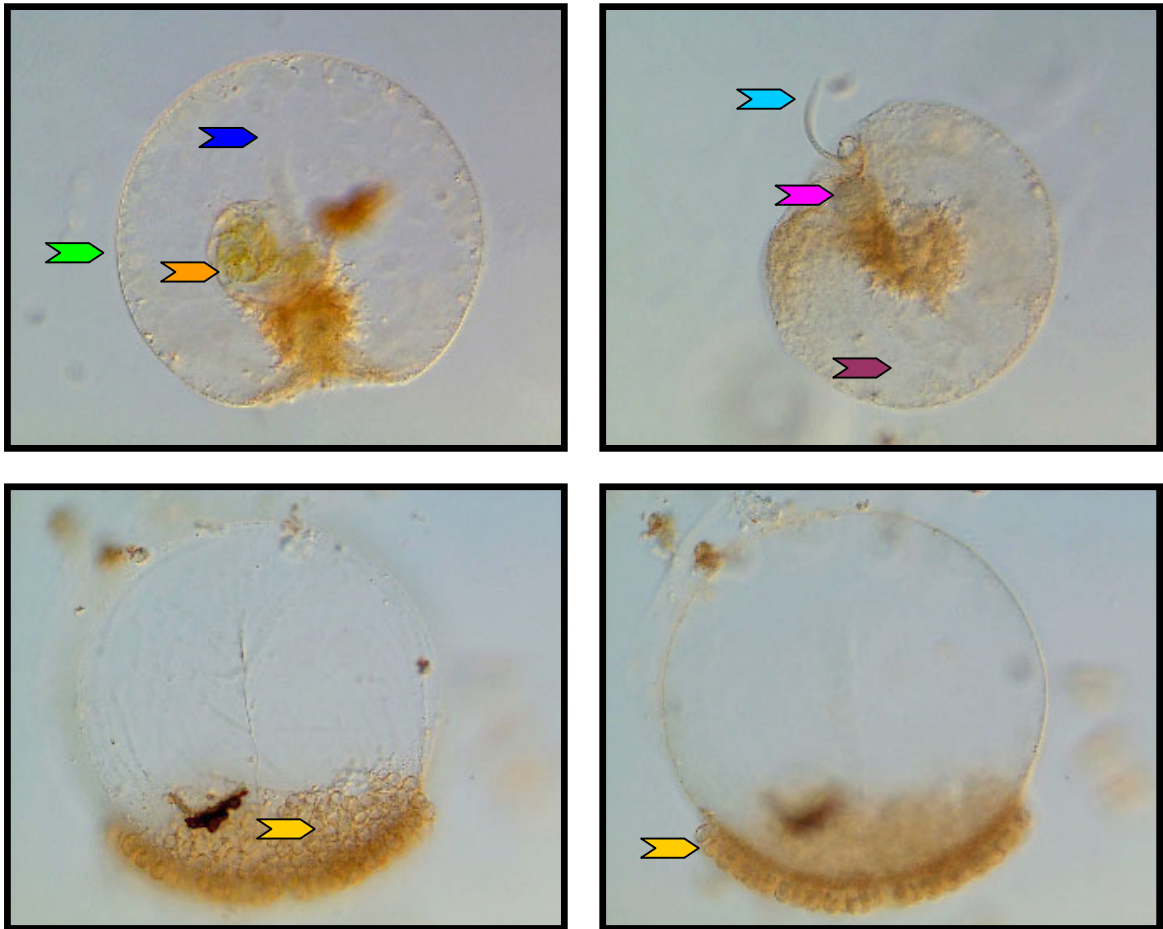









-  Large spindle shaped asymmetric cell with slight longitudinal twist.
-  Cingulum narrow, displaced  $\sim 1/3$  of the body length.
-  Big nucleus present.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	NOCTILUCALES
Family:	Noctilucaeae

### *Noctiluca scintillans*



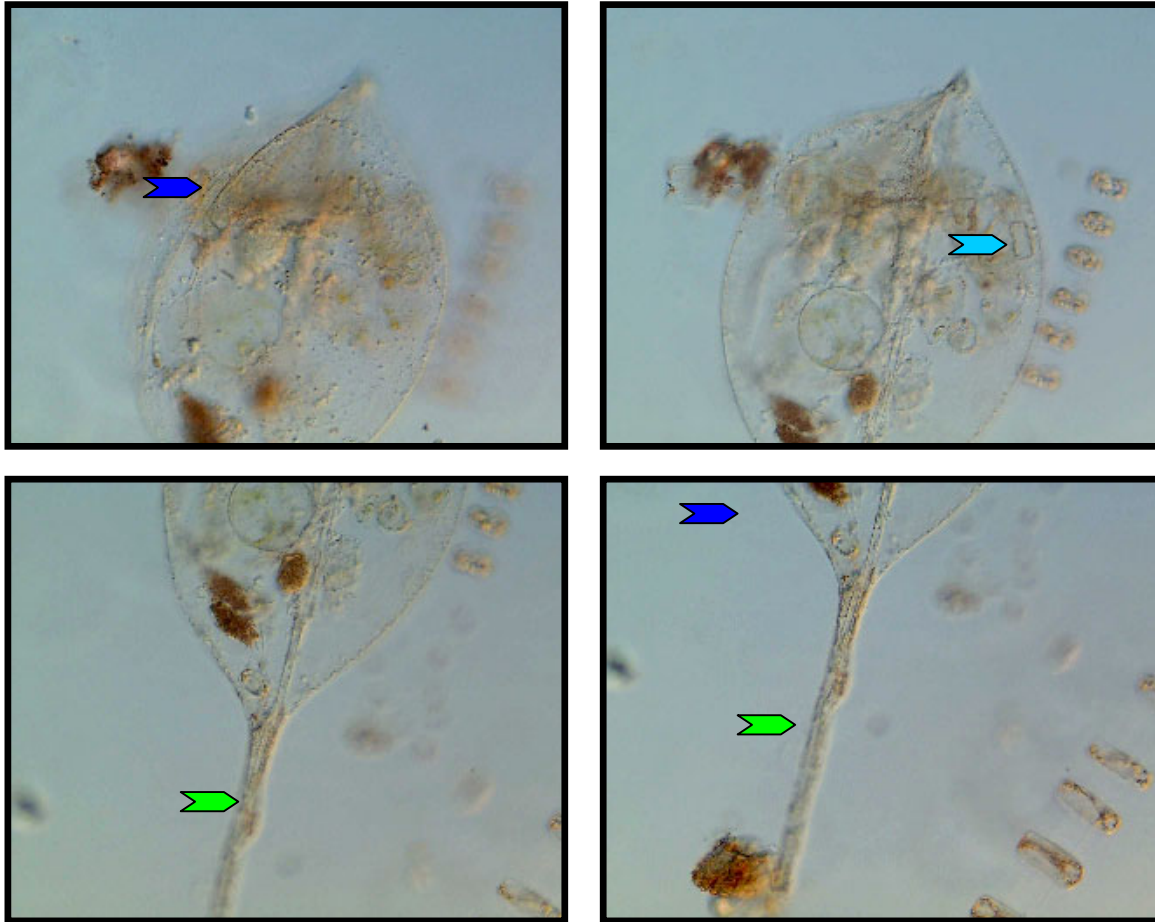
-  Cells large, subspherical and inflated.
-  Cells not differentiated into epitheca and hypotheca.
-  Two flagella and a striated tentacle.
-  Numerous food vacuoles, often containing diatoms
-  Chloroplasts are absent and the cytoplasm is colourless.
-  Eucaryotic nucleus situated near the sulcus.
-  Zoospore formation.






# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	NOCTILUCALES
Family:	Noctilucaeae

## *Spatulodinium* cf. *pseudonoctiluca*



-  Very large cell looking inflated like *Noctiluca scintillans*.
-  Pointed anteriorly with straight tentacle posteriorly.
-  Food vacuoles contain diatoms.





## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	GONYAULACALES
Family:	Ceratiaceae

### *Ceratium dens*

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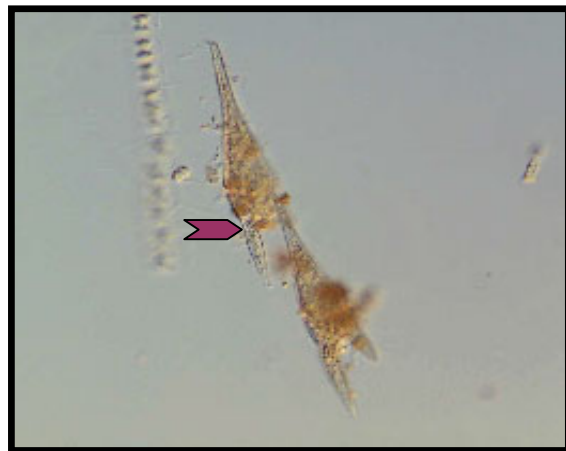
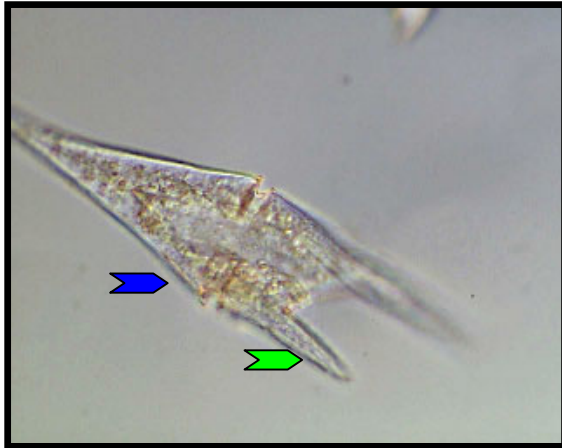







-  Pentagonal cell shape.
-  Epitheca forming a more or less equilateral triangle with a
-  sharp transition into a fairly long apical horn.
-  Hypotheca extends into two unequal antapical horns pointing in opposite directions.

# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	GONYAULACALES
Family:	Ceratiaceae

## *Ceratium furca*

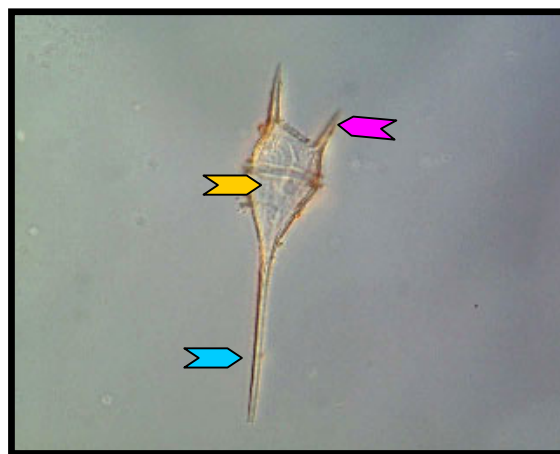
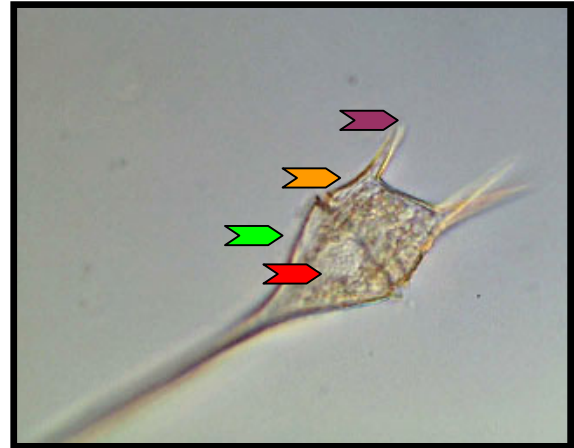
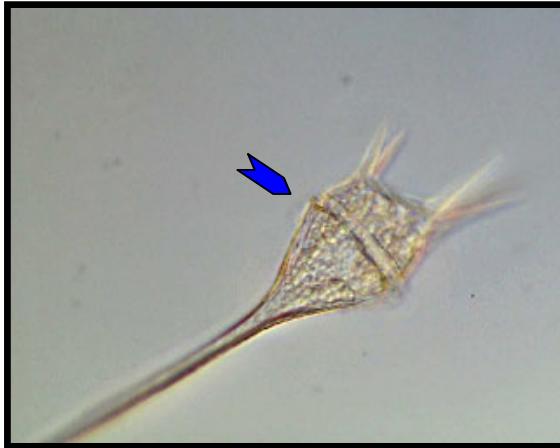










-  Large, straight body with cell being the widest either side of the girdle.
-  Two unequal, parallel or slightly divergent hypothecal horns, the right shorter than the left.
-  Epitheca tapering gradually into an apical horn.
-  Thecal plates thick and ornamented with surface ridges
-  Chain forming species.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	GONYAULACALES
Family:	Ceratiaceae

### *Ceratium lineatum*

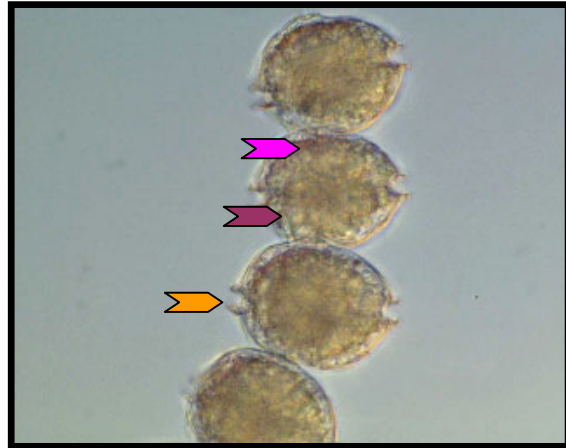
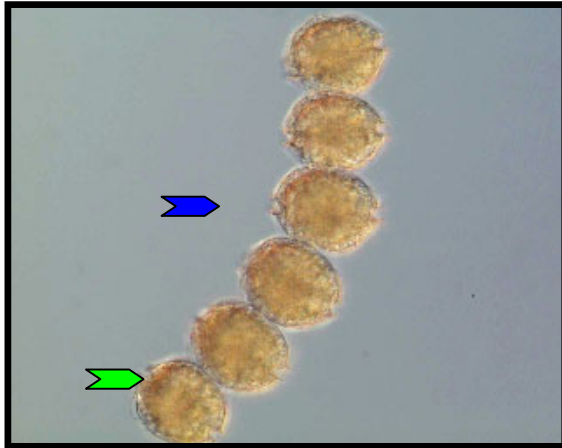








-  Pentagonal cell shape.
-  Epitheca forming a more or less equilateral triangle with a
-  sharp transition into a fairly long apical horn.
-  Hypotheca rather rectangular extended at the lower corners into
-  two unequal antapical horns which are straight but
-  diverge slightly, right horn shorter.
-  Thecal plates rather thin, not ornamented.
-  Nucleus.

# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	GONYAULACALES
Family:	Goniodomataceae

## *Alexandrium catenella*

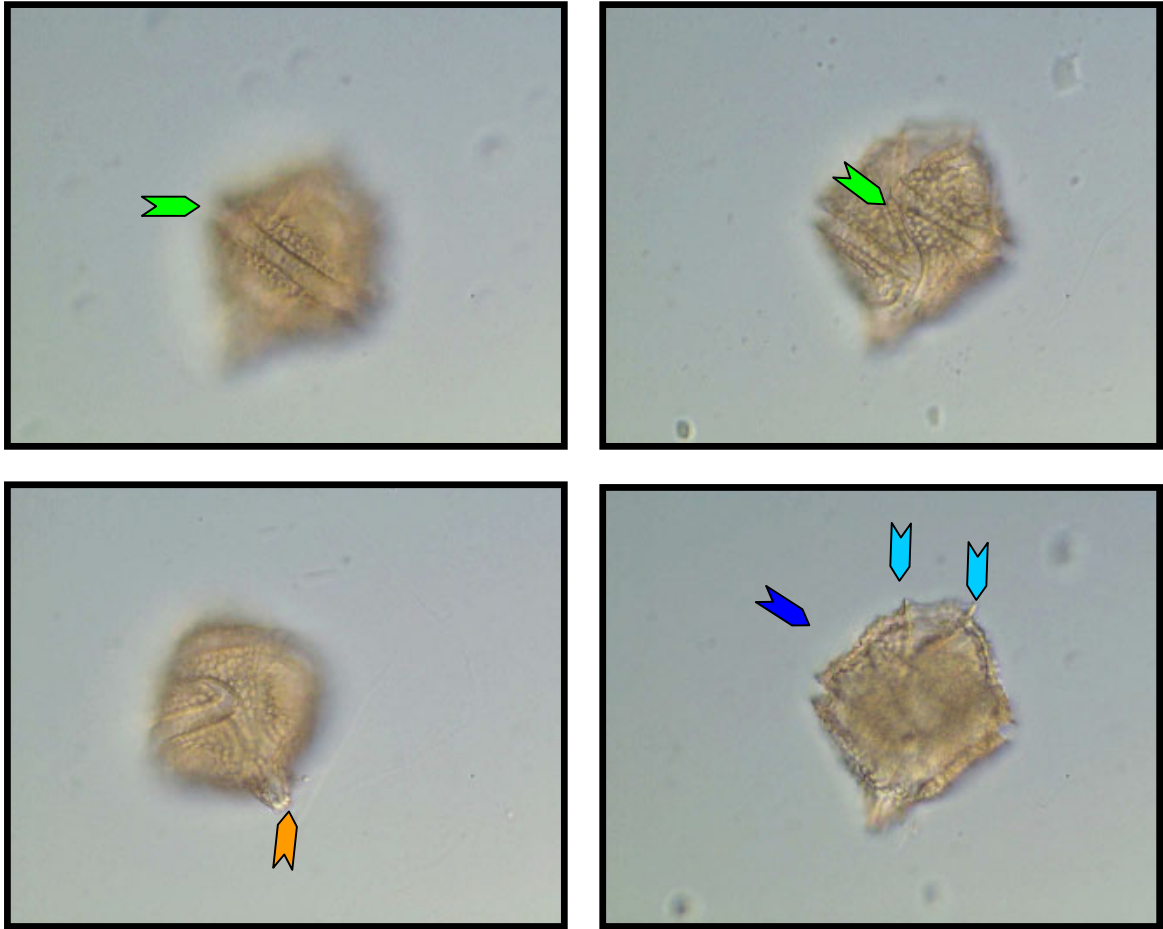






-  Chain forming species of 2-8 cells.
-  Cells globular, slightly wider than long.
-  Cingulum median, descending, displaced by its width.
-  Cingulum contains fins.
-  Antapex slightly concave.
-  Apex slightly convex.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	GONYAULACALES
Family:	Gonyaulacaceae

### *Gonyaulax spinifera*



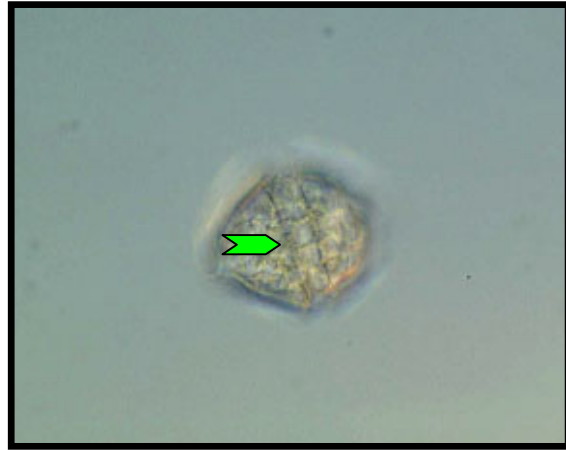
-  Cells thecate, elongated and tetragonal in dorso-ventral view.
-  Girdle relatively wide, descending in about twice its width with a large overhang.
-  Hypotheca bearing two antapical spines.
-  Epitheca with convex sides leading into an apical horn.


# Dinoflagellates


Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	GONYAULACALES
Family:	Gonyaulacaceae

## *Lingulodinium cf. polyedrum*

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 Cell polyedral shaped, without antapical spines and apical horn.

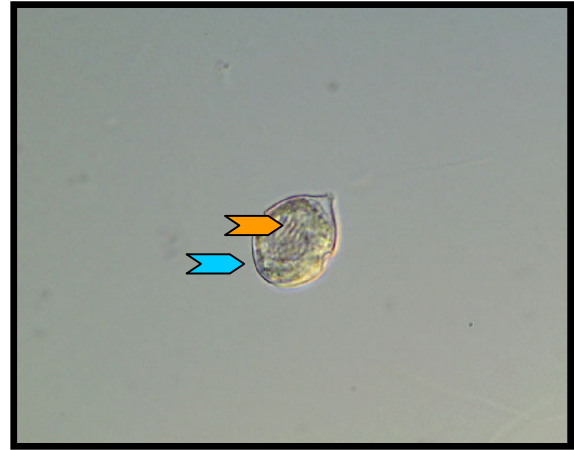
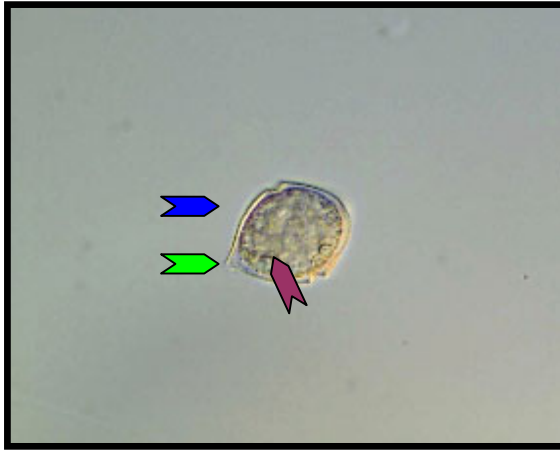
 Girdle wide and almost equatorial.






Note: *L. polyedrum* should have coarse areolation.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Calciodinellaceae

### *Scrippsiella trochoidea*



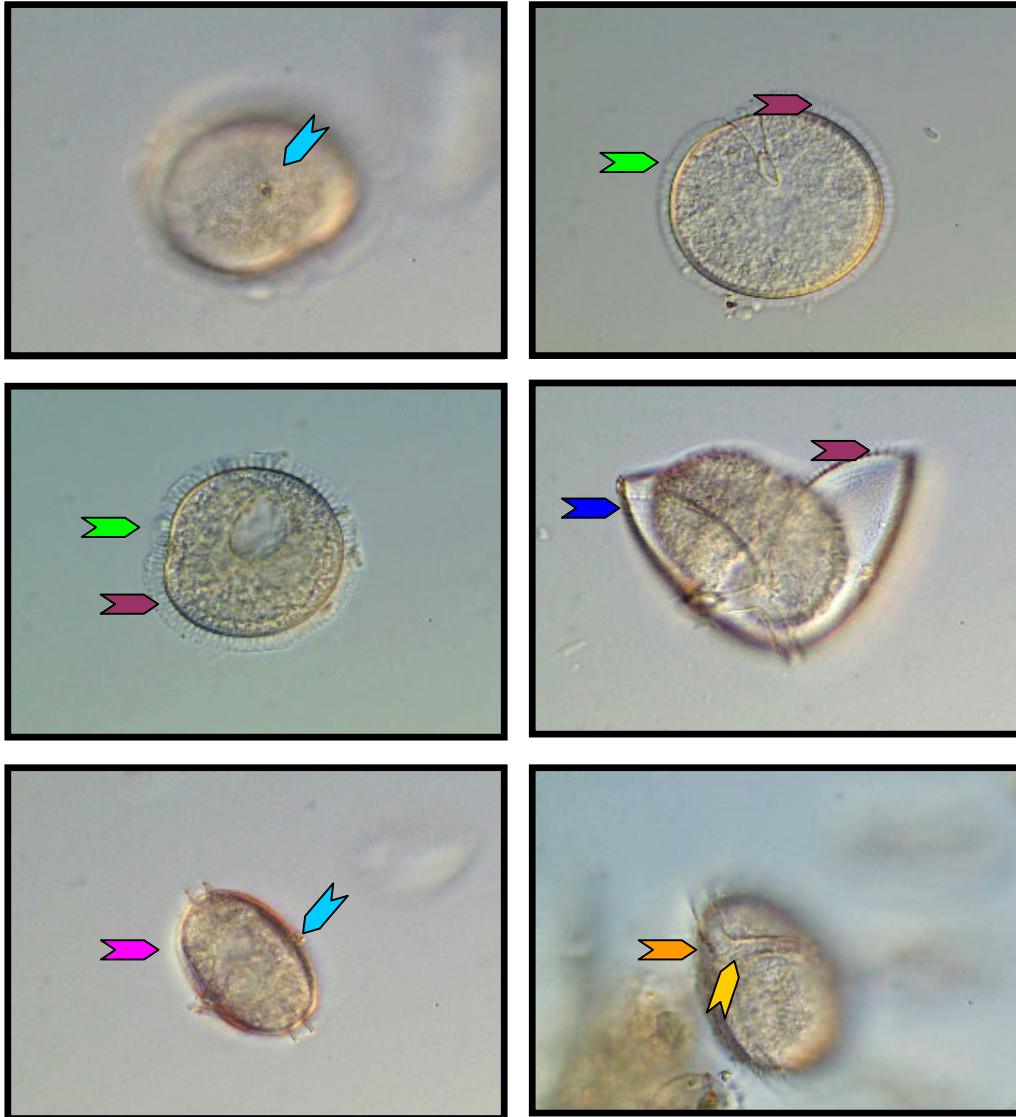
-  Small pear shaped cell.
-  Epitheca is conical with a raised apex.
-  Hypotheca hemispherical with no antapical projections
-  Nucleus central.
-  Chloroplasts discoidal.










# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Kolkwitzellaceae

## *Preperidinium meunieri* (Synonym: *Zygabikodinium lenticulatum*)

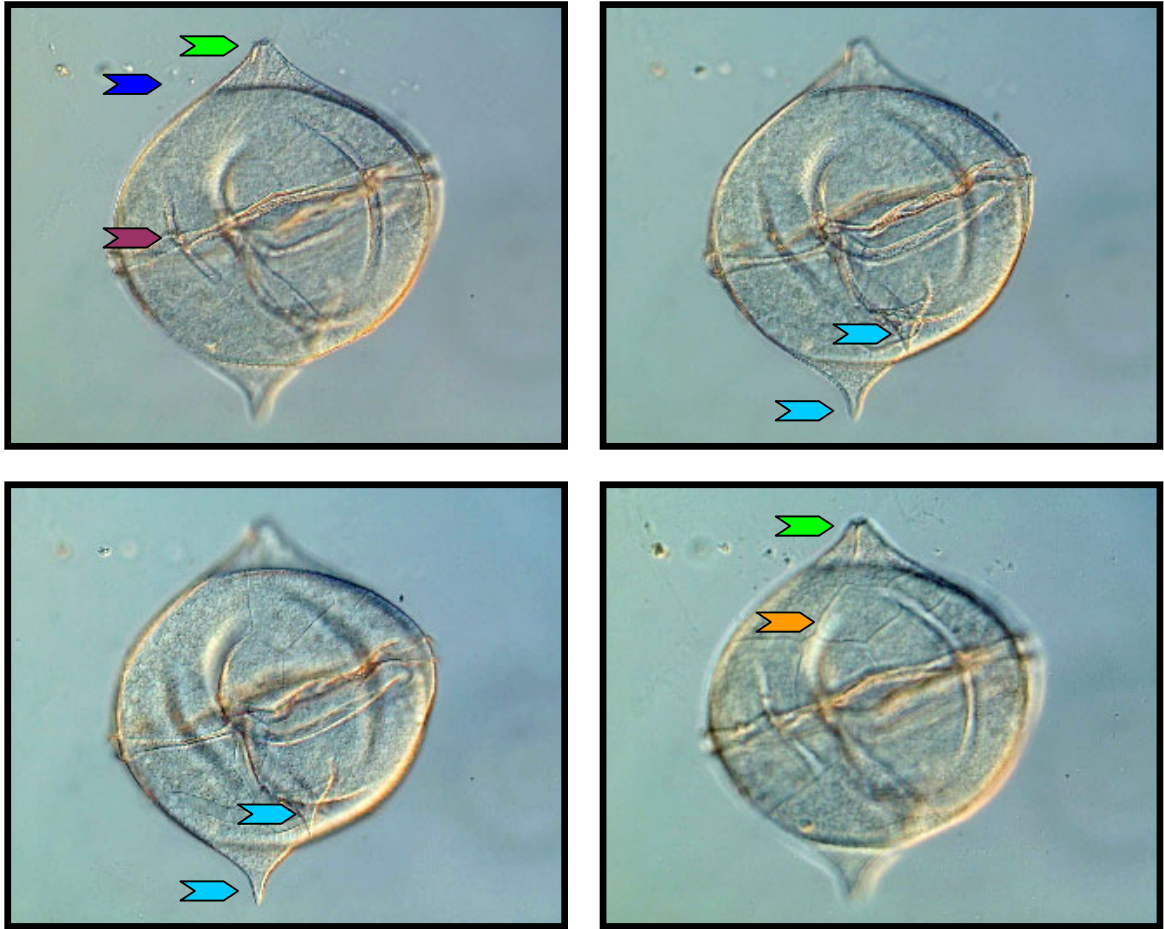







-  Cells armoured and  almost circular in apical view
-  Epitheca with convex sides and small apical projection.
-  The girdle is equatorial,
-  not incised but bordered by lists supported by spines.
-  Hypotheca has convex sides.
-  The sulcus almost reaches the centre of the hypotheca and is bordered by a narrow list.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

### *Protoperidinium* sp.



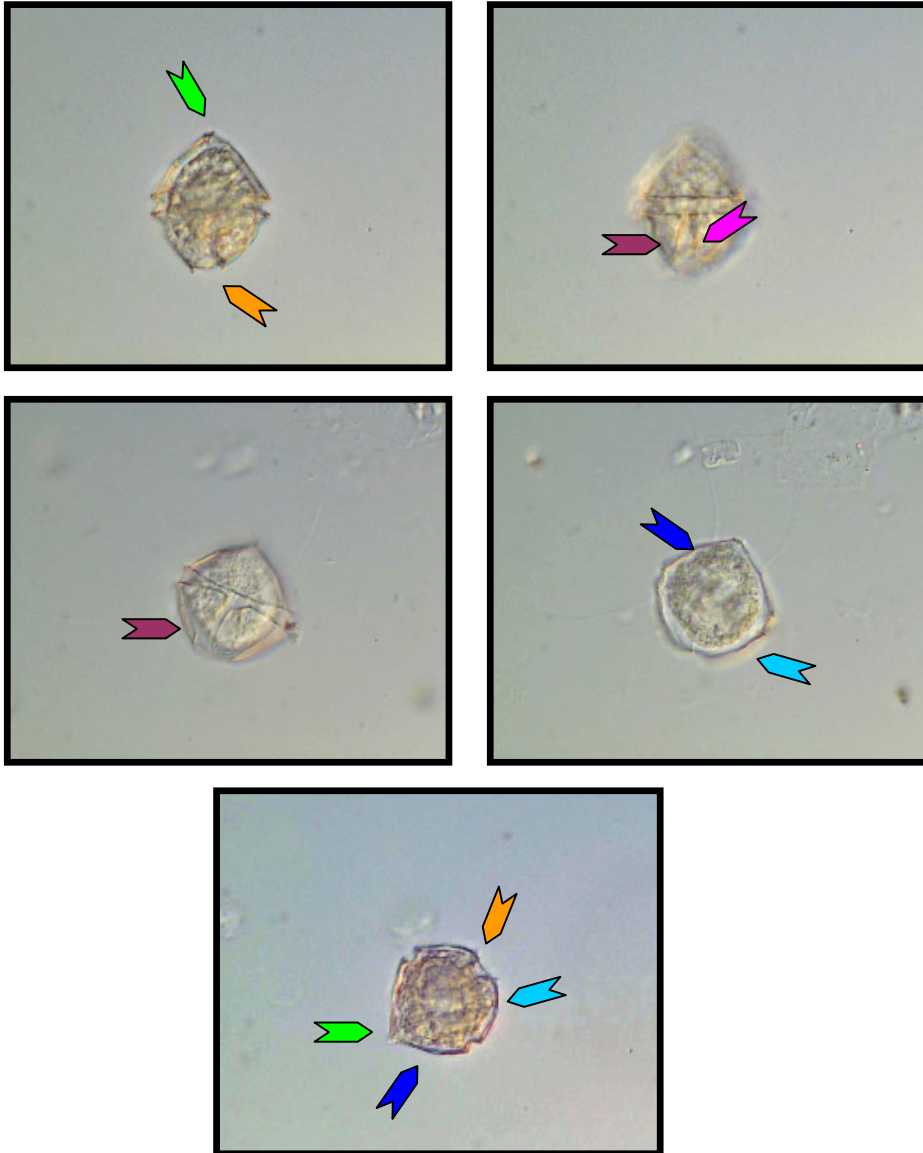
-  Large round cell.
-  Epicone convex ending in a apical horn.
-  Hypocone convex ending in two antapical horns.
-  Thecal plates present.
-  Cingulum is circular and not very wide.







# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

## *Protoperidinium conicoides*

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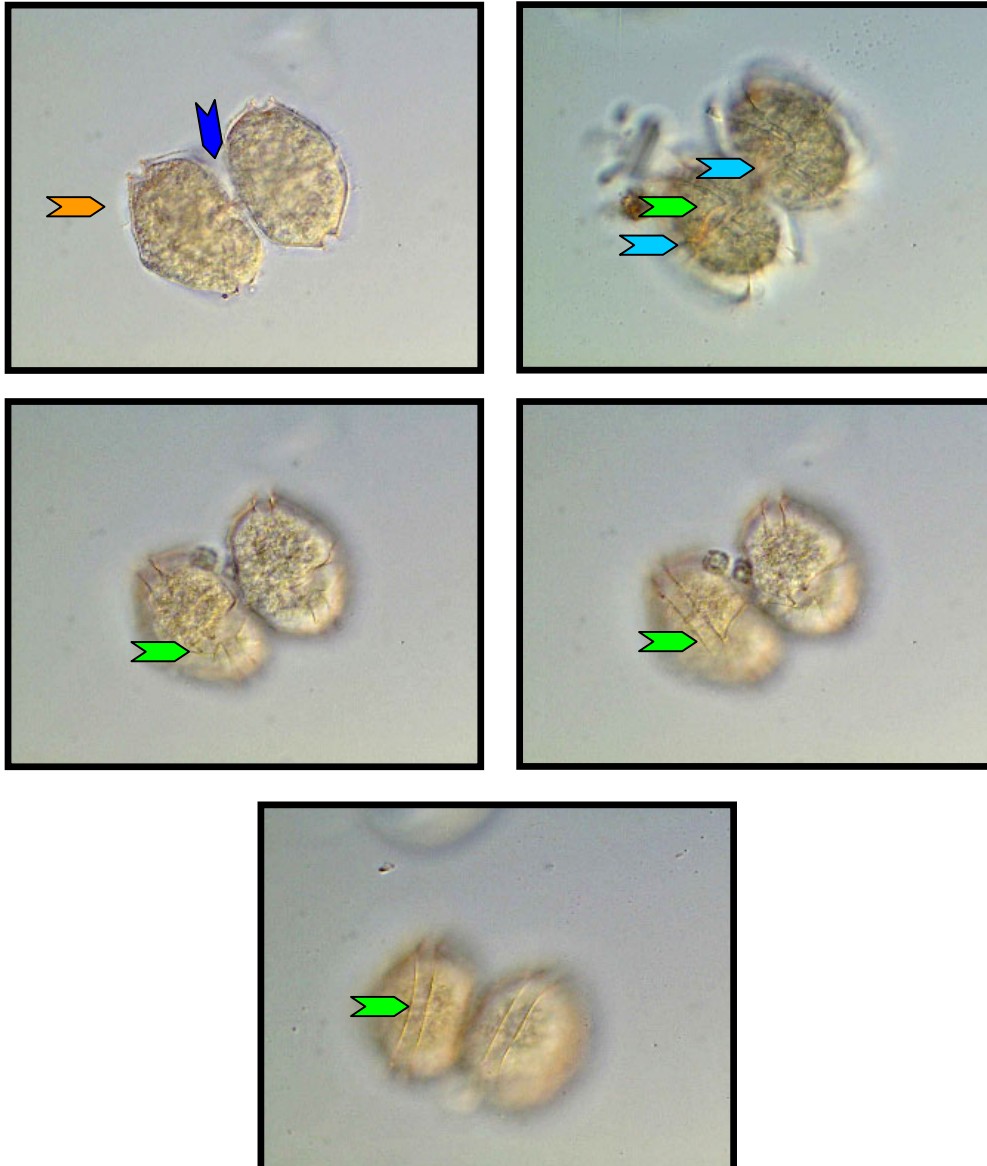






-  Epitheca slightly convex,
-  ending at the apex with a small projection.
-  Hypotheca also convex,
-  ending with two spines at the antapex.
-  Sulcus deeply excavated, broadening posteriorly with
-  a characteristic twist on the left just below the girdle.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

### *Protoperidinium denticulatum*

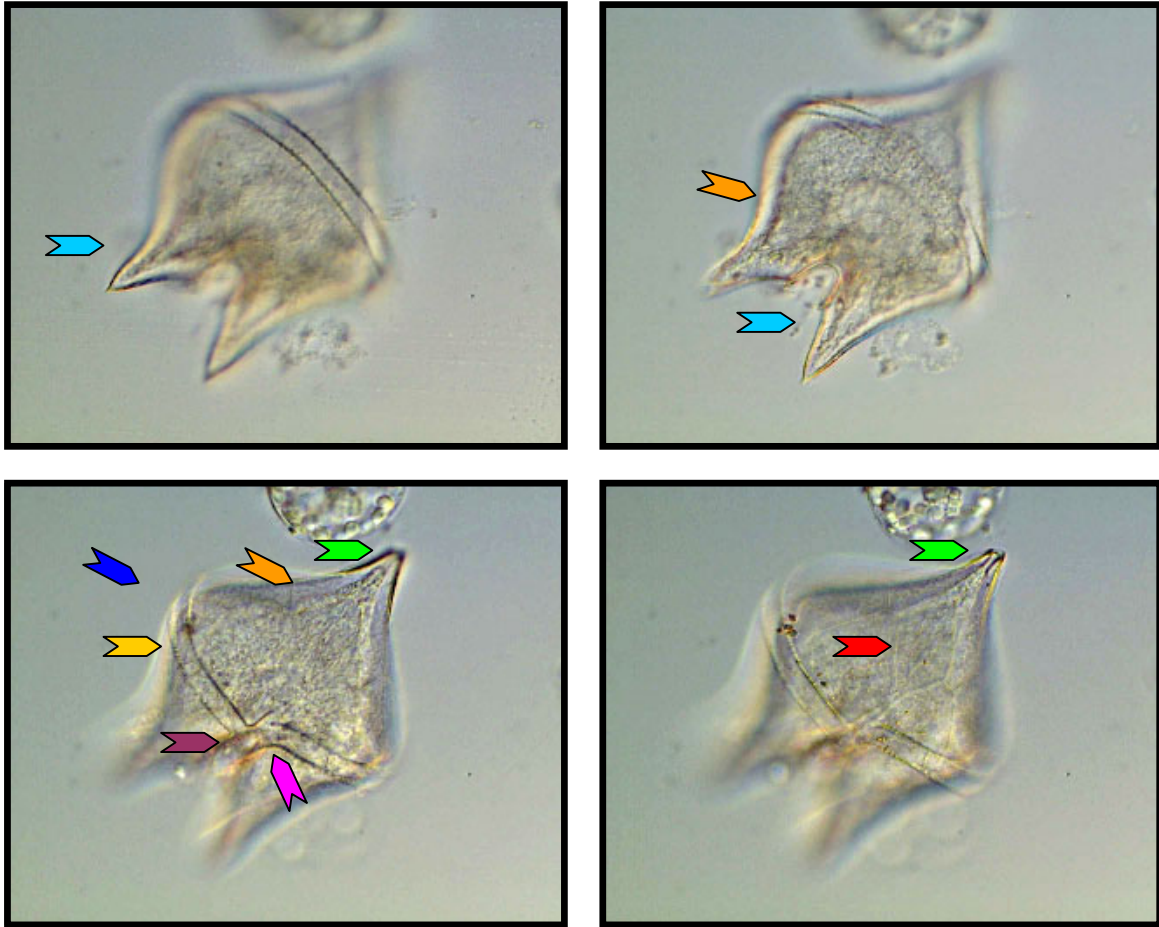










-  Very distinctively shaped species in which some cells have a flat epitheca whilst others a flat hypotheca.
-  Cingulum wide and displaced by one girdle width.
-  Sulcus is deep.
-  Often cells are found in pairs.

# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

## *Protoperidinium depressum*

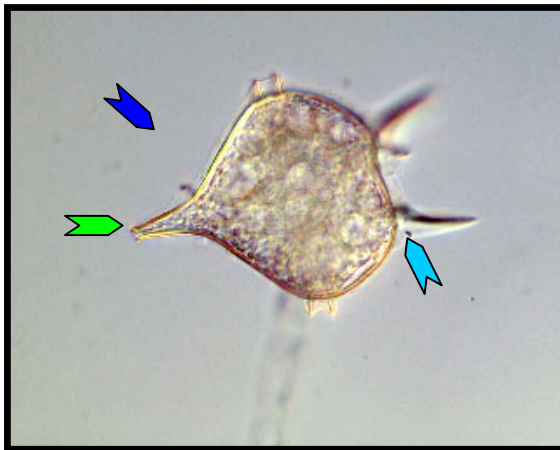









-  Large cell with  prominent apical horn and
-  two divergent antapical horns.
-  Epitheca and hypotheca concave
-  Sulcus deeply excavated.
-  Cingulum is left-handed, unexcavated and bordered by lists
-  supported by spines.
-  Thecal plates.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

### *Protoperidinium diabolum*

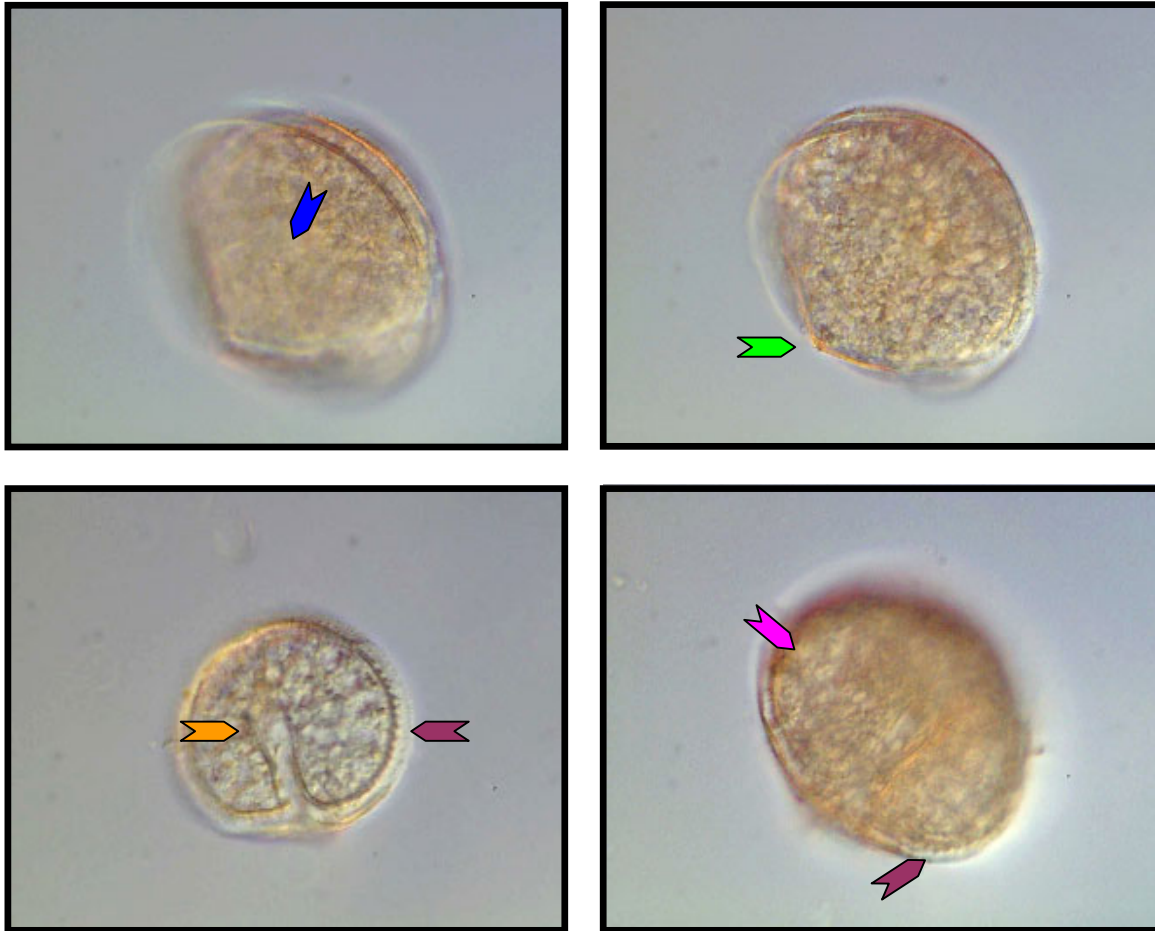







-  Cells are pear shaped and slightly dorso-ventrally flattened.
-  Long apical horn and
-  two long, winged antapical spines present.
-  Left spine has a small accessory spine at its base directed towards the right.
-  Cingulum is right-handed,
-  only slightly displaced,
-  not excavated but with prominent lists supported by spines.

# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

## *Protoperidinium excentricum*

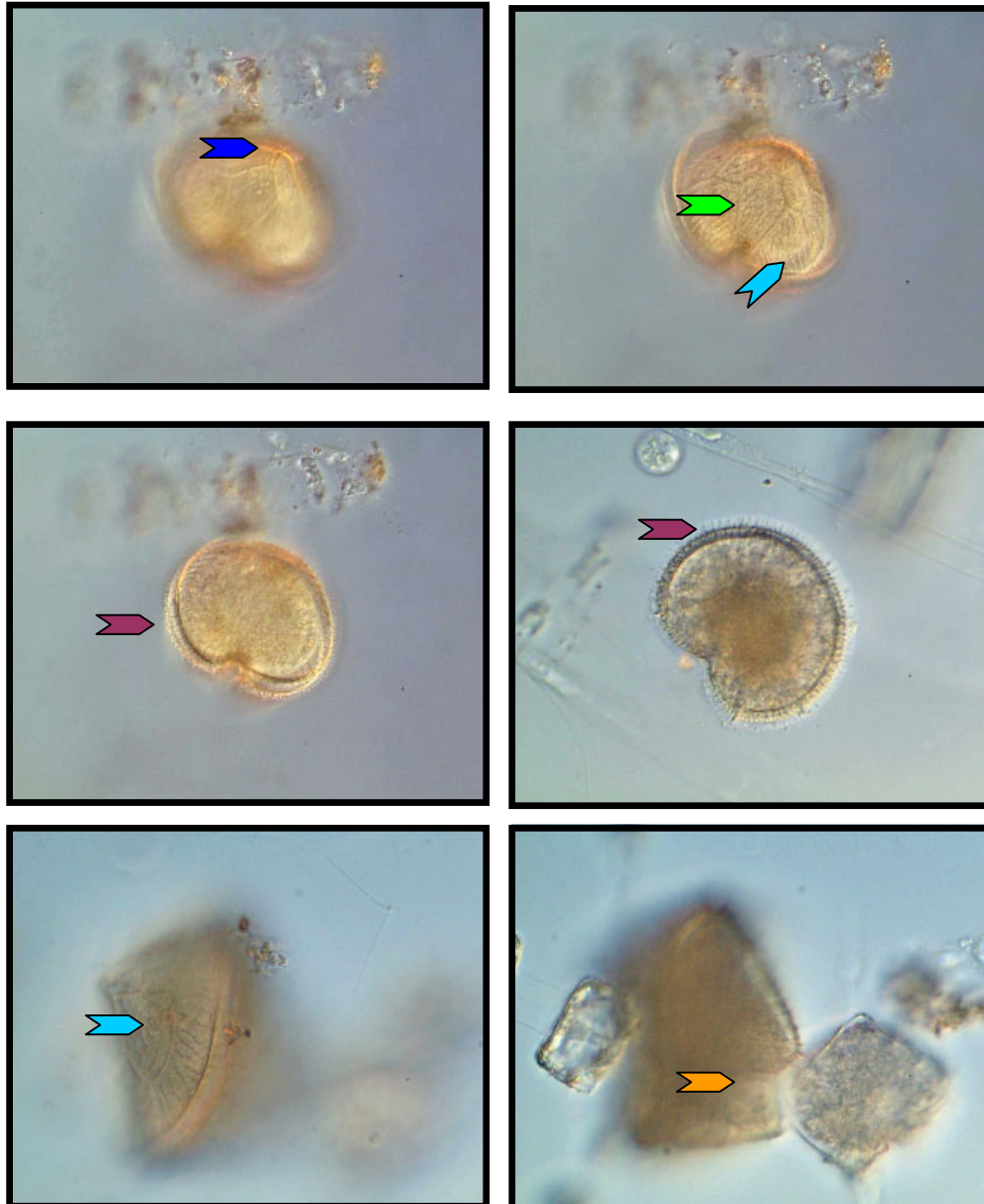







-  Cell is anteriorly-posteriorly compressed with the apical horn
-  offset to the left and ventral (apex-antapex axis is oblique).
-  Sulcus is deeply excavated and reaches beyond the centre of the hypotheca, the left projecting further than the right.
-  Cingulum is excavated, bordered by lists supported by spines.
-  Hypotheca is flattened.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

### *Protoperidinium obtusum*



-  Cell has a blunt apex and  an irregular first apical plate.
-  Epitheca covered by longitudinal striations.  Hypotheca has two antapical horns.
-  Cingulum bordered by a list, supported by spines.

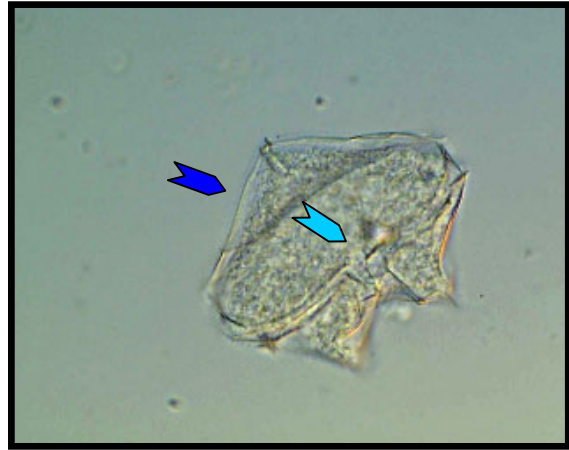






# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

## *Protoperidinium pentagonum*

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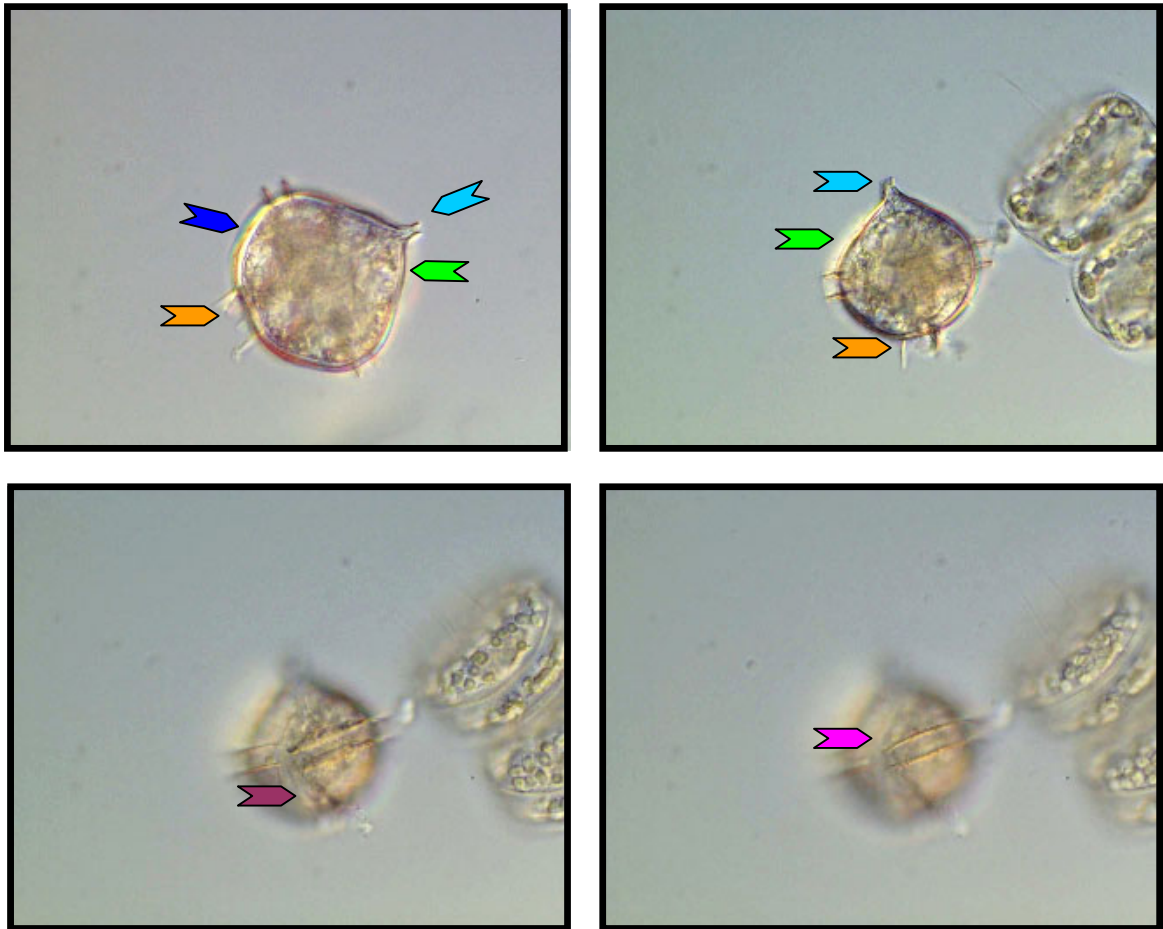








-  Cell large to broadly pentagonal.
-  Sulcus short and shallow.
-  Cingulum descending.
-  Two antapical horns present.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

### *Protoperidinium pyriforme*



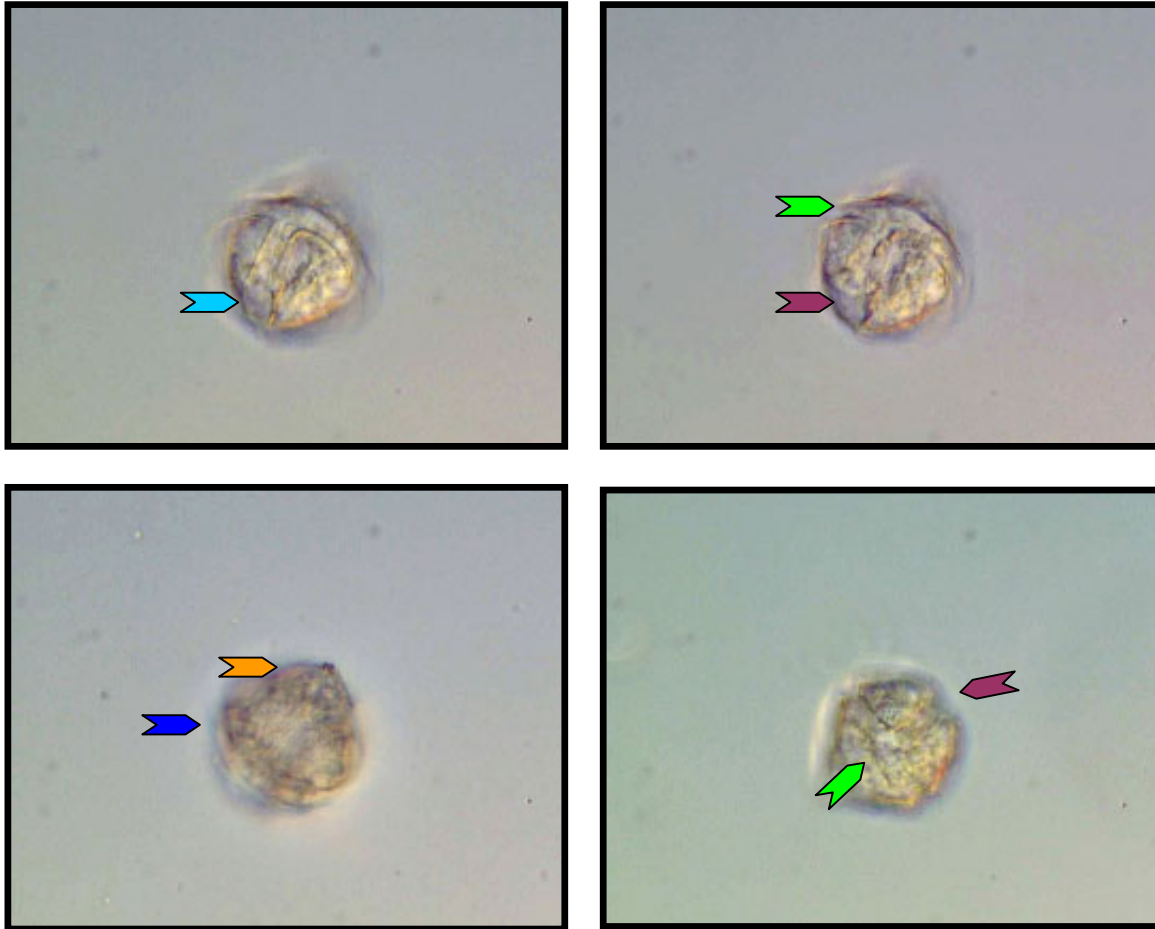
-  Cells pear shaped with
-  straight-sided to convex epitheca,
-  ending in an apical horn.
-  Hypotheca is rounded bearing two winged spines.
-  Sulcus broadens slightly posteriorly.
-  Cingulum is bordered by lists supported by spines.

Note: *Protoperidinium steinii* have longer antapical spines.

# Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

## *Protoperidinium subinermis*

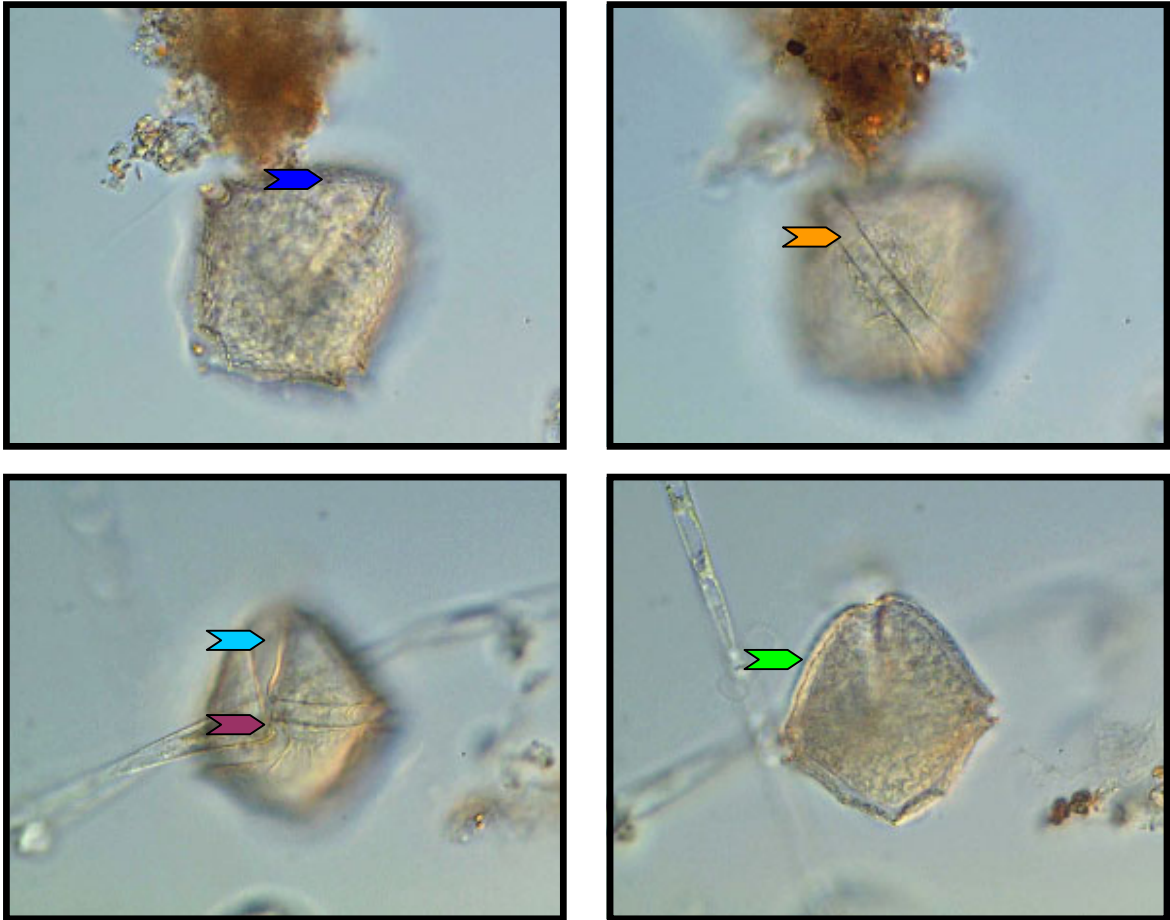







- ➡ Cell almost circular in cross section.
- ➡ Cingulum circular, not very displaced.
- ➡ Sulcus widening antapically.
- ➡ Epitheca is slightly convex and
- ➡ hypotheca is straight sided with a flat base.

## Dinoflagellates

Division:	DYNOPHYTA
Class:	DINOPHYCEAE
Order:	PERIDINIALES
Family:	Protoperidiniaceae

### *Protoperidinium thorianum*



-  Rounded cell characterised by strong papillate or wavy thecal surface.
-  Hypotheca exceeds epitheca in length.
-  Sulcus widening posteriorly.
-  Cingulum wide and
-  displaced by one cingulum width.



# Flagellates

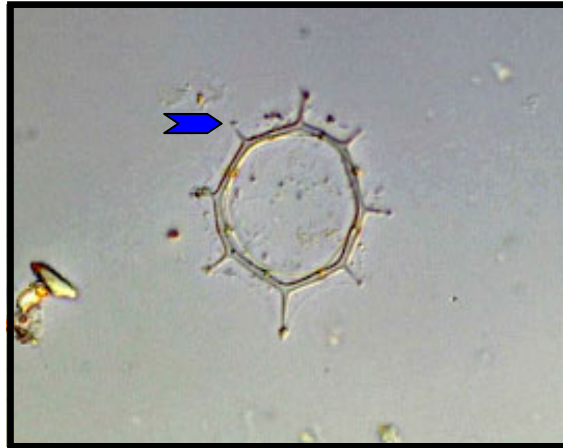
Flagellate species encountered in the study area are ordered according to Thronsen (1997)


# Flagellates

Division:	CHROMOPHYTA
Class:	DICTYOCOPHYCEAE
Order:	DICTYOCHELES
Family:	Dictyochaceae

## *Dictyocha octonaria*

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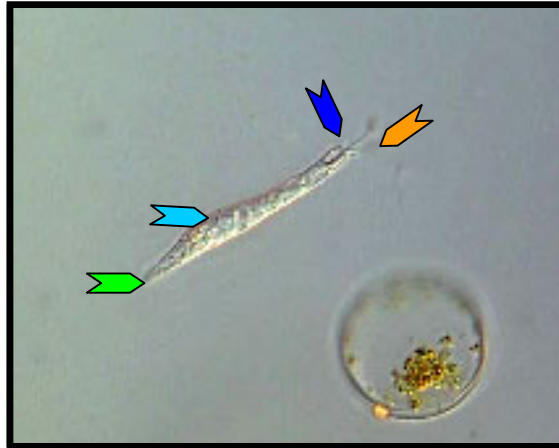
 Skeleton is cartwheel-like with eight spines.

## Flagellates

Division:	CHLOROPHYTA
Class:	EUGLENOPHYCEAE
Order:	EUGLENALES
Family:	Eutreptiaceae

### *Eutreptiella gymnastica*

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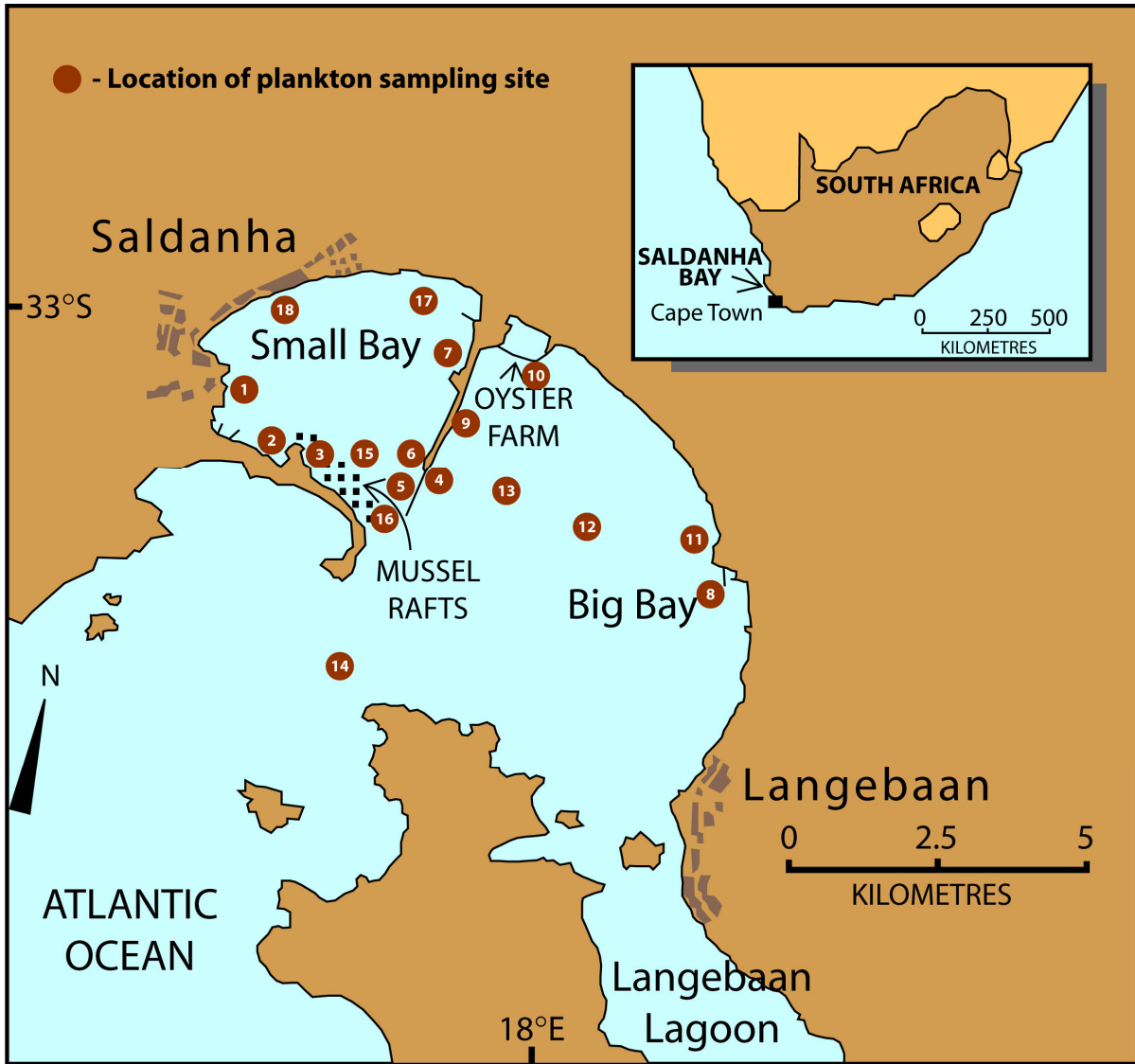


- Anterior end rounded
- and the posterior end slightly pointed.
- Single pyrenoid present.
- Two flagella, unequal in length.







# Sample Locations



- |                |                          |                          |
|----------------|--------------------------|--------------------------|
| 1 Protea Hotel | 7 Station 3              | 13 Mykonos outside       |
| 2 Tug basin    | 8 Mykonos marina         | 14 Channel outer         |
| 3 Mussel rafts | 9 Ore jetty dam corner   | 15 Small Bay middle      |
| 4 Ore jetty    | 10 Seafarm dam - outside | 16 Ore jetty corner west |
| 5 Station 1    | 11 Shed to Mykonos 1     | 17 Moss gas wall         |
| 6 Station 2    | 12 Shed to Mykonos 2     | 18 Long beach rocks      |

# Diatoms

Sample Site (see map)				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Genus	cf.	species																			
<i>Skeletonema</i>		<i>costatum</i>																			
<i>Thalassiosira</i>		spp.																			
<i>Melosira</i>		<i>sphaerica</i>																			
<i>Stephanopyxis</i>		<i>turris</i>																			
<i>Leptocylindricus</i>		<i>danicus</i>																			
<i>Corethron</i>		<i>criophilum</i>																			
<i>Coscinodiscus</i>		spp.																			
<i>Hemidiscus</i>		<i>cuneiformis</i>																			
<i>Actinoptychus</i>		<i>splendens</i>																			
<i>Rhizosolenia</i>		<i>hebetata</i>																			
<i>Rhizosolenia</i>		<i>imbricata</i>																			
<i>Guinardia</i>		<i>delicatula</i>																			
<i>Guinardia</i>		<i>striata</i>																			
<i>Eucampia</i>		<i>zodiacus</i>																			
<i>Chaetoceros</i>		spp.																			
<i>Ditylum</i>		<i>brightwelli</i>																			
<i>Asterionellopsis</i>		<i>glacialis</i>																			
<i>Licmophora</i>		<i>ehrenbergii</i>																			
<i>Striatella</i>		<i>unipunctata</i>																			
<i>Thalasionema</i>		<i>nitzschiodes</i>																			
<i>Navicula</i>		spp.																			
<i>Pleurosigma</i>		<i>capense</i>																			
<i>Pleurosigma</i>		<i>directum</i>																			
<i>Nitzschia</i>		<i>closterium</i>																			
<i>Nitzschia</i>		<i>sigma</i>																			
<i>Pseudo-nitzschia</i>		spp.																			

 Absence  
 Presence

# Dinoflagellates

Sample Site (see map)				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Genus	cf.	species																			
<i>Prorocentrum</i>		<i>micans</i>																			
<i>Dinophysis</i>		<i>acuminata</i>																			
<i>Dinophysis</i>		<i>fortii</i>																			
<i>Dinophysis</i>		<i>rotundata</i>																			
<i>Gyrodinium</i>		sp.																			
<i>Noctiluca</i>		<i>scintillans</i>																			
<i>Spataludinium</i>	cf.	<i>pseudonoclituca</i>	sp.1																		
<i>Ceratium</i>		<i>dens</i>																			
<i>Ceratium</i>		<i>furca</i>																			
<i>Ceratium</i>		<i>lineatum</i>																			
<i>Alexandrium</i>		<i>catenella</i>																			
<i>Gonyolax</i>		<i>spinefera</i>																			
<i>Lingulodinium</i>		<i>polyedron</i>																			
<i>Scripsiella</i>		<i>trochoidea</i>																			
<i>Preperidinium</i>		<i>meunieri</i>																			
<i>Protoperidinium</i>		sp.	sp.2																		
<i>Protoperidinium</i>		<i>conicoides</i>																			
<i>Protoperidinium</i>		<i>denticulatum</i>																			
<i>Protoperidinium</i>		<i>depressum</i>																			
<i>Protoperidinium</i>		<i>diabolium</i>																			
<i>Protoperidinium</i>		<i>exentricum</i>																			
<i>Protoperidinium</i>		<i>obtusum</i>																			
<i>Protoperidinium</i>		<i>pentagonum</i>																			
<i>Protoperidinium</i>		<i>periforme</i>																			
<i>Protoperidinium</i>		<i>subinermis</i>																			
<i>Protoperidinium</i>		<i>thorianum</i>																			

- Absence
- Presence
- Spp. Not regularly sited in the area

# Flagellates

Sample Site (see map)				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Genus	cf.	species																			
<i>Dictyocha</i>		<i>octonaria</i>																			
<i>Eutreptiella</i>		<i>gymnastica</i>																			

- Absence
- Presence

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## More Information?

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