8. Laboratory methodology

8.1. Cleaning samples for diatom investigation

Diatom cells are covered on the outside of their silica cell wall by a thin layer of organic material (membrane). This thin layer obscures morphologic features, such as the perforations and the raphe, needed for determination of the diatom species. The sample will also contain detritus, protists, bacteria and soft-bodied algae which are the usual components of a biofilm; this material will also obscure the structures of the diatom cell when viewed at high magnification. Therefore the organic material, not only in and around the diatom cell itself but also other organic material present in the sample, must be removed to obtain cleaned material for making permanent diatom slides. After such cleaning process all that remains are the resistant silica cell walls of the diatoms and occasionally other siliceous structures such as sponge spicules or phytoliths.

Material needed for the cleaning or oxidation of samples

- Beakers (heat-resistant glass) with a total volume of 100 or 250 ml depending on the sample volume and concentration.
- Watch glasses (heat-resistant).
- Hot plate for heating the material (to be used inside a fume cabinet).
- Bottles/vials (preferably glass).
- Pipettes.
- Safety pipette filler (Propipette) (Fig. 14).
- Reagents: peroxide (H_2O_2) 30 %,
  potassium permanganate ($KMnO_4$) for organic rich samples
  hydrogen chloride (HCl) for samples from environments rich in salts, especially calcareous waters.
- Waste bottles for disposal of hazardous compounds.
- Permanent marker.
- Centrifuge for 10 ml centrifuge tubes and centrifuge tubes (optional).

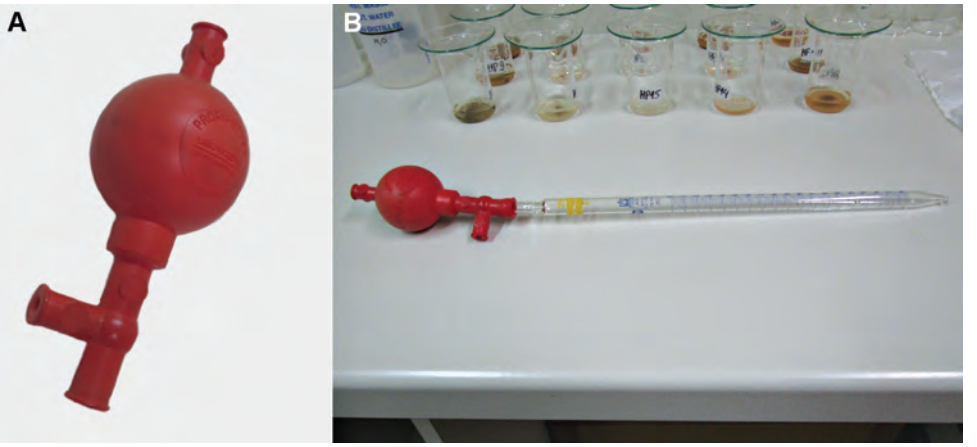


Fig. 14. A. Safety pipette filler. B. Safety pipette filler mounted on a pipette.

Protocol

As with sampling it is important that the final scatter of diatom cells on the slide is representative of the original sample. For this reason it is important to mix or shake the sample well at each stage in the process mentioned below.

- Allow the sample to stand for 24 h in the laboratory to allow the diatoms to settle at the bottom of the bottle. This is best done soon after the field sampling.

- After the period of 24 h to allow for settling, decant the supernatant liquid from the sample bottle (the supernatant liquid must be very clear) taking care not re-suspend any of the settled material which will cause the loss of diatom material. A better method, but more time consuming, is to remove off the supernatant liquid using a pipette provided with a safety pipette filler (follow the instructions in the product operating manual).

- Shake the remaining thick suspension well in the sample bottle to homogenize the material containing the concentrated diatoms and pour a part of the suspension (about 5 to 10 ml of the concentrated sample depending on the concentration of the material and the present organic material) into a heat-resistant beaker.

- Cover the heat-resistant beaker with a watch glass (heat-resistant) to prevent cross-contamination between the samples.

- Mark the heat-resistant beaker in several places with the sample number using a permanent marker.

- Add 10 to 20 ml H_2O_2 (30 %) to the concentrated sample in the heat-resistant beaker.

- Put the heat-resistant beaker with the material on the hot plate inside a fume cabinet at about 90-100°C for 2 to 3 h; the samples should be regularly observed to prevent boiling-over or drying out. The heat-resistant beaker should always be covered with a heat-resistant watch glass to prevent contamination between the beakers. Contamination can happen not only due to splashing of material if boiling becomes too vigorous but also due to diatoms present in the steam of the boiling material. (Fig. 15)

- When the material is very rich in organic material, add some drops of potassium permanganate ($KMnO_4$) to complete the oxidation process. The number of $KMnO_4$ drops needed depends on concentration of organic material in the sample: drops must be added until the suspension clears leaving a straw coloured supernatant and a precipitate ranging in colour from brown to grey to white depending of the geology of the sample site.

- Leave the cleaned solution in the heat-resistant beaker to cool down.

- Rinse the sample with distilled water. This can be done by centrifugation or by allowing the material to settle out for 24 h. For centrifugation the cleaned material must be transferred to 10 ml centrifuge tubes. Before pouring the cleaned solution from the beakers, the beakers must be vigorously swirled to re-suspend the diatoms: heavier particles such as sand grains particles will fall to the bottom of the beaker. Centrifugation is done for 10 min at a rotation speed of 3000 rpm (rotations per minute). After centrifugation the supernatant is decanted or pipetted off using a pipette provided with a safety pipette filler. This washing or rinsing is repeated 4 times; the pH of the final sample should be more or less circumneutral. When the preparation of permanent diatoms slides is not urgent, or when a centrifuge is not available, the material can be rinsed be leaving the material in the beaker or in a centrifuge tube to settle during for 24 h before removing the supernatant by decantation or by pipetting off. Again washing should be repeated 4 times.

The above protocol is only one of many that exist. Additional methodologies can be found in the literature, e.g. STOWA 2014, Taylor *et al.* 2007c.

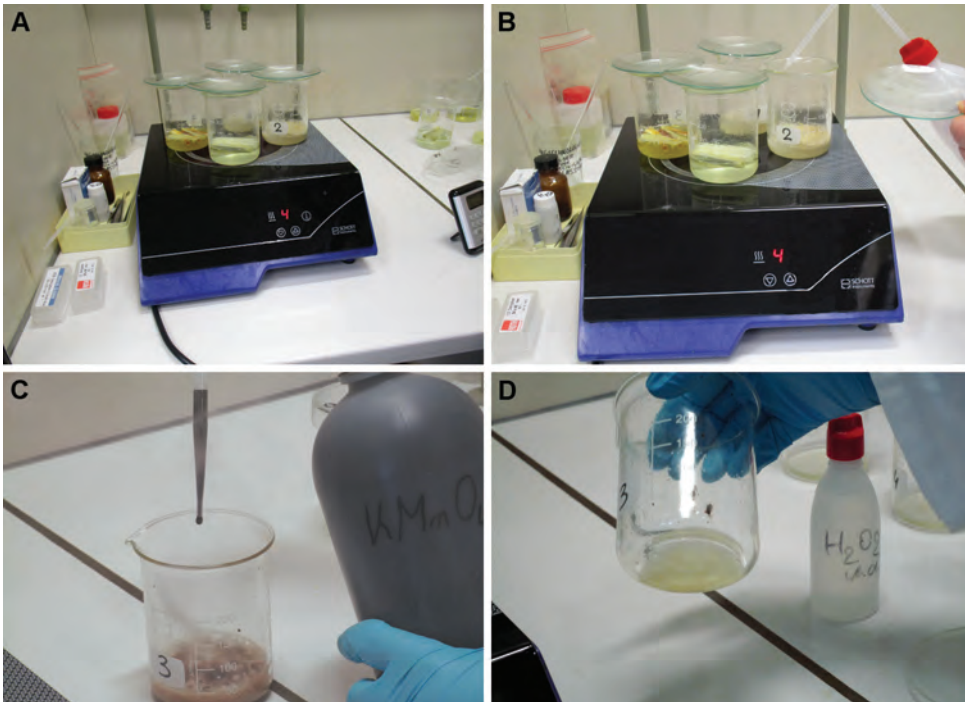


Fig. 15. Removing organic material in a diatom sample: part of the material is placed in a heat-resistant beaker, covered with a heat-resistant watch glass to prevent contamination between the beakers, and placed on a hot plate inside a fume cabinet at about 90-100°C for 2 to 3 hours. For material rich in organic material some drops of $KMnO_4$ are added to complete the oxidation process.

8.2. Permanent diatom slide preparation

Material needed for making permanent diatom slides

- Pasteur pipettes or automatic micro-pipette when quantitative slides are needed (Fig. 16).
- Diatom specific mounting media/mountant with high refraction index (RI ≥ 1.7), for example Naphrax (RI 1.73) or Pleurax (RI 1.73).
- Hot plate
- Microscope slides
- Cover slips (example: 20 x 20 mm, 22 x 22 mm, 22 x 40 mm)

Slide preparation

There are a number of slide preparation methods. The method chosen is less important than the final result. Diatom slides used for ecological and taxonomical studies are most often of the type known as 'strewn mounts'. These mounts represent as closely as possible the structure of the diatom community as collected in the original sample. In order to count or photograph cells on the slide it is important that they do not lie over each other and thus obscure each other (high concentration of material). It is also important that the sample is not highly dilute, in this case enumeration of the sample becomes very difficult and time consuming. A good rule of thumb is that a diatom strewn mount should have 5 – 50 cells visible in the field of the microscope at 1000 x magnification. This of course may not always be possible, especially if the sample has a high sediment content but it can be accepted as a general best practice guideline.

Take an aliquot of the cleaned sample and place in a test tube or other suitable vessel. Add one drop of ammonium chloride 10% solution to the tube and mix with the diatom material.

Put a drop of cleaned sample on a cover slip (about 0.5 - 2 ml depending on the size of the cover slip). If necessary concentrate the cleaned sample or dilute a part of the cleaned sample to a slightly cloudy solution. This is the most important step, if too little material is used the concentration of diatoms on the slide will be too low and making enumeration difficult, if too much material is used the diatom cells will lie over each other and it becomes impossible to identify individual cells. There is also no hard and fast rule for the dilution step, it will depend on the ratio of diatom cells to fine sediment, the initial concentration of diatoms in the field sample etc. This step requires practice and with experience it will be possible to successfully estimate the required concentration.

The volume of liquid placed on the cover slip is also of importance. The surface of the cover slip should only just be covered with liquid, if too much of the liquid (sample) is placed on the cover slip it will lead to unusual drying patterns – most often with the majority of the cells being deposited at the centre of the cover slip.

Let dry the sample on the cover slip. This can be done by two ways:

- air-dry, takes approximately 24 h, best to cover to prevent dust settling on the sample;

- hot plate dry, takes about 1-2 h, very slight warming around 40-50 °C, to avoid the material drying in rings, or leave under a 60 W incandescent lamp - there is less chance with overheating with this method.

At this stage the cover slip can be placed (still with the diatom facing up) on a microscope slide and viewed at low magnification under a light microscope. This is in order to determine of the appropriate concentration of diatom cells is present. If so then the slide can be made into a permanent mount as described below.

Mount in a high resolution mountant. The following mounting media are generally used: Naphrax (RI 1.73) or Pleurax (RI 1.73).

Perform the following procedures out doors or in a fume cabinet. Do not inhale gasses or fumes.

Naphrax: (Fig. 16)

- Put a drop of the mounting media on the microscope slide.
- Put the cover slip with the dried samples at a 90-degree angle on the microscope slide alongside the drop of Naphrax.
- Carefully lower the cover slip.
- Put the microscope slide with the cover slip on the hot plate at ~100 °C.
- Allow to 'boil' for 2 min (to remove the toluene – the solvent).
- Remove the microscope slide from the hot plate and let it cool down.

Pleurax:

- Place the cover slip, diatoms upward, onto the hot plate.
- Put a drop or two (depending on size of the cover slip) of the mounting media on the cover slip.
- Heat the sample until smoke starts to rise from the mounting media, allow this to continue for about 30 to 45 sec. The Pleurax burns easily so be careful not to overheat it at this stage.
- Carefully invert a clean microscope slide onto the cover slip, do not force the slide onto the Pleurax as this will cause it to be squeezed out of the edges. The cover slip should just be 'caught' by the slide.
- Turn the slide over and heat until the mounting media gently bubbles (~ 90 °C).
- Heat the slide until all air bubbles have been driven out.
- Remove the microscope slide from the hot plate and let it cool down.
- Once completely cool try to chip a small portion of the mountant at the edge of the cover slip. If the mountant is brittle the slide is cured. If viscous return to the hotplate and heat for another minute and test again.

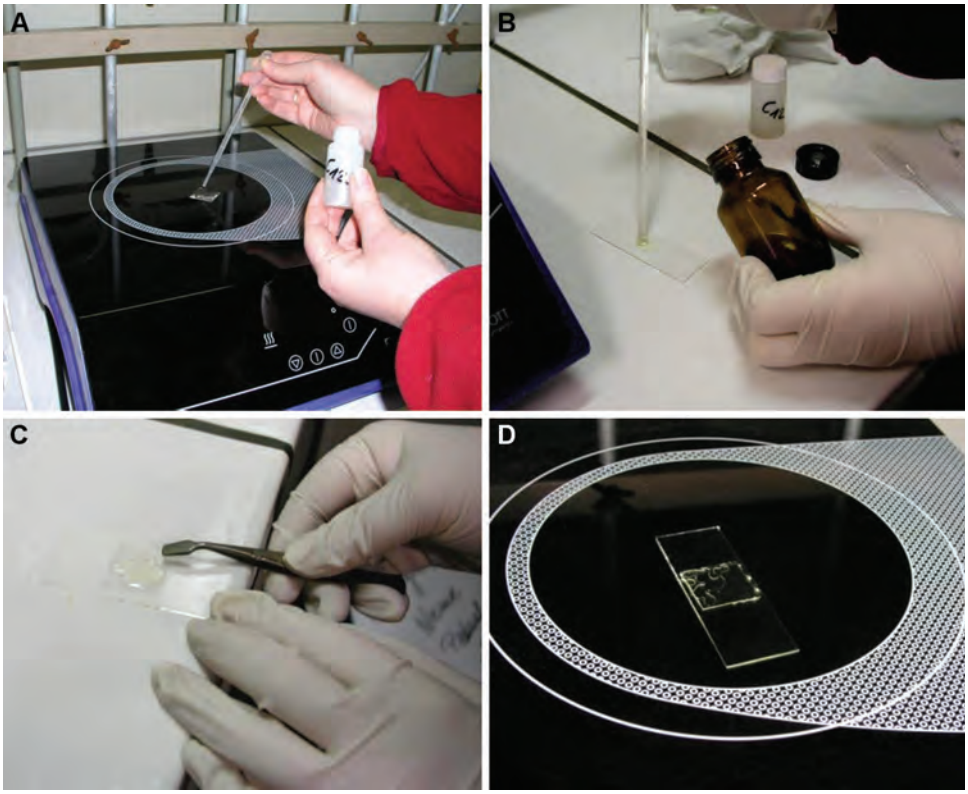


Fig. 16. Making a permanent diatom slide from cleaned diatom material. A. A drop of cleaned sample is placed on a cover slip and dried on a hot plate. B. A drop of the mounting media is placed on the microscope slide. C. The cover slip with the dried samples is held at a 90-degree angle on the microscope slide alongside the drop of mounting media and is carefully lowered. D. The microscope slide with the cover slip is placed on the hot plate at ~100 °C to boil.

8.3. Preparation for Scanning Electron Microscopy

Scanning Electron Microscopy (SEM) is used in diatom taxonomy to study the ultrastructure of the diatom frustules (valves and girdle bands). The valve and girdle ornamentations and perforations are often not fully discernible in light microscopy and can only be studied in detail using SEM. During SEM investigations a three dimensional impression of the structure of the diatom silica cell wall is gained but on the other hand it is not possible to look through the valve as can be easily done with LM. Diatoms with their silica cell wall do not require extra cleaning steps for SEM examinations, other than those explained in section 8.1. in contrast to other, soft-bodied algae which may require critical point drying. However, for water quality monitoring purposes these in-depth investigations using SEM are usually not essential. It should however be taken into account that a large number

of new species have been encountered during water quality studies and in this case it becomes important to document such taxa with SEM if such facilities are available.

Aluminium stubs are used for mounting material for SEM studies as aluminium is a conductive material. Cleaned diatom material can be transferred to these aluminium stubs in several ways:

- a drop of cleaned material can be placed directly on an aluminium stub and air dried;

- a drop of cleaned material can be put on a small cover slip (diameter of 12 mm) and air dried: once the material is totally dry the cover slip is fixed on the aluminium stub with carbon tape or a special conductive glue;

- a drop of cleaned material can be filtered through a Millipore® filter (≤ 2.5 µm); after the filter is totally air dried it is fixed on the aluminium stub with a carbon tape or a special conductive glue.

After mounting the diatoms the stubs are sputter coated with gold or gold palladium. Material is then ready for examination with the scanning electron microscope. Depending on the microscope an acceleration voltage of 10-15 kV is usually adequate for diatom examination, although the new generation of field emission scanning electron microscopes work at low voltages as low as 1 kV.

Stubs with the material must be completely dehydrated before entering in the SEM. Therefore they must be kept under very low humidity conditions. Stubs should always be placed in a dessicator containing silica gel for 24 hours to make sure they are completely dehydrated before SEM examination.

8.4. Storage of samples and permanent diatoms slides

It is always interesting to keep a portion of the original, untreated samples. If a sample is lost during preparation, if there is still a portion of the original material available this can then be used to replace the lost sample. In addition, other researchers may wish to study the material if further investigations are needed using LM or SEM, or especially in case new techniques are developed in the future. The same applies to the cleaned material. Therefore it is essential that the bottle/vials in which the material is preserved are well labelled.

Original uncleaned material is already fixed just after the sampling (formalin of ethanol); the cleaned material on the other hand is not. Therefore ethanol should be added to the bottle/vial to reach a final concentration of 20 % by volume to prevent the growth of micro-organisms such as bacteria, green algae and fungi. Alternatively some thymol crystals (2-isopropyl-5-methylphenol) can be added

to the bottles/vials or the material can simply be allowed to dry out (the bottle should still be kept sealed after drying).

Permanent diatom slides should be well labelled (country, site, locality, river, coordinates, date of collection and name of collector) and stored, preferably in a herbarium or diatom collection to facilitate cross-referencing. Besides their importance for taxonomists diatom slides are, from the point of view of water quality, very important as they provide a permanent historical record of water quality conditions at a site. They should be stored in order to ensure that they can be accessed for future analyses (e.g., hind-casting water quality). Moreover it is recommended that at least two slides are prepared from each sample. One of these should be lodged in the appropriate national herbarium or in another herbarium or institution where its future is assured. A database with all information on the material and on the preparation should be deposited together with the slides.

9. Diatom analysis

9.1. Light microscopic investigation

Diatom taxa in manuals, guides and books are usually depicted as a series of neatly aligned pictures. In the past these pictures were handmade drawings by the authors, e.g., Ehrenberg, Hustedt, Cholnoky. Around the second half of the 20th century the first photographic illustrations appeared. For tropical Africa we can mention here among others Hustedt (1942, 1949) later followed by Gasse (1986) and Cocquyt (1998). The diatom cells are illustrated in valve view showing the morphological characteristics used for determination. Seldom the girdle view is shown, except if it has a typical shape such as in several *Gomphonema* and *Surirella* species. Valve fragments or broken pieces are not or are rarely depicted. The diatom cells observed during investigation are seldom lying in a nice valve view, but are orientated at different angles, obliquely or in girdle view, and may be damaged or in fragments.

Different types of microscopic illumination exist, bright field, dark field, phase contrast, differential interference contrast (DIC), giving slightly different images than those found in the identification guides which use a selection of the best pictures the authors possess. Diatom counts can be easily done with bright field for routine investigation. However for taxonomic purpose more details are often needed which can't be (easily) observed using bright field. Phase contrast and/or differential interference contrast are then recommended (Fig. 17).

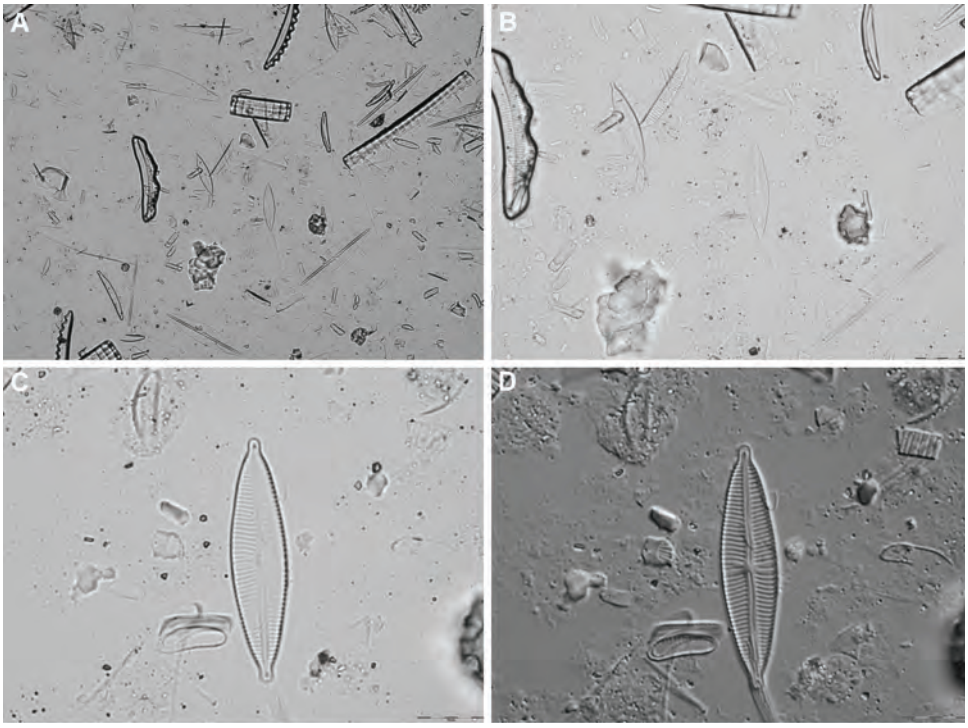


Fig. 17. View of a permanent slide of cleaned diatom cells mounted in Naphrax at different microscopic magnifications and with different illumination. A. Low magnification (200x). B. Medium magnification (400x). C. High magnification (1000x) using bright field. D. High magnification (1000x) using differential interference contrast (DIC).

10. Glossary

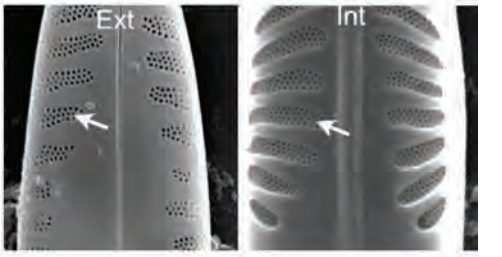
The glossary provides an overview of the most important terms used in diatom taxonomy. All terms indicated in bold in the discussion of the genera, in the present book, are included as well as some outdated terms that are commonly used in the literature, especially in older publications. To make the glossary assessable for French speaking researchers, the English terms are translated into French followed by a short description in French and illustrated using the pictures as in the English glossary (section 10.2). English and French terms are all put in alphabetical order.

10.1. Glossary

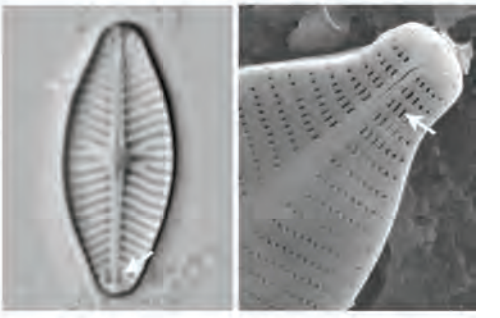
Adnate: cell attached by the raphe bearing valve face to the substratum.

Aerophilic: occurring in well oxygenated habitats such as on mosses, wet stones, moist earth.

Alveolus - alveoli: stria composed of a transversely linear chamber in the valve wall having many small openings to the exterior valve face and one large opening to the interior valve face.



Annulae: structure composed of one to four transapical striae interrupting the typical striae near the apices. Structure present only in the genus *Geissleria.*



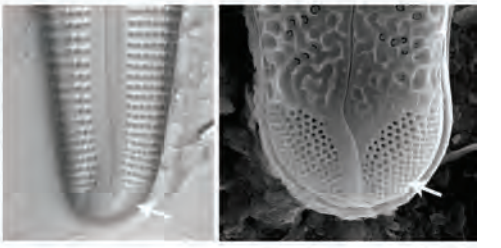
Apex - apices: the extremity of the valve in pennate diatoms, also called pole/poles.

Apical axis: the longitudinal axis of the valve face in pennate diatoms passing through the poles.

Apical nodule: highly silicified part of the diatom valve near the apex, where the raphe furrow ends; also known as the polar nodule.

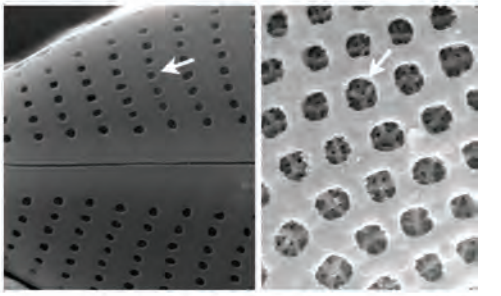
Apical pole: extremity in pennate diatoms

Apical pore field: area with small pores or perforations through the cell wall near one or both valve extremities in pennate diatoms. It is the place where mucopoly-saccharides (mucilage) forming stalks and pads are secreted.



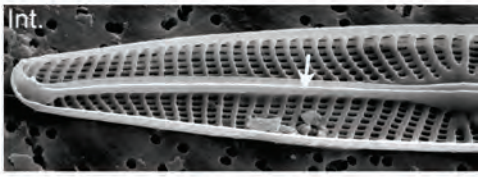
Araphid: pennate diatom valve without raphe slit.

Areola - areolae: round or nearly round perforation in the silica cell wall, also called punctum. The areolae are usually aligned and form striae.

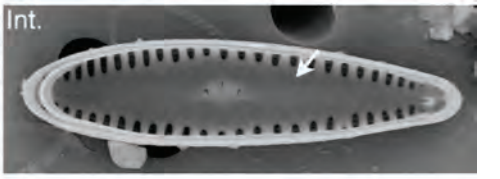


Axial area: hyaline area within the pennate diatoms located on the valve face along the longitudinal axis, between the raphe slit, if present, and the striae.

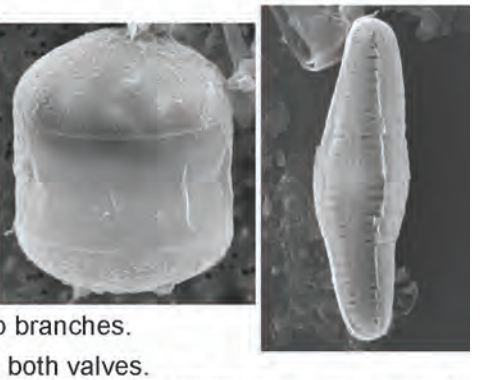
Axial costa: narrow siliceous ridge along the axial area, parallel to and bordering the raphe.



Axial plate: siliceous plate present on the internal part of the valve covering the internal openings of the areolae. The plate is present in some *Gomphoneis* species where its margin is visible as a longitudinal line in light microscopy.



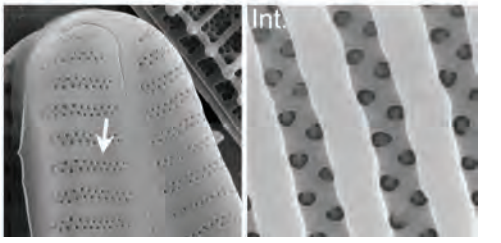
Auxospore: special cell formed during sexual reproduction after the fusion of the gametes. This cell is larger than the daughter cells and the maximum size of the diatom is thus re-established.



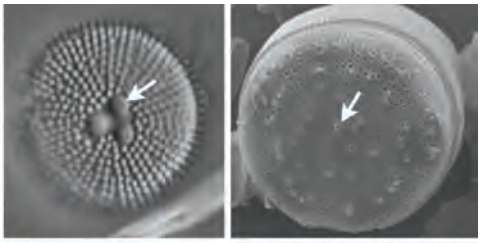
Bifurcate: a structure that is divided in two branches.

Biraphid: pennate diatom with a raphe on both valves.

Biseriate: composed of two parts; a biseriate stria is composed of a double row of areolae.

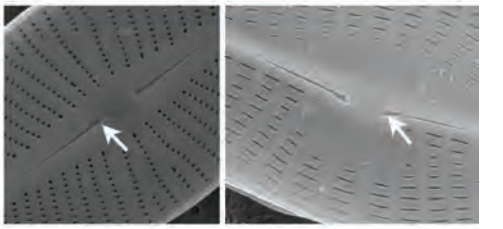


Carinoportula: central process, restricted to the genus *Orthoseira*; the internal openings are simple, the external openings are composed of well-defined collars.

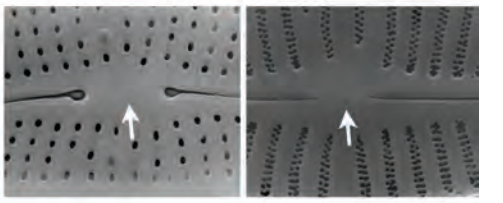


Central area: hyaline area (without areolae) in the middle of the valve face at the position of the central nodule within the pennates. In centric diatoms areolae are present in the central area

Central fissure: central raphe slit ending near the central nodule, may be enlarged or curved.

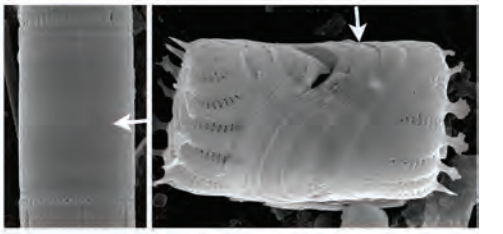


Central nodule: more heavily silicified part of the valve wall in between the central raphe fissures.



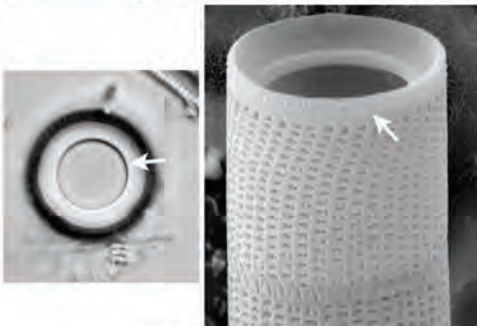
Chrysolaminarin: reserve material, a polysaccharide, present in diatoms and Chrysophytes.

Cingulum - cingula: series of siliceous bands associated with one valve only.

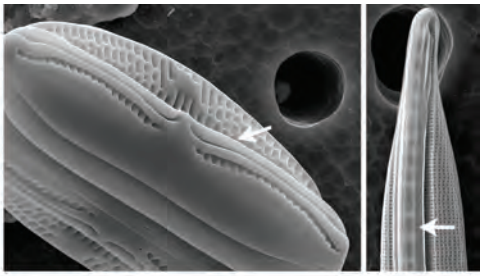


Clavate: club-shaped.

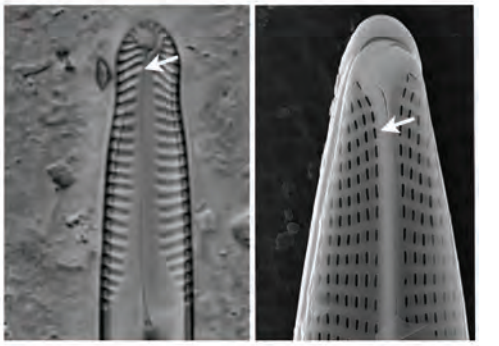
Collum: narrow and hyaline area on the valve mantle within the genus *Aulacoseira*. A small furrow, the sulcus or "Ringleiste" divides the collum from the part of the valve mantle bearing the areolae.



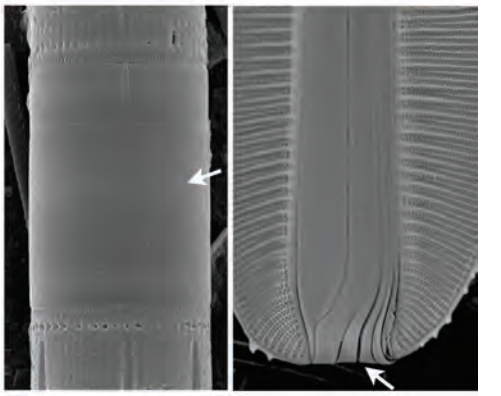
Conopeum - conopea: delicate siliceous flap lying along the apical axis and covering a part of the external valve face; can be slightly to distinctly elevated and partly or totally covering the striae and may extend up to the valve margin.



Convergent: striae are convergent when they are turned away from the central nodule and oriented to the terminal nodule.

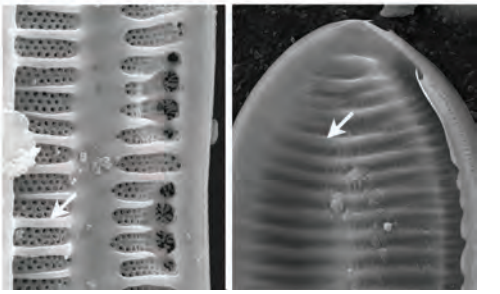


Copula - copulae: siliceous band in between both valves; also called intercalary band or girdle band.



Cosmopolite: occurring everywhere on earth in corresponding habitats.

Costa - costae: rib-like thickenings and non-ornamented part of the valve face parallel to the striae.



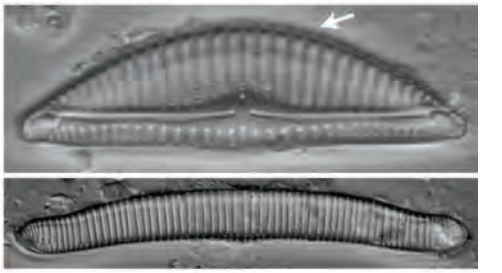
Craticula - craticulae: auxiliary structure on the internal valve face composed of a sternum and strong solid transverse bars, formed under conditions of higher osmotic pressure.

Cribrum - cribra: type of pore occlusion (perforated siliceous plate).

Cruciform: shape of a cross.

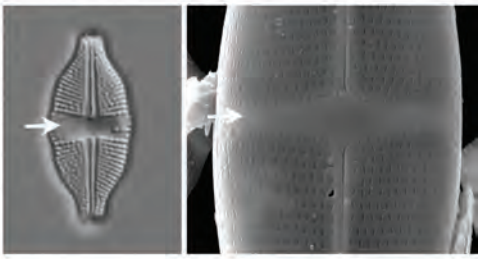
Dorsal side: in diatoms asymmetrical to the apical axis, the side of the valve that is the most convex.

Dorsiventral: valve with distinguishable dorsal and ventral sides.

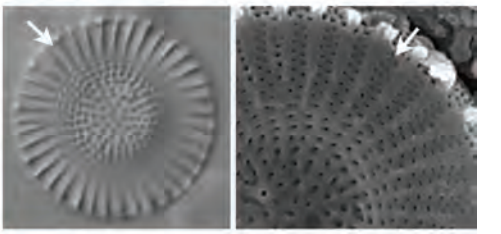


Epitheca: the larger and older of the two valves composing the diatom frustule.

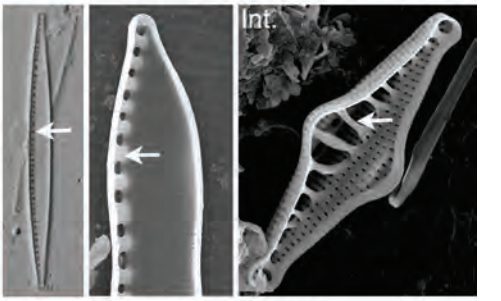
Fascia - fasciae: thick hyaline siliceous area, extending from the central area to the valve marging, in some pennate diatoms, and formed by secondary deposition of silica in depressions of the valve face.



Fascicle: series or bundle of rows of areolae oriented radially in some centric diatoms.



Fibula - fibulae: internal siliceous support of the canal that contains the raphe; also called keel puncta or carinal dot in older literature.

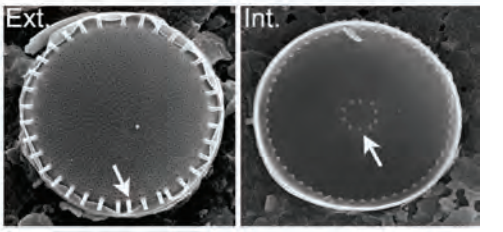


Foot pole: the narrower pole, extremity in heteropolar pennate diatoms.

Foramen - foramina: type of pore occlusion.

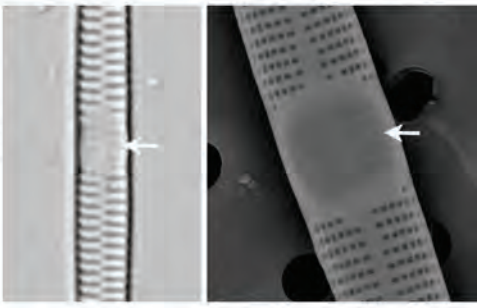
Frustule: diatom cell wall composed of silica, and having two valves and associated girdle bands.

Fultoportula - fultoportulae: or strutted process; tubular process in some centric diatoms, associated with the secretion of β-chitin. The tubular central process is accompanied by two or more satellite pores in internal valve view; a tube or a simple pore in the valve wall in external valve view.



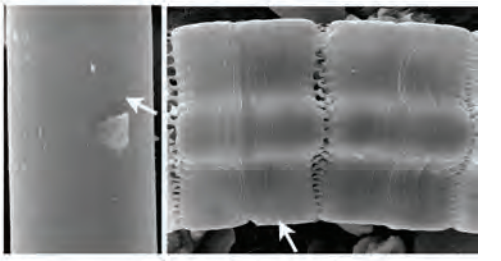
Fusiform: the shape of a spindle with the broadest part mid-valve and tapering to both ends.

Ghost striae: faint striae, composed of areolae that do not perforate the valve wall.



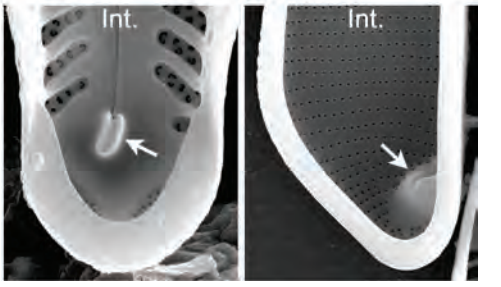
Girdle: series of siliceous bands associated with the valve; also called cingulum.

Girdle band: one of the bands associated with the valve.

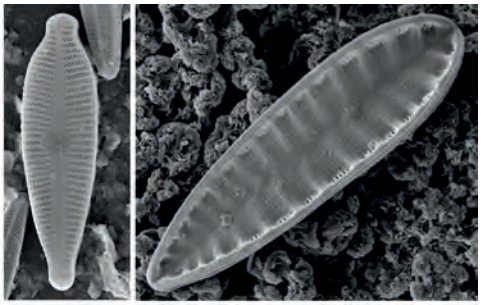


Head pole: the largest pole, extremity in heteropolar pennate diatoms.

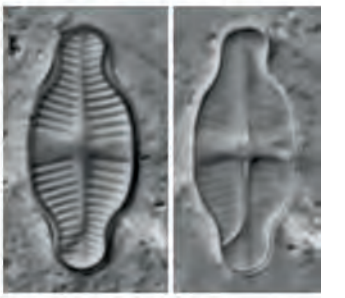
Helictoglossa - helictoglossae: structure with the shape of a pair of lips found at the end of the terminal raphe fissures near the internal ends of the valve in many pennate diatoms bearing a raphe; in the past also called an infundibulum.



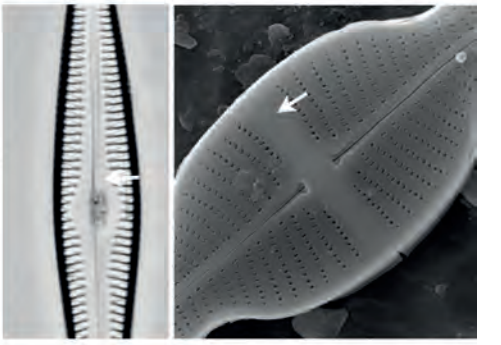
Heteropolar: asymmetric valve; having a different shape of poles or apices.



Heterovalvar: frustule composed of two different valves; difference can be in the presence or absence of a raphe or in the valve ornamentation.

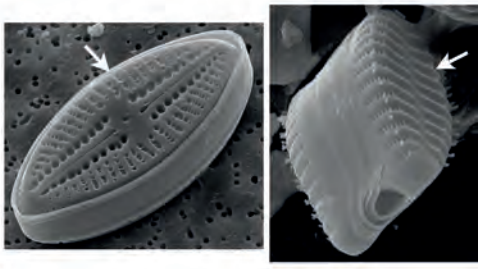


Hyaline area: area on the valve without perforations or ornamentations.



Hymen: type of pore occlusion.

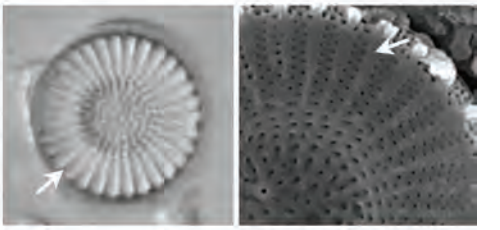
Hypotheca: the smaller and younger valve of the diatom frustule.



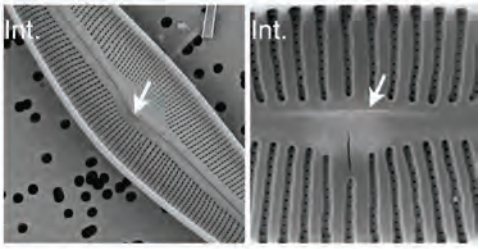
Infundibulum: structure with the shape of a pair of lips found at the end of the terminal raphe fissures near the internal ends of the valve in many pennate diatoms bearing a raphe; former name for a helictoglossa.

Intercalary band: siliceous band in between both valves; also called copula or girdle band.

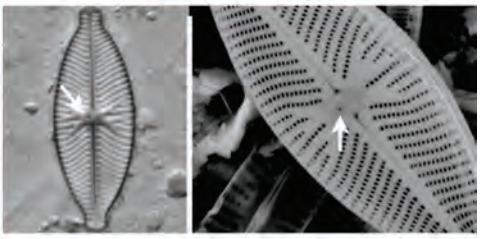
Interfascicle: rib-like thickened and unornamented part of the valve face in centric diatoms running parallel to the striae; also called a costa.



Intermissio: internal slit which connects the central raphe fissures in some cymbelloid taxa; instead of distinct internal central raphe endings, a fissure is present.

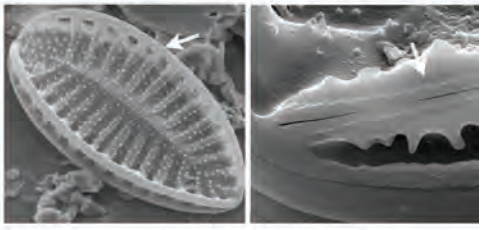


Isolated punctum: round opening in the valve wall in the central area clearly separated from the areolae of the striae. Present in genera such as *Geissleria*, *Placoneis*.



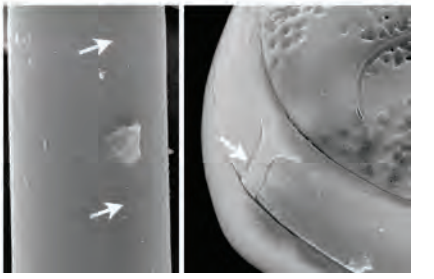
Isopolar: valve symmetric; both apices having the same shape and size.

Keel: elevated ridge bearing the raphe, formed by a folding of the valve wall. Present in genera such as *Nitzschia*, *Surirella*, *Cymatopleura*, *Campylodiscus*.

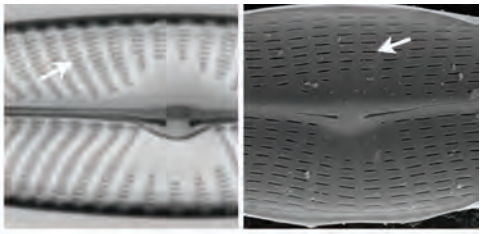


Keel puncta: internal siliceous support of the canal that contains the raphe; old name for fibula.

Ligula - ligulae: siliceous projection of a girdle band which fills the gap in the next band.

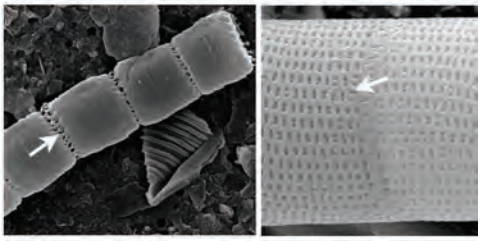


Lineola - lineolae: areola elongated in apical direction.

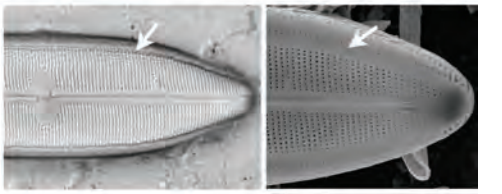


Lineolate stria: stria composed of areolae elongated in apical direction.

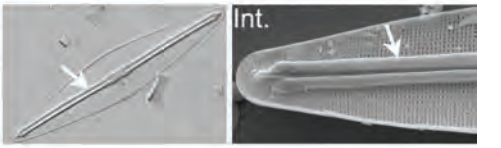
Linking spine: spine, silica extension of the valve, joining frustules together to form a chain.



Longitudinal canal: Chamber with the shape of a tube in the internal valve, oriented along the apical axis. Present in the genus *Neidium*.

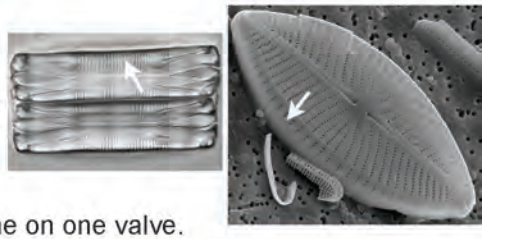


Longitudinal rib: longitudinal silica structure present on the valve face at each side of the raphe and crossing the striae.



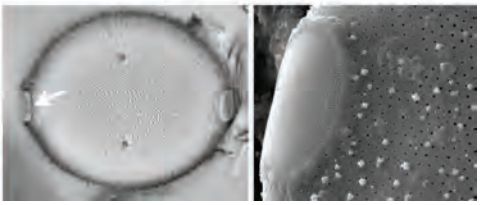
Lunate: shape of a crescent moon.

Mantle: vertical part of the valve, surrounding the valve face at usually 90°.

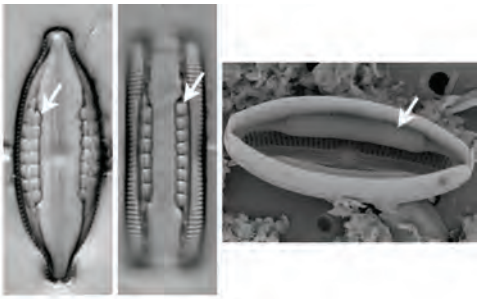


Monoraphid: pennate diatom with a raphe on one valve.

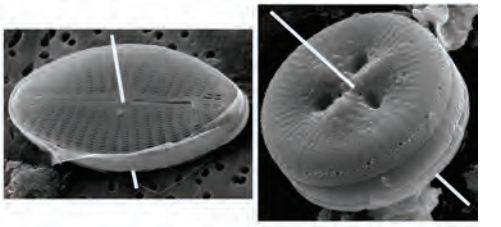
Ocellus - ocelli: eye-like structure composed of small pores surrounded by a shallow rim of silica. Present on the junction of the valve face and valve mantle in the genus *Pleurosira*. Secretes mucopolysaccharide pads that join the cells together.



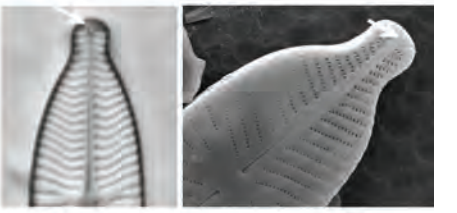
Partectum - partecta: bulbous chamber on the inside of the valvocopula, only present in *Mastogloia*. These chambers are usually arranged in a row along each side of the valvocopula, forming together the partectal ring.



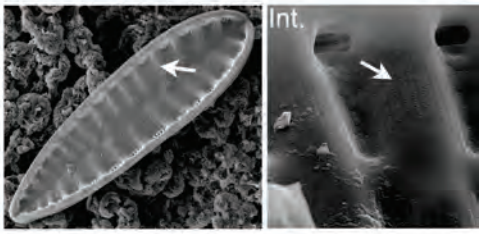
Pervalvar axis: the axis of the valve which is perpendicular to the center of the valve face; in pennate diatoms it is the point where the apical and the trans-apical axes meet; in the centric diatoms it is the point where the striae come together.



Polar nodule: more silicified part of the diatom valve near the apex, where the raphe furrow ends; also known as the apical nodule.

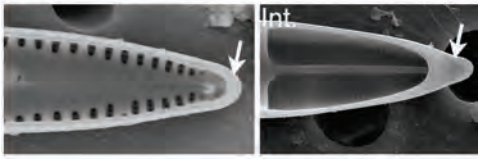


Porca - porcae: transapical undulation of the valve face in the genus *Surirella*; also called a corrugation ridge.



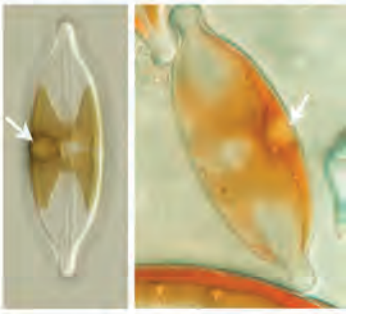
Primary side: the side of the valve formed from the initial branches of the raphe sternum during valve formation in raphid diatoms.

Pseudoseptum - pseudosepta: silica plate in the internal cell extending from the wall of the valve.

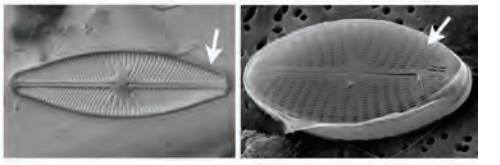


Punctum: round or ovate perforation in the silica cell wall, also called an areola.

Pyrenoid: structure present in the chloroplast of algae which is responsible for the CO_2 fixation and not for the production of starch as proposed in the past; it is often surrounded with starch granules.

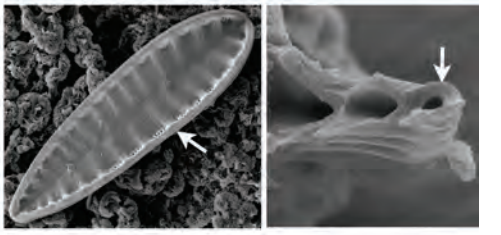


Radiate: striae are radiate when they are orientated away from the central nodule.



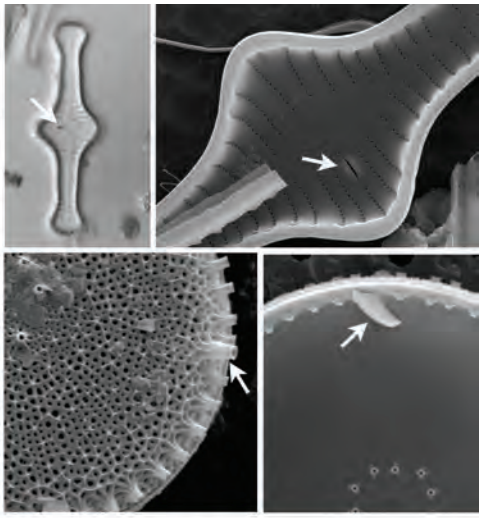
Raphe: slit or fissure through the valve face in the mono- and biraphids, often located along the apical axis.

Raphe canal: cylindrical structure bearing the raphe and more or less closed on the internal side of the valve.



Raphe keel: well pronounced elevated ridge, formed by folding of the valve wall, on the junction of the valve face and valve mantle. Present in genera such as *Nitzschia*, *Surirella*, *Cymatopleura and Campylodiscus*.

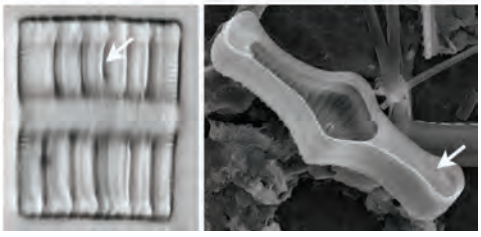
Rimoportula or labiate process: tubular process in some centric and pennate diatoms, associated with the secretion of mucopolysaccharides (mucilage) and other carbon compounds. On the internal valve face the opening of the process has the shape of a pair of lips; on the external valve face the opening is a tube extending out from the valve, or a simple pore in the valve wall.



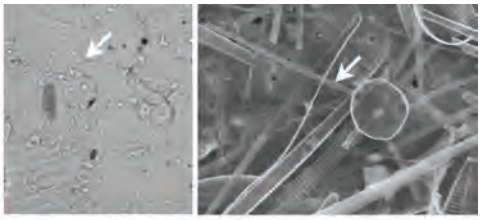
Ringleiste: small silica ledge dividing the collum from the part of the valve mantle bearing the areolae. Only present in the genus *Aulacoseira*.

Secondary side: the side of the valve formed after the primary side by fusion of the silica branches extending from the centre and the extremities of the raphe sternum during valve formation in the raphid diatoms. Junction where fusion takes place is known as the Voight discordance.

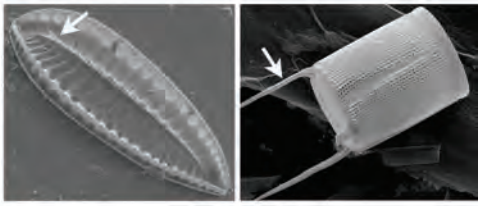
Septum - septa: silica plate in the internal cell extending from the wall of a girdle band.



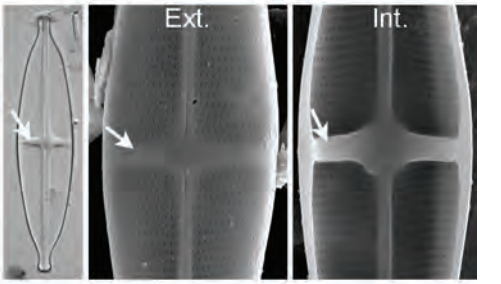
Seta - setae: simple or robust silica extension of the valve, longer than a spine. Present in the genus *Chaetoceros*. The setae join the cells together allowing them to form chains.



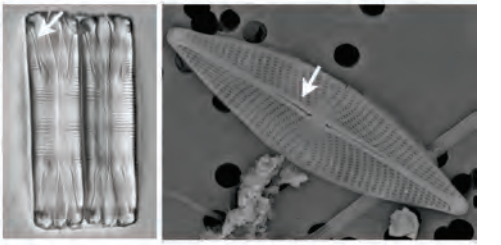
Spine: sharp pointed silica extension of the valve, solid or hollow, very long or tiny, arising at different places on the external valve face in different taxa.



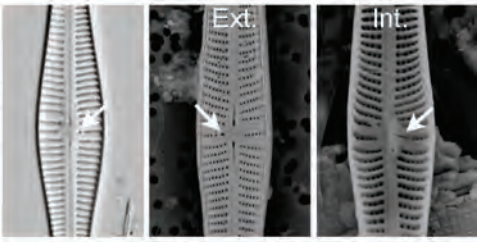
Stauros: hyaline thickening in the central area; in the cell ontogeny formed differently from a fascia; present only in the genus *Stauroneis*.



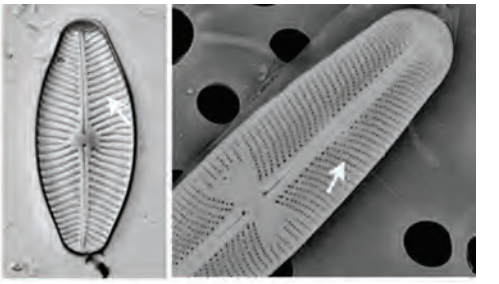
Sternum - sterna: thick siliceous structure of the valve face along the apical axis in pennate diatoms; it is the ontogenic center of the pennates. The sternum often contains the raphe, and may be positioned centrally as in *Navicula*, or marginally as in *Eunotia*.



Stigma - stigmata: opening in the valve wall in the central area distinct in structure from an areola; externally a round or elongate opening, internally it has the shape of a slit or a more complex structure.

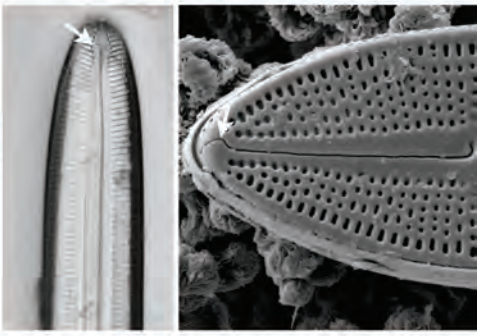


Stria - striae: a row of pores, areolae on the valve.



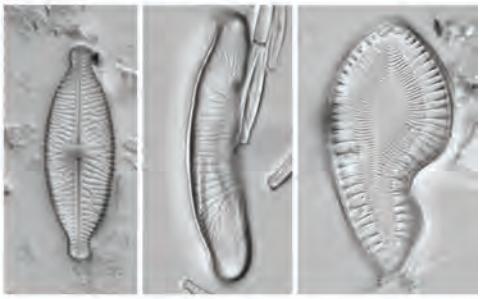
Stria density: number of striae present on the valve, expressed as number in 10 µm. In centric diatoms, it is the number of striae in 10 µm measured at the circumference.

Terminal fissure: terminal raphe slit ending near the pole/terminal nodule, may be expanded or curved.



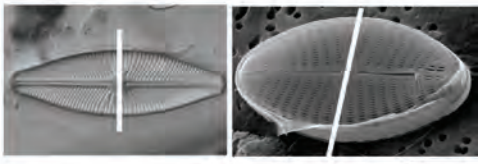
Terminal nodule: more heavily silicified part of the valve wall near a pole and a terminal raphe slit; the polar or apical nodule.

Teratologic form: deformations and abnormalities in the valve ornamentation.



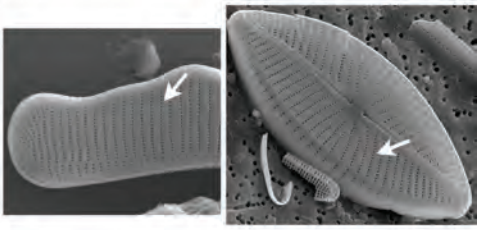
Theca: part of the frustule composed of a valve and its corresponding girdle bands.

Transapical axis: the short axis of a pennate diatom valve, crossing the middle of the valve face; axis perpendicular to the apical axis.



Ubiquitous: occurring everywhere on earth.

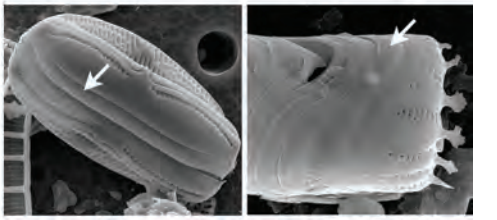
Uniseriate: stria composed of a single row of areolae.



Valve: part of a frustule, composed of a flat part, the valve face, and an extension, usually at 90°, the valve mantle.

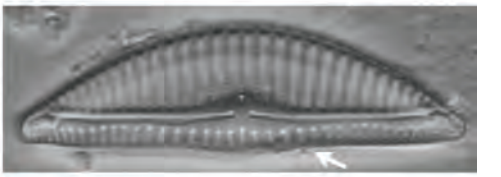
Valve view: view of the frustule turned so that the valve face is visible.

Valvocopula: the girdle band in contact with the valve; the first girdle band.

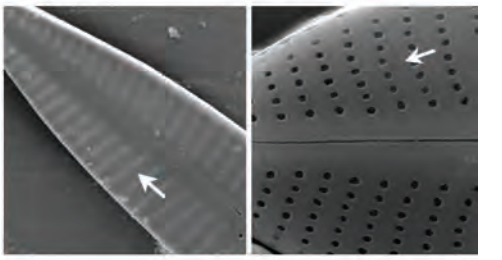


Velum: type of pore occlusion.

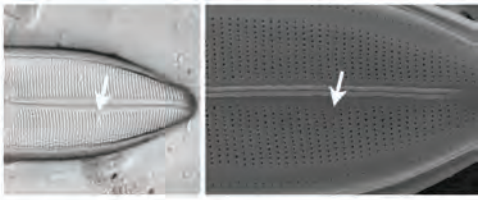
Ventral side: in diatoms asymmetrical to the apical axis, the side of the valve that is straight to slightly convex or concave.



Virga - virgae: solid siliceous rib between regularly aligned areolae, also called interstria/interstriae.



Voigt fault or Voigt discordance: discontinuity in the striae on the secondary side of the valve at the point where the two branches are joined to each other during valve formation.



Vola - volae: type of pore occlusion.

10.2. Translation of English terms into French

alveolus: alvéole
annulae: annulae
apex: apex
apical axis: axe apical
apical nodule: nodule apical
apical pole: pôle apical
apical pore field: champs de pores apicaux.
araphid: araphide
areola: aréole
axial area: aire axiale
axial costa: côte axiale
axial plate: plaque axiale
auxospore: auxospore
bifurcate: bifurqué
biraphid: biraphide
biseriate: bisérié
carinoportula: carinoportule
central area: aire centrale
central fissure: fissure centrale
central nodule: nodule central
chrysolaminarin: chrysolaminarine
cingulum: cingulum
clavate: allongé
collum: collet
conopeum: conopeum
convergent: convergente
copula: bande intercalaire
cosmopolite: cosmopolite
costa: côte
craticula: craticule
cribrum: cribrum
cruciform: cruciforme
dorsal side: côté dorsal
epitheca: épithèque
fascia: fascia
fascicle: fascicule
fibula: fibule
foot pole: apex/pôle podal
foramen: foramen
frustule: frustule
fultoportula: fultoportule
fusiform: fusiforme
ghost striae: stries fantômes
girdle: ceinture
girdle band: bande de ceinture
head pole: pôle apical
helictoglossa: hélictoglosse
heteropolar: hétéropolaire
heterovalvar: hétérovalvaire
hyaline area: aire hyaline
hymen: hymen
hypotheca: hypothèque
infundibulum: infundibulum
intercalary band: bande intercalaire
interfascicle: côte
intermissio: intermission
isolated punctum: point isolé
isopolar: isopolaire
keel: carène
keel puncta: fibule
ligula: ligule
lineola: linéole
lineolate stria: strie linéolée
linking spine: épine de jonction
longitudinal canal: canal longitudinal
longitudinal rib: côte longitudinale
lunate: luniforme
mantle: manteau
monoraphid: monoraphide
ocellus: ocellus
partectum: locule
pervalvar axis: axe pervalvaire
polar nodule: nodule polaire
porca: porca
primary side: côté primaire
pseudoseptum: pseudoseptum
punctum: point
pyrenoid: pyrénoïde
radiate: radiaire
raphe: raphé
raphe canal: canal raphéen
raphe keel: carène du raphé
rimoportula: rimoportule
Ringleiste: Ringleiste

secondary side: côté secondaire
septum: septum
seta: seta
spine: épine
stauros: stauros
sternum: sternum
stigma: stigma
stria: strie
stria density: densité des stries
terminal fissure: fissure terminale
terminal nodule: nodule terminal
teratologic form: forme tératologique
theca: thèque
transapical axis: axe transversal
ubiquitous: ubiquiste
uniseriate: unisérié
valve: valve
valvocopula: valvocopula
velum: vélum
ventral side: côté ventral
Voigt fault / Voigt discordance: défaut de Voigt
vola: vola

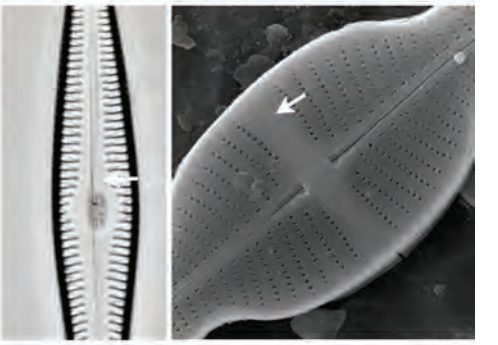
10.3. Glossaire

Adné: attaché au substrat par la surface de la valve à raphé.

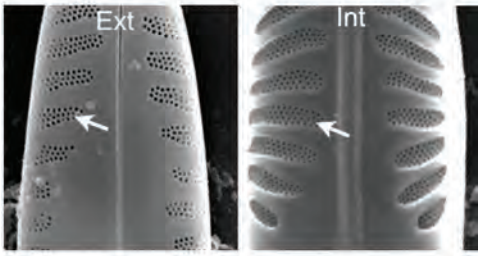
Aire axiale: espace hyalin sur la surface valvaire le long de l'axe longitudinal, entre le raphé, si présent, et les stries chez les diatomées pennées.

Aire centrale: espace hyalin au centre de la valve à hauteur du nodule central si présent, dépourvue d'aréoles.

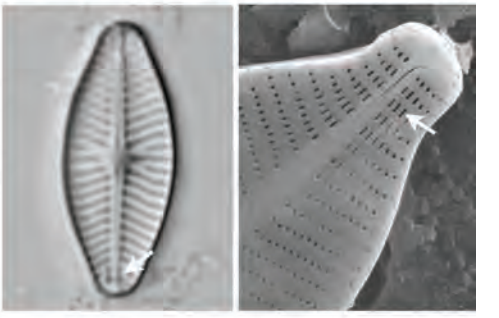
Aire hyaline: zone de la valve sans perforation ni ornementation.



Alvéole: strie composée d'une chambre transversalement linéaire dans la paroi de la valve avec de petites ouvertures multiples à la face extérieure et de grandes ouvertures à la face intérieure de la valve.



Annulae: structure composée d'une à quatre stries transapicales (perpendicu-laires) interrompant les stries typiques vers les apices. Structure restreinte au genre *Geissleria*.



Apex - apices: chez les diatomées pennées extrémité de la valve, aussi appelée pôle.

Apex apical: chez les diatomées pennées hétéropolaires extrémité de la valve la plus large, aussi appelée pôle apical.

Apex podal: chez les diatomées pennées hétéropolaires extrémité de la valve la plus fine, aussi appelée pôle podal ou pôle basal.

Araphide: diatomée pennée sans fissure raphéenne sur les deux valves.

Aréole: ou point, perforation ronde ou presque ronde de la paroi en silice. Les aréoles sont généralement alignées formant une strie.

Axe apical: axe longitudinal de la face valvaire des diatomées pennées reliant les apices.

Axe pervalvaire: axe de la valve qui est perpendiculaire vers le centre de la surface de la valve; dans les diatomées pennées c'est le point de rencontre entre les axes apical et transversal; dans les diatomées centriques c'est le point de rencontre des stries.

Axe transversal: axe de la valve le plus court, passant le centre de la surface de la valve; axe perpendiculaire à l'axe apical.

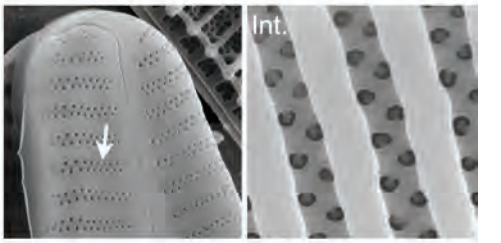
Auxospore: cellule spéciale formée dans la reproduction sexuelle après la fusion des gamètes ; la cellule formée est plus grande que les cellules filles et la taille maximale de la diatomée est rétablie.

Bande de ceinture ou bande intercalaire: une des bandes siliceuses associées à la valve.

Bifurqué: structure qui est divisée en deux parties.

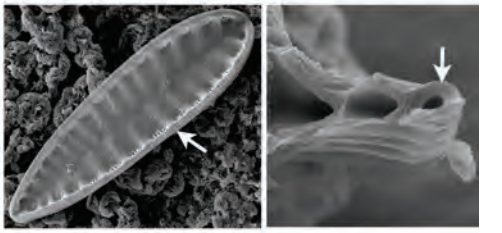
Biraphide: diatomée pennée qui porte un raphé sur chaque valve.

Bisérié: composé de deux parties; les stries bisériées portent deux lignes d'aréoles.

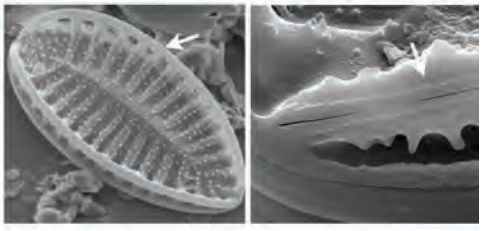


Canal longitudinal: chambre en forme de tube dans la valve interne orientée le long de l'axe apical. Présent dans le genre *Neidium*.

Canal raphéen: structure cylindrique plus ou moins fermée à l'intérieur de la valve, portant le raphé.



Carène: côte élevée qui contient le raphé, formée par un pli de la paroi de la valve. Présent dans des genres comme *Nitzschia*, *Surirella*, *Cymatopleura*, *Campylodiscus*.



Carène du raphé: structure ressemblant à une crête très distincte au bord de la valve où passe le raphé, formé par un pli de la paroi de la valve. Présent dans des genres comme *Nitzschia*, *Surirella*, *Cymatopleura*, *Campylodiscus*.