## ***Navicula*** Bory 1822

Type species: *Navicula tripunctata* (O.F. Müller) Bory

**Notes –** Throughout this book many genera have *Navicula* listed as a synonym. For many years all diatoms cells exhibiting isobilateral symmetry and having a median raphe were placed into *Navicula* sensu lato. *Navicula* sensu stricto (in the strict sense) is now restricted to the former section lineolatae or those taxa having striae composed of linear areolae. Over the last 3 decades many taxa have been split off from *Navicula*; it is important to remember that this is an on-going process and that many more species currently in *Navicula* may in future be placed in other genera. In the interim, what may be termed as a 'catch all' genus has been established - *Naviculadicta* Lange-Bertalot 1994. This genus contains taxa without enough characteristics for description as a separate genus and which cannot be placed in *Navicula* sensu stricto. As more data (morphological or molecular) become available these taxa will be placed in new genera. We will not discuss or illustrate *Naviculadicta* in this volume as we do for the other genera as it not clearly a delimited entity.

## ***Navicula*** Bory 1822

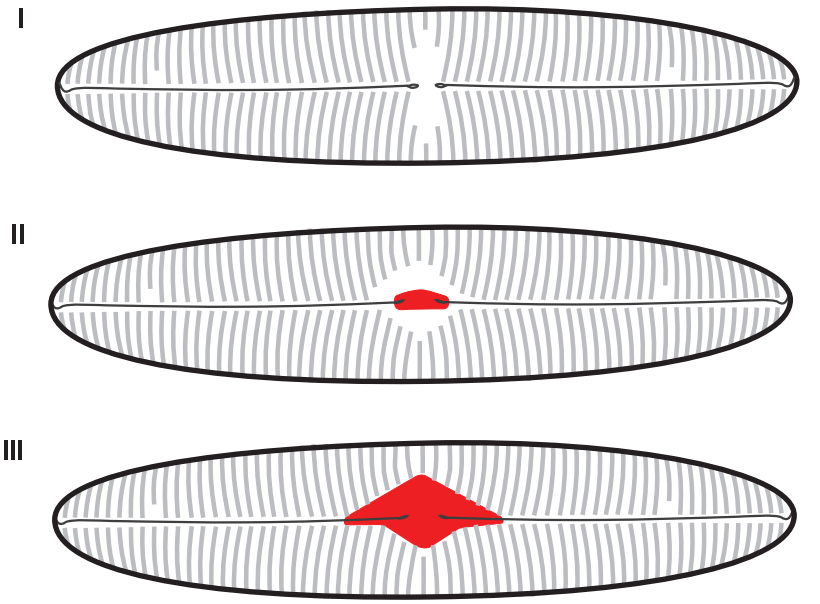
Type species: *Navicula tripunctata* (O.F. Müller) Bory

**Characteristics –** Cells **biraphid**, size, shape and apex structure variable. Striae discernable under LM (Fig. 145) and composed of a single row of linear areolae (**lineolae;** Fig. 146). In general striae are parallel mid-valve, become radiate and then often convergent towards the apices. Raphe carried in a sternum which in some taxa has a slight unilateral inflation (II) at the central nodule. The central area is variable in size and may not always be symmetrical (III).

**Plastid structure –** Cells with 2 plate-like chloroplasts, one along each side of the girdle (Fig. 144: B-E).

**Identification of species –** Species can be identified by cell size, cell shape, shape of the apices, structure and density of the striae as well as structure of the axial area and central area and the shape of the central and terminal raphe endings.

**Ecology –** Cells solitary, free living and motile. Found in the benthos of waters ranging from acidic to alkaline, oligotrophic to hypereutrophic and from low to high conductivities.



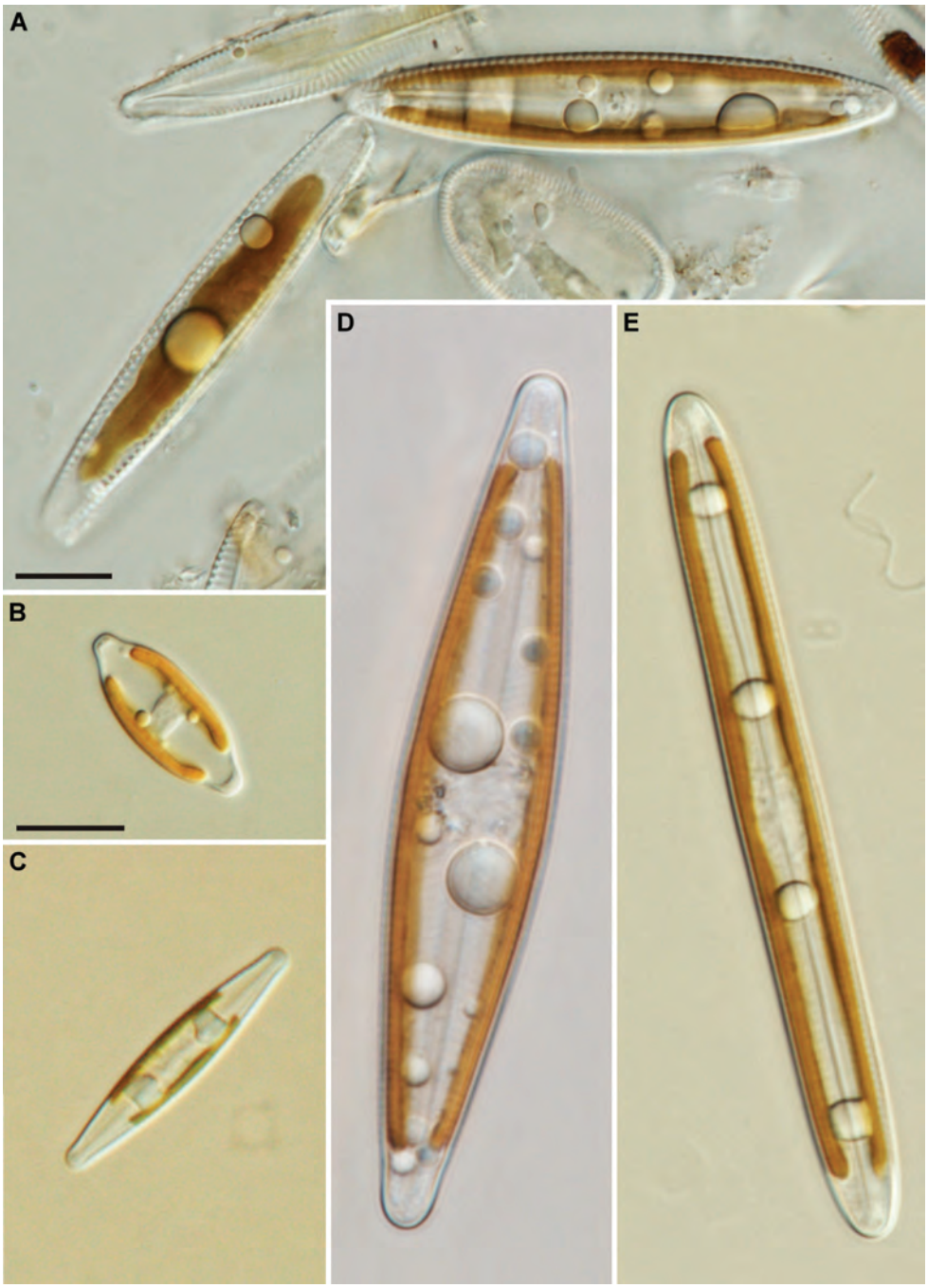



**Fig. 144.** *Navicula* spp. **A-E.** LM, living cells. **A.** *N. tripunctata*, valve view (right) and girdle view (left). **B-E.** Valve views. **B.** *N. radiosa* Kützing. **E.** *N. angusta* Grunow.
Scale bars = 10 µm (A-E).

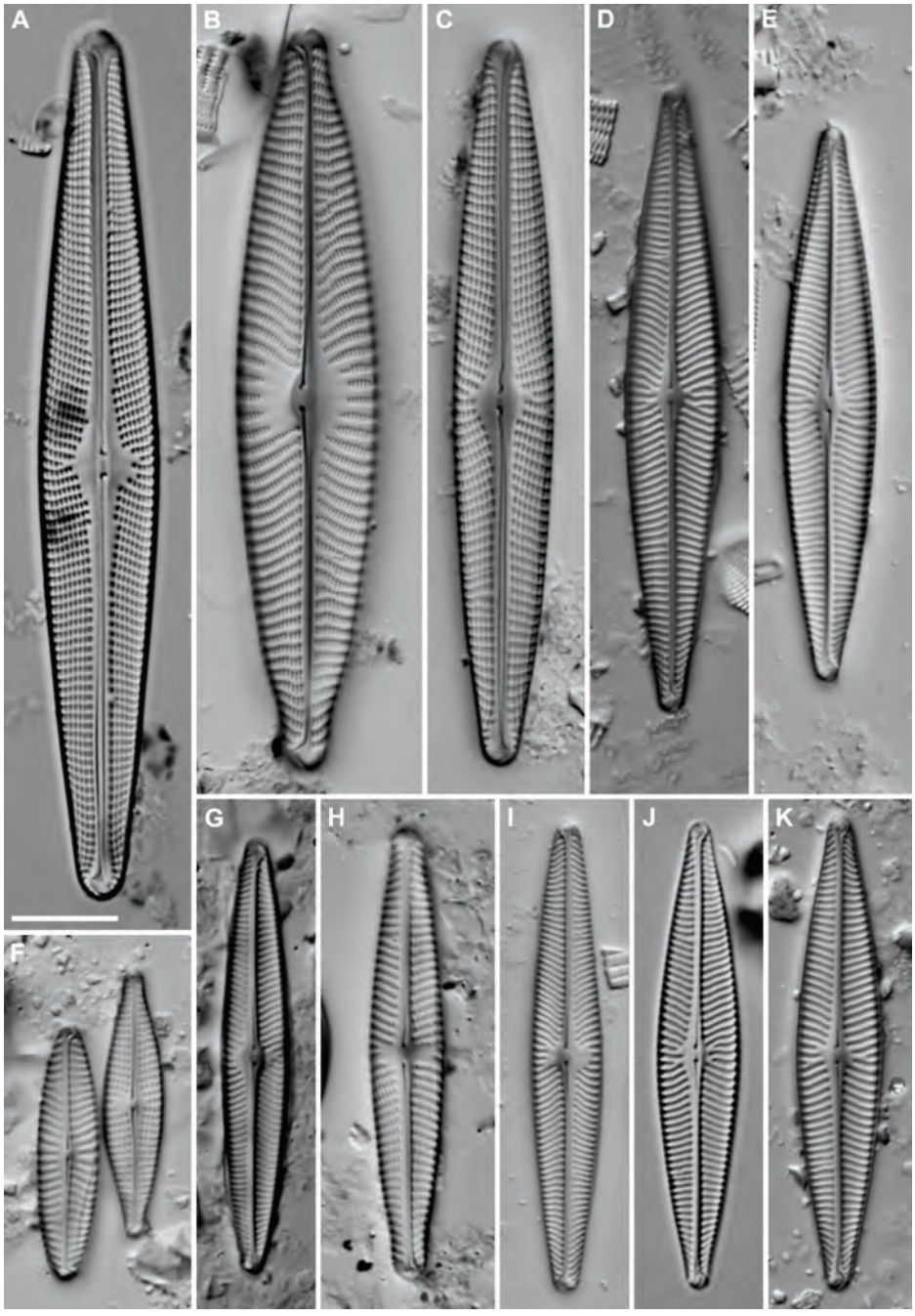



**Fig. 145** *Navicula* spp. **A-K.** LM, cleaned valves of various species. **B.** *N. viridula* (Kützing) Ehrenberg. **E.** *N. zanonii* Hustedt. **I.** *Navicula nielsfogedii* J.C. Taylor & Cocquyt.
Scale bar = 10 µm (A-K).

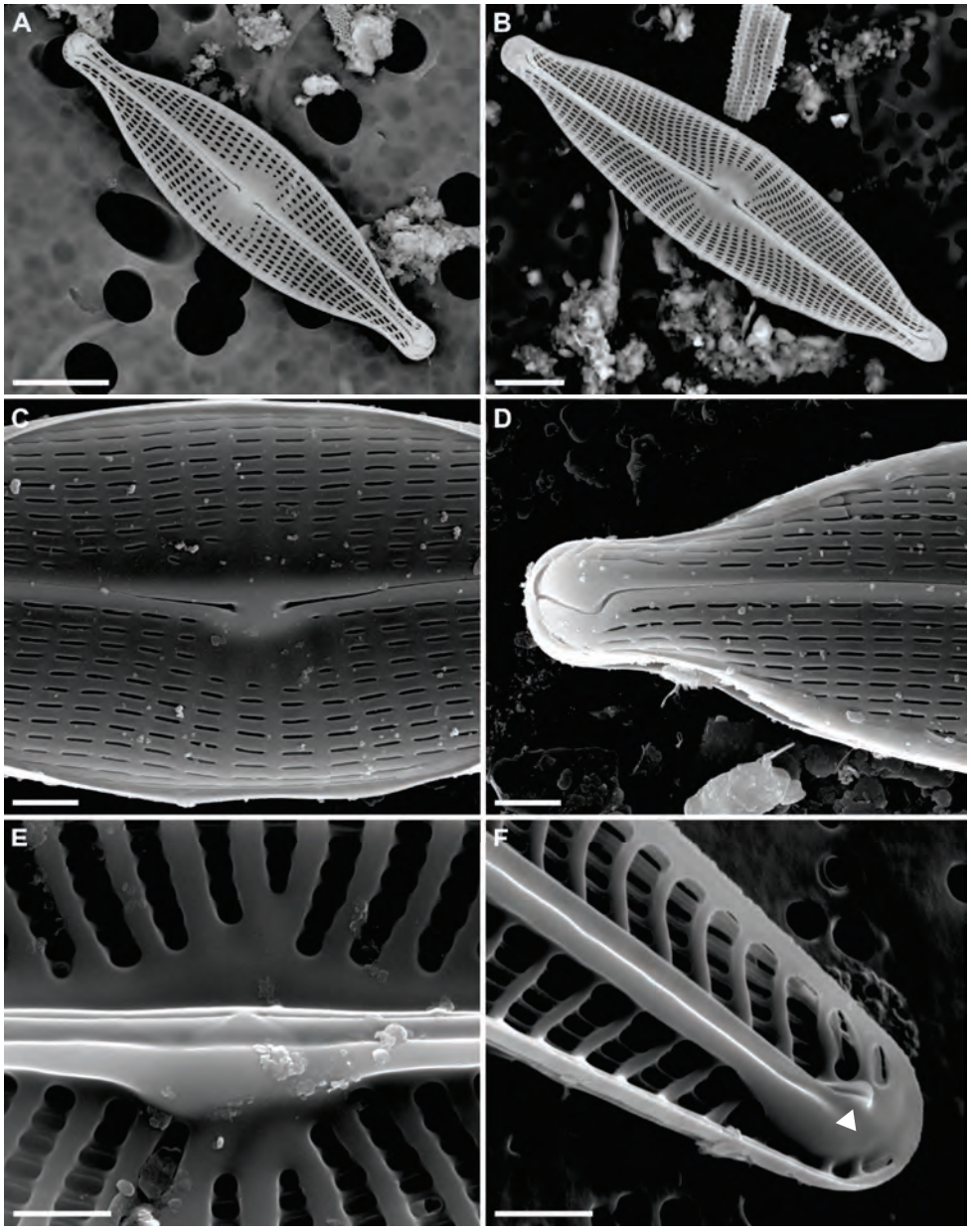



**Fig. 146.** *Navicula* spp. **A-F.** SEM. **A-D.** External view of valves. **C.** Detail of central raphe endings. **D.** Detail of terminal raphe ending. **E-F.** Internal view of valve. **E-F.** *N. nielsfogedii*, detail of central raphe endings (**E**) and terminal raphe ending (**F**), note helictoglossa (arrow).
Scale bars = 5 µm (A-B), 1 µm (C-F).

## ***Nupela*** Vyverman & Compère 1991

Type species: *Nupela giluwensis* Vyverman & Compère

SYNONYM:

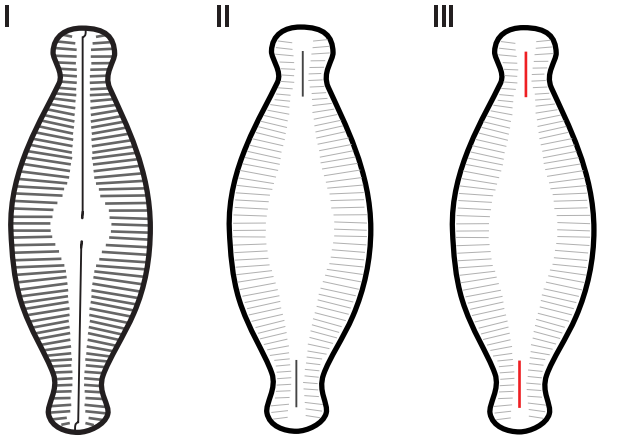
*Navicula* Bory 1822 pro parte

**Characteristics –** Cells **isovalvar** or **heterovalvar**, **biraphid**, small, elliptical to linear-elliptical, slightly asymmetric to the apical axis, with broadly rounded or protracted capitate or sub-capitate apices. Striae difficult to discern under LM (Fig. 147: E-R) composed of single rows of round or elongate areolae (Fig. 148: B-F). Raphe straight and simple (I; Fig. 148: C) extending on to the valve mantle, the opposite valve has short or very short and indistinct straight raphe branches which do not extend on to the valve mantle (III). Central area is asymmetrical and may be unilaterally expanded and may or may not reach the valve margins. Axial area often large (Fig. 148: B, D) and may be ornamented with valve face undulations .

**Plastid structure –** Cells with one plastid with lobes extending under the valve face (Fig. 147: A-D).

**Identification of species –** Species can be identified by cell size, cell shape, shape of the apices, orientation and density of the striae as well as shape of the central and axial areas.

**Ecology –** Cells solitary, free living and motile. Found in the benthos of slightly acidic to circumneutral waters with low conductivities.



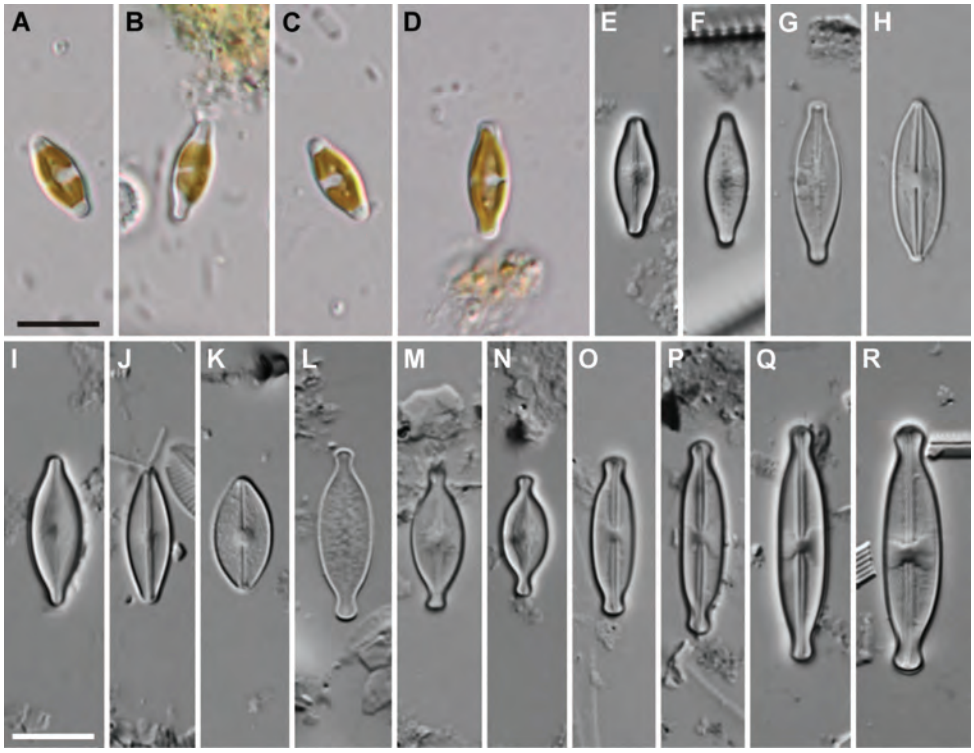



**Fig. 147.** *Nupela* spp. **A-R.** LM. **A-D.** Living cells. **E-R.** Valve views of cleaned material.
Scale bars = 10 µm (A-R).

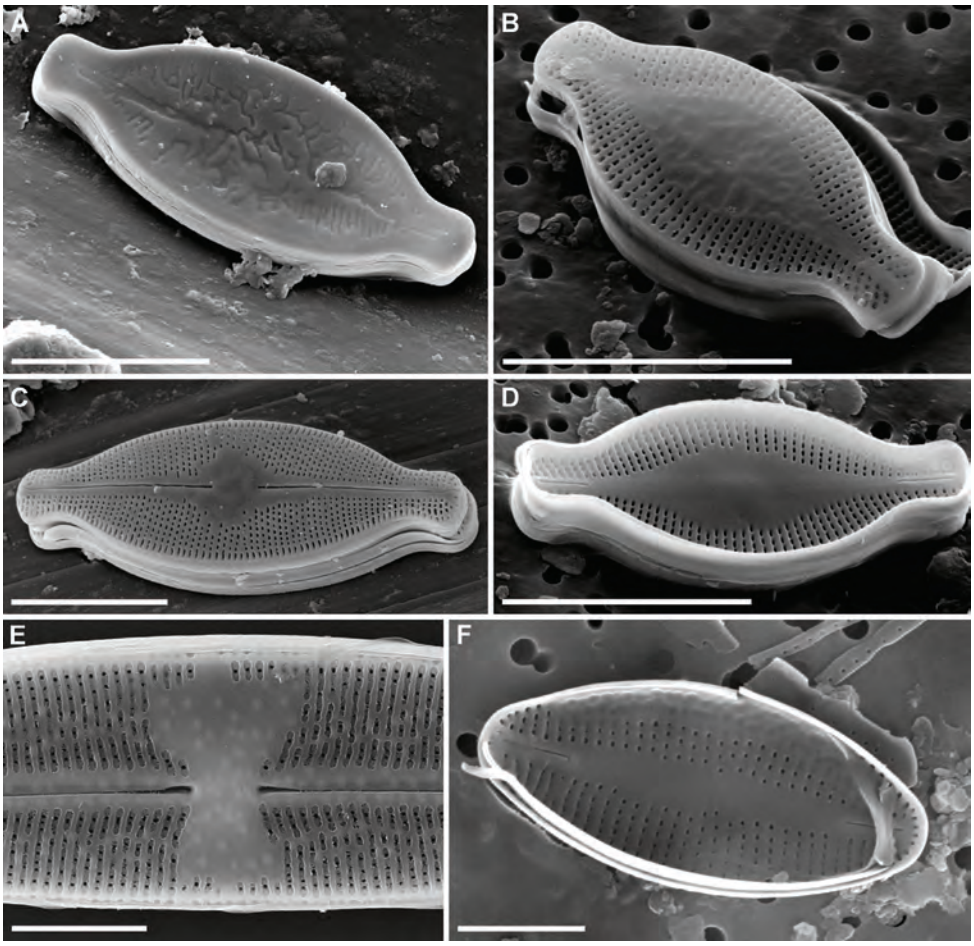



**Fig. 148.** *Nupela* spp. **A-F.** SEM. **A-C.** External view of valves, note short raphe branches (**B**). **D-F.** Internal view of valves, note short raphe branches (**D, F**). Scale bars = 5 µm (A-D), 2 µm (E-F).

## ***Seminavis*** D.G. Mann 1990

Type species: *Seminavis gracilenta* (Grunow ex A.W.F. Schmidt) D.G. Mann

SYNONYM:

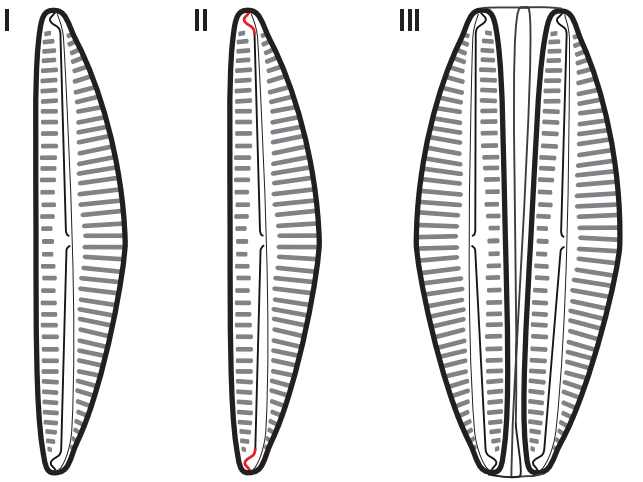
*Amphora* Ehrenberg ex Kützing 1844 pro parte

**Characteristics –** Cells **dorsiventral**, **biraphid**, straight ventral margin, curved dorsal margin with rounded apices. Striae discernable under LM (Fig. 149: A-C), composed of linear areolae only possible to resolve with SEM (Fig. 149: D-F). Raphe straight and simple (Fig. 149) carried in a sternum, terminal endings deflected to the dorsal side (II). Axial area and central area of different width and shape on dorsal and ventral sides. Differentiated from *Amphora* by the structure of the areolae and the plastids (naviculoid).

**Plastid structure –** Cells with 2 plate-like plastids, one along each side of the girdle.

**Identification of species –** Up till now only one species known from freshwaters of tropical Africa: *Seminavis strigosa* (Hustedt) Danielidis & Economou-Amili.

**Ecology –** Cells solitary, free living and motile. Found in the benthos of eutrophic waters with moderate to high conductivities.



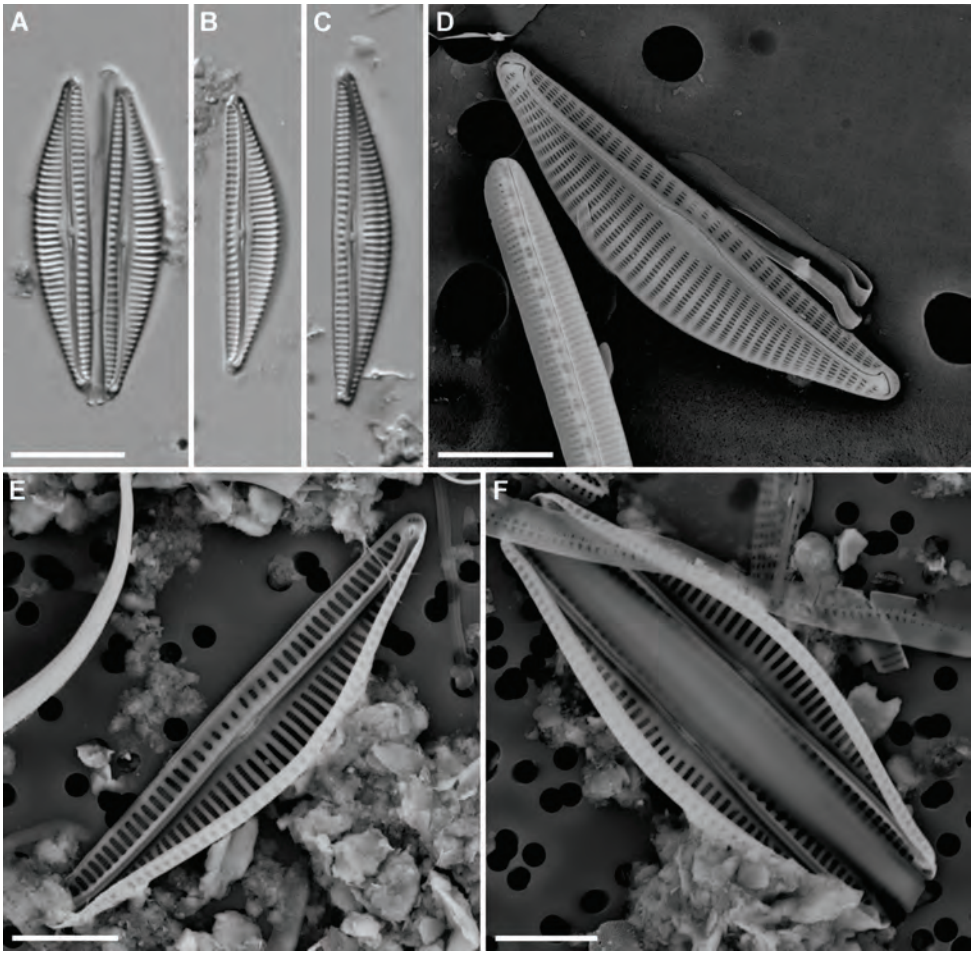



**Fig. 149.** *Seminavis strigosa.* **A-C.** LM, valve views. **D-F.** SEM. **D**. External view of valve. **E-F.** Internal view of valves.
Scale bars = 10 µm (A-C), 5 µm (D-F).

## ***Gyrosigma*** Hassall 1845

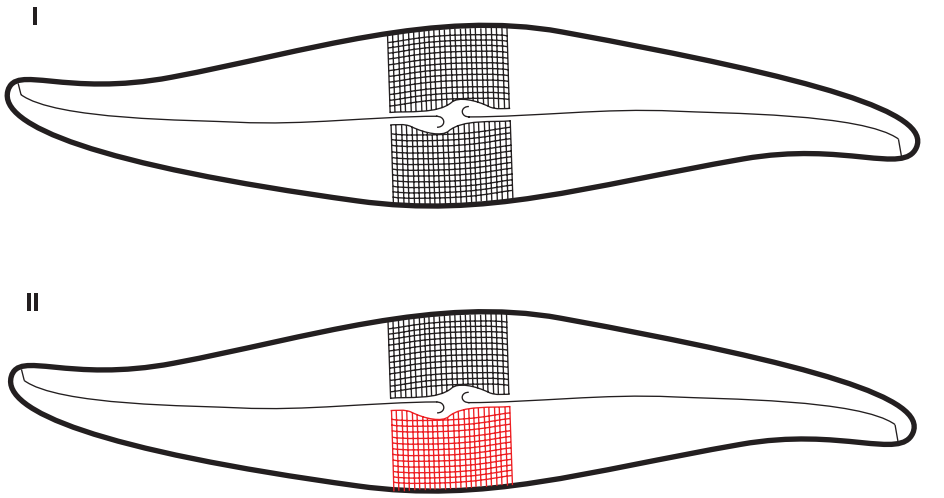
Type species: *Gyrosigma hippocampus* (Ehrenberg) Hassall

**Characteristics –** Cells **biraphid**, **sigmoid**, large to very large with rounded apices. Striae fine, transapical and longitudinal striae visible at right angles to each other (II; Fig. 151: C-D). Raphe sigmoid and simple (Fig. 150: C-D). Central area small and may contain special structures such as small silica ribs.

**Plastid structure –** Two plate-like chloroplasts sometimes with lobed margins lie along each side of the girdle (Fig. 150: A-B). Many lipid bodies scattered throughout the cell.

**Identification of species –** Species can be identified by cell size, cell shape, shape of the apices (degree of sigmoidality), structure and density of the transapical and longitudinal striae, structure of the central area as well as the shape and extent of the central raphe endings.

**Ecology –** Cells solitary, free living and motile. Found in the benthos of oligotrophic to eutrophic waters in both low and moderate conductivities.



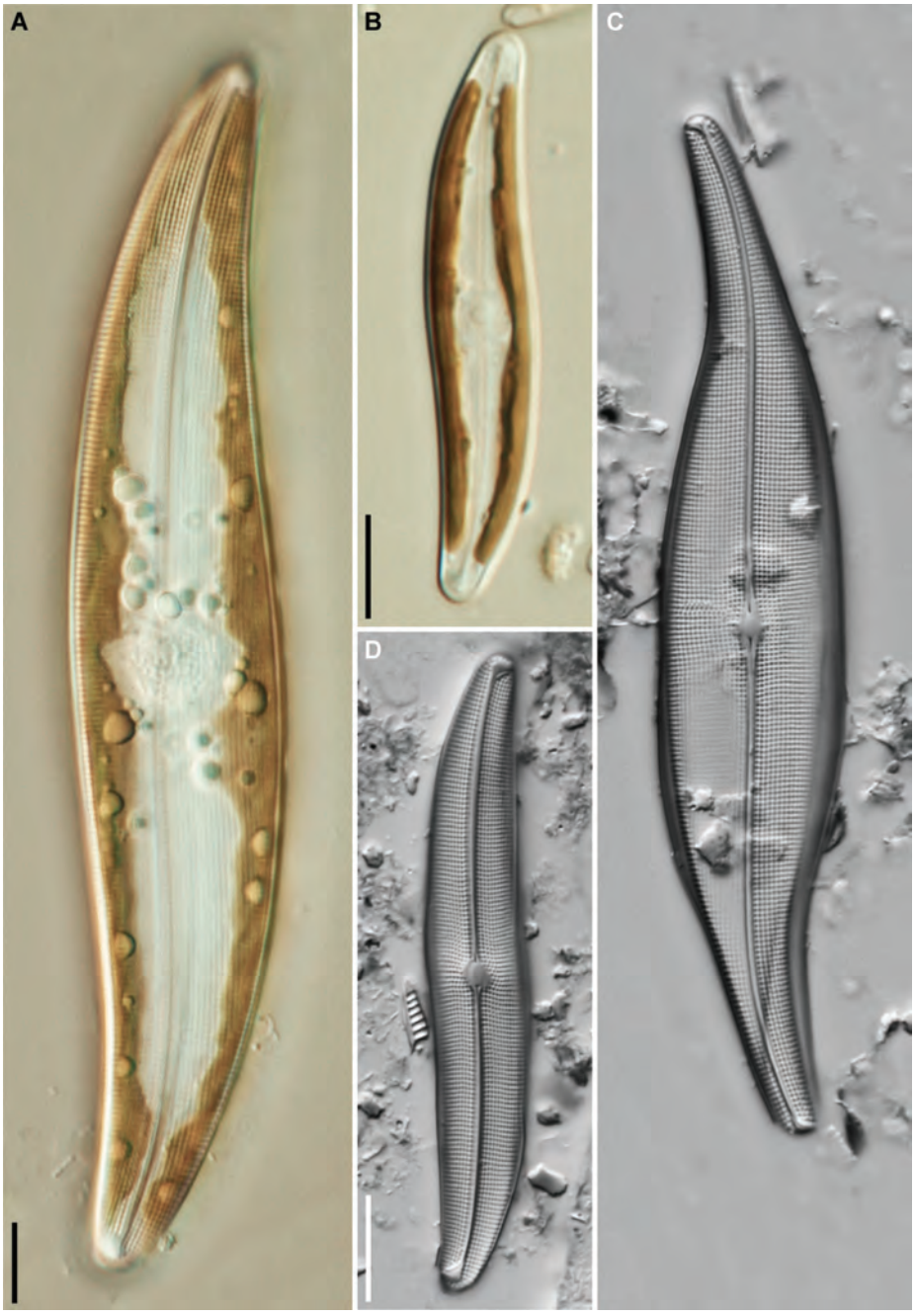



**Fig. 150.** *Gyrosigma* spp. **A-D.** LM. **A**. Living cell of *G. rautenbachiae* Cholnoky, note many lipd bodies. **B.** Living cell of *G. scalproides* (Rabenhorst) Cleve. **C.** Cleaned valve of *G. parkeri* (Harrison) Boyer. **D.** Cleaned valve of *G. scalproides*. Scale bars = 10 µm (A-D).

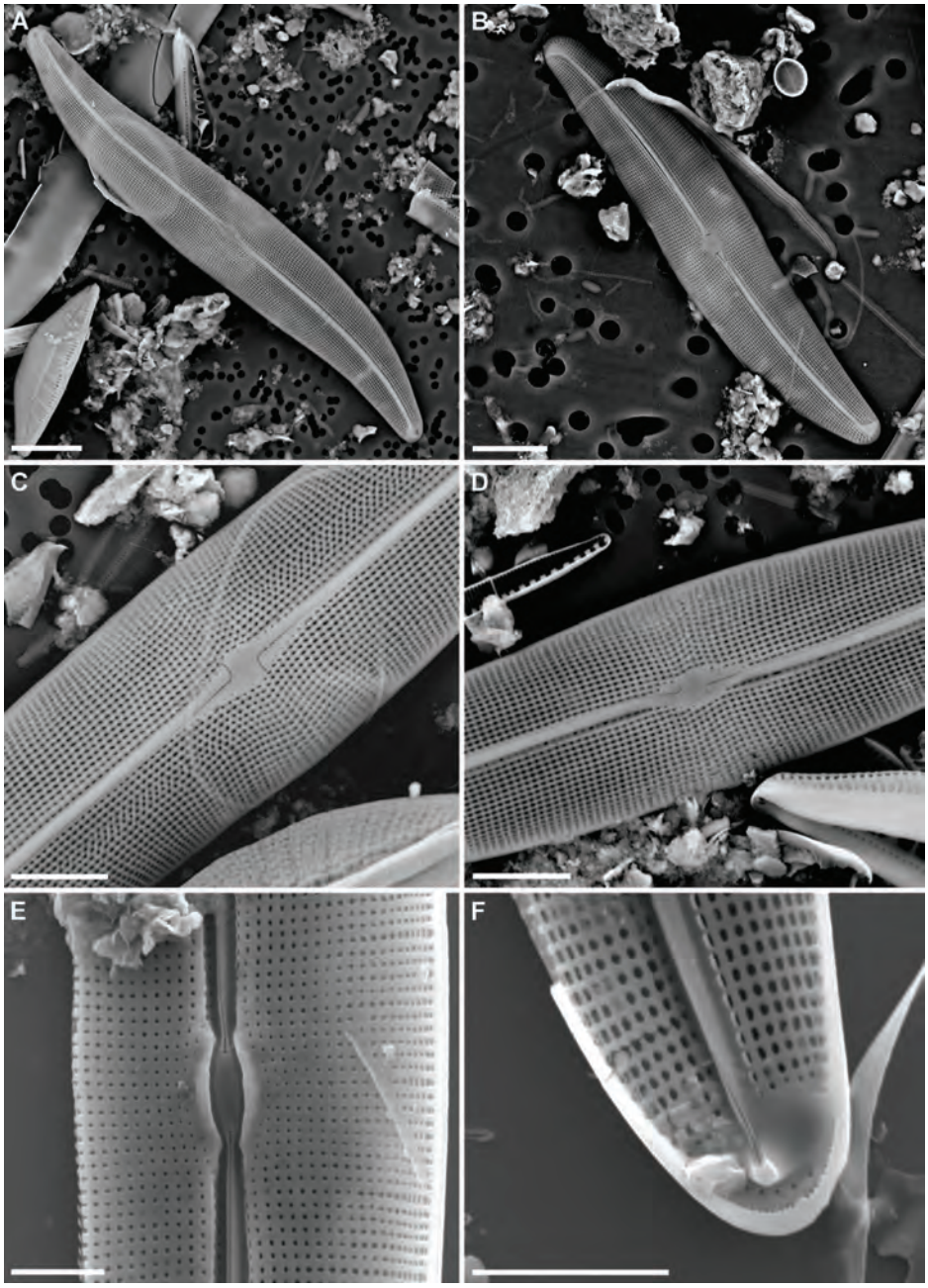



**Fig. 151.** *Gyrosigma* spp. **A-F.** SEM. **A-D.** External view of valves. **B.** *G. scalproides.* **C-D.** Detail of central raphe endings. **E-F.** Internal view of valves. **E.** *G. rautenbauchiae*, detail of internal central raphe endings. **F.** Detail of internal terminal raphe ending and helictoglossa.
Scale bars = 10 µm (A-B), 5 µm (C-F).

## ***Pleurosigma*** W. Smith 1852

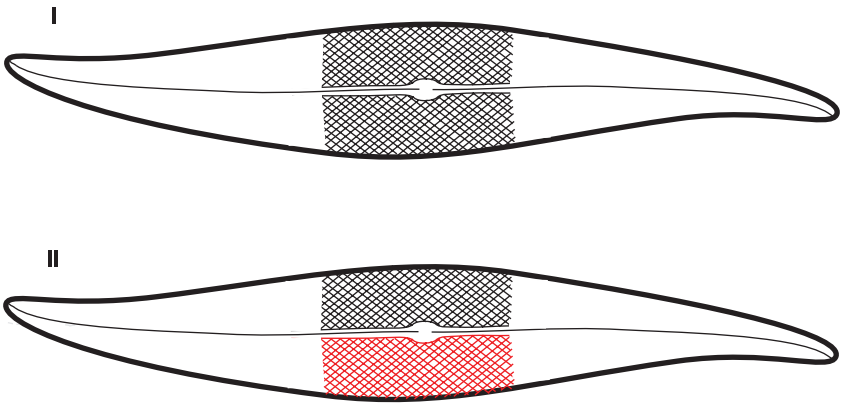
Type species: *Pleurosigma angulatum* (E.J. Quekett) W. Smith

**Characteristics –** Cells **biraphid**, **sigmoid**, large to very large with acutely rounded apices. Striae fine, transapical and longitudinal striae run diagonal to each other (II). Raphe sigmoid and simple (Fig. 152). Central area small, axial area very narrow.

**Plastid structure –** Two plate-like plastids, sometimes with lobed margins, lying along each side of the girdle (Fig. 152: A).

**Identification of species –** Species can be identified by cell size, cell shape, shape of the apices, structure and density of the striae as well as structure of the central area and the relative angle of the diagonal striae.

**Ecology –** Cells solitary, free living and motile. Found in the benthos of alkaline mesotrophic to eutrophic waters in moderate to high conductivities.



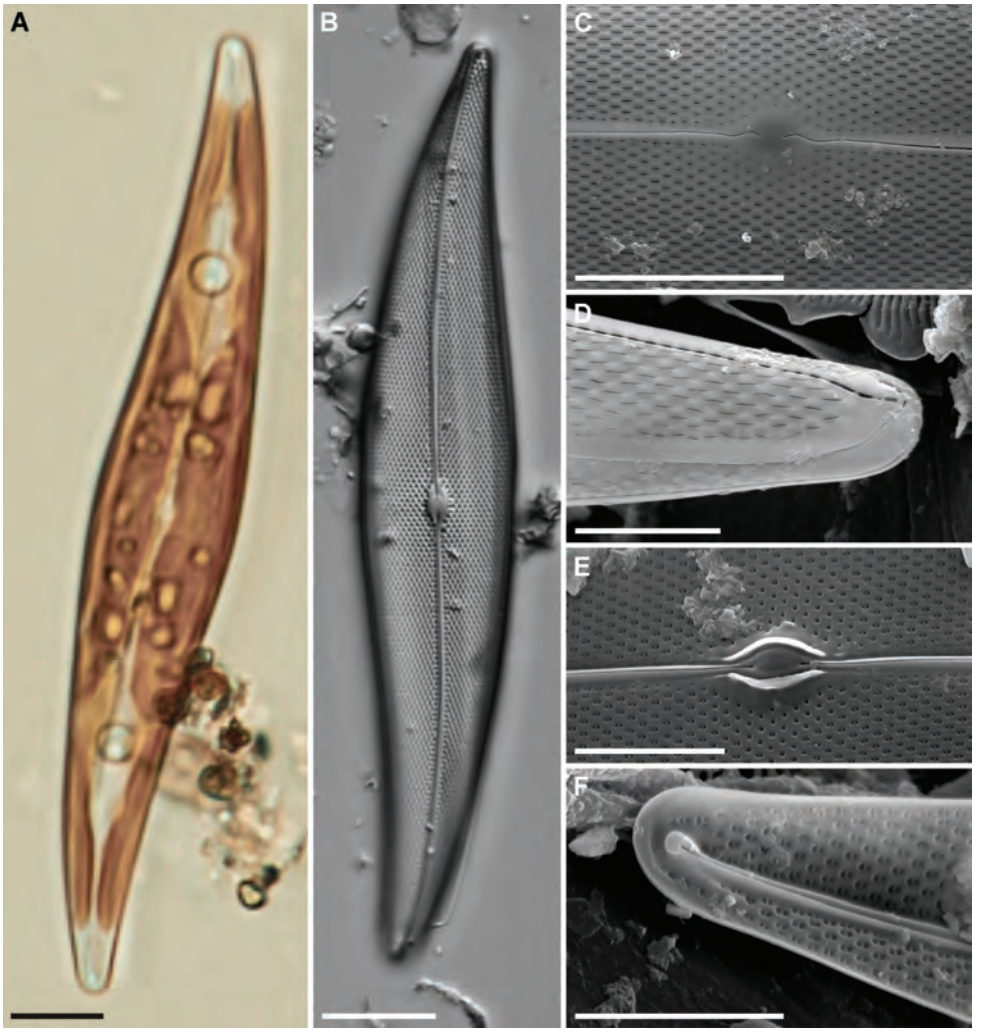



**Fig. 152.** *Pleurosigma salinarum* Grunow. **A-B.** LM. **A**. Living cell. **B.** Cleaned valve**. C-F.** SEM. **C-D.** External view of valve, detail of central raphe endings (**C**) and apex (**D**). **E-F.** Internal view of valve, detail of central raphe endings (**E**) and terminal raphe ending with helictoglossa (**F**).
Scale bars = 10 µm (A-B), 5 µm (C-F).

## ***Craticula*** Grunow 1868

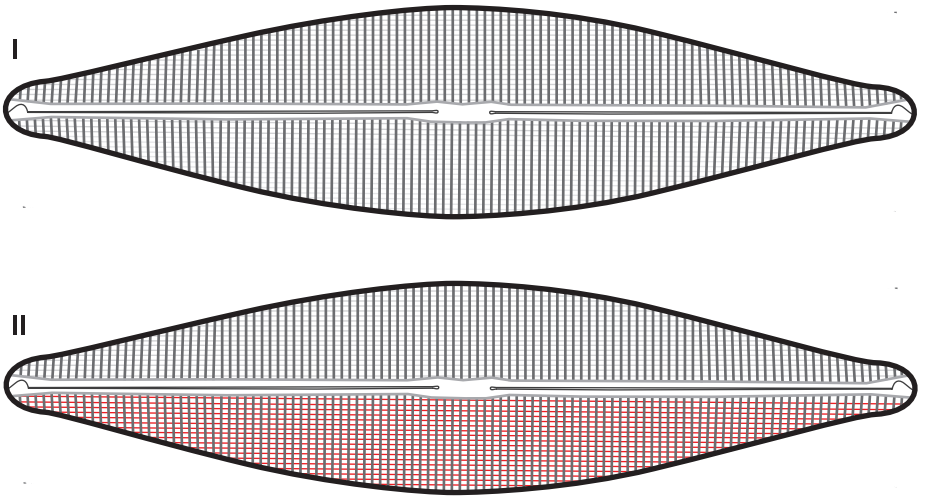
Type species: *Craticula perrotettii* Grunow

**Characteristics –** Cells **biraphid**, lanceolate with rostrate, capitate or broadly rounded apices. Striae parallel through the length of the valve. Areolae regularly arranged, very small and difficult to observe under LM (Fig. 154: A, B, D) but forming longitudinal striae (II). Cells of different species vary dramatically in size. Under certain conditions the cell forms a craticula (Fig. 1543: C), internal silica thickenings composed of a central rib and transverse ribs.

**Plastid structure –** Cells with one or two plastids on either side of the nucleus on each side of the girdle (clearly visible in large cells). Typically several small lipid droplets occur in the cytoplasm linking the plastids with one large droplet near to each pole (Fig. 153: C).

**Identification of species –** Species in this genus are distinguished based on cell size and shape as well as longitudinal and transverse striae density. The structure and shape of the central area can also be a useful characteristic.

**Ecology –** Cells solitary and motile. Found in the benthos of oligotrophic acidic water and extending into alkaline waters with high conductivity as well as very hard waters. Craticulae are formed when cells are exposed to high osmotic pressure.



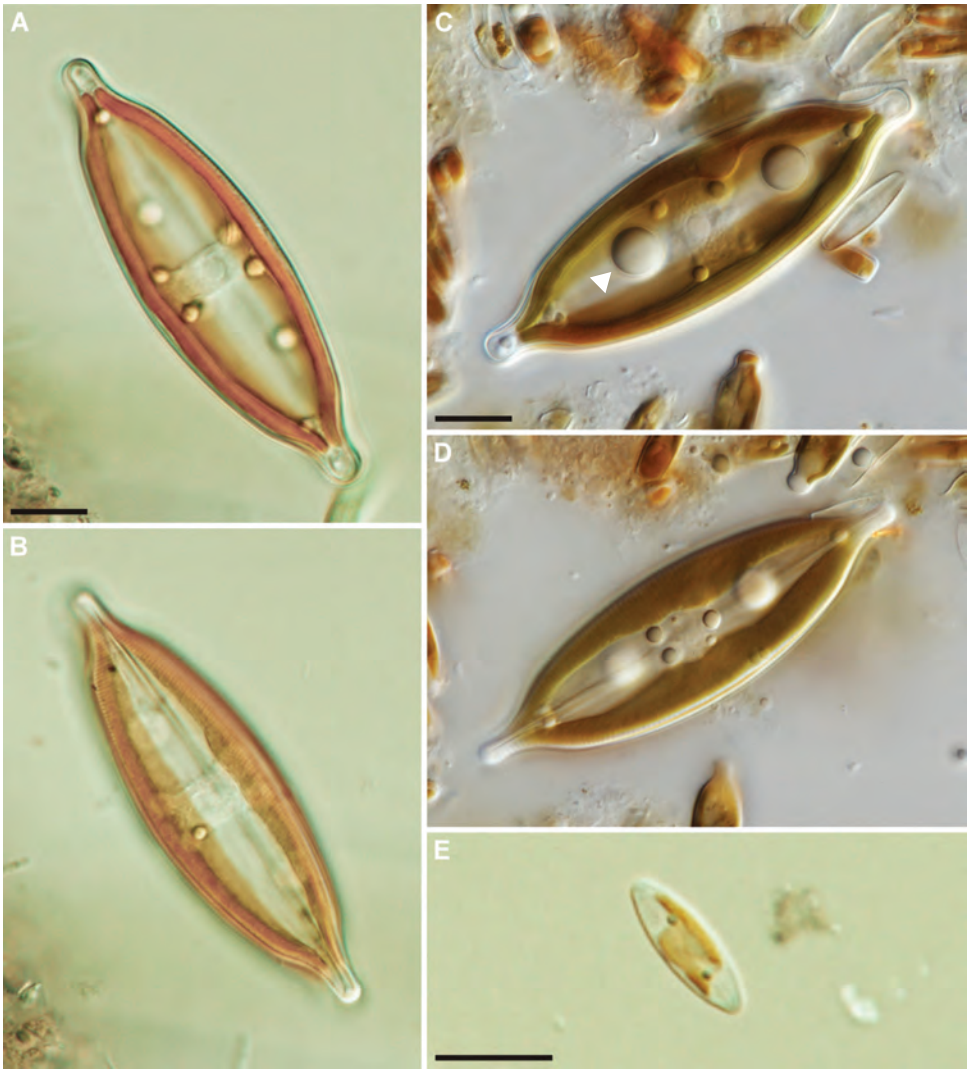



**Fig. 153.** *Craticula* spp. **A-E.** LM. **A-B.** Living cell of *Craticula ambigua* (Ehrenberg) D.G. Mann, valve view, different foci of same cell. **C-D.** Living cell of *Craticula ambigua*, valve view, different foci of same cell, note large lipid droplets (arrow). **E.** *Craticula molestiformis* (Hustedt) Mayama valve view. Scale bars = 10 µm.

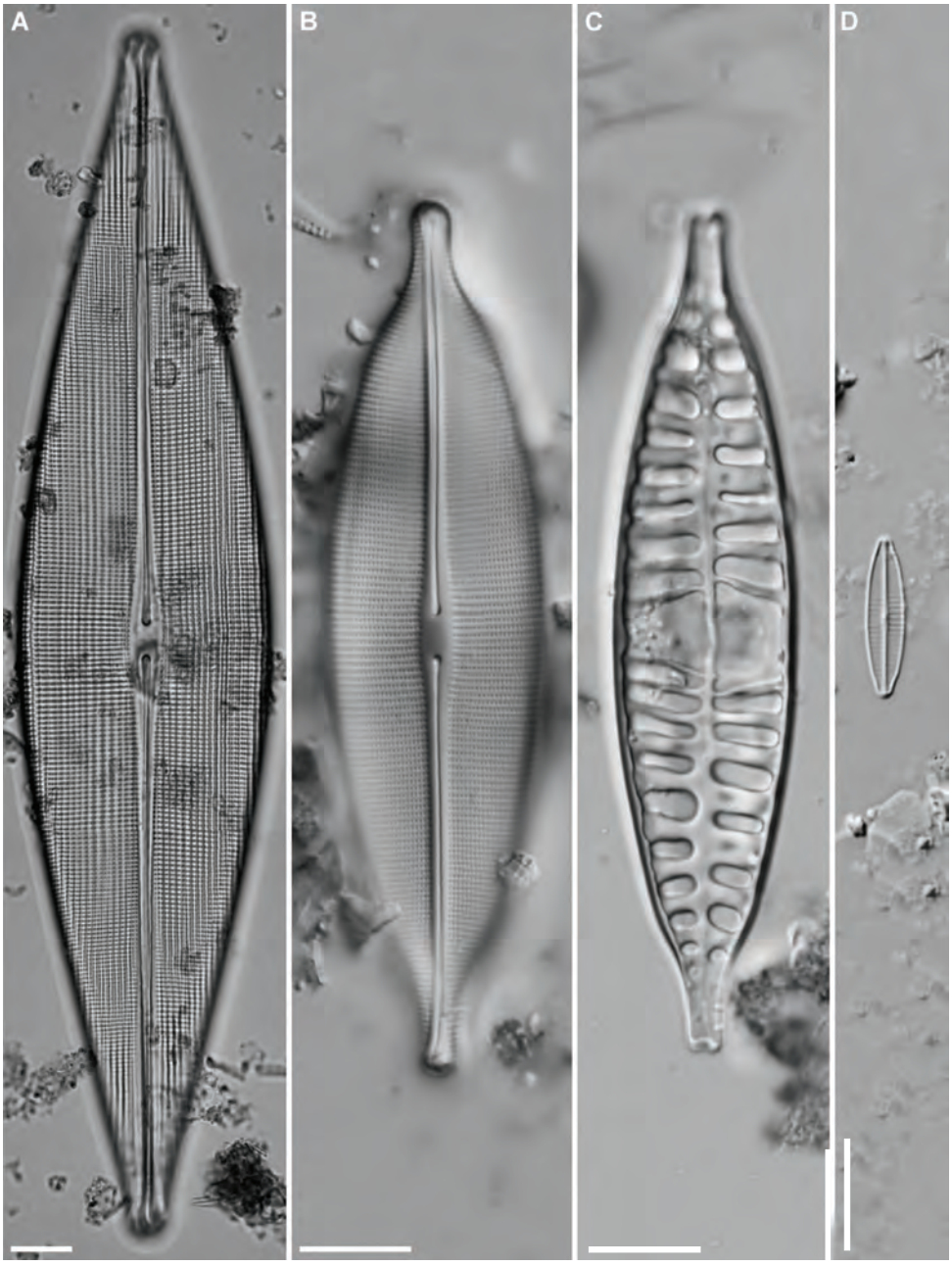



**Fig. 154.** *Craticula* spp. **A-D.** LM. **A.** Valve view of *Craticula perrotettii.* **B.** Valve view of *C. ambigua*. **C.** *Craticula* sp., a craticula. **D.** Valve view of *Craticula submolesta* (Hustedt) Lange-Bertalot.
Scale bars = 10 µm.

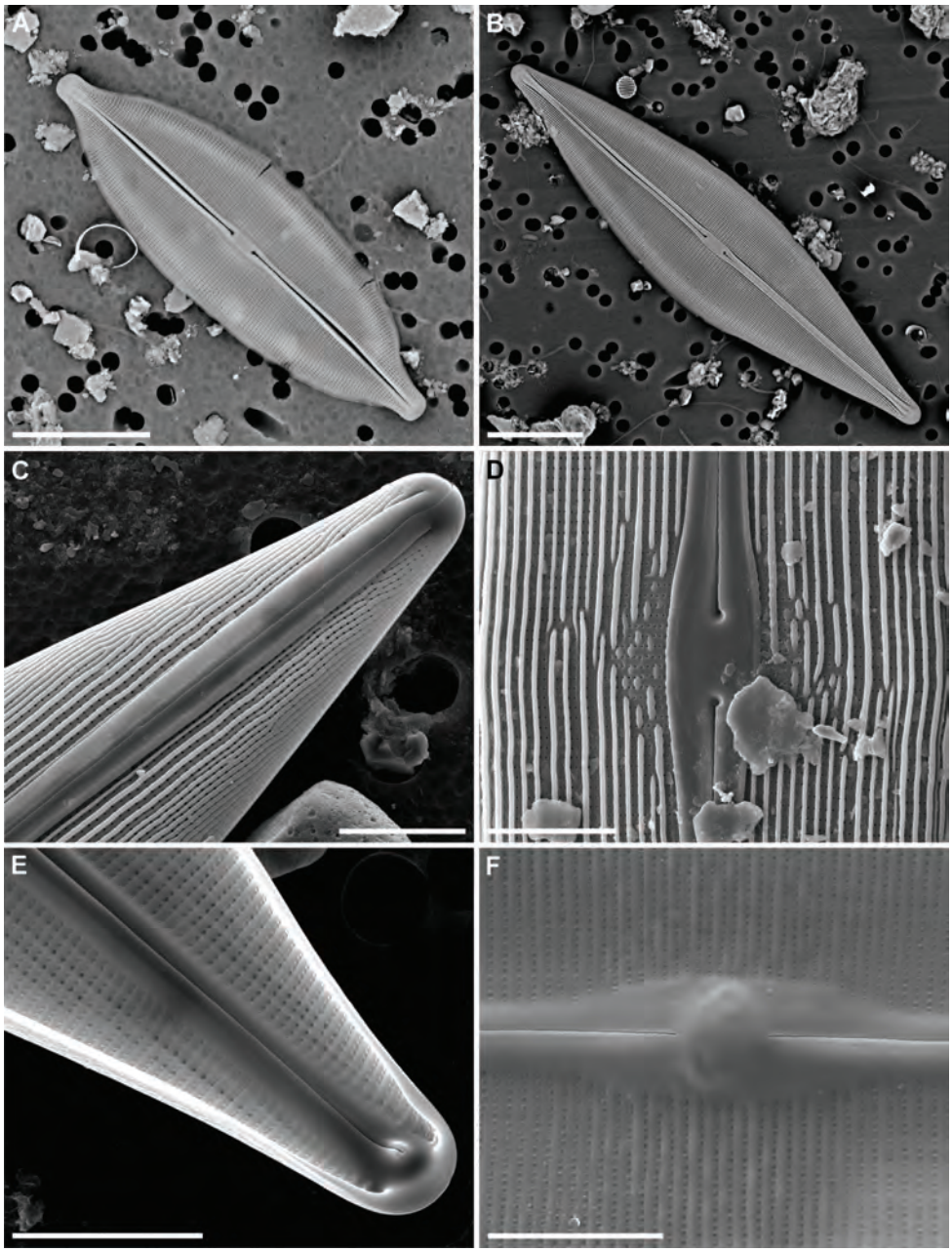



**Fig. 155.** *Craticula* spp. **A-F.** SEM. **A.** Valve view of *Craticula ambigua*. **B.** Valve view of *C. cuspidata* (Kützing) D.G. Mann . **C-F.** *C. perrotettii,* external view of terminal raphe ending (**C**), external view of central raphe endings (**D**), internal view of terminal raphe ending (**E**), internal view of central raphe endings (**F**). Scale bars = 20 µm (A-B), 10 µm (C-F).

## ***Stauroneis*** Ehrenberg 1843

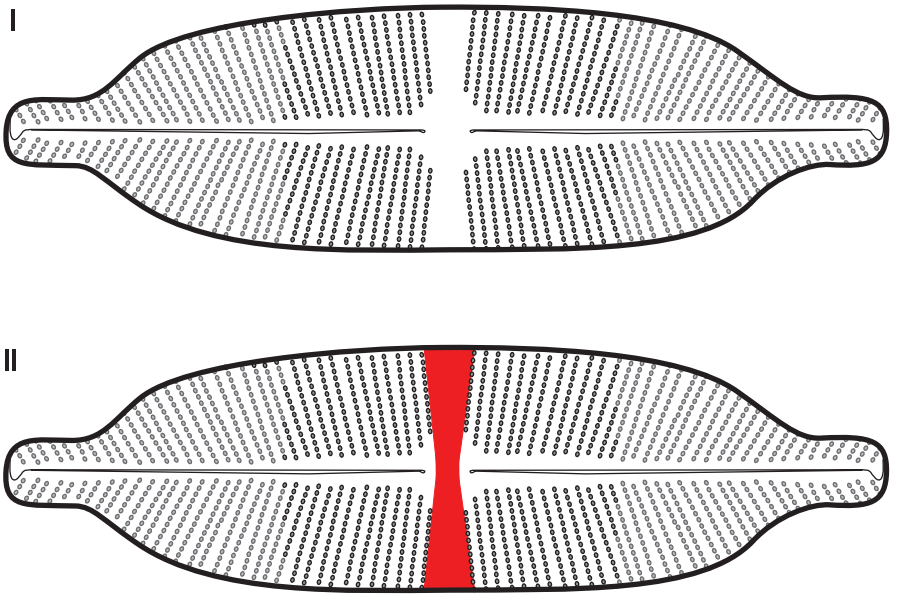
Type species: *Stauroneis phoenicenteron* (Nitzsch) Ehrenberg

**Characteristics –** Cells **biraphid**, cell may be large, elliptical to linear-elliptical and sub-capitate to capitate apices. Striae easily discernable under LM (Fig. 157) composed of a single row of round or elongate areolae (Fig. 158: A). Raphe carried in a sternum. **Stauros** present (II; Fig. 157; Fig. 158: D-E). **Pseudosepta** may be present at the apices (Fig. 158: C).

**Plastid structure –** 2 plate-like plastids extending under each valve (Fig. 156).

**Identification of species –** Species can be identified by cell size, cell shape, shape of the apices, structure and density of the striae, structure of the central raphe endings as well as structure of the central stauros and the presence/absence of pseudosepta.

**Ecology –** Cells solitary, free living and motile. Found mostly in the benthos of oligotrophic standing waters with low conductivities and also found in streams and sub-aerial habitats.



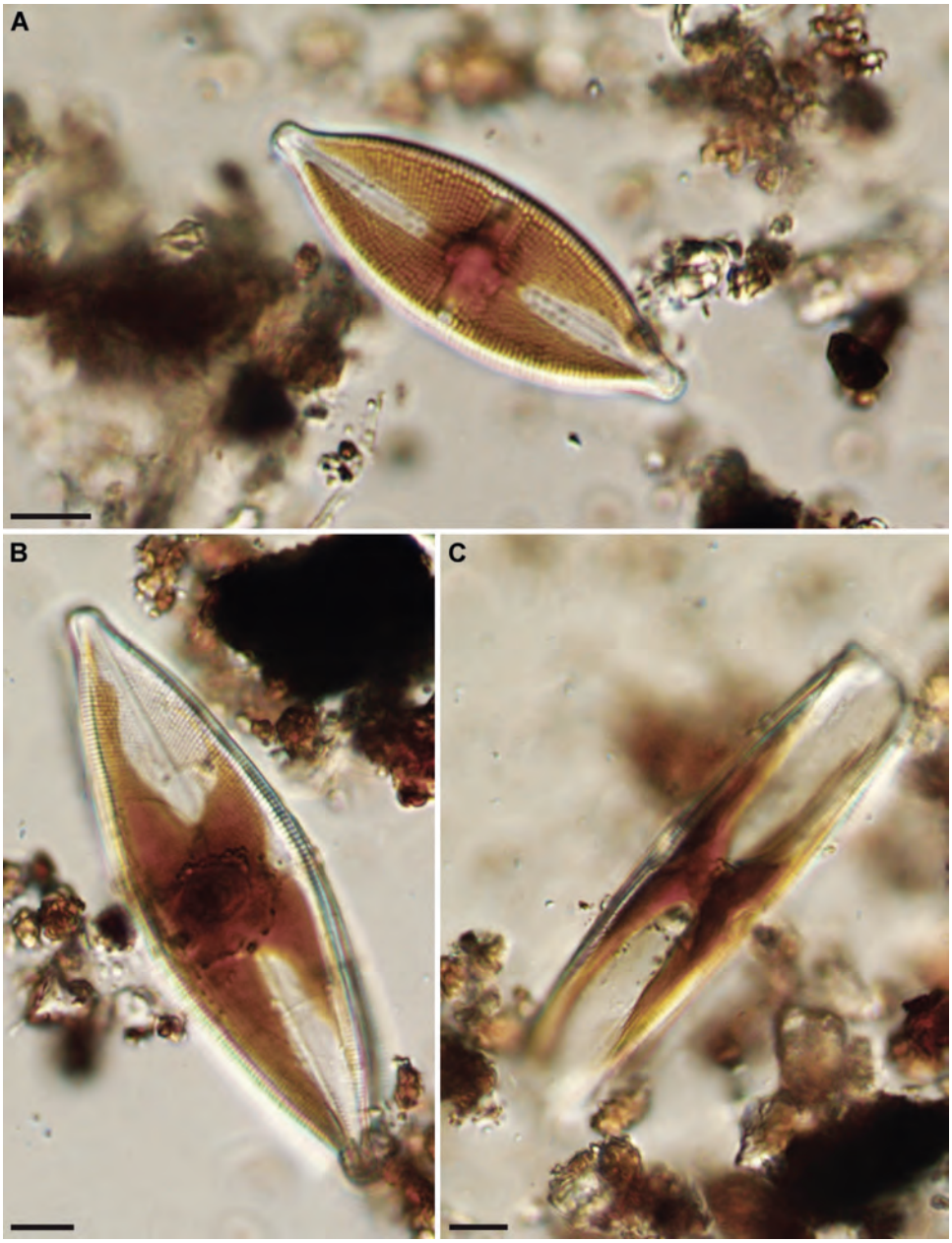



**Fig. 156.** *Stauroneis* spp. **A-C.** LM, living cells. **A-B.** Valve views. **C.** Girdle view. Scale bars = 10 µm.

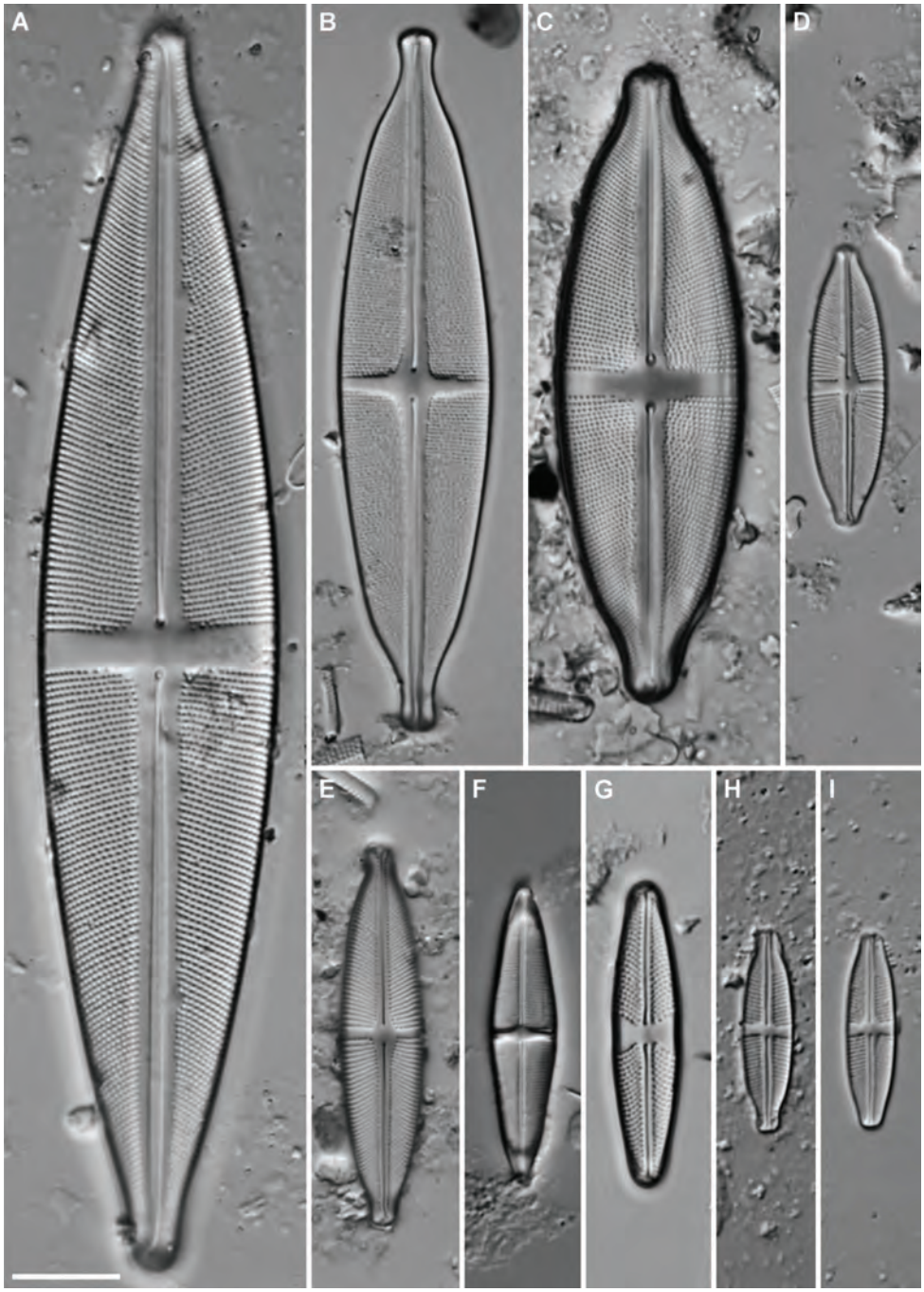



**Fig. 157.** *Stauroneis* spp. **A-I.** LM, cleaned valves. **B.** *Stauroneis gracilior* E. Reichardt. **H-I.** *Stauroneis kriegeri* R.M. Patrick.
Scale bar = 10 µm (A-I).

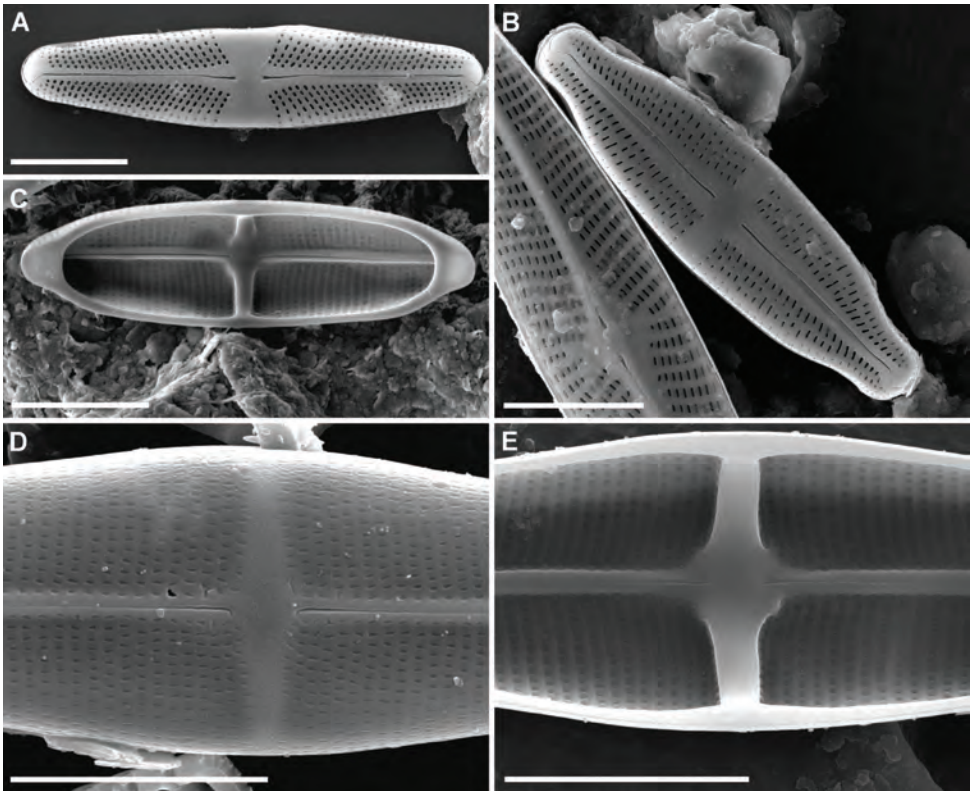



**Fig. 158.** *Stauroneis* spp. **A-E.** SEM. **A-B, D.** External view of valves. **B.** *Stauroneis kriegeri*. **C.** Internal view of valve, note the pseudosepta at both apices. **E.** Internal view of valve, detail of stauros. Scale bars = 5 µm (A-E).

## ***Envekadea*** Van de Vijver, Gligora, F. Hinz, Kralj & Cocquyt 2009

Type species: *Envekadea hedinii* (Hustedt) Van de Vijver, Gligora, F. Hinz, Kralj & Cocquyt

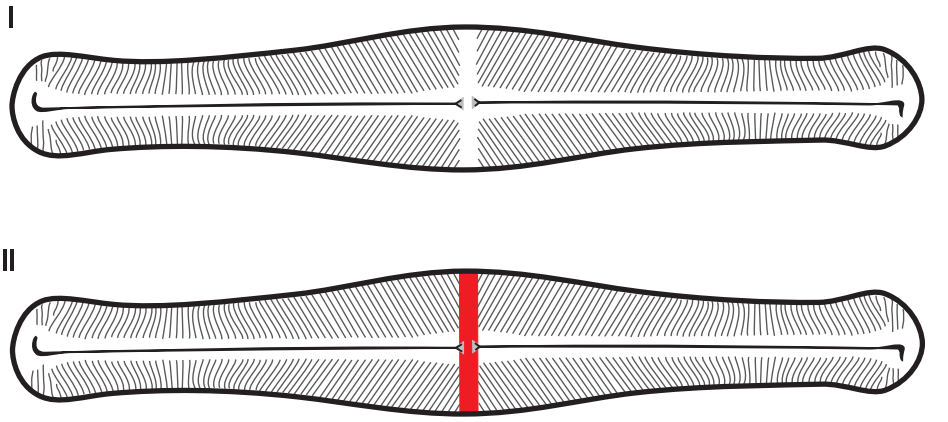
SYNONYM:
*Navicula* Bory 1822 pro parte
*Stauroneis* Ehrenberg 1843 pro parte

**Characteristics –** Cells **biraphid**, usually with expanded apices and expanded central region. Striae fine, strongly radiate in the mid-valve becoming strongly convergent near the apices. Raphe sigmoid, terminal raphe endings curved in opposite direction, golf club shaped under SEM, central raphe endings delta-shaped. Stauros may be present (II; Fig. 159).

**Plastid structure –** Cells with one H-shaped plastid.

**Identification of species –** Species can be identified by cell size, cell shape, shape of the apices, structure and density of the striae as well as structure of the central area.

**Ecology –** Cells solitary, free living and motile. Found in the benthos of oligotrophic to mesotrophic waters in both low and moderate conductivities.



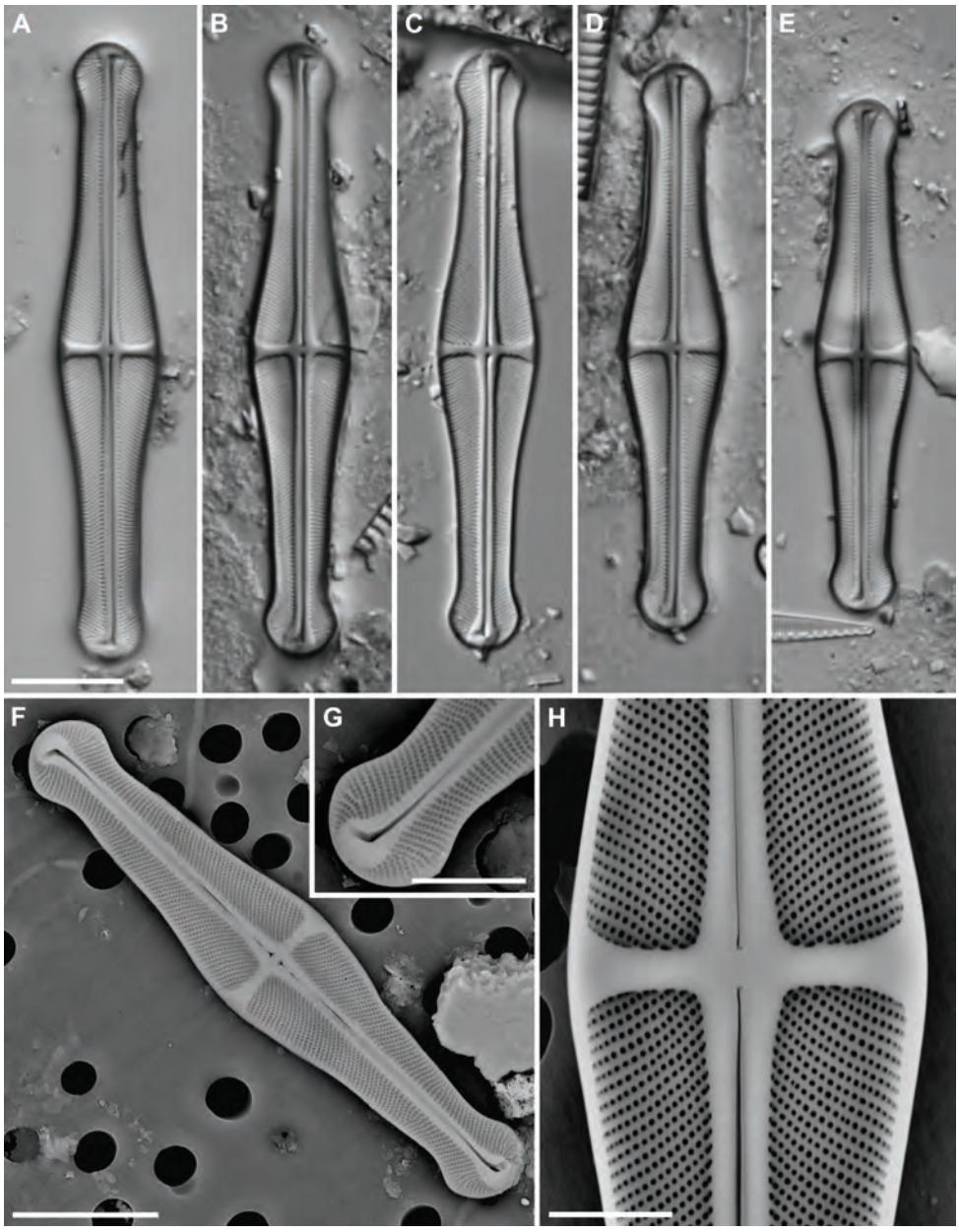



**Fig. 159.** *Envekadea* sp. **A-E.** LM, valve views. **F-H.** SEM, internal view of valve. **G.** Detail of apex, note golf club shaped terminal raphe ending. **H.** Detail of stauros, note delta-shaped central raphe endings.
Scale bars = 10 µm (A-F), 5 µm (G), 3 µm (H).

## ***Amphora*** Ehrenberg ex Kützing 1844

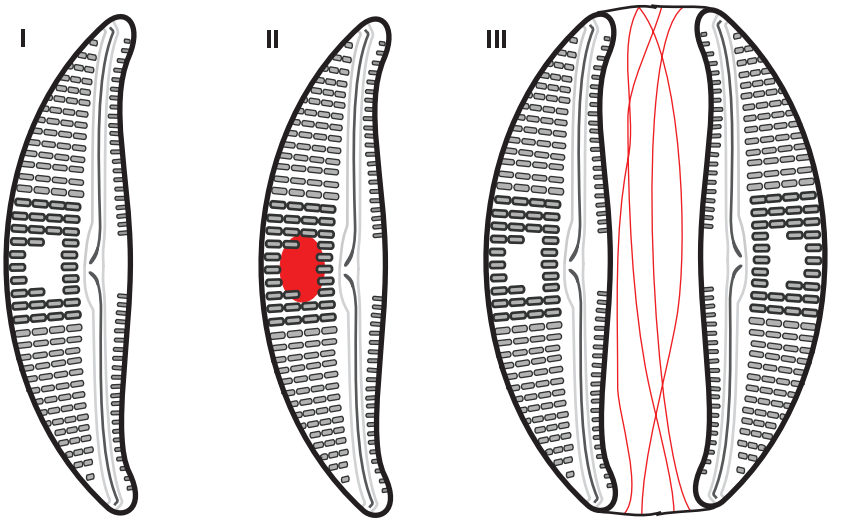
Type species: *Amphora ovalis* (Ehrenberg) Kützing

**Characteristics –** Cells **biraphid**, variable in terms of size and shape. Intact cells (i.e. both valves still joined by the girdle) are similar in shape to an orange segment, with the diatom valve faces being comparable to the faces of the orange segment, this is because cells have many more girdle bands on the dorsal side than on the ventral side (III; Fig. 161: A). The dorsal central striae are often separated by a thickened area of the valve known as a **semi-stauros** (II; Fig. 160: G-H; Fig. 161: D) absent in *Halamphora* Levkov. The striae on the ventral side of the valve are very short, composed of only a few areolae. In some species the areolae are clearly discernable under LM. Differentiated from *Halamphora* by the structure of the areolae (only visible under SEM).

**Plastid structure –** Single H-shaped plastid (Fig. 160: A). Lipid droplets (2-4) found towards the apex of each lobe of the plastid.

**Identification of species –** Species in this genus are distinguished based on cell size and shape and the shape of the apices. Striae density and angle relative to the **transapical axis** are also important characteristics to consider along with the size of individual areolae. The number of areolae on the ventral side of the valve is also important (IV) as well as the distance between the raphe and the ventral margin.

**Ecology –** Cells solitary, free living in the benthos of alkaline waters and occurring in a range of conductivities and trophic levels.



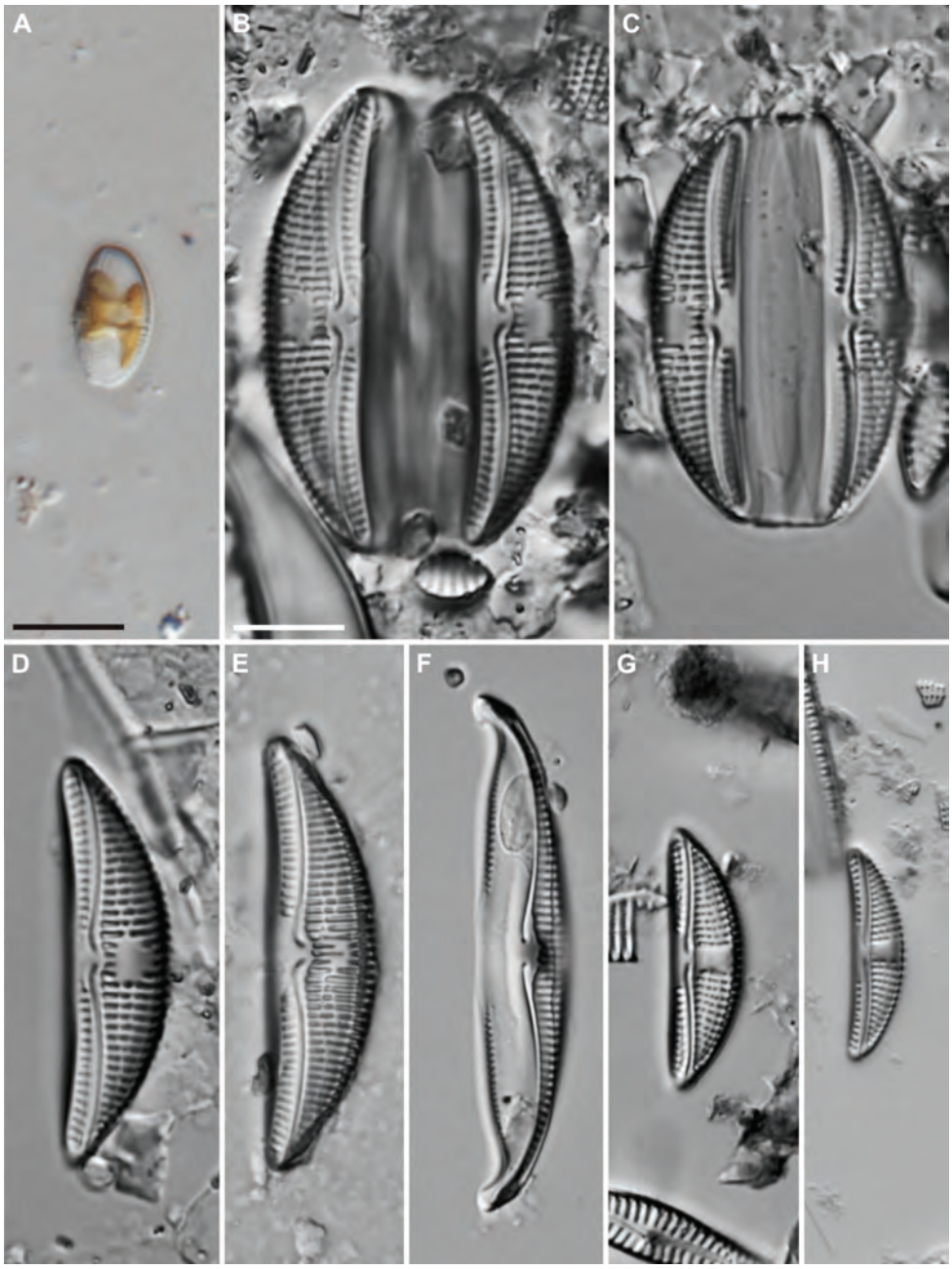



**Fig. 160.** *Amphora* spp. **A-H.** LM. **A.** Living cell. **B-H.** Cleaned valves. **B-D.** *Amphora copulata* (Kützing) Schoeman & R.E.M. Archibald. **E.** *Amphora ovalis*. Scale bars = 10 µm (A-H).

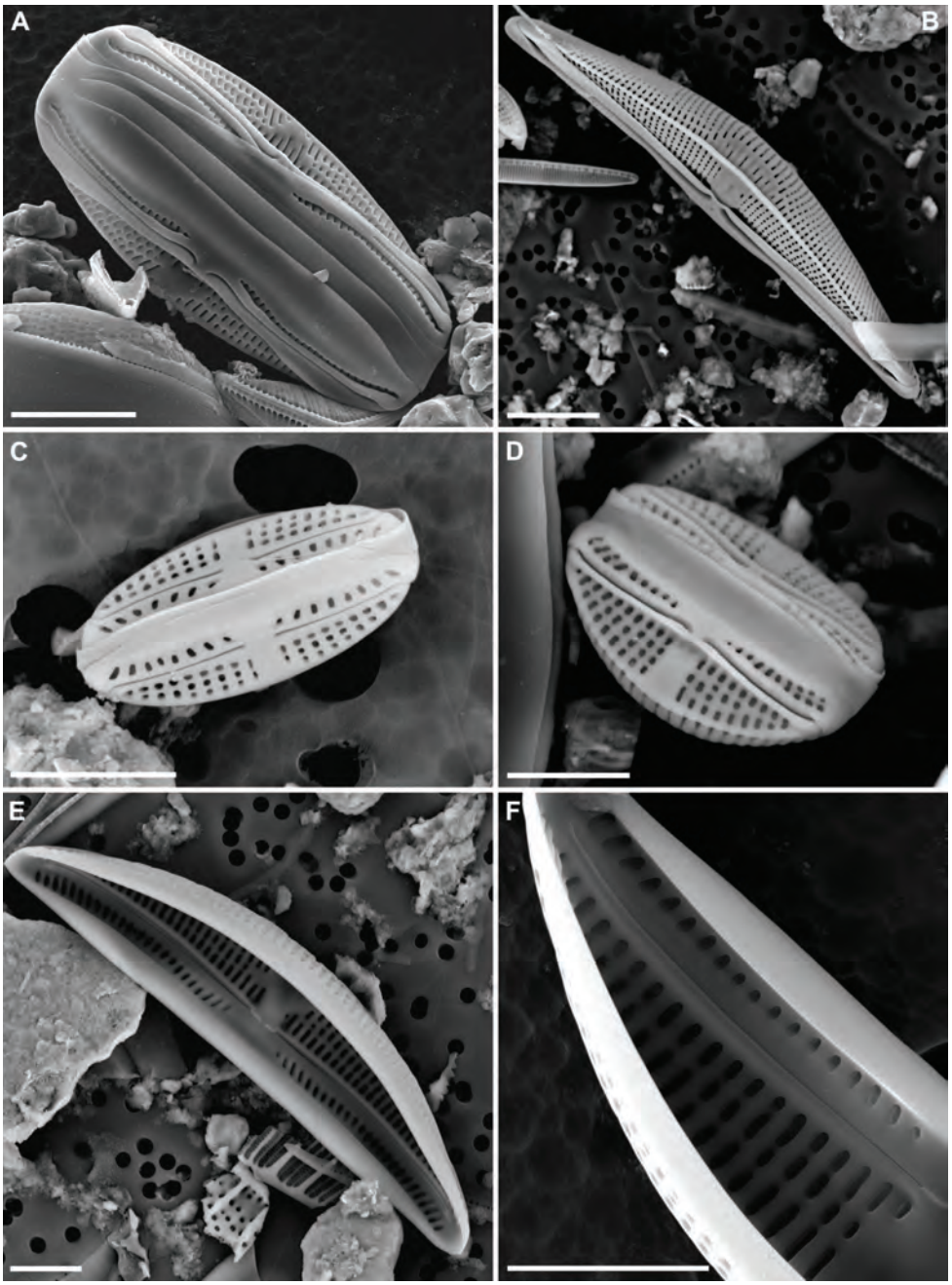



**Fig. 161.** *Amphora* spp. **A-F.** SEM. **A-D.** External view of valves. **C-D.** *Amphora pediculus* (Kützing) Grunow**. E-F.** Internal view of valve.
Scale bar = 10 µm (A-B), 5 µm (C-F).

## ***Halamphora*** (Cleve) Levkov 2009

Type species: *Halamphora coffeaeformis* (C. Agardh) Levkov

SYNONYM:

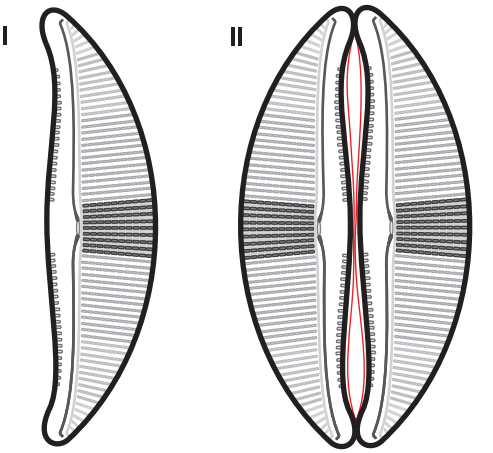
*Amphora* Ehrenberg ex Kützing 1844 pro parte

**Characteristics –** Cells **biraphid**, variable in terms of size and shape. Intact cells (i.e. both valves still joined by the girdle) are similar in shape to an orange segment, with the diatom valve faces being comparable to the faces of the orange segment, this is because cells have many more girdle bands on the dorsal side than on the ventral side (II; Fig. 163: A). Dorsal **semi-stauros** is absent. The striae on the ventral side of the valve are very short, composed of only a few areolae (Fig. 162: D, F-H; Fig. 163: C, E). In some species the areolae are clearly discernable under LM. Differentiated from *Amphora* by the structure of the areolae (only visible under SEM).

**Plastid structure –** Single H-shaped plastid (Fig. 162: A-B). Lipid droplets (2-4) found towards the apex of each lobe of the plastid (Fig. 162: A).

**Identification of species –** Species in this genus are distinguished based on cell size and shape and the shape of the apices. Striae density and angle relative to the **transapical axis** are also important characteristics to consider along with the size of individual areolae. The number of areolae on the ventral side of the valve is also important as well as the distance between the raphe and the ventral margin.

**Ecology –** Cells solitary, free living in the benthos. Occurs in a range of water quality with most species found at moderate conductivity and some species being specifically associated with high conductivity.



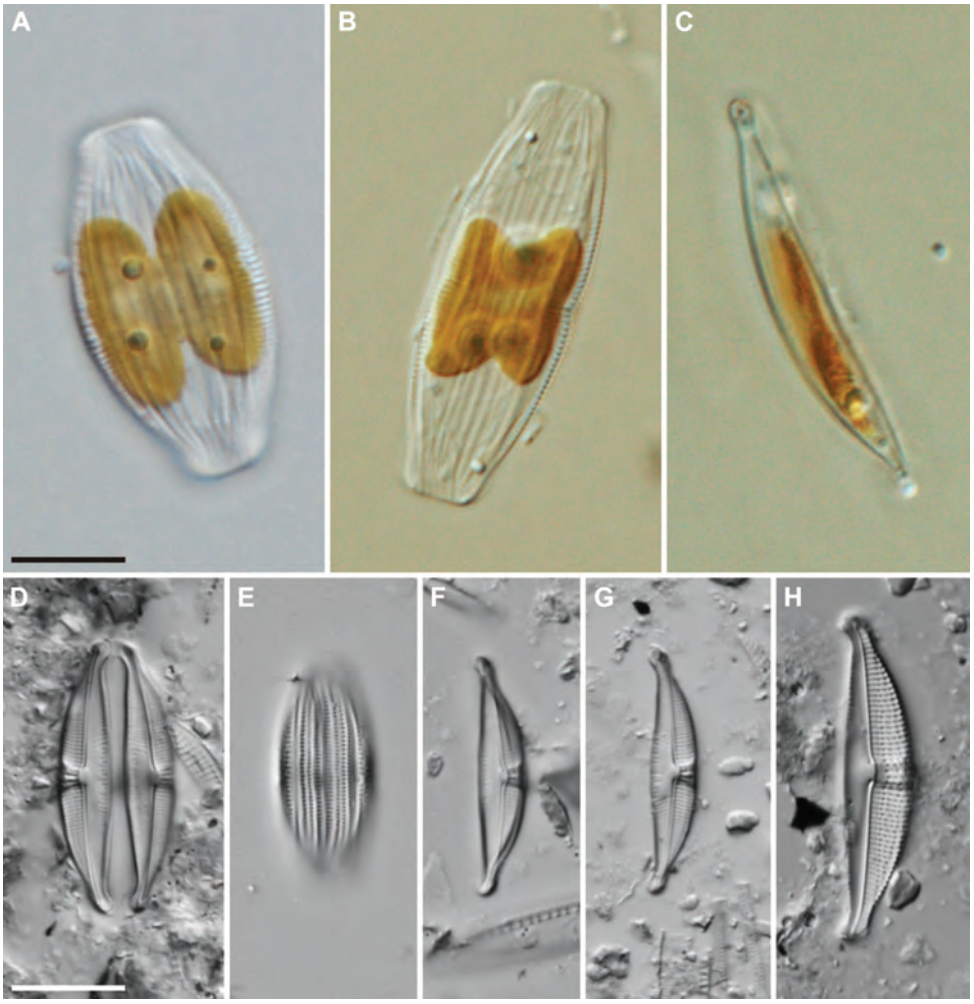



**Fig. 162.** *Halamphora* spp. **A-H.** LM. **A-B.** Living cells, girdle view. **C.** Living cell, valve view. **D-H.** Cleaned valves. **D, F, G.** *Halamphora submontana* Hustedt, valve view. **E.** *H. submontana*, girdle view.
Scale bars = 10 µm (A-H).