

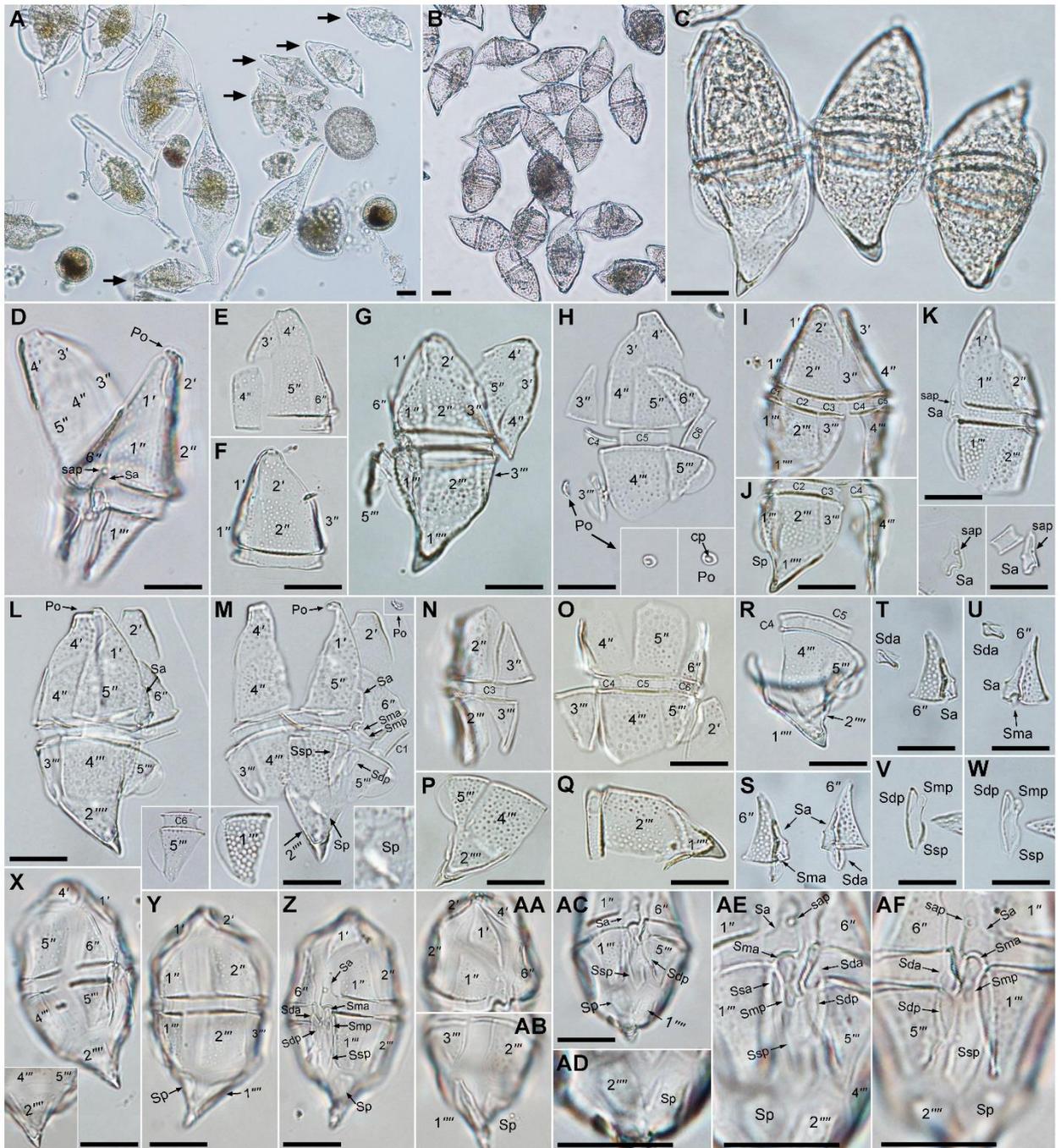
**Redefinition of the dinoflagellate genus *Alexandrium* based on *Centrodinium*:  
reinstatement of *Gessnerium* and *Protogonyaulax*, and *Episemicolon* gen. nov.  
(Gonyaulacales, Dinophyceae)**

**Supporting Information**

**Appendix S2. Detailed morphology of *Centrodinium* spp.**

***Centrodinium punctatum***

*Centrodinium punctatum* had a plate formula Po, 4', 6'', 6c, 8s+, 5''', and 2'''''. The epithecal plates consisted of the apical pore platelet (Po), four apical plates (1'-4') and six precingular plates (1''-6'') separated from the hypothecal plates by six cingular plates (C1-C6) (Figs 1D-I; 2A-B, D-G). The sulcus was comprised of eight clearly visible sulcal plates (8s), but it is possible that very small accessory plates were not viewed. There was an anterior sulcal (S.a.) plate indented in the epitheca (Figs 1K; 2A, H), and the other sulcal plates were in the hypotheca. The hypothecal plates consisted of five postcingular plates (1'''-5''') and two antapical plates (1''''-2''') (Figs 1G-J; 2A-G, M). The laterally flattened cells of *C. punctatum* settle on the left or the right faces. In the left face, the plates 1-2', 1-3'' and 1-3''', and 1'''' were visible (Figs 1F-G, I-K, Y-Z; 2A-F), while the plates 3-4', 3''-6'' and 4'''-5''' and 2'''' were visible in the right face (Figs 1E, H, L; 2G, X). The third precingular plate (3'') located in the dorsal side was partially visible in both left and right faces (Fig. 1I, N).



**Figure 1** Light micrographs of *Centrodinium punctatum*. (A) Plankton sample with *Centrodinium* spp. The arrows point *C. punctatum*. (B-C) Individuals used for molecular analyses. (D) Partially dissociated theca in ventral view. (E-F) Epitheca. (G) Left face. (H) Right face. The insets show the apical pore plate. (I-J) Dorsal view. (K) Left-ventral view. The inset shows the anterior sulcal plate. (L) Right face. The inset shows the fifth postcingular plate. (M) Squashed theca. The insets show the first postcingular plate and

the sulcal plate. **(N)** Left-dorsal view. **(O)** Right face. **(P-Q)** Right and left hypotheca, respectively. Please note that the plate 2'''' is larger than 1'''. **(R)** Right-dorsal hypotheca. **(S-U)** Different views of the sixth precingular plate and several sulcal plates. **(V-W)** Different views of the sulcal plates. **(X-AE)** Megacytic individual. **(X)** Right-ventral view. **(Y)** Left face. **(Z)** Ventral view. **(AA)** Ventral epitheca. **(AB)** Dorsal hypotheca. **(AC)** Ventral hypotheca. **(AD)** Ventral antapex. **(AE-AF)** Detail of the sulcal plates. 1'-4' = apical plates; 1''-6'' = precingular plates; 1'''-5''' = postcingular plates; 1''''-2'''' = antapical plates; C1-C6 = cingular plates; cp = closing, cover platelet or canopy; Po = apical pore plate; Sa = anterior sulcal plate; sap = pore of the anterior sulcal plate; Sda = right (dexter) anterior lateral sulcal; Sdp = right posterior lateral sulcal; Sma = anterior median sulcal; Smp = posterior median sulcal; Sp = posterior sulcal; Ssa = left (sinister) anterior lateral sulcal; Ssp = left posterior lateral sulcal plate. Scale bars = 20  $\mu$ m.

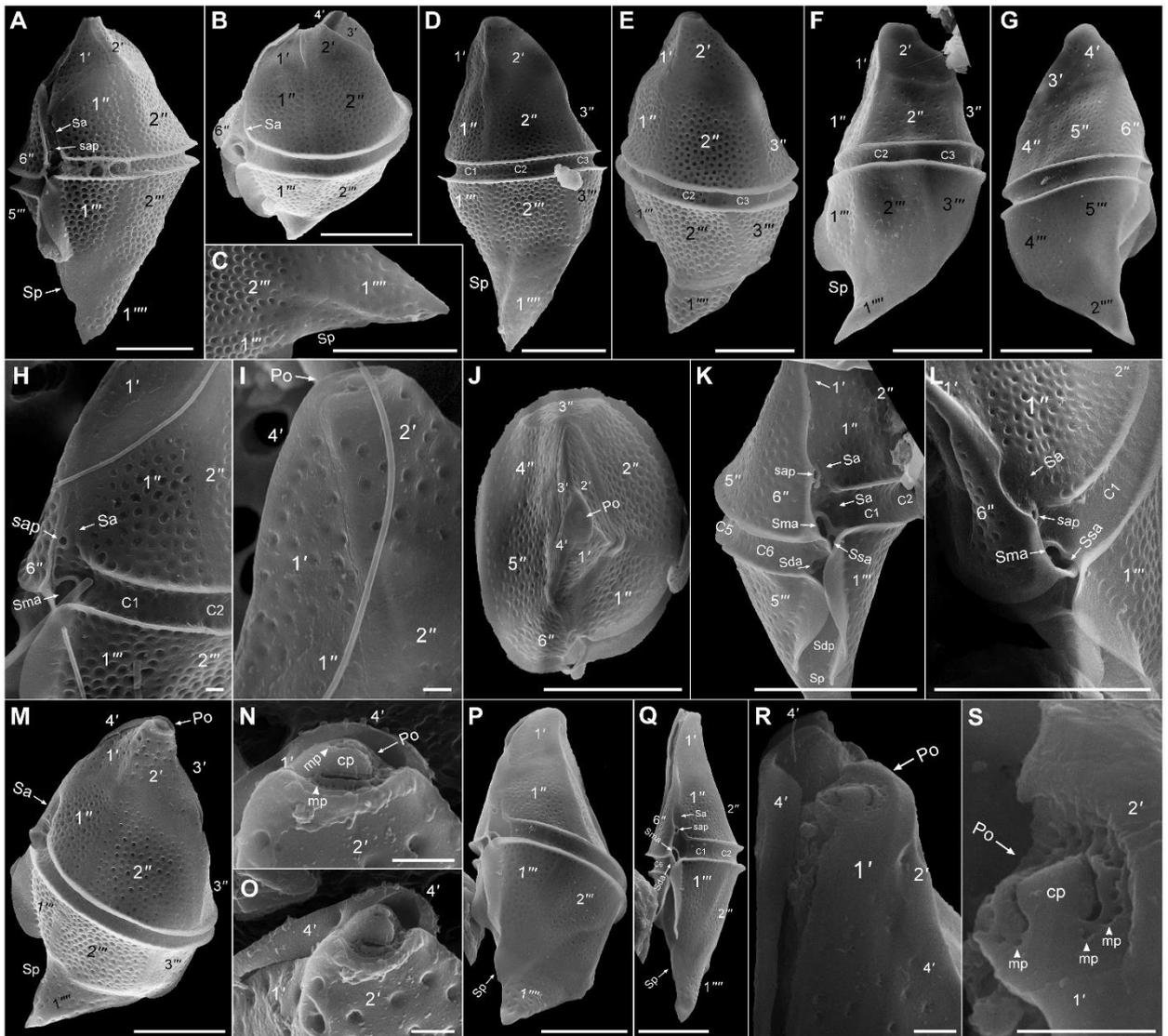
The apical pore plate (Po) was at the anterior most point of the epitheca, and surrounded by the anterior margin of the plates 2' and 4' that almost completely encircled the apical pore plate, while the contact with the plate 1' in the ventral side was much reduced (Figs 1D, H; 2I, M). Under inverted light microscopy (LM), the Po was approximately 2  $\mu$ m long, with a circular to ellipsoidal contour and slightly convex. There was a circular to horseshoe-shaped pore with a cover or closing platelet or canopy (cp) of about 1  $\mu$ m in diameter connected with the first apical plate in the ventral side (Fig. 1D, H, M). Scanning electron microscopy revealed a horseshoe-shaped apical pore surrounded by a rim of small marginal pores (Fig. 2M-O, Q-S). The marginal pores were absent in the ventral side that connect to the first apical plate (Fig. 2S). Numerous chain-forming species of gonyaulacoid dinoflagellates have an additional large pore in the apical pore plates, which functions to connect chain-forming cells by a cytoplasmic

strand. Cell chains of *C. punctatum* and the anterior attachment or connecting pore in the apical pore plate were not observed. If the anterior attachment pore was present, it was very small and could be mistaken for one of the marginal pores.

The anterior epitheca had four apical plates, two in the left and right faces. In the left face, the plate 1' had the shape of a narrow rhomboid with two anterior and posterior truncate apices, adjacent to the apical pore and the anterior sulcal plates, respectively. The right margin of the plate 1' was adjacent with plates 4' and 6'', showing a convex contour to articulate the latter plate (Figs 1A, GL-M, AA; 2A, H-S). The plate 2' was the largest of the apical series, with an elongated trapezoidal shape and a concave anterior margin that surrounded the Po. The posterior margin in contact with the plate 2'' slanted down to contact the most anterior point of plate 3'' (Figs 1F-G; 2B, D, D-G). In the right face, there were two apical plates: a larger pentagonal plate with a concave anterior margin that surrounded the Po (Fig. 1E, G), and a smaller trapezoidal plate that does not contact with the apical pore plate. This latter plate could be considered an anterior intercalary plate in a strict Kofoidian scheme. Unequivocally, the anterior development of this trapezoidal plate is hindered by the overlap growth of the other larger apical plate. These two plates are apicals from an evolutionary point of view. The smaller trapezoidal plate belongs to the apical series and corresponded to the third apical (3'), and the larger one was the four apical plate (4') (Figs 1D-E, G-I; 2G, J). The anterior half of the right margin of the plate 4' was in contact to plate 2' was concave, and the posterior half was also concave in contact to 3'. The left margin was adjacent to the plate 1'. The posterior margin was concave slanting down towards the plate 5'' (Fig. 1D-E, G-H). A ventral pore in the plates 1' or 4' was not observed, although the poroid surface of the theca made difficult to detect special pores (Fig. 2).

Six (1''-6'') precingular plates surrounded the apical plates and were immediately above the cingulum (Figs 1D, G-I; 2D-F). The first precingular plate (1'') was four-sided. The right margin was indented to articulate with the anterior sulcal plate (S.a.). The anterior margin slant down along the plate 1' to contact the plate 2' (Fig. 2A-B, D-F, M). The second precingular (2'') was rectangular, longer than wide and the largest plate of the left face of the epitheca. The anterior margin slanted down towards the left along the plate 2' (Fig. 1F, I). The third precingular (3'') was small and triangular, resembling the dorsal fin of a shark. The left margin adjacent to plate 4'' was straight, while the right margin showed an elevation in the intersection with the plates 2'' and 2' (Fig. 1H-I). The plate 4'' was rectangular, longer than wide, and with the anterior margin slanting down towards the left side (Fig. 1E, M, O). The fifth precingular (5'') was rectangular and the largest plate of the epitheca, with the anterior margin arched in the contact with the plates 3' and 4' (Fig. 1E, H, M, O). The sixth precingular (6'') plate was triangular. The left anterior margin was reinforced and the left posterior margin formed a moderate concavity joining the right margin of the anterior sulcal plate (Figs 1H, 2K). During the plate dissociations, the plate 6'' often remained attached to the anterior sulcal plate (Fig. 1S-U).

There were six cingular plates, more or less of the same width and length. The sutures of the first and second cingular plates were immediately above the sutures of the first and second postcingular plates, respectively. The third cingular and a part of the fourth cingular plate are located above the third postcingular plate. The fifth cingular and most of the four cingular plates are located above the fourth postcingular plate. The sixth cingular plate was located above the fifth postcingular plate (Figs 1H-J, N-O, R; 2D-F, K).



**Figure 2** Scanning electron micrographs of *Centrodinium punctatum*. (A) Left-ventral view. (B) Left face. (C) Left view of the apex. (D-F) Different angles of the left face. (G) Right face. (H) Detail of the left-ventral area of the epitheca. (I) Detail of the left side of the apex. (J) Apical view of the epitheca. (K-L) Ventral view. (M) Left face showing the apex. (N-O) Apex. (P-S) Several views of an individual. (P) Left-ventral view. (Q) Ventral view. (R-S) Apex. 1'-4' = apical plates; 1''-6'' = precingular plates; 1'''-5''' = postcingular plates; 1''''-2'''' = antapical plates; C1-C6 = cingular plates; cp = closing cover platelet or canopy; mp = marginal pores surrounding the apical pore plate; Po = apical pore plate; Sa = anterior sulcal plate; sap = pore of the anterior sulcal; Sma = anterior median sulcal; Sp = posterior sulcal; Ssa = left (sinister) anterior lateral sulcal;

Ssp = left posterior lateral sulcal. Scale bars (A-G, J-M, P-Q) = 20  $\mu\text{m}$ , (H-I, N-O, R-S) = 2  $\mu\text{m}$ .

The sulcal plates are placed between of the anterior sulcal plate (S.a.) in the epitheca (Figs 1D, K, S-U, AE-AF; 2H, L) and the posterior sulcal plate (S.p.) near the antapex (Figs 1M, AE-AF; 2C). Two small plates known as the anterior and posterior median plates (S.m.a. and S.m.p.) - one above the other - occurred below the anterior sulcal and the left and right anterior lateral plates (S.s.a. and S.d.a.). Two lateral pairs of plates were located below, the left and right posterior lateral plates (S.s.p. and S.d.p.), with the left plate being longer than the right pair (Fig. 1AE-AF). These plates were hidden by the marginal list of the plates 1''' and 5''' (Fig. 2K).

The anterior sulcal plate (S.a.) indented the epitheca. The anterior edge, below with the first apical plate, was transversally straight. The anterior left edge was concave and articulated with the plate 1'', and the posterior left margin was straight and adjacent to the first cingular plate (Fig. 1Z). The right margin of the S.a. was slightly concave and articulate with the 6'' (Fig. 1D). There was a conspicuous pore (sap, pore of the sulcal anterior) near the middle of the right margin (Figs 1K; 2H, K-L, Q). The anterior sulcal and the two posterior lateral plates were ornamented with few poroids (Fig. 2C, H), while the other sulcal plates were smooth. The posterior edge of the S.a. showed an armhole or sinus with a round and reinforced contour, giving rise to two posterior extensions or branches. The left branch was wider and more developed posteriorly like a brunt apophysis that contacted with the anterior corner of the 1''', and above the left anterior lateral plate (S.s.a.). The sinus of the S.a. enclosed the anterior half of the anterior median sulcal plate (S.m.a.) (Fig. 2H). The right branch was less conspicuous, with a truncate oblique edge that contact with the pointed anterior edge of the anterior lateral plate (S.d.a.)

(Fig. 1AF-AE). The S.d.a. was irregularly triangular in shape, longer than wide, with concave left and right edges. The anterior edge was in contact to the plate 6'' and truncated the right posterior corner of the S.a., and the posterior edge was transversely straight and laid on the S.d.a. The left margin was reinforced and articulated with the two median plates, and the right margin with the sixth cingular plate (Fig. 1T, AE-AF). The left anterior lateral plate (S.s.a.) was smaller than the right one, triangular to ellipsoidal shape and located below the left posterior corner of the S.a. The anterior median plate (S.m.a.) was oval shaped and enclosed the posterior sinus of the S.a., and between the left and right anterior plates (Fig. 1AE-AF). The posterior median (S.m.p.) plate was located between the left and right anterior sulcal plates and below the anterior sulcal plate (Fig. 1Z, AE-AF). The two posterior lateral plates were longer than wide, and the length of the left pair (S.s.p.) was about one half the length of the right pair (S.d.p.) (Fig. 1V-W). The S.s.p. was narrow pentagonal and asymmetrical with a pointed posterior edge curved towards the right side. The S.d.p. is located in a more anterior posterior than the left pair, and its posterior development was truncated by the growth of the S.s.p. The right and left posterior margins of the S.s.p. laid on the second antapical (2''') and the posterior sulcal plate (S.p.), respectively (Fig. 1Z, AC-AF). The S.p. was not covered by the marginal lists of the first and fifth postcingular plates (Figs 1Z, AC-AE; 2K-L). The shape of the S.p. was an irregular pentagon with length approximately equal to the width (Figs 1M, AC-AE; 2C). The S.p. plate displaced towards the left side below the plates 1''' and 2''' and the left margin joining to the plate 1'''. The species *C. punctatum* do not form chains, and the presence of an attachment or connection pore or any special pore in the S.p. plate was not observed. An alternative interpretation of the tabulation is to consider this plate as a posterior intercalary plate, but this will imply that there is no posterior sulcal plate in this genus.

The first postcingular plate (1''') was more or less triangular, with a smooth list along the right margin that covered most of the sulcus (Fig. 1M, Z). The second postcingular (2''') plate occupied most of the left epitheca. The posterior margin, adjacent to the posterior sulcal and plate 1''', slanted up to the left (Figs 1G, Q, J; 2D-F). The third postcingular plate (3''') was triangular and the smallest of the postcingular series. The posterior margin was truncated and directed to the right, to join the plate 1'''' (Fig. 1N-O). The plate 4''' was large and quadrangular, with the posterior margin slanting up towards the left side, and joined to the plate 2'''. The juncture of the fourth and fifth cingular plates was placed near the middle of the anterior margin of the plate 4''' (Fig. 1O, R). The fifth postcingular plate (5''') was triangular, with a prominent list along the left margin (Figs 1H, L, P; 2G). When compared to the list of the plate 1''', the list of the plate 5''' did not reach the most anterior margin (Fig. 1L-M). There were two antapical plates with a triangular shape that conformed a pointed antapex directed towards the ventral side. The first antapical (1''') in the left face (Figs 1G, J, Q, Y; 2A-F) was slightly smaller than the second antapical plate (2''') in the right face (Figs 1P, R, X; 2G). The plate 1'''' was in contact to posterior sulcal plate and the second antapical plate (Figs 1X-AF, 2C).

### ***Centrodinium intermedium***

The short apical horn showed a blunt apex, and a posterior hypotheca with an antapical horn inclined towards the left side (Fig. 3A-C). Cells were 130-175  $\mu\text{m}$  long. The depth of the cells (dorso-ventral distance) was 55-80  $\mu\text{m}$ . The width between the left and right sides is difficult to measure in these highly laterally flattened cells, with values of about 25-35  $\mu\text{m}$  wide at the cingulum level (Fig. 4A-C). The cytoplasm of the Lugol's solution fixed cells was retracted as an ellipsoid with a short anterior and posterior process (Fig. 3A-C). The theca was thin, smooth and with faint sutures between the thecal plates (Fig.

4). The dense poroid ornamentation of the theca observed in *C. punctatum* was missing in *C. intermedium*, with only scattered pores, more abundant in the right face of the apical horn (Fig. 4H). The apical horn (~20  $\mu\text{m}$  long) of *C. intermedium* was a short truncated cone (Fig. 4I-K). The antapical horn was longer (>50  $\mu\text{m}$ ) and directed towards the left-ventral side. Consequently the antapical horn was in a different same plane than the main body and the apical horn (Fig. 3C). The antapical horn had triangular section with a slight anticlockwise torsion, and three terminal spinules. Each face of the antapical horn had a row of sunken areas with 3-4 small pores (Figs 3K-R, 4E-G).

It is commonly assumed that congeneric species share a similar plate formula. The epithecal plate formula of *C. punctatum* is Po, 4', 6'' or alternatively 3', 1a, 6'' in a strict Kofoidian scheme. The species *C. intermedium* has an additional plate in the left face of the epitheca, and the plate formula in a strict Kofoidian scheme is Po, 2', 2a, 7''. The first apical plate of *C. punctatum* reached the apical pore (insert 1'), while in *C. intermedium* it does not reach the apex (exsert 1').



**Figure 3** Light micrographs of *Centrodinium intermedium*. (A) Several individuals. (B) Left face. (C) Left-ventral view. Note the antapical horn oriented toward the left side. (D-H) Different views of an epitheca. (D) Left-ventral. (E) Left face. (F) Right face. (G) Inner view. (H) Left and right faces of the same epitheca. The inset shows the apex. (I-J) Right face of different individuals. (L) Left hypotheca. (M) Antapex. The inset shows the first antapical plate. (N) Second antapical plate (=antapical horn). (O-P) Antapex. (Q-S) Hypotheca of several individuals. The arrows point the pore of the posterior sulcal plate. (T) Right face. (U) Detail of the sulcal area of an individual. (V) Sulcal plates. (W) Several anterior sulcal plates. (X) Two right sulcal anterior plates. (Y) Left sulcal anterior

plate. (**Z**) Dissociated plates of the ventral area. (**AA-AC**) Sulcal plates. (**AD-AE**) Right and left sulcal posterior plates. 1'-4' = apical plates; 1''-6'' = precingular plates; 1'''-5''' = postcingular plates; 1''''-2'''' = antapical plates; C1-C6 = cingular plates; Po = apical pore plate; Sa = anterior sulcal plate; sap = pore of the anterior sulcal plate; Sda = right (dexter) anterior lateral sulcal; Sdp = right posterior lateral sulcal; Sma = anterior median sulcal; Smp = posterior median sulcal; Sp = posterior plate sulcal; Ssa = left (sinister) anterior lateral sulcal; Ssp = left posterior lateral sulcal plate. Scale bars = 20  $\mu$ m.

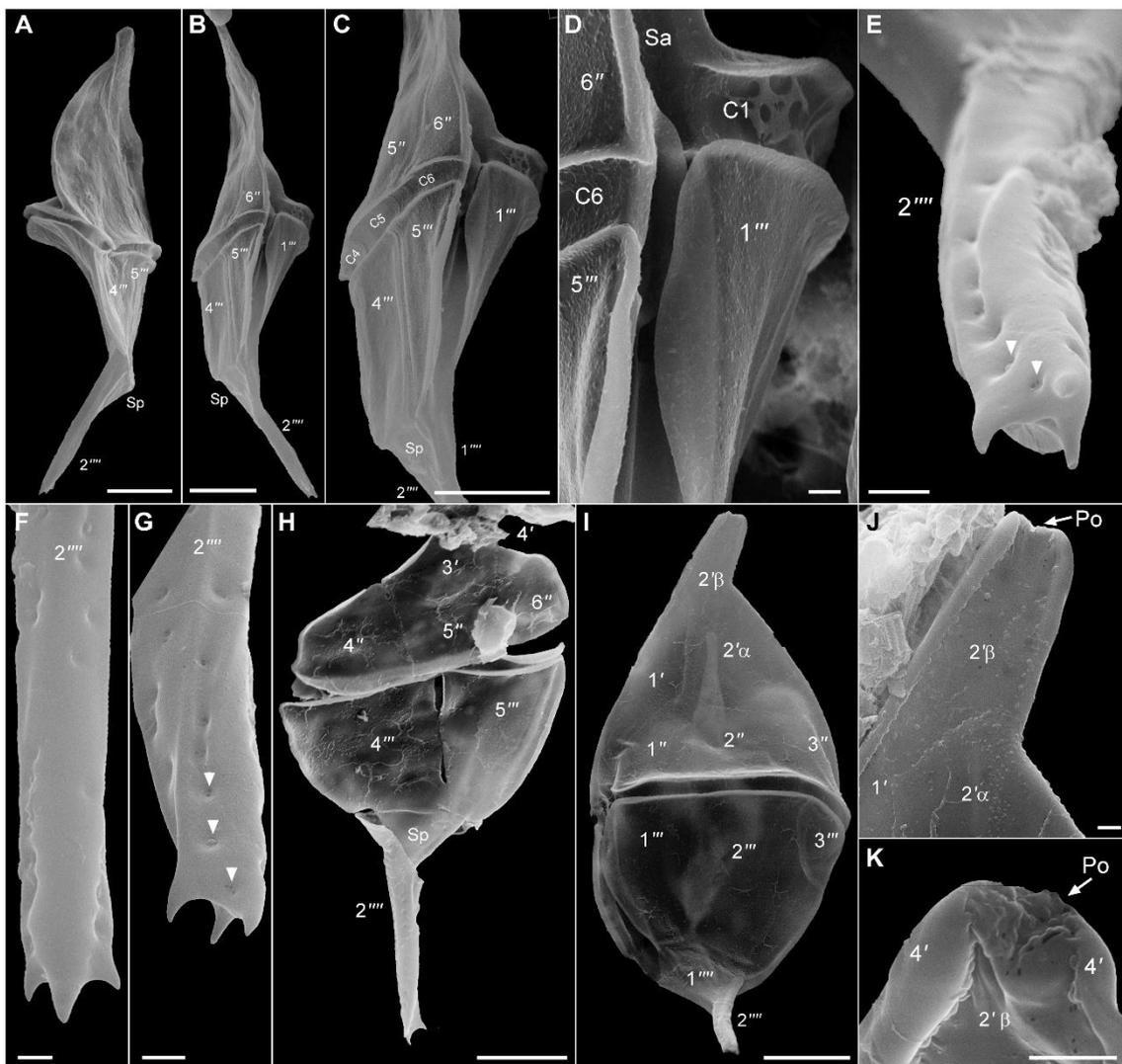
*Centrodinium punctatum* is used as a model to interpret the more derived plate arrangement of *C. intermedium*. These main modifications of *C. intermedium* were the elongation of the plates 4' and 2' (the latter split into two plates) to conform the apical horn, the different length of the posterior lateral sulcal plates, and the formation of a tubular antapical horn supported at its ventral basis by two triangular plates. The apical plates 2' and 4' of *C. intermedium* have extended anteriorly to conform the apical horn, and the development of these plates hindered that the plates 1' and 3' reached the apex. While the plate 4' was narrow and long, the elongation of the plate 2' have resulted in the split into two plates. The formula of the epitheca of *C. punctatum* and *C. intermedium* is similar, Po, 4', 6'', using the labelling 2' ( $\alpha+\beta$ ) to denote the split of the second apical plate in *C. intermedium*.

In the right face, the apical horn of *C. intermedium* was formed by the plate 4' that was coarse and ornamented with scattered poroids (Fig. 3D-F, H-K). The anterior margin of the plate 4' surrounded most of the apical pore plate and its margins were also visible in the left face. The plates 2' ( $\alpha+\beta$ ) were thin, smooth and extended anteriorly to form the left side of the apical horn (Fig. 4I-J). The right side of the epitheca was essentially similar to *C. punctatum*, where the fourth apical plate (4') has expanded anteriorly, and then the

third apical plate (3') was far from the apex (Fig. 3H-K). During the plate dissociations, the apical pore plate (Po) remain attached to the plate 2'β as circular structure of about 1 μm in diameter (Figs 3H). The tiny membranous Po platelet was poorly conserved in the SEM preparations (Fig. 4J-K). The very thin plate 2'β appeared crushed against the thick plate 4' (Fig. 4J-K). In contrast to *C. punctatum*, the apical plates of *C. intermedium* were larger than the precingular plates ones (Fig. 3D-K). In *C. punctatum*, the dorsal third precingular plate (3'') was in the left face and partially visible in the right face (Fig. 1I). As consequence of the high degree of lateral flattening, the plate 3'' of *C. intermedium* was only visible in the left face, with only the plates 4'', 5'' and 6'' occurring in the right epitheca (Fig. 3F-K).

In the hypotheca of *C. punctatum*, the third postcingular plate 3''' contacted with the two antapical plates (Fig. 1J, L). In contrast, the plate 3''' in *C. intermedium* was smaller, restricted to the right anterior corner of the hypotheca bordered by the plate 2''', without contact with the antapical plates (Figs 3L, 4I). The antapex of *C. punctatum* and *C. intermedium* showed important differences. The posterior hypotheca of *C. intermedium* was composed of three plates: a tubular plate that conforms the antapical horn and two plates in the ventral side that acted as a counterfort or backstay. These two triangular plates were slightly laterally inclined towards the left face, and the antapical horn was directed towards the left and ventral sides (Figs 3K-S, 4H-I). The most immediate interpretation was that the antapex consists on one antapical plate that conforms the horn, and two posterior intercalary plates that support the ventral basis of the antapical horn. This implies that the posterior sulcal plate (S.p.) was missing in *C. intermedium*. In *C. punctatum*, the S.p. was an irregular pentagon located in the left-ventral side below the plates 1''' and 2''' (Fig. 1M, AC-AF), while the S.p. of *C. intermedium* was triangular and located in the right face below the plates 4''' and 5''' (Figs

3K-M, P-T; 4H). There was a pore, the posterior attachment pore, located in this triangular plate in the right face (Fig. 3O-T), which is a characteristic of the posterior sulcal plate of numerous chain-forming gonyaulacoid dinoflagellates. In the left face, the first antapical (1''') was a triangular plate that often showed a posterior filiform extension (Fig. 3M). In the right face, the posterior sulcal plate (S.p.) was also a triangular plate with an attachment pore near the anterior margin (Fig. 3O-T). The plate 1''' showed a short pointed elevation in the middle of the anterior margin, while this elevation in the S.p. was more displaced towards the ventral side (Fig. 3M). The second antapical plate (2''') emerged from the dorsal side to conform a tubular antapical horn (Fig. 3N), with a slight anticlockwise torsion and three terminal spinules (Figs 3K-R, 4E-F).



**Figure 4** Scanning electron micrographs of *Centrodinium intermedium*. (A) Dorsal view. (B-C) Ventral view. (D) Detail of the ventral area. (E-G) Antapical horn. The arrowheads point the groups of pores. (H) Right face of dissociated thecal plates. (I) Left view. (J-K) Apex. 1'-4' = apical plates; 1'-6'' = precingular plates; 1'''-5''' = postcingular plates; 1''''-2'''' = antapical plates; C1-C6 = cingular plates; Po = apical pore plate; Sa = anterior sulcal; Sp = posterior sulcal plate. Scale bars (A-C, H-I) = 20  $\mu$ m, (D-G, J-K) = 2  $\mu$ m.

In the sulcal series, the anterior sulcal plate (S.a.) was part of the epitheca, enclosed between the plates 6'', 1' and 1'' and the first cingular plate (Fig. 3D). The shape was almost rectangular, with a straight anterior margin in contact with the plate 1' (Fig. 3T-U). There was a prominent pore in the middle of the plate connected to the right border by a narrow canal (Fig. 3U-W). The posterior margin was oblique towards the left side with a sinus with more anteriorly developed left corner. In some cells, the right posterior corner of the S.a. showed a membranous flange that connected with the first cingular plate (Fig. 3W). It is uncertain whether this extension of the S.a. plate could be interpreted as an accessory plate. The right anterior lateral sulcal plate (S.d.a.) was adjacent to the blunt corner in the right posterior margin of the S.a. The S.d.a. was larger than its left pair, with the shape of an irregular right triangle that resembled the shape of the Sicily Island (Fig. 3U-V, X, Z). The anterior margin of the S.d.a. was adjacent to the right posterior corner of the S.a. (Fig. 3U), and the right margin was reinforced and adjacent to the two median sulcal plates (Fig. 3X, Z). The posterior margin was shorter than the other margins and located above the right posterior lateral sulcal plate (S.d.p.). The left anterior lateral sulcal plate (S.s.a.) was small and more or less oval in shape. The acuter vertex of the anterior

margin of the S.s.a plate was located below the apophysis of the right posterior corner of the S.a. (Fig. 3Y). The shorter side of the S.s.a. plate laid above the left posterior lateral sulcal plate (S.s.p.). The other sulcal plates, except the posterior sulcal one, were covered by the sulcal lists of the first and fifth postcingular plates (Fig. 4C-D). There were two median plates enclosed between the right and left anterior lateral sulcal plates (Fig. 3U). The median anterior sulcal plate (S.m.a.) was more or less triangular and the anterior margin was enclosed in the sinus of the anterior sulcal plate (Fig. 3U), and laid above the oval-shaped median posterior sulcal plate (S.m.p.) (Fig. 3U, Z). The presence of other accessory plates was not detected, but the presence of these tiny platelets cannot be discarded. In *C. punctatum*, the left posterior lateral sulcal plate (S.d.p.) was longer than its right pair (Fig. 1V-W, AE-AF), while reversed in *C. intermedium* (Fig. 3AA-AE).

The S.d.p. of *C. intermedium* was the longest of the sulcal series and showed the shape of a knife, with a reinforcement in the left margin (Fig. 3AB-AE). During the plate dissociations, the right and left posterior lateral plates often remain fused (Fig. 3AC). The left posterior sulcal plate (S.s.p.) was smaller, like a very elongated pentagon that fit in the knife handle formed by the anterior left margin of the S.d.p. (Fig. 3AA, AC). The morphology of these plates suggests that the overlap growth of the S.d.p. has hindered the posterior development of the S.s.p. The posterior vertex of the S.d.p. contacted with the anterior ventral margins of two triangular plates: the posterior sulcal and the first antapical (Fig. 3K, Q, T).

### ***Centrodinium eminens***

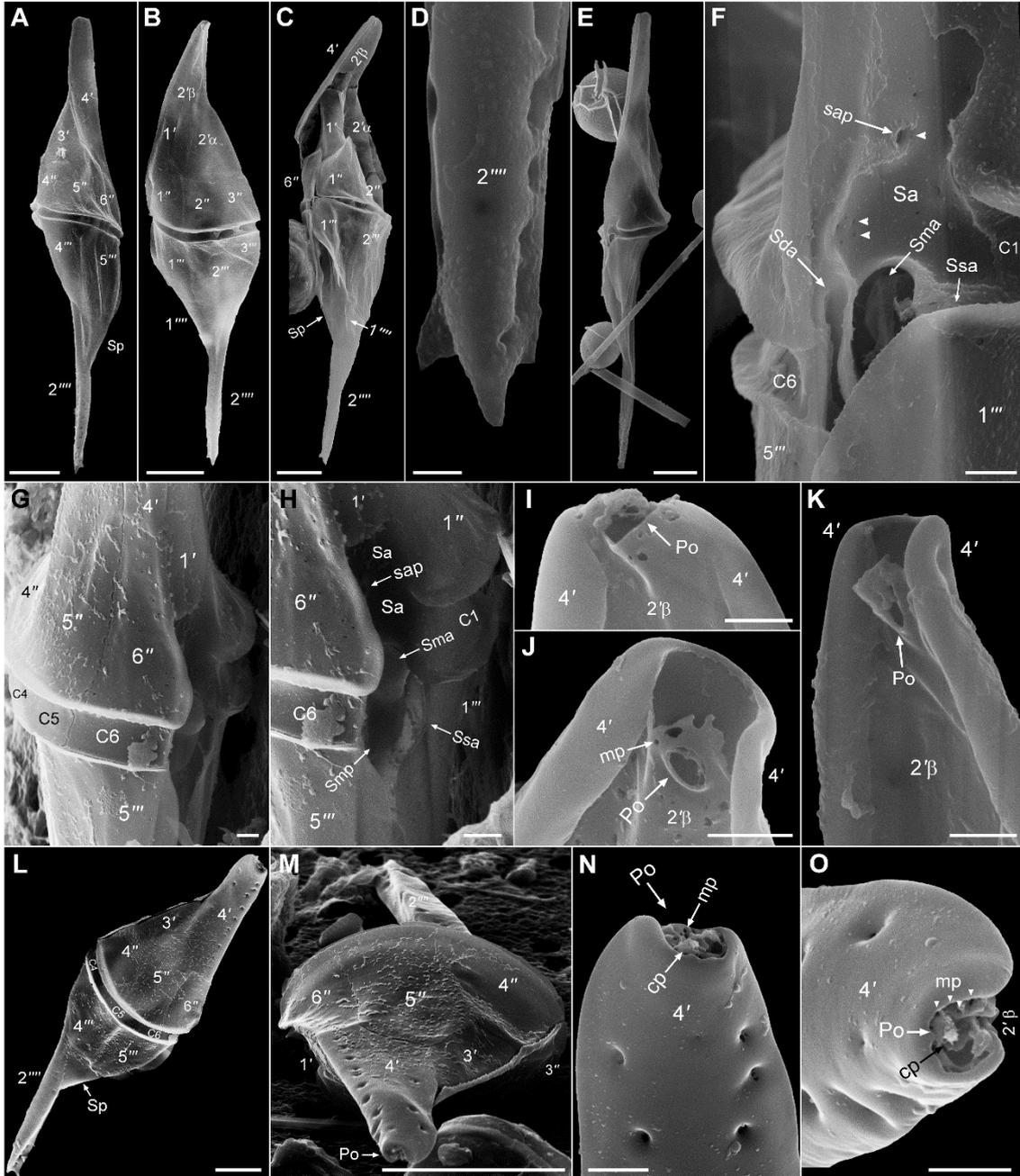
The plate arrangement of *C. eminens* and *C. intermedium* was similar, with more anterior-posteriorly elongated plates, especially in the apical series in *C. eminens* (Figs 5D-S; 6A-C, L). The distal antapical horn also showed three spinules (Figs 5X, 6D). The

sulcal series was fully similar (Fig. 5L-X). The triangular first antapical and the posterior sulcal plates showed filiform posterior extensions (Fig. 5W). The posterior sulcal plate showed a posterior attachment pore (Fig. 5W-X). In the SEM preparations, some individuals of *C. eminens* were in better stage than those of *C. intermedium*, and some details of the sulcal plates (Fig. 6E-H) and apex were revealed. The anterior sulcal plate showed clusters of small pores (Fig. 6F). The apex of *C. eminens* also collapsed in the SEM preparations but in some individuals the membranous apical pore plate and the thin second antapical were not crushed against the thicker four apical plate. In these cases, a large pore of 1-1.5  $\mu\text{m}$  in diameter was observed devoid of the cover plate (Fig. 6I-K). In few individuals, this membranous cover plate remained (Fig. 6L-O). The apical pore was surrounded by a few tiny pores (Fig. 6N), and a larger pore appeared in the right-dorsal side. It is uncertain whether this larger pore corresponded to the anterior attachment pore (aap) (Fig. 6J).



**Figure 5** Light micrographs of *Centrodinium eminens*. (A-C) Several individuals. (D) Left face. (E) Left-ventral view. (F) Plates of the apical horn. (G) Right face. (H-K) Several views of epithecae. (L-M) Ventral view. (N) Dissociated epitheca and hypotheca. (O-R) Several views of the same epitheca. (T) Dissociated sulcal plates. (U) Sulcal anterior plate. (V) Sulcal right posterior lateral plate. (W) First antapical and sulcal posterior plates. (X) Antapical horn (second antapical plate). 1'-4' = apical plates; 1'-6'' = precingular plates; 1'''-5''' = postcingular plates; 1''''-2'''' = antapical plates; C1-C6 = cingular plates; Sa = anterior sulcal plate; sap = pore of the anterior sulcal plate; Sda =

right (dexter) anterior lateral sulcal; Sdp = right posterior lateral sulcal; Sma = anterior median sulcal; Smp = posterior median sulcal; Sp = posterior sulcal; Ssa = left (sinister) anterior lateral sulcal; Ssp = left posterior lateral sulcal plate; Scale bar = 20  $\mu$ m.



**Figure 6** Scanning electron micrographs of *Centrodinium eminens*. (A) Right face. (B) Left face. (C) Left-ventral view of a partially dissociated theca. (D) Antapical horn. (E-F) Ventral view. (F) Detail of the ventral epitheca. The arrowheads point the pores in the

anterior sulcal plate. (G-H) Ventral view of the cingular-sulcal junction. (I-K) Apex of different individuals. (L-O) Several views of an individual. (L) Right face. (M) Right-apical view. (N-O) Apex. (O) The arrowheads point the marginal pores surrounding the apical pore plate. 1'-4' = apical plates; 1'-6'' = precingular plates; 1'''-5''' = postcingular plates; 1''''-2'''' = antapical plates; C1-C6 = cingular plates; cp = closing, cover platelet or canopy; mp = marginal pores surrounding the apical pore plate; Po = apical pore plate; Sa = anterior sulcal plate; sap = pore of the anterior sulcal plate; Sp = posterior sulcal plate. Scale bars (A-C, E, L) = 20  $\mu\text{m}$ , (D, F-K, M-O) = 2  $\mu\text{m}$ .