Cymatotheca , Tryblioptychus, Skeletonema and Cyclotella (Thalassiosirales) from Argentinian coastal waters. Description of Cyclotella cubiculata sp. nov.

E.A. Sar, I. Sunesen, A.S. Lavigne

CYMATOTHECA, *TRYBLIOPTYCHUS*, *SKELETONEMA* AND *CYCLOTELLA* (THALASSIOSIRALES) FROM ARGENTINIAN COASTAL WATERS. DESCRIPTION OF *CYCLOTELLA CUBICULATA* SP. NOV.

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FULTOPORTULOID DIATOMS
FINE MORPHOLOGY
DISTRIBUTION
ARGENTINA

ABSTRACT. – This study is devoted to analyze the fine structure of *Cymatotheca weissflogii*, *Tryblioptychus cocconeiformis*, *Skeletonema grethae, S. tropicum*, *Cyclotella atomus*, *C. choctawhatcheeana* and *C. litoralis* (Thalassiosirales). Net samples were collected from the surface layer of the water column at several coastal stations in Buenos Aires and Río Negro Provinces, Argentina. A new marine planktonic fultoportuloid diatom, *Cyclotella cubiculata* sp. nov., is described using light and scanning electron microscopy. This species resembles *Cyclotella litoralis* in general external aspect of the valve except for a minor difference in the position of the opening of the rimoportulae. Nevertheless, *Cyclotella cubiculata* clearly differs from *C. litoralis* by presenting marginal chambers easily visible with light microscopy and visible with scanning electron microscopy only in internal view. Comparisons between the new species and some allied brackish and marine species with marginal chambers as *Cyclotella striata* and *C. stylorum* are conducted. *Cyclotella atomus* and *C. choctawhatcheeana* are recorded for the first time from Argentinian coastal waters, *Cymatotheca weissflogii*, *Tryblioptychus cocconeiformis, Skeletonema tropicum* and *Cyclotella litoralis* are recorded for the first time from Argentina, and *Skeletonema grethae* is recorded for first time from the South Atlantic Ocean.

INTRODUCTION

Diatoms have been reported from marine coastal waters of Buenos Aires and Río Negro Provinces since the beginning of the twentieth century. The first comprehensive studies on the phytoplankton of the marine coastal waters of this area were made by Frenguelli (1928, 1930, 1938, 1939). Frenguelli's vast work, that includes 521 new taxa (see Sar *et al*. 2009), and his collections about fossil and extant diatoms have been of great value for further research.

Recent studies including ultrastructural analysis focused on members of the Order Thalassiosirales Glezer & Makarova in this area have been done by Lange *et al*. (1983), Gayoso (1988, 1989), Sar (1996), Sar *et al*. (2001, 2002), Sunesen & Sar (2004), and Sunesen *et al*. (2009). However, genera *Cymatotheca* Hendey, *Tryblioptychus* Hendey and *Cyclotella* (Kützing) Brébisson, which appeared in our sampling, have not been previously treated.

As far as we can determine the two former genera were poorly known until the recent study carried out by Tremarin *et al*. (2008) who analysed the fine structure of *Cymatotheca* in external view and by Prasad *et al*. (2002) who elucidated the fine structure, taxonomy, systematics and distribution of *Tryblioptychus* and compared it with other genera of the Thalassiosirales having radial, tangential, or both undulate valves.

Skeletonema Greville was recently reinvestigated by Zingone *et al*. (2005) and the description of the conserved generitype, *Skeletonema costatum* (Greville) Cleve, was emended by Zingone & Sarno in Zingone *et al*. (2005). Simultaneously, Sarno *et al*. (2005) conducted morphological investigations coupled with molecular analysis of several strains determined as *S. costatum* and described four new species. The mentioned papers and a subsequent one, Sarno *et al*. (2007), allow determination of striking features of the genus and understanding the specific limits. Based on this knowledge our determination of *Skeletonema costatum* (Sar *et al*. 2001) must be reconsidered.

Cyclotella is a large and complex genus primarily of freshwater that presents a few species from brackish and marine coastal waters (Prasad *et al*. 1990). Håkansson (2002) in her comprehensive revision of the genus pointed out that the knowledge of the latter group is very limited and there is uncertainty about the identity of small-sized species. Despite this opinion, several papers published by Lange & Syvertsen (1989), Prasad *et al*. (1990), Håkansson *et al*. (1993), Håkansson (1996), Håkansson & Clarke (1997), Håkansson (2002), and Prasad & Nienow (2006), allow the limits of this group to be clarified.

In the framework of a monitoring project of potentially toxic species, we have prepared a series of papers devoted to the diatom flora from Buenos Aires and Rio Negro coastal waters. The purpose of the present paper is to study the species of the genera *Cymatotheca*, *Tryblio*p-

tychus, *Skeletonema* and *Cyclotella* found in the area, to report novelties about their morphology and distribution, and to create a new species of *Cyclotella* providing comparison with allied taxa.

MATERIALS AND METHODS

The material analysed was collected in three areas (Fig. 1):

- at several locations along the northern coast of Buenos Aires Province: San Clemente del Tuyú, Santa Teresita, La Lucila del Mar, Mar de Ajó, Nueva Atlantis, Pinamar and Villa Gesell, from November 1994 to September 2000 and from March 2008 to May 2009;
- at several locations along the southern coast of Buenos Aires Province: Los Pocitos, Ría del Jabalí and San Blas, from May 2008 to May 2009 and;
- at several stations in the northern area of San Matías Gulf (Río Negro Province): Punta Orengo, Las Garzas, Banco Reparo, San Antonio Oeste, Los Álamos, Las Grutas, El Sótano and El Fuerte, from April 1998 to May 2000 and from March 2006 to April 2007.

In Buenos Aires Province, seawater temperature ranges from 8-24 °C and the salinity from 31-34.1 psu (unpublished data); and in the northern area of San Matías Gulf from 7-23.5 °C, with salinity ranging from 34-36 psu (Pascual *et al.* 2001). Qualitative samples were taken from the surface layer of the water column (between 0 and 5 m) with 30 μm net hauls and fixed with 4 % formalin. In the laboratory, the preserved samples were rinsed with distilled water to remove salt and preservatives, and then the organic matter was oxydized according to Hasle & Fryxell (1970) and Prygiel & Coste (2000). The cleaned material was mounted for light (LM) and scanning electron microscopy (SEM) according to Ferrario *et al.* (1995). Permanent mounts were made with Hyrax or Naphrax.

The materials were deposited in the Colección de Diatomeas Argentinas, Departamento Científico Ficología, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata under the numbers LPC 4250 to 4495, LPC 4550 to 4643, LPC 11001 to 11137, LPC 11601 to 11672, LPC 13648 to 13685.

Observations were made with microscopes under phase contrast Wild M20 and Nikon Microphot-FX. The microphotographs were obtained using Nikon Microphot-FX microscope and scanning electron microscopes Jeol JSMT 100 and Jeol JSM 6360 LV.

The terminology followed is that recommended by von Stosch (1975), Ross *et al.* (1979), Lange & Syvertsen (1989), Round *et al.* (1990), Theriot & Serieyssol (1994), Julius & Tanimura (2001) and Håkansson (2002). The classification scheme follows Round *et al.* (1990) due to the fact that it better reflects the phylogenetic reconstruction of the Thalassiosirales given by Kaczmarska *et al.* (2005) and Sims *et al.* (2006).

RESULTS

Family Thalassiosiraceae Lebour

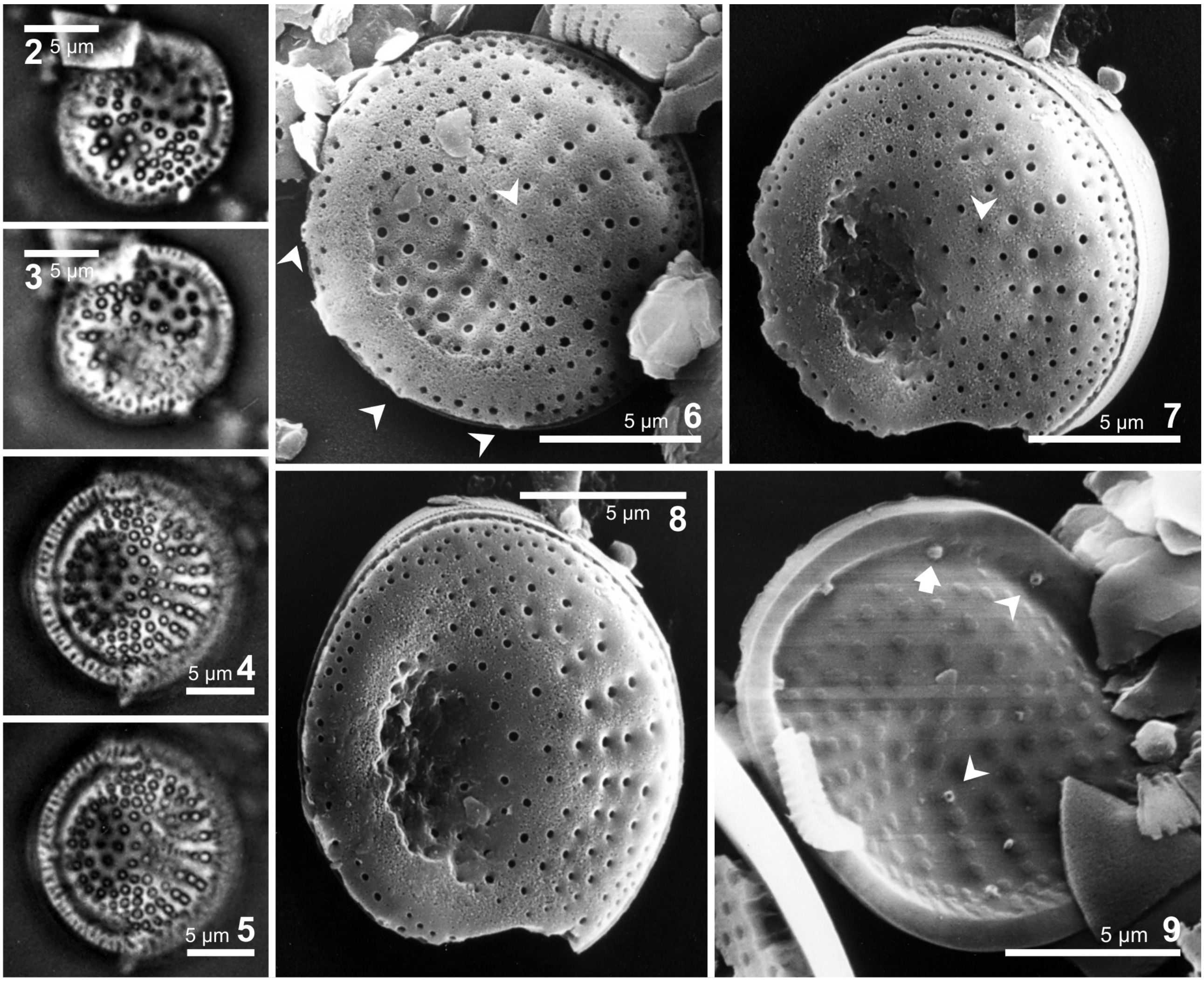
***Cymatotheca* Hendey**
***Cymatotheca weissflogii* (Grunow) Hendey, Figs 2-9**

Hendey 1958: 48, pl 5, Fig. 9; Tremarin *et al.* 2008: 1103, figs 3, 4, 60.

Basyonym: *Euodia weissflogii* Grunow in Van Heurck 1883, pl 126, Fig. 13.

Valves are circular or slightly elliptical in outline, 11-12 μm diameter in circular forms (Figs 2, 3), or 13.7-16.8 μm long and 11.6-15.2 μm wide in elliptical forms (Figs 4, 5). The valve is tangentially undulate (Figs 2-9). The raised sector presents a deeper mantle and the

Fig. 1. – Map of Buenos Aires and Río Negro Provinces, showing sampling stations and location of the area in Argentina. 1: San Clemente del Tuyú, 2: Santa Teresita, 3: Mar del Tuyú, 4: La Lucila del Mar; 5: Mar de Ajó, 6: Nueva Atlantis, 7: Pinamar, 8: Villa Gesell, 9: Mar Azul, 10: Los Pocitos, 11: Ría del Jabalí, 12: San Blas, 13: Punta Orengo, 14: Las Garzas, 15: San Antonio Oeste, 16: Banco Reparo, 17: Los Alamos, 18: Las Grutas, 19: Piedras Coloradas, 20: El Sótano, 21: El Fuerte.



Figs 2-9. – *Cymatotheca weissflogii*. Figs 2-5, LM. Figs 6-9, SEM. Figs 2, 3, Same circular valve at different focuses. Figs 4, 5, Same elliptical valve at different focuses. Figs 6-8, External view. Fig. 6, Valve showing subcentral and marginal fultoportulae (arrowheads). Fig. 7, Tilted frustule showing valve with subcentral fultoportula (arrowhead) and girdle. Fig. 8, Tilted valve showing hyaline area free of areolation and shallow valve mantle. Fig. 9, Valve in internal view showing marginal ring of fultoportulae, subcentral fultoportula (arrowheads) and sessile rimoportula (arrow).

depressed sector is associated to a hyaline area free of areolation and presents a shallower mantle (Figs 6-8). The striae are spaced with wider interstriae in the raised sector of the valve surface, 5-8 in 10 μm, and denser with narrower interstriae in the depressed sector, 10-12 in 10 μm (Figs 6, 7). The areolae are smaller on the valve mantle than on the valve surface and form striae more densely arranged, 18-24 in 10 μm (Figs 6, 7). Areolae, 1.0-1.5 in 1 μm, are loculate with external foramen and internal slightly domed-shaped cribra (Figs 6-9). The fultoportulae form a marginal ring placed on the valve mantle, 3-4 in 10 μm (Figs 6, 9 arrowheads). A single valve face fultoportula with no outwards extension lies at the raised area off the valve centre (Figs 6-9 arrowheads). The marginal fultoportulae present a short tube surrounded by three operculate satellite pores internally, with no outwards extensions. There is a single rimoportula, internally sessile and tangentially oriented, located next to the depressed area (Fig. 9 arrow) and included in the marginal ring of fultoportulae in front of the valve face fultoportula, with no outwards extensions. External opening of the portulae is conspicuous in the depressed sector of the valve and inconspicuous in the raised sector (Figs 6-8).

Distribution in Argentina: *Cymatotheca weissflogii* mentioned by Simonsen (1974) as "a tropical benthic species, allochthonous in the plankton sample" was found during the present study in plankton net samples from San Clemente del Tuyú, Santa Teresita, La Lucila del Mar, Mar de Ajó and Villa Gesell, rare all year round. This species is recorded for the first time from Argentinian coastal waters.

Photographed material: LPC 4297 11/03/1996, LPC 4338 01/08/1998, LPC 4449 08/29/2000, San Clemente del Tuyú; LPC 4375 01/13/1999, Santa Teresita; LPC 4393 11/10/1999, La Lucila del Mar.

Remarks: Simonsen (1987) pointed out that *Euodia* Bailey ex Ralfs in Pritchard (1861), a genus in which the analysed species was created by Grunow in Van Heurck (1883, pl 126, Fig. 13) as *E. weissflogii*, is a later synonym of *Hemidiscus* Wallich and a later homonym of *Euodia* J. R. Forster & G. Forster (Rutaceae). Hendey (1958) created the genus *Cymatotheca* and transferred Grunow's species as *Cymatotheca weissflogii*. Subsequently, Woodhead & Tweed (1960: 248) pointed out that the transfer of *E. weissflogii* Grunow to the genus *Cymatotheca* Hendey (1958) "seems preferable to merging the West African material under *Hemidiscus* Wallich" as proposed by Hustedt (1955). The taxonomic position of the genus *Cymatotheca* Hendey was controversial. Simonsen (1974) firstly placed it in the family Coscinodiscaceae Kützing but Simonsen (1979) assigned it to the family Thalassiosiraceae Lebour emend. Hasle (1973a). The genus was not included by Round *et al*. (1990) in their classification scheme, but it was rightly included by Nikolaev *et al*. (2001) within the Order Thalassiosirales, Family Thalassiosiraceae.

***Tryblioptychus* Hendey**
***Tryblioptychus cocconeiformis* (Grunow ex Cleve) Hendey, Figs 10-13**

Hendey 1958: 46, pl 2, Fig. 10; Prasad *et al*. 2002: 291, Figs 1-44; Tremarin *et al*. 2008: 1108, Fig. 41.

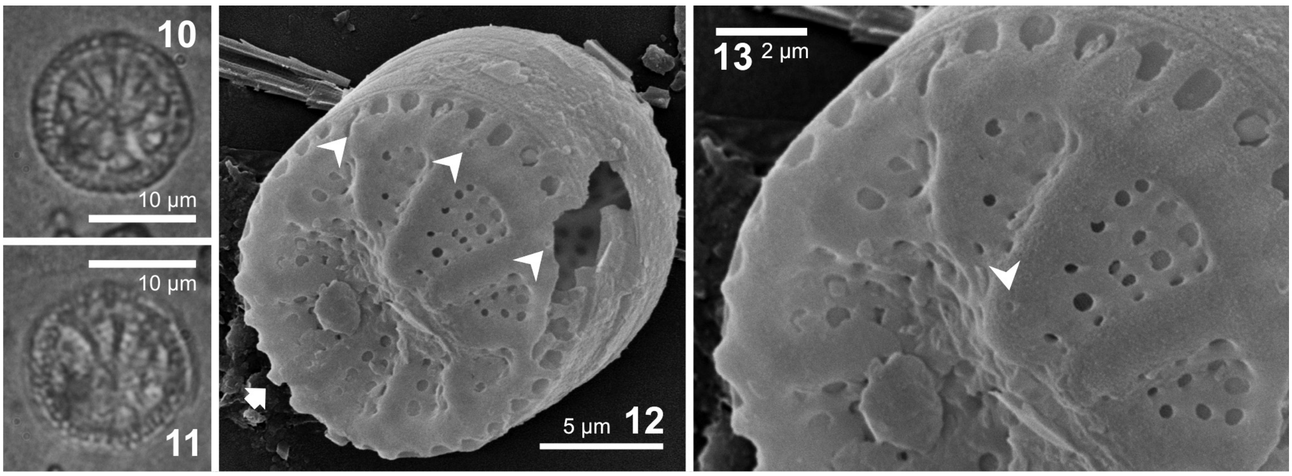
Basyonym: *Campylodiscus* (?) *cocconeiformis* Grunow ex Cleve 1883, pl 38, Fig. 78.

Frustules are drum-shaped, 5.4-7.0 μm in height (Fig. 12). Valves are circular in outline, 12.5-17.0 μm in diameter, tangentially undulate with a raised and a depressed sector (Figs 10-13). Valve surface is radially undulated with areas slightly depressed occupied by fascicles of 2-4 striae and areas slightly raised, hyaline, the inter-fascicles, 2.8 in 10 μm. Junction between valve surface and valve mantle is surrounded by a hyaline area free of areolation. Valve mantle abruptly sloped, deep, with a ring of larger areolae, 8.5 in 10 μm (Figs 12, 13). Areolae are loculate with external foramen and internal cribra. A single valve face fultoportula, with no outwards extensions, lies at the raised area off the valve centre on the central inter-fascicle (Fig. 13 arrowhead). Marginal fultoportulae with no outwards extensions are placed on the inter-fascicles and form a ring at the junction of the valve face/mantle (Fig. 12 arrowheads). A single rimoportula with external tube is located in the hyaline ring of the fascicle contiguous to the central inter-fascicle, in the depressed part of the valve, in front of the subcentral fultoportula (Fig. 12 arrow).

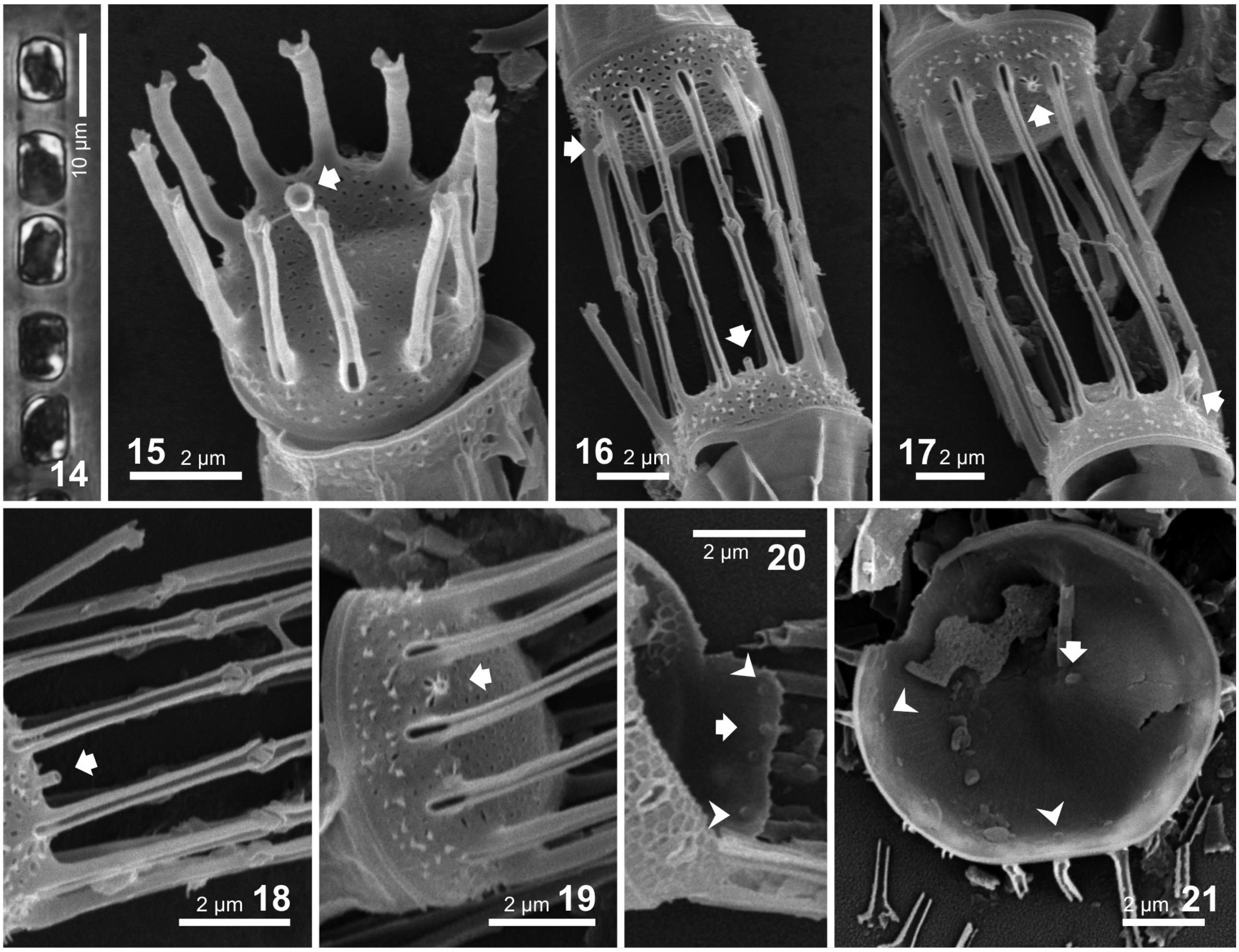
Distribution in Argentina: *Tryblioptychus cocconeiformis*, mentioned by Prasad *et al*. (2002) as "distributed in bays, estuaries and other shallow coastal waters environments between 15º S and 35º N" was found during the present study only in plankton net samples from Ría del Jabalí (40º32' S-62º19' W), rare in spring. This species was previously registered by Ferrario *et al*. (2006) from the Argentinian coastal waters and it is formally recorded for the first time from Argentinian coastal waters in this study.

Photographed material: LPC 11620, 09/29/2008, Ría del Jabalí.

Remarks: Cleve (1883) created a new taxon under the name *Campylodiscus* (?) *cocconeiformis* with doubts about the genus and Hendey (1958) transferred it to the genus *Tryblioptychus* Hendey as *Tryblioptychus cocconeiformis* (Grunow ex Cleve) Hendey. A comprehensive analysis of the morphology, distribution, taxonomic relationships and systematic position of the species was made by Prasad *et al*. (2002). Simonsen (1979) assigned the genus *Tryblioptychus* Hendey to the family Thalas-



Figs 10-13. – *Tryblioptychus cocconeiformis*. Figs 10, 11, LM. Figs 12, 13, SEM. Fig. 10, Valve showing radial undulation. Fig. 11, Same valve as in Fig. 10 at different focus showing tangential undulation. Fig. 12, Tilted frustule showing marginal fultoportulae (arrowheads) and broken rimoportula (arrow). Fig. 13, Detail of Fig. 12 showing the subcentral fultoportula (arrowhead).



Figs 14-21. – *Skeletonema grethae*. Fig. 14, LM. Figs 15-21, SEM. Fig. 14, Colony. Cells with one chloroplast. Fig. 15, Terminal valve showing a ring of fultoportulae with open tubes and subcentral rimoportula (arrow). Figs 16, 17, Sibling valves with intercalary fultoportulae joined in 1:1 type. Note the rimoportulae (arrows). Fig. 18, Detail of the 1:1, knuckle-like junction of the intercalary fultoportulae. Arrow shows rimoportula. Fig. 19, Valve mantle with spinulae. Fig. 20, Broken valve showing internal view of marginal rimoportula (arrow) and fultoportulae (arrowheads). Fig. 21, Terminal valve in internal view showing rimoportula (arrow) adjacent to the central annulus and marginal ring of fultoportulae (arrowheads).

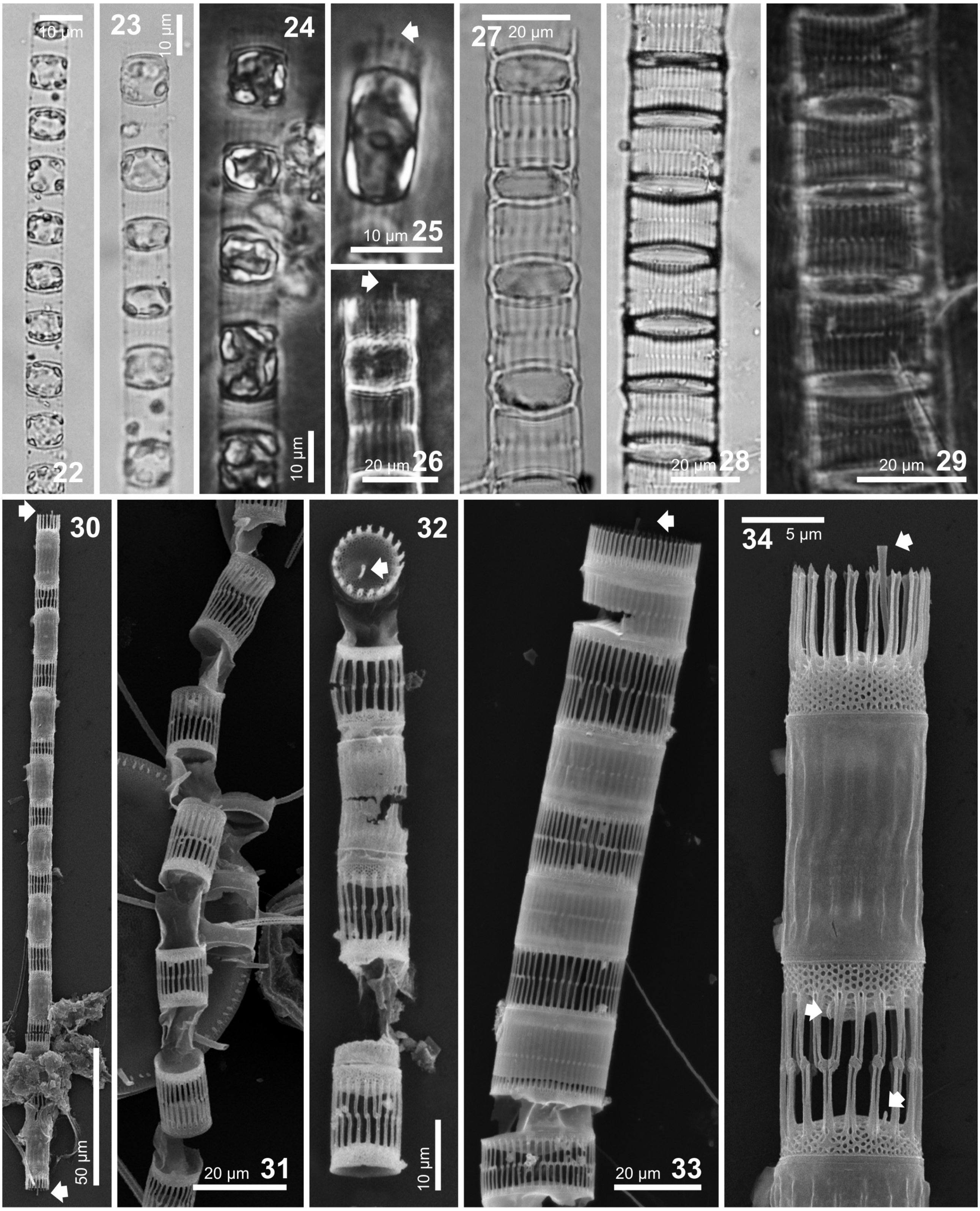
siosiraceae Lebour emend. Hasle (1973a), criterion subsequently followed by Prasad *et al.* (2002). Round *et al.* (1990) and Nikolaev *et al.* (2001) did not include *Tryblioptychus* in their classification schemes.

Family Skeletonemataceae Lebour emend. Round

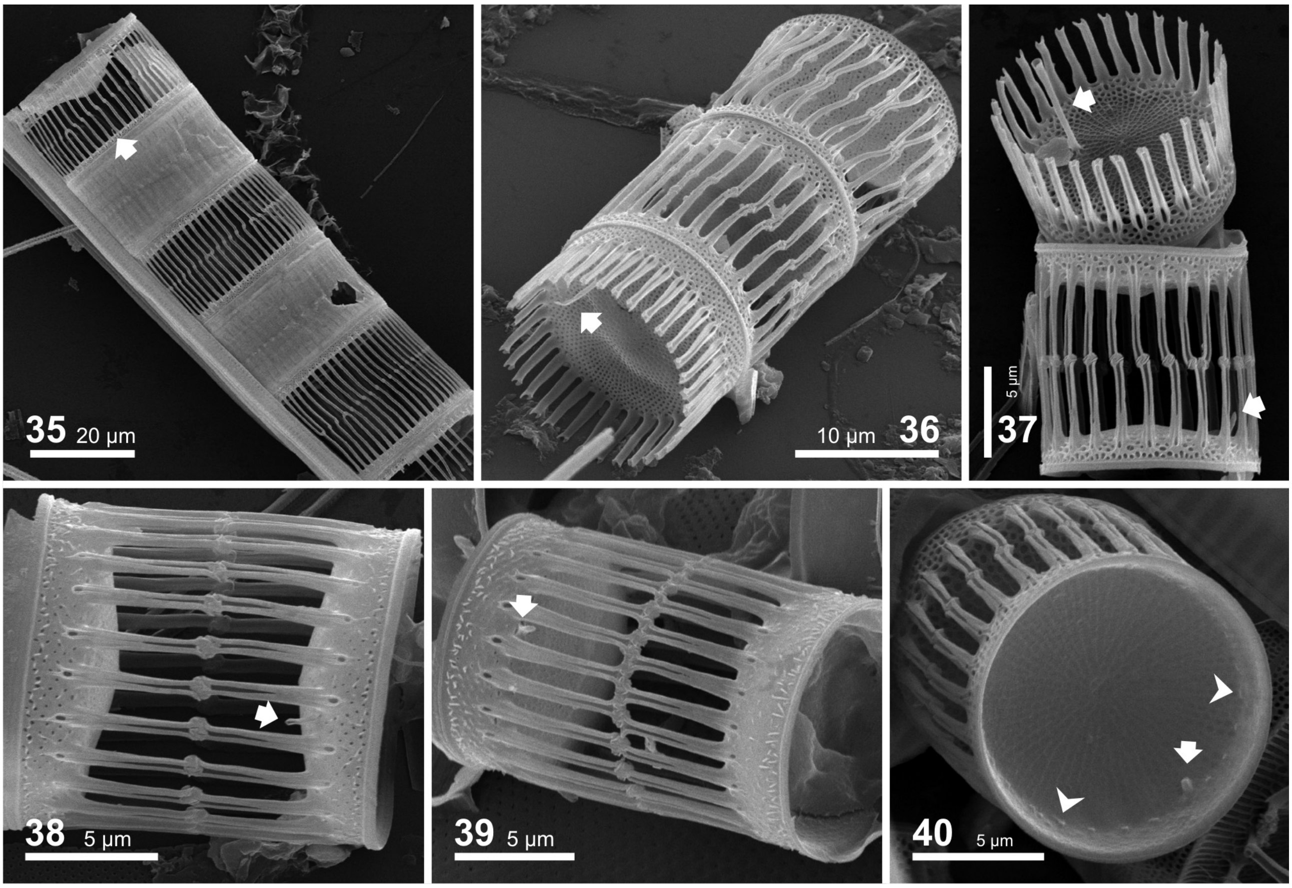
***Skeletonema* Greville emend. Sarno & Zingone**
***Skeletonema grethae* Zingone & Sarno, Figs 14-21**

Sarno *et al.* 2005: 156, Fig. 3, A-I.

Cells with one or two parietal chloroplasts, forming short and straight chains (Fig. 14). The valves are circular in outline, 3.2 to 8.8 μm in diameter. The valve surface is flat or slightly convex, and the valve mantle slightly oblique (Figs 15-17, 19). Areolae pseudoloculate, 35 to 39 in 10 μm, radiating from the central annulus with external openings (Fig. 21). Spinulae sometimes present on the valve mantle (Figs 15-19). Valves with a ring of fultoportulae placed on the junction of the valve surface/mantle (Figs 15-17, 19, 21). The intercalary fultoportulae present long and narrow tubes, open along their length, 8 to 11 in 10 μm, generally aligned and joined in 1:1 type to those of the sibling valve, with interlocking like a knuckle (Figs 16-18), and very short tubes internally (Figs 20-21 arrowheads). Fultoportulae are 4.5 to 7.0 μm in length, and 0.4 to 0.5 μm in width. The terminal fultoportulae present long, open tubes, and distal ends truncated with irregular margins (Fig. 15). Single rimoportula per valve. The intercalary rimoportula is located in the marginal area of the valve surface, near the ring of fultoportulae, with external tube short and cylindrical, and sessile internal lip obliquely placed (Figs 16-20 arrows). Terminal rimoportula adjacent to the central annulus, with external tube flared towards the apical opening, as long as or longer than the external tubes of the fultoportulae, internally sessile (Figs 15, 21 arrows).



Figs 22-34. – *Skeletonema tropicum*. Figs 22-29, LM. Figs 30-34, SEM. Figs 22-24, Colonies with several chloroplasts in each cell. Figs 25, 26, Terminal cells with long rimoportula (arrows). Figs 27-29, Details of the junction of the intercalary fultoportulae of the sibling cells. Note junctions 1:1 and 1:2 in the same colony in Figs 28 and 29. Fig. 30, Complete colony with a long rimoportula on each terminal valve (arrows). Fig. 31, Colony with intercalary fultoportulae straight or slightly curved and with junction 1:1 and 1:2. Fig. 32, Colony with terminal cell in valve view showing rimoportula half-way between central annulus and marginal ring of fultoportulae (arrow). Fig. 33, Wide colony with terminal cell showing the rimoportula (arrow). Note variability in intercalary fultoportulae junctions. Fig. 34, Terminal part of the colony of Fig. 30, note terminal and intercalary rimoportulae (arrows).



Figs 35-40. – *Skeletonema tropicum*. SEM. Fig. 35, Fragment of a wide colony showing intercalary rimoportula (arrow). Figs 36, 37, Tilted fragments of colonies showing terminal valves with rimoportula (arrows) and marginal ring of fultoportulae. Figs 38, 39, Sibling valves showing intercalary rimoportulae (arrows) and different kinds of junction. Fig. 40, Intercalary valve in internal view showing the sessile rimoportula (arrow) placed in the marginal ring of fultoportulae (arrowheads).

Distribution in Argentina: *Skeletonema grethae*, mentioned by Kooistra *et al*. (2008) as "a warm water species" was found during the present study in plankton net samples from San Clemente del Tuyú, Mar Azul, Los Pocitos and Ría del Jabalí, very rare in autumn and spring. This species is recorded for the first time from South Atlantic marine coastal waters in this study; previously Kooistra *et al*. (2008) pointed out that it was only found in US waters, thus the present report extends its geographical range.

Photographed material: LPC 11124, 04/08/2009, San Clemente del Tuyú; LPC 11619, 09/29/2008, Los Pocitos; LPC 11620, 09/29/2008, Ría del Jabalí.

Remarks: Recently, *Skeletonema grethae* was created based on the analysis of the morphology of several strains from the North Atlantic Ocean labelled as *Skeletonema costatum* (Greville) Cleve (Sarno *et al*. 2005). Our material of *S. grethae* showed some morphometric differences from the forms described by Sarno *et al*. (2005) in the length of the external tubes of the intercalary fultoportulae (4.5 to 7.1 µm in the former, 2.0 to 4.5 µm in the latter), in the distance between fultoportula (0.6 to 1.3 µm in the former, 0.2 to 1.0 µm in the latter), in the length of the external tube of the terminal rimoportulae (5.5 to 6.5 µm in the former, 1.8 to 3.6 µm in the latter) and in cell number per colony (few in the former and many in latter). These differences could be explained because we only examined sampled material, while the mentioned authors only examined cultured material.

Skeletonema tropicum **Cleve, Figs 22-40**

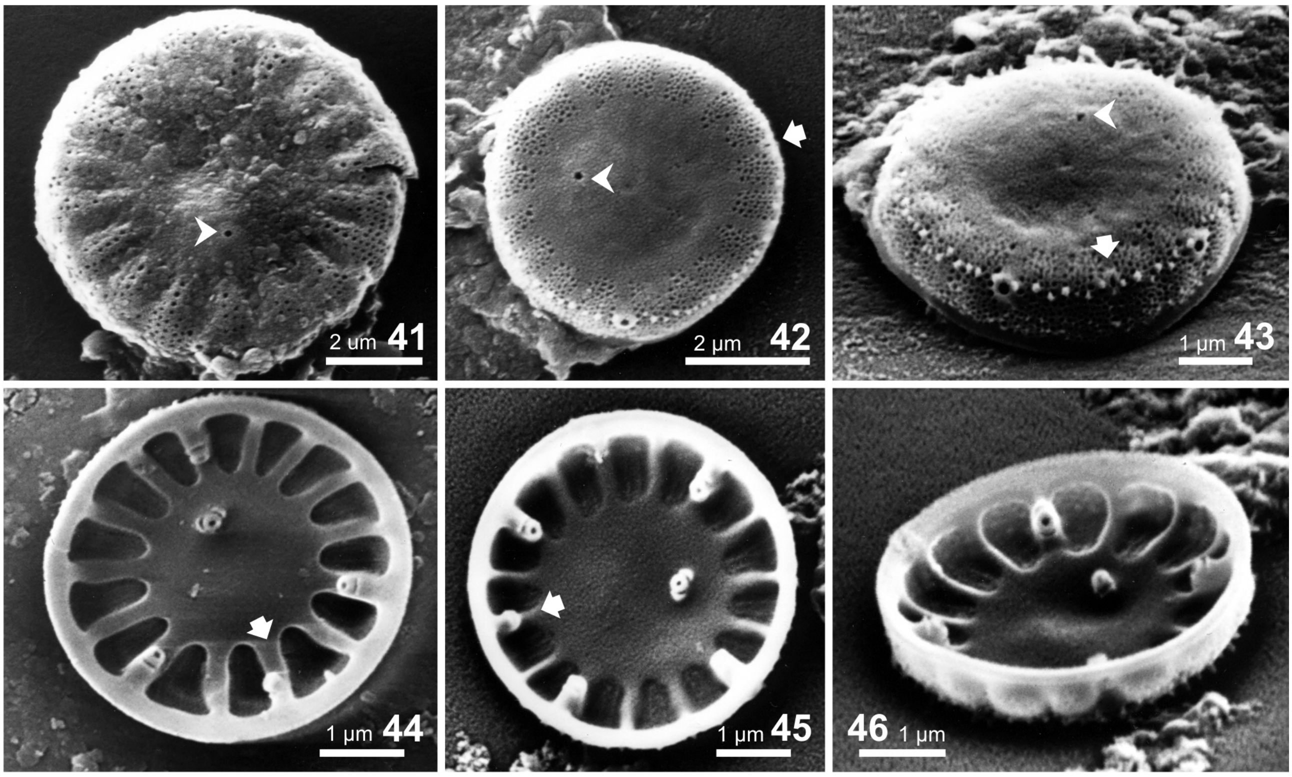
Cleve 1900, pl. 7, Figs 30, 31; Sarno *et al*. 2005: 166, Fig. 9 A-F; Sar *et al*. 2001: 221, Figs 73, 75, 76 (as *Skeletonema costatum*).

Cells with several parietal chloroplasts (Figs 22-25), forming long and straight chains (Figs 22-24, 27-33). The valves are circular in outline, 8.5 to 28.0 (32.0) µm in diameter. The valve surface is slightly convex, and the valve mantle is vertical, varying from shallow to deep (Figs 33, 34). Areolae pseudoloculate, 22 to 30 in 10 µm, radiating from the central annulus with external openings generally regular in size and ordered in rows in the valve mantle (Figs 34, 36, 40). Sometimes in the same colony a sibling cell presents areola openings disordered and spinulae scattered on the valve mantle (Figs 38, 39). Valves with a ring of fultoportulae, placed on the junction of the valve surface and valve mantle, 0.6 to 1.3 μm apart. The intercalary fultoportulae present long tubes, 5 to 9 in 10 μm, straight or slightly curved, open along their length, commonly aligned and joined in 1:1 type to those of the sibling valve (Figs 31, 35-39). Sometimes in the same colony a sibling cell presents fultoportulae with junction 1:2 type (Figs 28, 29, 33, 39). Interlockings among intercalary fultoportulae are like knuckles (Figs 38, 39). The terminal fultoportulae present long, open tubes and distal ends truncated with stout spines (Figs 34, 36, 37). Single rimoportula per valve. The intercalary rimoportula is located in the marginal area of the valve surface, near the ring of fultoportulae, with external tube slightly flattened and sometimes split at the end, and sessile internal lip obliquely arranged (Figs 34, 35, 37-40 arrows). Terminal rimoportula placed half-way between the central annulus and the ring of fultoportulae, with external tube flared towards the apical opening as a trumpet, as long as or longer than the external tubes of the fultoportulae (Figs 25, 26, 30, 32-34, 36, 37 arrows).

Distribution in Argentina: *Skeletonema tropicum*, considered by Kooistra *et al.* (2008) as a warm water to temperate species which appears where winter seawater surface temperatures are as low as 12-14 °C, was found during the present study in plankton net samples from San Clemente del Tuyú, Santa Teresita, La Lucila del Mar, Mar de Ajó, Nueva Atlantis, Pinamar and Villa Gesell, common all year round, with occasional blooms in spring and fall, and from Punta Orengo, San Antonio Oeste, Banco Reparo, Las Grutas and Piedras Coloradas, rare all year round.

Photographed material: LPC 11124, 04/08/2009, San Clemente del Tuyú. We chose microphotographs from the mentioned sample, where the species was very abundant (5.38 10^5 cell·l^{-1}), because they are better than all the others obtained.

Remarks: Our material of *Skeletonema tropicum* showed some differences with the material analysed by Sarno *et al.* (2005) in the cell diameter (8.5 to 28.0 [32.0] μm in the former, 5.3 to 10.0 μm in the latter), in the length of the external tubes of the intercalary and terminal fultoportulae (4.5 to 6.1 and 5.7 to 6.1 μm in the former, 1.2 to 4.1 and 2.1 to 3.5 μm in the latter respectively), in the width of external tubes of the intercalary and terminal fultoportulae (0.4 to 0.7 and 0.5 to 0.6 μm in the former, 0.1 to 0.5 and 0.2 to 0.6 μm in the latter respectively), in the length of the external tube of the terminal rimoportula (4 to 7 μm in the former, 2.8 to 5.3 μm in the latter). These differences could be explained because we only examined sampled material while mentioned authors only examined cultured material.



Figs 41-46. – *Cyclotella atomus*. SEM. Figs 41-43, External view. Figs 44-46, Internal view. Fig. 41, Valve showing fultoportula (arrowhead) in the raised sector of the tangential undulation. Fig. 42, Valve showing central fultoportula (arrowhead) and marginal rimoportula (arrow). Fig. 43, Same valve of Fig. 42 tilted. Note the rimmed pores of the marginal fultoportulae, the rimoportula (arrow) and central fultoportula (arrowhead). Figs 44, 45, Valves showing central and marginal fultoportulae with two satellite pores and single rimoportula (arrows). Fig. 46, Same valve of Fig. 45 showing detail of marginal fultoportulae.

Family Stephanodiscaceae Glezer & Makarova

***Cyclotella* (Kützing) Brébisson**
***Cyclotella atomus* Hustedt, Figs 41-46**

Genkal & Kiss 1993: 39, Figs 1-9; Håkansson & Clarke 1997: 207, Figs 1-16, 18-21; Håkansson 2002: 106, Figs 381-388.

Cells solitary. Valves circular in outline, 4.3 to 7.4 μm in diameter, externally divided in two concentric zones, a central field and a marginal area (Figs 41, 42). The central field is tangentially undulate to almost flat, internally and externally smooth, occupying about two thirds to half of the valve surface (Figs 43, 44-46). The marginal area presents raised striae and depressed interstriae extending to the edge of the valve mantle (Figs 41, 43). The striae, 8 to 14 in 10 μm, are formed by several rows of minute areolae, internally dug out in the vicinity of the central field (Figs 41-46). A marginal ring of fultoportulae is placed in the mantle just below the valve face/valve mantle junction (Fig. 43). Fultoportulae are arranged on every third to fifth interstria, opening outwards by a rimed pore and internally by a tube surrounded by two radial satellite pores (Figs 43-46). A single rimoportula is located on an interstria, between two fultoportulae, slightly above of the fultoportulae ring, in front of the raised central field. Externally the rimoportula opens by an elliptical pore with slightly thickened rim, smaller than fultoportula pores, and internally by a lip tangentially oriented (Figs 42-45 arrows). A ring of spinulae in the valve face/valve mantle junction is present in some specimens (Fig. 43). There is one fultoportula on the raised sector of the central field, externally opened by a pore (Figs 41-43 arrowheads) and internally by a short tube surrounded by two satellite pores (Figs 44, 45).

Distribution in Argentina: *Cyclotella atomus*, mentioned by Håkansson & Clarke (1997) as "a cosmopolitan, fresh- to brackish water species" was found during the present study in plankton net samples from San Clemente de Tuyú, La Lucila del Mar and Pinamar, very rare all year round. This species was previously reported from Argentinian continental waters (see Vouilloud 2003) and it is recorded for the first time from the marine coastal waters of Argentina in this study.

Photographed material: LPC 4304, 08/01/1997, La Lucila del Mar; LPC 4361, 07/31/1998, LPC 4390, 11/10/1999, San Clemente del Tuyú; LPC 4428, 04/27/2000, Pinamar.

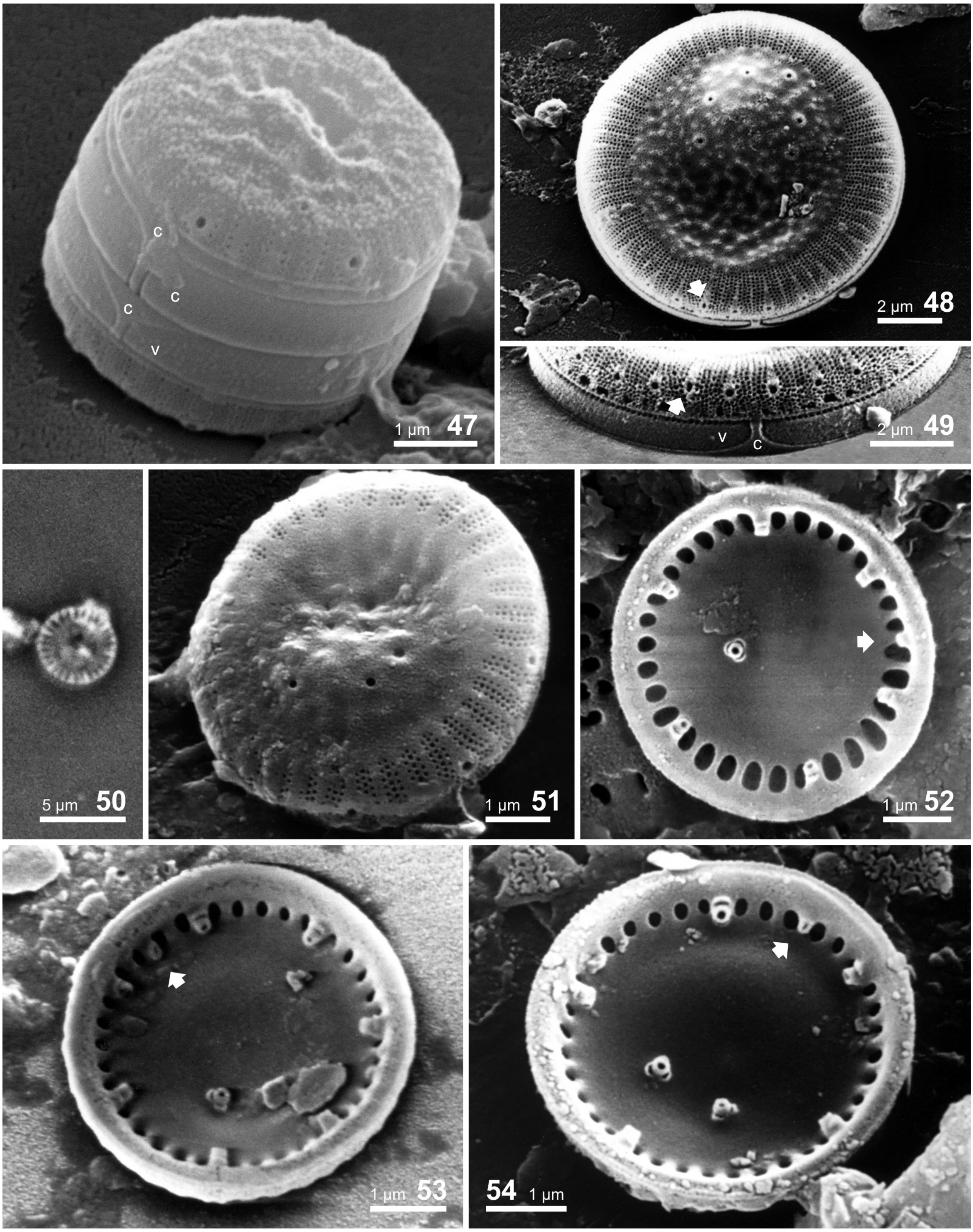
Remarks: Our specimens present central fultoportula with two satellite pores and resemble some shown by Hasle (1962), Sabater & Klee (1990), Håkansson & Clarke (1997), Håkansson (2002) in external and internal general aspect, morphology of marginal fultoportulae, internally with two satellite pores and externally with a rimmed pore, and arrangement of the rimoportula. However, the material from Argentinian coastal waters differs by the stria density, 9-14 striae in 10 μm, lower than reported in the literature for the species.

***Cyclotella choctawhatcheeana* Prasad, Figs 47-54**

Prasad *et al*. 1990: 419, Figs 2-26; Wendker 1991: 359, Figs 1-7, Håkansson *et al*. 1993: 337, Figs 1-10; Prasad & Nienow 2006: 133, Figs 47-55; Melo *et al*. 2006: 295, Figs 2-7.

Cells solitary. Frustules are drum-shaped, in girdle view (Fig. 47). Valves are circular in outline, 4.5-10 μm in diameter, externally divided in two concentric zones, a central field and a marginal area (Figs 48, 51). The central field is tangentially undulate having variable elevation, externally colliculate or slightly colliculate and internally smooth, occupying about two thirds of the valve surface (Figs 47, 48, 51, 54). The marginal area restricted to about a third of the valve surface, presents radial striae and interstriae extending to the edge of the valve mantle (Fig. 51). The striae are alveolate, 20-30 in 10 μm. The outside areolate layer can be formed of three or more rows of areolae (Figs 49, 51). Interstriae are wide or narrow in external view, and more or less raised of the valve surface. Internally, alveola open at the margin by elliptical apertures, marginal chambers are absent (Figs 52-54). A marginal ring of fultoportulae is present on the mantle, near the margin. Fultoportulae are placed on every fourth to ninth interstriae (Figs 47, 52-54) or less commonly on every second to third (Figs 48, 49), opening outwards by a circular pore with a thickened rim and internally by a tube surrounded by two radial satellite pores (Figs 47-49, 51-54). A single rimoportula is placed on an interstria, slightly over of the marginal fultoportulae horizon, between two fultoportulae, in front of the raised central field (Figs 48, 49 arrows). Externally, rimoportula opens by a circular to oval pore with a thickened rim, smaller than those of the fultoportulae (Figs 48, 49 arrows), and internally by a lip almost radially arranged (Figs 52-54 arrows). There are one to six fultoportulae on the raised sector of the valve surface, they externally open by a pore and internally by a short tube surrounded by three satellite pores. The cingulum is composed by four open, non porous bands, with the openings aligned in pervalvar direction. The valvocopula is wide, first copula reduced to a long and prominent ligula at the pars exterior, second copula wide, shortly ligulate (not illustrated) and third copula narrow, largely ligulate (Figs 47, 49 v, c).

Distribution in Argentina: *Cyclotella choctawhatcheeana*, mentioned by Prasad & Nienow (2006) as "cosmopolitan inhabitant of coastal brackish waters and saline lakes" was found during the present study in plankton net samples from San Clemente de Tuyú, Mar de Ajó, La Lucila del Mar, Nueva Atlantis and Villa Gesell, rare in spring and summer; and from Banco Reparo and Bahía San Antonio, rare in summer. This species was previous-



Figs 47-54. – *Cyclotella choctawhatcheeana*. Fig. 50, LM. Figs 47-49, 51-54, SEM. Figs 47-49, 51, External view. Figs 52-54, Internal view. Fig. 47, Frustule drum-shaped. Note the cingulum composed of a valvocopula (v), a first copula reduced to a long ligula at pars exterior (c), second and third copulae (c). Fig. 48, Valve showing several fultoportulae on the raised sector of the undulation and a rimoportula (arrow). Fig. 49, Detail of Fig. 48, tilted valve showing valvocopula (v) and first copula (c) with reduced pars exterior. Fig. 50, Valve showing marginal fultoportulae placed every fourth or fifth interstriae and central fultoportula. Fig. 51, Valve showing marginal fultoportulae with thickened rim. Figs 52-54, Valves showing marginal elliptical apertures of the alveola, central fultoportula, ring of fultoportulae and rimoportula (arrows). Note central fultoportulae with three satellite pores and marginal fultoportulae with two satellite pores.

ly reported by Maidana & Romero (1995) and González & Maidana (1998) from Argentinian hypersaline lakes and in this study it is recorded for the first time from the Argentinian coastal waters.

Photographed material: LPC 4250, 11/02/1994, Nueva Atlantis; LPC 4304, 01/11/1997, La Lucila del Mar; LPC 4310, 03/15/1997, San Clemente del Tuyú; LPC 4315, 03/16/1997, Villa Gesell; LPC 4374, 01/16/1997, Mar de Ajó; LPC 4607, 04/29/1999, Banco Reparo; LPC 4635, 02/29/2000, San Antonio Oeste.

Remarks: Prasad *et al*. (1990) created this brackish water, chain-forming taxon under the name of *Cyclotella choctawhatcheeana* and compared it with euryhaline species of *Cyclotella*. Almost simultaneously, Wendker (1991) also created a brackish-water, solitary taxon under the name of *Cyclotella hakanssoniae*. Håkansson *et al*. (1993) compared and discussed *C. choctawhatcheeana* Prasad, *C. hakanssoniae* Wendker and other related taxa as *C. caspia*, and *C. striata* var. *baltica* Grunow and *C. litoralis* Lange & Syvertsen. Authors analysed the type material of *C. caspia* from the Grunow Collection, established its taxonomic limits and pointed out that this species is quite different from the other treated taxa. Besides, based on their analysis of *C. choctawhatcheeana* and *C. hakanssoniae* they determined that both taxa are conspecific, thus *C. hakanssoniae* is a heterotypic synonym of *C. choctawhatcheeana*. Recently, Prasad & Nienow (2006) pointed out that *C. choctawhatcheeana* also appeared as single cells in the Florida Bay populations. This species was previously misidentified as *C. caspia* by Hasle (1962) and Bérard-Therriault *et al*. (1987).

Cyclotella litoralis Lange & Syvertsen, Figs 55-70

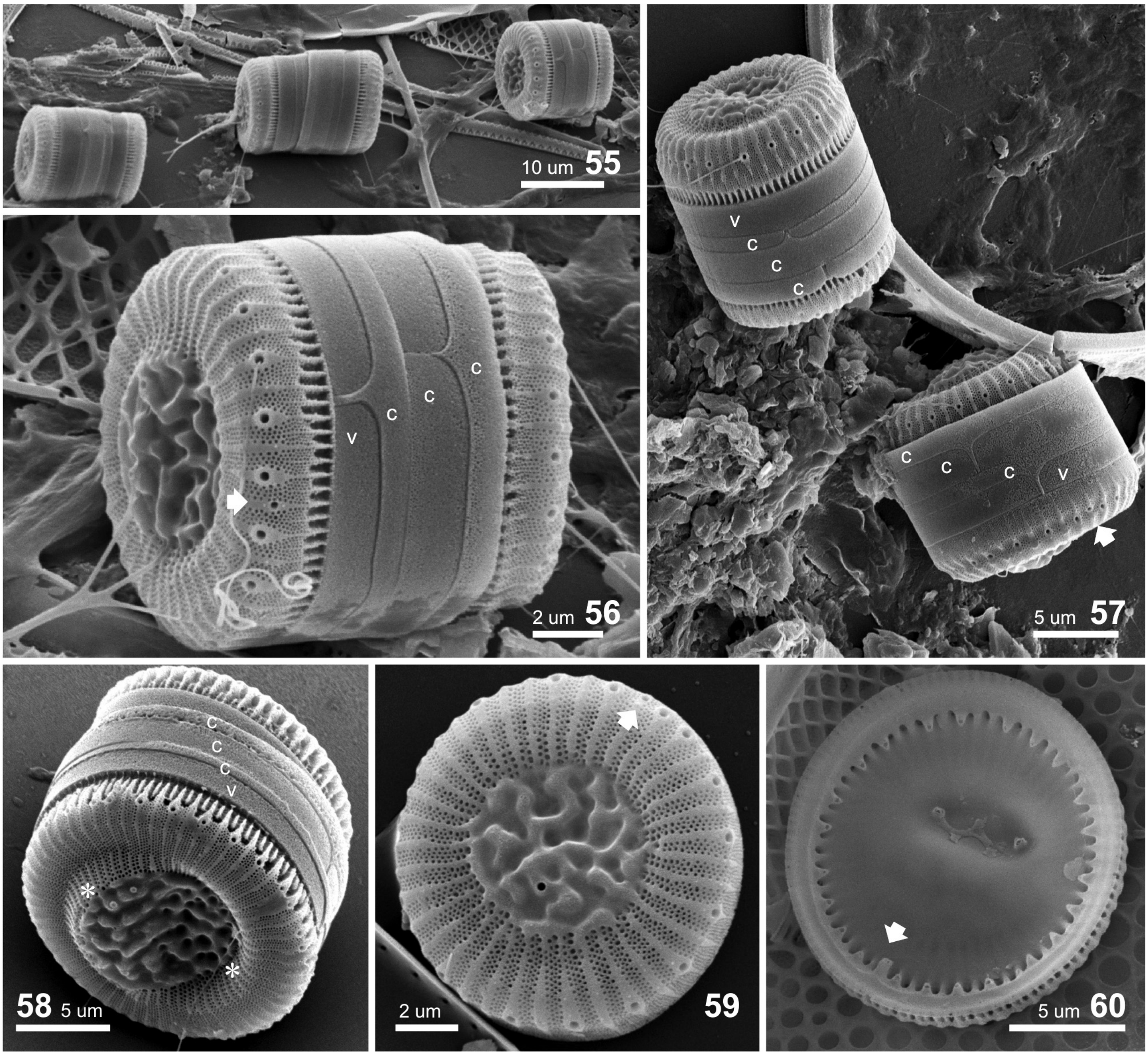
Lange & Syvertsen 1989: 343, Figs 1-30.

Cells solitary or joined in colonies by mucilaginous threads (Figs 55-57, 63, 64). Frustules drum-shaped, cylindrical or rectangular in girdle view, 9-16 μm in height. Valves are circular in outline, 10.0-62.8 μm in diameter, tangentially undulate, and externally divided in two concentric zones, a central field and a marginal area (Figs 59, 61, 62). The central field presents variable elevation, higher in the larger specimens and lower in the smaller specimens (Figs 63, 64 and 56 respectively). It is externally colliculate and internally smooth, occupying almost a half of the valve surface (Figs 56-59, 61-64). The marginal region restricted to a half of the valve surface, presents radial depressed striae, 9-14 in 10 μm, and interstriae (Figs 56, 59, 63, 64), extending from the vertical part of central area to the edge of the valve mantle (Figs 58, 63 asterisks). Interstriae are wider in the smaller specimens and narrower in the larger specimens (Figs 59, 68), and sometimes furnished with granules (Figs 65, 66). The striae are alveolate, the outside areolate layer presents two or three rows of areolae near the central field, four to six near the valve surface margin and sometimes more in the mantle (Figs 56, 58, 59, 65-68). Valve mantle with inserted interstriae close to the margin (Figs 58, 67, 68). Internally, alveola open at the margin by elliptical apertures, marginal chambers are absent (Figs 60, 69, 70). A marginal ring of fultoportulae is present on the mantle. Fultoportulae are placed on every second, less frequently on every or every third interstriae, opening outwards by a circular pore with a thickened rim (Figs 56, 59, 65, 66), and internally by a tube surrounded by two radial satellite pores (Fig. 70). A single rimoportula is placed on an interstria, slightly below the marginal fultoportulae horizon, between two fultoportula, in front of the raised central field (Figs 56, 59, 65-67 arrows). Externally, the rimoportula opens by a circular, oval or drop-shaped pore with a slightly thickened rim, smaller than those of the fultoportulae (Figs 56, 65-67 arrows), and internally by a lip, flat and radially arranged (Figs 60, 69, 70 arrows). There are one to many fultoportulae on the raised sector of the valve surface, they externally open by a pore (Figs 59, 61 arrowheads, 63, 64) and internally by a short tube surrounded by three satellite pores (Figs 60, 69). The cingulum is composed of four open, ligulate, unornamented bands with the openings arranged in dextral spiral (Figs 67, 68). The valvocopula, second and third copulae, are approximately of the same breadth and the first copula is narrow. The first and third copulae are largely ligulate and the second one is shortly ligulate (Figs 56-58, 67, 68 v, c).

Distribution in Argentina: *Cyclotella litoralis*, mentioned by Hasle & Syvertsen (1996) as inhabiting "southern and northern temperate region, coastal, marine" was found during the present study in plankton net samples from San Clemente del Tuyú, Santa Teresita, La Lucila del Mar, Mar de Ajó, Nueva Atlantis, Pinamar and Villa Gesell, rare all year around; and from Punta Orengo and Piedras Coloradas, rare all year around. This species is recorded for the first time from Argentinian coastal waters.

Photographed material: LPC 4262, 03/27/1995, Nueva Atlantis; LPC 4263, 03/28/1995, Pinamar; LPC 4303, 01/11/1997, Santa Teresita; LPC 4305, 01/11/97, Mar de Ajó; LPC 4367, 19/09/1998, LPC 4389, 10/06/1999, Villa Gesell; LPC 4610, 07/05/1999, Punta Orengo; LPC 13667, 06/14/2006, LPC 13669, 07/25/2006, LPC 13671, 08/05/2006, Piedras Coloradas.

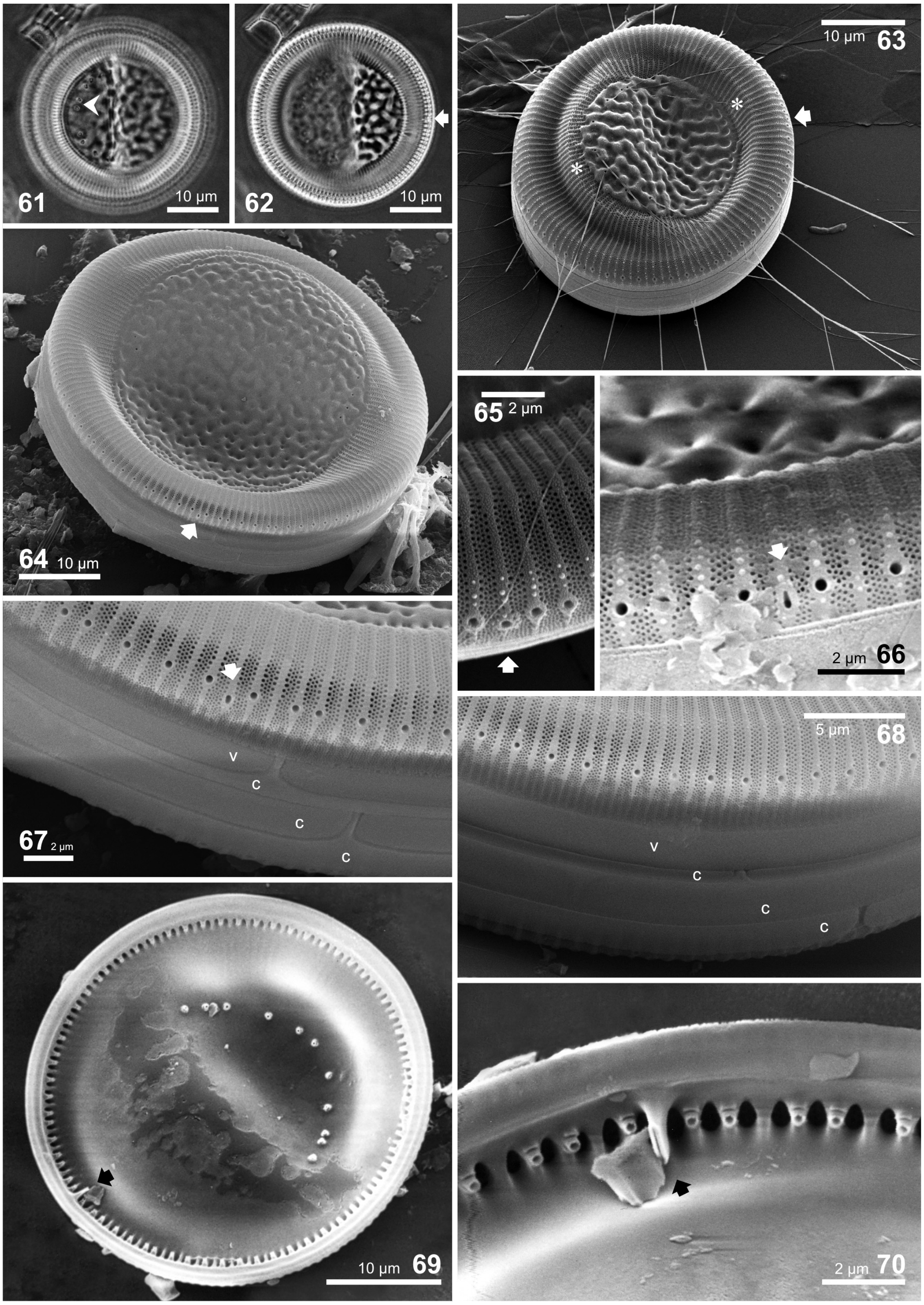
Remarks: Lange & Syvertsen (1989) created *Cyclotella litoralis* and compared it with *C. striata* (Kützing) Grunow and *C. stylorum* Brightwell. Håkansson (1996) analysed *C. striata* complex, lectotypified *C. striata* (Kützing) Grunow, and concluded that *C. striata* var. *baltica* Grunow in Van Heurck is conspecific with *C. litoralis*. Subsequently, Håkansson (2002) transferred, raised in rank and lectotypified *C. striata* var. *baltica* Grunow as *C. baltica* (Grunow) Håkansson considering some minor differences in the position of the valve mantle fultoportulae and of the rimoportula.



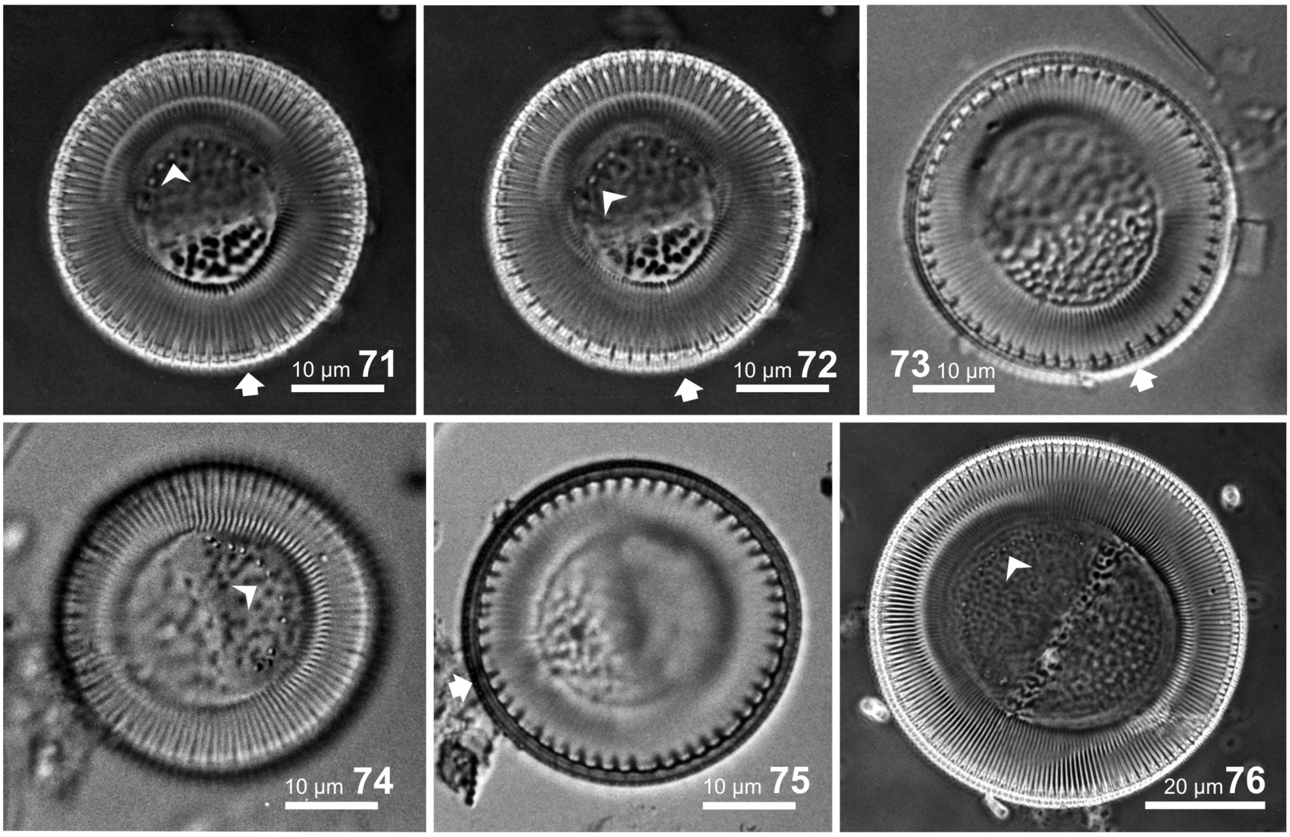
Figs 55-60. – *Cyclotella litoralis*. SEM. Fig. 55, Cells joined in a colony by mucilaginous threads. Fig. 56, Cell on the right of the colony of Fig. 55 showing marginal ring of fultoportulae, a rimoportula (arrow) and cingulum formed by a valvocopula (v) and three open copulae (c). Fig. 57, Lower cell shows the openings of the valvocopula (v) and second copula (c), first and third copulae ligulate (c). Upper cell shows the cingulum from the opposite side. Rimoportula is arrowed. Fig. 58, Frustule showing striae extending from the vertical part of the central area to the edge of the valve mantle (asterisks). Note inserted interstriae on the valve mantle. Fig. 59, Valve in external view showing the ring of fultoportulae and a rimoportula (arrow). Fig. 60, Valve surface in internal view showing the openings of the alveola, ring of fultoportulae and a rimoportula (arrow).

***Cyclotella cubiculata* sp. nov.**

Descriptio: Cellulae solitariae. Frustula typaniformia in facie connectivali visa. Valvae circulares, 23-63 µm diametro. Frons tangente valde undulata, in partibus concentricas duabus morphologia distincte differenti concentrice divisa. Area centralis ex exteriore parte colliculata, ex interiore parte levis. Area marginalis radiantibus striis depressis, 11-13 in 10 µm, et interstriis instructa, ad marginem valvae prolongatis. Interstriae interdum granulis instructae. Striae alveolatae, tegumento areolato exteriore serierum 2-6. Limbus intestriiis brevibus insertis praeditus. Cubicula marginalia ex interiore parte posita, 4-6 in 10 µm, crassiore interstria 1 (2) disjuncta. Cubicula omnia alveolis 2 (3) et interstriis 1 (2) recessis costatis fultoportulis duobus poris satellitariis radialibus instructa. Cubiculum rimoportulae maximum. Rimoportula in interstria recessa posita, oblique oriens. Fultoportulae in recessis interstriis positae, poro extrinseci aperientes in omnibus interstriis alteris, raro in ommibus interstriis primis vel tertiis, annulum in limbo valvae formantes. Rimoportula unica, in circulo fultoportularum vel supra circulum fultoportularum locata. Pars elevata areae centralis fultoportulis 5-15 seriem semicircularem formanti-



Figs 61-70. – *Cyclotella litoralis*. Figs 61, 62, LM. Figs 63-70, SEM. Fig. 61, Valve showing many fultoportulae on the raised sector (arrowhead). Fig. 62, Same valve of Fig. 61 in different focus showing the rimoportula (arrow). Fig. 63, Cell with long mucilaginous threads secreted by the fultoportulae. Note position of the rimoportula (arrow). Fig. 64, Tilted frustule showing high elevation. Note position of the rimoportula (arrow). Fig. 65, Detail of Fig. 63 showing the circular aperture of the rimoportula (arrow). Fig. 66, Detail of a drop-shaped opening of the rimoportula (arrow). Figs 67, 68, Details of Fig. 64 from opposite sides. Fig. 67, Note cingulum composed of four bands, one valvocopula (v) and three copulae (c), with the openings in dextral spiral. Fig. 68, Note the narrow first copula and the shortly ligulate second copula. Fig. 69, Valve in internal view. Rimoportula is arrowed. Fig. 70, Detail of Fig. 69 showing the marginal openings of the alveola, fultoportulae placed on the interstriae with two satellite pores and rimoportula (arrow).



Figs 71-76. – *Cyclotella cubiculata* sp. nov. LM. Figs 71, 72, Same valve in different focuses showing marginal chambers, arc of fultoportulae (arrowheads) and rimoportula (arrows). Figs 73-76, From holotype, slide LPC 4260 (1). Fig. 73, Valve showing the coarse interestriae that limit the marginal chambers. Rimoportula is arrowed. Figs 74, 75, Same valve in different focuses. Note the arc of fultoportulae (arrowhead) and the rimoportula (arrow). Fig. 76, Large specimen showing arc with many fultoportulae (arrowhead).

bus instructa. Fultoportulae in fronte interne poris stellitariis tribus. Limbus interstriis brevibus insertis praeditus. Cingulum taeniis 4 vel 5 apertis in cochleam dextrorsum retortis instructum.

Species planctonica, marina.

Holotypus: Praeparatio LPC 4260 (1) hic designatus (*holotypus Cyclotella cubiculata*), *in Collectio diatomarum* Departamento Científico Ficología, Facultad de Ciencias Naturales y Museo, Argentina.

Isotypus: Praeparatio LPC 4260 (2) hic designatus (*isotypus Cyclotella cubiculata*)*, in Collectio diatomarum* Departamento Científico Ficología, Facultad de Ciencias Naturales y Museo, Argentina.

Locus typicus: Nueva Atlantis, 36º 45' 81''S-56º 40' 04''W, Prov de Buenos Aires, Argentina.

Figs 71-91, Table I.

The cells are solitary. Frustules are drum-shaped in girdle view (Figs 77, 78). Valves are circular in outline, 23-63 μm in diameter. The valve surface is tangentially undulate, having pronounced elevation, and is externally divided in two concentric areas, a central field and a marginal area (Figs 77-79). The central field is externally colliculate, occupying almost half of the valve surface (Figs 71-79), and internally smooth (Figs 85-87). The marginal area is restricted to half of the valve surface, and presents radial depressed striae (11-13 in 10 μm) and interstriae, extending from the vertical part of central area to the edge of the valve mantle (Figs 78, 79 asterisks). Interstriae are wide, and frequently furnished with granules towards the junction valve face/mantle (Figs 77-84). The striae are alveolate, the outside areolate layer presents two or three rows of areolae near the central field, four to six near the valve surface margin and sometimes more in the mantle (Figs 80-84). Valve mantle with inserted interstriae close the margin (Figs 80-84). Internally, the valve presents marginal chambers, 4-6 in 10 μm, often separated by one coarse interstriae, less frequently by two (Figs 85-91). When seen in LM, the marginal chambers are evident (Figs 71-76) while this feature is not appreciated when the external view of the valve is observed in SEM. Each chamber contains commonly two (three) alveolus openings and one (two) recessed costate interstriae (Figs 85-91). The chamber that contains the rimoportula shows four to six alveolus openings (Figs 88, 90). The fultoportulae are located on every recessed costate interstria and bear two radial satellite pores (Figs 88-91). The single rimoportula is short and pedicellate, flat, with obliquely oriented lip (Figs 85, 87, 88, 90 arrows). The fultoportulae open outwards by a circular pore with a thickened rim and are placed on every second, less frequently on every first

Table I. – *Cyclotella cubiculata*: comparison with other similar species discussed in the text.

Taxon	Diameter in µm	Striae in 10 µm	Ratio central field/ diameter	Marginal chambers in 10 µm	Alveolus opening in each chamber	Position of marginal fultoportulae	Number of satellite pores	Valve face fultopotulae number and position	Number of satellite pores	Rimoportula
Cyclotella baltica[1]	11-45	9-12	nd	absent	---	On 2nd, 3rd (4th) interstria	2, in radial position	1 to several in a semicircular (half-moon) position uplift of the undulation	(2) 3	Sessile, radially oriented, above the marginal ring of fultoportulae
Cyclotella litoralis[2]	10-60	9-14	0.5 small specimens, 0.66 large specimens	absent	---	On every 2nd interstria, [1st or 3rd]*	2, in radial position	2-20 in an arc on the uplift of the undulation	3	Radially oriented, below the marginal ring of fultoportulae
Cyclotella litoralis[3]	10-62.8	9-14	0.45-0.66	absent	---	On every 2nd interstria, (1st or 3rd)	2, in radial position	1-many in an arc on the uplift of the undulation	3	Radially oriented, below the marginal ring of fultoportulae
Cyclotella cubiculata[3]	23-63	11-13	0.52-0.56	present, 4-6	2, (3)	On every 2nd interstria, (1st or 3rd)	2, in radial position	5-15 in an arc on the uplift of the undulation	3	Obliquely oriented, within a chamber, above or level with the marginal ring of fultoportulae
Cyclotella striata[1]	20-67	nd	nd	with recessed costae	nd	On every 3rd or 4th interstria	3	absent	---	[Tangentially oriented]*, very broad "mouth"
Cyclotella striata[2]	25-48	7-13	0.69-0.73	present 3-4	2	On every 2nd to 4th interstria	3	1-2	nd	Tangentially oriented, big
Cyclotella striata[4]	20-67	8-10	nd	present	nd	On every 3rd or 4th interstria	3	absent	---	[Tangentially oriented]*, very broad "mouth"
Cyclotella stylorum[2]	35-67	9-12	0.47-0.54	present 2-3	3-4	Grouped in pairs or triplets on interstriae	2, in radial position	6-12 in an arc on the uplift of the undulation	[3]*	Radially oriented, small
Cyclotella stylorum[5]	25-33	8-10	nd	present 3	nd	Grouped in pairs or triplets on interstriae	2, in radial position	6-12 in an arc on the uplift of the undulation	3	Obliquely oriented, within a chamber

Håkansson (2002)[1], Lange &Syvertsen (1989)[2], This study[3], Håkansson (1996)[4], Prasad & Nienow (2006)[5]
[ ]* observed by authors from the quoted paper .

or third interstriae (Figs 77, 78, 80-84). The rimoportula aperture is circular or elliptical placed between two or more fultoportulae level with or slightly above the marginal ring of fultoportulae (Figs 80, 82, 83 arrows), in front of the raised central field (Figs 77, 78 arrows). There are five to fifteen fultoportulae on the raised sector of the central field forming an arc, they open externally by a pore (Figs 71, 72, 74, 76 arrowheads, 79) and internally by a short tube surrounded by three satellite pores (Figs 85, 87). The cingulum is composed of a valvocopula and three or four copulae open, unornamented with the openings arranged in a dextral spiral (Figs 80, 81, 83, 84). The copulae are ligulate.

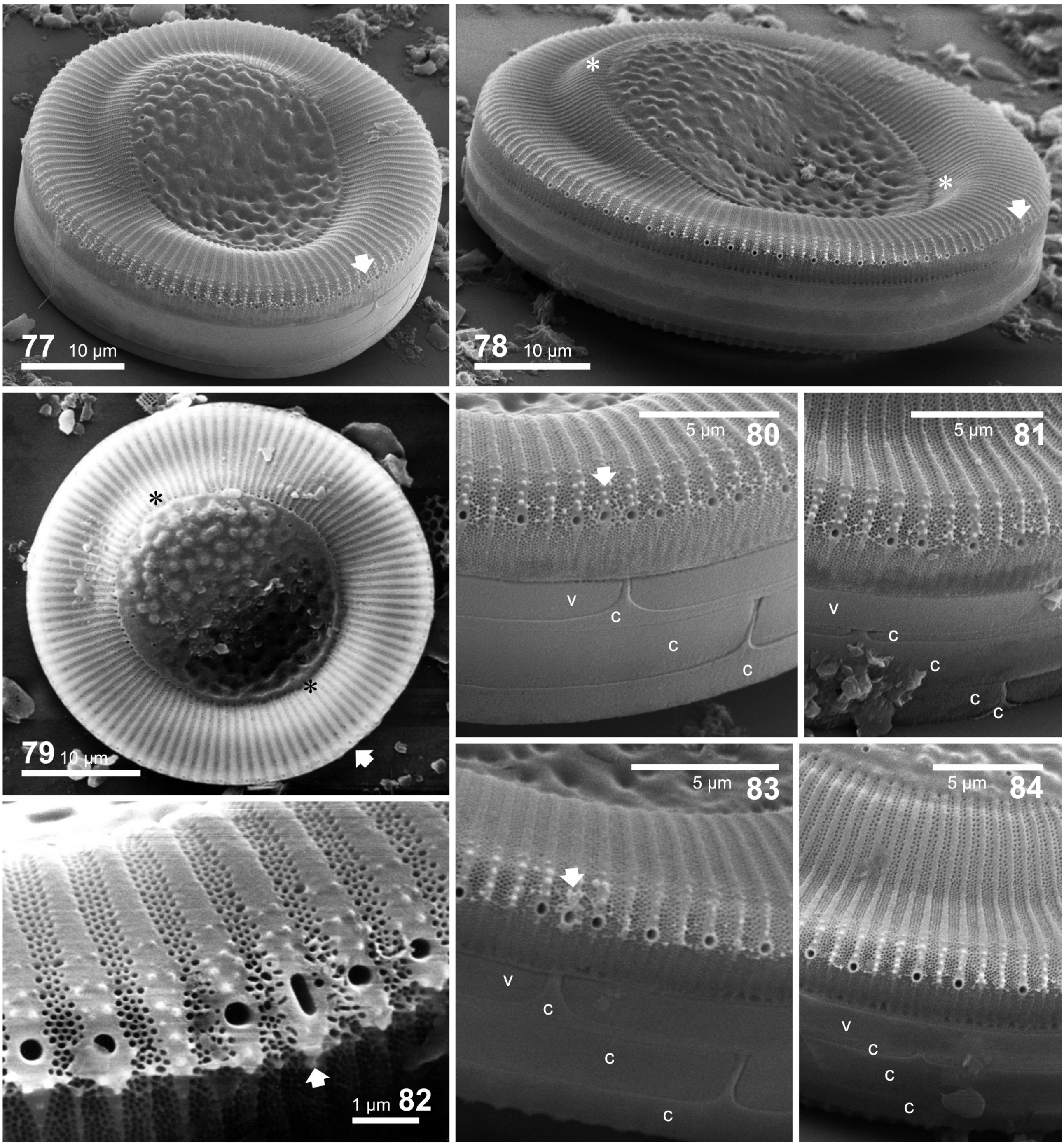
This species is planktonic, marine.

Holotype: Slide LPC 4260 (1) designated here, labelled holotype *Cyclotella cubiculata*, deposited at Colección de Diatomeas Argentinas, Departamento Científico Ficología, Facultad de Ciencias Naturales y Museo.

Isotype: Slide LPC 4260 (2) designated here, labelled isotype *Cyclotella cubiculata*, deposited at Colección de Diatomeas Argentinas, Departamento Científico Ficología, Facultad de Ciencias Naturales y Museo.

Type locality: Nueva Atlantis, 36º 45' 81''S-56º 40' 04''W, Prov. de Buenos Aires, Argentina.

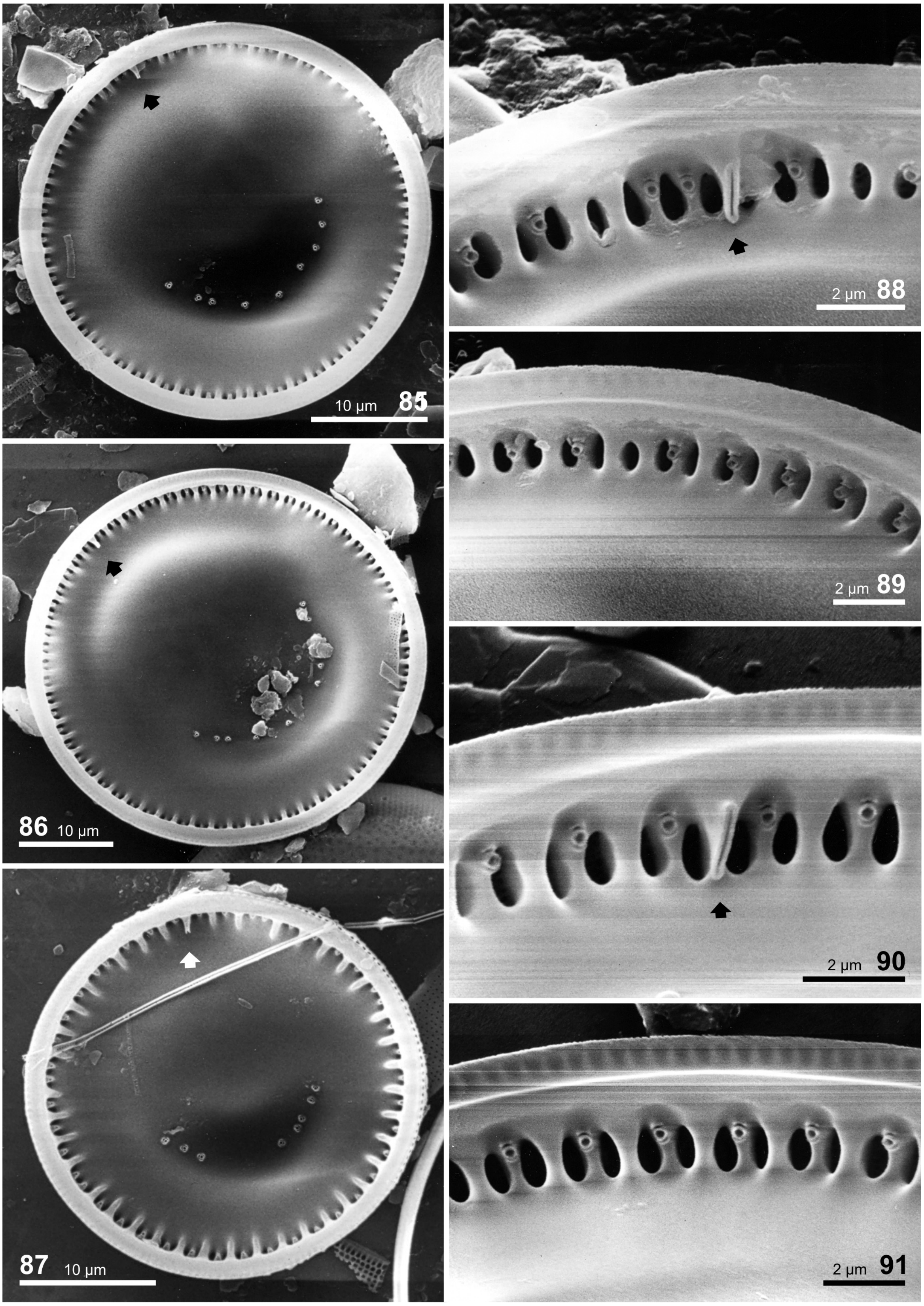
Etymology: The Latin word "cubiculata" means furnished with chambers, and "cubiculum" means chamber. See definition of chamber in Lange & Syvertsen (1989).



Figs 77-84. – *Cyclotella cubiculata* sp. nov. SEM. Figs 77, 78, Tilted frustules of different sizes. Arrows show the position of rimoportulae and the asterisks (Fig. 78) the striae extending from the vertical part of the central area to the edge of the valve mantle. Fig. 79, Valve surface. Arrow shows the position of the rimoportula. Figs 80, 81, Details of Fig. 77 from opposite sides. Fig. 80, Rimoportula's side (arrow). Note the cingulum composed of valvocopula (v) and three copulae (c). Fig. 81, Note the cingulum composed of five bands, the last one only visible as a ligula. Fig. 82, Detail of Fig. 79, note elliptical opening of the rimoportula (arrow) and inserted interstriae on the valve mantle. Figs 83, 84, Details of Fig. 78 from rimoportula (arrow) and opposite sides.

Distribution in Argentina: *Cyclotella cubiculata* was found during the present study in plankton net samples from San Clemente del Tuyú, Santa Teresita, La Lucila del Mar, Mar de Ajó, Nueva Atlantis, Pinamar and Villa Gesell, rare all year around. This variety was abundant in Nueva Atlantis, on January 11, 1995 and March 27, 1995.

Photographed material: LPC 4256, 01/11/1995, Nueva Atlantis; LPC 4260, 03/27/1995, Nueva Atlantis; LPC 4261, 03/27/1995, Nueva Atlantis. Considering that analysed with SEM the external view of *Cyclotella cubiculata* resembles *Cyclotella litoralis* and that both species frequently coexist in the samples, we chose the photographs



Figs 85-91. – *Cyclotella cubiculata* sp. nov. SEM. Internal view. Figs 85-87, Valves showing chambers. Note coarse and costate interstriae, arc of fultoportulae on the valve surface and position of the rimoportula (arrows). Figs 88, 89, Details of Fig. 85. Fig. 88, Chamber containing rimoportula (arrow), with six alveolus openings and five recessed costate interstriae. Fultoportulae placed on costate interstriae. Fig. 89, Marginal chambers containing one costate interstriae. Figs 90, 91, Details of Fig. 86. Fig. 90, Chamber containing rimoportula (arrow) with four alveolus openings and three costate interstriae. Fig. 91, Each marginal chamber containing one costate interstria with fultoportula. Note fultoportulae with two satellite pores.

of the samples 4256, 4260 and 4261 from Nueva Atlantis where the new species was abundant and *Cyclotella litoralis* rare.

Remarks: *Cyclotella cubiculata* resembles *C. litoralis* and *C. baltica* (Grunow) Håkansson in external view, and shows some similarities with *C. striata* (Kützing) Grunow and *C. stylorum* Brightwell in internal view (see Table I). We had to use published images for LM and SEM comparisons between the new taxon and the morphologically related taxa in order to establish the striking features for distinguishing them, and to justify the creation of the new species.

DISCUSSION

Cymatotheca weissflogii, particularly specimens with circular valve outline found in Buenos Aires coastal waters, resembles two marine species of *Thalassiosira* Cleve, *T. hyperborea* (Grunow) Hasle (Hasle & Lange 1989) and *T. cedarkeyensis* Prasad (Prasad *et al.* 1993) in having tangentially undulate valves, internal separate cribra, subcentral fultoportula placed at the convex part of the valve surface, marginal ring of operculate fultoportulae and marginal sessile rimoportula. Despite the above similarities, it is distinguished from both *Thalassiosira* species by the pattern of striation with wider interstriae in the raised sector and narrower interstriae in the depressed sector, the rimoportula placed in the position of a fultoportula but in a slightly different horizon, the processes with no tubes outwards and the conspicuous hyaline area placed at the depressed sector between valve surface and mantle. Additionally, *Thalassiosira hyperborea* presents one to eight subcentral fultoportulae and *T. cedarkeyensis* several occluded processes, and both taxa have the marginal fultoportulae with four satellite pores.

Studied material of *Tryblioptychus cocconeiformis* (Grunow ex Cleve) Hendey resembles those analysed by Prasad *et al.* (2002) in their detailed morphological study. We agree with authors that pointed out that this taxon resembles *Cymatotheca weissflogii*. Both taxa present tangentially undulate valves, valvar outline circular to broadly elliptical, a subcentral fultoportula placed at the convex part of the valve surface and a marginal ring of fultoportulae including a rimoportula placed in the depressed side of the valve. However, *T. cocconeiformis* is quite different in having radial depressed sectors with areolae in fascicles and raised sectors (inter-fascicles), a hyaline area free of areolation around the valve surface, valve mantle with a ring of larger areolae, fultoportulae with four satellite pores placed in the inter-fascicles and rimoportula with external tube.

Julius & Tanimura (2001) made a cladistic analysis of several species of *Thalassiosira* with tangentially undulate valves in which they included *Cymatotheca weissflogii* and *Tryblioptychus cocconeiformis*. The authors concluded that the plicate studied taxa form a monophyletic group and proposed to transfer them to a genus whose name should be *Cymatotheca* or *Tryblioptychus* for priority reason. Prasad *et al.* (2002) pointed out that *Tryblioptychus* should remain separate as a distinct genus, we share the supported opinion of Prasad *et al.* (2002) and we think that the genus *Cymatotheca* should also remain separate as a distinct genus. We believe that the analysis of Julius & Tanimura (2001) failed in considering some morphological characters such as the striation pattern, radial undulations delimiting fascicles and inter-fascicles, width of the interstriae in depressed and raised sectors, and presence of marginal hyaline areas. Besides, these authors erroneously included some character states e.g., the external opening of the marginal fultoportulae for both taxa as tubes (they present pores, according to their illustration 16), subcentral fultoportula with two satellites pores for *Cymatotheca weissflogii* (it presents three satellite pores).

Skeletonema tropicum was frequently misidentified in the literature as *S. costatum* (Greville) Cleve (e.g., Hasle 1973b, Aké Castillo *et al.* 1995, Sar *et al.* 2001). Kooistra *et al.* (2008) pointed out that "*Skeletonema costatum* s. l. was considered morphologically plastic, genotypically diverse, physiologically versatile, and was found worldwide except in the Antarctic Ocean". Zingone *et al.* (2005) based on the analysis of the lectotype material designated by Ross *et al.* (1996), clarified the specific limit of *S. costatum* (Greville) Cleve emend. Zingone & Sarno and designated an illustration as epitype selected to serve as interpretative of the lectotype (Art. 19.7 of the ICBN, McNeill *et al.* 2006). Additionally, authors created a new species *Skeletonema grevillei* Sarno & Zingone based on material much rarer and smaller in size present in the lectotype slide of *S. costatum*. Besides, Sarno *et al.* (2005) clarified the specific limits of *Skeletonema tropicum* among other previously created species of *Skeletonema* and described *Skeletonema grethae* Zingone & Sarno and other three new species. In our material, *Skeletonema tropicum* and *S. grethae* can be easily differentiated with LM considering the number of chloroplasts, several in the former and one or two in the latter. The SEM analysis of both species allow us to find the striking features established by Sarno *et al.* (2005): the position of the terminal rimoportulae, half-way between the central annulus and the marginal ring of rimoportulae in the former and adjacent to the central annulus in the latter; the morphology of the external tube of the intercalary rimoportula, larger and flattened in the former and shorter and cylindrical in the latter; and the junction of the tubes of the intercalary fultoportulae, 1:1 or 1:2 in the former and 1:1 in the latter. *Skeletonema costatum* differs from both analysed species in the position and morphology of the terminal tube of the rimoportula, near the marginal ring of fultoportulae and with the distal end never flared; in the position and the morphology of the tube of the intercalary rimoportula, placed in the marginal ring of fultoportulae and similar in length with the fultoportulae; in the morphology of the tubes of intercalary fultoportulae, completely closed or sometimes only closed in the basal part. *Skeletonema costatum*, profusely recorded from Argentinian coastal waters in the literature (see Vouilloud 2003), was never found during the present study.

Analysed material of *Cyclotella choctawhatcheeana* resembles those illustrated by Prasad *et al*. (1990), Prasad & Nienow (2006), Wendker (1991) and Håkansson (1993) from marine coastal waters, by Maidana & Romero (1995), and Carvalho *et al*. (1995) from hypersaline lakes, and by Oliva *et al*. (2008) from a hyposaline aquatic system. Minor differences in the presence/absence, and position of the granules were observed between our material and other's shown in the quoted literature. According to Prasad *et al*. (1990), Maidana & Romero (1995) and Melo *et al*. (2006), the cingulum of *C. choctawhatcheeana* consists of one valvocopula and one copula. However, the cingulum of analysed specimens is formed by four bands with aligned openings, the valvocopula and the second copula have approximately the same width, the first copula is reduced to a long and prominent ligula at the pars exterior (Figs 47, 49), and third copula is narrow and broadly ligulate (Fig. 47). The cingular morphology is similar in the specimens photographed by Melo *et al*. (2006, Fig. 7) and Maidana & Romero (1995, Fig. 15). Based on the facts that the ligula lacking valvocopula and that both valvocopulae of the same frustule are similar, thus the last narrow ligulate band is a copula and the girdle is composed by four bands. This morphological pattern of the girdle is consistent with the pattern described for *Cyclotella litoralis* by Lange & Syvertsen (1989) and for *Cyclotella cubiculata* in this study with the difference that in the two latter species the band openings are arranged in a dextral spiral. The morphology of the second copula and the band openings aligned should be considered as striking features of *Cyclotella choctawhatcheeana*. More variability of band openings pattern was found for the genus *Thalassiosira* by Fryxell *et al*. (1981), since a sinistral spiral pattern was also observed. Additionally, while all the bands of the species of *Cyclotella* analysed in this study are non porous, the valvocopula, the first copula and in some cases all the copulae are porous in *Thalassiosira* (Fryxell *et al*. 1981).

Studied specimens of *Cyclotella litoralis* perfectly coincide in morphology with those described by Lange & Syvertsen (1989) (see Table I), however, some information about the colony formation in this species is added. In the sampling area together with *C. litoralis* there was found a new taxon that we created under the name *Cyclotella cubiculata* sp. nov. Both species resemble in general external aspect of the valve, elevation of the tangential undulation, structure of the central field, ratio diameter of the central field/total diameter, density of alveolate striae, arrangement of the fultoportulae in the central field and in the valve mantle, and morphology of the cingulum (Table I). Only a minor difference was found in external view, the opening of the rimoportula placed level with or above the marginal ring of fultoportulae in *Cyclotella cubiculata*, similar in position to that of *C. baltica*, and below the level of the marginal ring of fultoportula in *C. litoralis*. However, *Cyclotella cubiculata* clearly differs from *C. litoralis* and *C. baltica* by presenting marginal chambers easily visible with LM and with SEM only in internal view. Additionally, *C. cubiculata* differs from *C. baltica* in external arrangement of the fultoportulae in the valve mantle, more densely arranged in the former than in the latter.

Cyclotella cubiculata was also compared to two marine species with marginal chambers, *C. striata* and *C. stylorum* (see Table I). In LM analysis the new species differs from type material of *C. striata* illustrated by Håkansson (1996, Figs 9, 10) and by Lange & Syvertsen (1989, Figs 34, 35) in the ratio diameter of the central field/total diameter, 0.52-0.56 in the former and 0.69-0.73 in the latter; in stria density, 11-13 in 10 μm in the former and 8-10 in 10 μm in the latter, and in the distribution of fultoportulae on the valve surface, 5 to 15 on undulation of the valve surface in the former and completely absent in the latter. Håkansson (1996, Figs 20-24) and Lange & Syvertsen (1989, Figs 36, 37) also presented a SEM analysis of *C. striata* from the type locality. These specimens internally present chambers, 3-4 in 10 μm, separated by two, three or more coarse interstriae, with two alveolus openings, marginal fultoportulae with three satellite pores, and rimoportula tangentially oriented. The new species is clearly different, it presents 4-6 chambers in 10 μm, generally separated by only one (sometimes two) coarse interstria, with two (three) alveolus openings, marginal fultoportulae with two satellite pores, and rimoportula obliquely oriented. Additionally, both taxa differ in the arrangement of marginal fultoportula openings, placed on every third or fourth interstria in *C. striata* and on every second (less frequently first or third) interstria in *C. cubiculata*. The specimens of *C. stylorum* from Sierra Leona and from Brazil photographed with LM by Lange & Syvertsen (1989) and Prasad & Nienow (2006) and specimens of *C. cubiculata* analysed with LM in this study, show notable differences in chamber morphology, the coarse interstriae are very robust in the former and they are more subtle in the latter, and in chamber density, 2-3 in 10 μm in the former and 4-6 in 10 μm in the latter. A comparative SEM analysis of chamber morphology shows that in *C. stylorum* (see Lange & Syvertsen 1989, Fig. 33) chambers contain two or three costate interstriae, while in *C. cubiculata* they generally contain only one, less frequently two, costate interstria. Additionally, the costate interstriae are very different in thickness and position, lying more recessed in the chamber in *C. stylorum*. *C. cubiculata* superficially resembles another species with marginal chambers, *C. desikacharyi* Prasad (see

Prasad & Nienow 2006, Figs 16-34), but differs from it by the external morphology of the valve, density of the striae, morphology of the chambers and position of the rimoportulae in internal view. The new species was the only taxon with marginal chambers found in the area during the present study; we never found either *C. striata* or *C. stylorum*.

Our material of *Cyclotella cubiculata* sp. nov. perfectly fits with material illustrated by Tanaka (2007: pl. 23-25) under the name *C. litoralis* Lange & Syvertsen from Isahaya Bay, Nagasaki Prefecture. This author interpreted that the figure 26 given by Lange & Syvertsen (1989) shows the fultoportulae on slightly recessed interstriae however, in this figure as in our figures 60, 69, 70 the intestriae are all at the same level and the fultoportulae protrude from this level. Based on this point of view he stretched the determination of his material as *C. litoralis*. In material of *C. cubiculata* from Buenos Aires coastal waters and from Isahaya Bay (see our Figs 85-91 and Tanaka's plate 25 Figs 1-3) the recessed interstriae bear the fultoportulae and these never reach the level of the coarser interstriae. Besides, we also consider that Tanaka's specimens illustrated with light micrographs (plate 11 figures 2a, 2b, 3a) as *Cyclotella baltica* do not fit with this species but with *Cyclotella cubiculata* because they clearly show marginal chambers which are completely absent in internal view of the valve of *C. baltica* (see Tanaka's plate 13, figs 1, 2, 4, 5). Based on this evidence we can speculate that the new species is widely distributed, probably cosmopolitan.

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