

The diatom genus *Thalassiosira*: species from the northern San Matías Gulf (Río Negro, Argentina)

by

Eugenia A. Sar¹, Inés Sunesen² and Andrea S. Lavigne

Departamento Científico Ficología, Facultad de Ciencias Naturales y Museo
Paseo del Bosque s/n, 1900 La Plata, Argentina

With 13 figures and 3 tables

Sar, E.A., I. Sunesen & A.S. Lavigne (2002): The diatom genus *Thalassiosira*: species from the northern San Matías Gulf (Río Negro, Argentina). - Nova Hedwigia 74: 373-386.

Abstract: This study deals with the morphology, taxonomy and distribution of species belonging to the diatom genus *Thalassiosira* found in the marine waters along the northern coast of San Matías Gulf, Argentina. Net samples were collected from the surface layer of the water column at Punta Orego, Las Garzas, Banco Reparo, Los Álamos, Las Grutas, Piedras Coloradas, Bajo de Oliveira and El Fuerte from April 1998 to February 2000. Untreated and cleaned diatom samples were examined by light and scanning electron microscopy. Eighteen taxa were identified. *T. frenguelliopsis* is reported for the first time after its original description. *T. mediterranea* is a new record for the southwestern Atlantic Ocean, *T. mala* is a new record for Argentina, and *T. angulata*, *T. endoseriata*, *T. hendeyi*, *T. nanolineata*, *T. pacifica* and *T. proschkinae* are new records for Patagonia. Descriptions, illustrations, analysis of valve morphology and distribution are provided for the species not previously studied in detail from Argentinian coastal waters. New observations on *T. frenguelliopsis* and comparisons with related species known to have, or suspected of having, a similar ultrastructure are also included.

Introduction

Previous studies on the diatom flora of the San Matías Gulf, Argentina, are scarce. In a study on the morphology of *Dictyocha fibula* (Silicoflagellatae), Frenguelli (1935) provided a list of seventy-nine taxa of Bacillariophyceae. In a comprehensive paper, Frenguelli (1939) presented an examination of two samples and described the diatom flora of the area, reporting ninety-six taxa. Subsequently, Carreto & Verona

¹Consejo Nacional de Investigaciones Científicas y Técnicas

²Comisión de Investigaciones Científicas de la Provincia de Buenos Aires

(1974), Carreto et al. (1974) and Verona et al. (1974) carried out studies on phytoplankton ecology of the San Matías Gulf. More recent studies in the area include ultrastructural analysis (Sar 1989, 1996a,b, Sar & Ferrario 1990). However, none of the previous studies focuses on the genus *Thalassiosira*.

Thalassiosira Cleve is one of the largest and most widespread diatom genera in the world. However, in the San Matías Gulf area it constituted only a minor component in phytoplankton assemblages collected from April 1998 to May 2000 (this study). The identification of *Thalassiosira* species is problematic because the essential morphological features such as number, distribution and morphology of processes, are revealed only by electron microscopy in most taxa. Previous ultrastructural studies of *Thalassiosira* species in Argentina were carried out by Lange et al. (1983), Gayoso (1989), Sar et al. (2001) from Buenos Aires, by Sar (1996a) from San Antonio Bay and by Ferrario & Sar (1988) from Chubut.

The aim of this paper is to add new information about the species of *Thalassiosira* in the San Matías Gulf area and to discuss the taxonomy, morphology and distribution of the taxa that in this study were recorded for the first time in Argentinian coastal waters.

Materials and methods

The diatom material was collected monthly from April 1998 to February 2000 at several stations in the northern part of the San Matías Gulf: Punta Orenge, Las Garzas, Banco Reparo, Los Álamos, Las Grutas, Piedras Coloradas, Bajo de Oliveira and El Fuerte (Fig. 1). Qualitative samples were taken in the near-surface layer of the water column (between 0 and 5 m) with 30 µm net and fixed with 4% formalin. In the laboratory, the samples were rinsed with distilled water to remove salt and preservatives, whereafter the organic matter was oxidised according to the method described by Hasle & Fryxell (1970). The cleaned material was mounted for light and scanning microscopy following Ferrario et al. (1995). Permanent mounts were made with Hyrax. 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 4550 to 4645. Light microscopy (LM) was carried out with Wild M20 and Nikon Microphot-FX microscopes using phase contrast, and scanning electron microscopy (SEM) with a Jeol JSMT 100. The general terminology follows Ross et al. (1979) and that used to describe the ultrastructure of the strutted processes follows Hasle & Fryxell (1979a).

Results

Eighteen taxa belonging to the genus *Thalassiosira* were identified: *T. angulata* (Gregory) Hasle, *T. anguste-lineata* (Schmidt) Fryxell & Hasle, *T. delicatula* Ostensfeld, *T. eccentrica* (Ehrenberg) Cleve, *T. endoseriata* Hasle & Fryxell, *T. frenguelliopsis* Fryxell & Johansen, *T. hendeyi* Hasle & Fryxell, *T. mala* Takano, *T. mediterranea* (Schröder) Hasle, *T. minima* Gaarder, *T. minuscula* Krasske, *T. nanolineata* (Mann) Fryxell & Hasle, *T. pacifica* Gran & Angst, *T. proschkinae* Makarova, *T. punctigera* (Castracane) Hasle, *T. rotula* Meunier, *T. simonsenii* Hasle & Fryxell and *T. tenera* Proschkina-Lavrenko. Fifteen of these species have previously been studied in detail from Argentinian coastal waters, but *T. frenguelliopsis*, *T. mala* and

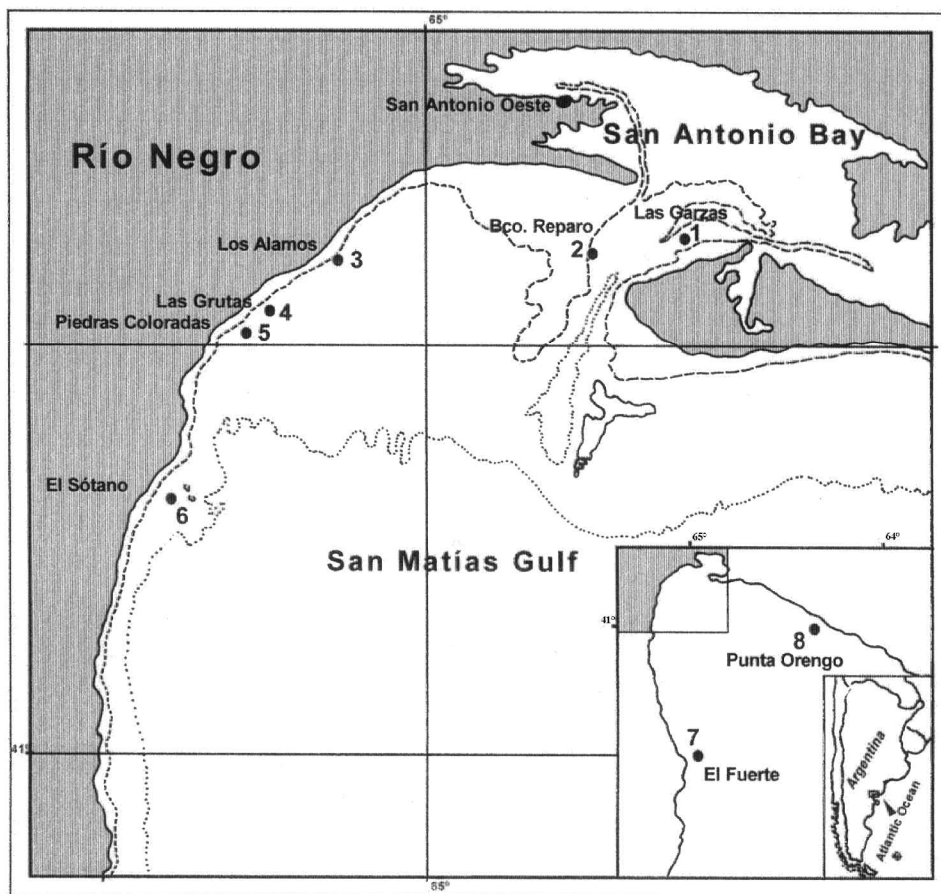


Fig. 1: Map of the northern San Matías Gulf showing sampling stations and the location of the area in Argentina.

T. mediterranea are recorded for the first time for Argentina. Table 1 summarises information about the characteristics and morphometric data of the different species, except for *T. frenguelliopsis*, which is treated separately. The seasonal distribution of the *Thalassiosira* species from San Matías Gulf coastal waters for the period 1998-2000 is presented in Table 2. This information is based on the analysis of oxidised material.

Below, detailed descriptions are given of the three *Thalassiosira* species that have not previously been reported for Argentina: *T. frenguelliopsis*, *T. mala* and *T. mediterranea*. Each description is accompanied by LM and SEM micrographs, relevant literature references used for identification, notes on diagnostic features, distribution in Argentinian coastal waters and sample number of the photographed material.

Table 1: Summary of our own measurements and observations of the species of *Thalassiosira* analysed in this study, except for *T. frenguelliopsis*.

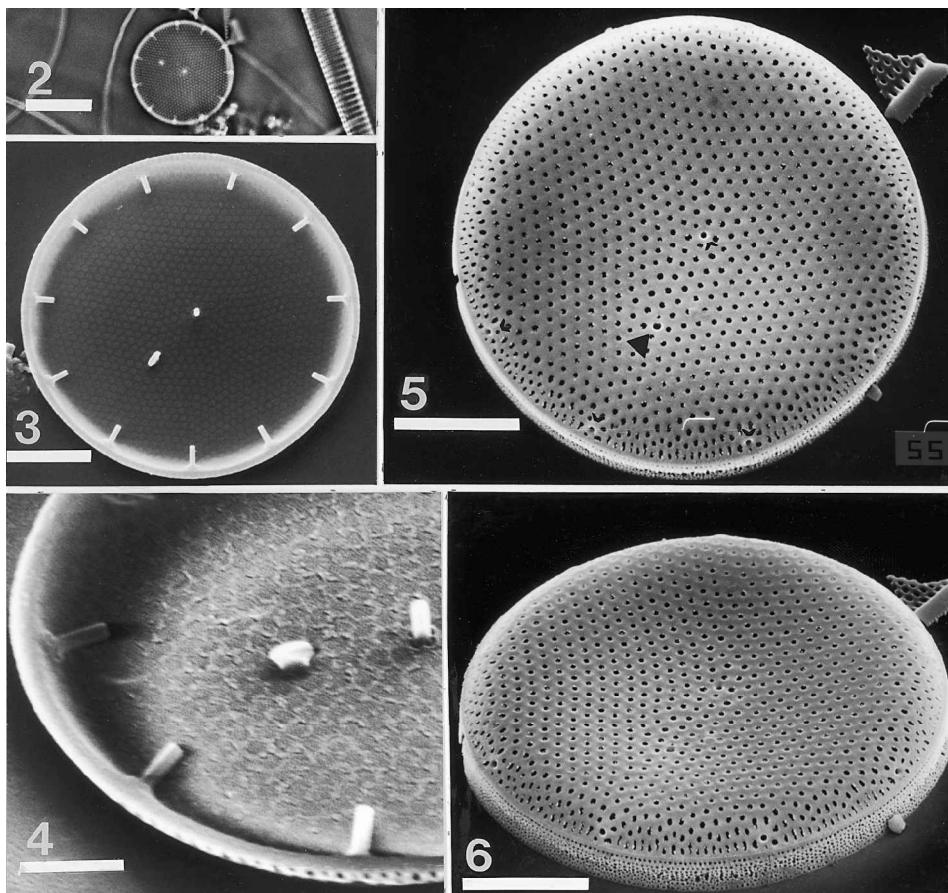
Species	Diameter in μm	Areolae in 10 μm		Strutted processes		Occluded processes	Labiate processes	Observations
		Valve	Marginal	Marginal in 10 μm	Valve face			
<i>T. angulata</i> (Gregory) Hasle*	8-21	8-14	12-18	one ring 2-5	One central		One close to a marginal strutted process	Areolae in tangential curved rows on valve face and in radial rows on mantle
<i>T. anguste-lineata</i> (Schmidt) Fryxell & Hasle	19-36	14	28	one ring 3	Arcs of 2-6 processes in a ring at some distance from valve centre		Single with prominent external tube between two marginal processes	Linear to eccentric to fasciculated areolation pattern
<i>T. delicatula</i> Ostenfeld	12-26	28-32	32-34	three rings 2-4 (in each ring)	One prominent strutted process close to a large areola in the central concavity	Variable number in a ring, between valve face and mantle, (can be absent in our materials)	One large labiate process on the inner marginal ring of strutted processes between valve face and mantle	Radial to fasciculated areolation pattern. Scattered strutted processes absent
<i>T. eccentrica</i> (Ehrenberg) Cleve	24-77	4-7	12-17	2-3 rings 2-4 (in each ring)	One adjacent to the central areola. Numerous scattered over the valve face.		One marginal	Eccentric areola array. Numerous spines on valve mantle
<i>T. endoseriata</i> Hasle & Fryxell *	24-54	10-13		one ring 5-6	One subcentral ring of 6-7 processes (each process takes the place of an areola within the complete radial rows)		One on valve face, between the marginal and subcentral rings of strutted processes	Fasciculated areola pattern
<i>T. hendeyi</i> Hasle & Fryxell*	40-100	5-6	12-13	two rings 3-5 (in each ring)	One adjacent to the central areola		Two with prominent external tubes 180° apart	Linear areola pattern
<i>T. mala</i> Takano**	6-8	25-35	40-50	one ring 10-14	Single eccentric		One marginal, between two marginal strutted processes	Eccentric-linear areolation pattern

<i>T. mediterranea</i> (Schröder) Hasle***	9-15	Not well defined	30	one ring close to valve margin 4	One ring of 4-6 processes, half way from centre to margin	One between two marginal strutted processes	Areolation not resolved with LM
<i>T. minima</i> Gaarder	10-12	22-26	28-30	one ring 4-5	Two central strutted processes with short external tubes	One near the margin close to one strutted process	Radial to eccentric areolation pattern
<i>T. minuscula</i> Krasske	10-32	32	32-36	one ring 4-5	One central	Single prominent process radially oriented, in from the margin	Fasciculated areolation pattern
<i>T. nanolineata</i> (Mann) Fryxell & Hasle*	15-24	14	14	one ring 4-5	One to six around the central areola	One marginal between two strutted processes	Linear areolation pattern
<i>T. pacifica</i> Gran & Angst*	14-21	12-19	22-25	one ring 4-5	One central adjacent to a large areola	One, as for a strutted process	Linear to eccentric to fasciculated areolation pattern
<i>T. proschkinae</i> Makarova*	4.5-10	24-29	24-29	one ring 1.8-2.1 µm apart	One central with six areolae around	One in radial position, one areola away from the central strutted process	Numerous spines on valve mantle
<i>T. punctigera</i> (Castracane) Hasle	43-170	10-14	15-20	one ring 4-8	One central	One, with large external tube	Fasciculated areolation pattern
<i>T. rotula</i> Meunier	25-58				Central cluster; scattered over the valve face	Single prominent between valve face and mantle	Valve face with radial ribs
<i>T. simonsenii</i> Hasle & Fryxell	20-21	7	10	two rings 4 (in each ring)	One central, adjacent to a small areola	Two, 180° apart	Linear areola pattern
<i>T. tenera</i> Proschkina-Lavrenko	6-26	10-13	13-16	one ring 3-5	One inside central areola	One between two marginal strutted processes	Linear areolation pattern

* New record for the Patagonia

** New record for Argentina

*** New record for the Southwestern Atlantic Ocean



Figs 2-6: *Thalassiosira frenguelliopsis*. Fig. 2. (LM). Valve view showing the distributional pattern of processes. Figs 3-6. (SEM). Fig. 3. Internal valve view showing the labiate process set halfway between centre and margin, one central strutted process and a marginal ring of strutted processes with internal tubes. Fig. 4. Detail of the central strutted process and the labiate process. Note the operculate strutted processes. Fig. 5. External valve view, with no external tubes of the processes. Small arrow: strutted processes, large arrow: labiate process. Fig. 6. External valve view showing the valvocopula. Fig. 2: scale bar = 10 μ m. Figs 3, 5, 6: scale bar = 5 μ m. Fig. 4: scale bar = 2 μ m.

***Thalassiosira frenguelliopsis* Fryxell & Johansen**

Figs 2-6

Johansen & Fryxell 1985: 168, figs 6, 67-68, 71, 81.

This small species is little known and has not been found since it was first described. Published figures show the species in LM and in internal SEM view. The valves are circular and flat, 12-34 μ m in diameter with no external projections of the processes. The valvocopula is striated with 50-52 vertical rows of pores in 10 μ m. The areolation

Table 2: Seasonal distribution of *Thalassiosira* species in the northern San Matías Gulf, April 1998 - February 2000.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
<i>T. angulata</i>		■	■	■	■	■		■	■	■		
<i>T. anguste-lineata</i>								■	■			
<i>T. delicatula</i>							■	■	■			
<i>T. eccentrica</i>		■	■	■		■	■	■	■	■	■	■
<i>T. endoseriata</i>					■							
<i>T. frenguelliopsis</i>			■	■	■	■		■	■			
<i>T. hendeyi</i>		■			■							
<i>T. mala</i>			■	■	■	■	■	■	■			
<i>T. mediterranea</i>				■	■	■	■	■	■			
<i>T. minima</i>				■		■		■	■			
<i>T. minuscula</i>		■	■	■	■	■	■	■	■	■		
<i>T. nanolineata</i>					■	■			■			
<i>T. pacifica</i>		■		■		■		■			■	
<i>T. proschkinae</i>		■		■	■	■		■			■	
<i>T. punctigera</i>					■	■	■	■	■		■	
<i>T. simonsenii</i>		■			■	■	■	■				
<i>T. rotula</i>					■	■	■	■	■	■		
<i>T. tenera</i>		■	■	■	■	■	■	■	■			

pattern of the valve face is irregularly eccentric to irregularly linear. The areolae are more closely arranged near the mantle than in the centre, 20-22 and 16-18 in 10 μ m, respectively. The single labiate process takes the place of an areola and is located on the valve surface set about halfway between centre and margin. One strutted processes is situated in the centre of the valve and further strutted processes are situated in a ring on the mantle close to the margin, 5-6.5 μ m apart. The processes have operculae partly occluding the satellite pores and long internal tubes. The density of the marginal striae is 24-29 in 10 μ m.

Diagnostic features: Operculate strutted processes with extending internal tubes, one in the centre. One labiate process located halfway between centre and margin.

Remarks: Our material differs from that described and illustrated by Johansen & Fryxell (1985) with respect to the number of areolae in 10 μ m in the centre (Table 3) and the morphology of the labiate process, apparently this was broken in their SEM micrographs.

Distribution in Argentina: *T. frenguelliopsis* has been reported from the south-western Atlantic Ocean by Johansen and Fryxell (1985). The type location is Agulhas 1980, station 20, 50°06'S, 11°46'E, and a paratype location is John Biscoe III, station 247, 54°55'S, 35°31'W. The material was collected from both stations in March, early austral autumn. In this study we found *T. frenguelliopsis* in Punta Orenge, Los Álamos, Las Grutas, Piedras Coloradas and Bajo de Oliveira, where it was rare to common in fall and winter.

Sample numbers of photographed material: 4611, 4612 and 4644.

Table 3: Comparisons of *T. frenguelliopsis* and other species with similar distributional patterns of processes on the valve.

Species	Reference	Diameter in μm	Areolae in $10\ \mu\text{m}$		Labiate process	Strutted processes		Areola pattern
			centre	edge		central	Distance apart μm	
<i>T. perpusilla</i>	Fryxell & Hasle (1979a)	6-15	18-22	18-22	1 (eccentric)	1 (eccentric)	8-10	Operculate Irregular, sometimes linear, fasciculated
<i>T. gracilis</i> var. <i>gracilis</i>	Fryxell & Hasle (1979a)	5-28	8-12	16-20	1 small, away from margin	1	3-3.5	Operculate Large areolae in centre
<i>T. gracilis</i> var. <i>expecta</i>	Fryxell & Hasle (1979a)	7-17	14-15	16-20	1 small, away from margin	1	2.5-3.5	Operculate Slightly larger areolae in centre
<i>T. oestrupii</i> var. <i>oestrupii</i>	Fryxell & Hasle (1980)	7-60	5-9	9-12	1 (2-3 areolae distant of the centre)	1 (nearly centre)	0.8-1.9	Trifurcate Sublinear
<i>T. oestrupii</i> var. <i>venrickae</i>	Fryxell & Hasle (1980)	5.5-39	6-9	7-11	1 (2-3 (1-5) areolae distant of the centre)	1 (nearly centre)	4-7	Trifurcate Eccentric
<i>T. rosulata</i>	Takano (1985)	7-22			1 radial, away from margin	1	3.4-5.6	? Radial striae Areola with no tangential walls
<i>T. proschkinae</i>	Hasle & Syvertsen (1996)	3-11.5 4.5-8*	25-30 24-29*	25-30 24-29*	1 (1 areolae distant of the centre)	1	1.8-2.1 1.5*	With no extending tubes inside the valve Eccentric
<i>T. frenguelliopsis</i>	Johansen & Fryxell (1985)	12-34 10-26*	7.5-16 16-20*	18 16-20*	1 radial, away from margin	1	6-8 6-6.5*	Operculate Irregular, linear or eccentric
<i>T. bioculata</i>	Hasle & Syvertsen (1996)	20-60	16-20	16-20	1 subcentral	1	5-7	Operculate Fasciculated

* This study

Thalassiosira mala Takano

Figs 7-10

Takano 1965: 1-4, figs 1 a-m, pl. 1, figs 1-8. Takano 1976: 57-65, figs 1-18. Hallegraeff 1984: 497, figs 2 a,b,c.

The cells are connected with mucilage threads and embedded in gelatinous formless masses. The valves are circular, flat, 6-8 μm in diameter. The areolation pattern is eccentric to irregularly linear. The areolae are hexagonal and large on the valve face (25-35 in 10 μm), and denser on the valve mantle (40-50 in 10 μm). There is one ring of strutted processes 10-14 in 10 μm . These strutted processes have four satellite pores, short internal tubes, no external tubes and they are externally surrounded by a hyaline area. A labiate process is situated in-between two marginal strutted processes and its external opening is larger than that of the strutted processes. A single strutted process set on the valve face with three satellite pores is placed near the radius passing through the marginal labiate process.

Diagnostic features: Operculate strutted processes with extending internal tubes, one eccentric and always placed near the radius passing through the marginal labiate process. The external openings of the labiate process and the eccentric strutted process are not easily distinguished from the areolae.

Remarks: *T. mala* was one of the first marine planktonic diatoms reported as being harmful to shellfish. The species grows embedded in gelatinous colonies that, in blooms, can produce the death of the bivalves by clogging their gills (Takano 1965). Our material is similar to that described by Takano (1965), with marginal strutted processes with four satellite pores and a subcentral one with three satellite pores. Aké-Castillo et al. (1999) described the marginal fulcra with three satellite pores, however their figure 19 shows three in lateral view so that it is to be expected to have a fourth one not seen in the perspective of the picture.

Distribution in Argentina: This warm to temperate water species (Hasle & Syvertsen 1996) is reported for the first time for Argentinian coastal waters. It was found in Punta Orengo, Banco Reparo, Los Álamos, Las Grutas, Piedras Coloradas, El Fuerte and Bajo de Oliveira, rare to common in fall and winter.

Sample numbers of photographed material: 4551 and 4582.

Thalassiosira mediterranea (Schröder) Hasle

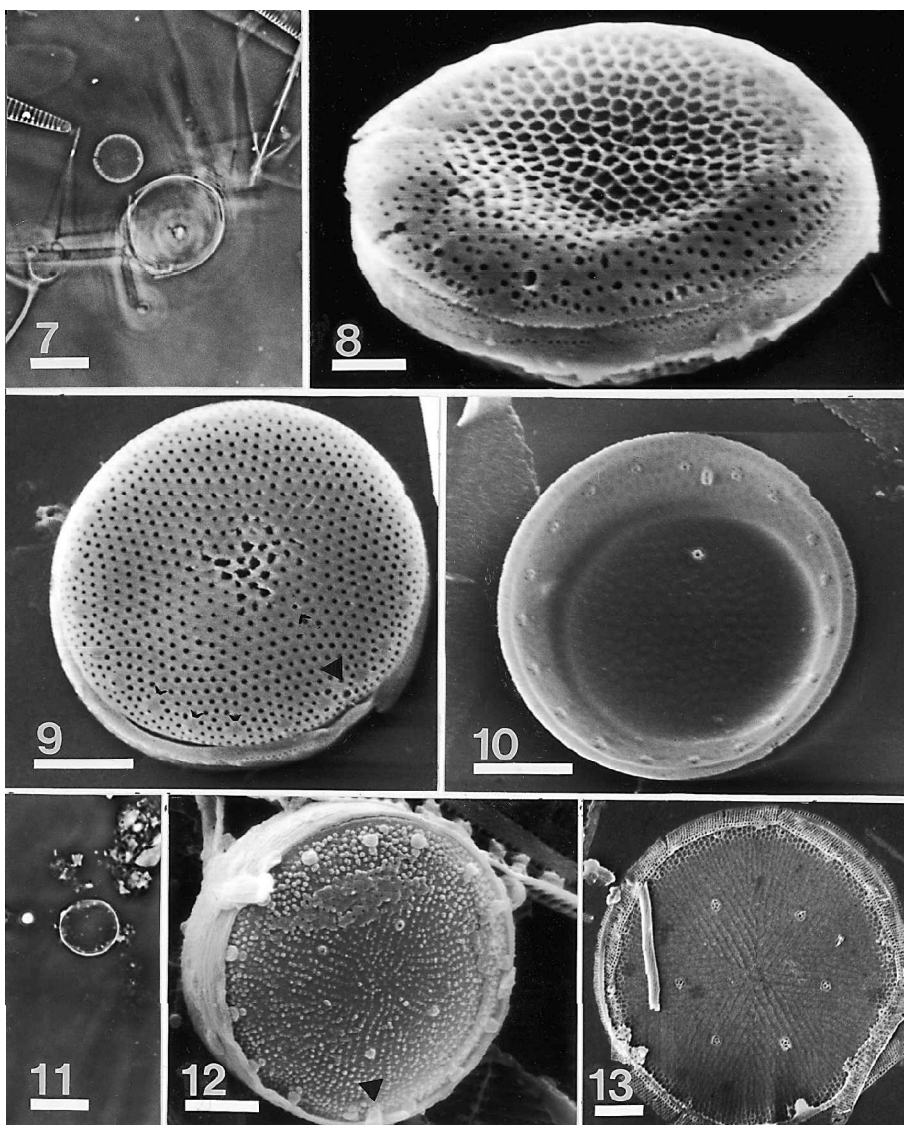
Figs 11-13

Hasle 1990: 415-418, figs 1-13. Fryxell & Hasle 1977: 72-73, figs 16-21 (as *T. stellaris*). Rivera 1981: 120-123, figs 353-358 (as *T. stellaris*).

Basionym: *Coscinosira mediterranea* Schröder

Synonyms: *Thalassiosira stellaris* Hasle & Guillard in Fryxell & Hasle

T. mediterranea was described as *T. stellaris* by Hasle & Guillard in Fryxell & Hasle (1977). Hasle (1990) designated the holotype and isotype of *T. stellaris* as neotype and isoneotype of *T. mediterranea*, and its diagnosis as the emended diagnosis. The cells are connected by many threads at some distance from the valve centre. The valves are disc-shaped, weakly silicified, and 12-14 μm in diameter. The areolae on



Figs 7-10. *Thalassiosira mala*. Fig. 7. (LM). Valve view showing the distributional pattern of processes. Figs 8-10. (SEM). Fig. 8. Whole cell showing external openings of marginal processes. Note the larger opening of the labiate process and the hyaline area surrounding the openings of the strutted processes. Fig. 9. External valve view showing a marginal ring of strutted processes, a labiate process and a subcentral strutted process. Small arrows: strutted processes, large arrow: labiate process. Fig. 10. Internal valve view showing the labiate process between two strutted processes and placed near the radius passing through the subcentral strutted process. Figs 11-13. *Thalassiosira mediterranea*. Fig. 11. (LM). Valve view showing the distributional pattern of processes. Fig. 12-13. (SEM). Fig. 12. Whole cell showing the subcentral ring and the marginal ring of strutted processes and the labiate process. Arrow: labiate process. Fig. 13. Internal valve view showing the areolation pattern. Figs 7, 11: scale bar = 10 μ m. Figs 9, 10, 12, 13: scale bar = 2 μ m. Fig. 8: scale bar = 1 μ m.

the valve face are elongated from centre to margin with some of the tangential walls missing. The radial striae are divergent towards the valve margin from a central annulus in fasciculated bundles. The marginal areolae on the valve mantle, ca. 30 in 10 µm, have fully developed walls. One ring of 3-6 evenly spaced strutted processes is located halfway between centre and margin. Each process takes the place of one areola in the central stria of the bundle. There is one marginal ring of strutted processes, 4 in 10 µm. One labiate process is placed either close to one strutted process or in-between two strutted processes of the marginal ring.

Diagnostic features: The stellate appearance of the areolation pattern in radial bundles and the subcentral ring of strutted processes.

Remarks: More silicified specimens with moderate to well defined areolae on valve face are shown in Fryxell & Hasle (1977, figs 17-20). Some of their specimens show in external view siliceous knobs at the areolae corners and siliceous warts on the strutted processes.

Distribution in Argentina: This warm to temperate water species (Hasle & Syvertsen 1996) is reported for the first time to the South Atlantic Ocean. It was found in Punta Orenge, Banco Reparo, Los Álamos, Las Grutas, Piedras Coloradas and Bajo de Oliveira, rare to common in fall and winter.

Sample numbers of photographed material: 4553, 4578, 4579, 4583, 4586, 4610 and 4644.

Discussion

In this study we report eighteen species of *Thalassiosira* of which *T. frenguelliopsis* is found for the first time since its description, *T. mediterranea* is a new record for the southwestern Atlantic Ocean, *T. mala* is a new record for Argentina, whereas *T. angulata*, *T. endoseriata*, *T. hendeyi*, *T. nanolineata*, *T. pacifica* and *T. proschkiniae* are new records for Patagonia. *T. eccentrica* was the most frequent and abundant species throughout the year. Almost all the species were a minor component of the plankton in fall and winter except *T. punctigera*, *T. tenera*, *T. mediterranea*, *T. mala* and *T. rotula* which were occasionally abundant.

T. mediterranea was compared with those species that have a modified ring of strutted processes set at some distance from the valve centre by Hasle and Fryxell (1977) and Rivera (1981), and *T. mala*, which has a unique process pattern (Takano 1990), was compared with *T. pseudonana* by Takano (1976). *T. frenguelliopsis* however, was only compared with a few akin species by Johansen & Fryxell (1985). The distributional pattern of processes on the valve in *T. frenguelliopsis* is similar to that in *T. bioculata* (Grunow) Ostenfeld, *T. gracilis* var. *expecta* Fryxell & Hasle, *T. gracilis* (Karsten) Hustedt var. *gracilis*, *T. oestrupii* (Ostenfeld) Hasle var. *oestrupii*, *T. oestrupii* var. *venrickae* Fryxell & Hasle, *T. perpusilla* Kozlova, *T. rosulata* Takano and *T. proschkiniae* Makarova. Some morphological and morphometrical data about these species, with one central or subcentral strutted process and one labiate process on the valve face are summarised in Table 3. *T. proschkiniae* differs from *T. fren-*

guelliopsis and the other species of the group by having strutted processes with no long tubes inside and with short tubes outside the valve (Sar et al. 2001).

Morphological similarities of the species mentioned above, except *T. proshkinae*, include long tubes of the strutted processes internally but not externally. However *T. oestrupii* var. *oestrupii* and *T. oestrupii* var. *venrickae* have trifultate strutted processes and coarse areolation in the centre of the valve (Fryxell & Hasle 1980) while *T. frenguelliopsis* has operculate processes and fine areolation. In the case of *T. rosulata*, according to the description and micrographs shown by Takano (1985), the areolae have no tangential walls and the labiate process is located rather near the edge of the valve, on the other hand *T. frenguelliopsis* has clearly walled areolae and labiate process set about half way from the centre and the margin. The fine structure of strutted processes can not be compared because Takano (1985) presents no information about them.

We agree with the observations of Johansen & Fryxell (1985) concerning the differences between *T. frenguelliopsis* and both varieties of *T. gracilis*: the distance of the marginal strutted processes is greater in *T. frenguelliopsis*. In addition, *T. gracilis* var. *gracilis* and *T. gracilis* var. *expecta* have a small labiate process near the margin (Fryxell & Hasle 1979a) while *T. frenguelliopsis* has a larger labiate process, more distant from the margin. On the other hand Johansen & Fryxell (1985) mentioned in their discussion that the areolar density of *T. frenguelliopsis* is coarser than that of *T. perpusilla*. Our material has 16-20 areolae in 10 µm in the centre, not so different from *T. perpusilla* (18-22), but the marginal strutted processes are more distant in this species and the strutted process on valve surface is eccentric as illustrated by Fryxell & Hasle (1979a).

According to the morphological and morphometric data given by Hasle (1972) and Hasle & Syvertsen (1996) for *T. bioculata*, this species is very similar to *T. frenguelliopsis* (Table 3). However, the labiate process has a different position in both species, just beside the valve centre in the former (Hasle & Heimdal 1998, fig. 5A) and more distant from the centre in the latter species.

The separation of *T. frenguelliopsis* from *T. frenguelli* Kozlova pointed out by Johansen & Fryxell (1985) was based in the differences about fine structure of strutted processes in each species, operculate in the former and trifultate in the latter (Fryxell & Hasle 1979b), and in the number of marginal striae in 10 µm, which is higher in *T. frenguelliopsis*. Another distinguishing characteristic is the number of central strutted processes, only one in *T. frenguelliopsis* and one or two in *T. frenguelli* (Hasle & Syvertsen 1996). It is necessary to use multiple characters, some of them ultra-structural, to separate *T. frenguelliopsis* from the similar species.

Acknowledgements

We would like to thank Dr. Silvia Sala for critically reading the manuscript and Ms. Nilda Malacalza and Mr. Javier Farina for their technical assistance. Special acknowledgements are due to an anonymous reviewer, who contributed to improving this paper. The electron microscopy was carried out at the Servicio de Microscopía Electrónica of the Facultad de Ciencias Naturales y Museo. The research was supported by grants from the CONICET, PIP 0525/98, and the Agencia Nacional de Promoción Científica y Tecnológica, PICT 98/4221.

References

- AKÉ-CASTILLO, J.A., D.U. HERNÁNDEZ-BECERRIL & M.E. MEAVE DEL CASTILLO (1999): Species of the genus *Thalassiosira* (Bacillariophyceae) from the Gulf of Tehuantepec, Mexico. - *Bot. Mar.* **42**: 487-503.
- CARRETO, J.I. & C.A. VERONA (1974): Fitoplancton, pigmentos y condiciones ecológicas del Golfo San Matías I. Campaña SAO I. C.I.C. - Inst. Biol. Mar. Mar del Plata, Contr. **235**. Informe 10 de la Comisión de Investigaciones Científicas de la Provincia de Buenos Aires: 1-20.
- CARRETO, J.I., C.A. VERONA, A.B. CASAL & M.A. LABORDE (1974): Fitoplancton, pigmentos y condiciones ecológicas del Golfo San Matías III. - Inst. Biol. Mar. Mar del Plata, Contr. **237**. Informe 10 de la Comisión de Investigaciones Científicas de la Provincia de Buenos Aires: 49-76.
- FERRARIO, M.E. & E.A. SAR (1988): Marine diatoms from Chubut (Argentina Republic) Centrales II - *Thalassiosira*. - *Rev. Brasil. Biol.* **48**: 421-429.
- FERRARIO, M.E., E.A. SAR & S.E. SALA (1995): Metodología básica para el estudio del fitoplancton con especial referencia a las diatomeas. - In: ALVEAL, K., M.E. FERRARIO, E.C. DE OLIVEIRA & E. SAR (eds): Manual de Métodos Ficológicos: 1-23. Universidad de Concepción, Editora A. Pinto, Chile.
- FRENGUELLI, J. (1935): Variaciones de *Dictyocha fibula* en el Golfo de San Matías (Río Negro). - *Anal. Mus. Argent. Cs. Nat. 'Bernadino Rivadavia'* **38**, Protist. **4**: 265-281.
- FRENGUELLI, J. (1939): XV Contribución al conocimiento de las diatomeas argentinas. Diatomeas del Golfo de San Matías (Río Negro). - *Revista de museo de La Plata (N.S.)* **2**, Sección Botánica **10**: 201-226.
- FRYXELL, G.A. & G.R. HASLE (1977): The genus *Thalassiosira*: some species with a modified ring of central strutted processes. - *Nova Hedwigia, Beih.* **54**: 67-98.
- FRYXELL, G.A. & G.R. HASLE (1979a): The genus *Thalassiosira*: species with internal extensions of the strutted processes. - *Phycologia* **18**: 378-393.
- FRYXELL, G.A. & G.R. HASLE (1979b): The genus *Thalassiosira*: *T. trifulta* sp. nov. and other species with tricolunular supports on strutted processes. - *Nova Hedwigia, Beih.* **64**: 13-32.
- FRYXELL, G.A. & G.R. HASLE (1980): The marine diatom *Thalassiosira oestrupii*: structure, taxonomy and distribution. - *Amer. J. Bot.* **67**: 804-814.
- GAYOSO, A.M. (1989): Species of the diatom genus *Thalassiosira* from a coastal zone of the South Atlantic (Argentina). - *Bot. Mar.* **32**: 331-337.
- HALLEGRAEFF, G.M. (1984): Species of the diatom genus *Thalassiosira* in Australian waters. - *Bot. Mar.* **27**: 495-513.
- HASLE, G.R. (1972): Two types of valve processes in centric diatoms. - *Nova Hedwigia, Beih.* **39**: 55-78.
- HASLE, G.R. (1990): The planktonic marine diatom *Thalassiosira mediterranea* (synonym *Thalassiosira stellaris*). - *Diat. Res.* **5**: 415-418.
- HASLE, G.R. & G.A. FRYXELL (1970): Diatoms: cleaning and mounting for light and electron microscopy. - *Trans. Amer. Microscop. Soc.* **89**: 469-474.
- HASLE, G.R. & G.A. FRYXELL (1977): The genus *Thalassiosira*: Some species with a modified ring of central strutted processes. - *Nova Hedwigia, Beih.* **54**: 67-98.
- HASLE, G.R. & B.R. HEIMDAL (1998): The net phytoplankton in Kongsfjorden, Svalbard, July 1988, with general remarks on species composition of arctic phytoplankton. - *Polar Res.* **17**: 31-52.
- HASLE, G.R. & E.E. SYVERTSEN (1996): Marine diatoms. - In: TOMAS, C.R. (ed.): Identifying Marine Phytoplankton: 5-385. Academic Press, San Diego, California.

- JOHANSEN, J.R. & G.A. FRYXELL (1985): The genus *Thalassiosira* (Bacillariophyceae): studies on species occurring south of the Antarctic Convergence Zone. - *Phycologia* **24**: 155-179.
- LANGE, C., R.M. NEGRI & H.R. BENAVIDES (1983): Algunas especies del género *Thalassiosira* (Bacillariophyceae) del Mar Argentino. (Parte 1). - *Iheringia, Bot.* **31**: 9-30.
- RIVERA, P. (1981): Beiträge zur Taxonomie und Verbreitung de Gattung *Thalassiosira* Cleve (Bacillariophyceae) in den Küstengewässern Chiles. - *Biblioth. Phycol.* **56**: 1-220.
- ROSS, R., E.J. COX, N.I. KARAYEVA, D.G. MANN, T.B. PADDOCK, R. SIMONSEN & P.A. SIMS (1979): An amended terminology for the siliceous components of the diatom cell. - *Nova Hedwigia, Beih.* **64**: 513-533.
- SAR, E.A. (1989): Ultrastructure of *Odontella rostrata* (Hustedt) Simonsen, a new record for the South Atlantic Ocean. - *Bot. Mar.* **32**: 187-189.
- SAR, E.A. (1996a): Flora diatomológica de Bahía San Antonio (Prov. de Río Negro, Argentina). O. Centrales I. - *Revista del Museo de La Plata (N.S.)* **14**, Sección Botánica **106**: 365-400.
- SAR, E.A. (1996b): Flora diatomológica de Bahía San Antonio (Prov. de Río Negro, Argentina) Orden Pennales I. - *Revista del Museo de La Plata (N.S.)* **14**, Sección Botánica **107**: 399-432.
- SAR, E.A. & M.E. FERRARIO (1990): *Licmophora flabellata*: ultrastructure and taxonomy I. Implications. - *Diat. Res.* **5**: 403-408.
- SAR E. A., I. SUNESEN & C. CASTAÑOS (2001): Marine diatoms from Buenos Aires coastal waters (República Argentina). I. *Thalassiosiraceae*. - *Nova Hedwigia* **73**(1-2): 199-228.
- TAKANO, H. (1965): New and rare diatom from Japanese marine waters - *Bull. Tokai Reg. Fish. Res. Lab.* **42**: 1-9.
- TAKANO, H. (1976): Scanning electron microscopy of diatoms - II. *Thalassiosira mala* Takano. - *Bull. Tokai Reg. Fish. Res. Lab.* **87**: 57-65.
- TAKANO, H. (1985): Two new diatoms in the genus *Thalassiosira* from Japanese marine waters. - *Bull. Tokai Reg. Fish. Res. Lab.* **116**: 1-11.
- TAKANO, H. (1990): Diatoms. - In: FUKUYO, Y., H. TAKANO, M. CHIHARA & K. MATSUKA (eds): Red tides organisms in Japan - An illustrated taxonomic guide: 162-331. Uchida Rokakuho, Tokyo.
- VERONA, C.A., J.I. CARRETO & A. HINOJAL (1974): Fitoplancton, pigmentos y condiciones ecológicas del Golfo San Matías II. Campaña SAO II (mayo de 1971). - *Inst. Biol. Mar. Mar del Plata, Contr.* **236**. Informe 10 de la Comisión de Investigaciones Científicas de la Provincia de Buenos Aires: 23-48.

Received 24 August 2000, accepted in revised form 5 September 2001.