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First record of *Thalassiosira catharinensis* (Bacillariophyta) from Argentinean marine coastal waters

ANDREA S. LAVIGNE[1], INÉS SUNESEN[1,2] and EUGENIA A. SAR[1,2*]

Summary: Several ultrastructural analyses of taxa belonging to the genus *Thalassiosira* from Argentinean coastal waters were carried out, nevertheless, the smaller fraction of the nanoplanktonic *Thalassiosira* was frequently overlooked. The aim of this study is to show the morphological variation of *T. catharinensis*, to compare material found in marine coastal waters of Anegada Bay, Province of Buenos Aires, with the material analyzed in the protologue and allied taxa, and to record the species for the first time in Argentina, extending its distribution.

Key words: Anegada Bay, Argentina, diatoms, first record, marine coastal waters, *Thalassiosira catharinensis.*

Resumen: Primer registro de *Thalassiosira catharinensis* (Bacillariophyta) en aguas costeras marinas argentinas. A pesar de que se llevaron a cabo varios estudios ultraestructurales de taxones pertenecientes al género *Thalassiosira* procedentes de las aguas costeras de la Argentina, la fracción más pequeña de los taxones nanoplanctónicos de *Thalassiosira* fue pasada por alto con frecuencia. El objetivo de este estudio es mostrar la variabilidad morfológica de *T. catharinensis*, comparar los materiales encontrados en las aguas marinas costeras de la Bahía Anegada (Provincia de Buenos Aires) con el material analizado en el protólogo y con taxones afines, y registrar la especie por primera vez para Argentina, extendiendo su distribución.

Palabras clave: aguas marinas costeras, Argentina, Bahía Anegada, diatomeas, primer registro, *Thalassiosira catharinensis*

Introduction

The genus *Thalassiosira* Cleve emend. Hasle (1973) is an important component of the marine phytoplankton in coastal environments worldwide. According to the diatom list in DiatomBase (Kociolek *et al*., 2017) it comprises 381 specific and infraspecific names, including synonyms. The genus *Thalassiosira* was more or less recently split into new genera: *Roundia* Makarova (1994), *Takanoa* Makarova (1994), *Shionodiscus* Alverson, Kang & Theriot (2006), *Spicaticribra* Johansen, Kociolek & Lowe (2008) and *Conticribra* Stachura-Suchoples & Williams (2009).

Ultrastructural analyses of taxa belonging to the genus *Thalassiosira* from Argentinean coastal waters were carried out by Lange *et al*. (1983), Sar & Ferrario (1987), Ferrario & Sar (1988), Gayoso (1989), Sar (1996), Sar *et al*. (2001, 2002, 2011), Sunesen & Sar (2004), Sunesen (2007) and Sar & Sunesen (2017). Some of the taxa analyzed in the mentioned literature were transferred to *Shionodiscus* Alverson, Kang & Theriot in Alverson *et al*. (2006) and *Minidiscus* Hasle emend Park in Park *et al*. (2017), and most part of them corresponds to the microplankton or to the largest fraction of the nanoplankton. By contrast, the smaller fraction of the nanoplanktonic *Thalassiosira* species was frequently overlooked.

Recently, Garcia & Mareschi Bissa (2016) and Garcia & Bärwaldt Dutra (2016) analyzed two small nanoplanktonic species of *Thalassiosira* from the South Atlantic Ocean. Garcia & Bärwaldt Dutra (2016) described *T. catharinensis* Garcia,

[1] División Ficología "Dr. Sebastián A. Guarrera", Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, Argentina.
[2] Consejo Nacional de Investigaciones Científicas y Técnicas, CONICET, Argentina.
* easar@fcnym.unlp.edu.ar

from Praia do Gi, Laguna, Santa Catarina State, Southern of Brazil.

The aim of this study is to show the morphological variation of *Thalassiosira catharinensis*, a small nanoplanktonic species found for the first time in Argentinean waters, and to compare it with material analyzed in its protologue and other allied taxa.

Material and Methods

The material analyzed was collected at three locations along Anegada Bay: Los Pocitos (40º 25' 47''S-62º 25' 18''W), Ría del Jabalí (40º 32' 25''S-62º 17' 36''W) and Bahía San Blas (40º 32' 49''S-62º 14' 13''W), at the southern coast of Province of Buenos Aires, from May 2008 to December 2017. 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 oxidized according to Hasle & Fryxell (1970) and Prygiel & Coste (2000). The cleaned material was mounted for light (LM) and scanning electron microscopy (SEM) after Ferrario *et al*. (1995). Permanent mounts were made with Naphrax (Brunel Microscopes, Chippenham, UK).

The raw and treated samples, slides and stubs material were deposited in the Herbarium (index herbariorum LPC), División Ficología "Dr. Sebastián A. Guarrera", Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata, under the numbers LPC 11601 to LPC 12146.

Observations were made with a light microscope Zeiss Axiovert 40 CFL (phase contrast and DIC diferential interference contrast). Photomicrographs were taken with a Jeol JSM 6360 LV (JEOL, Tokyo, Japan) scanning electron microscope.

Terminology follows Fryxell & Hasle (1979), Ross *et al*. (1979), Syvertsen & Hasle (1984) and Round *et al*. (1990). Considering the very small diameter of the analyzed material, fultoportula density in 10 µm was determined following Hasle (1983) as: $n \times 10 / \pi \times d$, where n is the number of marginal fultoportulae observed in the valve and d is the valve diameter.

Results

Morphological characterization of Anegada Bay's taxon

Fig. 1 A-D

The material presents circular valves (Fig. 1A, B), 6.2-7.4 µm in diameter. The valve is slightly silicified, the valve surface is frequently collapsed (Fig. 1B) and the valve mantle is shallow, 2-3 areolae in height. The striation pattern is radial, areolae are elliptical, 39-43 in 10 µm, arranged in radial striae, 47-52 in 10 µm. The portula pattern is characterized by one central fultoportula, a marginal ring of fultoportulae on the valve mantle, 3.0-3.4 in 10 µm (Fig. 1A, B) and a marginal rimoportula (Fig. 1A, arrowhead). The central fultoportula has a very short external (Fig. 1A, B) and internal tube (Fig. 1B, D, arrowheads). The marginal fultoportulae have cylindrical external tubes, and shorter internal tubes (Fig. 1A, B) surrounded by 3 operculate satellite pores (Fig. 1C). The rimoportula is close to one fultoportula of the marginal ring, similar in diameter, with the external tube opening in different direction than the tubes of fultoportulae (Fig. 1A, arrowhead).

The comparison of our taxon with the specimens illustrated by Garcia & Bärwaldt Dutra (2016: 62, Figs. 1-14) as *Thalassiosira catharinensis* based on distribution pattern of portulae, density of fultoportulae, location, morphology of the external apertures of fultoportulae and rimoportula, number of satellite pores of the marginal fultoportulae (Table 1), allowed us to determine that both taxa are conspecific. *T. catharinensis* material from Anegada Bay shows subtle differences with that described in the protologue in size (6.2-7.4 vs. 4.4-6.6 µm) and stria density (47-52 vs. 50-60). Valve mantle was described by Garcia & Bärwaldt Dutra (2016) as 1-2 areolae in height, nevertheless protologue's figures 5-8 show mantle is 2-3 areolae height.

Photographed material: LPC 11644, Ría del Jabalí, 18/01/2009.

Distribution: *Thalassiosira catharinensis* was scarce in phytoplankton samples in Ría del Jabalí on summer (waters temperature ranged between 18.5 and 19.5ºC). This is the first record of the species in Argentinian coastal waters and extends the distribution given by Garcia & Bärwaldt Dutra

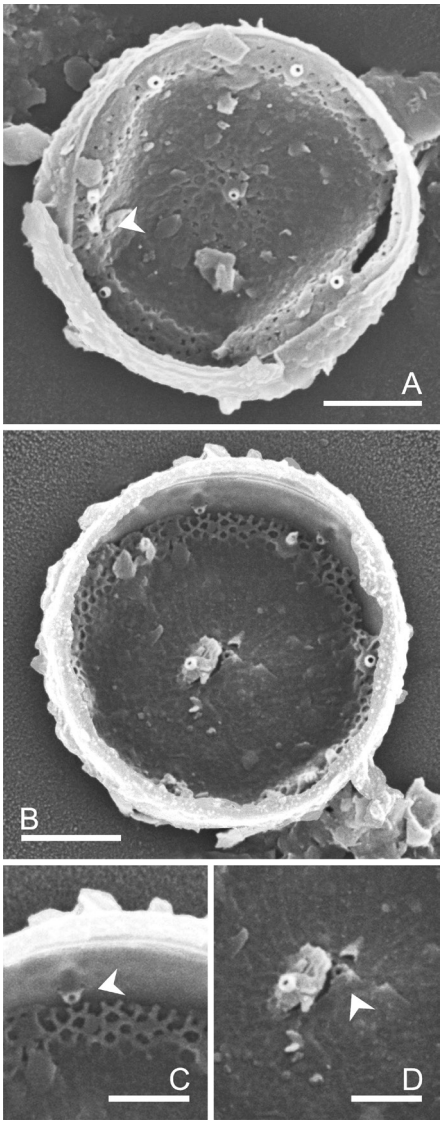

Fig. 1. *Thalassiosira catharinensis.* SEM. **A-D**: Valves in external view. **A**: Frustule showing external tubes of the central fultoportula, the marginal fultoportulae, and a marginal rimoportula close to one fultoportula of the marginal ring (arrowhead), LPC 11644. **B**: Frustule with a collapsed valve showing external tube of one valve (apparently eccentric due to the displacement of the valve towards one side of the frustule) and internal tube of the other valve. Note marginal fultoportulae in internal view at 2 and 12 o'clock, LPC 11644. **C**: Detail of the figure B. Note internal view of a marginal fultoportula showing three satellite pores (arrowhead). **D**: Detail of the broken central area of a valve showing external and internal (arrowhead) tube of the fultoportula. Scale bars: A, B = 2 µm; C, D = 1 µm.

(2016) that described it from Southern Brazil. It occurs in some samples together with *T. laevis*, recently cited by Sar & Sunesen (2017) from northern coastal waters of the Province of Buenos Aires, Argentina, and found for first time from Anegada Bay during this study.

Discussion

Thalassiosira catharinensis belongs to the nanoplanktonic size group of the genus with a central fultoportula, a marginal ring of fultoportulae and a marginal rimoportula. *T. laevis*, *T. mala* Takano, *T. pseudonana* Hasle & Heimdal, *T. allenii* Takano, *T. binata* Fryxell and *T. conferta* Hasle, previously quoted for Argentina, belong to the same group. The comparison between *T. catharinensis* and *T. laevis*, *T. mala*, *T. profunda* (Hendey) Hasle, and *T. pseudonana* was presented by Garcia & Bärwaldt Dutra (2016, Table 1). In this study we added comparisons of *T. catharinensis* with other species previously quoted for Argentina having diameter of less than 10 µm and sharing portulae pattern.

Thalassiosira catharinensis can be distinguished from *T. allenii* (Takano, 1965, figs. 2, 9-11; Hasle & Fryxell, 1978, figs. 100-128) by a higher density of areolae on valve surface, not resolved in LM (39-48 vs. 18-24) and lower density of marginal fultoportulae (3.0-3.4 vs. 5-7).

Thalassiosira binata (Hasle & Fryxell, 1977, figs. 24-38; Sar *et al*., 2001, figs. 8-10) is easily distinguished from *T. catharinensis* by the height of the valve mantle (6 vs. 2-3 areolae), the length of the external tubes of the marginal fultoportulae (long vs. short), and the presence of a depressed central areola adjacent to the central fultoportula in *T. binata*.

Thalassiosira conferta Hasle (Hasle & Fryxell, 1977, figs. 1-23; Lange *et al*., 1983, figs. 10-12) differs from *T. catharinensis* by the position and diameter of the rimoportula, placed between two closely located fultoportulae with narrower external tube.

In addition, the comparison was also extended to other members of *Thalassiosira* belonging to the same group, *T. bulbosa* Syvertsen, *T. oceanica* Hasle and *T. partheneia* Schrader, not quoted for Argentina until now.

Table 1. Comparison between *Thalassiosira catharinensis* from Anegada Bay (this study) and Santa Catarina State based on the protologue. Abbreviations: nd, no data; *, measured or observed from the protologue's figures.

Thalassiosira catharinensis	Garcia & Bärwaldt Dutra (2016)	This study (n = 20)
Diameter in µm	4.4-6.6	6.2-7.4
Striation pattern	radial	radial
Valve mantle, areolae in height	1-2	2-3
	2-3*	
Striae at the margin of the valve surface in 10 µm	nd	47-52
	ca. 50-60*	
Areolae in 10 µm on valve face	39-48	39-43
Fultoportulae on valve face: number, location, morphology	1 central, with external and internal tube	1 central, with external and internal tube
Marginal fultoportulae in 10 µm, morphology	3.0-3.3, with external and internal tubes	3.0-3.4, with external and internal tubes
Number of satellite pores of the marginal fultoportulae	3, operculate*	3, operculate
Rimoportula	one, close to one fultoportula of the marginal ring, with external tube	one, close to one fultoportula of the marginal ring, with external tube
External aperture of the rimoportula	cylindrical tube, opening in different direction than the tubes of fultoportulae	cylindrical tube, opening in different direction than the tubes of fultoportulae

Thalassiosira bulbosa Syvertsen (Syvertsen & Hasle, 1984, figs. 1-32) has marginal fultoportulae with low bulb-shaped outer tubes while *T. catharinensis* presents cylindrical outer tubes, the marginal fultoportulae are denser in the former than in the latter (4.5 vs. 3.0-3.4) and rimoportula is placed between two fultoportulae in the former and next to one fultoportula in the latter.

Thalassiosira oceanica Hasle (Hasle, 1983, figs. 1-18; Park & Lee, 2010, figs. 15-22) has a marginal ridge structure between the fultoportulae absent in *T. catharinensis* and *Thalassiosira partheneia* Schrader (Schrader, 1972, figs. 1-12; Hasle, 1983, figs. 19-33) has long internal tubes of the marginal fultoportulae with two satellite pores while *T. catharinesis* has short internal tubes of the marginal fultoportulae with three satellite pores.

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