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Marine diatoms from Buenos Aires coastal waters (Argentina). IV. *Rhizosolenia s. str.*, *Neocalyptrella*, *Pseudosolenia*, *Proboscia*

INÉS SUNESEN[†,‡]* AND EUGENIA A. SAR[§]

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

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The present paper describes the morphology, taxonomy, and distribution of species belonging to the diatom genera *Rhizosolenia s. str*., *Neocalyptrella*, *Pseudosolenia* and *Proboscia*, found in the marine coastal waters of Buenos Aires Province, Argentina. The phytoplankton samples were collected from October 1994 to September 2000 at seven locations and were analyzed by light and scanning electron microscopy. *Rhizosolenia antennata* f. *antennata*, *R. bergonii*, *R. hyalina*, *R. imbricata*, *R. setigera* f. *setigera*, *R. setigera* f. *pungens*, *Neocalyptrella robusta*, *Pseudosolenia calcar-avis*, *Proboscia alata* and *P. indica* were studied and compared with allied taxa. Morphology of the frustule and of the resting spore of *R. setigera*, which is considered by some authors *incerta sedis*, shows that this species might be included into the genus *Rhizosolenia s. str*. *Rhizosolenia hyalina* is reported for the first time from Argentinean coastal waters. *R. setigera* f. *setigera*, *R. setigera* f. *pungens*, *P. alata,* and *P. calcar-avis*, cited as harmful non-toxigenic taxa in other geographical areas, were never associated with harmful events in the study area.

KEY WORDS: Diatoms, Harmful species, *Rhizosolenia s. str.*, *Neocalyptrella*, *Pseudosolenia*, *Proboscia*

INTRODUCTION

The genus *Rhizosolenia* was established by Ehrenberg (1843) with *R. americana* as the type. Later, Brightwell (1858) provided a detailed description of the genus. Subsequently, Hendey (1937) proposed that *Rhizosolenia* Brightwell should be conserved against *Rhizosolenia* Ehrenberg, with *R. styliformis* as the type. According to Fourtanier & Kociolek (1999) *Rhizosolenia* Brightwell was formally conserved by Lanjouw *et al.* (1956) and *R. styliformis* was selected as the type of the genus by Greuter *et al.* (1994).

Rhizosolenia Brightwell was considered by Hasle (1975) as a morphologically heterogeneous genus. More recently, based on the review of *Rhizosolenia sensu lato* presented by Sundström (1986) and other studies carried out by Round *et al.* (1990) and Hernández-Becerril & Meave del Castillo (1996, 1997), the genus was split into the following genera: *Rhizosolenia* Brightwell *sensu stricto*, *Neocalyptrella* Hernández-Becerril & Meave, *Pseudosolenia* Sundström, *Urosolenia* Round & Crawford and *Proboscia* Sundström. All the above-mentioned genera are found exclusively in marine environments, except for *Urosolenia*, which is restricted to continental waters (Rott *et al.* 2006). In addition, some species traditionally included in *Rhizosolenia* were transferred to *Guinardia* H. Peragallo and *Dactyliosolen* Castracane (Hasle & Syvertsen 1996).

According to Sundström (1986) and Hernández-Becerril & Meave del Castillo (1996, 1997), *Rhizosolenia s. str.*, *Neocalyptrella*, *Pseudosolenia* and *Proboscia* are very common marine diatoms and sometimes dominate the phytoplankton biomass in highly productive areas of the ocean.

Several species of *Rhizosolenia s. l.* have been reported as producers of important blooms in different areas of the world (Jordan & Priddle 1991; Jordan *et al.* 1991; Takahashi *et al.* 1994; Gárate-Lizárraga *et al.* 2003) and some of them as forming macroscopic aggregates up to 30 cm in size (Shipe *et al.* 1999).

In areas where filter-feeding bivalve molluscs are harvested from natural banks or aquaculture sites, blooms of some species of *Rhizosolenia* (i.e. *R. chunii* Karsten among others) may produce noxious effects related to changes in the taste of mussels, scallops and oysters (Blanco-Pérez 2001; Fryxell & Hasle 2004). Horner *et al.* (1997) established that *R. setigera* Brightwell produces harmful non-toxic blooms that may kill fish or invertebrates due to oxygen depletion or may change or disrupt food-web dynamics on the west coast of North America.

Some of the solenoid diatoms, particularly those not analyzed by Sundström (1986), Jordan *et al.* (1991), Takahashi *et al.* (1994), Jordan & Saito (1999), Jordan & Ligowski (2004, 2006) and Hernández-Becerril & Meave del Castillo (1996, 1997), require detailed scanning electron microscope (SEM) studies to elucidate their taxonomical position from a morphological point of view. We used the samples collected in the course of a monitoring project on harmful non-toxic diatoms from Buenos Aires coastal waters (Argentina) to study ultrastructural features of these taxa and to provide new data on their distribution.

Vouilloud (2003), in her diatom bibliography catalogue from Argentina, listed 19 taxa of *Rhizosolenia s. l.*, 11 of which are now included in the genus *Rhizosolenia s. str.*, one in the genus *Neocalyptrella*, one in the genus *Pseudosolenia*,

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* Corresponding author: isunesen@fcnym.unlp.edu.ar

[†] Universidad Nacional de La Plata

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[§] Consejo Nacional de Investigaciones Científicas y Técnicas

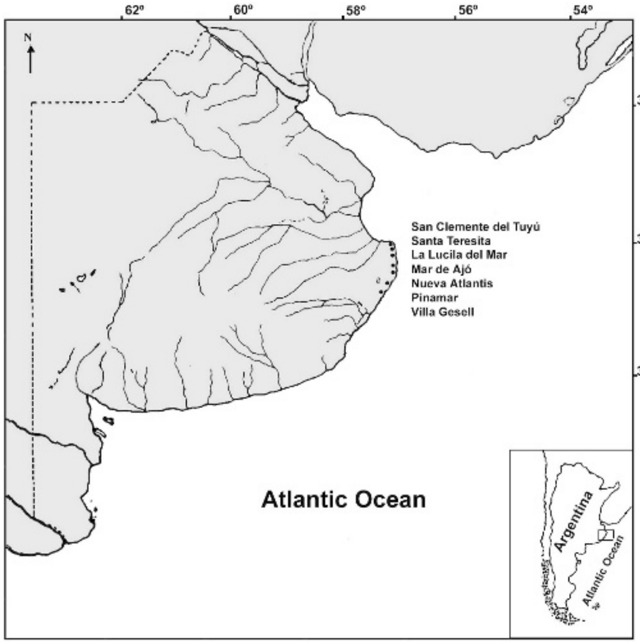


Fig. 1. Map of Buenos Aires Province showing the sampling stations and location of the area in Argentina.

three in the genus *Proboscia*, while the other three belong to the genera *Guinardia* and *Dactyliosolen*, which are not treated in this paper. All these taxa were reported in checklists or in papers without detailed morphological analysis. We have focused our attention on the analysis of some diatoms from the families *Rhizosoleniaceae* De Toni and *Probosciaceae* Jordan & Ligowski, which were common in the Buenos Aires area. The purposes of this paper were to provide an account of the genera *Rhizosolenia s. str.*, *Neocalyptrella*, *Pseudosolenia* and *Proboscia* in Argentinian waters and to search for associations between detected harmful species and registered harmful events in our area.

MATERIAL AND METHODS

Phytoplankton samples were collected at seven stations located along the coast of Buenos Aires Province between parallels 36°20′ and 37°20′S: San Clemente del Tuyú, Santa Teresita, La Lucila del Mar, Mar de Ajó, Nueva Atlantis, Pinamar and Villa Gesell (Fig. 1). Thirty-four sample sets comprising 211 qualitative samples were acquired from November 1994 to September 2000 (Table 1). Samples were collected from the surface layer of the water column, between 0 and 5 meters depth, with 30 μm net hauls, and fixed with 4% formalin.

Samples were treated to eliminate organic matter following Hasle & Fryxell (1970) and Prygiel & Coste (2000). The cleaned material was mounted and then observed using light and scanning electron microscopes according to Ferrario *et al.* (1995). Raw and treated samples, and permanent slides correlatively labeled, were incorporated into the Colección de Diatomeas Argentinas and deposited at the Departamento Científico Ficología, Facultad de Ciencias Naturales y Museo, Universidad Nacional de La Plata under the numbers LPC 4250 to 4449 and 4485 to 4495 (Table 1).

Microscopic observations were made with two light microscopes (LM), Wild M20 and Nikon Microphot FX, using phase contrast and with two SEM, Jeol JSMT 100 and Jeol JSM 6360 LV. The microphotographs were taken with the Nikon Microphot FX, Jeol JSMT 100 and Jeol JSM 6360 LV microscopes. The cell length of *Rhizosolenia s. str.* taxa was measured excluding the length of the processes, which appeared frequently broken due to their fragility.

The catalogues considered to determine previous reports of each taxon from Argentina were Ferrario & Galván (1989) and Vouilloud (2003). The consulted bibliography of the fine structure of diatom frustules was that compiled by Gaul *et al.* (1993) and Henderson & Reimer (2003). The terminology followed Ross *et al.* (1979), Sundström (1986), Round *et al.* (1990) and Hernández-Becerril & Meave del Castillo (1996).

RESULTS AND DISCUSSION

Rhizosoleniaceae De Toni

Rhizosolenia Brightwell *sensu stricto*

Section *Rhizosolenia*

Rhizosolenia antennata (Ehrenberg) Brown f. *antennata*

Figs 2, 3

REFERENCES: Sundström (1986, 42, figs 115, 119–120); Priddle *et al.* (1990, 117, pl. 15.1 figs 5a–c); Hasle & Syvertsen (1996, 147, pl. 27).

SYNONYM: *R. styliformis* f. *bidens* (Karsten) Frenguelli.

MORPHOLOGY: *R. antennata* f. *antennata* has valves with two apical processes without otaria (Figs 2, 3). Girdle bands are arranged in two dorsiventral columns. Another form of this species, f. *semispina,* can be distinguished by the presence of otaria and only one apical process.

DISTRIBUTION: *Rhizosolenia antennata* is a species from the southern cold water region (Sundström 1986, Hasle & Syvertsen 1996) and has been reported from the Argentine Sea by Hendey (1937, f. *antennata*) and Romero & Hensen (2002, f. *antennata* and f. *semispina*). Frenguelli & Orlando (1958) and Frenguelli (1960) reported f. *antennata* from the South American Antarctic Sector under the name of *R. styliformis* f. *bidens* (Karsten) Frenguelli. We have found f. *antennata* in one sample from Santa Teresita, collected in February 2000 at low abundance.

Rhizosolenia bergonii H. Peragallo

Figs 4–15

REFERENCES: Peragallo (1892, 15, pl. 3 fig. 5); Hustedt (1920, 318, figs 1–3, as *R. amputata* Ostenfeld); Hustedt (1929, 575, fig. 327); Cupp (1943, 81, fig. 43a–g); Hendey (1964, 151, pl. 3 fig. 4); Sundström (1986, 72, figs 32, 33, 177–189); Hernández-Becerril (1995, 256, figs 13–16); Hasle & Syvertsen (1996, 155, pl. 29).

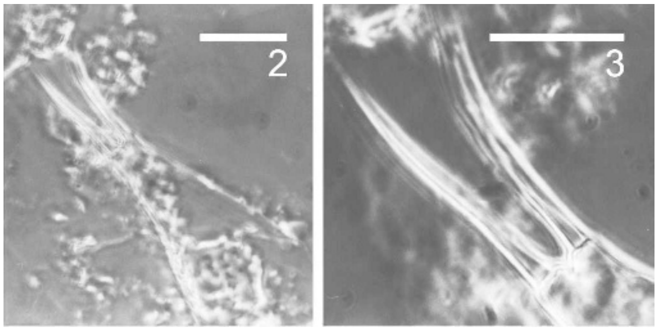
Table 1. List of the phytoplankton samples collected in the coastal waters of the Buenos Aires Province and stored at the Diatom Collection of Argentina.

Date	SC[1]	ST	LL	MA	NA	PI	VG
Nov. 1994		4250		4251	4252		4253
Jan. 1995		4254		4255	4256		4257
Mar. 1995		4258		4259	4260	4263	4264
Nov. 1995		4266	4267	4268	4269	4270	4271
Jan. 1996		4272	4273	4274	4275	4276	4277
Apr. 1996	4279	4280	4281	4282	4283	4284	4285
Jun. 1996	4286	4287	4288	4289		4290	4291
Sep. 1996	4292	4293		4294		4295	4296
Nov. 1996	4297	4298	4299	4300			4301
Jan. 1997	4302	4303	4304	4305	4306/7	4308	4309
Mar. 1997	4310	4311	4312	4313		4314	4315
May 1997	4316	4317	4318	4319		4320	4321
Jul. 1997	4322	4323	4324	4325		4326	
Sep. 1997	4327	4328	4329	4330		4331	
Nov. 1997	4332	4333	4334	4335		4336	4337
Jan. 1998	4338	4339	4340	4341		4342	4343
Mar. 1998	4344	4345	4346	4347		4348	4349
May 1998	4250	4351	4352	4353		4354	4355
Jul. 1998	4356	4357	4358	4359		4360	4361
Sep. 1998	4362	4363	4364	4365		4366	4367
Dec. 1998	4368	4369	4370	4371		4372	4373
Jan. 1999	4374	4375	4376	4377		4378	4379
Oct. 1999	4384	4385	4386	4387		4388	4389
Nov. 1999	4390	4391/2	4393	4394		4395	4396
Dec. 1999	4398	4399/4400	4401	4402		4403	4404
Jan. 2000	4405	4406	4407			4408	4409
Feb. 2000	4410	4411/2	4413	4414		4415	4416
Mar. 2000	4417	4418	4419	4420		4421	4422
Apr. 2000	4423	4424/5	4426	4427		4428	4429
May 2000	4430	4431/2	4433	4434		4435	4436
Jun. 2000	4437	4438	4439	4440		4441	4442
Jul. 2000	4443	4444	4445	4446		4447	4448
Aug. 2000	4449	4485	4486	4487		4488	4489
Sep. 2000	4490	4491	4492	4493		4494	4495

[1] SC, San Clemente del Tuyú; ST, Santa Teresita; LL, La Lucila del Mar; MA, Mar de Ajó; NA, Nueva Atlantis; PI, Pinamar; VG, Villa Gesell.

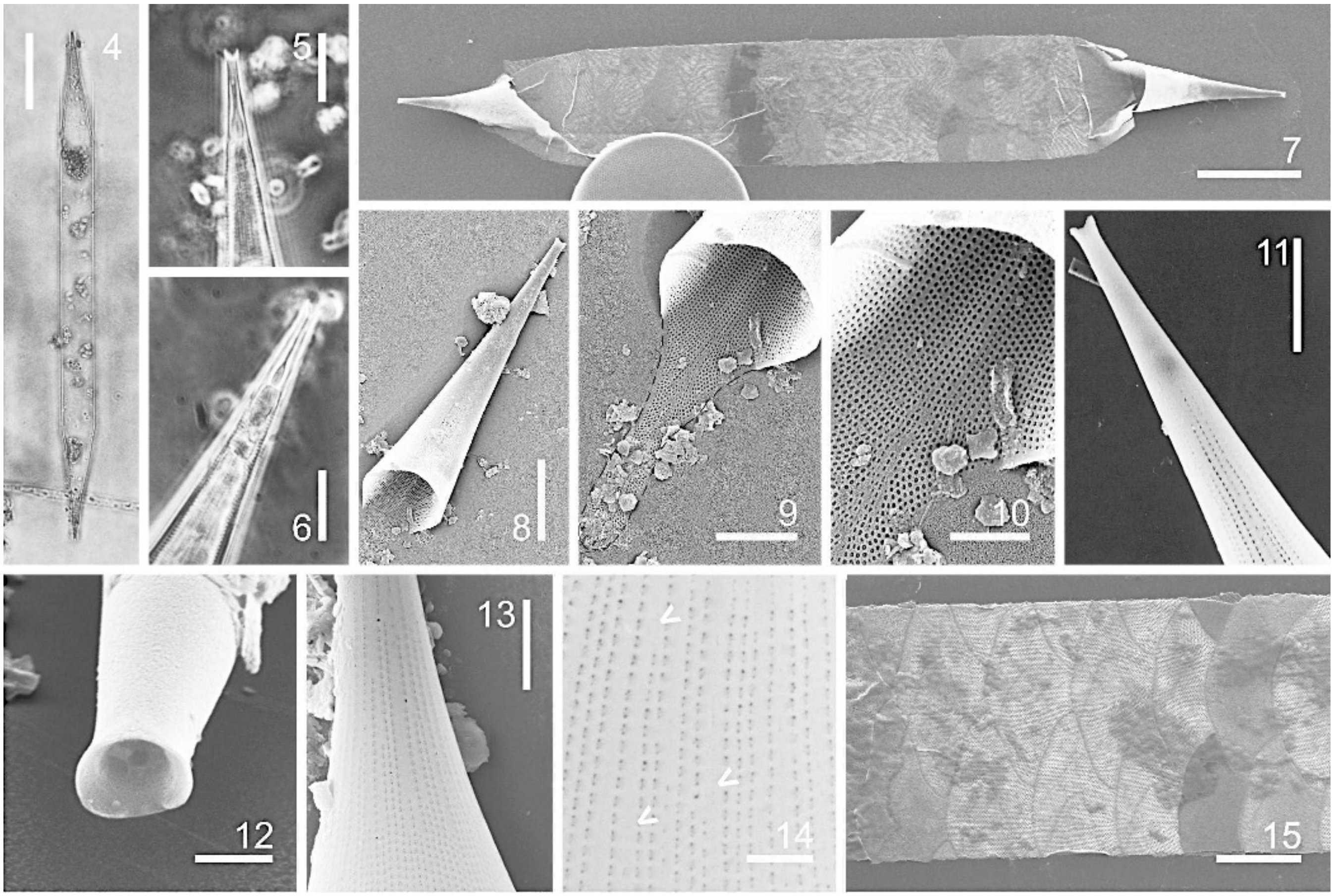
SYNONYM: *R. amputata* Ostenfeld.

MORPHOLOGY: The cells of *R. bergonii* are usually solitary, cylindrical, and circular in cross-section (Figs 4, 7). Specimens found in Buenos Aires coastal waters are 20 to 52 µm in diameter, in a narrower range than described in the literature (9 to 115 µm, Sundström 1986 and Hasle & Syvertsen 1996). The acutely conical valves (Figs 7, 8) are 94–100 µm high, and cells are 342–440 µm long. The ventral part of the valve is longer than dorsal, with a medial tongue-like extension where the impression of the adjacent valve process is placed (Figs 8–10). Contiguous area is not visible with LM, slightly depressed, not delimited by marginal ridges. Claspers and otaria are lacking. The process is thick, straight, short, and truncated at the end, 12.5–15.5 µm long (Figs 5, 6, 11). Internal structure of the process is visible in LM, with basal lumen spindle-shaped, abruptly narrowed in a tubular canal and expanded into a funnel-shaped aperture at the tip (Figs 5, 6, 12). Basal lumen communicates with the cell interior via a rimoportula. The valve areolae are elongated in pervalvar direction, 16.5–20 in 10 µm, arranged in striae converging towards the apex, 20–24 in 10 µm (Figs 11, 13, 14). The cingulum is composed of a large valvocopula, contiguous with most of valve margin, and four columns of segments, trapezoidal in outline (Fig. 15). Band areolae, 19–22 in 10 µm, are arranged in striae parallel to the pervalvar axis, 22–24 in 10 µm, with a secondary quincuncial pattern. According to Sundström (1986) the girdle bands of this species are variable in size, shape (rhomboidal or trapezoidal), and column number (2n column, $n = 2, 3, 4, 5, 6$).



Figs 2, 3. *Rhizosolenia antennata*, LM, LPC 4411.
Fig. 2. General appearance of the valve.
Fig. 3. Detail of the apical processes. Scale bars: Fig. 2 = 20 µm; Fig. 3 = 10 µm.

R. bergonii resembles *R. temperei* H. Peragallo and *R. acuminata* (H. Peragallo) H. Peragallo in general appearance, areolar structure and lack of otaria. Nevertheless, the



Figs 4–15. *Rhizosolenia bergonii*.

Fig. 4. A complete frustule, LM, LPC 4389.

Figs 5, 6. Apical parts of the valves. Note the internal structure of the process at different focal planes, LM, LPC 4316 (Fig. 5), LPC 4411 (Fig. 6).

Fig. 7. A frustule with collapsed girdle, SEM, LPC 4428.

Fig. 8. A valve with ventral part longer than dorsal, SEM, LPC 4411.

Figs 9, 10. Details of Fig. 8.

Fig. 9. Note the ventral tongue-like extension, delimited by a dotted line.

Fig. 10. Internal surface of the valve with areolae arranged in striae.

Fig. 11. Detail of the apical part of the valve, SEM, LPC 4399. Note striae converging towards the base of the truncate process.

Fig. 12. Apical view of the process showing a funnel-shaped aperture at the tip, SEM, LPC 4411.

Fig. 13. Detail of a valve showing the striation pattern, SEM, LPC 4409.

Fig. 14. Detail of the valve areolae occluded by velum, SEM, LPC 4428. Note hyaline areas at the point of origin of incomplete striae (arrows).

Fig. 15. Detail of the girdle from Fig. 7. Note four columns of copulae, trapezoidal in outline. Scale bars: Figs 4, 7 = 50 μm; Figs 8, 15 = 20 μm; Figs 5, 6, 9, 11 = 10 μm; Figs 10, 13 = 5 μm; Figs 12, 14 = 2 μm.

former may be well separated based on the morphology of the process, with a funnel-shaped aperture at the tip.

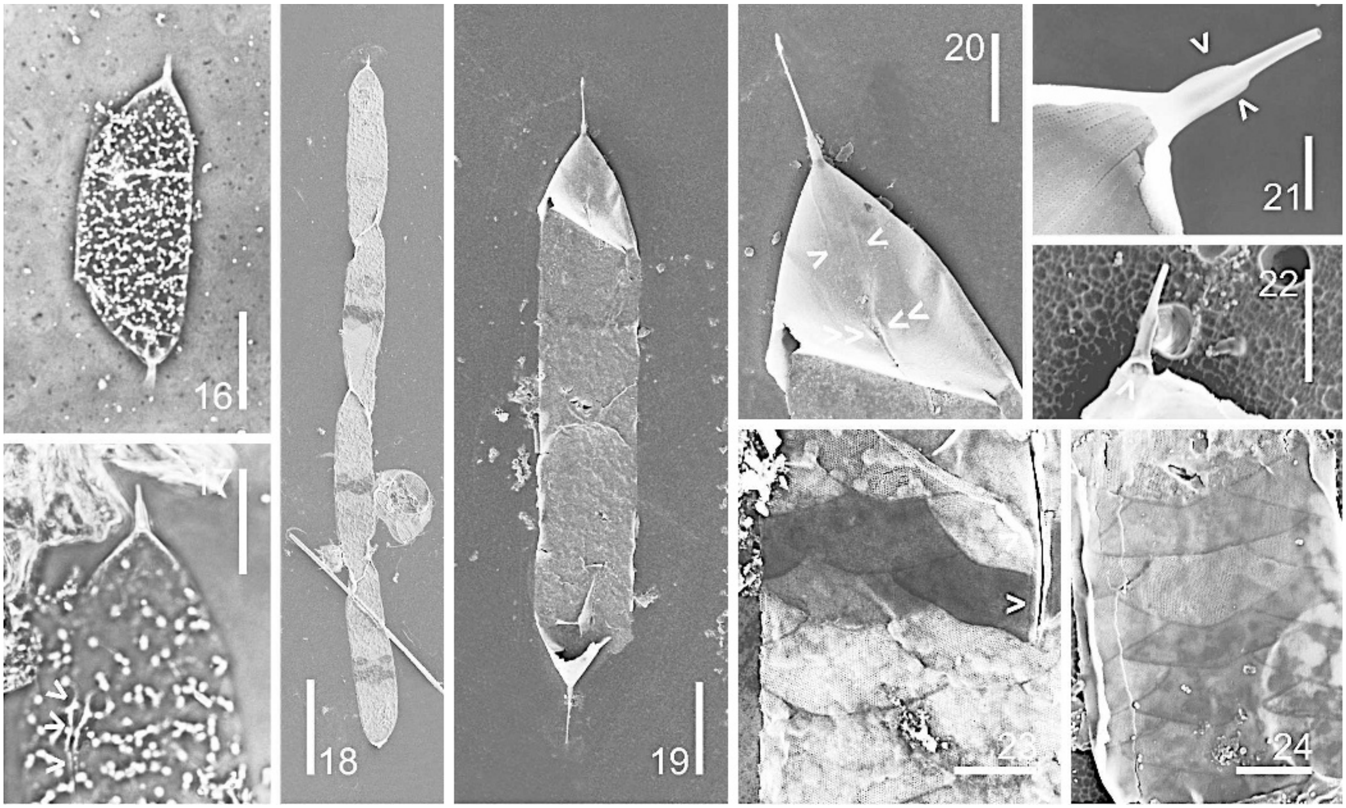
DISTRIBUTION: *R. bergonii* is a species from the warm water region (Sundström 1986; Hasle & Syvertsen 1996; Romero & Hensen 2002). It has been reported from neritic and oceanic waters of the Buenos Aires Province (Negri *et al.* 1988; Ferrario & Galván 1989; Romero & Hensen 2002, without illustrations) and it is a common species in coastal waters of Brazil (Müller-Melchers 1955; Rosa 1982; Torgan *et al.* 1999). The species was found sporadically and at low abundance in our samples.

REMARKS: The illustrations of *R. bergonii* presented by Peragallo (1892), Hustedt (1929), Cupp (1943) and Hendey (1964) show valves in dorsal view, in which the ventral tongue-like extension and the funnel-shaped opening cannot be seen. Sundström (1986) analyzed the slides from Villefranche used by Peragallo (1892) to describe the species, but did not find specimens of *R. bergonii*, and pointed out that the original illustration (Peragallo 1892, pl. 3, fig. 5) was insufficient to be considered the lectotype. Taking into account this fact he designed as neotype the slide 'Herb. H. Peragallo' number 1632 from Marseille labeled with the taxon's name.

Rhizosolenia hyalina Ostenfeld

Figs 16–24

REFERENCES: Hustedt (1920, pl. 319 figs 11–13); Sundström (1986, 76, figs 34, 190–194), Hernández-Becerril



Figs 16–24. *Rhizosolenia hyalina*.

Fig. 16. A complete frustule, LM, LPC 4428.

Fig. 17. A valve showing the contiguous area and claspers (arrows), LM, LPC 4428.

Fig. 18. Chain formed by four cells, SEM, LPC 4428.

Fig. 19. Frustule with collapsed girdle, SEM, LPC 4433.

Fig. 20. Detail of Fig. 19 showing the valve in ventral view and the valvocopula, SEM, LPC 4433. Note the narrow contiguous area (arrows) and claspers (double arrows).

Fig. 21. Detail of the process, otaria (arrows) and striation pattern of the valve, SEM, LPC 4428.

Fig. 22. A valve broken at the process, SEM, LPC 4428. Note the rimoportula (arrow).

Fig. 23. Detail of a collapsed girdle composed by several columns of copulae, SEM, LPC 4428. Note the first ventral segment with the abvalvar side extended in a tongue-like expansion, where the impression of the adjacent valve process is placed (arrow).

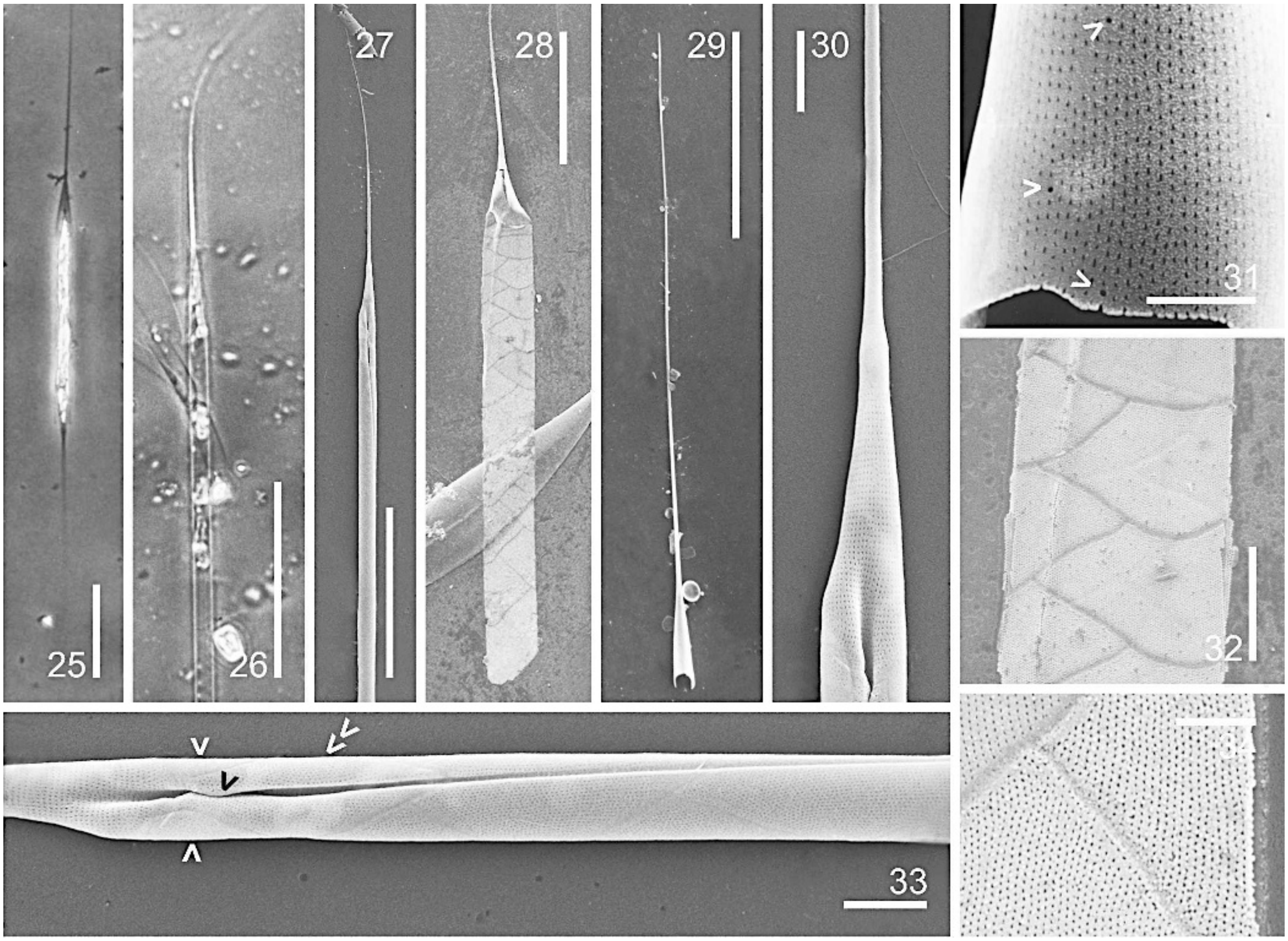
Fig. 24. Part of the collapsed girdle composed of the four columns of rhomboidal copulae, SEM, LPC 4428. Scale bars: Fig. 18 = 100 µm; Figs 16, 19 = 50 µm; Figs 17, 20 = 20 µm; Figs 22–24 = 10 µm; Fig. 21 = 5 µm.

(1995, 258, figs 32–35); Hasle & Syvertsen (1996, 151, pl. 28).

SYNONYM: *R. pellucida* Cleve.

MORHPOLOGY: The morphometric data of the specimens found in Buenos Aires coastal waters agree with those presented by Sundström (1986) and Hasle & Syvertsen (1996), although the diameter range found in our material is narrower (27 to 46 µm) than that described by the above-mentioned authors (9 to 60 µm). Cells are solitary (Figs 16, 19) or in short chains (Fig. 18), up to 5 cells, cylindrical, circular in cross-section, 152 to 320 µm long. Valve is conical, with the ventral part two to two and a half times longer than the dorsal part (Fig. 20). Valve areolae are subrectangular, 30 to 32 in 10 µm, arranged in striae converging towards the apex (Fig. 21), 30 to 32 in 10 µm. Contiguous area is narrow, limited by inconspicuous marginal ridges, more distinctive in the claspers region (Figs 17, 20). Tubular process is slightly curved near the end of the otaria, wide at the base and tapering towards the distal part, 20 to 30 µm long (Figs 20–22). The otaria are narrow (0.7 µm), extending along the process from the apex of the valve for 4 to 6 µm, with the external edge slightly convex and the distal edge oblique to the process (Fig. 21). Cingulum is composed of a large valvocopula, contiguous with most of the valve margin, and several columns of segments (Figs 23, 24). First ventral segment has the abvalvar side centrally extended in a tongue-like expansion where the impression of the adjacent valve process can be seen (Fig. 23). Other bands are rhomboidal to trapezoidal, with subrectangular to rounded areolae, 28 to 32 in 10 µm, arranged in pervalvar striae, 32 to 36 in 10 µm, with secondary quincuncial pattern. The distinctive outline of the frustule, the morphology of the valves, processes and otaria allow an easy identification of *R. hyalina* even with LM.

DISTRIBUTION: *R. hyalina* is a species from the warm water region (Sundström 1986, Hasle & Syvertsen 1996). It was reported for the first time from the South Atlantic Ocean in 1982 from marine waters of Río Grande do Sul by Rosa (1982) and subsequently quoted in several papers from



Figs 25–34. *Rhizosolenia setigera f. setigera.*
Fig. 25. A complete frustule, LM, LPC 4446.
Fig. 26. Part of a frustule showing a very long, needle-shaped process, LM, LPC 4384.
Fig. 27. Part of a frustule showing a needle-shaped process, SEM, LPC 4492.
Fig. 28. A frustule fragment in ventral view showing valve and girdle composed of two columns of rhomboidal copulae, SEM, LPC 4492.
Fig. 29. A valve, SEM, LPC 4289.
Fig. 30. Detail of Fig. 27, SEM, LPC 4492. Note the impression of the adjacent valve process beginning in the ventral valvar edge.
Fig. 31. The basal part of a valve in dorsal view showing the striation pattern, SEM, LPC 4491. Note scattered pores (arrows).
Fig. 32. Detail of the girdle, collapsed, showing rhomboidal copulae arranged in two columns, SEM, LPC 4492.
Fig. 33. Part of frustule showing the impression of the adjacent valve process running across more than four girdle segments and the claspers located on the first ventral segment, SEM, LPC 4492. White arrows show the valvocopula, double arrow shows first ventral segment, black arrow shows claspers.
Fig. 34. Detail of the striation pattern of the copulae, SEM, LPC 4488. Scale bars: Figs 25–29 = 50 µm; Fig. 32 = 10 µm; Figs 30, 33 = 5 µm; Figs 31, 34 = 2 µm.

coastal waters of Brazil (Moreira Filho *et al.* 1999). During this study *R. hyalina* was found in April, May and September 2000, as common to scarce (abundant only from Santa Teresita in May). This species is reported for the first time from Argentina.

Rhizosolenia setigera Brightwell f. *setigera*

Figs 25–34

REFERENCES: Hustedt (1929, 588, fig. 336); Sundström (1986, 104, figs 286–288); Hernández-Becerril (1995, 264, figs 44, 45); Hasle & Syvertsen (1996, 157, pl. 30).

MORPHOLOGY: The cells are solitary or in pairs, cylindrical, circular in cross-section, 2.6–20 µm in diameter, 100–300 µm long (Fig. 25). The valve is acutely conical, elongated, with a very long needle-like process, almost straight, wider at the base and gradually tapering towards the tip (Figs 25–29). Valve areolae are poroid, with external vela perforated by slit-like pores longitudinally oriented, 26 to 34 in 10 µm, and arranged in striae parallel to the pervalvar axis, 40 to 45 in 10 µm, with a secondary orthostic pattern (Figs 30, 31). Scattered pores are circular, irregularly distributed among areolae or taking the place of some areolae, distinguishable in external view (Fig. 31). Contiguous area and otaria are absent (Fig. 30). Impression of the adjacent valve process is present from the ventral valvar edge or the advalvar edge of the first ventral segment until the fourth to seventh segment, forming a groove, deeper in the proximal region than in the distal region (Figs 30, 33). Claspers are poorly to well developed on the first ventral segment (Fig. 33). Girdle bands are rhomboidal to trapezoidal and arranged in two dorsiventral columns (Figs 32, 33). Band areolae are rounded to oval in outline, 32 to 50 in 10 μm, arranged in striae oriented in pervalvar direction, 41 to 46 in 10 μm, with a secondary quincuncial pattern (Fig. 34). We observed that the areola and stria density increases towards the valve process and decreases on the valvocopula towards the copulae of the same girdle

R. setigera f. *setigera* resembles *R. antennata* f. *semispina* and *R. hebetata* f. *semispina* in valve and process morphology, and differs from both taxa in the lack of otaria and contiguous area. Additionally, claspers, if present, are located in the first ventral segment in *R. setigera* and on the valve in the two other taxa, and the impression of the adjacent valve process runs across more than one girdle segment in the former, and is limited to the first ventral segment in the latter two.

DISTRIBUTION: *R. setigera* f. *setigera* is a cosmopolitan taxon, probably absent from polar waters according to Hasle & Syvertsen (1996). This form frequently has been reported from Argentinian waters (Vouilloud 2003, as variety in some cases). *R. setigera* f. *setigera* was found sporadically in our samples, most often at low or medium abundance, occasionally reaching a higher abundance in winter and spring.

REMARKS: This taxon has been reported as a producer of harmful algal blooms on the US west coast (Horner *et al.* 1997) that may kill fish and invertebrates due to oxygen depletion or may change or disrupt food-web dynamics. It was occasionally abundant in the plankton of the study area, but was never observed forming a bloom.

Rhizosolenia setigera f. *pungens* (Cleve-Euler) Brunel

Figs 35–47

REFERENCES: Brunel (1962, 66, pl. 4 figs 5, 6); Hernández-Becerril (1995, 264, figs 36–40, as *R. pungens*); Hasle & Syvertsen (1996, 157, pl. 30, as *R. pungens*); Sar (1996, 381).

SYNONYM: *R. pungens* Cleve Euler.

MORPHOLOGY: This form (Figs 35–47) may be differentiated from the nominal form by the morphology of the process, which is basally thickened up to the middle part and becomes needle-like only in the distal half (Figs 36–41). Cell length is 116–310 μm and diameter is 9–20 μm. Valve areolae and striae are 26–40 and 42–46 in 10 μm, respectively. Band areolae and striae are 34–50 and 42–56 in 10 μm, respectively.

DISTRIBUTION: *R. setigera* f. *pungens* is distributed mainly in brackish waters according to Hasle & Syvertsen (1996) and in temperate and subtropical waters according to Hernández-Becerril (1995). This taxon has been reported from coastal waters of the San José Gulf (Ferrario *et al.* 1986) and San Matías Gulf (Sar 1996). In the present study *R. setigera* f. *pungens* was found sporadically in the study area all year round, occasionally being abundant in winter and spring.

REMARKS: Brunel (1962) classified *R. pungens* Cleve-Euler as a form of *R. setigera* Brightwell based on the similarities in the general appearance of frustules and valves, areola morphology, shape and arrangement of the girdle bands. The author pointed out that the two forms differ in the morphology of the process. Nevertheless, Hasle & Syvertsen (1996) and Throndsen *et al.* (2003) considered them to be two distinct species, based on the morphology of the process. We found in our material specimens with processes gradually tapering and others thickened in the middle part, but in the same sample we also have found specimens with intermediate thickening of the processes. The ultrastructural analysis of specimens without thickening or with different kinds of thickening of the processes showed that all of them share the same fine morphology. Based on these results, we agree with Brunel (1962) and Moreno *et al.* (1996) in considering *Rhizosolenia pungens* as a form of *R. setigera*.

Section *Imbricatae*

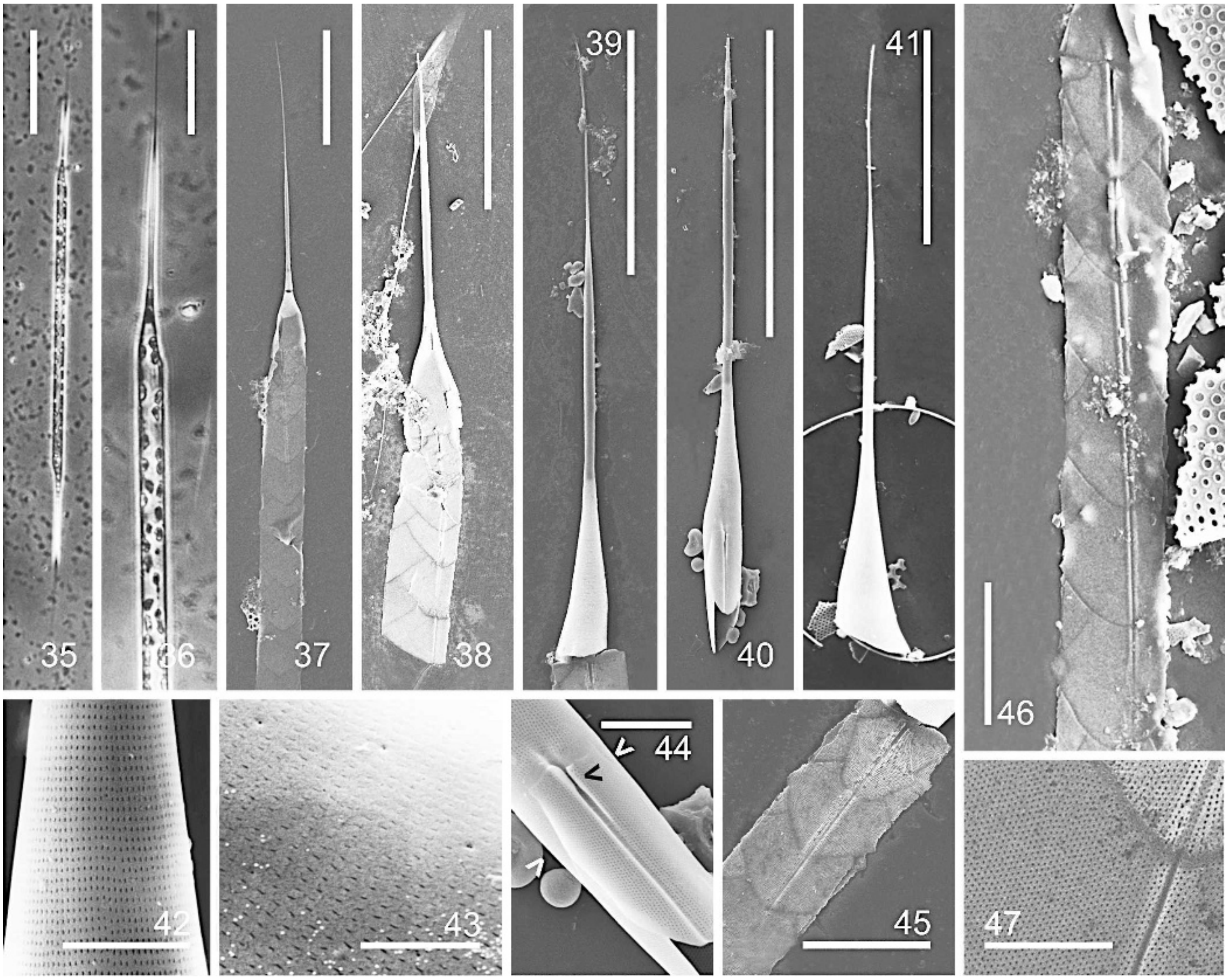
Rhizosolenia imbricata Brightwell

Figs 48–61

REFERENCES: Sundström (1986, 80, figs 200–208); Hendey (1964, 149, pl. 3 fig. 1 as *R. imbricata*, fig. 2 as *R. shrubsolei*); Hasle & Syvertsen (1996, 155, pl. 29).

SYNONYMS: *R. shrubsolei* Cleve, *R. imbricata* var *shrubsolei* (Cleve) Schröder.

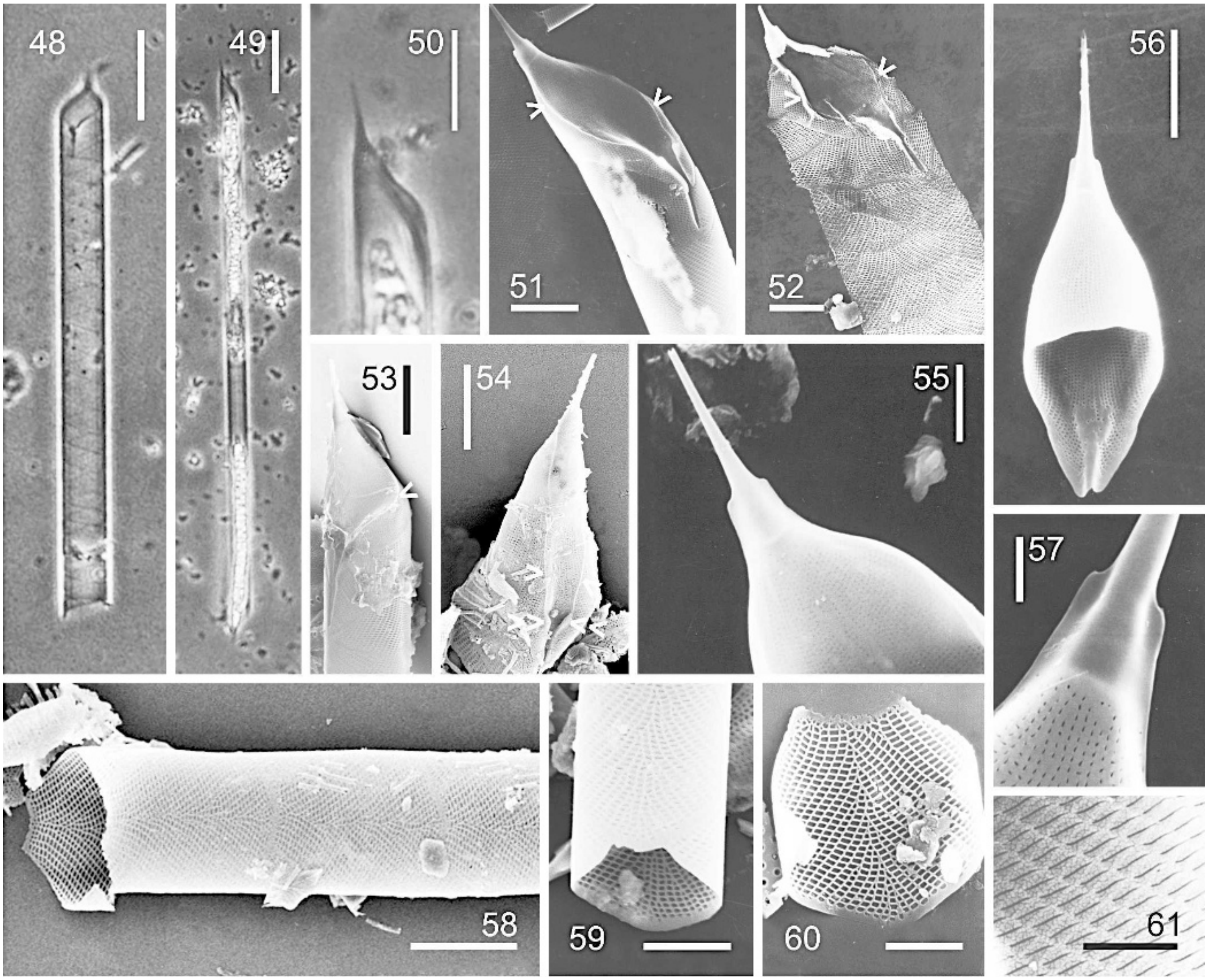
MORPHOLOGY: The cells are solitary or in short chains, cylindrical, circular to slightly elliptical in cross-section, 11–26 μm in diameter, 180–460 μm long (Figs 48, 49). The valve is obliquely conical, with the ventral part much longer than the dorsal part (Figs 50–54, 56). Contiguous area is large, variable in shape, ranging from circular in specimens with circular cross-section to oval in specimens with elliptical cross-section, limited by well-developed marginal ridges, with conspicuous claspers (Figs 51–54). The surface outside the contiguous area is perpendicular to contiguous area in specimens with circular cross-section, and with gentle slope in specimens with elliptical cross-section. The process is displaced to the dorsal edge of the valve surface, dorsiventrally compressed (Figs 50, 51, 54), 15 μm long, wide at the base and abruptly tapering towards the distal part opening into a dorsal pore (Figs 55, 56). Otaria are small, extended along the wide basis of the process, with outer margin forming a fine point with the distal margin (Fig. 57). The areolae are rectangular, 24–35 in 10 μm, arranged in striae converging at the apex, 20–35 in 10 μm (Figs 55, 57). The cingulum is composed of a valvocopula, contiguous with most of the valve margin, and two lateral columns of scale-like to trapezoidal copulae with hyaline edges (Figs 58–60). First segment contiguous to the valvocopula bears the impression of the adjacent valve process towards one side (Figs 51–53). The areolae on segments are rectangular, 18–35 in 10 μm, arranged in oblique striae, 12–20 in 10 μm, converging along a middle line of the band (Figs 58–60). The areolae of valve and bands are occluded externally by vela with slit-like obliquely oriented pores (Fig. 61).



Figs 35–47. *Rhizosolenia setigera f. pungens.*
Fig. 35. A complete frustule, LM, LPC 4389.
Fig. 36. Detail of frustule from Fig. 35 showing conical valve with long process swollen in the proximal part, LM, LPC 4389.
Figs 37, 38. Valves with part of the cingula, SEM, LPC 4492.
Fig. 38. Note the impression of the adjacent valve process running across more than five girdle segments.
Figs 39, 40. Valves in ventral view, SEM, LPC 4492.
Fig. 40. Valve showing the process broken at the end of the swollen part.
Fig. 41. Valve in lateral view, SEM, LPC 4284.
Fig. 42. Detail of a valve showing striation pattern, SEM, LPC 4486.
Fig. 43. Valve surface with areolae and scattered pores, SEM, LPC 4284.
Fig. 44. Detail of Fig. 40 showing the basal part of the valve, the first ventral segment with well-developed claspers (black arrow) and a small part of the valvocopula (white arrows), SEM, LPC 4492.
Figs 45, 46. Collapsed cingula in ventral view showing the copulae arranged in two dorsiventral columns, SEM.
Fig. 45. Note the impression of adjacent valve process running across four segments, LPC 4492.
Fig. 46. Note the impression running across six segments, LPC 4491.
Fig. 47. Detail of the striation pattern of the girdle bands, SEM, LPC 4491. Scale bars: Fig. 35 = 100 μm; Figs 36–41 = 50 μm; Figs 45, 46 = 20 μm; Figs 42, 44, 47 = 5 μm; Fig. 43 = 2 μm.

DISTRIBUTION: *R. imbricata* is a species found almost everywhere except polar regions (Sundström 1986; Hasle & Syvertsen 1996). Several authors have reported it from Argentinian coastal waters (Vouilloud 2003). The species was found sporadically in our study area, at low abundance around the year, but occasionally reaching higher abundance in fall and winter.

REMARKS: In the Section *Imbricatae* the velum structure of the valve areolae and bands is an important diagnostic feature. The velum structure found in *R. imbricata* is also characteristic of *R. striata* Greville, and according to Sundström (1986) it is different in the other species of the Section. *R. imbricata* also resembles *R. striata* in the general appearance of the frustule, the striation pattern and the



Figs 48–61. *Rhizosolenia imbricata.*

Fig. 48. Part of a frustule showing girdle bands arranged in two lateral columns, LM, LPC 4395.

Fig. 49. A complete frustule, LM, LPC 4445.

Fig. 50. A valve of the frustule from Fig. 49 in lateral view, LM, LPC 4445.

Figs 51–53. Parts of frustules in oblique ventral view, SEM, LPC 4428 (Figs 51, 52), LPC 4279 (Fig. 53). Note the different shapes of the contiguous area always bordered by a small marginal ridge (arrows).

Fig. 54. A valve with narrow contiguous area (arrows) and well-developed claspers (double arrows), SEM, LPC 4279.

Fig. 55. Valve showing the process with otaria, SEM, LPC 4436.

Fig. 56. Dorsal valve view, SEM, LPC 4279.

Fig. 57. Detail of the otaria of the valve from Fig. 56, SEM, LPC 4279.

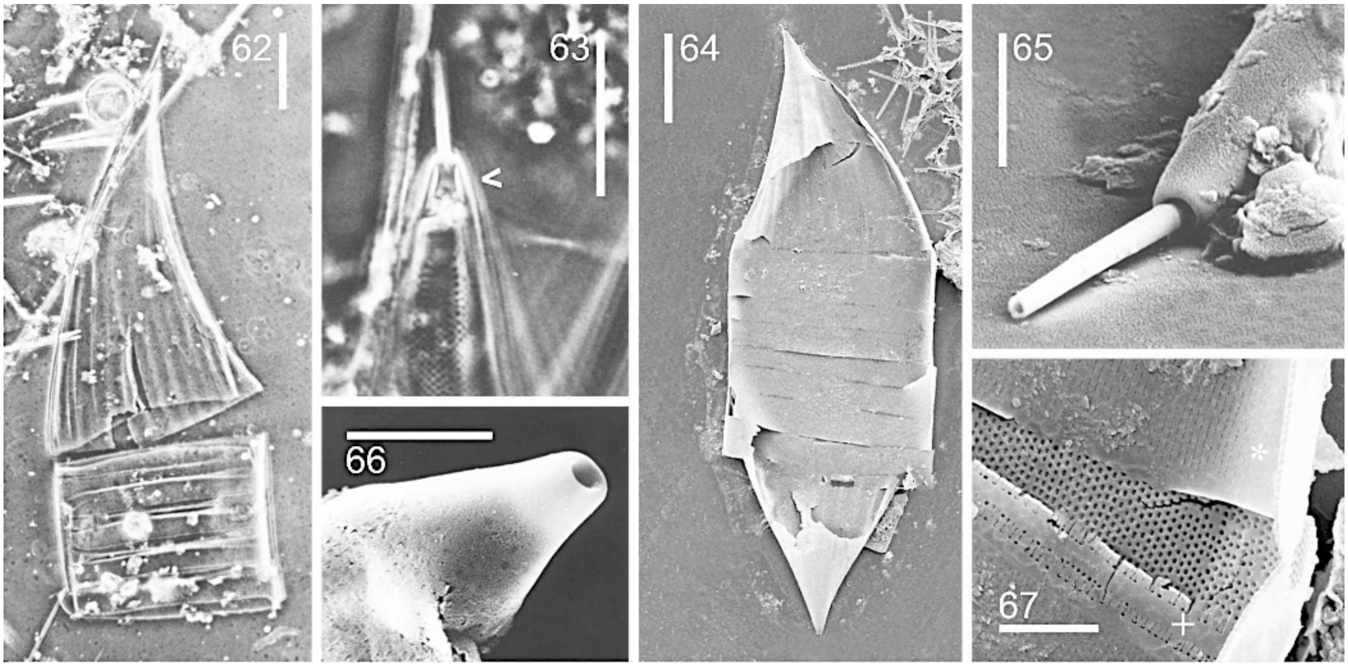
Fig. 58. A part of the cingulum in lateral view, SEM, LPC 4279.

Fig. 59. The copulae showing areolae in external and internal view and hyaline edge, SEM, LPC 4428.

Fig. 60. Internal view of an isolated, rhomboidal band, SEM, LPC 4494.

Fig. 61. Rectangular girdle band areolae, occluded externally by vela with oblique slit-like pores, SEM, LPC 4428. Scale bars: Figs 48, 49 = 50 μm; Fig. 50 = 20 μm; Figs 51–54, 56, 58 = 10 μm; Figs 55, 59, 60 = 5 μm; Figs 57, 61 = 2 μm.

morphology of valve and band areolae. Hustedt (1929) and Hendey (1937, 1964) among other authors, considered these two taxa conspecific. This idea was refuted by Sundström (1986) who studied the type materials and determined that two species differ in the shape of the cell cross-section, which is circular to slightly elliptical in *R. imbricata* and elliptical in *R. striata*; in the morphology of the process, wide at the base and abruptly tapering towards the distal part in the former and triangular in the latter; and in the shape of the otaria, with outer margin forming a fine point with the distal margin in the former and obtuse in the latter. Additionally, Sundström (1986) and Hasle & Syvertsen (1996) pointed out that the areola and stria density in the girdle bands is higher in *R. imbricata* (10–18 striae and 23–32 areolae in 10 μm) than in *R. striata* (6–12 striae and 12–19 areolae in 10 μm) and the distribution is cosmopolitan (although absent in polar regions) in the former and probably restricted to warm waters in the latter.



Figs 62–67. *Neocalyptrella robusta.*
Fig. 62. Valve with part of the cingulum, LM, LPC 4411.
Fig. 63. Valve apex showing calyptra (arrow) and process, LM, LPC 4411.
Fig. 64. Frustule in dorsiventral view, SEM, LPC 4433. Note the longitudinal undulations of the valve.
Figs 65, 66. Details of valve apex, SEM.
Fig. 65. Note the external tube of the process merging with the calyptra. LPC 4411.
Fig. 66. Note that the external tube of the process is lost. LPC 4425.
Fig. 67. Detail of the valve (asterisk) with part of the valvocopula (cross), SEM, LPC 4433. Note the morphology of the areolae and the advalvar fimbriate margin of the valvocopula. Scale bars: Figs 62, 64 = 50 μm; Fig. 63 = 10 μm; Figs 65–67 = 5 μm.

Neocalyptrella Hernández-Becerril & Meave

Neocalyptrella robusta (Norman) Hernández-Becerril & Meave

Figs 62–67

REFERENCES: Sundström (1986, 104, figs 289, 290 as *R. robusta*); Hernández-Becerril & Meave del Castillo (1996, 199, figs 1–20 as *Calyptrella robusta*); Hasle & Syvertsen (1996, 159. pl. 30 as *R. robusta*).

SYNONYMS: *R. robusta* Norman in Pritchard, *Calyptrella robusta* (Norman) Hernández-Becerril & Meave.

MORPHOLOGY: Cells are solitary, large, 80–200 μm in diameter, 350–540 μm long, subcylindrical, elliptical in cross-section, half moon-shaped in lateral view and sigmoid in dorsiventral view (Fig. 64). Valve is conical, 120–224 μm long, with longitudinal undulations converging towards the truncated to rounded apex (Figs 62, 64). Process has a cylindrical external tube, straight or tapered towards the distal part, merging with the calyptra and open as a circular pore at the distal end (Figs 63, 65, 66). Valve areolae, 17 in 10 μm, are arranged in longitudinal striae, 22–25 in 10 μm, with a secondary quincuncial pattern (Figs 63, 67). Otaria, claspers and contiguous area are lacking. Girdle bands nonimbricate, split-ring shaped, arranged in two dorsiventral columns (Figs 62, 64). Band areolae, 22–23 in 10 μm, are arranged in longitudinal striae, 27 in 10 μm, with a secondary quincuncial pattern. The valve and girdle band areolae are loculate, with vela perforated by slit-like pores and internal foramina, circular to subcircular (Fig. 67). Valvocopula has an advalvar fimbriate margin (Fig. 67).

DISTRIBUTION: *Neocalyptrella robusta*, a species distributed in tropical and temperate waters (Hernández-Becerril & Meave 1996), has been reported in several papers from littoral Argentinean waters (Ferrario & Galván 1989, under the name *R. robusta*). In our study area the species was found sporadically, always at low abundance.

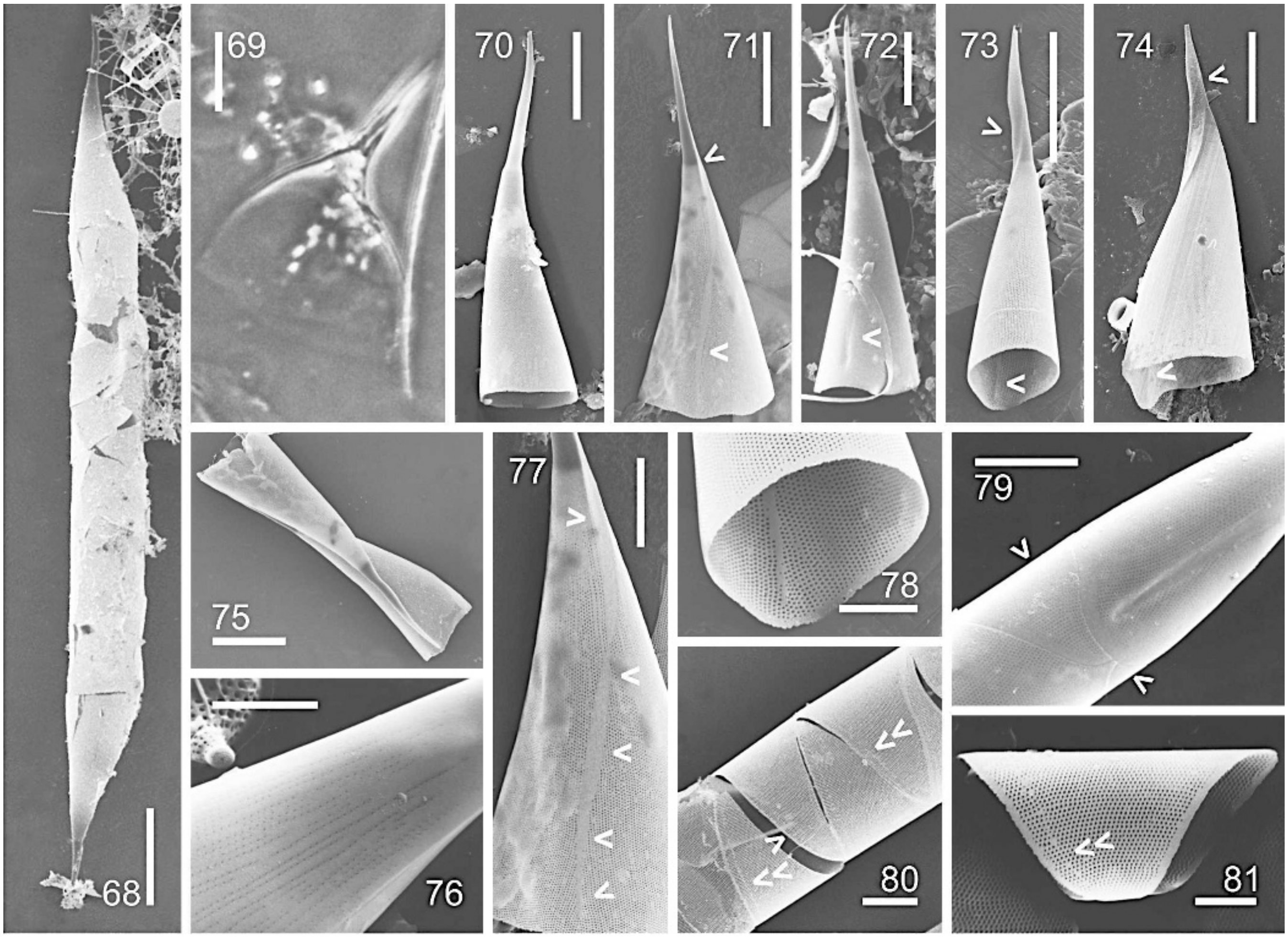
REMARKS: Hernández-Becerril & Meave (1996) erected the genus *Calyptrella* to contain *R. robusta*. Because the name *Calyptrella* was occupied in botanical nomenclature, the authors proposed *Neocalyptrella* as a replacement name in a subsequent paper (Hernández-Becerril & Meave 1997).

Pseudosolenia Sundström

Pseudosolenia calcar-avis (Schultze) Sundström

Figs 68–81

REFERENCES: Hustedt (1929, 592, fig. 339 as *R. calcar-avis*); Cupp (1943, 89, fig. 51 as *R. calcar-avis*); Sundström (1986, 95, figs 40–46, 247–257); Hasle & Syvertsen (1996, 160, pl. 30).



Figs 68–81. *Pseudosolenia calcar-avis.*

Fig. 68. A complete frustule, SEM, LPC 4405.

Fig. 69. A valve, LM, LPC 4411.

Figs 70–74. Valves of different shapes, SEM, LPC 4411 (Figs 70, 71, 73), LPC 4405 (Fig. 72), LPC 4257 (Fig. 74).

Figs 71, 72. Arrows show the contiguous area in external view.

Figs 73, 74. Valves with the ventral part longer than the dorsal one. Note contiguous area in external and internal views (arrows).

Fig. 75. Sibling valves, SEM, LPC 4411.

Fig. 76. Detail of the valve showing the areolae arranged in striae converging at apex, SEM, LPC 4449.

Fig. 77. Detail of the valve showing the narrow, hyaline, sigmoid contiguous area (arrows), SEM, LPC 4411.

Fig. 78. Detail of the valve areolation in internal view, SEM, LPC 4411.

Fig. 79. Detail of valve showing the contiguous area, valvocopula (arrows) and first ventral segment, SEM, LPC 4411. Note the hyaline margins of valve and bands.

Fig. 80. Detail of a cingulum with two columns of copulae, SEM, LPC 4411. Note the hyaline entire margin of copulae (arrow) and the seam-like, narrow, hyaline structure close to advalvar margin (double arrows).

Fig. 81. An isolated band, SEM, LPC 4411. Double arrow shows the seam-like structure. Scale bars: Fig. 68 = 50 μm; Figs 69–75 = 20 μm; Figs 77, 79, 80 = 10 μm; Figs 76, 78 = 5 μm; Fig. 81 = 2 μm.

SYNONYM: *R. calcar-avis* Schultze.

MORPHOLOGY: Cells are usually solitary, cylindrical, 11–60 μm in diameter, 400–533 μm long (Fig. 68). Valve is subconical, asymmetrical, with hyaline margin and in some specimens with ventral part slightly longer than dorsal part (Figs 69–75). Contiguous area is narrow, hyaline, sigmoid, extended from the base of the process towards the proximity of the margin in the ventral part of the valve (Figs 70–74, 77–79). Valve areolae are poroid, rounded to slightly oval, 23–32 in 10 μm, arranged in striae converging at apex, 28–30 in 10 μm, with a secondary quincuncial pattern (Figs 76–78). Process is claw-shaped, slightly to strongly eccentric, curved, and tapering towards the distal part (Figs 70–75), opening by a pore (Fig. 72). Girdle bands are scale-shaped to rhomboidal, arranged in two or multiples of two columns, with a sub marginal seam-like structure close to the advalvar margin and with entire hyaline edges (Figs 79–81). Band areolae, 28–32 in 10 μm, are arranged in longitudinal striae, 27–30 in 10 μm, with a secondary quincuncial pattern (Fig. 81).

DISTRIBUTION: *Pseudosolenia calcar-avis* is widely distributed in warm waters and occasionally in temperate waters (Hasle & Syvertsen 1996). It has been reported several times in both oceanic and near-shore waters along the coastline of

Argentina (Ferrario & Galván 1989, as *R. calcar-avis*). It was found in 85% of our samples around the year and sometimes reaching high abundance.

REMARKS: *P. calcar-avis* was listed by Koray (2004) as causing mass mortalities of aquatic organisms related to anoxic and hyperoxic conditions generated by its blooms in eutrophic zones along the Turkish coastline. In our study area this species has not been related to harmful events, despite being occasionally abundant.

Probosciaceae Jordan & Ligowski

Proboscia Sundström

Proboscia alata (Brightwell) Sundström

Figs 82–88, 98

REFERENCES: Hustedt (1929, 600, fig. 345); Cupp (1943, 90, figs 52A,B); Hendey (1964, 146, pl. 2 fig. 2); Sundström (1986, 99, figs 258–266); Jordan *et al.* (1991, 65, figs 1–9); Hernández-Becerril (1995, 252, figs 2–4); Hasle & Syvertsen (1996, 159, pl. 30).

SYNONYMS: *R. alata* Brightwell, *R. alata* f. *gracillima* (Cleve) Gran.

MORPHOLOGY: Cells are solitary or in short chains, cylindrical, 7–11 µm in diameter, 320–400 µm long. Valve is subconical, slightly asymmetric, with the ventral part longer than the dorsal part (Figs 82–84). Proboscis is subcylindrical, straight or slightly curved, tapered towards the distal part (Figs 82–84), with a dorsal, short, longitudinal slit below the tip. Distal surface of the proboscis is flat, smooth or with pores, limited by a ring of spinulae (Fig. 85). Contiguous area represents a groove, distally delimited by unequal claspers (Figs 82, 83, 86). The areolae are rounded, 54 in 10 µm, arranged in longitudinal striae, 45 in 10 µm, converging towards the apex (Figs 85–87). Interlocular pores are irregularly scattered. Rhomboidal copulae, with areolae arranged in striae irregularly oriented, are arranged in two dorsiventral columns (Fig. 88). Valve and girdle band areolae are loculate, with external vela perforated by central pores, and internal circular foramina. Scattered interlocular pores are usually surrounded by six loculae (Fig. 98).

Proboscia alata resembles *P. indica* (Peragallo) Hernández-Becerril, *P. inermis* (Castracane) Jordan & Ligowski and *P. truncata* (Karsten) Nöthig & Ligowski. The comparison with *P. indica* is included in the remarks of this species. The striking feature distinguishing *P. alata* from the other two species is the morphology of the claspers, which are unequal and asymmetrical in *P. alata* and equal and symmetrical in the others.

DISTRIBUTION: *Proboscia alata* frequently has been reported in the Argentine Sea (Ferrario & Galván 1989, as *R. alata* Brightwell and *R. alata* f. *gracillima* (Cleve) Grunow). In our study area we found *P. alata* in many samples, usually at low abundances. Sundström (1986) commented that he was unable to determine the biogeographical limits of *Proboscia alata* because the epithet has been used for probably all the taxa included in the genus. The specific limits of the taxa included in *Proboscia* were determined by Jordan & Priddle (1991), Jordan *et al.* (1991), Takahashi *et al.* (1994), Jordan & Saito (1999), Jordan & Ito (2002) and Jordan & Ligowski (2004, 2006). Takahashi *et al.* (1994) pointed out that the genus contains five modern species, whose distribution is polar to temperate. Jordan & Ligowski (2004) mention firstly, it is likely that *P. alata* is not cosmopolitan because it appears to be a complex of cryptic species and secondly, as it stands (i.e. until the cryptic species are separated), *P. alata* commonly is found in polar waters. Nevertheless, Hernández-Becerril (1995) found *P. alata* from tropical to subtropical waters.

REMARKS: Koray (2004) listed *R. alata* f. *gracillima* (Cleve) Gran, the heterotypic synonym of *P. alata*, as causing mass mortalities of aquatic organisms related to anoxic and hyperoxic conditions generated by its blooms in eutrophic zones along the Turkish coastline. In Buenos Aires coastal waters *P. alata* was always found in low abundance and was never associated with noxious events.

Proboscia indica (Peragallo) Hernández-Becerril emend. Jordan & Ligowski

Figs 89–97, 99

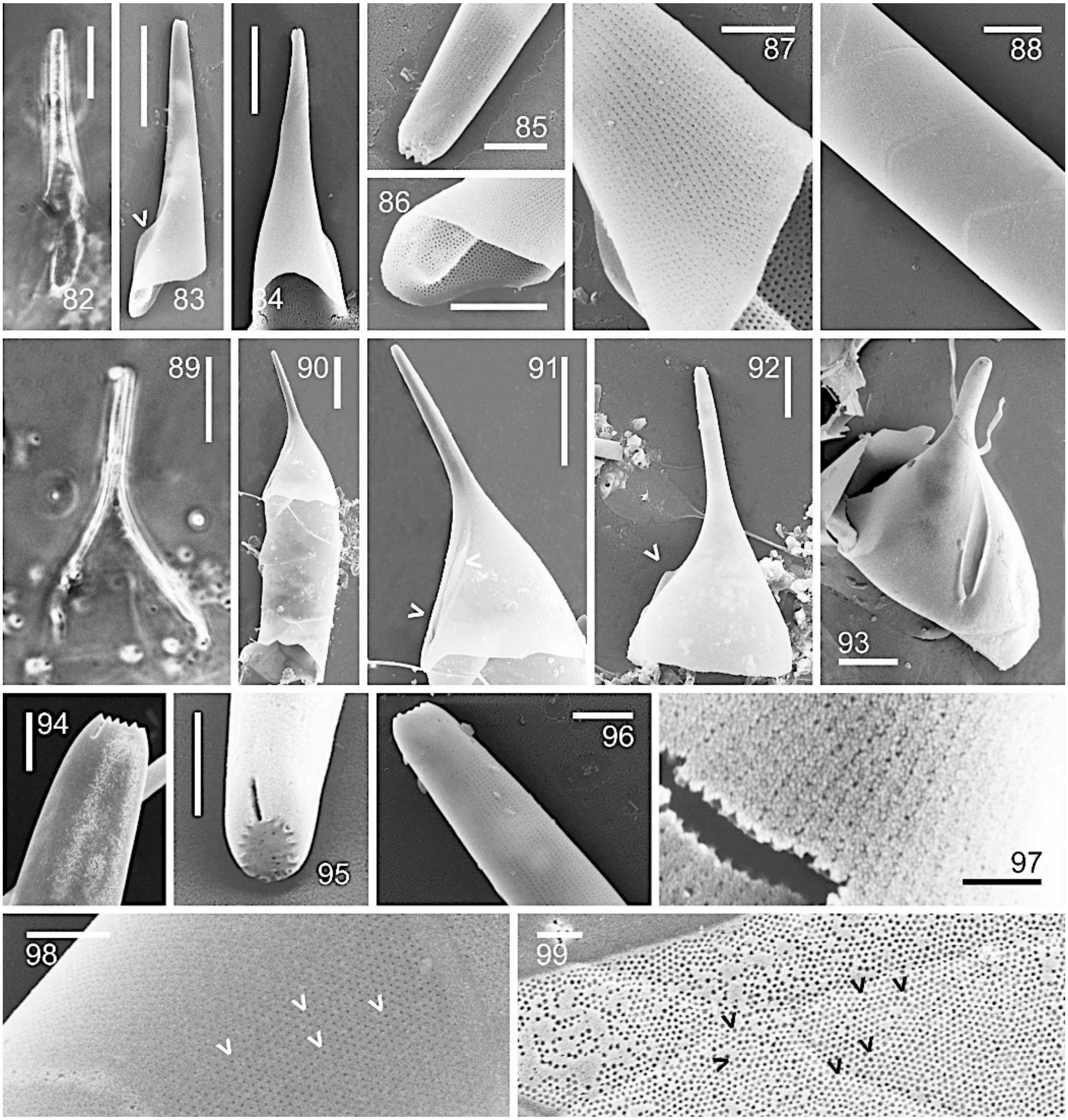
REFERENCES: Hustedt (1929, 602, fig. 346); Cupp (1943, 93, fig. 52C); Hendey (1964, 147, pl. 2 fig. 4); Moreno *et al.* (1996, 15, pl. 29 figs 6, 7); Jordan & Ligowski (2004, 98, pl. 4 figs 5–7).

SYNONYMS: *R. indica* H. Peragallo, *R. alata* f. *indica* (Peragallo) Gran.

MORPHOLOGY: This species differs from *P. alata* by the larger diameter of the frustule, by the morphology of the valve, subconical, rounded, and abruptly tapering into a proboscis more or less curved (Figs 89–93), and by the pattern of the interlocular pores, usually surrounded by four loculae (Fig. 99), feature previously described by Hasle (1975) and Takano (1990). *Proboscia indica* has generally the same ultrastructural features (Figs 90–97) as *P. alata*, but the latter has interlocular pores surrounded by six loculae (Fig. 98), as observed by Sundström (1986). The areola and stria density (30 and 36 in 10 µm) is lower in *P. indica* than in *P. alata*. Our specimens closely resemble those illustrated by Moreno *et al.* (1996), Hustedt (1929), Cupp (1943) and Hendey (1964), but their valve diameter is smaller (27–37 µm) than that described by Jordan & Ligowski (2004) with diameter ranging between 40 and 73 µm.

DISTRIBUTION: According to Hendey (1964) this species is common in temperate and sub-tropical seas. *P. indica* has been reported from Buenos Aires marine waters by Marqués Da Cunha & Da Fonseca (1917), Balech (1964, 1971, 1979) and Lange (1985) as *R. alata* var. *indica*. In our study area the species was found in most samples, usually at low abundance.

REMARKS: Sundström (1986) pointed out that the taxon known as *R. alata* f. *indica* or *R. indica* probably belonged to *Proboscia*. Subsequently, Hernández-Becerril (1995) transferred *R. indica* Peragallo to *Proboscia indica* and



Figs 82–88, 98. *Proboscia alata.*

Fig. 82. A complete valve, LM, LPC 4428.

Fig. 83. Valve in lateral view showing the ventral part (left) longer than dorsal one, SEM, LPC 4366. Note the external view of one of the claspers (arrow).

Fig. 84. Valve in dorsal view, SEM, 4409.

Fig. 85. Distal part of the proboscis showing striae, SEM, LPC 4366. Note the distal surface of the proboscis flat, with pores, limited by a ring of spinulae.

Fig. 86. Detail of Fig. 83 showing the internal view of the grooved contiguous area, SEM, LPC 4366.

Fig. 87. Valve in external view showing areolae arranged in striae converging towards the apex, SEM, LPC 4366.

Fig. 88. Detail of a cingulum, SEM, LPC 4409.

Fig. 98. Detail of a band in external view showing the interlocular pores surrounded by six loculae (arrows), SEM, LPC 4409.

Figs 89–97, 99. *Proboscia indica.*

Fig. 89. A complete valve, LM, LPC 4411

Fig. 90. Valve in lateral view with part of the cingulum, SEM, LPC 4366.

Figs 91, 92. Valves in lateral and dorsal view, respectively, SEM, LPC 4366. Arrows show claspers.

Jordan & Ligowski (2004) emended its description. Moreno *et al*. (1996) and Jordan & Ligowski (2004) pointed out that the material analyzed by Hernández-Becerril (1995, figs 5, 6) does not correspond to this taxon. In our point of view, valves illustrated by Hernández-Becerril (1995) show more similarity with *R. bergonii* than with *Proboscia indica* considering the morphology of the distal part of the process.

CONCLUSIONS

Rhizosolenia s. l. is represented by 10 taxa in Buenos Aires coastal waters, six belonging to *Rhizosolenia s. str.*, two to *Proboscia*, one to *Pseudosolenia* and one to *Neocalyptrella*. Nine of these taxa were reported previously from Argentina, while *R. hyalina* was recorded for the first time.

Pseudosolenia calcar-avis, *Proboscia alata*, *P. indica*, *Rhizosolenia setigera* f. *setigera* and *R. setigera* f. *pungens*, were frequently found in the plankton of the area all year round, while *R. hyalina*, *R. imbricata*, *R. bergonii* and *Neocalyptrella robusta* were found sporadically. The presence of the warm water species *R. bergonii* and *R. hyalina* in coastal waters of Buenos Aires could be explained by the influence of the warm waters of the Brazil Current between 35 to 40°S (see Boltovskoy *et al*. 1999; Romero & Hensen 2002). *R. antennata* f. *antennata*, which has a distribution limited to the southern cold water region, appeared in only one sample and its presence in coastal waters off Buenos Aires might be due to the influence of the cold waters of the Malvinas Current. *P. calcar-avis*, a species referred to as widely distributed in warm waters and occasionally in temperate waters, frequently has been found in the plankton of coastal waters of Buenos Aires and San Matías Gulf (Río Negro; Sar 1996), thus we propose its range to be extended to temperate waters.

The biogeographical distribution of *P. alata* should be revised when the cryptic species complex mentioned by Jordan & Ligowski (2004) clearly is delimited and discussed.

The other taxa analyzed in this study have been reported previously from temperate waters. *R. imbricata* and *R. setigera* f. *setigera* are cosmopolitan taxa excluded from polar regions, and *R. setigera* f. *pungens*, *P. indica* and *N. robusta* are characteristic taxa from warm to temperate waters.

Sundström (1986) included *R. setigera* among the species that did not fit into the genus *Rhizosolenia s. str.* and pointed out that more research was needed before their taxonomic position could be determined. According to this author, *R. setigera, R. pungens* Cleve Euler and *R. crassispina* Schröder differ from *Rhizosolenia s. str.* species in the lack of otaria, in the impression of the adjacent valve process running across more than one girdle segment and in the morphology of the areolae, i.e. poroid with velum perforated by slit-like pores. From a morphological point of view, we consider that the only striking feature of the complex *R. setigera-pungens-crassispina* is the impression of the adjacent valve process running along several girdle bands with claspers, if present, located on the first ventral segment, because some *Rhizosolenia s. str.* species, as *R. bergonii*, lack otaria, and other species, as *R. imbricata*, have poroid areolae. Additionally, Sundström (1986) was reluctant to consider *R. setigera* as a true member of the genus based on 'the morphology of the resting spores, produced in pairs and with different structure from the mother cell'. Nevertheless, Hargraves (1976) pointed out that resting spores of *R. setigera* are paired in the parent cell, similar to those of *R. styliformis* Brightwell, the only other *Rhizosolenia s. str.* species known to form spores.

Contrary to the opinion given by Sundström (1986), and according to the results of our analysis, we think that there is not enough conclusive evidence to erect a new genus. Thus, we included *R. setigera* into the genus *Rhizosolenia s. str.* based on the ultrastructural comparison of this species with other members of the genus and considering the description of the resting spores given by Hargraves (1976). We believe that the length of the impression of the adjacent valve process across several girdle bands and the location of the claspers on the first ventral segment must be considered as specific differential features. Besides, despite the opinions of Hernández-Becerril (1995), Hasle & Syvertsen (1996) and Sundström (1986), who considered *R. setigera* and *R. pungens* as good species, the ultrastructural analysis of our material allows us to determine that the differences between both taxa are so subtle that Brunel's decision to change the taxonomic status of *R. pungens* to *R. setigera* f. *pungens* appears justified. Medlin & Kaczmarska (2004) commented that 'Within the Rhizosoleniales, the genus *Rhizosolenia* is not monophyletic and species of *Guinardia* Peragallo root each of two lineages in this clade. Further investigations into the relationship between *Guinardia* and *Rhizosolenia,* as shown in the molecular analyses, are warranted'. Subsequently, Medlin (2006), based on an unpublished study of *R. setigera* with transmission electron microscope (TEM) and SEM and with molecular techniques, reported that her strains fall into multiple clades and assumed that there is a complex of the so-called cryptic species. We believe that our study of this taxon, scarcely analyzed at the present, could be useful for adding morphological information about specimens of another region of the world to the revision of the complex.

Some species of *Rhizosolenia*, *P. alata* and *P. calcar-avis*, previously have been associated with harmful events in

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Fig. 93. Valve in ventral view showing the contiguous area, SEM, LPC 4366. Note that claspers are lost.

Figs 94–96. Details of the different probosces, SEM, LPC 4366 (Figs 94, 96), LPC 4363 (Fig. 95). Note ring of spinulae, flat distal surface with pores, and longitudinal slit below the tip and areolation pattern.

Fig. 97. Broken valve showing loculate areolae, SEM, LPC 4363.

Fig. 99. Detail of a band in external view showing the interlocular pores usually surrounded by four loculae (arrows), SEM, LPC 4366.

Scale bars: Figs 82, 89–91 = 20 μm; Figs 83, 84, 92, 93 = 10 μm; Figs 86, 88 = 5 μm; Figs 85, 87, 94–96, 98, 99 = 2 μm; Fig. 97 = 1 μm.

other geographical regions. *R. setigera*, *P. alata* and *P. calcar-avis* were found in our area and, in the cases of *P. calcar-avis* and both forms of *R. setigera*, they were occasionally abundant to dominant; however, despite this fact, they were never related to harmful events.

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