Morphology and distribution of *Paralia* Heiberg (*Coscinodiscophyceae*) in southern Brazil[1]

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ABSTRACT – The morphology and distribution of *Paralia fenestrata* Sawai & Nagumo and *P. sulcata* (Ehrenberg) Cleve were studied within a set of 50 samples from plankton and sandy sediment, which were collected along the coast of Santa Catarina and Rio Grande do Sul states. Regarding morphology, the Brazilian specimens differ from the Northern Hemisphere specimens, in number of cells in the chain and in number of ring of pores on the valve face of separating valves. Both species were reported in high relative abundance and they have been found in environments with wide water temperature (16.5 ºC-28.2 ºC) and salinity (29.05-36) ranges.

Key words: diatoms, *Paralia fenestrata, Paralia sulcata*

RESUMO – **Morfologia e distribuição de *Paralia* Heiberg (*Coscinodiscophyceae*) no Sul do Brasil.** A morfologia e distribuição de *Paralia fenestrata* Sawai & Nagumo e *P. sulcata* (Ehrenberg) Cleve foram estudadas em 50 amostras do plâncton e sedimentos arenosos, os quais foram coletados ao longo da costa dos estados de Santa Catarina e Rio Grande do Sul. Com relação à morfologia, os espécimes registrados no Brasil diferem dos encontrados no Hemisfério Norte, principalmente em número de células na cadeia e número de anéis de poros sobre a face valvar das valvas de separação. Ambas as espécies foram reportadas em alta abundância relativa e foram encontradas em ambientes com ampla variação de temperatura (16.5 ºC-28.2 ºC) e salinidade (29.05-36).

Palavras-chave: diatomáceas, *Paralia fenestrata, Paralia sulcata*

INTRODUCTION

The genus *Paralia* Heiberg has thirteen taxonomically accepted species. Among these, *Paralia sulcata* (Ehrenberg) Cleve is a widely known and cited species. In the last years, Garcia (2003) added a new species to the genus, *P. elliptica* Garcia, a benthic taxon with elliptical outline found in the marine sandy beaches of the State of Santa Catarina (26ºS and 27°S). Afterwards, Sawai *et al.* (2005) described two species of *Paralia*: *P. fenestrata* Sawai & Nagumo and *P. capitata* Sawai & Nagumo, found in Japanese waters. More recently, MacGillivary & Kaczmarka (2012) described three species within the *P. longispina* Konno & Jordan species complex (*P. allisonii* MacGillivary, *P. crawfordii* MacGillivary, and *P. ehrmanii* MacGillivary) found in Jamaica, Panama, Mexico, and Hawaii.

Paralia fenestrata was found in plankton and mud of Japanese samples of an interior bay (Ariake Bay, 31º N) from a brackish tidal lake (Koshiki Island, 32º N), while *P. capitata* was less widely distributed on a coral reef (Ishigaki Island, 24º N). In the same region, Sawai *et al*. (2005) also found *P. sulcata* but the three species of *Paralia* did not occur in the same localities and samples. These three species of *Paralia* differ in several details in SEM, and the dimension data are easily assessed in LM.

Paralia sulcata may represent an important plankton component in several areas around the world. Blooms were registered by Hobson & McQuoid (1997), Roelofs (1984) reported it in a

relative abundance of 24% related to high salinity in Southern British Columbia, and elevated numbers of this species have recently been found in Helgoland by Gebühr *et al*. (2009).

Several Brazilian authors have registered *P. sulcata* in their samples, but few have provided illustrations. Fine and reliable illustrations (line drawings and LM micrographs) are found in Rosa (1982), Busellato-Toniolli (1986), Felício-Fernandes *et al*. (1994), Souza-Mosimann *et al*. (1993), Souza-Mosimann & Ross-Oliveira (1998), Moura *et al*. (2007), Medeanic *et al.* (2008), and Medeanic *et al.* (2009). Environmental data have been registered for the states of Pernambuco (Moura *et al*., 2007) and Rio Grande do Sul (Rosa, 1982).

Paralia fenestrata was illustrated with LM and SEM observations by Souza-Mosimann *et al*. (2011) from Lagoa da Conceição, but no environmental data was reported.

The aim of this study was to present morphological observations on *P. fenestrata* and *P. sulcata* based on LM and SEM of Brazilian specimens comparing them with specimens illustrated in the literature, and investigate their distribution and relative abundance in the waters of southern Brazil.

MATERIAL AND METHODS

Sampling were carried out in Santa Catarina Island (Florianópolis, Santa Catarina State (SC), 27°10'S and 27°50'S-48°25'W and 48°35'W). Three sites were established: Pântano do Sul, Ratones Grande, and Guarás. Ratones Grande and Guarás are located in a semi-closed bay (Baía Norte) and they are under the influence of two rivers and mangroves (Ratones and Itacorubi river), on the other hand, Pântano do Sul site is located inshore. The depth of the sampling location Guarás ranged between 3 and 4 m, in the Ratones Grande the variation was between 8 and 10 m, and in Pântano do Sul between 12 and 14 m. In total, 36 net plankton samples were collected monthly from January 2007 to January 2008, and fixed with formaldehyde at 4%.

In addition to the sampling described above, 14 Herbarium slides from samples collected on the coasts of Santa Catarina and Rio Grande do Sul states over the last 20-25 years were observed to understand the distribution and frequency of *P. fenestrata* and *P. sulcata* in southern Brazil (Tab. 1). All these beaches are on Quartenary sediments and are subject to microtides, mainly semidiurnal with a mean range of around 0.8 m and a maximum tide of 1.2 m (Toldo *et al.,* 2000; Klein & Menezes, 2001).

Table 1. Distribution of *Paralia fenestrata* e *P. sulcata* on the cost of Santa Catarina and Rio Grande do Sul states in southern Brazil on plankton and sediment samples.

Locality and Period	Samples	Species
Santa Catarina State		
Araçá (27°08'S-48°31'W)	Sediment (sand)	
October 2001		*P. sulcata*
Baia Sul (27º40'S-48º35'W)	Plankton	
July, 1990		
October 1992		*P. sulcata*
October 1995		*P. fenestrata*
October 2005		
Canto Grande (27°10'S-48°32'W)	Sediment (sand)	
November 2001		*P. sulcata*
		P. fenestrata
Guarás (27º33'S-48º33'W)	Plankton	
January 2007 - March and May - January, 2008		*P. sulcata* *P. fenestrata*
April 2007		*P.fenestrata*
Lagoa da Conceição (27º 34'S-48º 27'W)	Plankton	
March 2002		*P. fenestrata*
Ratones Grande (27º28'S - 48º33'W)	Plankton	
January 2007 - January 2008		*P. sulcata*
		P. fenestrata
Pântano do Sul (27º47'S-48º30'W)	Plankton	
January 2007, February 2007, April 2007, May 2007,		*P. sulcata*
September 2007 - December 2007		*P. fenestrata*
March 2007, July 2007, August 2007, January 2008		*P. fenestrata*
Ribeirão da Ilha (27º43'S-48º34'W)	Plankton	
March 1984		*P. fenestrata*
Ribeirão Fazenda (27º37'S-48º34'W)	Plankton	
June 1990		*P. sulcata*
		P. fenestrata
Zimbros (27°12'S-48°29'W)	Sediment (sand)	
January 1996		*P. fenestrata*
March 2002		*P. sulcata*
Rio Grande do Sul State		
Cassino beach (32º12'S-52º10'W)	Plankton	
April 2001		*P. sulcata*
		P. fenestrata
November 2003		*P. sulcata*
December 2006		*P. sulcata*

In Santa Catarina, samples were collected using a net (25 µm mesh aperture), fixed with formaldehyde at 4% and kept in the refrigerator. At Cassino beach (Rio Grande do Sul-RS), plankton samples were collected with a conical net (20 µm mesh aperture), preserved with 4% buffered formaldehyde and kept in glass flasks (200 mL). Sediment samples from the coast of Santa Catarina State were taken from the splash zone by scraping the superficial sand until 2 mm depth. Sediment was kept in flasks with 20 ml of 3% lugol solution and later 4% formaldehyde was added. Sampling sites where the species were observed are presented in Figure 1.

The samples from Santa Catarina State are registered in the Herbarium of the Universidade Federal de Santa Catarina (FLOR), Herbarium Prof. Dr. Alarich R. H. Schultz of the Museu de Ciências Naturais da Fundação Zoobotânica do Rio Grande do Sul (HAS) and Herbarium of the Universidade Federal de Pelotas (PEL), whereas the samples from Rio Grande do Sul State are deposited in the Herbarium of the Universidade Federal do Rio Grande (HURG).

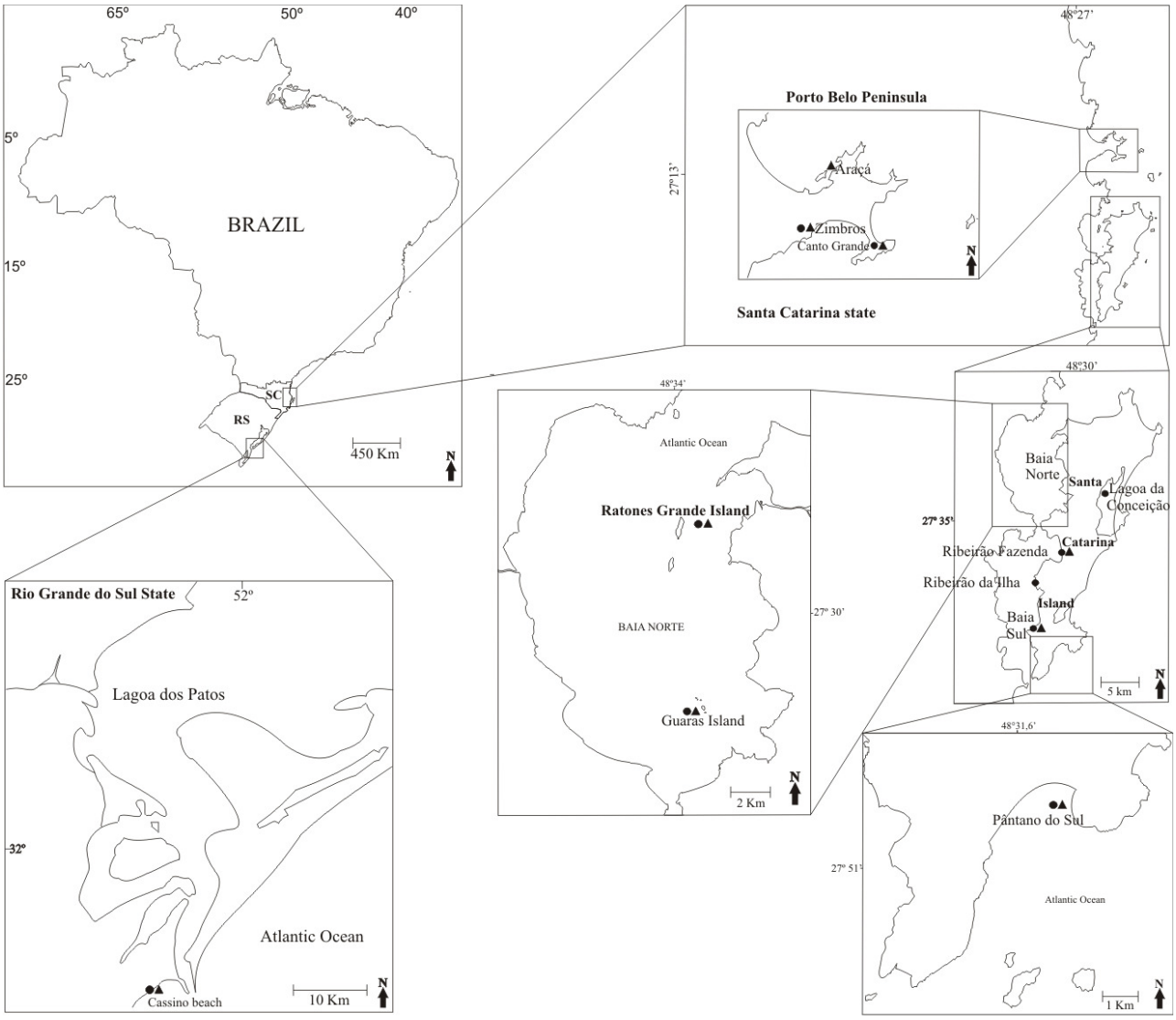


Fig. 1. Sampling sites where *Paralia fenestrata* (•) e *P. sulcata* (▲) were found in Santa Catarina (SC) and Rio Grande do Sul (RS) states, southern Brazil.

Temperature and salinity were measured only of the three sites (Ratones Grande, Guarás, and Pântano do Sul) from Santa Catarina Island (SC) and these data are shown in Table 2. The temperature was measured with portable probes (HACH-16046) and salinity using a conductivity electrode (HACH-2100P).

Subsamples from each site were cleaned using the technique described by Simonsen (1974). Part of the material was mounted onto a glass slide with Naphrax® to make two permanent slides per sample, and examined with an Olympus BX 50 light microscope.

For Scanning Electron Microscopy (SEM), cleaned specimens were dried onto stubs and coated with gold at 40 mA for 100 seconds using the Baltec SCD 050 sputter coater. The stubs were observed using a JEOL 6390 LV microscope at accelerating voltages of 20kV. The working distance was 10 mm.

The species were quantified counting 400 valves per slide in order to estimate their relative abundance. The relative abundance data for each species from Ratones Grande, Guarás and Pântano do Sul sites (Santa Catarina Island) are shown in the Figure 2.

RESULTS AND DISCUSSION

Morphology of the taxa

Paralia fenestrata Sawai & Nagumo, Phycologia, 44:520, figs. 26-42. 2005.

(Figs. 3-10)

Paralia fenestrata was found forming chains with three to forty-four cells (n = 28, average = 9 per filament) on Santa Catarina Island (SC), while only isolated frustules were found at Cassino beach (RS) (Figs. 3-5). Separation valves do not present spines and the radial markings on the valve face are located midway between the valve margin and center. Next to the valve margin there is a single row of pores (Fig. 6). The mantle has wide arches filled with 4 to 5 rows (not regularly organized) of fine pores of approximately the same size (Fig. 7) and a ring of rimoportulae on the mantle edge (Fig. 8). Intercalary valves present spatulate spines (Fig. 9) around the valve margin and well developed markings on the valve face (Fig. 10). The diameter of the specimens found on Santa Catarina Island varied between 10 and 27.5 µm (n = 41) at stations Guarás, Ratones Grande, and Pântano do Sul, whereas at Baia Sul, Lagoa da Conceição, Ribeirão da Ilha, and Ribeirão Fazenda, it was 17.5-27.5 µm (n = 20). In Porto Belo peninsula the variation was 20-29 µm (n = 4). The valve diameter registered at Cassino beach was 22-43 µm (n = 5).

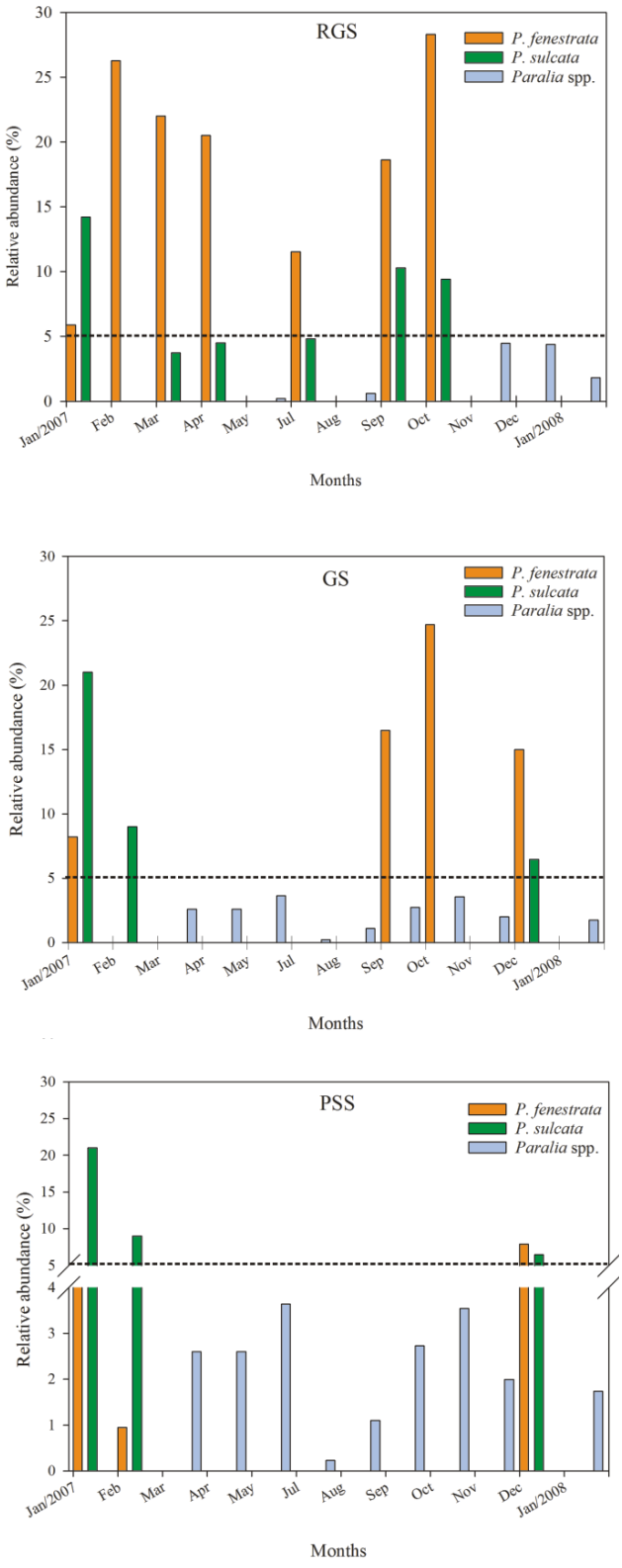


Fig. 2. Relative abundance of *Paralia fenestrata*, *P. sulcata* and *Paralia* spp. (two species together when the relative abundance was less than 5%) in the Santa Catarina Island, SC (RGS: Ratones Grande Site; GS: Guarás Site; PSS: Pântano do Sul Site).

Examined material: BRAZIL, SANTA CATARINA, Porto Belo, Canto Grande, IX.2001, (PEL 22583); Zimbros, I.1996, (ICN 91485); Zimbros, III.2002, (PEL 22629); Florianópolis, Baia Sul, X.1992, (FLOR 12837-12839); Baia Sul, X.2005, (FLOR 13001-13003); Ribeirão da Ilha, III.1984, (FLOR 12380-12384); Lagoa da Conceição, III. 2002, (FLOR 12970-12979): Guarás, I.2007, (FLOR 13005); Guarás, II.2007, (FLOR 13008);. Guarás, III.2007, (FLOR 13011);Guarás, IV.2007, (FLOR 13014); Guarás, V.2007, (FLOR 13017); Guarás, VII.2007, (FLOR 13020); Guarás, VIII.2007, IX.2007, (FLOR 13023); Guarás, X.2007, (FLOR 13029); Guarás, XI.2007, (FLOR 13032); Guarás, XII.2007, (FLOR 13035); Guarás, I.2008, (FLOR 13038); Pântano do Sul, I.2007, (FLOR 13006); Pântano do Sul, II.2007, (FLOR 13009). Pântano do Sul, III.2007, (FLOR 13012); Pântano do Sul, IV.2007, (FLOR 13015); Pântano do Sul, Pântano do Sul, VIII.2007, (FLOR 13024); Pântano do Sul, V.2007, (FLOR 13018); Pântano do Sul, VII.2007, (FLOR 13021); Pântano do Sul, IX.2007, (FLOR 13027); Pântano do Sul, XII.2007, (FLOR 13036); Pântano do Sul, I.2008, (FLOR 13223); Ratones Grande, I.2007, (FLOR 13004); Ratones Grande, II.2007, (FLOR 13007); Ratones Grande, III.2007, (FLOR 13010); Ratones Grande, IV.2007, (FLOR 13013); Ratones Grande, V.2007, (FLOR 13016); Ratones Grande, VII.2007, (FLOR 13019); Ratones Grande, VIII.2007, (FLOR 13022); Ratones Grande, IX.2007, (FLOR 13025); Ratones Grande, X.2007, (FLOR 13028); Ratones Grande, XI.2007, (FLOR 13031); Ratones Grande, XII.2007, (FLOR 13034); Ratones Grande, I.2008, (FLOR 13037). RIO GRANDE DO SUL, Rio Grande, Cassino, IV. 2001, (HURG 10918A).

Paralia sulcata (Ehrenberg) Cleve, Bihang till Kongl. Svenska Vetenskaps-Akademiens Handlingar, 1(13):7. 1873. *Gallionella sulcata* Ehrenberg, Naturforschender Freunde zu Berlin, 31. 1837.

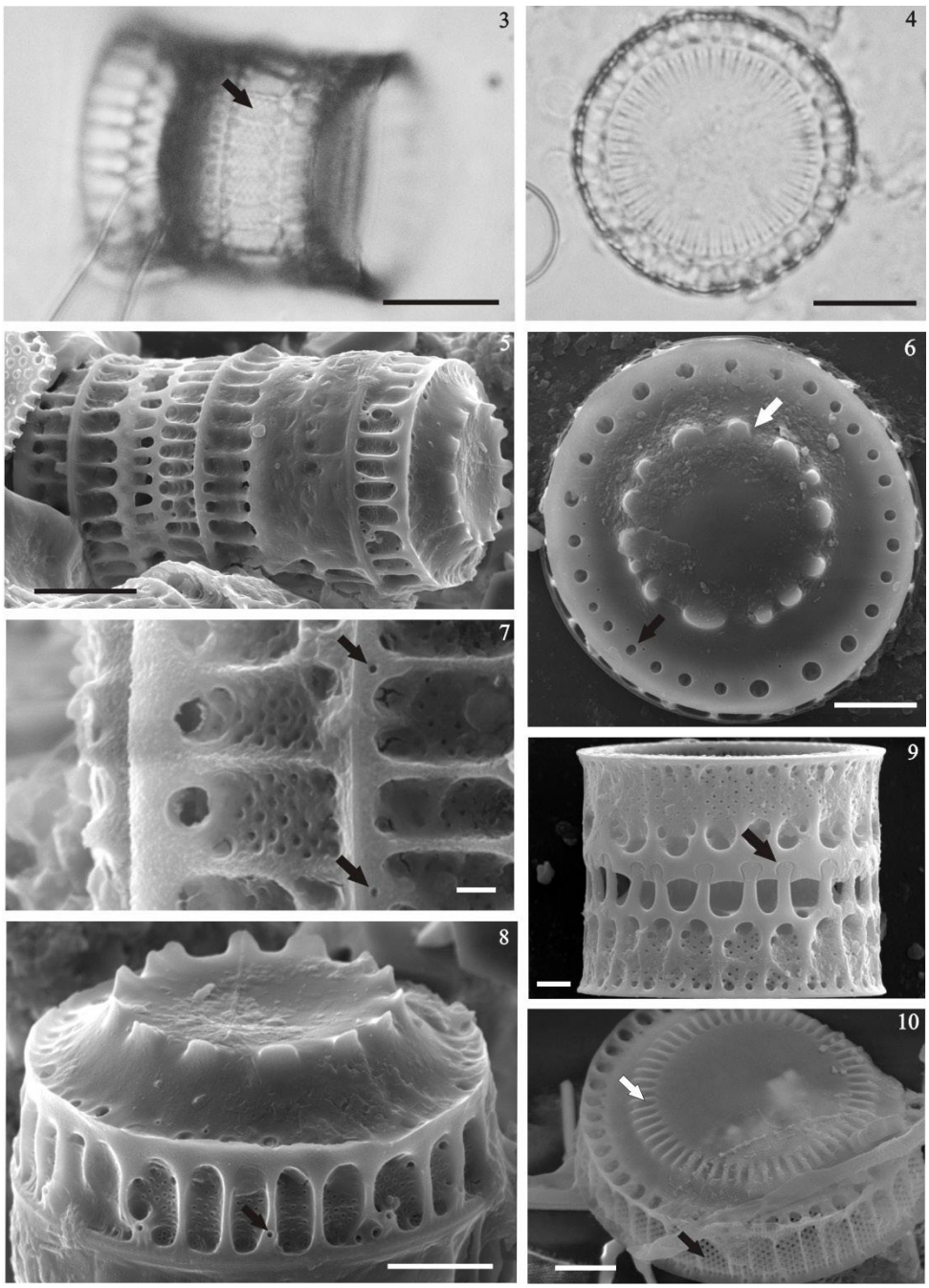
(Figs. 11-17)

Paralia sulcata was found forming chains with three to twenty-six cells (n=15, average=11 cells per filament) on the isle of Santa Catarina (SC), while only isolated frustules were found on Cassino beach (Figs. 11-13). Separation valves do not present spines and the radial markings on the valve face are located midway between the valve margin and centre (Fig. 14). Next to the valve margin there are two single rows of pores. Intercalary valves have spines around the valve margin and well-developed markings on the valve face (Fig. 15). Interlocking spines are short and in some valves slender and a ring of rimoportulae is present on the mantle edge (Fig. 16). The external layer of the mantle in the separation and intercalary valves (Fig. 17) has a variable number of pores with a distinct shape and irregular distribution. The diameter of the specimens found on Santa Catarina Island (SC) varied between 12.5 and 20 µm (n=21) at stations Guarás, Ratones Grande, and Pântano do Sul, whereas at Baia Sul, Lagoa da Conceição, Ribeirão da Ilha, and Ribeirão Fazenda, it was 12.5-15 µm (n=4). On Porto Belo peninsula (SC), the variation was 10-12 µm (n=12). The valve diameter registered in Rio Grande do Sul State (Cassino beach) was 16-19 µm (n=4).

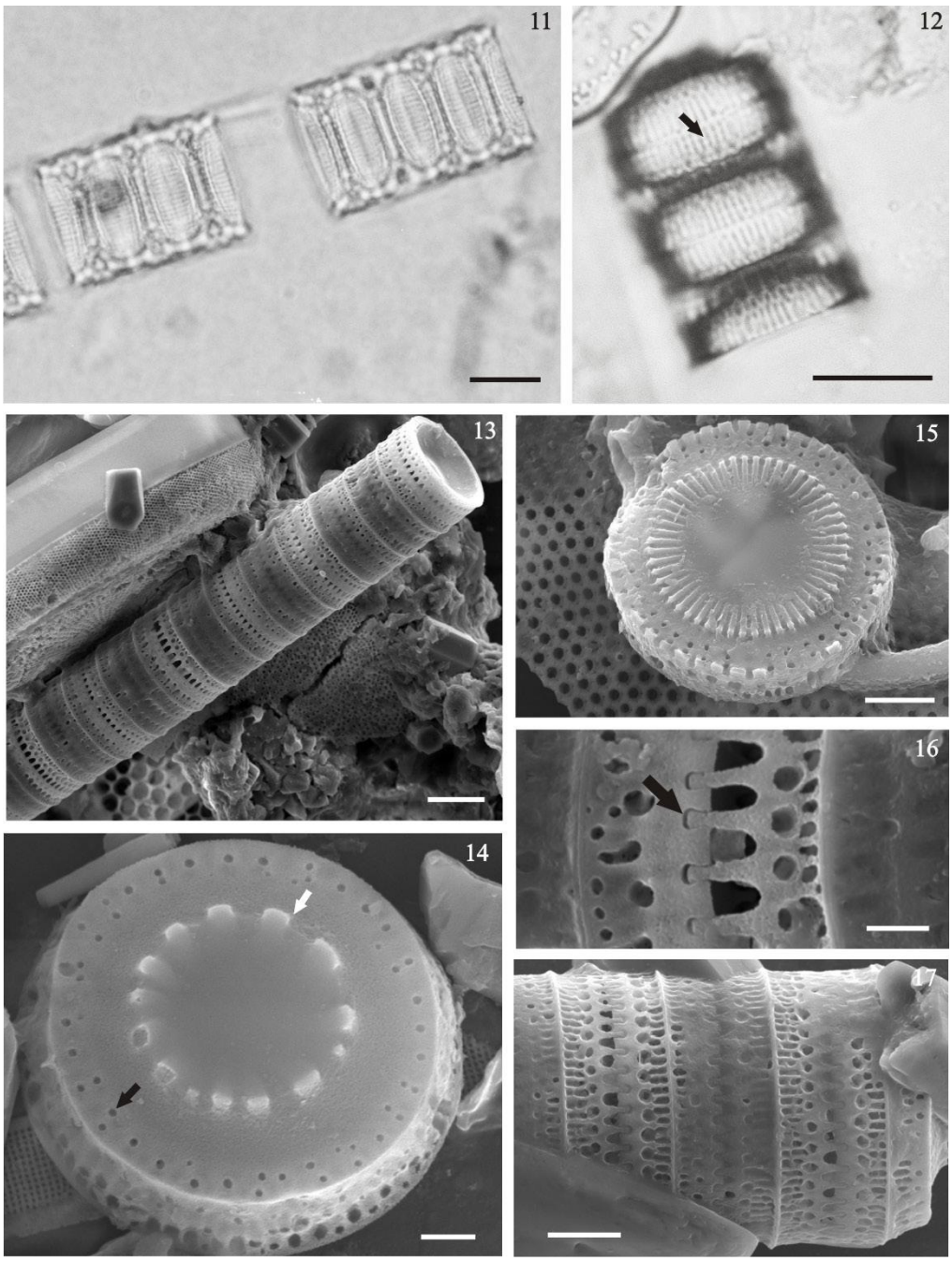
Examined Material: BRAZIL, SANTA CATARINA, Porto Belo, Araçá, X.2001, (PEL 22581); Canto Grande, IX.2001, (PEL 22583); Zimbros, I.1996, (ICN 91485); Zimbros, III.2002, (PEL 22629); Florianópolis, Baia Sul, X.1992, (FLOR 12837-12839); X.2005, (FLOR 13001-13003); Ribeirão Fazenda, VI.1990, (FLOR 12741-12743); Guarás, I.2007, (FLOR 13005); Guarás, II.2007, (FLOR 13008); Guarás, III.2007, (FLOR 13011); Guarás, V.2007, (FLOR 13017); Guarás, VII.2007, (FLOR 13020); Guarás, VIII.2007, IX.2007, (FLOR 13023); Guarás, X.2007, (FLOR 13029); Guarás, XI.2007, (FLOR 13032); Guarás, XII.2007, (FLOR 13035); Guarás, I.2008, (FLOR 13038); Pântano do Sul, I.2007, (FLOR 13006); Pântano do Sul, II.2007, (FLOR 13009) Pântano do Sul, IV.2007, (FLOR 13015); Pântano do Sul, V.2007, (FLOR 13018); Pântano do Sul, IX.2007, (FLOR 13027); Pântano do Sul, XII.2007, (FLOR 13036); Ratones Grande, I.2007, (FLOR 13004); Ratones Grande, II.2007, FLOR 13007); Ratones Grande, III.2007, (FLOR 13010); Ratones Grande, IV.2007, (FLOR 13013); Ratones Grande, V.2007, (FLOR 13016); Ratones Grande, VII.2007, (FLOR 13019).; Ratones Grande, VIII.2007, (FLOR 13022); Ratones Grande, IX.2007, (FLOR 13025); Ratones Grande, X.2007, (FLOR 13028 (); Ratones Grande, XI.2007, (FLOR 13031); Ratones Grande, XII.2007, (FLOR 13034); Ratones Grande, I.2008, (FLOR 13037). RIO GRANDE DO SUL, Rio Grande, Cassino, IV. 2001, (HURG 10918A); IX. 2003, (HURG 10996A); XII.2006, HURG (HURG 11112A).

The number of cells per filament in *P. fenestrata* is more commonly higher than in *P. sulcata*. Sawai *et al.* (2005) reported short filaments (4 to 10 cells) for *P. fenestrata* while we have found filaments ranging widely from 3 to 44 cells. For *P. sulcata*, Crawford (1979) recorded 5 cells (in average) per filament and we observed 11 cells (in average) per filament. The number of ring of pores on the valve face of the separating valves was different between the species (Tab. 3). *Paralia sulcata* has a double ring of pores in contrast with the single ring observed by Sawai *et al.* (2005) and McQouid & Nordberg (2003). Though, in the Fig. 15 by Crawford (1979), he shows a specimen that has similar pore arrangement as the Brazilian specimens. In the same way, separation valves of *P. fenestrata* from Brazil show a single row of pores on the valve face but in the diagnosis two rings were described. Some interlocking spines of *P. sulcata* are more slender than illustrated by Sawai *et al.* (2005) and Crawford (1979).

In Japanese waters, *P. sulcata* presented a small diameter ranging from 8 to 25 µm, while *P. capitata* and *P. fenestrata* reached wider dimensions, ranging from 8 to 60 µm. Specimens from Santa Catarina Island had wide-ranging diameters: *P. fenestrata* ranged from 10 to 27.5 µm and a shorter variation from 12.5 to 20 µm was observed in *P. sulcata*. Diameter measurements of *Paralia fenestrata* were consistent with its type material and *P. sulcata* presented a range similar to that cited by Sawai *et al.* (2005).



Figs. 3-10. Light and electron microscope micrographs of *Paralia fenestrata*; **3.** Girdle view showing the mantle ornamented by several rows of areolae separated by ribs (arrow); **4.** Valve view of sibling valve; **5.** Short filament with one separation valve and 2-3 sibling valves; **6.** Separation valve in valve view presenting one ring of large areolae next to the margin (black arrow) and markings halfway between valve center and margin (white arrow); **7.** Details of external rimoportulae apertures (arrows); **8.** Separation valve without connecting spines and one ring of large areolae next to the margin. Arrow shows the external rimoportula aperture; **9.** Sibling valves with spatulate spines (arrow). **10.** Sibling valve with markings on valve face (white arrow) and 4-5 rows of pores on the mantle (black arrow). Scale bars: **Figs. 3-5** = 10 μm; **Figs. 6, 8, 10** = 5 μm; **Fig. 7** = 1 μm; **Fig. 9** = 2 μm.



Figs. 11-17. Light and electron microscope micrographs of *Paralia sulcata*; **11.** Part of a filament in girdle view; **12.** Part of a filament showing very closely arranged ribs (arrow); **13.** Part of a filament of about 7 cells; **14.** Separating valve in valve view presenting two rings of large areolae (black arrow) and marks midway between valve centre and margin (white arrow); **15.** Sibling valve in valve view; **16.** Detail of a thin interlocking spine (arrow); **17.** Detail of a filament with closely arranged ribs. Scale bars: **Figs. 11-13** = 10 µm; **Figs. 14, 16** = 2 µm; **Figs. 15, 17** = 5 µm.

Differences between both species have been emphasized by Sawai *et al*. (2005) and are based mainly on the mantle organization. In *P. fenestrata*, the mantle of separation valves presents well defined arches with several (4-5) rows (not regularly organized) of small pores of approximately the same size. In *P. sulcata*, separation valves do not present arches and pores of distinct sizes are irregularly distributed on the mantle (Sawai *et al*., 2005).

Until the present, only *P. elliptica, P. fenestrata*, and *P. sulcata* were registered for Brazil. These three species are different mainly under scanning electronic microscopy (see Tab. 3).

Distribution, abundance and environmental data

Analyses of the images and dimension data provided by Brazilian material suggest that *P. fenestrata* is widely distributed in southern Brazil and *P. sulcata* may occur with *P. fenestrata* in several other areas besides Santa Catarina Island (SC) (Tab. 1). The girdle view of *P. sulcata* from the mangrove of Tavares river (27° 38´S and 48° 30´W) illustrated by Felício-Fernandes & Souza-Mosimann (1994) can be identified as *P. fenestrata*. The diameters cited by the above authors were between 25 and 50 μm that is also in agreement with *P. fenestrata*.

Considering *Paralia* species seasonal distribution and the water temperature, in Pântano do Sul, Ratones Grande, and Guarás, *P. fenestrata* and *P. sulcata* were observed together all year round and highest peaks of the relative abundance were registered in warm temperature (summer and spring, Tab. 2 and Fig. 2). In Santa Catarina Island (SC), water temperature was found to be in Ratones Grande between 16.5 ºC and 27.8 ºC, in Guarás between 16.5 ºC and 28.2 ºC, and in Pântano do Sul within a range smaller than that found in other stations (17 ºC e 23.74 ºC).

Rosa (1982) recorded *P. sulcata* as a rare species present all year round in six sampling stations with temperature ranging between 14 ºC and 26 °C; Moura *et al.* (2007) reported it in every month of two collecting periods: September to December 1999 and April to July 2000, during which water temperatures ranged from 27.5 ºC to 35.5 °C and Busellato-Toniolli (1986) registered the species in spring and summer, associated with *Hypnea musciformis* (Wulfen) Lamouroux. Brazilian records differ from observations made on *P. sulcata* from the North Sea by Gebühr *et al.* (2009), where the species was registered mainly in late autumn and winter.

Simonassi *et al.* (2010) show than the waters of Ratones Grande, Guarás, and Pântano do Sul have been classified as mesotrophic and eutrophic during some periods of the year (March and May 2007). In this period, the relative abundance of *Paralia* spp. showed no notable differences when compared with others months (Fig. 2). *Paralia* spp. can reach over 45% of the valves counted on Santa Catarina Island (SC), and similar values, such as 24% frequency, was reported by Roelofs (1984), and blooms by Hobson & McQuoid (1997) for the Northern Hemisphere. These data suggest *Paralia* spp. in Brazil most likely grow in warm and non-eutrophic waters.

Regarding the salinity in the studied area and *Paralia* spp. distribution, in Ratones Grande station salinity ranged from 29.05 to 35.5, in Guarás from 30.1 to 35.5 and in Pântano do Sul from 34 to 36 (Tab. 2). Cloern & Dufford (2005) registered *P. sulcata* in areas with 12 to 30 salinity. The Brazilian specimens occurred in a wider salinity than found by previous studies, (0 to 35.5) according to Rosa (1982) and (29.05 to 36) in the present study (Tab. 2). These data differ from observations by Roelof (1984) and McQouid & Nordberg (2003) regarding the occurrence of a high number of *P. sulcata* in areas with higher salinity and the relation between small size and high salinity values, because small and large *P. sulcata* were observed in the same samples (Tab. 2).

The distribution of *P. fenestrata* described here for southern Brazil (Tab. 1) in plankton and benthos samples agree with the observations made by Sawai *et al.* (2005) in Japan, where the species also occurs in areas subjected to a wide salinity variation. Guarás and Ratones Grande sites are influences by rivers and are shallower than Pântano do Sul site. These data can explain the highest values of relative abundance of *Paralia* spp. registered in Guarás and Ratones Grande (Fig. 2), considering there is greater mix in the water column with suspension of sediment. This information and data of occurrence de *P. fenestrata* and *P. sulcata* in the plankton and sediment studied in Brazil indicate than these species have tychoplanktonic behavior.

The more abundant species found together with *Paralia* spp., on Santa Catarina Island (SC) were found in plankton samples, were *Actinocyclus octonarius* Ehrenberg, *A. octonarius* var. *crassuss* (William Smith) Hustedt, *Anorthoneis eurystoma* Cleve, *Asterionellopsis glacialis* (Castracane) Round, *Coscinodiscus radiatus* Ehrenberg, *C. wailesii*

Gran & Angst, *Cyclotella litoralis* Lange & Syvertsen, *Entomoneis alata* (Ehrenberg) Ehrenberg, *Grammatophora oceanica* Ehrenberg, *Navicula pennata* A. Schmidt, *Neodelphineis pelagica* Takano, *Nitzschia lorenziana* Grunow, *Odontella aurita* (Lyngbye) Agardh, *Pleurosigma affine* Grunow, *Psammodictyon panduriforme* (Grunow) D.G.Mann, *Rhizosolenia setigera* Brightwell, *Skeletonema grethae* Zingone *et* Sarno, *S. pseudocostatum* Medlin *emend.* Zingone & Sarno, *Thalassionema frauenfeldii* (Grunow) Tempère & Peragallo, *Thalassionema synedriforme* (Greville) Hasle, *Thalassiosira angulata* (Gregory) Hasle, *T. decipiens* (Grunow) E.G. Jørgensen, *T. eccentrica* (Ehrenberg) Cleve, *T. rotula* Meunier and *T. simonsenii* Hasle & Fryxell. *Grammatophora oceanica, Odontella aurita*, and *Thalassiosira* spp. are taxa in common with those found in Japanese waters (Sawai *et al.,* 2005), where *P. fenestrata* was described.

Mcquoid & Nordberg (2003) pointed out that *P. sulcata* can be used as a paleoindicator because it is heavily silicified and thus preserves well in sedimentary records, but its tychopelagic nature has made detailed paleoecological interpretations complicated. In this study, the authors observed that environmental conditions influence the morphology and abundance of *P. sulcata.* The results found in the present study showed that *P. fenestrata* can also be used in this type of study in Brazil, because it is abundant in several places in the southern part of the country. Otherwise, like *P. sulcata,* recorded for sediment and planktonic samples, the interpretation about paleoenvironmental conditions can be difficult.

We hope that data herein presented give subsidies for future studies related to the influence of environmental conditions on morphology and ecology, helping clarify the paleoindicator-potential of these species in coastal environments.

Table 2. Environmental data in Ratones Grande, Guarás and Pântano do Sul sites, Santa Catarina Island (Santa Catarina State, Brazil), between January 2007 and January 2008.

Years/Months	Ratones Grande	Guarás	Pântano do Sul
2007			
January	Temp.: 23 ºC Salinity: 34 ‰	Temp.: 23 ºC Salinity: 34 ‰	Temp.: 19.25 ºC Salinity: 35 ‰
February	Temp.: 27.8 ºC Salinity: 34 ‰	Temp.: 28.2 ºC Salinity: 34 ‰	Temp.: 19.7 ºC Salinity: 34.5 ‰
March	Temp.: 27.3 ºC Salinity: 33 ‰	Temp.: 27.8 ºC Salinity: 33 ‰	Temp.: 23.75 ºC Salinity: 35 ‰
April	Temp.: 22.25 ºC Salinity: 35 ‰	Temp.: 22 ºC Salinity: 35.5 ‰	Temp.: 20.85 ºC Salinity: 34 ‰
May	Temp.: 18 ºC Salinity: 35.5 ‰	Temp.: 17.8 ºC Salinity: 35 ‰	Temp.: 18.25 ºC Salinity: 34.5 ‰
July	Temp.: 17.4 ºC Salinity: 35.5 ‰	Temp.: 17.5 ºC Salinity: 35 ‰	Temp.: 17.25 ºC Salinity: 34 ‰
August	Temp.: 16.5 ºC Salinity: 30 ‰	Temp.: 16.5 ºC Salinity: 30 ‰	Temp.: 17.25 ºC Salinity: 36 ‰
September	Temp.: 19.25 ºC Salinity: 34 ‰	Temp.: 19 ºC Salinity: 35 ‰	Temp.: 17 ºC Salinity: 36 ‰
October	Temp.: 20.5ºC Salinity: 29.05 ‰	Temp.: 21 ºC Salinity: 30.1 ‰	Temp.: 18.05 ºC Salinity: 33.8 ‰
November	Temp.: 24ºC Salinity: 31.9 ‰	Temp.: 24.5 ºC Salinity: 32.1 ‰	Temp.: 19.4 ºC Salinity: 34 ‰
December	Temp.: 25.25 Salinity: 34 ‰	Temp.: 25.5ºC Salinity: 34 ‰	Temp.: 21.5 ºC Salinity: 36 ‰
2008			
January	Temp.: 26.25 ºC Salinity: 33 ‰	Temp.: 28 ºC Salinity: 33 ‰	Temp.: 22.1 ºC Salinity: 34.2 ‰

Table 3. Morphological features comparison of *Paralia elliptica*, *P. fenestrate*, and *P. sulcata* species from southern Brazil.

Features	*P. elliptica*	*P. fenestrata*	*P. sulcata*
Dimensions (μm)	25-42 X 10-12	10-43 (diameter)	10-20 (diameter)
Separating valva	Weak ridges reduced sometimes to marks.	Central ring of rounded protuberances on the valve face. One ring of pores on the valve margin.	Central ring of rounded protuberances on the valve face. Double ring of pores on the valve margin.
Valve face of the intercalar valve	Parallel and crenulated ridges. Pores irregularly distributed on the valve margin.	Radiating ridges. One ring of poros on the valve margin.	Radiating ridges. Double ring of poros on the valve margin.
External mantle of the intercalary valve	Large pores organized in parallel lines.	Fine pores organized in lines	Large pores with distinct shape and irregular distribution.
Linking spines	Spatulate with smooth surface.	Spatulate with a slit along the edge.	Spatulate with a slit along the edge.
Internal rimoportula aperture	Below the rim of the valve.	On the rim of the valve. (information from Sawai *et al.*, 2005)	On the rim of the valve. (information from Sawai *et al.*, 2005)
Reference	Garcia (2003)	This study	This study

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