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Three new araphid diatoms (Bacillariophyta) from the Maritime Antarctic Region

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Abstract

A revision of taxa from the genus *Staurosira* and *Staurosirella* from the Maritime Antarctic Region, formerly identified as *Staurosirella* (*Fragilaria*) *pinnata* and *Fragilaria alpestris*, resulted in the description of three new taxa: *Staurosira pottiezii* Van de Vijver sp. nov., *Staurosirella antarctica* Van de Vijver & E.Morales sp. nov. and *S. frigida* Van de Vijver & E.Morales sp. nov. Detailed light (LM) and scanning electron microscope (SEM) observations are used to better characterize the morphology and ultrastructure of these three new taxa. Comparisons with similar taxa and the ecological preferences of each species are added. The revision of these species confirmed the endemic nature of the Antarctic diatom flora.

Key words: Antarctica, Bacillariophyta, morphology, new species, *Staurosira*, *Staurosirella*, taxonomy

Introduction

Contrary to the relatively large amount of araphid taxa that have been described worldwide during the past 2 decades (e.g., Morales 2001, 2005, Morales & Edlund 2003, Morales *et al.* 2010a), only a few new taxa were described from the sub-Antarctic and Antarctic Region. The first was *Fragilaria maillardii* Le Cohu in Lange-Bertalot & Le Cohu (1985: 213), but later this was transferred to the raphid genus *Frankophila* (Lange-Bertalot 1997: 66) as *Frankophila maillardii* (Le Cohu) Lange-Bertalot & Rumrich (in Lange-Bertalot 1997: 71). In 1990, Reichardt & Lange-Bertalot described *Fragilaria germainii* E.Reichardt & Lange-Bert. (1990: 204), which, together with the sub-Antarctic species *Fragilaria husvikensis* Van de Vijver, Denys & Beyens (2000: 538), was transferred to the genus *Distrionella* (Williams 1990: 175) by Flower (2005), as *Distrionella germainii* (E.Reichardt & Lange-Bert.) R.Flower 2005: 62. Other relevant new taxa include *Opephora naveana* Le Cohu (1988: 107), described from the Kerguelen Islands (Le Cohu 1988), later transferred to *Pseudostaurosira* as *Pseudostaurosira naveana* (Le Cohu) E.Morales & Edlund (2003: 237), *Staurosira jolinae* Van de Vijver in Van de Vijver & Beyens (2002: 320), *Staurosira circula* Van de Vijver & Beyens (2002: 325), both described from Iles Crozet, and *Stauroforma inermis* Flower, Jones & Round (1996: 54), described from the South Orkney Islands (Flower et al. 1996). Despite this rather low number, araphid taxa are rather commonly reported from sub-Antarctic and Antarctic localities. Based on the list of records provided in Kellogg & Kellogg (2002), it is clear that the most reported taxa, *Staurosirella* (*Fragilaria*) *pinnata* (Ehrenb. 1843: 127) D.M.Williams & Round (1987: 274) (51 records), *Staurosira* (*Fragilaria*) *construens* var. *venter* (Ehrenb. 1854: pl. 8/1, fig. 12) P.B.Hamilton (in Hamilton *et al.* 1992: 29) (30 records), *Stauroforma* (*Fragilaria*) *exiguiformis* (Lange-Bert.) Flower, Jones & Round (1996: 53, basionym: *Fragilaria exiguiformis* Lange-Bertalot 1993: 45) (29 records) and *Fragilariforma virescens* (Ralfs) D.M.Williams & Round (1987: 265; basionym: *Fragilaria virescens* Ralfs 1843: 110) (26 records), all show cosmopolitan distributions. This dominance of cosmopolitan taxa is in clear contrast with the nowadays generally accepted view that the Antarctic region is home to a highly specific diatom flora (Sabbe *et al.* 2003, Van de Vijver *et al.* 2005, 2011, Van Ormelingen *et al.* 2008, Vyverman et al. 2010) and raises questions regarding the correct taxonomic identity of the recorded populations. It has been demonstrated for a large number of raphid diatoms such as the genera *Hantzschia* (Zidarova *et al.* 2010), *Navicula* (Van de Vijver *et al.* 2011), *Muelleria* (Van de Vijver *et al.* 2010) and

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Stauroneis (Van de Vijver *et al.* 2004, 2005) that species drift and force-fitting Antarctic populations into European and north-American names (Tyler 1996) has led in the past to the incorrect idea that the Antarctic diatom flora was dominated by cosmopolitan taxa. Recent revisions of the genera *Staurosirella*, *Pseudostaurosira* and *Staurosira* have clearly indicated that the species concept for some of the dominant taxa was too broad which has resulted in the description of a large number of new taxa (e.g. Morales & Edlund 2003, Morales 2006, Morales & Manoylov 2006a,b, Morales *et al.* 2010a,b,c, 2012, Cejudo-Figueiras *et al.* 2011).

During the ongoing revision of the Antarctic diatom flora of some islands in the Maritime Antarctic Region, several araphid populations belonging to the genera *Staurosira* and *Staurosirella* were found. Based on light (LM) and scanning electron microscopy (SEM) , they could not be identified using the currently available literature and three of them are described here as new species: *Staurosira pottiezii* Van de Vijver sp. nov., *Staurosirella antarctica* Van de Vijver & E.Morales sp. nov. and *Staurosirella frigida* Van de Vijver & E.Morales sp. nov. The new taxa are compared to other *Staurosira* and *Staurosirella* taxa and notes on their ecological preferences are presented.

Material & Methods

During several austral summers (2004–2012), material for diatom analysis has been sampled from various lakes, ponds, seepage areas and terrestrial moss carpets of Livingston Island, mainly from the Byers Peninsula, and from James Ross Island. Details about sampling localities and samples are given in Kopalová *et al.* (2012, 2013) and Kopalová & Van de Vijver (2013).

Diatom samples were prepared following the method described in Van der Werff (1955). Sub-samples were cleaned by adding 37% H_2O_2 and heating to 80°C for about 1h. The reaction was completed by addition of $KMnO_4$. Following digestion and centrifugation (x 3 for 10 minutes at 3700 x g), cleaned material was diluted with distilled water to avoid excessive concentrations of diatom valves on the slides. Cleaned diatom material was mounted in Naphrax®. The slides were analyzed using an Olympus BX51 microscope, equipped with Differential Interference Contrast (Nomarski) and the Colorview I Soft Imaging System. Samples and slides are stored at the BR-collection, property of the Belgian federal government and given in permanent loan to the Botanic Garden Meise (Belgium). For scanning electron microscopy (SEM), parts of the oxidized suspensions were filtered through polycarbonate membrane filters with a pore diameter of 1 µm, pieces of which were fixed on aluminum stubs after air-drying. The stubs were sputter-coated with a Gold-Palladium layer of 20 nm in thickness and studied in a ZEISS ULTRA SEM microscope at 3 kV at the Natural History Museum of London, UK.

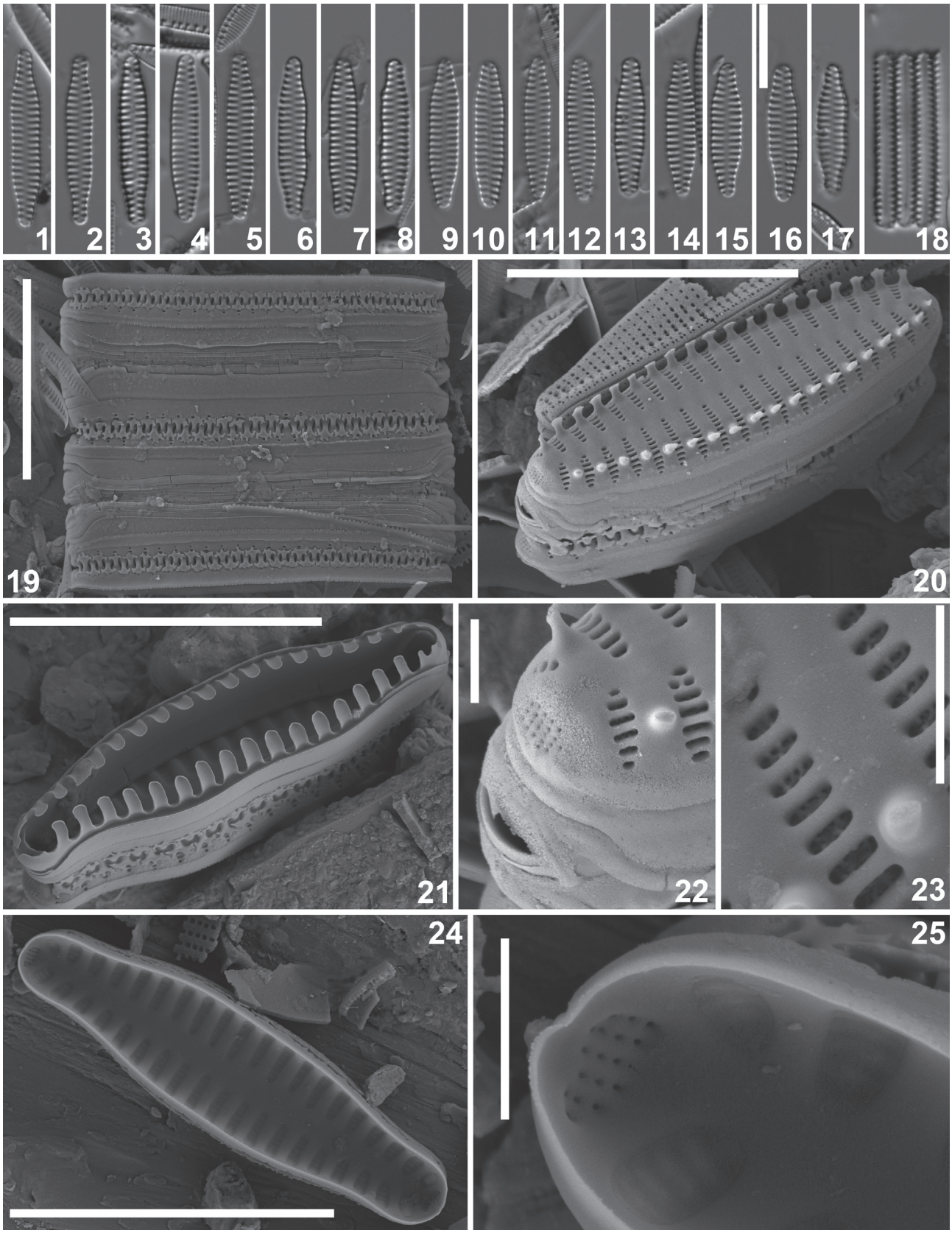
Morphological terminology follows Hendey (1964), Anonymous (1975), Cox & Ross (1981), Round *et al.* (1990) and Morales (2006). Comparisons were made with taxa described among others in Morales (2001, 2005), Morales & Edlund (2003), Morales & Manoylov (2006a, b), Morales *et al.* (2010a) and Cejudo-Figueiras *et al.* (2011).

Results

Staurosira pottiezii Van de Vijver *sp. nov.* (Figs 1–25)

Cells linear to linear-lanceolate with weakly or markedly constricted margins and rostrate to subcapitate ends. Length 15–22 µm, width 3.2–3.6 µm, stria density 12–13 in 10 µm. Central sternum narrow, linear to lanceolate, narrow at apices. Striae alternate, parallel in central area and radiate at apices. Areolae slightly lineolate, running continuously from valve face to mantle, 50–60 in 10 µm and bearing intricate volae. Spines spatulate, lobed at ends and located on the virgae. Apical pore field at each apex, located on the valve mantle, comprising 3–5 rows of round poroids. Girdle bands open, non-perforated. Valvocopula wider than copulae, bearing well-developed fimbriae.

LM (Figs 1–18): Frustules are rectangular in girdle view, forming long ribbon-like colonies of up to several tens of individuals. Valves are linear to weakly linear-lanceolate with parallel, often constricted margins and rostrate to subcapitate apices. Valve dimensions (n=25): length 15–22 µm, width 3.2–3.6 µm. The central sternum is moderately narrow, linear to weakly lanceolate, gradually narrowing towards the apices. The striae are alternating, parallel and becoming slightly radiate near the apices; 12–13 in 10 µm. The areolae are weakly discernible in LM.



FIGURES 1–25: *Staurosira pottiezii* Van de Vijver sp. nov. All pictures taken from the holotype population (sample BY038). Figs 1–18. LM images. Fig. 18 shows a girdle view, whereas Figs 1–17 show valve views. Figs 19–25: SEM images. Fig. 19: Chain of two entire frustules showing the linking spines, parts of the girdle bands and the mantle. Fig. 20: External view of an entire valve showing the linking spines, the apical pore field and the striae. Fig. 21: Valvocopula with fimbriae. Fig. 22: Detail of the apical pore field showing 5 rows of small, rounded poroids separated from the striae. Fig. 23: Detail of the striae with the areolae. Note the volae forming a complex structure within the areolae. Fig. 24: Internal view of an entire valve. Fig. 25: Internal detail of the apical pore field. Scale bar represents 10 µm except for Figs 22, 23, 25 where scale bar = 1µm.

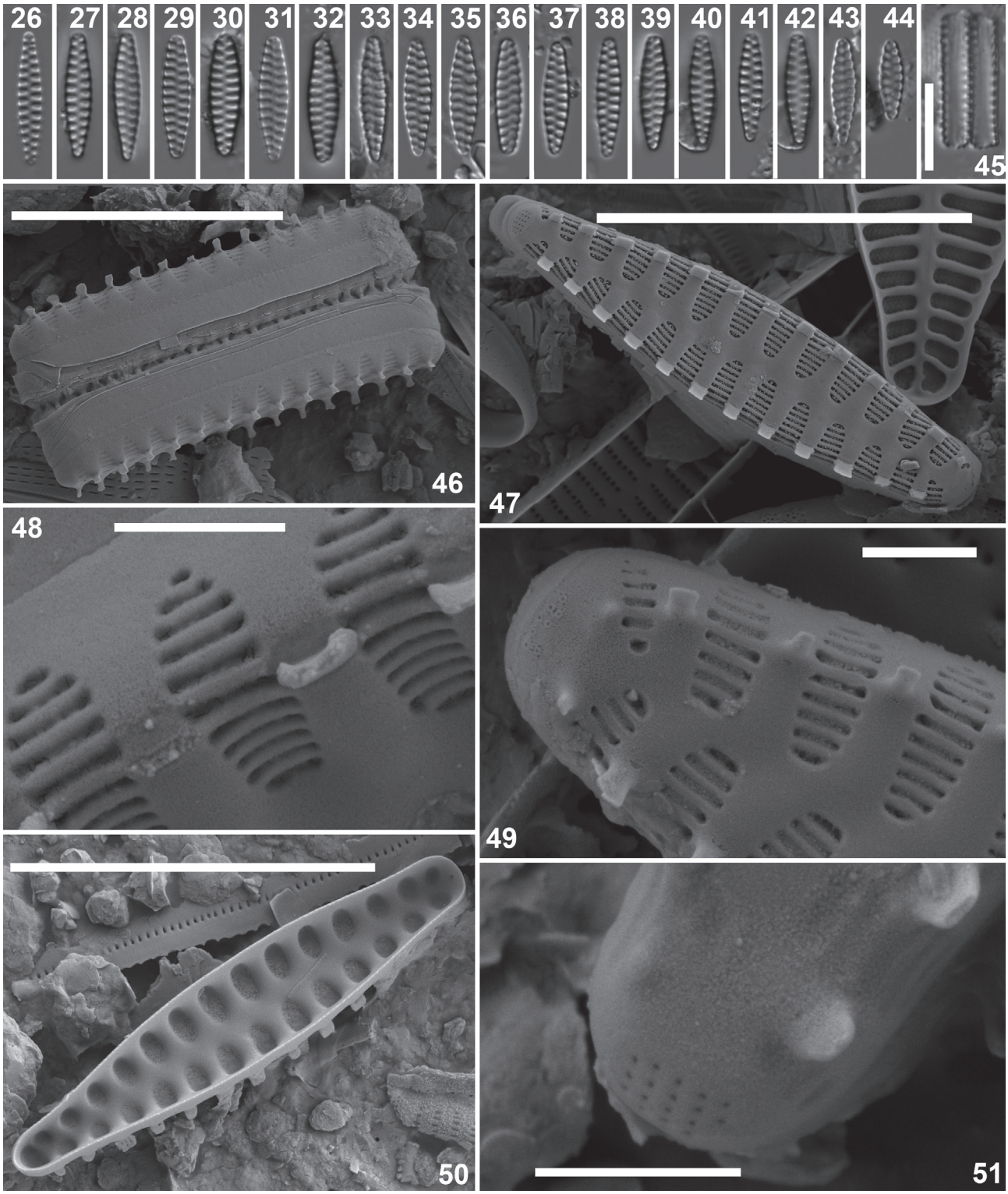
SEM (Figs 19–25): Frustules are linked by single, spatulate, lobed, solid linking spines, located on the costae at the valve face/mantle junction (Figs 19, 21). The valve surface is flat and smooth (Fig. 20). The costae are rarely raised above the striae (Fig. 20). Apical pore fields are present on each apex, located on the valve mantle and composed of several, usually 3–5, rows of small rounded poroids (Figs 20, 22). Internally, the apical pore fields are well-separated from the striae and formed within a depression at the valve apex (Fig. 25). Rimoportulae are absent. The striae are composed of narrow slit-like to rectangular areolae, running continuously from the valve face onto the mantle and decreasing in size toward the axial and mantle abvalvar areas (Figs 20, 23). Areolae ca. 50–60 in 10 µm along the striae (Fig. 23). There are usually 3–4 mantle areolae (Fig. 20). The mantle abvalvar edge has a ridge that is running continuously around the valve perimeter (Figs 19, 20). The ridge is sometime ornamented with blister-like depositions of silica located toward the very edge of the mantle (Fig. 19). The volae are clearly developed, forming a complex structure within the areolae (Fig. 23). Internally, the costae are raised and slightly thickened compared to the striae (Fig. 24). The girdle bands are open and lack perforations. (Figs 19–22). The valvocopula is fimbriate (Fig. 21) and wider than the other, quite narrow and usually broken, copulae (Fig. 19).

Type:—ANTARTICA. Pool near Domo Lake, Byers Peninsula, Livingston Island (South Shetland Islands), sample BY038 (62°38'56.6" S, 60°58'27.0" W), Leg. B. Van de Vijver, coll. date 12/01/2009 (BR-4325, holotype!, University of Antwerp, Belgium slide PLP-226, isotypes).

Etymology:—This species is dedicated to the senior author´s dear friend Jean Pottiez (Wilrijk, Belgium).

Observations:—*Staurosira pottiezii* resembles other species in the genus *Staurosira*, sharing with them the type of striae, position of spines, and characteristics of the apical pore fields and girdle bands. The species can be confused with several other *Staurosira* and *Staurosirella* species presenting a similar apically elongated valve outline with undulated margins. *Staurosirella oldenburgiana* (Hust. 1959: 29) E.Morales (2005: 118) has narrower valves (max. valve width <2.5µm) with narrower, more protracted apices. The costae bear only rudimentary spines that never show the spatulate structure that can be found in *S. pottiezii*. The apical pore fields are larger with larger poroids in *S. oldenburgiana* compared to the small poroids in *S. pottiezii*. Moreover, at the apices in valves of *S. oldenburgiana*, striae are absent isolating the apical pore field from the striae by a hyaline zone. *Staurosirella confusa* E.Morales (2005: 122) has a different valve outline, being much more lanceolate with acutely rounded, protracted apices. On average, valves are broader for any given length (width 3.5–4.5 µm) in *S. confusa*. The single apical pore field in this taxon is much larger with up to 10 rows of large, rounded poroids. Also in this taxon, between the striae, often two spines can be observed, but despite this, ribbon-like colonies have never been observed. Instead, *S. confusa* produces stellate colonies (Morales 2005). *Staurosira construens* var. *binodis* (Ehrenb. 1840: 212) P.B.Hamilton in Hamilton et al. (1992: 29) shows a similar valve outline, similar spine structure and similar ribbon-like colonies, but it differs from *S. pottiezii* in having larger valve dimensions (width 4.5–6.0 µm), smaller apical pore fields with only two rows of small poroids, and smaller areolae (Morales 2005). On the sub-Antarctic islands in the southern Indian Ocean, a similar taxon was found and identified by several authors as *Fragilaria alpestris* [also reported as *Staurosirella alpestris* (Krasske) Le Cohu (1999: 826) or *Staurosira alpestris* (Krasske) Van de Vijver & Beyens in Van de Vijver et al. (2002: 114)]. Le Cohu (1988) discusses the morphology of the *F. alpestris* populations in the Kerguelen Islands, one of the archipelagos in the southern Indian Ocean. The recorded populations on the other Indian Ocean islands also had always larger valve dimensions (valve length >25 µm and valve width >4.0 µm) giving them a more robust appearance, contrary to *S. pottiezii*, where valves never exceeded 3.5 µm in breadth. Based on Le Cohu (1988), only one single apical pore field is observed in *F. alpestris*, whereas *S. pottiezii* always has two. In South Georgia, another similar taxon was found, most likely erroneously identified as *Fragilaria neoproducta* Lange-Bert. (1993: 48) in Van de Vijver & Beyens 1996. A preliminary LM analysis (Van de Vijver, unpubl. res.) showed that the valves are always larger (width >4.0 µm) with usually less subcapitate and more subrostrate apices. Conspecificity between *S. pottiezii* and the populations from the Southern Indian Ocean and South Georgia can most probably be excluded based on current data, but more detailed SEM analysis of the latter populations will be necessary for a final decision.

Ecology & Distribution:—*Staurosira pottiezii* was found on many islands of the South Shetland Island archipelago [Livingston Island, Deception Island, Nelson Island and Dart Island (R. Zidarova, pers. com.), King George Island]. However, its exact distribution is not well known due to confusion with other cosmopolitan taxa such as *Fragilaria alpestris* Krasske (in Hustedt 1931: 165), *F. bidens* Heiberg (1863: 60) and *Staurosira construens* Ehrenb. (1843: 424). *Staurosira pottiezii* seems to prefer small, shallow, usually temporary pools, most likely originating from meltwater streams or seepage areas. On average, these pools had an alkaline pH (7.5-9.0) and rather low conductivity (80–110 µS/cm). In one pool on Dart Island, a large population was found at pH 9.4 and a conductivity of 576 µS/cm (R. Zidarova, pers. com.). All major populations on Byers Peninsula were associated with large algal mats, developed in these small pools.



FIGURES 26–51: *Staurosirella antarctica* Van de Vijver & E.Morales sp. nov. All pictures taken from the holotype population (sample BY049). Figs 26–45. LM images. Fig. 45 shows a girdle view, whereas Figs 26–44 show valve views. Figs 46–51: SEM images. Fig. 46: Two entire frustules showing the linking spines, parts of the girdle bands and the mantle. Fig. 47: External view of an entire valve showing the heteropolar valve outline, the linking spines, the apical pore field and the striae. Fig. 48: Detail of the striae with slit-like areolae. Spines are positioned between the striae. Fig. 49: Detail of the apical pore field at the head pole showing 2 rows of small, rounded poroids separated from the striae. Fig. 50: Internal view of an entire valve. Fig. 51: External detail of the apical pore field at the foot pole. Scale bar represents 10 µm except for Figs 48, 49, 51 where scale bar = 1µm.

Staurosirella antarctica Van de Vijver & E.Morales *sp. nov.* (Figs 26–51)

Cells lanceolate to ovoid, heteropolar, with openly convex margins and subrostrate to rounded apices. Length 9.5–15.5 µm, width 2.9–3.9 µm, stria density 9–10 in 10 µm. Central sternum narrow, linear to lanceolate, raised and forming a continuum with the virgae. Striae alternate, parallel in central area and radiate at apices. Areolae markedly lineolate, running continuously from valve face to mantle, 55–60 in 10 µm, and bearing well-developed volae. Spines flat, spatulate and located on the virgae. One apical pore field at each apex, located on the valve mantle. Foot-pole apical pore field larger and compose of up to 5 rows of round poroids. Girdle bands open, non-perforated with valvocopula wider than rest of girdle elements.

LM (Figs 26–45): Frustules are rectangular in girdle view (Fig. 45). Valves are lanceolate to narrowly ovoid, faintly or conspicuously heteropolar with subrostrate to rounded apices (Figs 26–44). Valve dimensions (n=25): length 9.5–15.5 µm, width 2.9–3.9 µm. The central sternum is narrow and linear to lanceolate. The striae are alternating, parallel and becoming slightly radiate near the apices, 9–10 in 10 µm. The areolae are not discernible in LM.

SEM (Figs 46–51): Frustules are linked by single, spatulate and solid linking spines, which are located on the costae at the valve face/mantle junction (Figs 46–49). The valve surface is slightly undulate due to the raised costae and the axial area, which are smooth (Fig. 47). Apical pore fields are present on each apex, better developed at the foot-pole that at the head-pole. They are located on the valve mantle and composed of several, usually up to 6, rows of small round poroids (Figs 47, 49, 51). Internally, the apical pore fields are well separated from the striae and formed within a depression at the valve apices (Fig. 50). Rimoportulae are absent. The striae are composed of narrow slit-like to rectangular areolae running continuously from the valve face onto the mantle and becoming smaller toward the axial and mantle abvalvar areas (Figs 48, 49). Areolae ca. 55–60 in 10 µm along the striae (Figs 47–49). The mantle areolae, usually 4-5, are gradually becoming smaller than the areolae toward the axial area (Fig. 48). The volae are clearly developed and form a complex structure within the areolae (Fig. 47–49). Internally, the costae are also raised and thickened compared to the striae (Fig. 50). The girdle bands are open and lack perforations (Fig. 46). The valvocopula are presumably fimbriate and wider than the other narrower copulae (Fig. 46).

Type:—ANTARTICA. Pool near Limnopolar Lake, Byers Peninsula, Livingston Island (South Shetland Islands), sample BY049 (62°38'43.1"S, 61°06'22.9"W), Leg. B. Van de Vijver, coll. date 14/01/2009 (BR-4326 holotype!, University of Antwerp, Belgium slide PLP-227, isotypes).

Etymology:—The species epithet refers to the general geographic area were this diatom was found.

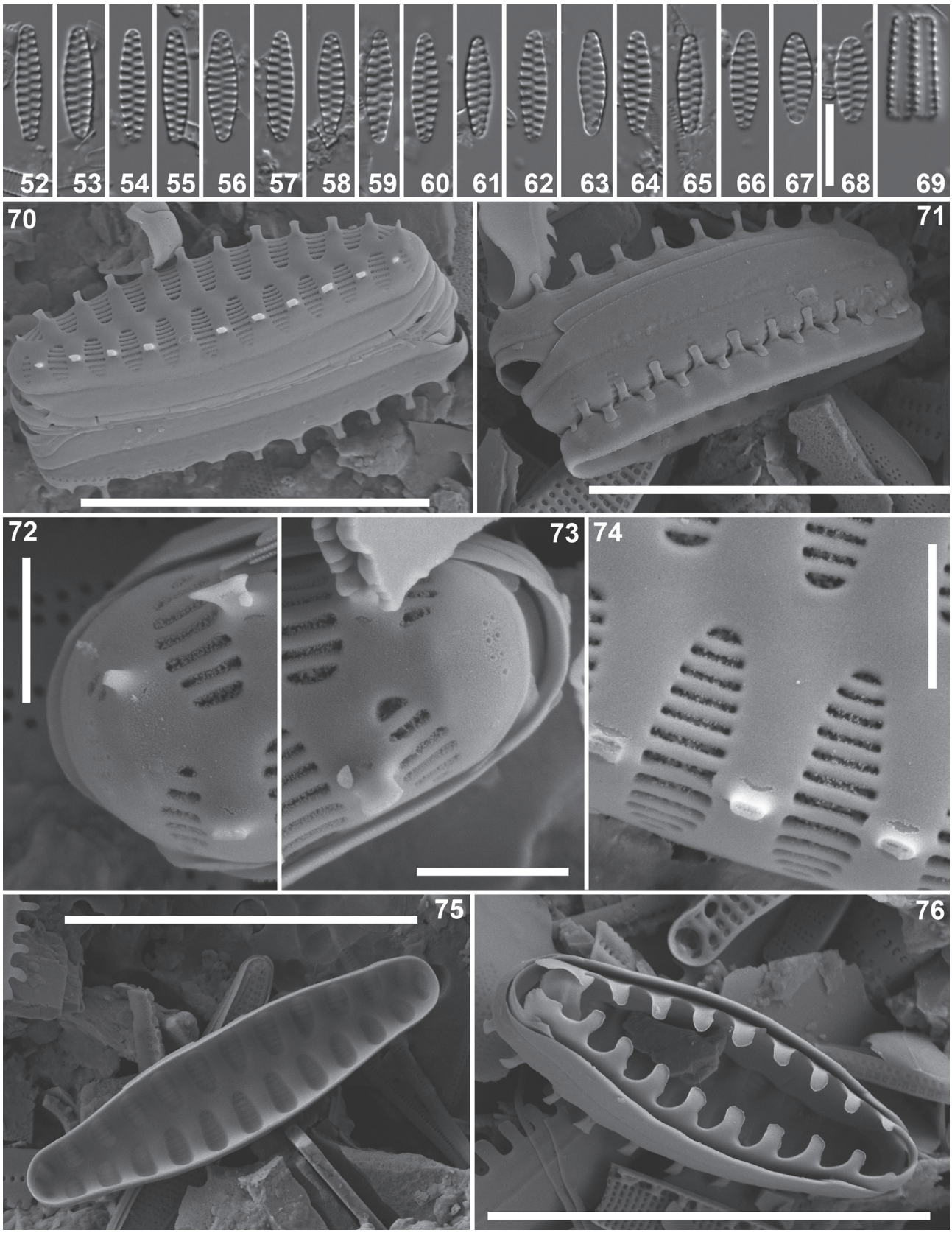
Ecology & Distribution:—Due to force-fitting, all *Staurosirella* populations in the Maritime Antarctic Region have been grouped under *Staurosirella* (*Fragilaria*) *pinnata* making it at present impossible to determine the exact distribution of the new species. *Staurosirella antarctica* was with certainty found in one small pool (10 m diameter) close to Limnopolar Lake. On one side of the pool water was dripping from a rock surface in the pool while on the other side, water was flowing out in a small braided river. The bottom was covered sediment with fine sediment and larger pebbles. Thin algal mats were present in the pool. The pool had a rather alkaline pH (7.6) with a low specific conductance value (58 µS/cm).

Staurosirella frigida Van de Vijver & E.Morales *sp. nov.* (Figs 52–76)

Cells ovoid to elliptic, openly convex margins and rounded apices. Length 10–14 µm, width 3.1–4.2 µm, stria density 9–10 in 10 µm. Central sternum narrow, linear to weakly lanceolate, raised and forming a continuum with the virgae. Striae alternate, parallel in central area and radiate at apices. Areolae lineolate, running continuously from valve face to mantle, 60 in 10 µm, and bearing delicate volae. Spines spatulate and located on the virgae. One apical pore field at each apex, located on the valve mantle and composed of 4–5 rows of round poroids. Girdle bands open and non-perforated. Valvocopula wider than rest of girdle elements and bearing well-developed fimbriae.

LM (Figs 52–69): Frustules are rectangular in girdle view (Fig. 69). Valves are ovoid to elliptic with convex sides and rounded apices (Figs 52–68). Valve dimensions (n=25): length 10–14 µm, width 3.1–4.2 µm. The central sternum is narrow and linear to weakly lanceolate. The striae are alternating, parallel and becoming slightly radiate near the apices, 9–10 in 10 µm. The areolae are not discernible in LM.

SEM (Figs 70–75): Frustules are linked by single, spatulate and solid linking spines, that are located on the costae at the valve face/mantle junction (Figs 70–74). The valve surface is wavy due to the raised costae and the axial area, which are smooth (Figs 70, 74). Apical pore fields are present on each apex, located on the valve mantle and composed of several, usually 4–5, short rows of small rounded poroids (Figs 72, 73). Internally, the apical pore fields are well-



FIGURES 52–76: *Staurosirella frigida* Van de Vijver & E.Morales sp. nov. All pictures taken from the holotype population (sample BY047). Figs 52–69. LM images. Fig. 69 shows a girdle view whereas Figs 52–68 show valve views. Figs 70–76: SEM images. Fig. 70: External view of an entire valve showing the linking spines, the striae and part of the girdle. Fig. 71: Entire frustule linked to another valve showing the linking spines, parts of the girdle bands and the mantle. Fig. 72: Detail of the apical pore field at the foot pole, separated from the striae. Fig. 73: Detail of the apical pore field at the head pole showing 2 rows of small, rounded poroids. Fig. 74: Detail of the slit-like areolae. Fig. 75: Internal view of an entire valve. Fig. 76: Valvocopula with the fimbriate edges. Scale bar represents 10 µm except for Figs 72–74 where scale bar = 1µm.

separated from the striae and formed within a depression at the valve apex (Fig. 75). Rimoportulae are absent. The striae are composed of narrow slit-like to rectangular areolae running continuously from the valve face onto the mantle and become smaller toward the axial and mantle abvalvar areas (Figs 70, 74). Areolae ca. 60 in 10 µm along the striae (Fig. 74). There are usually 3–5 mantle areolae. The volae are delicate and form a complex structure within the areolae (Figs 72–74). Internally, the costae are raised and slightly thickened compared to the striae (Fig. 75). The girdle bands are open and lack perforations. The valvocopula are fimbriate and wider than the other copulae.

Type:—lake next to Limnopolar Lake, Byers Peninsula, Livingston Island (South Shetland Islands), sample BY047 (62°38'54.9"S, 61°06'39.6"W), Leg. B. Van de Vijver, coll. date 14/01/2009 (BR-4327, holotype!, University of Antwerp, Belgium slide PLP-228, isotypes!).

Etymology:—The species epithet makes reference to the cold ecological conditions in which this taxon thrives.

Ecology & Distribution:—*Staurosirella frigida* is a rather common species on Livingston Island. It was found in several mostly larger lakes with a rather alkaline pH varying between 7.2 and 7.9 and a specific conductance value between 60 and 130 µS/cm. Most lakes are fed by meltwater coming from nearby snowfields. Other dominant taxa in the samples include *Fragilaria capucina* s.l. Desm. (1825: fasc. 10, No. 453) and several *Nitzschia* [*N. homburgiensis* Lange-Bert. (1978: 650), *N. paleacea* Grunow in Van Heurck (1881: pl. 68, fig. 9-10)] and *Navicula* [*N. cremeri* Van de Vijver & Zidarova in Van de Vijver et al. (2011: 289), *N. australoshetlandica* Van de Vijver in Van de Vijver et al. (2011: 287)] species.

Observations on *Staurosirella antarctica* and *Staurosirella frigida*:—Both new species of *Staurosirella* correspond entirely with the morphological description of the genus *Staurosirella* (as outlined in Morales & Manoylov 2006a). They both show slit-like areolae, volae forming complex subareolar structures and apical pore fields developing on both valve apices. *Staurosirella antarctica* and *Staurosirella frigida* can be separated from each other by several features. The apical pore fields are larger and better developed in *S. antarctica* with 6 rows of small poroids, whereas *S. frigida* has smaller apical pore fields with a maximum of 4–5 rows of poroids. In LM, the two species can be separated by their valve outline and valve width, with *S. antarctica* being slightly narrower (valve width 2.9–3.9 vs. 3.1–4.2 µm) than *S. frigida,* and has a typical heteropolar, more slender valve outline contrary to the isopolar and rather sturdy valves with convex margins in *S. frigida*.

Only a few *Staurosirella* species from the former *S. pinnata* complex can be confused with the new species. *Staurosirella oldenburgiana* looks similar to *S. antarctica*, but has typical isopolar valves, smaller -even only rudimentary- spines, more developed apical pore fields and *Staurosirella dubia* (Grunow 1862: 54) E.Morales & Manoylov (in Morales *et al.* 2010a: 43) is much larger with valves up to 38 µm in length and a valve width of 3.5–6.5 µm. Likewise, *Staurosirella ovata* E.Morales in Morales & Manoylov (2006a: 357) and *S. martyi* (Héribaud 1902: 43) E.Morales & Manoylov (2006a: 254) have large valve widths (up to 7 and 9 µm, respectively) and lack marginal spines (Morales & Manoylov 2006a). *Staurosirella incognita* E.Morales & Manoylov (2006b: 331) has heteropolar valves, but has larger valves (width 4–6 µm) than *S. antarctica*, lacks marginal spines and has larger apical pore fields with up to 10 rows of poroids on the foot pole (Morales & Manoylov 2006b). Also similar is *S. confusa* showing comparable valve dimensions, but presenting a more elongate valve outline with clearly protracted apices and typical stellate colonies, which clearly separates this taxon from the two *Staurosirella* species described here.

Biogeographical conclusions

Based on these observations, it is clear that the cosmopolitan species *Staurosirella pinnata* is not present in the Maritime Antarctic Region. Recently however, Morales *et al.* (2013) investigated the correct taxonomic identity of *Fragilaria pinnata* Ehrenb. and concluded (p.100) that *'We currently do not know what [name applies to] the araphid commonly referred to as Fragilaria/Staurosirella pinnata really is.'* The separation of *Staurosirella antarctica* and *Staurosirella frigida* from the catch-all name *S. pinnata* at least clarifies the identity of the Maritime Antarctic taxa making a better geographical delimitation of this species group in this region possible.

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