Analysis of the type material of *Achnanthidium lanceolatum* Brébisson ex Kützing (Bacillariophyta) with the description of two new *Planothidium* species from the Antarctic Region

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Abstract: The type material of *Achnanthidium lanceolatum* (transferred in 1999 to the genus *Planothidium*) is investigated to reveal the identity of several *Planothidium* populations from the Antarctic Region. The morphology and the ultrastructure was analysed using light and scanning electron microscopy. The results of this analysis revealed the presence of two so far undescribed *Planothidium* species in the investigated Antarctic material. Both species are described as new to science: *P. rostrolanceolatum* Van de Vijver, Kopalová et Zidarova sp. nov. and *P. subantarcticum* Van de Vijver et C.E.Wetzel sp. nov. The new species can be differentiated based on differences in valve outline and the shape and size of the central area. *Planothidium lanceolatum* is formally lectotypified. Notes on the ecology and distribution of the new Antarctic species are added.

Key words: *Achnanthidium lanceolatum*, Antarctic Region, morphology, new species, *Planothidium*, type material

Introduction

Achnanthidium lanceolatum was originally described in 1846 [and not in 1849: see Lange–Bertalot (1999)] by Kützing based on material that Louis Alphonse de Brébisson sent him from Falaise, a city situated near Caen, Calvados department, Basse–Normandie region, north–western France. The species is often referred to as *A. lanceolatum* Brébisson ex Kützing since Kützing in 1849 added '*De Brébisson in litt.*'. In the original text (Kützing 1846), the species is described as "*A. a latere secundario elliptico–lanceolato; apicibus obtusis, rotundatis. – Long. 1/140"' – Falaise Brébisson!*", an *Achnanthidium* with an elliptic–lanceolate secondary side and broadly rounded apices. Length 16 µm. According to Lange–Bertalot & Krammer (1989), showing four light microscopy pictures of the type material ("*Typenmaterial, Coll. Eulenstein, Species originale 61, Falaise/ Frankreich*"), there is no controversy about the identity of the species due to the presence of the type material. The original Kützing material was conserved in two places: the British Museum in London and the Van Heurck Collection (formerly in Antwerp, Belgium, now at the National Botanic Garden in Meise, Belgium) (Cox 1995). Moss & Carter (1982) showed the first SEM images illustrating two internal valves of the type material, prepared from the material present in the British Museum [Kützing Collection n°1237 (BM18442)]. In the latter paper, a clear distinction was made in the terminology of the characteristic horseshoe in the central area. In the group of species around *P. lanceolatum* (Brébisson ex Kützing) Lange–Bertalot, the horseshoe shaped structure is a simple depression, called a 'sinus' whereas in other taxa [in the group of *P. frequentissimum* (Lange–Bertalot) Lange–Bertalot], a hollow chamber covers the horseshoe shaped structure in the valve interior for which the name 'cavum' was used (Moss & Carter 1982).

Since the original description, almost a hundred infraspecific taxa (subspecies, varieties and formas) have been described to separate *lanceolatum*–populations with differences in valve outline or structure of the horseshoe–shaped spot in the central area (Fourtanier & Kociolek 2011). Unfortunately, a thorough study of the type of *Achnanthidium lanceolatum* was never published. The species was transferred several times to different genera. Grunow placed the species within the genus *Achnanthes* in 1880 (Cleve & Grunow 1880). When the catch–all genus *Achnanthes* was split in a large number of (usually newly described) genera (Bukhtiyarova & Round 1996; Round & Bukhtiyarova 1996), two new genera were erected almost simultaneously for the species–complexes of *A. lanceolata* and *A. delicatula* (Kützing) Grunow; *Planothidium* Round & Bukhtiyarova and *Achnantheiopsis* Lange–Bertalot (Round & Bukhtiyarova 1996; Lange–Bertalot 1997). Based on the priority rule, the latter can only be considered as a synonym of *Planothidium*. The original transfer of *A. lanceolatum* to *Planothidium* in 1996 by Round & Bukhtiyarova was declared invalid based on the absence of the publication of the basionym, which was rectified by Lange–Bertalot in 1999.

During a survey of the freshwater diatom flora in the Antarctic Region, large *Planothidium* populations from various Antarctic and sub–Antarctic localities were identified as *Achnanthes lanceolata* or *Planothidium lanceolatum.* Kellogg & Kellogg (2002) list more than 50 (sub–)Antarctic references for *Achnanthes lanceolata*. Analysis of some of these records revealed that most of them in fact represent two different taxa (e.g., Le Cohu & Maillard 1983; Van de Vijver et al. 2002) although the valves in Oppenheim (1994) most likely belong to *P. lanceolatum* s.s. These incorrect identifications increased the uncertainty on the biogeography of this taxon, at the moment apparently considered being cosmopolitan. The type material of this species has been investigated by Patrick & Reimer (1966, 10 LM drawings of valves), Moss & Carter (1982, two SEM internal views illustrated), Lange–Bertalot & Krammer (1989, four LM valves) and Krammer & Lange–Bertalot (1991, eight LM valves and one SEM internal view).

The present paper discusses the morphology of the type of *Achnanthidium lanceolatum* using both light (LM) and scanning electron microscopy (SEM) observations. Additionally, several large Antarctic populations are reviewed and two new *Planothidium* taxa, *Planothidium rostrolanceolatum* Van de Vijver, Kopalová et Zidarova sp. nov. and *Planothidium subantarcticum* Van de Vijver et C.E.Wetzel sp. nov. are described based on LM and SEM observations.

Material and Methods

A duplicate made by Eulenstein (Cox 1995) of the original raw material of *Achnanthidium lanceolatum* was found in the Eulenstein Collection deposited in the Van Heurck Collection, housed at the National Botanic Garden (Meise) of Belgium. From this material, i.e. Eul. Diat. spec. typ. 61 in Cent. I, Eulenstein made a large number of slides that have been sent all over the world. Three slides are present in the Van Heurck collection. One of these slides (acc. n° IV–2–C6) has been investigated using LM. A subsample from the original raw material deposited in the Van Heurck Collection in Meise was prepared for SEM analysis.

The past 15 years, aquatic, moss and soil samples were collected during several field campaigns on islands in the southern Indian and southern Atlantic Ocean [Livingston Island (South Shetland Islands), James Ross Island, Prince Edward Islands, Iles Crozet, Iles Kerguelen and Heard Island] (Fig. 1).

Diatom samples for LM observation were prepared following

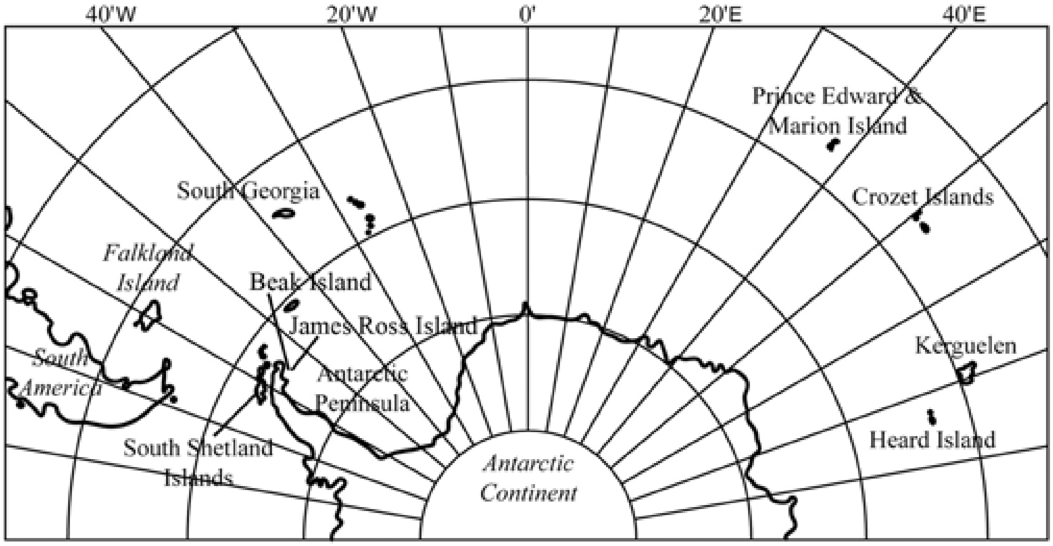
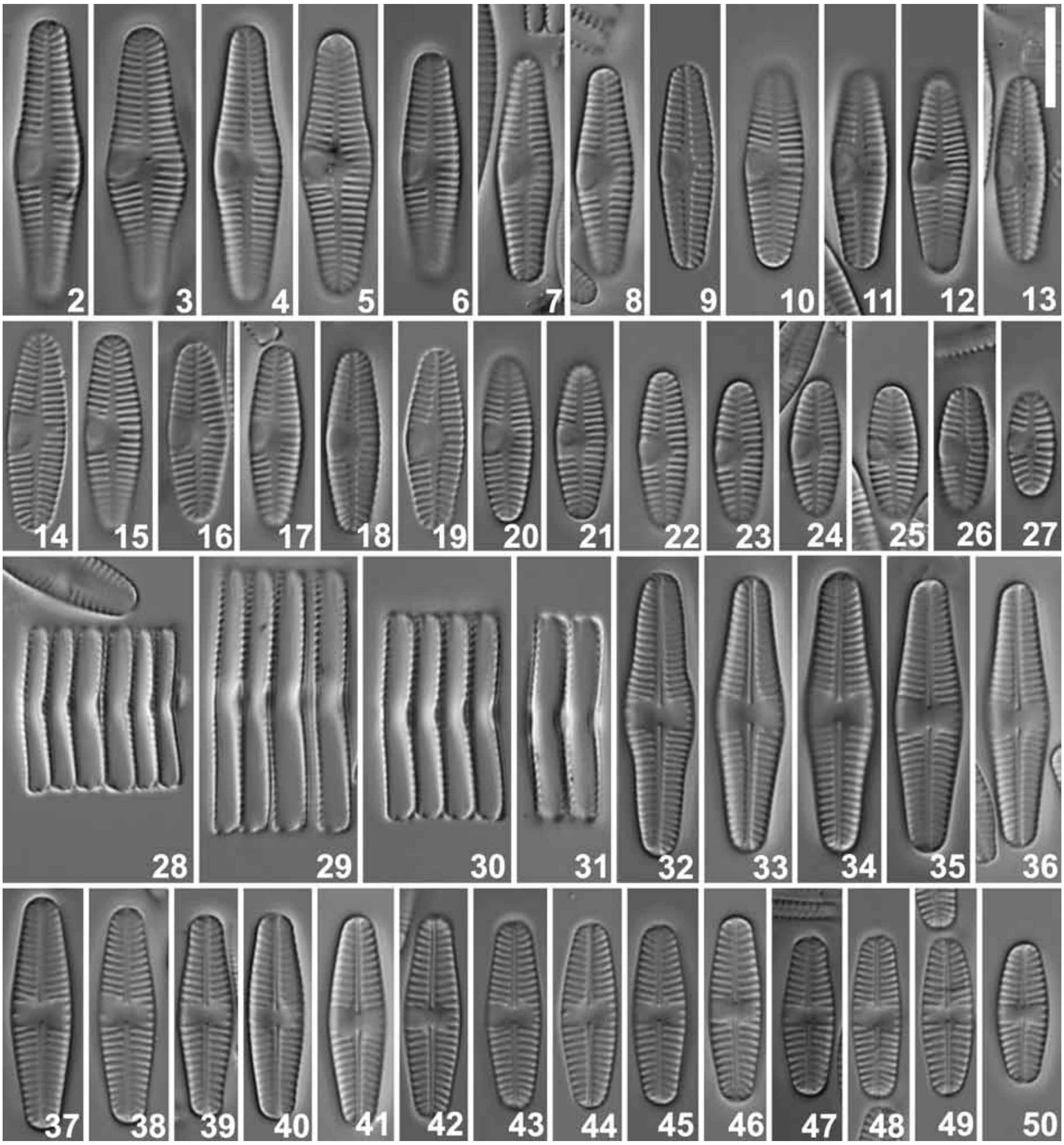


Fig. 1. The Antarctic region with the location of the sampled islands and archipelagos.

the method described in Van der Werff (1955). In total 26 samples were examined (Table 1). Subsamples of the original material were oxidized using 37% H_2O_2 and heating to 80 °C for approximately 1 h. The reaction was further completed by the addition of $KMnO_4$. Following digestion and centrifugation (three times 10 minutes at 3700× g), the material free of organic matter was diluted with distilled water for sample mounting to avoid excessive concentrations of diatom valves and frustules on the slides. A subsample from the organic–free material was mounted in Naphrax® for diatom community studies. The slides were analyzed using an Olympus BX51 microscope, equipped with Differential Interference Contrast (Nomarski), and the Colorview I Soft Imaging System. For scanning electron microscopy (SEM), parts of the oxidized suspensions were filtered and rinsed with additional deionized water through a 3–µm Isopore™ polycarbonate membrane filter (Merck Millipore). Filters were mounted on aluminum stubs and coated with platinum using a BAL–TEC MED 020 Modular High Vacuum Coating System for 30 s at 100 mA. An ultra–high–resolution analytical field emission (FE) scanning electron microscope Hitachi SU–70 (Hitachi High–Technologies, Europe, GmbH) operated at 5 kV and 10 mm distance was used for the analysis. SEM images were taken using both upper (SE–U) lower (SE–L) detector signal. Micrographs were digitally manipulated and plates containing light and scanning electron microscopy images were created using CorelDraw X5®. Diatom terminology follows Ross et al. (1979) and Round et al. (1990). Comparison of the new species was made based on Lange–Bertalot & Krammer (1989), Krammer & Lange–Bertalot (1991) and Rumrich et al. (2000).

Table 1. List of samples used in this study.

Sample ID	Geographic locality	Source
C–BA27	Crozet	Van de Vijver et al. (2002)
C–BA56	Crozet	Van de Vijver et al. (2002)
C–BM173	Crozet	Van de Vijver et al. (2002)
C–BM213	Crozet	Van de Vijver et al. (2002)
C–BM230	Crozet	Van de Vijver et al. (2002)
C–BM271	Crozet	Van de Vijver et al. (2002)
C–BM274	Crozet	Van de Vijver et al. (2002)
He–D16	Heard Island	Van de Vijver et al. (2004)
He–D27	Heard Island	Van de Vijver et al. (2004)
He–D53	Heard Island	Van de Vijver et al. (2004)
K–NK782	Kerguelen	unpublished data
K–N4.2	Kerguelen	Gremmen et al. (2007)
K–N22	Kerguelen	Gremmen et al. (2007)
PEI–D055	Prince Edward Islands	Van de Vijver et al. (2008)
PEI–D061	Prince Edward Islands	Van de Vijver et al. (2008)
PEI–D305	Prince Edward Islands	Van de Vijver et al. (2008)
PEI–D364	Prince Edward Islands	Van de Vijver et al. (2008)
PEI–G03–164b	Prince Edward Islands	Van de Vijver et al. (2008)
PEI–G03–196	Prince Edward Islands	Van de Vijver et al. (2008)
SG–W381	South Georgia	Van de Vijver & Beyens (1996)
SG–W387	South Georgia	Van de Vijver & Beyens (1996)
SG–W393	South Georgia	Van de Vijver & Beyens (1996)
LIV–BY028	Livingston Island	Kopalová & Van de Vijver (2013)
LIV–BY037	Livingston Island	Kopalová & Van de Vijver (2013)
LIV–BY065	Livingston Island	Kopalová & Van de Vijver (2013)
JRI2008–D11	James Ross Island	unpublished data



Figs 2–50. *Planothidium lanceolatum*. LM. Valve views. Lectotype slide IV–2–C6: Falaise, Caen, Calvados department, Basse–Normandie region, France, Eulenstein Diat. Spec. typ. N° 61 (coll. n° IV–2–C6) in the National Botanic Garden of Belgium (Belgium). (2–27) Rapheless valves; (28–31) Girdle views; (32–50) Raphe valves. Scale bar 10 µm.

RESULTS

Planothidium lanceolatum (BRÉBISSON ex KÜTZING) LANGE–BERTALOT 1999 (Figs 2–60)

Light microscopy (Figs 2–50): Frustules in girdle view rectangular forming short chains of up to 6 cells, clearly bent in the middle making the view somewhat V–shaped (Figs 28–31). Valves narrowly rhombic–lanceolate to lanceolate in larger valves to broadly lanceolate and even elliptical in smaller valves. Valve margins clearly convex, in larger valves even gibbous in the center. Apices obtusely rounded, rarely protracted although in some valves weakly rostrate. Valve dimensions (n=45): length 10–30 µm, width 4.5–8.5 µm. Rapheless valve (Figs 2–27): Axial area narrow, 1/10 of valve width, lanceolate, gradually widening from the apices towards the central area. Central area with a large horseshoe–shaped hyaline area on one side and 1–3 slightly shortened striae forming a small circular area on the other side. Striae almost parallel to weakly radiate in the centre, becoming distinctly radiate towards the apices, 12–14 in 10 µm. Raphe valve (Figs 32–50): Axial area very narrow, less than 1/10 of valve width, linear to slightly lanceolate, widening near the central area. Central area forming a rectangular to bow–tie shaped fascia, on one side bordered by 1–3 clearly shortened striae. Raphe branches straight with expanded, drop–like proximal raphe endings. Distal raphe fissures unilaterally deflected. Striae radiate becoming distinctly radiate towards the apices, 12–15 in 10 µm. Areolae never discernible in LM.

Scanning electron microscopy (Figs 51–60): Proximal raphe endings straight to very weakly deflected, expanded (Figs 52, 53). Distal raphe fissures clearly bent, continuing shortly onto the valve mantle (Fig. 54). Striae sunken between raised virgae (Figs 55–56, 59–60), composed of 3–4 rows of small, rounded poroids (Figs 53, 58). Striae continuing on the valve mantle by one or two irregularly organised areolae (Figs 51, 57). Internally, areolae probably covered by individual hymenes but due to erosion hymenes removed in all observed valves (Figs 55–56, 59–60). Proximal raphe endings not coaxial, short and very weakly deflected (Fig. 55). Distal raphe endings terminating in very faint helictoglossae (Fig. 56).

Formal lectotypification: Despite numerous records of *Planothidium lanceolatum* in the literature, a formal lectotype was never designated for this taxon. Therefore, the slide with accession number IV–2–C6 in the Van Heurck Collection, made from the Eulenstein Diat. Spec. typ. N° 61, was chosen to be the lectotype for this species.

Lectotype (designated here): Slide IV–2–C6, Eulenstein Diat. Spec. typ. N° 61, Van Heurck Collection, National Botanic Garden of Belgium, Meise, Belgium.

Lectotype locality: Falaise, Caen, Calvados department, Basse–Normandie region, France.

Basionym: *Achnanthidium lanceolatum* Brébisson ex Kützing 1846, Botanische Zeitung 4, p. 27

Synonyms: *Achnanthes lanceolata* (Brébisson ex Kützing) Grunow in Cleve & Grunow 1880, *Microneis lanceolata* (Brébisson in Kützing) Frenguelli 1923, *Achnantheiopsis lanceolata* (Brébisson ex Kützing) Lange–Bertalot 1997.

Antarctic Distribution: The species was identified with certainty in all samples from Heard Island (Van de Vijver et al. 2004) and in several samples from Iles Kerguelen (Gremmen et al. 2007; Van de Vijver et al. 2001). On Iles Crozet and the Prince Edward Islands, the species was reported as being present (Van de Vijver et al. 2002, 2008) but careful analysis revealed that all populations have to be identified as *P. subantarcticum* Van de Vijver et C.E.Wetzel sp. nov. (see below). On Livingston Island, the species was identified by Oppenheim (1994) although in later studies (Kopalová & Van de Vijver 2013), the reported populations are described below as *P. rostrolanceolatum* Van de Vijver, Kopalová et Zidarova sp. nov.

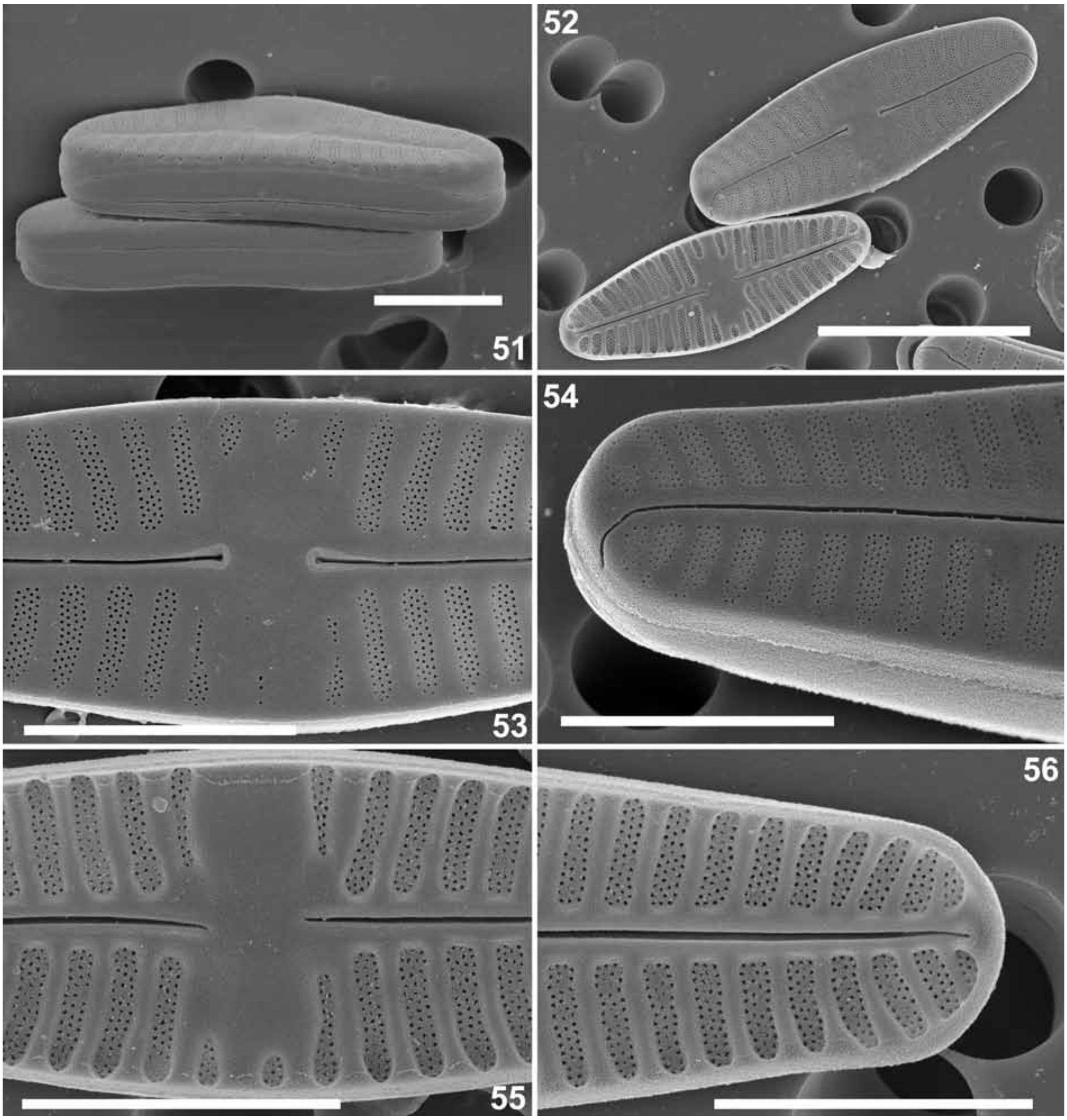
Planothidium rostrolanceolatum Van de Vijver, Kopalová et Zidarova sp. nov. (Figs 61–84, 108–114)

Light microscopy (Figs 61–84): Valves lanceolate to elliptic–lanceolate with clearly convex margins and rostrate, protracted apices, in smaller valves sometimes with subrostrate apices. Valve dimensions (n=45): length 15–28 µm, width 5.6–7.8 µm. Rapheless valve (Figs 61–72): Axial area narrow, 1/10 of total valve width, linear, very slightly widening towards the central area. Central area with a large horseshoe–shaped hyaline area on one side. On the other side, striae either not shortened or 1–2 slightly shortened striae forming hence a small circular area. Striae weakly radiate almost throughout the entire valve, becoming distinctly radiate near the apices, 14–16 in 10 µm. Raphe valve (Figs 73–84): Axial area narrow, less than 1/10 of total valve width, linear, widening near the central area. Central area rectangular to bow–tie shaped bordered on each side by 2–5 clearly shortened striae. Real fascia never present. Raphe branches straight with expanded, drop–like proximal raphe endings. Distal raphe fissures unilaterally deflected, hard to observe in LM. Striae radiate throughout the entire valve, becoming more distinctly radiate near the apices, 13–15 in 10 µm. Areolae not discernible in LM.

Scanning electron microscopy (Figs 108–114): Striae of the rapheless valve composed of three rows of small rounded poroids, the inner row being much smaller than the two outer rows (Figs 108–109). Near the central area, striae often with only two rows or three rows, the middle one being reduced to a few areolae (Fig. 109). Striae continuing shortly on the valve mantle (Fig. 109). Striae of the raphe valve broader than the virgae, composed of four rows of rounded areolae (Figs 110–111), near the central area of only three rows of areolae (Fig. 111). Striae clearly sunken between raised virgae (Figs 112–114). Areolae covered by individual perforated hymenes (Fig. 113). Proximal raphe endings straight terminating in expanded pores (Figs 110–111). Distal raphe fissures clearly bent, continuing shortly onto the valve mantle (Fig. 110). Internally, central nodule raised (Fig. 114). Proximal raphe endings deflected to opposite sides, terminating inconspicuously (Fig. 114). Distal raphe endings terminating on faint helictoglossae, shortly continuing on the valve mantle. Irregular shallow depressions present in the central and axial area (Figs 108–109). Horseshoe–shaped sinus clearly present on the rapheless valve, forming a shallow circular depression on one side of the central area (Fig. 112).

Holotype (designated here): BR–4307 (National Botanic Garden, Meise, Belgium)

Isotypes (designated here): PLP–222 (University of Antwerp, Belgium), BRM–ZU8/99 (Hustedt Collection, Bremerhaven, Germany)



Figs 51–56. *Planothidium lanceolatum*. SEM views. Falaise, Caen, Calvados department, Basse–Normandie region, France, Eulenstein Diat. Spec. typ. N° 61 (coll. n° IV–2–C6) in the National Botanic Garden of Belgium (Belgium). (51) Girdle view of two frustules, the upper valve is a rapheless valve; (52) Valve views of two raphe valves, one view (a) represents an outside view, the other (b) is an inside view; (53) External view of a raphe valve, detail of the central area; (54) External view of a raphe valve, detail of the valve apex; (55) Internal view of a raphe valve, detail of the central area; (56) Internal view of a raphe valve, detail of the valve apex. Scale bars 10 µm, 5 µm (Figs 53–56).

Type locality: Byers Peninsula, Livingston Island, South Shetland Islands, sample BY028 (Leg. B. Van de Vijver; coll. date 11/01/2009).

Etymology: The specific epithet refers to the rostrate valve ends in combination with the close relationship with *P. lanceolatum*.

Ecology and distribution: So far, the species seems to be restricted to the South Shetland Islands. Large populations were found on Livingston Island, Deception Island and King George Island, usually reported under the name of *P. lanceolatum*. The largest populations on Byers Peninsula (Livingston Island) were found living epilithically in several smaller rivers and brooks with an almost circumneutral to slightly alkaline pH (7.5) and low specific conductance levels (75–100 µS.cm^{-1}). Smaller populations (< 5% of total diatom count) were present in lakes. Dominant taxa in the samples include *Nitzschia perminuta* s.l. (GRUNOW) PERAGALLO, *Psammothidium papilio* (D.E.KELLOGG, STUIVER, T.B.KELLOGG et DENTON) VAN DE VIJVER et KOPALOVÁ, *Fistulifera pelliculosa* (BRÉBISSON) LANGE–BERTALOT and *N. gracilis* HANTZSCH. The species seems to be absent from the sub–Antarctic Region and the Antarctic Continent.

Planothidium subantarcticum **Van de Vijver et C.E.Wetzel sp. nov. (Figs 85–107, 115–121)**

Light microscopy (Figs 85–107): Valves strictly lanceolate with convex margins, gradually tapering towards the only weakly protracted apices, acutely rounded apices. Some specimens within the population sometimes with subrostrate apices. Valve dimensions (n=30): length 11–43 µm, width 5.8–10.8 µm. Rapheless valve (Figs 85–95): Axial area narrow, ca. 1/8 of total valve width, linear, very slightly widening towards the central area. Central area with a large horseshoe–shaped hyaline area on one side. On the other side, striae usually not shortened, in some specimens 1–2 slightly shortened striae forming hence a very small circular area. Striae weakly radiate almost throughout the entire valve, becoming more radiate near the apices, 13–14 in 10 µm. Raphe valve (Figs 96–107): Axial area narrow, less than 1/7 of total valve width, clearly linear, gradually widening towards the central area. Central area rectangular to bow–tie shaped bordered on, each side by 2–6 clearly shortened striae. Real fascia never present. Raphe branches straight with straight to weakly deflected expanded proximal endings. Distal raphe fissures unilaterally deflected, hard to observe in LM. Striae distinctly radiate throughout the entire valve, 13–14 in 10 µm. Areolae not discernible in LM.

Scanning electron microscopy (Figs 115–121): Proximal raphe endings undulating, weakly deflected terminating in expanded pores (Figs 117–118). Distal raphe fissures clearly bent, continuing shortly onto the valve mantle (Fig. 117). Striae of the rapheless valve always composed of three rows of small rounded areolae (Fig. 116), occasionally fourth row of small areolae near the valve margin inserted in each stria (Fig. 115). Areolae of equal size. Striae continuing shortly on the valve mantle (Fig. 115). Striae of the raphe valve broader than the virgae (Fig. 117), composed of four rows of rounded areolae, near the central area only three rows of areolae per stria present (Fig. 118). Striae broader towards the apices. Internally, central nodule raised (Fig. 121). Proximal raphe endings deflected to opposite sides, terminating inconspicuously (Fig. 121). Striae clearly sunken between raised virgae. Areolae covered by individual perforated hymenes (Fig. 119). Irregular shallow depressions present in the central and axial area (Fig. 115). Horseshoe–shaped sinus clearly present, forming a shallow circular depression on one side of the central area (Fig. 119). Girdle composed of several open copulae (Fig. 120).

Holotype (designated here): BR–4308 (National Botanic Garden, Meise, Belgium)

Isotypes (designated here): PLP–223 (University of Antwerp, Belgium), BRM–ZU8/100 (Hustedt Collection, Bremerhaven, Germany)

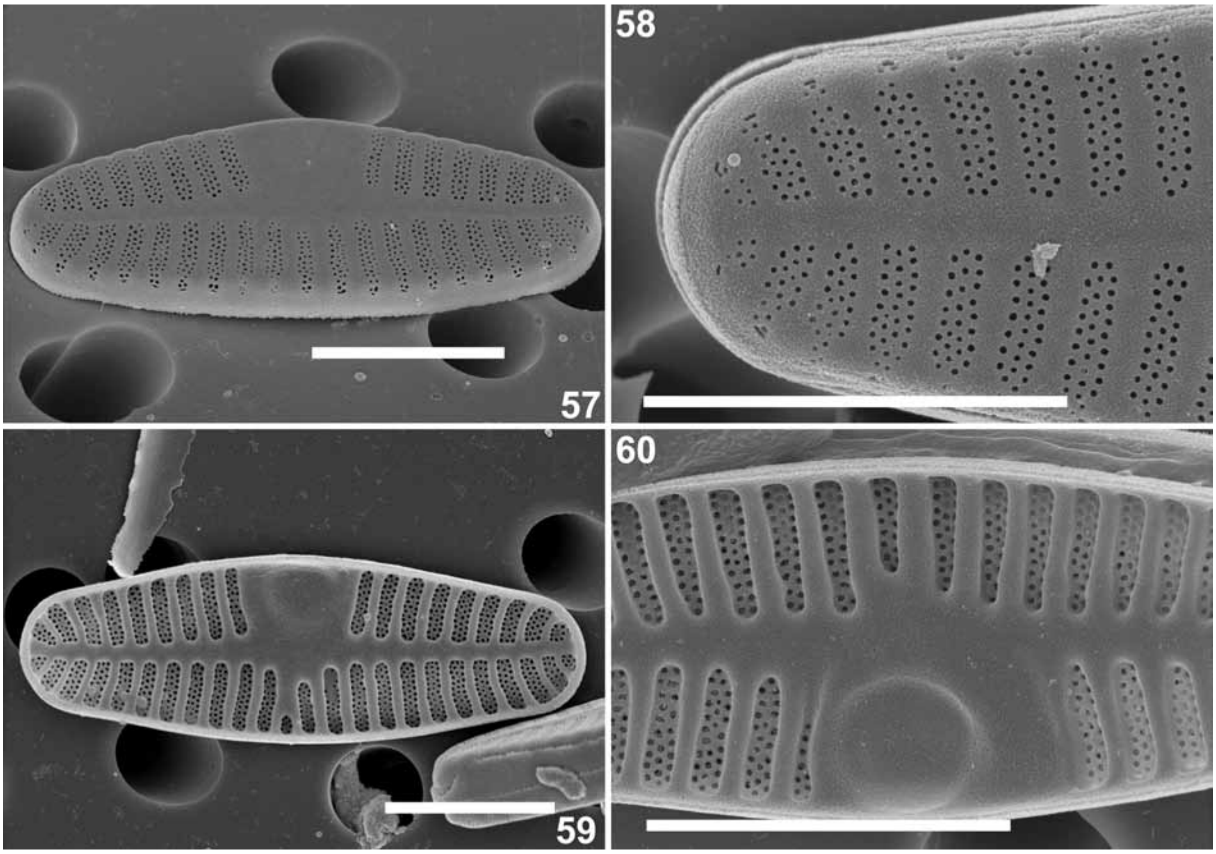
Type locality: Pointe de Bougainville, Ile de la Possession, Crozet Archipelago, sample BM173 (Leg. B. Van de Vijver; coll. date 24/12/1997).

Etymology: The specific epithet refers to the sub–Antarctic region where the species is abundantly present on all investigated localities.

Ecology and distribution: The new species is present on three islands in the southern Indian Ocean (Prince Edward Islands, Iles Crozet and Iles Kerguelen) and was reported under the name *Achnanthes lanceolata* var. *lanceolata* (Van de Vijver et al. 2001) or *P. lanceolatum* (Van de Vijver et al. 2002, 2008). It was abundantly found living epiphytically on wet to semi–wet mosses sampled in a wide variety of alkaline habitats ranging from small pools to lakes and rivers and in wet soils with a mean pH of 7.7 and a specific conductance range from 60–2000 µS.cm^{-1}. Accompanying (sub–) dominant taxa include *P. cyclophorum* (Heiden) Van de Vijver, *Navicula gregaria* Donkin and *Fragilaria capucina* s.l. Desmazières.

DISCUSSION

And although the correct identity of *Planothidium lanceolatum* has already been known for a long time, the species was rarely identified correctly in the Antarctic Region. Almost all records of *P. lanceolatum* in the Antarctic Region should be considered as a clear example of force–fitting these populations into European or North–American names (Tyler 1996). Only in Oppenheim (1994; Figs 40–45, 75–78) some valves were shown, recorded on Signy Island (South Orkney Islands), that without doubt belong to *P. lanceolatum* with lanceolate valves and clearly broadly rounded apices. Similar valves have never been observed in the investigated material from South Georgia, Livingston Island or James Ross Island. A careful comparison of the morphological features of the type of *Achnanthidium lanceolatum* and the Antarctic populations reveal sufficient differences to exclude conspecificity. *Planothidium rostrolanceolatum* was identified by Ko–Bayashi (1965) as *Achnanthes lanceolata* var. *lanceolata* f. *dubia* (Grunow) Ts.Kobay. Analysis of illustrations of the lectotype of the latter taxon in Krammer & Lange–Bertalot (1991; plate 42, figs 7–8) confirms that this identification cannot be accepted since the latter has a clearly elliptical valve outline with very short, acutely rounded, protracted apices, contrary to *P. rostrolanceolatum* that has gradually tapering apices. However, conspecificity between *P. rostrolanceolatum* and the Antarctic populations reported by Ko–Bayashi (1965) from South Georgia is highly likely based on a similar valve outline, valve dimensions and diminution series. Several populations from South Georgia (formerly identified as *A. lanceolatum*, Van de Vijver & Beyens 1996), have been investigated and could all



Figures 57–60. *Planothidium lanceolatum*. SEM views. Falaise, Caen, Calvados department, Basse–Normandie region, France, Eulenstein Diat. Spec. typ. N° 61 (coll. n° IV–2–C6) in the National Botanic Garden of Belgium (Belgium). (57) External view of an entire valve; (58) External view, detail of the valve apex; (59) Internal view of an entire valve; (60) Internal view, detail of the central area. Scale bars 10 µm, 5 µm (Figs 58, 60).

be identified as *P. rostrolanceolatum*. Another species that showed some similarities is *P. cyclophorum*, usually reported under the name of *P. lanceolatoides* (Sovereign) Lange–Bertalot. However, the larger valve width and the clearly elliptical valve outline of the latter clearly separate both taxa. *Planothidium rhombicuneatum* Lange–Bertalot et Rumrich, described in Rumrich et al. (2000) from the Chilean Altiplano, has clearly convex margins from the valve center up to the apices lacking the typical shoulders as is the case in *P. rostrolanceolatum*.

Planothidium subantarcticum and *P. rostrolanceolatum* can be separated based on several morphological features, although they have a similar valve width. Both taxa differ in valve outline with *P. rostrolanceolatum* showing more elongated, protracted apices where in *P. subantarcticum*, the apices are less differentiated from the rest of the valve. The central area in *P. rostrolanceolatum* is generally more developed than in *P. subantarcticum* due to the shortening of several central striae whereas in *P. subantarcticum*, the central area is much less developed and in some specimens even absent. Due to its longer valves, *P. subantarcticum* always shows a more slender outlook whereas *P. rostrolanceolatum* is sturdier due to the presence of the more pronounced shoulders. The raphe valve in *P. subantarcticum* has a slightly smaller central area whereas in *P. rostrolanceolatum*, more central striae are shortened enlarging the central area. The ultrastructure of the proximal raphe endings also presents some differences with a more undulating course in *P. subantarcticum* whereas in *P. rostrolanceolatum*, these proximal endings are straight. The striae in *P. rostrolanceolatum* are generally less radiate than in *P. subantarcticum*, although no difference in stria density or structure can be observed. The latter is not surprising since a lot of *Planothidium* taxa show a similar stria structure with only 3–4 rows of small areolae, the inner ones, usually smaller than the outer rows (Lange–Bertalot & Krammer 1989).

The question is however whether these two taxa really represent independent species or whether they represent a rather broad phenotypic plasticity of only one species. Nevertheless, the past few years, it became more and more clear that diatom present a high degree of cryptic and semi–cryptic diversity. Recently, Souffreau et al. (2013) revealed the presence of seven different lineages within *Pinnularia borealis* Ehrenberg whereas based on classical morphological research, it was impossible to separate these seven morphotypes from each other. Similar studies were published by Beszteri et al. (2005) on *Cyclotella meneghiniana*

Kützing, Poulíčková & Mann (2006) on *Navicula cryptocephala* Kützing, Evans et al. (2008) on *Sellaphora pupula* (Kützing) Mereschkowski and Vanelslander et al. (2009) on *Navicula phyllepta* Kützing. In all cases, cryptic diversity was confirmed in these widespread taxa. It is therefore highly likely that the differences found between the Antarctic populations reflect a separation of these populations into two different species *P. rostrolanceolatum* and *P. subantarcticum*. But as long as molecular studies are lacking, all answers to this question will remain speculative.

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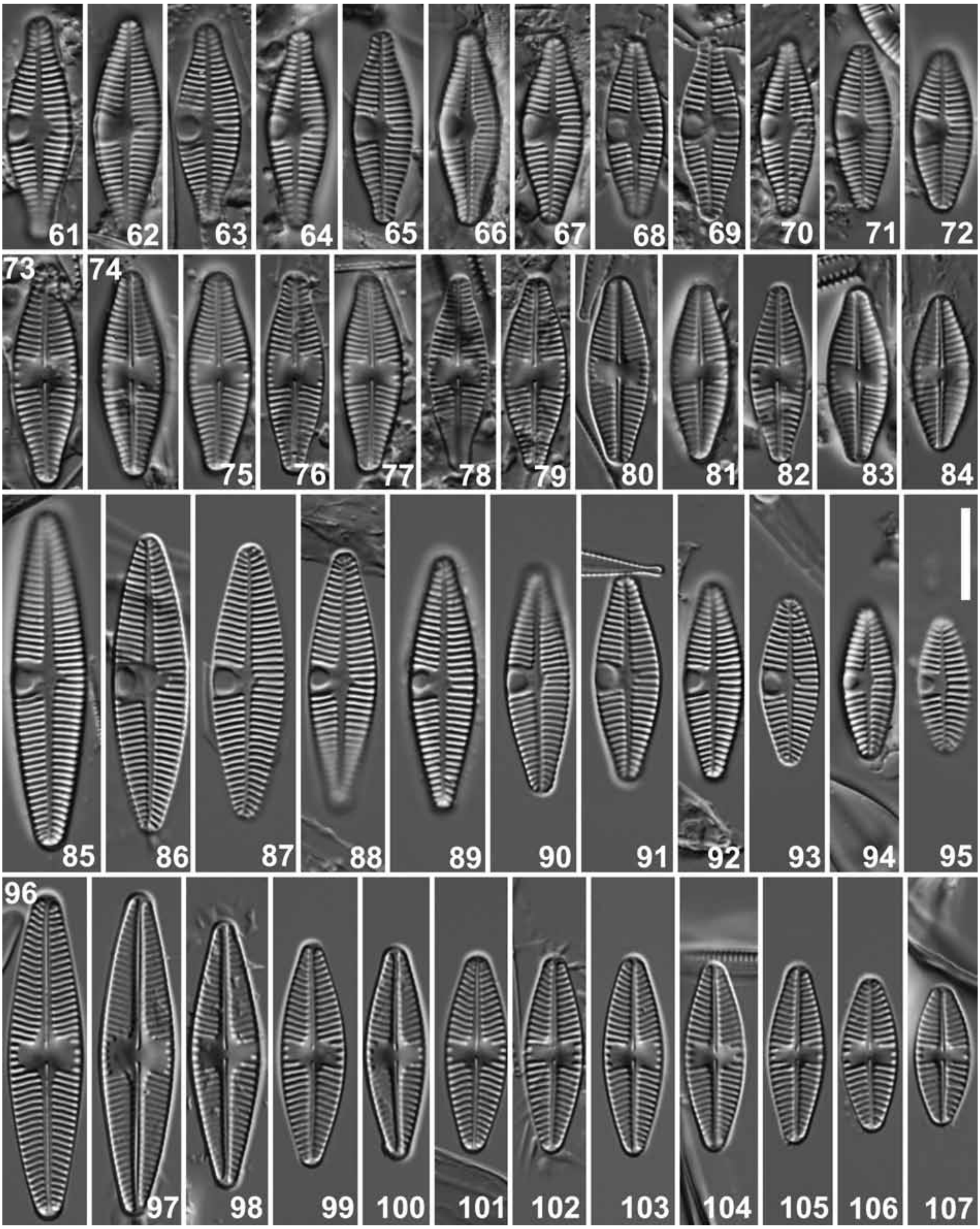
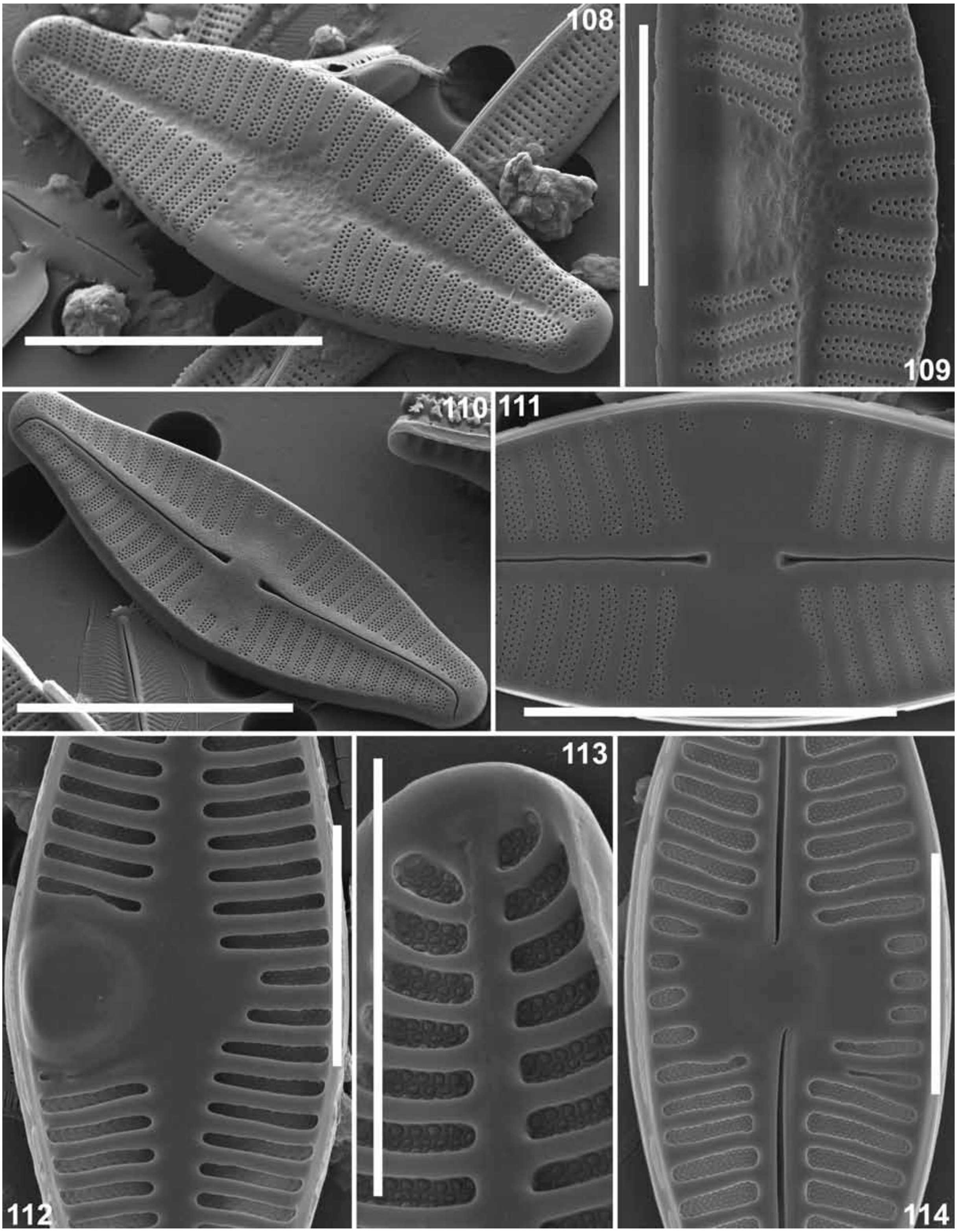
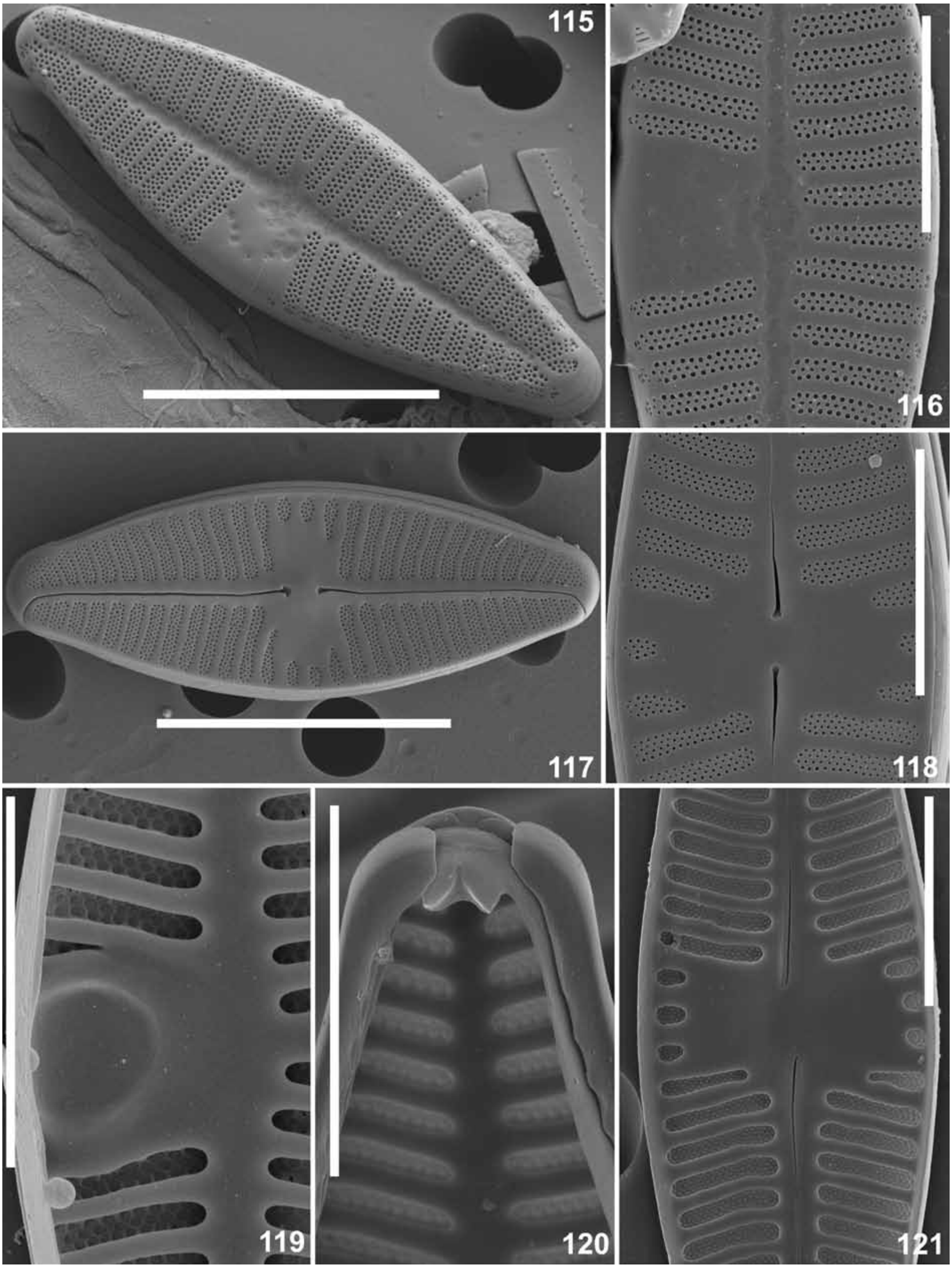


Figs 61–107. New *Planothidium* species from the Antarctic Region. (61–72) *Planothidium rostrolanceolatum*, rapheless valves; (73–84) *Planothidium rostrolanceolatum*, raphe valves; (85–95) *Planothidium subantarcticum*, rapheless valves; (96–107) *Planothidium subantarcticum*, raphe valves. Scale bar 10 µm.



Figs 108–114. *Planothidium rostrolanceolatum*, SEM views. (108) External view of an entire rapheless valve; (109) External view of the central area of a rapheless valve. Note the shallow markings in the central area; (110) External view of an entire raphe valve; (111) External view of the central area of a raphe valve; (112) Internal view of the central area of a rapheless valve; (113) Internal view of the apex of a rapheless valve; (114) Internal view of the central area of a raphe valve. Scale bar 10 µm, 5 µm (Figs 109, 111–114).



Figs 115–121. *Planothidium subantarcticum*, SEM views. (115) External view of an entire rapheless valve; (116) External view of the central area of a rapheless valve. Note the shallow markings in the central area; (117) External view of an entire raphe valve; (118) External view of the central area of a raphe valve; (119) Internal view of the central area of a rapheless valve; (120) Internal view of the apex of a rapheless valve. Part of the (open) valvocopula is covering the valve; (121) Internal view of the central area of a raphe valve. Scale bar 10 µm, 5 µm (Figs 116, 118–121).

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