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Article

New and interesting small-celled naviculoid diatoms (Bacillariophyta) from the Maritime Antarctic Region

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With 116 figures

Abstract: Four new small-celled naviculoid diatom species belonging to the genera *Adlafia*, *Chamaepinnularia*, *Mayamaea,* and *Microcostatus* were found during a survey of the non-marine diatom flora of the South Shetland Islands and James Ross Island (Maritime Antarctic Region). Following both light and scanning electron microscopy, the following species were described as new: *Adlafia submuscora* sp. nov., *Mayamaea josefelsteri* Kopalová, Nedbalová & Van de Vijver sp. nov., *Microcostatus australoshetlandicus* sp. nov. and *Chamaepinnularia antarctica* sp. nov. The new species are compared to other morphologically similar species from Europe, South America and the (sub-)Antarctic region. Data on their ecology and biogeography are included. In addition, the morphology, biogeography and taxonomic position of two other small-celled naviculoid diatoms, *Craticula glaberrima* (W. & G.S.West) nov. comb. and *Sellaphora nana* (Hustedt) Lange-Bertalot et al. are discussed.

Key words: Bacillariophyta, Diatoms, Maritime Antarctic Region, morphology, new species, taxonomy.

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Introduction

Diatoms are one of the most abundant algal groups in the Antarctic Region, both in number of species and number of individuals (Jones 1996, Van de Vijver & Beyens 1999). For a long time, this diatom flora was considered to comprise mainly cosmopolitan taxa (Sabbe et al. 2003), although intensive taxonomic research during the past few years has shown that, due to force-fitting (Tyler 1996) and taxonomic drift, the actual diatom diversity in this region has been severely underestimated. The ongoing revision of the non-marine diatom flora of the Maritime Antarctic Region has already resulted in the description of a large number of new taxa, mainly belonging to the genera *Pinnularia* (Van de Vijver & Zidarova 2011, Zidarova et al. 2012), *Stauroneis* (Van de Vijver et al. 2004), *Hantzschia* (Zidarova et al. 2010), *Muelleria* (Van de Vijver et al. 2010a), *Luticola* (Van de Vijver & Mataloni 2008, Van de Vijver et al. 2011a, Kopalová et al. 2011) and *Navicula* (Van de Vijver et al. 2011b). Most of these taxa have a restricted and sometimes even endemic distribution (Van de Vijver et al. 2005), indicating that it is highly likely that more new taxa belonging to currently under-studied genera await formal description.

During the Antarctic diatom survey, several small-celled (valve length < 20 µm) taxa belonging to several genera (formerly within the catch-all genus *Navicula* s.l.) were observed, but could not be identified using the currently available literature. Following detailed scanning electron microscopy, four of them are described as new: *Adlafia submuscora* sp. nov., *Mayamaea josefelsteri* Kopalová, Nedbalová & Van de Vijver sp. nov., *Microcostatus australoshetlandicus* sp. nov. and *Chamaepinnularia antarctica* sp. nov., and are compared with similar taxa. A fifth presumed new taxon belonging to the genus *Craticula* was finally identified as *C. glaberrima* (W. & G.S.West) nov. comb., previously only known from the type locality on the Antarctic Continent (West & West 1911, Van de Vijver et al. 2012), and is morphologically characterized. A sixth taxon, *Sellaphora nana* (Hustedt) Lange-Bertalot et al., shows some morphological variability when populations from different islands are compared.

Material and methods

Sediment samples were collected from various freshwater habitats on Livingston Island, Deception Island (South Shetland Islands) and James Ross Island. The South Shetland Islands (63°00'S/60°00'W), situated just north of the Antarctic Peninsula, consist of 11 larger and many smaller islands and islets, with King George Island (1150 km²) and Livingston Island (972 km²) being the largest. They have a typically maritime oceanic climate with mean annual temperatures around -5°C, high precipitation rates and strong westerly winds. Most of the land areas are covered by permanent ice and snow cover, leaving only small parts ice-free. The terrestrial vegetation is limited to lichens and mosses with only two flowering plants [*Colobanthus quitensis* (Kunth) Bartling and *Deschampsia antarctica* Desvaux].

James Ross Island (64°10'S, 57°45'W), is located further south, in the north-western part of the Weddell Sea, close to the northern tip of the Antarctic Peninsula. This fairly large island (2450 km²) is situated in the transition zone between the Maritime Antarctica and Continental Antarctica regions (Øvstedal & Lewis-Smith, 2001). Only its northern part, Ulu Peninsula, is ice-free. The temperature is comparable to the South Shetland Islands but precipitation is limited to only 150 mm/y in the northern part (Aristarain et al. 1987), with high evaporation rates reducing the formation of large open waterbodies. The terrestrial vegetation is limited to non-vascular plants forming a bryophyte-and-lichen-tundra in places.

Sampling methods follow those described in Kopalová et al. (2012) and Kopalová & Van de Vijver (2013). Diatom samples were prepared following the method of Van der Werff (1955). Small parts of the samples were cleaned by adding 37% H_2O_2 and heating to 80°C for about one hour, followed by addition of $KMnO_4$. After digestion and centrifugation (3 × 10 minutes at 3700g), the material was diluted with distilled water to avoid excessive concentrations of diatom valves. Cleaned diatom valves were mounted in Naphrax®. All samples and slides are stored at the National Botanic Garden of Belgium (BR), Department of Bryophyta and Thallophyta. 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), part of the suspension was filtered through polycarbonate membrane filters with a pore diameter of 1 µm, pieces of which were fixed on aluminium stubs after air-drying. The stubs were sputter-coated with 20 nm of Au-Pd and studied in a Zeiss Ultra microscope at 3 kV. Terminology is based on Hendey (1964), Ross et al. (1979) and Round et al. (1990). The new species were compared with similar taxa from the Antarctic Region (Van de Vijver et al. 2002), Europe and South America (Lange-Bertalot & Genkal 1999, Lange-Bertalot 2001, Lange-Bertalot et al. 2003, Metzeltin & Lange-Bertalot 2007).

Results

Adlafia submuscora sp. nov. Figs 1–19

Descriptio: Valvae lanceolatae at anguste lanceolatae marginibus claro convexis apicibusque protractis, subrostratis. Longitudo 10–12 µm, latitudo 2.5–3.1 µm. Area axialis angustissima, linearis omnino. Area centralis paene absens. Rami raphis externi leviter undulati, terminationibus proximalibus rectis, non expansis. Fissurae distales longae, non extensae in limbo, unilateraliter curvatae, expansae. Striae transapicales uniseriatae, claro radiatae, convergentes in apices, paene discernendae in microscopio photonico, 40–45 in 10 µm. Striae in area centrali leviter magis distantes.

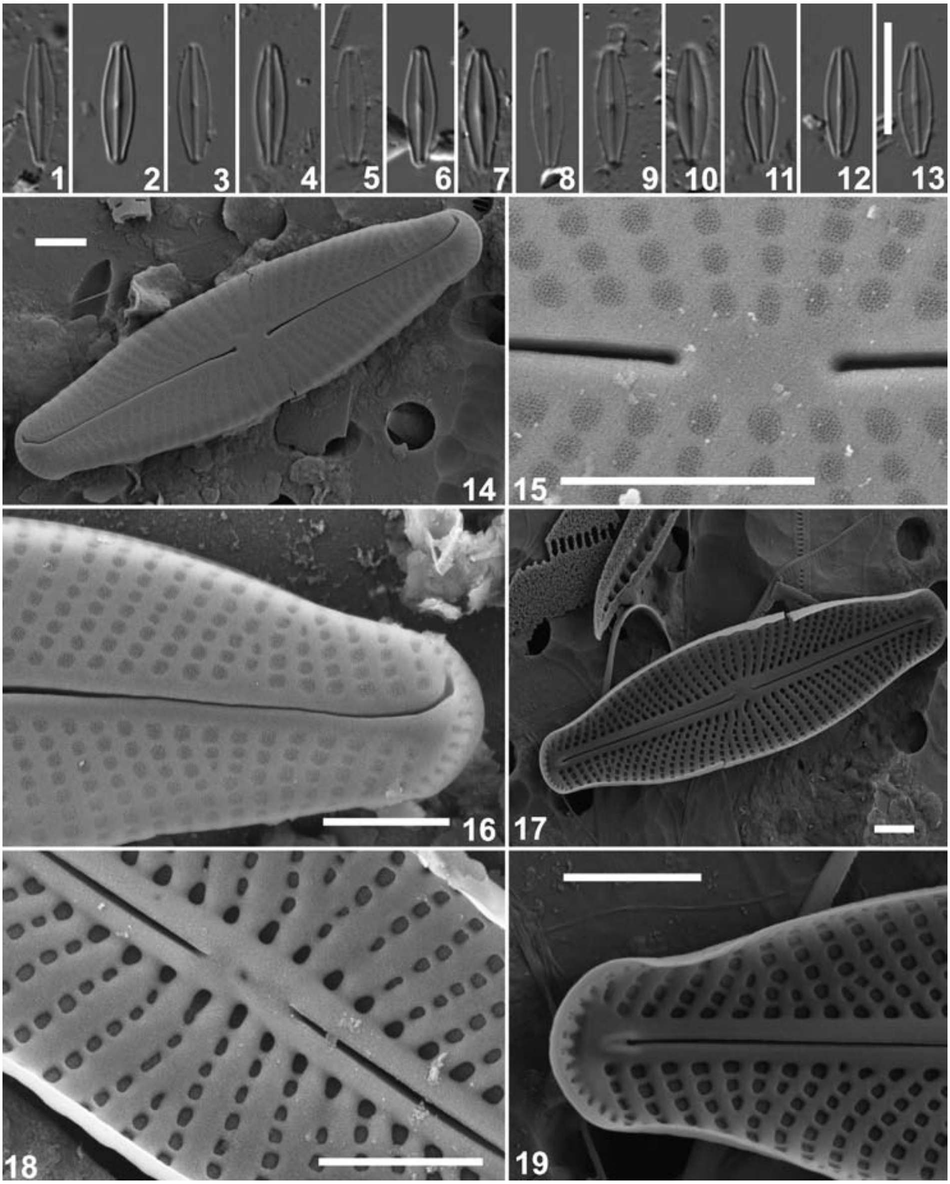
Holotype: BR-4271 (National Botanic Garden, Meise, Belgium)

Isotypes: PLP-215 (UA, University of Antwerp, Belgium), BRM-ZU8/51 (Hustedt Collection, Bremerhaven, Germany)

Type locality: Lake 3, Clearwater Mesa, James Ross Island, sample CLW60 (Coll. L.Nedbalová & J.Elster, 09/02/2009).

Etymology: the specific epithet refers to the close resemblance to *Adlafia muscora* (Kociolek & Reviers) Lange-Bertalot in Moser et al. but the valves are always much smaller (Latin: *sub*-: under, lower)

Morphology: Valves lanceolate to narrowly lanceolate with clearly convex margins and bluntly rounded, subrostrate apices (Figs 1–13). Valve dimensions (n=15): length 10–12 µm, width 2.5–3.1 µm. Axial area very narrow, less than 1/6 of the total valve width, linear throughout its entire length (Figs 14, 17). Central area almost non-existent, formed by a slight widening of the axial area (Figs 14, 17). External raphe branches slightly curved with almost straight proximal raphe endings (Fig. 15). External distal raphe fissures unilaterally bent, terminating in a wider groove, not extending onto the valve mantle (Fig. 16). Internally, raphe branches straight in a slightly raised sternum (Fig. 17), with straight proximal endings (Fig. 18) and distal endings terminating in small helictoglossae (Fig. 19). Striae radiate, becoming abruptly convergent near the apices (Figs 16, 19), hardly discernible in LM, 40–45 in 10 µm, slightly more widely spaced near the central area (Fig. 14). Occasionally, one shortened stria is inserted beside the central area (Fig. 17). Striae uniseriate, composed of large, rounded areolae covered externally by a (porous) hymen (Fig. 15).



Figs 1–19. *Adlafia submuscora*. Specimens from the type population on the Clearwater Mesa, James Ross Island. Figs 1–13. Light microscopy showing the variation in size and outline. Fig. 14. SEM external view of an entire valve showing the ultrastructure of the raphe and the areolae. Fig. 15. SEM external view of the externally hymenate areolae. Fig. 16. SEM external view of the valve apex with the distal raphe fissures. Fig. 17. SEM internal view of an entire valve. Fig. 18. SEM internal view of the central area with the straight proximal raphe endings and the open areolae. Fig. 19. SEM internal view of the apex with the helictoglossa. Scale bar represents 10 µm except for Figs 14–19 where scale bar = 1 µm.

Confirmed Distribution: *Adlafia submuscora* has been found on several islands in the Maritime Antarctic Region including Livingston Island and James Ross Island, but it is also possible that it has been confused with the much larger *Adlafia bryophila* (Petersen) Lange-Bertalot in Moser et al., which has been recorded several times from the Maritime Antarctic Region (Kellogg & Kellogg 2002). Unfortunately, as long as these records cannot be verified, its distribution in this region remains unclear. It has not yet been found on the sub-Antarctic islands in the southern Indian Ocean (Van de Vijver et al. 2002).

Ecology: The type population was found on the Clearwater Mesa, a table mountain in the northern part of James Ross Island. The sample was taken from a stable, shallow lake with rather alkaline pH (8.2), moderately high specific conductance (479 µS/cm) and very low nutrient concentrations. The sample was dominated by *Nitzschia perminuta* (Grunow) Peragallo, *Amphora* cf. *veneta* Kützing, *Pinnularia australomicrostauron* Zidarova et al. and *Achnanthidium lailae* Van de Vijver. Other sizeable populations were present on Livingston Island, where the species was observed in several larger lakes on the central plateau of Byers Peninsula, and in a pond on Hurd Peninsula, with slightly alkaline to alkaline pH (7.3–8.9), low specific conductance (60–150 µs/cm) and low nutrient concentrations.

***Chamaepinnularia antarctica* sp. nov.** Figs 20–36

Diagnose: Valvae anguste lanceolate marginibus leviter convexis, paene parallelis. Apîces leviter protractae, aliquando subrostratae. Longitudo 7.5–12.0 µm, latitudo 2.4–2.8 µm. Area axialis angusta, linearis, dilatans in aream centralem. Area centralis rectangularis, cum 1–3 striis abbreviates. Fascia numquam praesens. Rami raphis claro curvati terminationibus proximalibus rectis, guttiformibus, fissuris distalibus flexis. Striae radiatae, paene parallelae in apices, 21–23 in 10 µm.

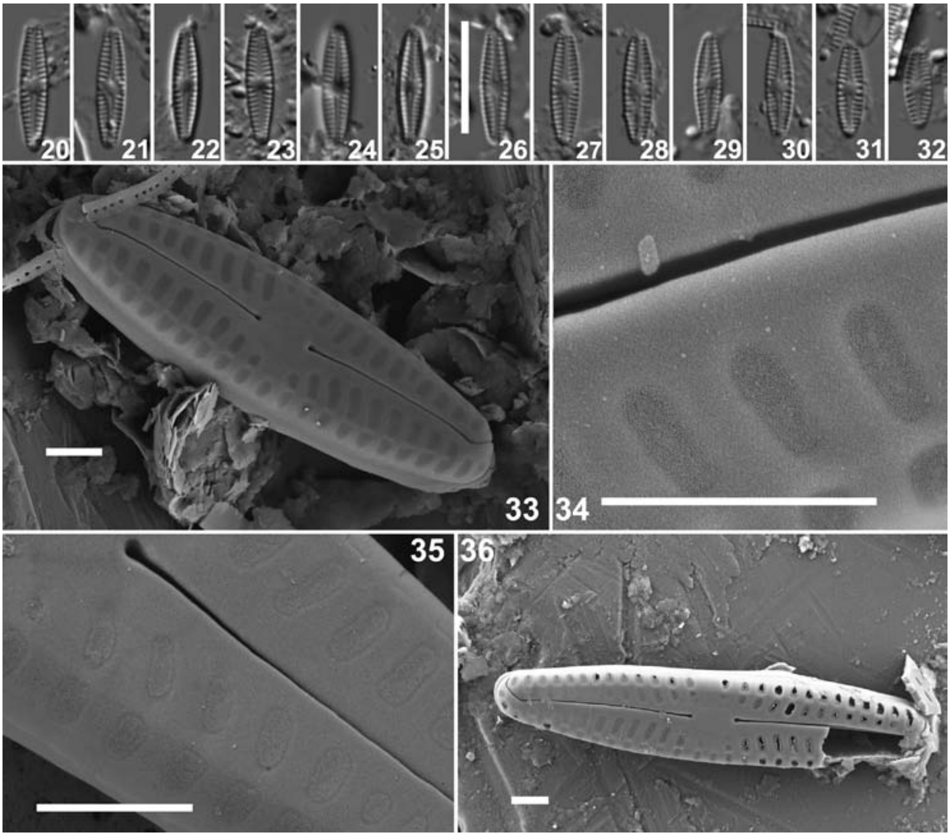
Holotype: BR-4272 (National Botanic Garden, Meise, Belgium)

Isotypes: PLP-216 (UA, University of Antwerp, Belgium), BRM-ZU8/52 (Hustedt Collection, Bremerhaven, Germany)

Type locality: Byers Peninsula, Livingston Island, South Shetland Islands, sample BY049 (Coll. B.Van de Vijver, Coll. date 14/01/2009)

Etymology: The specific epithet refers to the Antarctic region where the species was first discovered.

Morphology: Valves (very) narrowly lanceolate with weakly convex, almost parallel margins gradually tapering towards the bluntly rounded, very slightly protracted, sometimes weakly subrostrate apices (Figs 20–32). Valve dimensions (n=15): length 7.5–12.0 µm, width 2.4–2.8 µm. Axial area narrow, less than 1/4 of the total valve width, linear, widening beside the central area (Fig. 33). Central area rectangular due to the presence of 1–3 irregularly shortened striae, but never extended into a fascia. External raphe branches curved with almost straight, drop-like expanded proximal endings and unilaterally bent distal fissures, continuing onto the valve mantle (Fig. 33). Transapical striae radiate, becoming almost parallel near the apices, 21–23 in 10 µm. Striae composed of two large areolae, one on the valve face, the other on the mantle, separated by solid silica near the valve face/mantle junction (Fig. 35) and continuing around the valve apices (Fig. 33). Areolae covered externally by a hymen (Fig. 34).



Figs 20–36. *Chamaepinnularia antarctica*. Specimens from the type population on Byers Peninsula, Livingston Island. Figs 20–32. Light microscopy showing the variation in size, striation and outline. Fig. 33. SEM external view of an entire valve showing the external raphe path and the striae interrupted near the valve face/mantle junction. Fig. 34. SEM external view of the large, externally hymenate areolae. Fig. 35. SEM external view of the striae. Fig. 36. SEM external view of a broken valve with eroded striae showing the large areolae. Scale bar represents 10 µm except for Figs 33–36 where scale bar = 1 µm.

When eroded, the areolae appear as simple open foramina (Fig. 36). Internal structure could not be observed.

Confirmed Distribution: Due to confusion with *C. australomediocris* (Lange-Bertalot & Schmidt) Van de Vijver, the current distribution of *C. antarctica* is not well known. The species was definitely found on Livingston Island (Kopalová & Van de Vijver, 2013) and James Ross Island (Kopalová et al. unpubl. data). It is probably also present on other localities in the Maritime Antarctic Region but this needs to be confirmed by further study of the recorded *C. australomediocris* populations.

Ecology: The type population of *Chamaepinnularia antarctica* was taken from a relatively large lake situated next to Limnopolar lake, at an altitude of 75 m on the central plateau of Byers Peninsula. The lake has a pH of 7.6 with specific conductance of 60 µS/cm. Both nutrient and mineral concentrations are quite low (Kopalová & Van de Vijver, 2013). The sample is dominated by *Staurosirella pinnata* (Ehrenberg) D.M.Williams & Round, *Fragilaria capucina* s.l. Desmazières, *Planothidium frequentissimum* (Lange-Bertalot) Round & Bukhtiyarova and *Psammothidium papilio* (Lange-Bertalot & Rol.Schmidt) Van de Vijver & Kopalová. The species was found in several other lakes and streams on Byers Peninsula, but always in low abundance. Almost all samples were taken in or near flowing water, or where flowing water entered the lake. The species has not yet been observed on Hurd Peninsula where several populations of *C. australomediocris* occur. Only very small populations of the species were observed on James Ross Island.

Mayamaea josefelsteri Kopalová, Nedbalová & Van de Vijver **sp. nov.** Figs 37–51

Diagnose: Valvae elongatae, ellipticae at ellipticae-lanceolatae marginibus convexis, apicibusque obtuse rotundatis, non protractis. Longitudo 10.5–11.5 µm, latitudo 2.9–3.4 µm. Area axialis potius angusta, linearis. Area centralis rectangularis ad paene rotunda, marginata a 2–5 striis abbreviatis. Rami raphis externi claro curvati terminationibus proximalibus deflexis fissurisque distalibus flexis, non extensis in limbo. Striae transapicales radiatae, curvatae prope aream centralem, parallae in apices, 25–27 in 10 µm.

Holotype: BR-4273 (National Botanic Garden, Meise, Belgium)

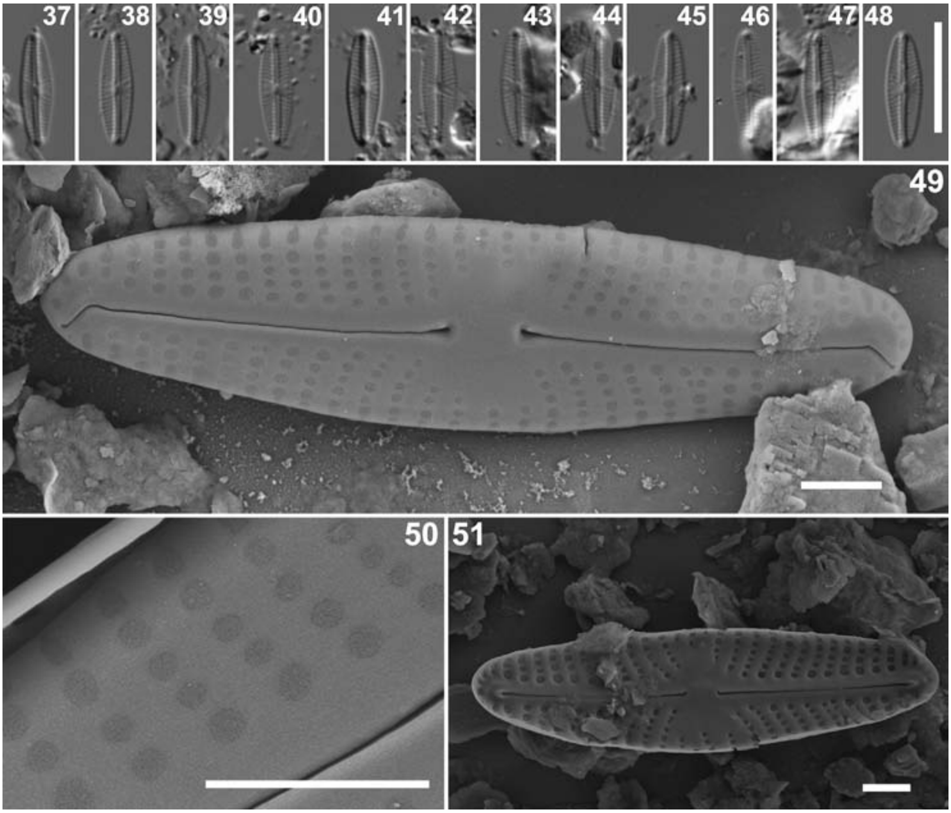
Isotypes: PLP-217 (UA, University of Antwerp, Belgium), BRM-ZU8/53 (Hustedt Collection, Bremerhaven, Germany)

Type locality: Láska Lake, Ulu Peninsula, James Ross Island, sample JRI-D22 (Coll. L.Nedbalová, coll. date 17/02/2008).

Etymology: The species is named after our colleague Dr. Josef Elster (University of South Bohemia, Czech Republic) in honour of his impressive contribution to Arctic and Antarctic (algal) science.

Morphology: Valves linear-elliptical to elliptic-lanceolate with convex margins and bluntly rounded apices (Figs 37–48). Valve dimensions (n=15): length 10.5–11.5 µm, width 2.9–3.4 µm. Axial area rather narrow, linear (Fig. 49). Central area rectangular to almost rounded, bordered by several (2–5) shorter striae. External raphe branches curved with unilaterally deflected, expanded proximal raphe endings and bent distal raphe fissures (curving in the opposite direction to the proximal endings), not continuing onto the valve mantle (Fig. 49). Internally, raphe branches straight with short, simple, deflected proximal raphe endings (Fig. 51). Internal distal raphe endings terminating in small helictoglossae (Fig. 51). Transapical striae slightly radiate, curved near the central area, becoming straight and almost parallel near the apices, 25–27 in 10 µm (Fig. 49). Striae continuing around the valve apices (Fig. 49). Striae uniseriate, composed of several large, rounded areolae, covered externally by hymenes (Fig. 50).

Confirmed Distribution: *Mayamaea josefelsteri* has, to date, only been found on James Ross Island. Its presence in other localities of the Maritime Antarctic Region must be confirmed after re-examination of previously reported *Mayamaea* populations.



Figs 37–51. *Mayamaea josefelsteri*. Specimens from the type population on Ulu Peninsula, James Ross Island. Figs 37–48. Light microscopy showing the variation in size, striation and outline. Fig. 49. SEM external view of an entire valve showing the raphe and areolae ultrastructure. Fig. 50. SEM external view of the externally hymenate areolae. Fig. 51. SEM internal view of an entire valve. Scale bar represents 10 µm except for Figs 49–50 where scale bar = 1 µm.

Ecology: *Mayamaea josefelsteri* has been found in several larger lakes on Ulu Peninsula in the northern part of James Ross Island. The type population is from a thermokarst lake with almost circumneutral pH (6.9), very low specific conductance (26 µS/cm) and low nutrient concentrations (Nedbalová et al. unpubl. data). All other populations were found in coastal lakes with comparable pH (7.0–7.5) although the specific conductance in one lake was much higher (up to 1038 µS/cm). Dominating species in the diatom flora include *Nitzschia homburgiensis* Lange-Bertalot, *Microcostatus naumanii* (Hustedt) Lange-Bertalot, *Mayamaea atomus* (Kützing) Lange-Bertalot and *Psammothidium papilio*.

***Microcostatus australoshetlandicus* sp. nov.** Figs 52–69

Diagnose: Valvae lanceolatae ad ellipticae-lanceolatae in speciminibus minoribus, marginibus convexis, apicibusque paene non protractis, cuneatim rotundatis. Longitudo 6.5–9.0 µm, latitudo 2.9–3.2 µm. Area axialis moderate lata, formans sternum elevatum cum conopeo tegenti partes striarum, marginatum a fissuribus longitudinalibus.Area centralis rotunda, marginata a striis abbreviatis. Raphe filiformis, terminationibus proximalibus rectis, leviter expansis, fissurisque distalibus claro flexis. Microcostae absunt. Striae transapicales claro radiatae, geniculatae, parallelae ad apices, 24–28 in 10 µm. Solum una areola transapicaliter elangata pro stria.

Holotype: BR-4274 (National Botanic Garden, Meise, Belgium)

Isotypes: PLP-218 (UA, University of Antwerp, Belgium), BRM-ZU8/54 (Hustedt Collection, Bremerhaven, Germany)

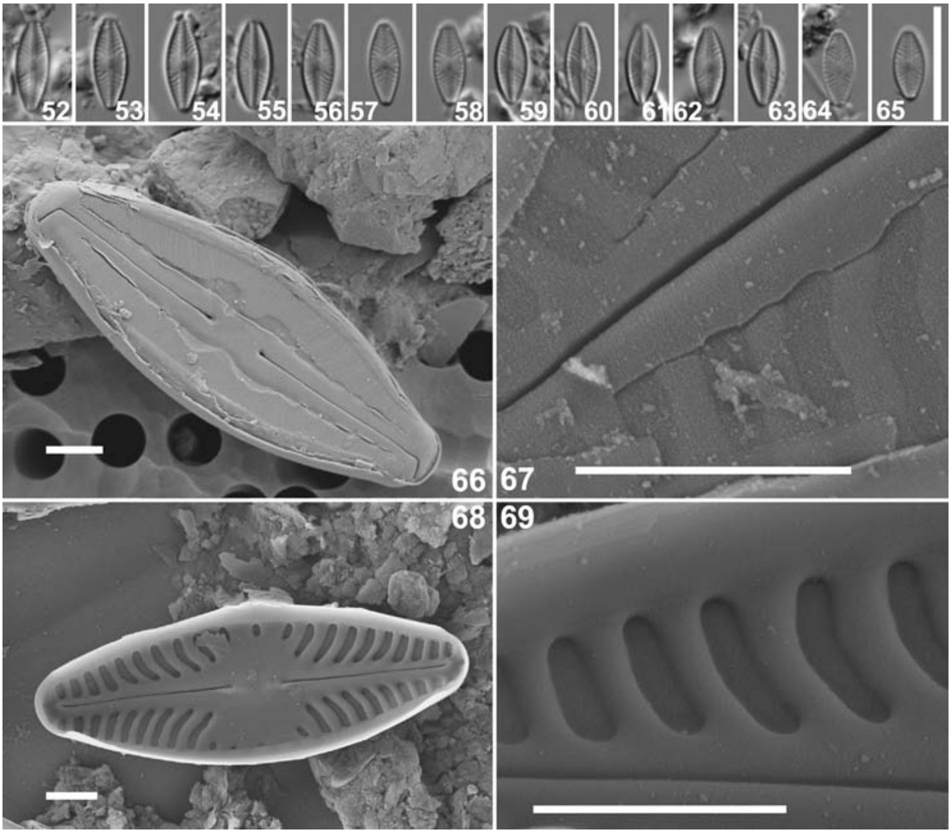
Type locality: Deception Island, South Shetland Islands, sample IR, near Irizar Lake (coll. G.Mataloni, coll. date February 2002).

Etymology: the specific epithet refers to the South (Latin *australis*) Shetland (Latin *shetlandicus*) Islands since the species was found on several islands of this archipelago.

morphology: Valves lanceolate to elliptic-lanceolate in smaller specimens with convex margins and bluntly cuneate apices (Figs 52–65). Valve dimensions (n=15): length 6.5–9.0 µm, width 2.9–3.2 µm. Axial area moderately wide, almost 1/3 to 1/4 total valve width, formed by a raised sternum flanked by a conopeum covering part of the striae, its lateral margin bordered by longitudinal grooves (Figs 66, 67). Central area large and rounded, bordered by several shorter striae (Fig. 68). External raphe branches straight with slightly expanded proximal raphe endings and unilaterally bent distal raphe fissures (Fig. 66). Internally, proximal raphe endings not or very slightly unilaterally deflected (Fig. 68). Internal distal raphe endings terminating in poorly developed helictoglossae (Fig. 68). Transapical striae radiate at the centre, then geniculate (Fig. 69) and becoming parallel towards the apices, 24–28 in 10 µm (Fig. 68). Striae composed of one transapically elongated areola reaching the valve margin (Fig. 69), covered on the outside by a hymen (Fig. 67). Striae continuing under the conopeum towards the sternum. Microcostae not discernible.

Confirmed Distribution: *Microcostatus australoshetlandicus* has been found on Livingston Island and Deception Island, two islands of the South Shetland Islands, but has not yet been found on James Ross Island (Kopalová et al. 2012, unpublished results). Due to its small size, it is possible that the taxon occurs in more Antarctic localities but has been overlooked.

Ecology: The type population was collected from a circumneutral soil sample (pH = 6.95) near Irizar Lake on the southwestern side of the island. The sample has a low mineral and organic content, and very low nutrient concentrations (Fermani et al. 2007). It is dominated by several *Muelleria* species including *M. aequistriata* Van de Vijver & Spaulding, *M. sabbei* Van de Vijver & Spaulding and *M. australoatlantica* Van de Vijver & Spaulding, together with *Pinnularia borealis* Ehrenberg s.l. and *Psammothidium germainii* (Manguin) Sabbe. Smaller populations were found in other samples in the same area on Deception Island, all taken from very stable soils with a low degree of historical disturbance by volcanic and/or human activity (Fermani et al. 2007). Only



Figs 52–69. *Microcostatus australoshetlandicus*. Specimens from the type population near Irizar Lake, Deception Island. Figs 52–65. Light microscopy showing the variation in size, striation and outline. Fig. 66. SEM external view of an entire valve showing the sternum, the conopeum and the areolae. Fig. 67. SEM external view of the areolae with the typical external hymenate areola occlusions and the conopeum covering the striae. Fig. 68. SEM internal view of an entire valve. Fig. 69. SEM internal view of the areolae. Scale bar represents 10 µm except for Figs 66–69 where scale bar = 1 µm.

very small populations were found in algal mat samples on Livingston Island, taken from small pools on Byers Peninsula and among almost dry mosses on Hurd Peninsula.

Sellaphora nana (Hustedt) Lange-Bertalot et al. Figs 70–99

MORPHOLOGY: Valves narrowly lanceolate to elliptic-lanceolate in some populations with strongly to moderately convex margins and bluntly rounded, rostrate to subrostrate apices (Figs 70–93). Valve dimensions (n=25): length 8.5–19 µm, width 3.5–5.3 µm. Axial area narrow, formed by a weakly raised sternum widening towards the central area, bordered by shallow grooves (Figs 94–96). Central area typically bow-tie-shaped, bordered by several (5-12) shortened striae composed of only a few (<10) areolae

(Figs 94–96). External raphe branches straight with expanded and slightly deflected or undulating proximal raphe endings and unilaterally deflected distal raphe fissures, continuing onto the valve mantle (Figs 94–96). Internally, proximal raphe endings expanded, short and unilaterally deflected (Fig. 98). Internal distal raphe endings terminating in helictoglossae (Fig. 98). Transapical striae radiate, at the centre, becoming slightly geniculate and then abruptly convergent about 1/3 valve length from the valve apices, 40–50 in 10 µm (Fig. 95). Striae continuing onto the valve margin and comprised of many, very small, rounded areolae (ca. 90 in 10 µm).External areola openings sometimes confluent into the shallow grooves near the sternum (Fig. 97). Internally, areolae covered individually by hymenes (Fig. 99).

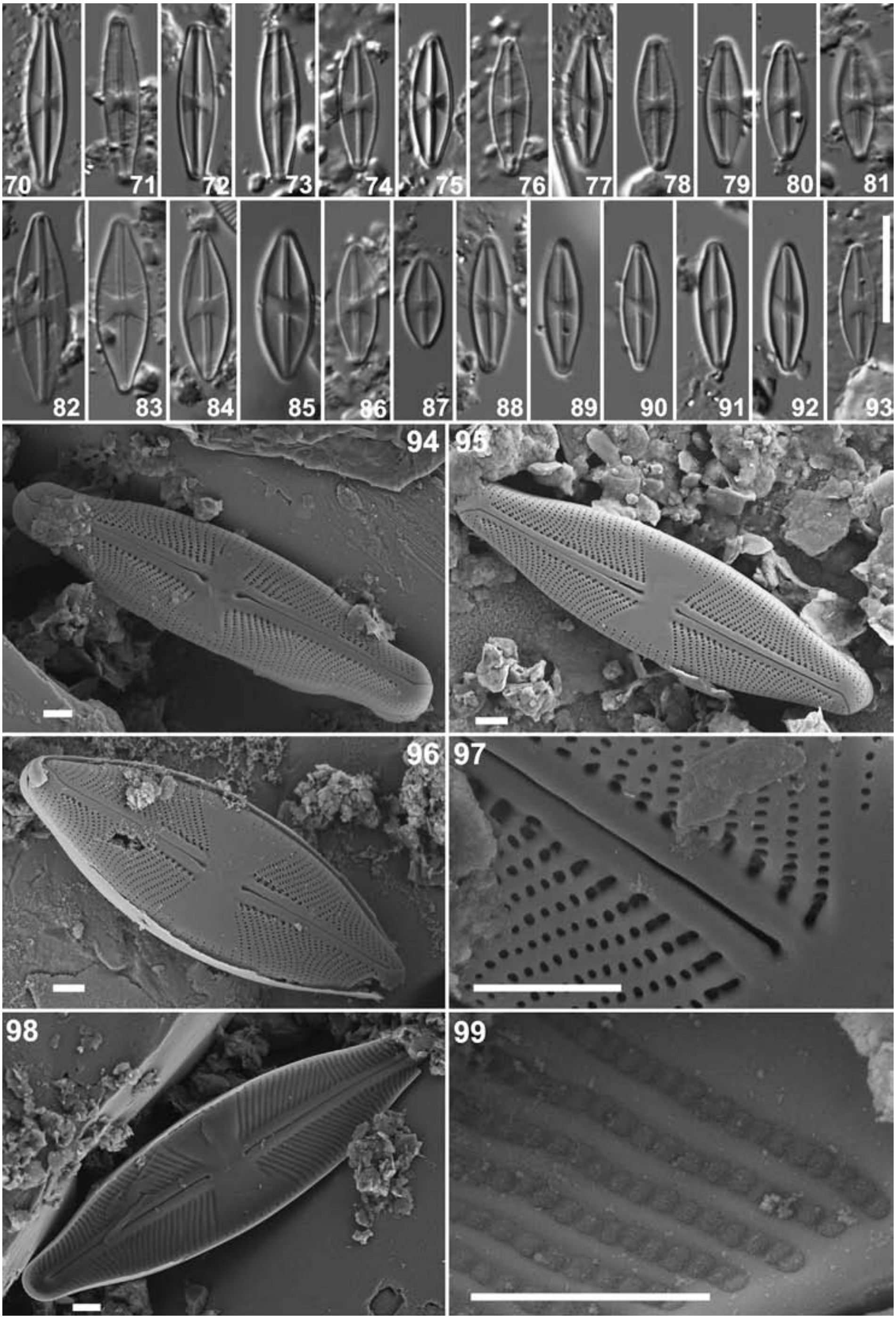
Confirmed Distribution: *Sellaphora nana* is presumably a cosmopolitan species with records from e.g. Sardinia (Lange-Bertalot et al. 2003), Finland (Lange-Bertalot & Metzeltin 1996), Germany (Hustedt 1957), Argentina (Romero 1995), South Africa (Schoeman 1970) and Maritime Antarctica. In the Antarctic Region, the species was found on the South Shetland Islands, James Ross Island and Signy Island (Sterken, pers. comm.). So far, no records exist for the sub-Antarctic islands nor the Antarctic Continent. The record of *S. nana* from the Crozet archipelago (as *Stauroneis nana* Hustedt in Van de Vijver & Beyens 1998) was based on a misidentification. This was corrected to *Frustulia cirisiae* Van de Vijver (Van de Vijver 2002).

Ecology: Several populations of *Sellaphora nana* were found in the Maritime Antarctic Region, mostly on the South Shetland Islands. On Hurd Peninsula (Livingston Island), a small population was found in a large coastal pond of slightly alkaline pH (7.35), very low specific conductance (25 µS/cm) and low nutrient concentrations. The species was also rarely observed epiphytically on moist to almost dry mosses bordering small puddles and streams, and in soil samples collected below mosses. The largest population was found in Asa Lake, a large lake on the central plateau on the other large ice-free peninsula, Byers Peninsula. This slightly alkaline lake (pH=7.5) has a low specific conductance (114 µS/cm) and is located in a stony area surrounded by seepage areas. The dominant taxa in the sample included *Nitzschia paleacea* Grunow, *Fragilaria capucina* s.l. and *Sellaphora* cf. *seminulum* (Grunow) D.G.Mann. On James Ross Island, small populations were found in coastal lakes and stable shallow lakes at higher altitudes (Vondra Lakes). All lakes were characterized by having a more alkaline pH (7.5–8.0) and a broad range of specific conductance (<50 to >1000 µS/cm).

Craticula glaberrima (W. & G.S.West) **nov. comb.** Figs 100–116

Basionym: *Navicula glaberrima* W. & G.S.West Freshwater algae. British Antarctic Expedition (1907–1909) Science Report, Biology 1(7): 282, Plate XXVI, Fig. 125 (1911).

morphology: Valves lanceolate to rhombic-lanceolate with convex (never parallel) margins and blunt, sub-rostrate to rostrate apices (Figs 100–112). Valve dimensions (n=20): length 13–15 µm, width 3.4–4.5 µm. Axial area very narrow, linear. Central area absent. External raphe branches straight with straight, non-expanded proximal external raphe endings (Figs 113, 114). External distal raphe fissures deflected, terminating on the valve face (Fig. 113). Internally, raphe situated on a slightly raised linear sternum (Fig. 115), proximal raphe endings very weakly deflected (Fig. 116), distal endings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short, terminating on well developed helictoglossae (Fig. 115). Transapical striae parallel to weakly radiate throughout the entire valve, becoming slightly convergent near the apices (Fig. 113). Central striae more widely spaced (28–30 in 10 µm) than those near the apices (34–40 in 10 µm), only discernible at the centre in LM. Apices solid, with only one short stria composed of very small, rounded areolae (Fig. 113, arrows). Striae uniseriate, composed of small areolae, ca. 90 in 10 µm, with apically elongated, external openings (Fig. 114). Areolae slightly enlarged beside the axial area, internally occluded by hymenes (Fig. 116).

Confirmed Distribution: *Craticula glaberrima* has so far only been found on the Antarctic Continent (West & West 1911), probably due to confusion with similar taxa such as *C. molestiformis* (Hustedt) Lange-Bertalot or *C. submolesta* (Hustedt) Lange-Bertalot. The species definitely occurs on James Ross Island, where several small populations have been found (Kopalová et al. unpublished results). In the South Shetland Islands, the species has only been found on Livingston Island. A very small population was recorded from Byers Peninsula, and a few valves were observed from Hurd Peninsula.

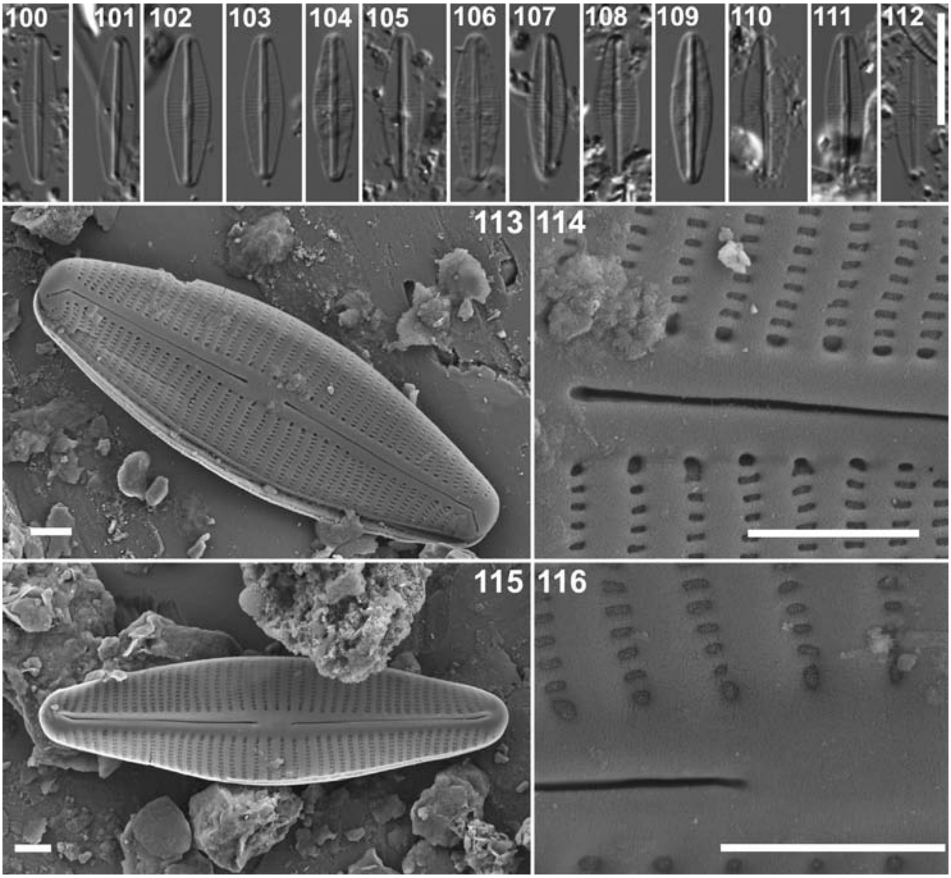
Ecology: *Craticula glaberrima* is a rare species with its largest population (<1% of all counted valves) in the thermokarstic Láska Lake, located on the ice-free area of Ulu Peninsula. This lake has almost circumneutral pH, very low specific conductance (26 µS/cm) and low nutrient concentrations. Dominant taxa in the sample included *Nitzschia homburgiensis, Sellaphora nana* and *Microcostatus naumanii*.

Discussion

The four new taxa each present a unique combination of morphological characters that separates them from similar taxa worldwide. The application of a more fine-grained taxonomy based on a narrower species concept, separates these taxa from their European or American relatives. It is highly likely that they were previously lumped with the latter, making (palaeo-)ecological or biogeographical interpretations from literature data quite difficult, possibly incorrect. Nevertheless, the four new naviculoids are readily distinguished.

Based on the structure of the raphe and the areolae covered by external hymenes *A. submuscora* clearly belongs to *Adlafia*. The new taxon resembles several other

Figs 70–99. *Sellaphora nana*. Specimens from the various populations in the Maritime Antarctic Region. Figs 70–93. Light microscopy showing the variation in size and outline between different populations. Figs 70–81. Ulu Peninsula, James Ross Island. Figs 82–87. Deception Island. Figs 88–93. Byers Peninsula, Livingston Island. Figs 94–96. SEM external view of entire valves from the three different Maritime Antarctic locations showing the ultrastructure of the raphe and the striae. Fig. 94. Livingston Island. Fig. 95. James Ross Island. Fig. 96. Deception Island. Fig. 97. SEM external detail of the areolae and the proximal raphe endings (James Ross Island). Fig. 98. SEM internal view of an entire valve (Deception Island). Fig. 99. SEM internal view of the individually hymenate areolae (Deception Island). Scale bar represents 10 µm except for Figs 94–99 where scale bar = 1 µm.



Figs 100–116. *Craticula glaberrima*. Specimens from the largest population on the Clearwater Mesa, James Ross Island. Figs 100–112. Light microscopy showing the variation in size, striation and outline. Fig. 113. SEM external valve view of an entire valve showing the raphe and areolae ultrastructure. The arrow indicates the short striae at the apices, composed small, rounded areolae. Fig. 114. SEM external valve view of the central area showing the hymenate areolae and a proximal raphe ending. Fig. 115. SEM internal valve view of an entire valve. Fig. 116. SEM internal valve view showing the hymenate areolae. Scale bar represents 10 µm except for Figs 113–116 where scale bar = 1 µm.

Adlafia species, such as *A. muscora*, *A. minuscula* (Grunow) Lange-Bertalot and even *A. suchlandtii* (Hustedt) Monnier & Ector. Larger taxa such as *A. bryophila* and *A. parabryophila* Lange-Bertalot differ sufficiently in shape and size (much larger with capitate to subcapitate apices), not to be confused with *A. submuscora*. *Adlafia suchlandtii* is narrower (2.5–3 µm wide) with straight, parallel margins. *Adlafia minuscula* has more elliptic-lanceolate valves without subrostrate apices and with shorter external distal raphe endings. *Adlafia muscora* shows the greatest similarity but can be differentiated by its larger valve dimensions (around 20 µm long vs. 10–12 µm), more rostrate apices, deflected expanded central raphe endings (unlike the straight simple endings in *A. submuscora*) and less dense striae (23–26 in 10 µm vs. 40–45 in 10 µm in *A. submuscora*) (Kociolek & de Reviers 1996). *Adlafia multnomahii* Morales & Le is another small *Adlafia* species but has a clearly elliptical outline with well protracted apices, two features not present in the new species (Morales & Le 2005).

Chamaepinnularia antarctica is a typical member of *Chamaepinnularia*, based on the stria structure composed of one large areola on the valve face and one on the mantle, separated by solid silica along the valve /mantle junction, the raphe with bent distal fissures and the presence of external hymenes (Lange-Bertalot & Metzeltin 1996). Like *C. antarctica*, *Chamaepinnularia* species are almost always quite small. The new taxon has been confused with *C. australomediocris*, another typical constituent of the Antarctic diatom flora (Schmidt et al. 1990, Van de Vijver et al. 2002), although the latter can be separated based on its more broadly lanceolate valve outline with protracted, subrostrate apices, the presence of a large fascia (never observed in *C. antarctica*), its often larger valve dimensions (3–4 µm wide vs. 2.4–2.8 µm in *C. antarctica*) and denser striae (above 23 vs. 21–23 in *C. antarctica*). Where the species co-occur, the presence of a fascia is a good criterion on which to separate *C. australomediocris* from *C. antarctica*. *Chamaepinnularia submuscicola* (Krasske) Lange-Bertalot and *C. soehrensis* (Krasske) Lange-Bertalot & Krammer both have more protracted, almost capitate apices, whereas *C. antarctica* has only weakly subrostrate apices (Lange-Bertalot & Metzeltin 1996, Werum & Lange-Bertalot 2004). *Chamaepinnularia reinventa* Wydrzycka & Lange-Bertalot has more linear valves but less radiate striae and usually a narrow rectangular fascia (Wydrzycka & Lange-Bertalot 2001).

Species of *Mayamaea* are characterized in having small valves, elliptical to lanceolate-elliptical valves, a simple raphe with bent distal fissures and rounded areolae with external hymenes (Lange-Bertalot 1997). The latter feature discriminates the genus from *Eolimna* whose species have areola occlusions positioned in the middle of the areolar canal (Schiller & Lange-Bertalot 1997). *Mayamaea josefelsteri* clearly belongs to *Mayamaea*. Several *Mayamaea* species belonging to the complex around *M. atomus* have been found in the Antarctic Region (Kellogg & Kellogg 2002). They all have more rounded, elliptical valves, unlike the more elongated, elliptical valves of *M. josefelsteri*. The only species that can be confused with *M. josefelsteri* is *M. agrestis* (Hustedt) Lange-Bertalot, but the latter has more acute valve apices and simply radiate striae, whereas *M. josefelsteri* has curving radiate striae near the central area. The central area in *M. agrestis* is smaller due to the longer central striae (Lange-Bertalot et al. 2003). Other *Mayamaea* taxa with a similar valve outline or dimensionssuch as *M. aliena* (Krasske) Lange-Bertalot and *M. cahabaensis* Morales & Manoylov, differ in the shape of the central area and the striation pattern (Lange-Bertalot 2001, Morales & Manoylov 2009).

It is not entirely clear whether *M. australoshetlandicus* belongs to *Microcostatus*. Based on valve outline, the presence of the raphe enclosed by an asymmetrically constricted sternum and the raphe structure, this species belongs in *Microcostatus*. On the other hand, there are several features that do not match the original generic description (Johansen & Sray 1998). The striae in most *Microcostatus* species are composed of a series of small linear-elongate areolae, whereas in *M. australoshetlandicus* they comprise a single areola. Internally, the striae show more affinities with *Chamaepinnularia* although there is no interruption near the valve face/mantle junction, as commonly seen in the latter. Such chamber-like striae have never been observed in *Microcostatus*. Striae composed of one areola have only been observed in *M. monsviridis* Metzeltin & Lange-Bertalot, described from Costa Rica. Metzeltin & Lange-Bertalot (2007) commented on the conflict with the description of *Microcostatus* but were not in favour of describing a new genus based on these differences. According to the generic description, *Microcostatus* lacks a conopeum, a 'flap of silica attached to or near to, the axial area and extending over the valve towards the margin' (Ross et al. 1979). The presence of a conopeum can be seen covering the longitudinal groove in *M. australoshetlandicus*, and Taylor et al. (2010) reported the presence of a conopeum and a pseudoconopeum in several new *Microcostatus* species from South Africa. The so-called microcostae, the defining feature of *Microcostatus* could not be observed in *M. australoshetlandicus*, but this may be due to the conopeum covering most of the axial area and extending over the striae. Other genera with striae composed of elongated areolae only, such as *Diadesmis*, *Microfissurata*, *Gomphosphenia*, and the complex around *Navicula schmassmannii* Hustedt, present too many morphological differences to be considered host genera for this new species, making a combination in *Microcostatus* the most satisfactory solution.

Sellaphora nana was originally described as *Stauroneis nana* Hustedt (1957) based on a single valve found in the plankton of the River Weser in Germany. Lange-Bertalot et al. (2003) transferred it to *Sellaphora* although with some doubt about this being its correct taxonomic position. The populations observed in the Maritime Antarctic Region show considerable morphological plasticity. The shape of the valve varies from clearly elliptic-lanceolate with convex margins to narrowly lanceolate with almost parallel margins and seems to be determined by geographic locality. On Livingston Island and Deception Island, valves tend to become broader, whereas on James Ross Island and Signy Island, narrower valves are found. Apart from the shape variability, no other differences could be found, making it unlikely that these populations are taxonomically distinct, despite the fact that some of them do not correspond to the single valve on which Hustedt based the species. The shape plasticity shown by Lange-Bertalot et al. (2003) is likewise quite large and corresponds to some of that found in the Maritime Antarctic Region. Several other species are similar to *S. nana*, such as *Sellaphora nanoides* Lange-Bertalot et al. and *S. stauroneioides* (Lange-Bertalot) J.Vesela & J.R.Johansen. *Sellaphora nanoides* can be separated by its coarser striation (30–33 striae in 10 µm vs 37–40 in *S. nana*) and wider valves (4.5–7.0 vs. 3–4.5 µm). *Sellaphora stauroneioides* has more parallel valve margins with rostrate to capitate apices and wider valves (5.5–6.5 µm). The valves shown in Rumrich et al. (2000, plate 79, figs 1–4 and plate 87, figs. 21–23) under the names *Adlafia* sp. and *Naviculadicta* (?nov.) spec., respectively, probably also belong to *S. nana*.

Navicula glaberrima was originally described by W. & G.S.West from the Antarctic Continent (1911). A re-analysis of the type material with LM yielded only two valves, with no SEM observations (Van de Vijver et al. 2012). It is probable that the valves observed from James Ross Island represent *Craticula* (*Navicula*) *glaberrima* although they seem to be less capitate than in the West & West material. However, the original drawing does not show capitate apices so it is likely that the James Ross population belongs to the same species. *Craticula glaberrima* shows some similarities in valve outline, dimensions and stria density with *C. submolesta*. *Craticula submolesta* has never been observed on the Antarctic Continent (Kellogg & Kellogg 2002) although it was reported from nearby localities such as the South Shetland Islands (Håkansson & Jones 1994) and Horseshoe Island (Wasell & Håkansson 1992, Wasell 1993). Based on morphological analysis of the James Ross Island populations, several important differences can be noted. *Craticula glaberrima* has a higher stria density (>30 vs 19–24 in 10 µm in *C. submolesta*) and valves of *C. submolesta* tend to be more linear, with more parallel margins and protracted (sub-rostrate) apices, which are never observed in *C. glaberrima*. *Craticula molestiformis* is another smaller taxon, but its stria density is again much lower (23–26 in 10 µm), with striae visible almost to the apices in LM.

Another *Craticula* species has been regularly found in larger populations on the Antarctic Continent and the Maritime Antarctic region. For a long time this was identified as *Craticula* (*Navicula*) *molesta* (Krasske) Lange-Bertalot & Willmann, a species described in 1938 from Spitsbergen by G.Krasske (later designated *Navicula zizix* Van Landingham) but this has recently been described as *Craticula antarctica* Van de Vijver & Sabbe (Van de Vijver et al. 2010b). Conspecificity between *C. glaberrima* and *C. antarctica* can be excluded based on differences in valve outline and dimensions.

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References

ARISTARAIN, A.J., J.F. PINGLOT & M. POURCHET 1987: Accumulation and temperature measurements on the James Ross Island, Antarctic Peninsula, Antarctica. – J. Glaciol. **33**: 1–6.

FERMANI, P., G. MATALONI & B. VAN DE VIJVER 2007: Soil microalgal communities on an Antarctic active volcano (Deception Island, South Shetlands). – Polar Biol. **30**: 1381–1393.

HÅKANSSON, H. & V.J. JONES 1994: The compiled freshwater diatom taxa list for the maritime region of the South Shetland and South Orkney Islands. – In: HAMILTON, P.B. (ed.), Proc. Fourth Arctic-Antarctic Diatom Symposium Workshop, Canadian Tech.Report of Fisheries and Aquatic Sciences **157**: 77–83.

HENDEY, N.I. 1964: An Introductory Account of the Smaller Algae of British Coastal Waters. Part V. Bacillariophyceae (Diatoms). – Her Majesty’s Stationery Office, London.

HUSTEDT, F. 1957: Die Diatomeenflora des Fluss-systems der Weser im Gebiet der Hansestadt Bremen. – Abh. Naturw. Ver. Bremen **34**: 181–440.

JOHANSEN, J.R. & J.C. SRAY 1998: *Microcostatus* gen. nov., a new aerophilic diatom genus based on *Navicula krasskei* Hustedt. – Diat. Res. **13**: 93–101.

JONES, V.J. 1996: The diversity, distribution and ecology of diatoms from Antarctic inland waters. – Biodivers. Conserv. **5**: 1433–1449.

KELLOGG, T.B. & D.E. KELLOGG 2002: Non-marine and littoral diatoms from Antarctic and subantarctic regions. Distribution and updated taxonomy. – Diatom Monogr. **1**: 1–795.

KOCIOLEK, J.P. & B. DE REVIERS 1996: The diatom types of Emile Manguin. II. Validating descriptions and designation of types for the new Caledonia species. – Crypt. Algol. **17**: 193–215.

KOPALOVÁ, K. & B. VAN DE VIJVER 2013: Freshwater benthic diatom communities from Byers Peninsula (Livingston Island, South Shetland Islands). – Ant. Sci. **25**: 239–253.

KOPALOVÁ, K., L. NEDBALOVÁ, M. DE HAAN & B. VAN DE VIJVER 2011: Description of five new species of the diatom genus *Luticola* (Bacillariophyta, Diadesmidaceae) found in lakes of James Ross Island (Maritime Antarctic Region). – Phytotaxa **27**: 44–60.

KOPALOVÁ, K., J. VESELÁ, J.ELSTER, L. NEDBALOVÁ, J. KOMÁREK et al. 2012: Benthic diatoms (Bacillariophyta) from seepages and streams on James Ross Island (NW Weddell Sea, Antarctica). – Plant Ecol. Evol. **145**: 190–208.

KRASSKE, G. 1938: Beiträge zur Kenntnis der Diatomeenflora von Island und Spitzbergen. – Arch. Hydrobiol. Planktonk. **33**: 503–533.

LANGE-BERTALOT, H. 1997: *Frankophila*, *Mayamaea* und *Fistulifera*, drei neue Gattungen der Klasse Bacillariophyceae. – Arch. Protistenk. **148**: 65–76.

LANGE-BERTALOT, H. 2001: *Navicula* sensu stricto. 10 genera separated from *Navicula* sensu lato. *Frustulia*. – Diatoms of Europe **2**: 1–526.

LANGE-BERTALOT, H. & S.I. GENKAL 1999: Diatoms from Siberia I. Islands in the Arctic Ocean (Yugorsky-Shar Strait). – Iconogr. Diatomol.**6**: 1–271.

LANGE-BERTALOT, H. & D. METZELTIN 1996: Indicators of oligotrophy – 800 taxa representative of three ecologically distinct lake types, Carbonate buffered – Oligodystrophic – Weakly buffered soft water. – Iconogr. Diatomol. **2**: 1–390.

LANGE-BERTALOT, H., P. CAVACINI, N. TAGLIAVENTI & S. ALFINITO 2003: Diatoms of Sardinia. – Iconogr. Diatomol. **12**: 1–438.

METZELTIN, D. & H. LANGE-BERTALOT 2007: Tropical diatoms of South America II. Special remarks on biogeographic disjunction. – Iconogr. Diatomol. **18**: 1–867.

MORALES, E.A. & M. LE 2005: A new species of the diatom genus *Adlafia* (Bacillariophyceae) from the United States. – Proc. Acad. Nat. Sci. Philadelphia **154**: 149–154.

MORALES, E.A. & K.M. MANOYLOV 2009: *Mayamaea cahabaensis* sp.nov. (Bacillariophyceae), a new freshwater diatom from streams in the southern United States. – Proc. Acad. Nat. Sci. Philadelphia **158**: 49–59.

ØVSTEDAL, D.O. & R.L. LEWIS-SMITH 2001: Lichens of Antarctica and South Georgia. A Guide to their Identification and Ecology. – Cambridge Univ. Press, Cambridge.

ROMERO, O.R. 1995: Bacillariophyceae de la provincial de La Pampa (Argentina). II. – Darwiniana **33**: 177–193.

ROSS, R., E.J. COX, N.I. KARAYEVA, D.G. MANN, T.B.B. PADDOCK et al. 1979: An amended terminology for the siliceous components of the diatom cell. – Nova Hedw. Beih. **64**: 513–533.

ROUND, F.E., R.M. CRAWFORD & D.G. MANN 1990: The diatoms. Biology and Morphology of the Genera. – Cambridge Univ., Cambridge.

RUMRICH, U., H. LANGE-BERTALOT & M. RUMRICH 2000: Diatomeen der Anden. Von Venezuela bis Patagonien/Feuerland. – Iconogr. Diatomol. **9**: 1–649.

SABBE, K., E. VERLEYEN, D.A. HODGSON, K. VANHOUTTE & W. VYVERMAN 2003: Benthic diatom flora of freshwater and saline lakes in the Larsemann Hills and Rauer Islands, East-Antarctica. – Ant. Sci. **15**: 227–248.

SCHILLER, W. & H. LANGE-BERTALOT 1997: *Eolimna martinii* n.gen., n.sp. (Bacillariophyceae) aus dem Unter-Oligozän von Sieblos/Rhön im Vergleich mit ähnlichen, rezenten Taxa. – Paläontol. Zeitschr. **71**: 163–172.

SCHMIDT, R., R. MÄUSBACHER & J. MÜLLER 1990: Holocene diatom flora and stratigraphy from sediment cores of two Antarctic lakes (King George Island). – J. Paleolimnol. **3**: 55–74.

SCHOEMAN, F.R. 1970: Diatoms from the Orange Free State (South Africa) and Lesotho I. – Nova Hedw. Beih. **31**: 331–353.

TAYLOR, J., A. LEVANETS, S. BLANCO & L. ECTOR 2010: *Microcostatus schoemanii* sp. nov., M. *cholnokyi* sp. nov. and *M. angloensis* sp. nov. three new terrestrial diatoms (Bacillariophyceae) from South Africa. – Phycol. Res. **58**: 177–187.

TYLER, P.A. 1996: Endemism in freshwater algae, with special reference to the Australian region. – Hydrobiologia **336**: 127–135.

VAN DE VIJVER, B. 2002: *Frustulia cirisiae* sp. nov., a new aerophilous diatom from Ile de la Possession (Crozet Archipelago, Subantarctica). – Diatom Res. **17**: 415–421.

VAN DE VIJVER, B. & L. BEYENS 1998: A preliminary study on the soil diatom assemblages from Ile de la Possession (Crozet, Subantarctica). – Eur. J. Soil Biol. **34**: 133–141.

VAN DE VIJVER, B. & L. BEYENS 1999: Biogeography and ecology of freshwater diatoms in sub-Antarctica: a review. – J. Biogeogr. **26**: 993–1000.

VAN DE VIJVER, B. & G. MATALONI 2008: New and interesting species in the genus *Luticola* D.G. Mann (Bacillariophyta) from Deception Island (South Shetland Islands). – Phycologia **47**: 451–467.

VAN DE VIJVER, B. & R. ZIDAROVA 2011: Five new taxa in the genus *Pinnularia* sectio Distantes (Bacillariophyta) from Livingston Island (South Shetland Islands). – Phytotaxa **24**: 39–50.

VAN DE VIJVER, B., Y. FRENOT & L. BEYENS 2002: Freshwater diatoms from Ile de la Possession (Crozet Archipelago, Subantarctica). – Biblioth. Diatomol. **46**: 1–412.

VAN DE VIJVER, B., L. BEYENS & H. LANGE-BERTALOT 2004: The genus *Stauroneis* in the Antarctic and (Sub-)Antarctic Regions. – Biblioth. Diatomol. **51**: 1–317.

VAN DE VIJVER, B., N.J.M. GREMMEN & L. BEYENS 2005: The genus *Stauroneis* (Bacillariophyceae) in the Antarctic region. – J. Biogeogr. **32**: 1791–1798.

VAN DE VIJVER, B., G. MATALONI, L. STANISH & S.A. SPAULDING 2010a: New and interesting species of the genus *Muelleria* (Bacillariophyta) from the Antarctic Region and South Africa. – Phycologia **49**: 22–41.

VAN DE VIJVER, B., M. STERKEN, W. VYVERMAN, G. MATALONI, L. NEDBALOVÁ et al. 2010b: Four new non-marine diatom taxa from the Subantarctic and Antarctic regions. – Diatom Res. **25**: 431–443.

VAN DE VIJVER, B., R. ZIDAROVA & M. DE HAAN 2011a: Four new *Luticola* taxa (Bacillariophyta) from the South Shetland Islands and James Ross Island (Maritime Antarctic Region). – Nova Hedw. **92**: 137–158.

VAN DE VIJVER B., R. ZIDAROVA, M. STERKEN, E. VERLEYEN, M. DE HAAN et al. 2011b: Revision of the genus *Navicula* s.s. (Bacillariophyceae) in inland waters of the Sub-Antarctic and Antarctic with the description of 5 new species. – Phycologia **50**: 281–297.

VAN DE VIJVER B., I. TAVERNIER, T.B. KELLOGG, J.A. GIBSON, E. VERLEYEN et al. 2012: Revision of the Antarctic diatom species (Bacillariophyta) described by West & West (1911) with the description of two new species. – Fottea (in press)

VAN DER WERFF, A. 1955: A new method for cleaning and concentrating diatoms and other organisms. – Verh. Int. Vereinigung Theor. Limnol. **12**: 276–277.

WASELL, A. 1993: Diatom Stratigraphy and evidence of Holocene environmental changes in selected lake basins in the Antarctic and South Georgia. Stockholm Univ., Dep. Quaternary Res., PhD Thesis.

WASELL, A. & H.HÅKANSSON 1992: Diatom stratigraphy in a lake on Horseshoe Island, Antarctica: a marine-brackish-freshwater transition with comments on the systematics and ecology of the most common diatoms. – Diatom Res. **7**: 157–194.

WERUM, M. & H. LANGE-BERTALOT 2004: Diatoms in springs from Central Europe and elsewhere under the influence of hydrogeology and anthropogenic impacts. – Iconogr. Diatomol. **13**: 3–417.

WEST, W. & G.S. WEST 1911: Freshwater algae. – In: MURRAY, J. (ed.): Biology, vol. 1. Reports on the Scientific Investigations, British Antarctic Expedition 1907–09: 263–298. Heinemann, London.

WYDRZYCKA, U. & H. LANGE-BERTALOT 2001: Las diatomeas (Bacillariophyceae) acidófilas del río Agrio y sitios vinculados con su cuenca, volcán Poás, Costa Rica. – Brenesia **55–56**: 1–68.

ZIDAROVA R., B. VAN DE VIJVER, A. QUESADA & M. DE HAAN 2010: Revision of the genus *Hantzschia* (Bacillariophyceae) on Livingston Island (South Shetland Islands, Southern Atlantic Ocean). – Plant Ecol. Evol. **143**: 318–333.

ZIDAROVA, R., K.KOPALOVÁ & B.VAN DE VIJVER 2012: The genus *Pinnularia* (Bacillariophyta) excluding the section Distantes on Livingston Island (South Shetland Islands) with the description of twelve new taxa. – Phytotaxa **44**: 11–37.

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