

# Antarctic species in the genus *Ditrichum* (Ditrichaceae, Bryopsida), with a description of *D. gemmiferum* sp. nov.

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There are five species in the genus *Ditrichum* Hampe in the Antarctic: *D. heteromallum* (Hedw.) Britt., *D. conicum* (Mont.) Mitt., *D. austrogeorgicum* (Card.) Seppelt, *D. lewis-smithii* Ochyra and *D. gemmiferum* Ochyra & Lewis-Smith. Of these, the first two are newly recorded from the region, whereas the last is described as new to science from material collected from the South Sandwich and South Shetland Islands, as well as from Marion Island in the Subantarctic and southern Chile. The new species is readily recognized by its short, rigid and strongly papillose leaf subulae and the frequent occurrence of small, pale yellowish or pale brownish rhizoidal gemmae. A key to determination of Antarctic species is provided and all species, except for *D. lewis-smithii*, are fully described and illustrated and their Antarctic and global distributions mapped. *Ditrichum brotherusii* (R. Br. ter.) Seppelt is excluded from the moss flora of Antarctica since information on its occurrence was based upon misidentification of the specimens. *Blindia maxwellii* Vitt from Campbell Island is briefly assessed and it is shown that it correctly belongs within *Ditrichum* as *D. maxwellii* (Vitt) Ochyra & Lewis-Smith. Lectotype is selected for *Pseudoditrichium austrogeorgicum* Card., and *P. austrogeorgicum* fo. *brevifolium* Card. and *P. austrogeorgicum* var. *longifolium* Broth. in Card. & Broth. are reduced to synonymy with *Ditrichum austrogeorgicum*.

Key words: Antarctic, bryogeography, Bryopsida, Ditrichaceae, *Ditrichum*, Subantarctic, taxonomy

## INTRODUCTION

The moss genus *Ditrichum* Hampe is a prominent constituent of the bryoflora of the cool and

cold regions in the Southern Hemisphere. Seppelt (1982) recorded eleven species in Australia, New Zealand and on adjacent islands, and another from Campbell Island is added in the present account.

In southern South America and Antarctica the genus is still imperfectly known and needs careful taxonomic appraisal. Greene (1986) enumerated 15 species from this region, and recently Matteri (1996) and Ochyra (1996a) reported two distinct species from southern South America and the northern maritime Antarctic, respectively. A further species is described here as new to the Antarctic, Marion Island and Western Patagonia, but this is balanced by reduction of some species names to synonymy (cf. Ochyra 1994). Furthermore, there are Subantarctic endemic species of *Ditrichum*, *D. subaustrale* Broth., and *D. immersum* Zant. from Heard and Marion Islands (Brotherus 1906, van Zanten 1971, Seppelt 1996) and *D. validinervium* Kaal. from Îles Crozet (Kaalaas 1912), which also require careful taxonomic re-examination.

Species of *Ditrichum* are uncommon in the impoverished moss flora of Antarctica, which is defined by Greene (1964) as comprising all land south of latitude 60°S, together with the South Sandwich Islands and the remote island of Bouvetøya lying between 54°S and 60°S. They are restricted to the northern part of the maritime Antarctic (*sensu* Lewis-Smith 1984a) where they are widely distributed but scattered on the archipelagoes of the South Sandwich, South Orkney and South Shetland Islands only, and so far none are known from the Antarctic mainland or the Antarctic Peninsula. Because populations of *Ditrichum* species in the Antarctic region are usually small and the plants inconspicuous and mostly sterile they have commonly been overlooked by early collectors and no information on this genus was given by Cardot (1908).

Robinson (1972) was the first to report *Ditrichum brotherusii* (R. Br. ter.) Seppelt, as *Pseudoditrichum fuegianum* Roiv., from the Antarctic, from several localities on Livingston Island in the South Shetland Islands archipelago. Seppelt (1980) showed that *Pseudoditrichum* Card. is congeneric with *Ditrichum*, and *P. fuegianum* conspecific with *D. brotherusii* (Seppelt 1982).

Subsequent records of the genus *Ditrichum* in Antarctica refer almost exclusively to *D. austrogeorgicum* (Card.) Seppelt which is the most frequently collected species of the genus in this region. Lewis-Smith (1984bc) reported it from the volcanic Deception Island (as *Pseudoditrichum*

*austrogeorgicum*) and Ochyra (1984) distributed two specimens collected on King George Island in his *Bryophyta Antarctica Exsiccata* (BAE 105 and 181) (see also Ochyra *et al.* 1986). This species was additionally reported from King George Island (Kanda 1987, Myrcha *et al.* 1991, Chen *et al.* 1995) where it seems to be relatively frequent. However, it was not mentioned by Putzke and Pereira (1990) in their survey of the moss flora of King George Island. Schulz (1993) discovered *D. austrogeorgicum* on Livingston Island in the South Shetland Islands, while Ochyra (1996a) described *D. lewis-smithii*, a species apparently endemic to this region, from the three widely separate stations in the northern maritime Antarctic. Finally, Ochyra (1996b) reported *D. brotherusii* from Deception Island.

During the present study we located almost all voucher collections of the Antarctic *Ditrichum* species. A critical examination of them showed that *D. brotherusii* has been reported erroneously from Antarctica. An investigation of large unnamed collections, mostly in the herbarium of the British Antarctic Survey (AAS), revealed one species new to science and two species new to the Antarctic region.

Five species of *Ditrichum* are currently known from the Antarctic region. Four are described in full because they lack modern descriptions from the western part of the austral region. The species are illustrated and their local and global distributions mapped. The fifth species, *D. lewis-smithii*, was described and illustrated by Ochyra (1996a). Descriptions and illustrations are based largely on the Antarctic material, although information on the full range of variation shown by the taxa is also provided.

### Key to the species

1. Cells elongate throughout the lamina; leaf base non-sheathing, without hyaline margin; costa without or with a weak adaxial stereid band ..... *D. heteromallum*
1. Cells of the upper leaf base subquadrate to shortly rectangular; leaf base vaginate with distinct hyaline margin; costa with two strong stereid bands ..... 2
  2. Costa narrow, 60–70 µm wide at the base; leaf subula flexuose; capsule immersed in the perichaetial leaves; peristome absent .... *D. lewis-smithii*
  2. Costa broad, 90–160 µm wide at the base; leaf subula mostly straight and rigid or somewhat

- crisped; capsule exerted on a long seta; peristome present ..... 3
3. Leaf subula strongly papillose; rhizoidal tubers common ..... *D. gemmiferum*
3. Leaf subula smooth or weakly roughened; rhizoidal tubers absent ..... 4
4. Cells irregular in outline, isodiametric to shortly elongate, 3–5 × 1 throughout the leaf sheath (except for its base); costa 130–180 µm wide at base; capsule symmetric, straight; peristome teeth strongly papillose, without striolations; spores 10–14 µm in diameter; dioicous ..... *D. conicum*
4. Cells subquadrate at the shoulders becoming elongate rectangular, 6–10 × 1 in the mid-sheath and below; costa 100–120 µm wide at base; capsule asymmetric, slightly curved; peristome teeth papillose with oblique striolations; spores 22–34 µm in diameter; monoicous ..... *D. austrogeorgicum*

## SYNOPSIS OF ANTARCTIC SPECIES

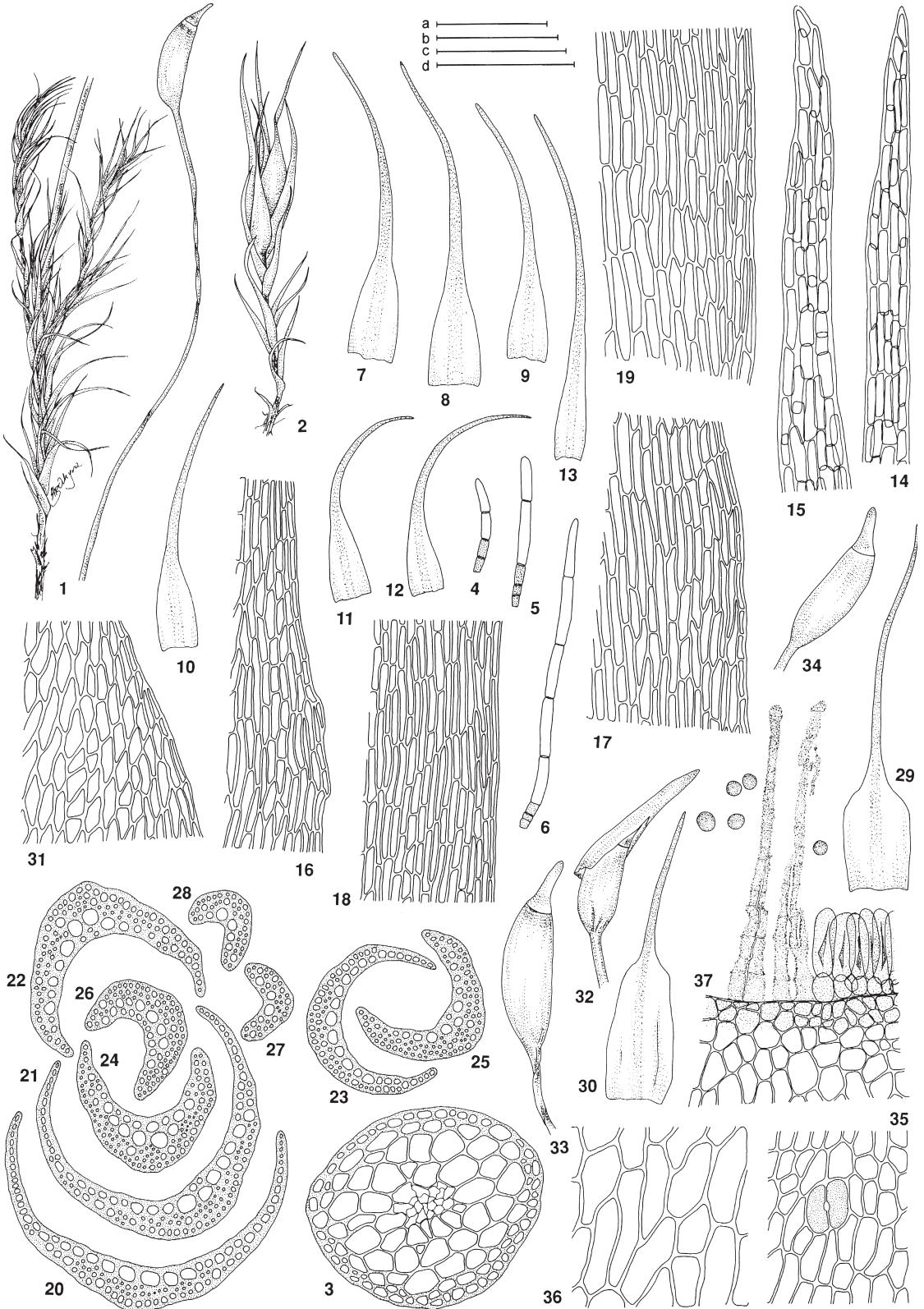
### 1. *Ditrichum heteromallum* (Hedw.) Britt. (Figs. 1 and 2)

N. Am. Fl. 15: 64. 1913. — *Weissia heteromalla* Hedw., Spec. Musc. 71. 1801. — *Grimmia heteromalla* (Hedw.) Web. & Mohr, Ind. Mus. Pl. Crypt. 2. 1803. — *Didymodon heteromallus* (Hedw.) Hook. & Tayl., Musc. Brit. 68, t. 20. 1818. — *Trichostomum heteromallum* (Hedw.) Lindb. ex Aust., Bull. Torrey Bot. Cl. 6: 74. 1876. — Type: In montibus Saxoniae silvis, ad vias cavas, udas et earum orbitas pfofundiores [sic!]. (In Hercynia, Sudetibus, Austria.) (No material suitable for typification of this name is present in G-Hedwig.)

*Plants* rather small, green or yellowish-green, lustrous, somewhat silky, in loose tufts or seldom gregarious, often intermixed with other mosses and liverworts. *Stems* simple or most often forked, bearing straight innovations, 5–15 mm high, brown to yellow-brown, erect, sparsely radiculose below with long, reddish-brown, smooth, branched rhizoids; in transverse section rounded or elliptic to bluntly triangular, consisting of a uni- to bistratose cortex composed of small brown to yellow-brown cells with moderately thickened walls, medulla 3–5-stratose of large, hyaline, thick-walled cells, and a large and distinct central strand. *Axillary hairs* 4–7-cellular, composed of 2–3 small, brown basal cells and 2–4 elongate, hyaline upper cells. *Leaves* erect to erect-spreading, straight to secund, mostly rigid, (1.3–)1.8–2.5(–3.0) mm long, from a non-sheathing, concave, short, ovate-lanceolate to lanceolate base, 0.25–

0.5 mm wide, gradually narrowed into a rigid, straight or falcate, channelled subula, entire or indistinctly sinuate and bluntly rounded or acute at the apex, 2–3 times exceeding the leaf base length; *margins* entire throughout, plane; *costa* single, yellow to pale yellow–brown or sometimes concolorous with the lamina cells, usually poorly differentiated from the adjacent lamina cells because of several rows of bistratose juxtacostal cells, 110–140 µm wide at the base, filling most of the width of the subula and excurrent, smooth on both surfaces, in transverse section very flattened, with large guide cells in a single row, a strong abaxial stereid band, 2–4-stratose and a very weak adaxial stereid band, reduced to a few cells above and completely missing in the base; *lamina cells* smooth, non-porose, transparent, often yellowish at the base, thin to moderately thick-walled, especially near the base, narrowly rectangular to linear throughout, (4–)6–10 µm wide, (25–)40–70(–80) µm long, unistratose or bistratose in several rows near the costa, mostly with truncate, less frequently oblique or rounded ends, becoming narrower and thicker-walled towards the margins but not forming a distinct band; *angular cells* not differentiated.

*Dioicous*. *Perigonia* gemmate, terminal, ca. 1 mm long, brown, with outer bracts similar to the vegetative leaves and inner bracts ovate, strongly concave, brown; *antheridia* about 10 per perigonium, club-shaped, short-stalked, brownish, intermixed with filiform, light brownish paraphyses somewhat exceeding them. *Perichaetia* terminal, with single sporophytes; *outer perichaetial leaves* similar to the vegetative leaves; *inner perichaetial leaves* up to 3.3 mm long from an oblong-ovate, base abruptly long subulate and with areolation of elongate-rectangular to linear cells throughout becoming rhomboidal at the shoulders. *Sporophytes* terminal but often appearing lateral because of the subfloral innovations; *calyptra* cucullate, smooth, covering only the upper half of the urn; *setae* erect, straight, 1.0–1.5 cm long, somewhat flexuose and dextrorse above when dry, shining, yellowish-brown to reddish-brown with age; *capsules* long exerted, erect, symmetric to somewhat gibbous or curved, abruptly narrowed into the seta and narrowed at the mouth, smooth, reddish-brown to blackish-brown with age, mostly with a varnish lustre, nar-





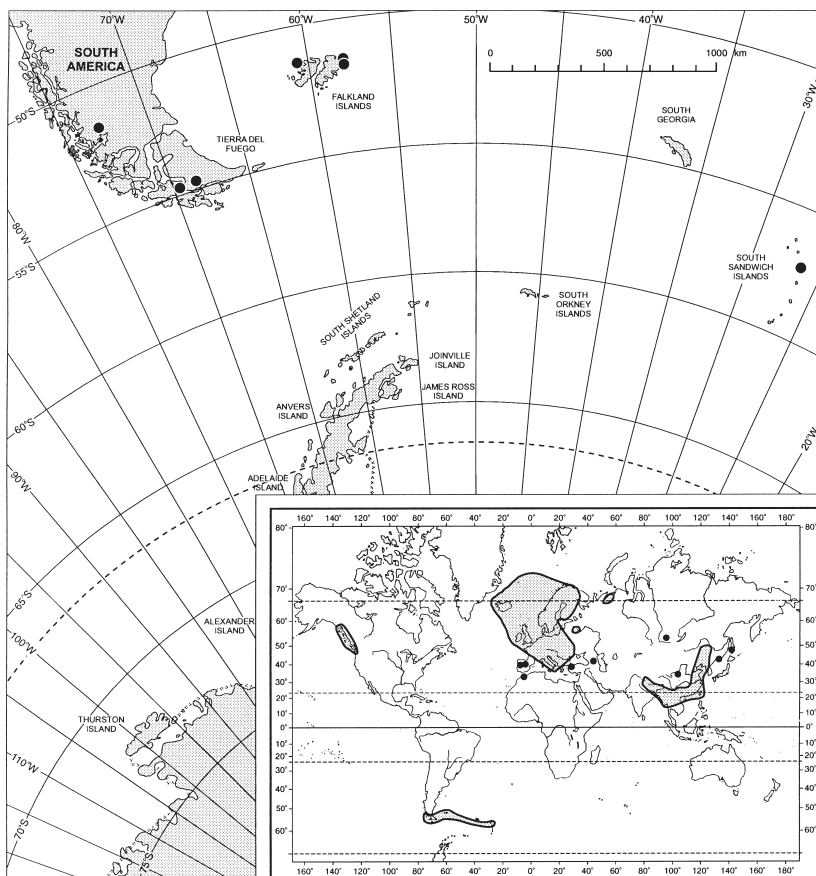


Fig. 2. Distribution map for *Ditrichum heteromallum* (Hedw.) Britt. in the Fuegian–Antarctic Peninsula region and the global range of the species (inset).

rowly oblong–ovoid or ellipsoid, 1.0–1.5 mm long, 0.5–0.6 mm wide; *operculum* short, ca. 1/4 of the capsule length, conical, slanted; *annulus* large, consisting of 2 rows of cells, revolute; *exothecial cells* rectangular to oblong–hexagonal, thin-walled in the mid-urn, 20–30  $\mu\text{m}$  wide, 40–90  $\mu\text{m}$  long, becoming regularly rectangular and thicker-walled at the base of the urn; *cells at the mouth* rounded to hexagonal, rather firm-walled and concolorous with the other exothecial cells;

*stomata* 6–8 per capsule at the extreme base of the urn, superficial, rounded, ca. 30  $\mu\text{m}$  in diameter, bicellular, variously oriented, with rounded pori; *peristome teeth* 16, yellow-brown, 240–280  $\mu\text{m}$  long, finely papillose, with a very low basal membrane, usually divided in the basal part into two filiform, mostly closely joined arms or with elongate gaps between them along the mid-line. *Spores* globose, pale, 11–14  $\mu\text{m}$  in diameter, appearing smooth.

Fig. 1 (Opposite). *Ditrichum heteromallum* (Hedw.) Britt. — 1. Plant with mature sporophytes, dry. — 2. Male plant with perigonium, dry. — 3. Cross-section of the stem. — 4–6. Axillary hairs. — 7–13. Vegetative leaves. — 14–15. Leaf apices. — 16. Cells at the leaf shoulder. — 17–18. Mid-leaf cells. — 19. Basal leaf cells. — 20–28. Cross-sections of the leaves, a sequence from the base to the apex. — 29–30. Perichaetial leaves. — 31. Cells at the shoulder of the perichaetial leaf. — 32. Capsule with calyptra. — 33–34. Operculate capsules, dry. — 35. Exothecial cells at the base of the urn and stoma. — 36. Exothecial cells in the middle of the urn. — 37. Exothecial cells at the orifice, annulus, portion of the peristome and spores. — 1, 3–37 drawn from *Convey 180*; 2 from *Convey 213A*; both in KRAM-B. — Scale bars: a: 1 mm (7–13, 29–30, 32–34); b: 2 mm (1) and 100  $\mu\text{m}$  (3, 20–28); c: 1 mm (2) and 100  $\mu\text{m}$  (4–6, 35–37); d: 100  $\mu\text{m}$  (14–19, 31).

*Ditrichum heteromallum* is a very distinct species which is immediately distinguished by its leaf areolation of long-rectangular to linear cells throughout the lamina, the lack of the hyaline marginal border of the leaf base and anatomically by the absence or the poor development of the adaxial stereid band in the costa. The Antarctic material agrees in all essential diagnostic characters with the northern hemisphere populations of this species. The abundantly produced sporophytes with their reddish-brown, at least below, setae and more or less symmetric, erect capsules with short, conical and oblique opercula make this species readily identifiable from all other Antarctic acrocarps. Sterile plants might be mistaken for *Kiaeria pumila* (Mitt.) Ochyra, but in that species the narrow costa and the presence of the alars should dispel any doubts regarding the identity of the material. In its broad costa and long subulate leaves *D. heteromallum* is likely to be confused with *Leptobryum pyriforme* (Hedw.) Wils. which is known in the Antarctic region from heated ground on the volcanic Deception Island and may be expected to occur in similar habitats on the South Sandwich Islands. However, the leaves of *L. pyriforme* are flexuose when dry and have a long setaceous subula which is finely denticulate at the apex, whereas *D. heteromallum* has a stiff, straight or secund and entirely smooth subulae.

In its habit, leaf shape and especially anatomical structure of the costa *Ditrichum heteromallum* is also similar to *Campylopus pyriformis* (K. F. Schulz) Brid. which occurs in geothermal areas on Mt. Melbourne in the central Victoria Land, continental Antarctica (Broady *et al.* 1987). However, this species is easily recognized by its slightly flexuose leaves which are serrate at the apex as well as its leaf areolation of quadrate, rhomboidal or short rectangular upper leaf cells and short rectangular, widened and relatively lax basal cells.

*Ditrichum heteromallum* has not previously been reported from the Antarctic region. As elsewhere in its range, it is a colonizer of bare ground. Although found on the volcanic Candlemas Island in the South Sandwich Islands archipelago (Fig. 2), the species was not observed here during the botanical surveys of the island in the early 1960s (Longton & Holdgate 1979), so it may represent a recent introduction via long distance dispersal.

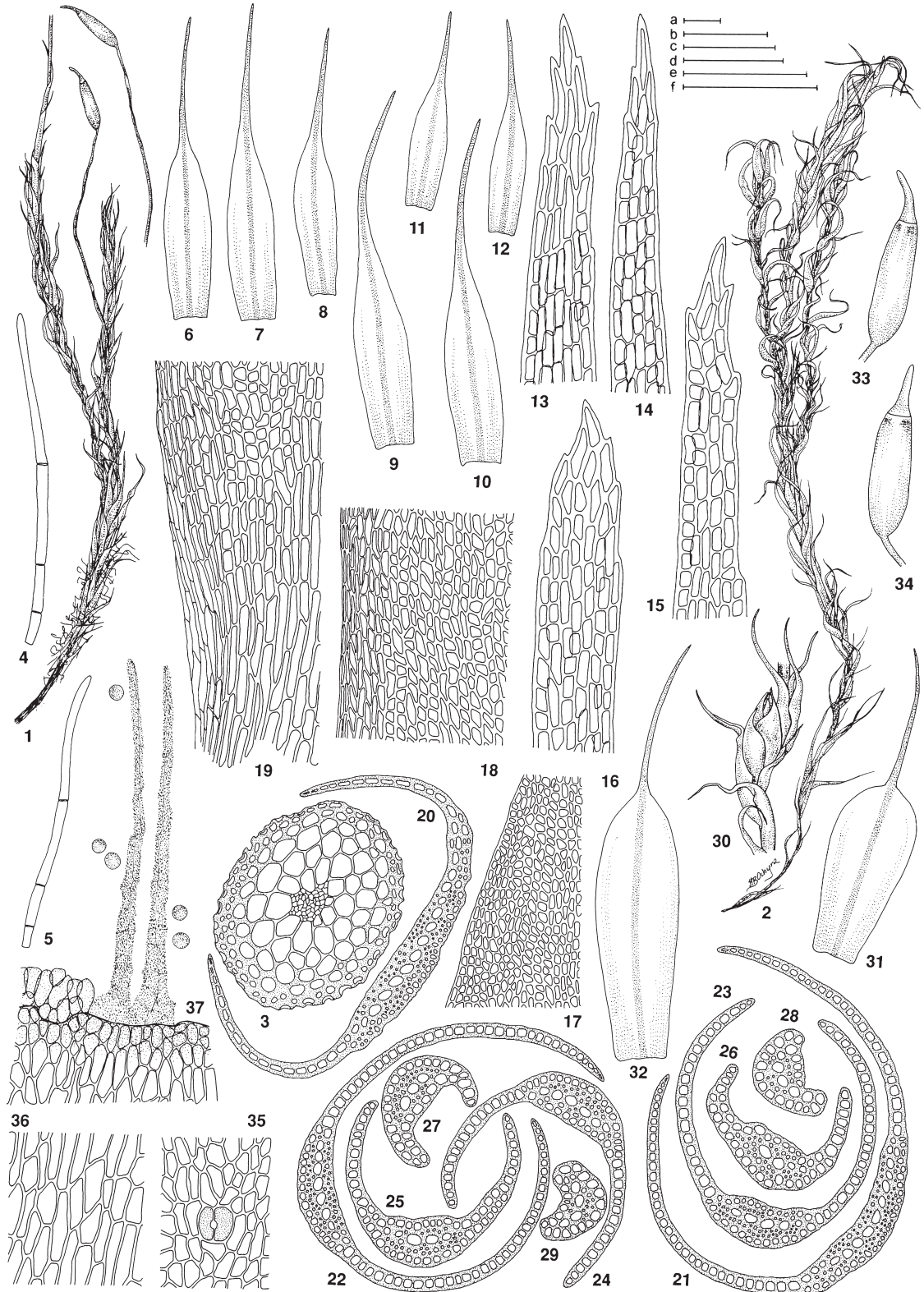
*Ditrichum heteromallum* is a bipolar species (Fig. 2). In the Northern Hemisphere it is widespread throughout much of Europe where it seems to have its main centre of occurrence. It is widely distributed but scattered in temperate Asia in Russia (Afonina & Ignatov 1992) and China (Gao 1994, Redfearn *et al.* 1996) and in western North America where it ranges from southern Alaska to Oregon (Lawton 1971). In the Southern Hemisphere the species is scattered in Tierra del Fuego (Cardot & Brotherus 1923), Western Patagonia (Matteri 1985) and on the Falkland Islands (Matteri 1986). Ochyra (1992a) considered *D. heteromallum* as a strictly bipolar species but it occurs at high elevations in the northern Andes of Colombia (Florschütz-de Waard & Florschütz 1979, Churchill *et al.* 1995).

*Specimens seen.* — **SOUTH SANDWICH ISLANDS. Candlemas Island:** W rim of SW crater of Lucifer Hill, lat. 57°04'S, long. 26°42'W, on ground, 12.II.1997, *Convey 180* (AAS, KRAM-B); SW crater of Lucifer Hill, lat. 57°04'S, long. 26°42'W, colonising bare ground, 12.II.1997, *Convey 213A* (AAS, KRAM-B).

## 2. *Ditrichum conicum* (Mont.) Mitt. (Figs. 3 and 4)

Phil. Trans. R. Soc. London 168: 25. 1879. — *Aschistodon conicus* Mont., Ann. Sc. Nat. Bot. Sér. 3, 4: 110. 1845. — *Cynodontium conicum* (Mont.) Mitt., J. Linn. Soc. Bot. 15:

Fig. 3 (Opposite). *Ditrichum conicum* (Mont.) Mitt. — 1. Plant with mature sporophytes, dry. — 2. Sterile plant, dry. — 3. Cross-section of the stem. — 4–5. Axillary hairs. — 6–12. Vegetative leaves. — 13–16. Leaf apices. — 17. Cells at the leaf shoulder. — 18. Mid-leaf cells. — 19. Basal leaf cells. — 20–29. Cross-sections of the leaves, a sequence from the base to the apex. — 30. Male plant with perigonium. — 31–32. Perichaetial leaves. — 33–34. Operculate capsules, wet. — 35. Exothecial cells at the base of the urn and stoma. — 36. Exothecial cells in the middle of the urn. — 37. Exothecial cells at the orifice, annulus, portion of the peristome and spores. — 1, 11–13, 31–34 drawn from *Gay s.n.* (isotype), BM; 2–10, 14–30 from *Lewis Smith 3642*, KRAM-B; 35–37 from *Lobb 23*, BM. — Scale bars: a: 1 mm (1–2); b: 1 mm (6–12, 31–32) and 50 µm (13–16); c: 1 mm (30, 33–34); d: 100 µm (17–19); e: 100 µm (3, 20–29); f: 100 µm (4–5, 35–36).





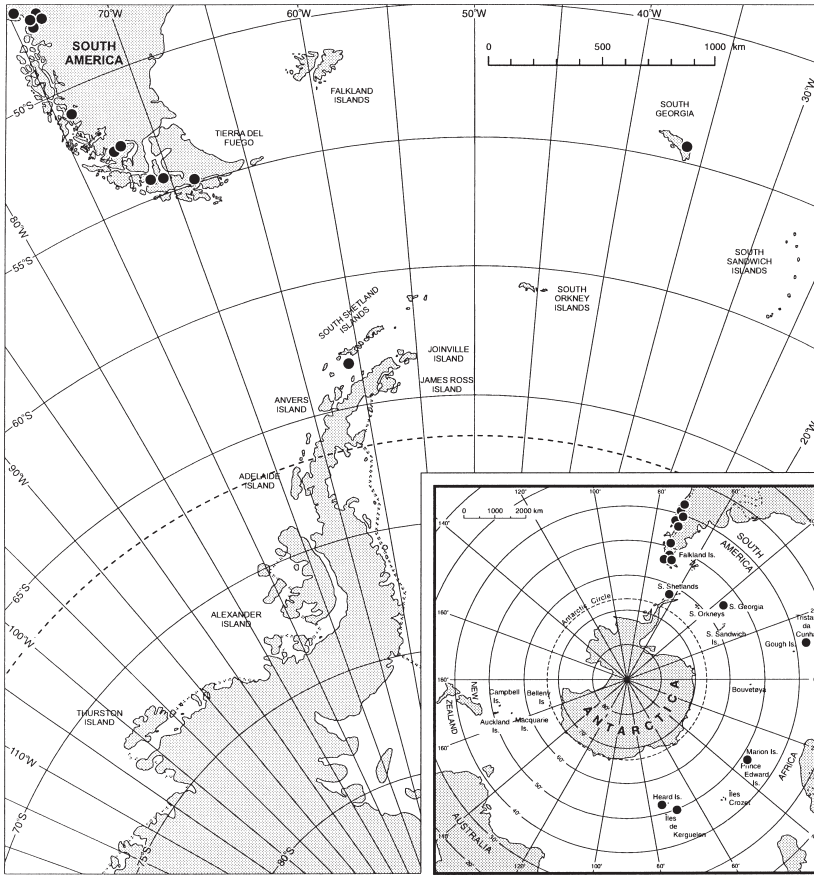


Fig. 4. Distribution map for *Ditrichum conicum* (Mont.) Mitt. in the Fuegian–Antarctic Peninsula region and the global range of the species (inset).

528. 1877. — Type: Chile. In provinciis meridionalibus Chiles à cl. C. Gay lectus. (Holotype: “Herb. Mus. Paris. Herbarium du Chili austral envoyé par M. Gay (3<sup>me</sup> envoi) *Aschistodon* nov. gen. Mont. *A. conicus* Montag.” — PC-Mont!; isotypes: BM-Hook!, BM-Schimp!, BM-Dix!).

*Plants* medium-sized, rather delicate, dull to lustrous, growing in tall, relatively dense to compact tufts, olivaceous, yellow or light green above, brown to blackish-brown below. *Stems* simple or often repeatedly forked, 2.0–3.5 cm tall, occasionally up to 10 cm high, pale brown, erect or sometimes ascending, with scattered, pale brownish or yellowish, smooth, branched rhizoids below not forming a tomentum; in cross-section rounded, consisting of (1–)2(–3) rows of smaller, moderately thick-walled, brownish cells surrounding 3–4 layers of large, hyaline and thin-walled medullary cells and a large, conspicuous central strand. *Axillary hairs* hyaline, composed of 4–6, elongate cells. *Leaves* (2.0–)2.5–3.5(–4.0) mm long, (0.4–)0.6–0.7(–0.9) mm wide, spirally arranged on the stem, erect, appressed, not or more or less

contorted in the upper part when dry, erect-spreading when moist, from an oblong-ovate to oblong-lanceolate, concave, non-decurrent and sheathing base gradually narrowed into a channelled, smooth or weakly mamilliose subula; *subula* rigid, strict or curled on the upper leaves, erect, usually as long as or up to 1.5 times longer than the leaf base, narrow, acute, entire or more or less denticulate at the apex; *margins* entire, plane in the sheath, inflexed in the subula; *costa* single, pale yellowish-brown to brown, usually not sharply separated from the lamina cells, percurrent to excurrent, 130–180  $\mu\text{m}$  wide at the base, flattened, filling most of the width of the subula, smooth on the abaxial surface, in cross-section consisting of a median row of large guide cells and 2 stereid bands; *lamina cells* smooth, non-porose, transparent, thin- to moderately thick-walled, randomly arranged, in transverse section unistratose throughout and distinctly thinner towards the margins, rounded, subquadrate to transversely elliptical at the shoulders, 6–10  $\mu\text{m}$  wide, 6–12  $\mu\text{m}$  long, be-



coming variable in shape below, irregular, elliptical, obliquely rhomboidal to short rectangular, 7–10  $\mu\text{m}$  wide, 10–35  $\mu\text{m}$  long; *marginal cells* firm- to thin-walled, narrower towards the margin, oblong-rhomboidal to linear-rectangular, 4–6  $\mu\text{m}$  wide, up to 50  $\mu\text{m}$  long, usually forming a distinct basal hyaline border, often extending as high as the mid-sheath; *cells in the subula* isodiametric to short rectangular, rhombic, rounded or elliptic, 5–15  $\mu\text{m}$  long, 4–8  $\mu\text{m}$  wide, unistratose.

*Diocious*. *Perigonia* gemmiform, about 1.2 mm long, sessile on the short lateral branches; *inner bracts* small, 0.8–0.9 mm long, ovate, concave, brown, rounded at the apex to short subulate; *antheridia* few, brown intermingled with the filiform, light brown paraphyses as long as or shorter than the antheridia. *Perichaetia* terminal with single sporophytes; *outer perichaetial leaves* 3.0–4.0 mm long, from an ovate or oblong-ovate sheathing base abruptly narrowed into the subula, with elliptic to elongate-elliptic, thick-walled cells at the shoulders and rectangular to linear-rectangular, regularly disposed cells below; *the innermost perichaetial leaves* strongly modified, enlarged, up to 6.0 mm long, 1.1–1.3 mm wide, from a broad, convolute, oblong-lanceolate base gradually tapering into a short subula, much shorter than the lamina and with areolation of linear-rectangular cells becoming short rectangular to elliptic at the shoulder. *Sporophytes* terminal; *calyptra* cucullate, smooth; *setae* erect, yellow or pale brownish, not twisted when dry, 0.7–1.5 cm long; *capsules* long exserted, erect, symmetric, smooth, light brown to dark brown with age, more or less glossy, short cylindrical, 1.3–1.5 mm long, 0.6–0.7 mm wide, slightly narrowed at the orifice, abruptly constricted into the seta; *operculum* conical, with a straight beak; *annulus* persistent; *exothelial cells* thin-walled, oblong-hexagonal to hexagonal throughout the urn, except its base, 40–60  $\mu\text{m}$  long, 10–20  $\mu\text{m}$  wide, decreasing in size towards the rim and forming a distinct, orange-brown strip of 3–4 rows of isodiametric cells; *basal urn cells* hexagonal, 15–25  $\mu\text{m}$  long, 10–15  $\mu\text{m}$  wide; *stomata* few at the base of the urn, bicellular, superficial, variously oriented with rounded pori; *peristome* of 16 yellow or pale, papillose teeth, split to the base into 2 filiform branches, 240–300  $\mu\text{m}$  long. *Spores* unicellular, 10–14  $\mu\text{m}$  wide, brownish, finely papillose.

This epigean moss, exhibiting great variability with regard to the size of plants and the form of the leaf marginal border, is otherwise easily recognized by its characteristic and unique leaf areolation. The lamina cells are very irregular in outline and short throughout the leaf, usually only three times as long as wide, occasionally somewhat longer, but the length/width ratio never exceeds five. The marginal cells in the lower part of the sheathing base are thin-walled and hyaline and form a distinct border extending usually to the mid-sheath, but becoming narrower and less hyaline upwards. The cells of the vaginate leaf base are usually disposed irregularly on the vegetative leaves in contrast to the cells of the perichaetial leaves which are rectangular to linear-rectangular and arranged in regular lengthwise rows. The leaf areolation makes *Ditrichum conicum* distinct from other species of the genus in Antarctica, all of these having elongate-rectangular mid-sheath cells.

The species is similar in habit to *Kiaeria pumila* but that species has more or less developed alar cells and a much narrower costa without internal differentiation. In the leaf areolation *D. conicum* approaches *Dicranoweisia grimmiacea* (C. Müll.) Broth. but that species has distinct alars, much narrower costa and numerous lengthwise cuticular thickenings over the cells giving the leaves a papillose appearance when viewed in cross-section.

In its vaginate leaves *Ditrichum conicum* is likely to be confused in Antarctica with *Dicranella* species, namely *D. cardotii* (R. Br. ter.) Dix. and *D. hookeri* (C. Müll.) Card. However, they can be distinguished by their squarrose leaf limbs and short, more or less square leaf bases. Microscopically, the *Dicranella* species are distinguished by their bistratose and highly mamillose cells of the leaf subula.

*Ditrichum conicum* is recorded for the first time from Antarctica, from a single collection on Deception Island where it grew near fumaroles (Fig. 4). The species was not observed prior to the 1967 eruption of the volcano, but no major collecting was done on this island before then. The Antarctic material has no mature capsules, but it possesses sexual organs and young setae in abundance.

*Ditrichum conicum* is an amphiatlantic temperate species widespread in the *Nothofagus* zone

along the western fringe of southern South America from the Valdivian region at ca. 40°S to Tierra del Fuego. It is also known from South Georgia (Lewis-Smith 2060 — AAS, KRAM-B), Tristan da Cunha (Dixon 1960) and the subantarctic islands of Marion (van Zanten 1971), Heard (Bergstrom & Seppelt 1988, Bergstrom & Selkirk 1997) and Kerguelen (Hébrard 1970, Ochyra 1992b) (Fig. 4).

*Specimen seen.* — SOUTH SHETLAND ISLANDS. *Deception Island*: Port Foster, Pendulum Cove, heated ground (fumarole) beyond ridge behind the ruined Chilean station, 50 m, lat. 62°57'S, long. 60°38'W, 25.III.1981, Lewis-Smith 3642 (AAS, KRAM-B).

### 3. *Ditrichum austrogeorgicum* (Card.) Seppelt (Figs. 5 and 6)

J. Hattori Bot. Lab. 51: 142. 1982. — *Pseudoditrichum austrogeorgicum* Card., Rev. Bryol. 32: 45. 1905. — Type: Géorgie du Sud [Lectotype (*nov.*): “Svenska Sydpolarexpeditionen 1901–03. Nr. 287. *Pseudoditrichum austrogeorgicum* Card. gen. et spec. nov. + *Philonotis scabrifolia* (HfW) Broth.) South Georgia, Cumberland Bay Bore valley 4/5 1902 Carl Skottsberg Det. J. Cardot” — S!; isolectotype: PC!].

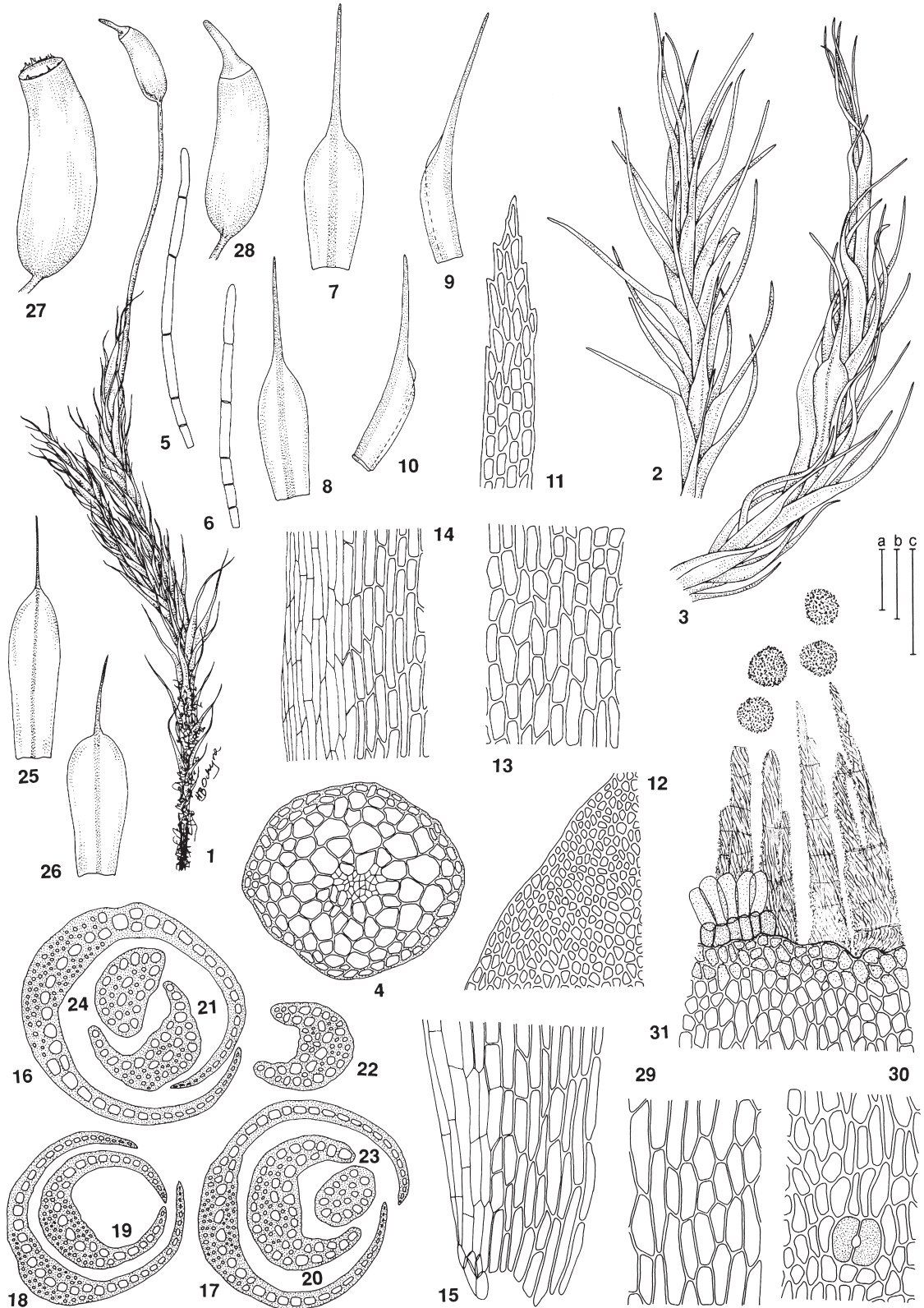
*Pseudoditrichum austrogeorgicum* Card fo. *brevifolium* Card., Wiss. Ergebn. Schwed. Südpolar-Exp. 1901–1903 4(8): 209. 1908 [“-folia”], *syn. nov.* — Type: [Géorgie du Sud] West-fjord (Skottsberg, n°288) [Lectotype (*nov.*): “Svenska Sydpolarexpeditionen 1901–03. Nr. 288. *Pseudoditrichum austrogeorgicum* Card. gen. et spec. nov. forma *brevifolia* South Georgia, Cumberland Bay interior of the West Fjord 13/5 1902 Carl Skottsberg Det. J. Cardot” — S!; isolectotype: PC!].

*Pseudoditrichum austrogeorgicum* Card var. *longifolium* Broth. in Card. & Broth., K. Svensk. Vet. Akad. Handl. 63(10): 18. 1923, *syn. nov.* — *Ditrichum austrogeorgicum* (Card.) Seppelt var. *longifolium* (Broth. in Card. & Broth.) Ochyra & Matteri, Fragm. Flor. Geobot. 41: 1007. 1996. — *Pseudoditrichum falklandicum* Card. in Card. & Broth., K. Svensk. Vet. Ak. Handl. 63(10): 18. 1923, *nom. nud. in*

*syn.* — Type: W. Falkland, Roy Cove, ad rupes litoreas: Mt. Maria [Lectotype (*vide* Ochyra & Matteri 1996: 1007): S!; isolectotype: H-BR!].

*Plants* small to medium-sized, forming low compact tufts or occasionally deeply tufted, sometimes loosely gregarious, dull or somewhat glossy, dark olive-green or yellowish- to brownish-green above, dark brown to blackish-brown below. *Stems* 0.5–1.5 cm high, occasionally up to 4.5 cm tall, brown, erect or ascending, sparsely branched, moderately radiculose below with light brown, smooth rhizoids; in transverse section rounded, consisting of 1 or incomplete 2 rows of the outer cortex composed of smaller cells with moderately thickened, brown walls surrounding 3–4 layers of large, hyaline and thin-walled medullary cells and a large and very distinct central strand. *Axillary hairs* numerous in the apical part of the stem and branches, hyaline, composed of 5–7 elongate cells. *Leaves* (1.2–)2.5–3.5(–5.0) mm long, (0.3–)0.4–0.5(–0.7) mm wide in the middle of the lamina, arranged around the stem, usually tightly appressed and not altered when dry, from an oblong or oblong-ovate, concave, non-decurrent and sheathing base rather abruptly tapering to a channelled, smooth or weakly roughened subula, erect when dry, erect-spreading when wet; *subula* strict or sometimes weakly flexuose, erect, usually as long as or to 1.5 times exceeding the leaf base length, narrow, acute and more or less denticulate at the apex; *margins* entire, plane in the vaginate leaf base, inflexed in the subula; *costa* single, pale yellowish-brown, usually not sharply differentiated from the lamina cells, percurrent to short excurrent, flattened, (90–)100–120 µm wide at the base, occupying most of the width of the subula, smooth on the abaxial surface, in transverse section consisting of a median row of large guide cells between 2 stereid bands; *lamina cells*

Fig. 5 (Opposite). *Ditrichum austrogeorgicum* (Card) Seppelt. — 1. Habit. — 2. Portion of shoot, wet. — 3. Portion of shoot, dry. — 4. Cross-section of the stem. — 5–6. Axillary hairs. — 7–10. Vegetative leaves. — 11. Leaf apex. — 12. Cells at the leaf shoulder. — 13. Mid-leaf cells. — 14. Mid-leaf cells at the margin. — 15. Basal leaf cells at the margin. — 16–24. Cross-sections of the leaves, a sequence from the base to the apex. — 25–26. Perichaetial leaves. — 27. Deoperculate capsule, wet. — 28. Operculate capsule, wet. — 29. Exothelial cells in the middle of the urn. — 30. Exothelial cells at the base of the urn and stoma. — 31. Exothelial cells at the orifice, annulus and spores. — 1–26, 28 drawn from Ochyra 590/80, KRAM-B; 27, 29–31 from Roivainen s.n., 10.III.1929, H. — Scale bars: a: 1 mm (1) and 0.5 mm (27–28); b: 1 mm (25–26) and 50 µm (4–6, 11–24, 29–31); c: 1 mm (2–3, 7–10).





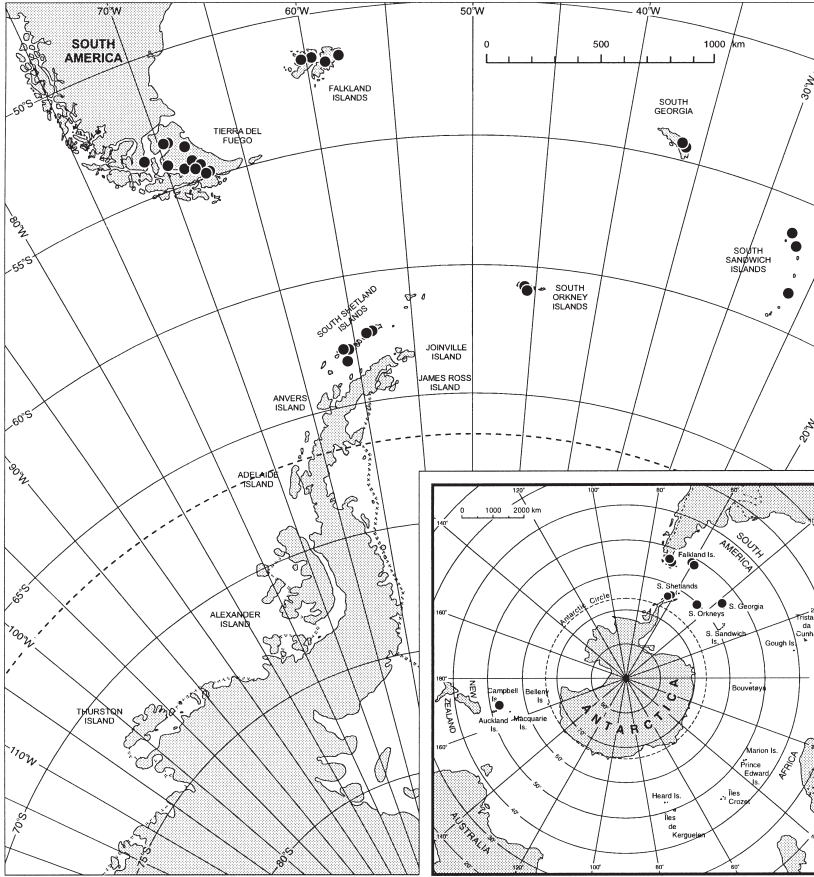


Fig. 6. Distribution map for *Ditrichum austrogeorgicum* (Card.) Seppelt in the Fuegian–Antarctic Peninsula region and the global range of the species (inset).

smooth, non-porose, transparent, in transverse section unistratose throughout and distinctly thinner towards the margins; *cells at the shoulders* mostly irregular in outline, varying from subquadrate, rounded or elliptic to short rectangular, (4–)8–15(–20)  $\mu\text{m}$  long, (4–)8–10(–12)  $\mu\text{m}$  wide, thick-walled, becoming moderately thick- to thin-walled, elongate from the mid-sheath to the base, (20–)30–60  $\mu\text{m}$  long, 8–14  $\mu\text{m}$  wide, with oblique or truncate ends, arranged in more or less regular longitudinal rows; *marginal cells* thin-walled, narrower towards the margin, usually forming a distinct hyaline border extending from the mid-sheath to the base; *cells in the subula* mostly isodiametric, rounded or elliptic, 6–20  $\mu\text{m}$  long, 4–8  $\mu\text{m}$  wide, unistratose.

*Autoicous*. *Perigonia* bud-like, about 1.5 mm long, sessile on the short lateral branchlets just below the perichaetium; *outer bracts* similar to the vegetative leaves but smaller, up to 1.5 mm long; *inner bracts* ovate, obtuse, concave, ca.

1 mm long; *antheridia* few, pale brown intermingled with the filiform, pale brown paraphyses slightly exceeding them. *Perichaetia* terminal with solitary sporophytes; *perichaetial leaves* similar in shape to the vegetative leaves, somewhat larger and more abruptly narrowed into the subula. *Sporophytes* terminal; *calyptra* cucullate, smooth; *setae* erect, yellow or pale reddish-brown to brown with age, not twisted when dry, about 1 cm long; *capsules* exserted, erect to somewhat inclined, asymmetric, smooth to slightly wrinkled with age, brown, lustrous, short cylindrical, 1.3–1.5(–2.0) mm long, 0.5–0.8 mm wide, slightly narrowed at the mouth and abruptly constricted into the seta; *operculum* low-conical, with a straight or slanted beak; *annulus* present, compound, revoluble, composed of 1 outer row of large, thin-walled cells and 1 row of smaller basal cells; *exothelial cells* thin-walled, oblong-hexagonal to hexagonal throughout the urn, except its base, 40–90  $\mu\text{m}$  long, 10–20  $\mu\text{m}$  wide, decreasing in size



towards the rim, forming a distinct, orange-brown strip composed of 4–5 rows of isodiametric cells; *basal cells* of the urn hexagonal, 20–30 µm long, 10–15 µm wide; *stomata* few at the base of the urn, bicellular, superficial, variously oriented with rounded pori; *peristome* of 16 reddish or yellowish teeth, unequally split longitudinally, papillose, obliquely striolate. *Spores* unicellular, (22–)25–30(–34) µm wide, brownish, finely papillose.

*Ditrichum austrogeorgicum* is identified by its low dense tufts and erect and strict leaf subulae which are almost unaltered in the dry state and microscopically by its rectangular cells from mid-sheath to the base. The length of the subulae varies considerably in this species. In the South Georgian type material the subulae slightly exceed the sheath length. However, Cardot (1908) described phenotypes, also from South Georgia, with shorter subulae (fo. *brevifolium*) and later Cardot and Brotherus (1923) recognized, from the Falkland Islands, var. *longifolium* with extremely long subulate leaves. These taxa are doubtless habitat responses caused by local climatic conditions. Because they fall within the continuous variation that includes the type specimens, they are not accepted here as distinct taxa and are reduced to synonymy. Such a taxonomic conclusion was already suggested by Roivainen and Bartram (1937) who stated that “this form [var. *longifolium*] has no systematic value, but is a simple local modification, a result of favourable circumstances for the vegetative development”.

The majority of Antarctic populations have short subulate leaves, probably a response to the severe climatic conditions. Long-subulate phenotypes matching well the South Georgian type are found on Deception Island in geothermal areas, which locally create favourable conditions for the development of vegetation (Lewis-Smith 1988). Fertile plants of *Ditrichum austrogeorgicum* with fully mature sporophytes occur rarely in Antarctica. They are immediately distinguished from other species of the genus by their monoicy, cylindrical and curved capsules, obliquely striolate peristome teeth and large spores, 22–34 µm in diameter.

*Ditrichum austrogeorgicum* is likely to be mistaken in Antarctica for *Kiaeria pumila* with which it shares a similar leaf shape. For distinguishing features of that species see discussion under

*D. conicum*. Some large plants of *D. austrogeorgicum* may be confused with depauperate phenotypes of *Chorisodontium aciphyllum* (Hook. f. & Wils.) Broth., which were described in the Antarctic as *Blindia skottsbergii* Card. (Ochyra 1993). The two have similarly subulate leaves and broad costae with identical internal structure but *Ch. aciphyllum* has lax hyaline alar cells.

*Ditrichum austrogeorgicum* is an epigeal moss growing in the Antarctic usually on dry mineral soil amongst stones and boulders, on soil and humus over rock outcrops and in rock crevices, as well as on volcanic ash. Occasionally it occurs on moist clayey soil. The species is most frequently associated with various associations of the fruticose lichen and moss cushion sub-formation typical of sparsely vegetated fellfield (Lewis-Smith 1972) which is dominated by moss species of the genera *Andreaea*, *Dicranoweisia*, *Schistidium* and *Hennediella*, as well as the lichens *Usnea* spp. and many crustose taxa. Less frequently *D. austrogeorgicum* is found in the association of *Polytrichastrum alpinum* (Hedw.) G. L. Sm. and *Sanionia uncinata* (Hedw.) Loeske and *S. nivalis* Hedenäs. Its altitudinal range extends from sea level to almost 300 m.

*Ditrichum austrogeorgicum* is an amphipacific temperate species (Fig. 4, inset). It is very rare in the eastern austral region where it is known from a single sterile collection from Campbell Island (Seppelt 1982), but is frequent and locally abundant in the Fuegian–Antarctic region in the western hemisphere. It occurs on Isla Grande de Tierra del Fuego where it seems to have its main centre of occurrence (Roivainen & Bartram 1937), on the Falkland Islands (Matteri 1986) and South Georgia (Cardot 1908, Cardot & Brotherus 1923) as well as the northern maritime Antarctic (Fig. 6). It is rare on the South Sandwich and South Orkney Islands and relatively frequent on King George, Livingston and Deception Islands in the South Shetland Islands archipelago. On Deception Island the species was only observed before the 1967 volcanic eruption (Lewis-Smith 1984c).

*Specimens seen.* — SOUTH SANDWICH ISLANDS. *Zavodowski Island*: warmed ground in central N ash plain, lat. 56°18'S, long. 27°34'W, 16.I.1997, *Convey 259A & 260* (AAS, KRAM-B). *Visokoi Island*: Wordie Point, lat. 56°41'S, long. 27°13'W, 30.I.1997, *Convey 102A* (AAS, KRAM-B). *Montagu Island*: Allen Point, higher terrace, ca. 70 m, lat. 58°29'S, long. 26°14'W, 29.I.1997, *Convey*

100A (AAS, KRAM-B). **SOUTH ORKNEY ISLANDS.** *Coronation Island*: Cape Hansen, 20–200 m, lat. 60°39'S, long. 45°38'W, *Lewis-Smith 3237* (AAS, KRAM-B). *Signy Island*: Rusty Bluff above Moraine Valley, lat. 60°43'S, long. 45°36'W, *Lewis-Smith 1788* (AAS, KRAM-B); Polynesia Point, 50 m, lat. 60°43'S, long. 45°35'W, *Lewis-Smith 8616* (AAS, KRAM-B); Factory Bluffs, lat. 60°42'S, long. 45°36'W, *Lewis-Smith 8617* (AAS, KRAM-B). **SOUTH SHETLAND ISLANDS.** *King George Island*: Potter Cove: Three Brothers Hill, lat. 62°16'S, long. 58°40'W, 24.I.1981, *Jabłoński 228* (KRAM-B). Barton Peninsula: Noel Hill, lat. 62°13'S, long. 58°44'W, 23.I.1981, *Jabłoński 202* (KRAM-B) and 27.I.1989, *Li Xue-dong K15* (AAS). Fildes Peninsula: Ardley Island, 25 m, lat. 62°13'S, long. 58°56'W, 2.III.1980, *Ochyra 2492/80* (KRAM-B) and 18.XI.1988, *Li Xue-dong AW8* (AAS); Bellinghousen Station area, 15 m, lat. 62°12'S, long. 58°58'W, 1.III.1980, *Ochyra 2405/80* (BAE-105) (KRAM-B). King George Bay: Turret Point, lat. 62°05'S, long. 57°57'W, 22.I.1981, *Jabłoński 129* (KRAM-B). Bransfield Strait: Red Hill, 100 m, lat. 62°14'S, long. 58°18'W, 25.I.1980, *Ochyra 1086/80, 1097/80 & 1099/80* (KRAM-B); Blue Dyke, 90 m, lat. 62°13'S, long. 58°27'W, 26.I.1980, *Ochyra 1182/80* (KRAM-B); Demay Point, 40 m, lat. 62°13'S, long. 58°25'W, 27.I.1980, *Ochyra 1369/80* (KRAM-B) and 50 m, 2.II.1980, *Ochyra 1388/80* (KRAM-B). Ecology Glacier area: Sphinx Hill, 100 m, lat. 62°11'S, long. 58°26'W, 5.I.1980, *Ochyra 227/80 & 241/80* (KRAM-B); Czajkowski Needle, lat. 62°11'S, long. 58°27'W, 245 m, 16.I.1980, *Ochyra 656/80* (KRAM-B), 250 m, *Ochyra 658/80 & 662/80* (KRAM-B) and 260 m, *Ochyra 663/80* (KRAM-B). Point Thomas area: moraines by the northern edge of Ecology Glacier, 25 m, lat. 62°10'S, long. 58°28'W, 19.I.1980, *Ochyra 905/80* (KRAM-B); Hala, 25 m, lat. 62°09'S, long. 58°29'W, 31.XII.1979, *Ochyra 5218/79* (KRAM-B); Ubocz, 125 m, lat. 62°10'S, long. 58°29'W, 24.II.1980, *Ochyra 2367/80* (KRAM-B); Jersak Hills, 100 m, lat. 62°09'S, long. 58°09'W, 27.XII.1979, *Ochyra 5068/79, 5070/79, 5072/79* (BAE-181) & *5073/79* (KRAM-B); unnamed hill between Jersak Hills and Krokiew, 170 m, lat. 62°09'S, long. 58°29'W, 3.I.1980, *Ochyra 130/80* (KRAM-B). Ezcurra Inlet: Jardine Peak, 285 m, lat.

62°10'S, long. 58°30'W, 30.XII.1979, *Ochyra 5190/79* (KRAM-B); Italia Valley, 100 m, lat. 62°30'S, long. 58°31'W, 3.I.1980, *Ochyra 106/80 & 107/80* (KRAM-B); Breccia Crag, 140 m, lat. 62°10'S, long. 58°32'W, 20.I.1980, *Ochyra 932/80* (KRAM-B). MacKellar Inlet: Kapitan Peak, 200 m, lat. 62°05'S, long. 58°29'W, 16.II.1980, *Ochyra 1924/80* (KRAM-B); Wegger Peak, 295 m, lat. 62°05'S, long. 58°28'W, 16.I.1980, *Ochyra 2000/80* (KRAM-B). Martel Inlet: Ullman Spur, 40 m, lat. 62°05'S, long. 58°20'W, 11.I.1980, *Ochyra 590/80* (KRAM-B). **Livingston Island**: Byers Peninsula, Clark Nunatak, 180 m, lat. 62°40'S, long. 60°55'W, 8.XII.1965, *Lindsay 238* (AAS, KRAM-B); Hurd Peninsula: vicinity of the Spanish Station, lat. 62°37'S, long. 60°30'W, II.1992, *Schulz 112* (KRAM-B) and 10.II.1996, *Acuña 7006* (KRAM-B); E side of False Bay, lat. 62°43'S, long. 60°20'W, 25.I.1969, *Schuster 536, 562, 569, 587, 691 & 699a* (US); W side of Miers Bluff, lat. 62°42'S, long. 60°25'W, 28.I.1969, *Schuster 804* (US); Johnson Dock, alt. 20 m, lat. 62°40'S, long. 60°20'W, 17.XII.1976, *Redon 100b* (AAS, KRAM-B). **Deception Island**: SSW of Ronald Hill, 10–15 m, lat. 62°59'S, long. 60°35'W, 3.XII.1963, *Longton 32a & 34* (AAS); between Kroner Lake and Ronald Hill, ca. 15 m, lat. 62°59'S, long. 60°35'W, 10.XII.1964, *Longton 904* (AAS); near Kroner Lake, 10 m, lat. 62°57'S, long. 60°38'W, 2.XII.1963, *Corner 872* (AAS); SW of Ronald Hill, ca. 10 m, lat. 63°00'S, long. 60°35'W, 10.XII.1964, *Lewis-Smith 65* (AAS); crater basin below Ronald Hill, ca. 10 m, lat. 62°59'S, long. 60°35'W, 10.II.1967, *Lewis-Smith 736* (AAS).

#### 4. *Ditrichum gemmiferum* Ochyra & Lewis-Smith, sp. nov. (Figs. 7 and 8)

*Musci mediocres, laxi vel dense caespitosi, olivaceo-virides vel in parte superiori pallide luteo-olivacei. Caulis erectus, subsimplex, basi radiculosus, rhizoideis pallide fuscis, laevissimis, tuberis copiosis, pallide luteis ad brunneis, cellulis paucis*

Fig. 7 (Opposite). *Ditrichum gemmiferum* Ochyra & Lewis Smith. — 1. Plant with mature sporophytes, dry. — 2. Sterile plant, dry. — 3. Male plant with perigonium. — 4. Cross-section of the stem. — 5–6. Axillary hairs. — 7–11. Rhizoidal tubers. — 12–18. Vegetative leaves. — 19–20. Leaf apices. — 21. Papillae of the subula in profile. — 22. Cells at the leaf shoulder. — 23. Lamina cells above the mid-sheath at the margin. — 24–25. Lamina cells just below the mid-sheath at the margin. — 26–27. Basal leaf cells. — 28–38. Cross-sections of the leaves, a sequence from the base to the apex. — 39–40. Outer perichaetial leaves. — 41. Inner perichaetial leaf. — 42. Young operculate capsule. — 43–44. Deoperculate capsules. — 45. Exothecial cells at the base of the urn and stoma. — 46. Exothecial cells in the middle of the urn. — 47. Exothecial cells at the orifice, peristome and spores. — 1, 5–6, 12–13, 20–21, 23–24, 28, 39, 41–47 drawn from *Lewis Smith 6921* (isotype); 2 from *Lewis Smith 6925* (paratype); 3, 19, 25–26, 31–32, 38 from *Lewis Smith 6926* (paratype); 4, 7–11, 14–16, 22, 27, 29, 33–35, 37 from *Ochyra 2792/80* (paratype); 18, 40, 44 from *Mahu 22834* (paratype); 17, 30 from *Longton 572* (paratype) (all in KRAM-B). — Scale bars: a: 2 mm (1); b: 2 mm (3), 50 µm (21) and 100 µm (5–6); c: 1 mm (12–18, 39–41); d: 100 µm (4, 19–20, 22–38); e: 1 mm (42–44), 4 mm (2) and 100 µm (7–11, 45–47).





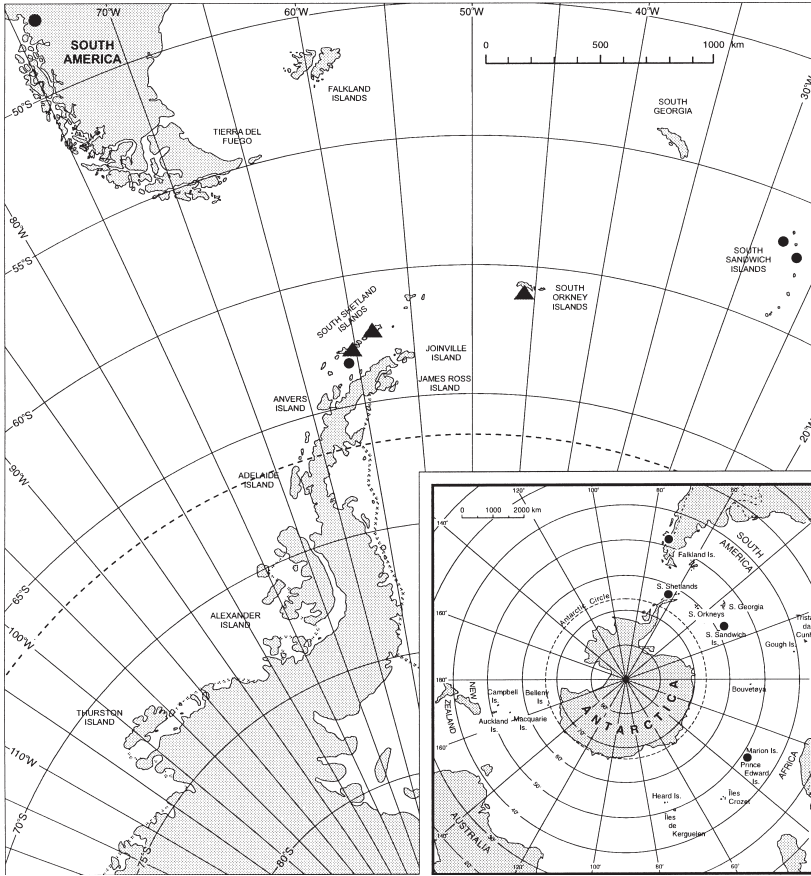


Fig. 8. Distribution map for *Ditrichum gemmiferum* Ochyra & Lewis Smith (black dots) and *D. lewis-smithii* Ochyra (triangles) in the Fuegian–Antarctic Peninsula region. Inset: global range of *Ditrichum gemmiferum*.

*protuberantibus efferentis. Folia non disticha, e basi semivaginate, ovato vel oblongo-ovato, erecta vel erecto-patentia, subulata, costa lata, deplanata in subulam scaberrimam excedente apice dentatam instructa, retis superioribus quadratis vel ellipticis basin versus longioribus, in ipsa basi mediocriter magnis hyalinis. Flores dioici. Perichaetium vaginans. Capsula in pedicello recto, rarius curvato, pallide fusco-luteo, erecta, anguste cylindracea, basi subito rotundata, leptoderma, castanea, nitens. Operculum brevirostre. Peristomii dentes perbreves, usque versus basin bifidi, cruribus inaequalibus, filiformibus, fragilibus, remote articulatis, papillois, pallidis. Sporae sphaericae, papillosoe, 14–18  $\mu$ m latae.*

Type: Antarctica, South Shetland Islands, Deception Island: Port Foster, geothermal area on slopes to E and SE of Pendulum Cove, lat. 62°57'S, long. 60°38'W, plants on rocks with no soil, 50–100 m; 1987–1988, R. I. Lewis-Smith 6921 (Holotype: AAS; isotype: KRAM-B).

Plants small to medium-sized, growing in low, loose or compact tufts 0.5–1.5 high, dull or weakly glossy, olive-green to light olivaceous or dark green above and dark brown to blackish-green below, sometimes light olive-brown throughout. Stems erect, usually sparingly branched, yellowish-brown; in transverse section rounded, consisting of 2(–3) rows of the smaller cortical cells with moderately thickened, yellowish-brown walls surrounding 3(–4) layers of large, hyaline and thin-walled medullary cells, central strand relatively large and conspicuous. Rhizoids common in the lower part of the stem, long and sparsely branched, light brown, not forming a tomentum. Rhizoidal tubers common, relatively small, pale yellowish to brownish, consisting of (2–)3–4 large, bulging, roughly spherical cells, from 25–50  $\mu$ m in diameter, arranged in a short row and attached to the rhizoid by a much smaller cell. Axillary hairs numerous in the apical part of the stem and branches, hyaline throughout, composed of 7–10



elongate cells. *Leaves* (1.5–)1.8–2.5(–3.0) mm long, (0.4–)0.6–0.8 mm wide, spirally arranged on the stem, from a concave, ovate to oblong-ovate, non-decurrent and more or less vaginate base rather abruptly contracted into the subula, erect and more or less contorted in the upper part when dry, erect-spreading when wet; *subula* dull or slightly lustrous, rigid, straight to curved when dry, about as long as the sheathing base, channelled, coarsely papillose throughout, usually sharply denticulate or sometimes entire and rounded at the apex; *margins* plane, entire throughout or slightly crenulate at the shoulders; *costa* single, pale yellowish-brown, often concolorous with the lamina cells and not sharply differentiated from them, subpercurrent to percurrent, strongly flattened, 100–160 µm wide at the base, occupying most of the width of the subula and gradually merging into the multistratose lamina cells, usually ridged on the abaxial surface, in transverse section consisting of a median row of large guide cells between 2 stereid bands, sometimes with a row of larger adaxial cells; *lamina cells* thick-walled throughout, smooth or with strong cuticular ridges over the longitudinal walls giving them a papillose appearance in transverse section; *cells at the shoulders* mostly regular in outline, varying from quadrate or rounded to elliptic, 8–18 µm long, 6–8(–10) µm wide, unistratose or mostly variously bistratose but otherwise translucent, becoming short to linear-rectangular in the mid-sheath to the base, transparent, (25–)40–60(–80) µm long, (4–)6–8(–10) µm wide, with thick and non-porose walls, in transverse section unistratose and distinctly thinner towards the margins; *marginal cells* narrower and thin-walled, usually forming a distinct, often hyaline border extending from the mid-sheath to the base; *cells in the subula* strongly papillose due to the strongly collapsed thin longitudinal cell walls and protuberant thickened ends of cell cross-walls at the point of junction, giving the subula a papillose appearance, short rectangular over the costa, isodiametric in the lamina, 10–20 µm long, 8–10 µm wide.

*Diocious*. *Perigonia* gemmiform, 1.5–2.0 mm long, sessile on the short lateral branchlets; *outer bracts* similar to the vegetative leaves but with the oblong sheathing base, up to 2.0 mm long; *inner bracts* strongly concave, yellow-brown,

without or with a short subula, 1.2–1.5 mm long; *antheridia* few, pale yellow intermingled with the filiform, pale yellow-brownish paraphyses slightly exceeding them. *Perichaetia* terminal with single sporophytes; *outer perichaetial leaves* similar to the vegetative leaves, only somewhat larger, to 3.5 mm long, and abruptly narrowed into the subula with the almost truncate upper part of the sheathing base; *the innermost perichaetial leaves* strongly modified, enlarged and clasping at the base, 3.5–4.0 mm long, 1.0–1.2 mm wide, from a broad, convolute, oblong-lanceolate base gradually narrowed into a short subula, much shorter than the lamina and with areolation of linear-rectangular cells throughout except for the shoulder and wider costa, up to 200 µm at the base. *Sporophytes* terminal; *calyptra* cucullate, smooth, brown; *setae* erect or somewhat bent, pale yellow-brown, not twisted when dry, 6–7 mm long; *vaginula* ca. 1 mm long with thin-walled epidermal cells; *capsules* exserted over the perichaetial leaves, erect to somewhat inclined, symmetric or slightly gibbous, smooth, brown, usually with a varnish luster, cylindrical, 1.0–1.5 mm long, ca. 0.5 mm wide, not or slightly narrowed at the mouth and abruptly constricted into the seta; *operculum* conical, long rostrate, with a straight, ca. 1/2 length of the urn; *annulus* persistent; *exothecial cells* thin-walled, oblong-hexagonal to hexagonal throughout the urn, except its base, 40–60 µm long, 15–25 µm wide, decreasing in size towards the mouth, cells at the rim somewhat smaller, forming a narrow, deeper brown strip composed of 2–3 cell rows, cells at the urn base hexagonal, 20–30 µm long, 10–15 µm wide; *stomata* few at the base of the urn, bicellular, superficial, variously oriented with rounded pori; *peristome* single, inserted below the mouth, pale yellowish, ca. 100 µm long, composed of 16 teeth split irregularly nearly to the base into 2 filiform, terete, papillose divisions. *Spores* 14–18 µm wide, brownish, finely papillose-verrucose.

*Other specimens seen (paratypes)*. — SOUTH AMERICA. CHILE. Prov. de Aisén, Lago General Carrera, Lago Plomo, lat. 47°S, long. 73°W, at lake shore, 1967, *Seki 1437* (HIRO, KRAM-B, hb. C. M. Matteri). SUBANTARCTICA. MARION ISLAND. North-eastern coast, Transvaal Cove, Nellie Humps in the vicinity of Meteorological Station, lat. 46°52'20''S, long. 37°50'30''E, 60 m, on soil between scattered *Blechnum penna-marina*, 11.V.1982, *Hertel 24601A* (KRAM-B). ANTARCTICA. SOUTH SANDWICH ISLANDS. *Zavodovski Island*: ash plain above NW coast, ca. 20 m,

lat. 56°18'S, long. 27°34'W, 16.I.1997, *Convey 258* (AAS, KRAM-B). **Leskov Island:** summit ridge, lat. 56°40'S, long. 28°10'W, ca. 200 m, outer edge of fumarole vegetation, 5.III.1964, *Longton 509b* (AAS, KRAM-B); same locality, 100 m, 30.I.1997, *Convey 245A & 246D* (AAS, KRAM-B); same locality, E side, 100 m, 30.I.1997, *Convey 249I* (AAS, KRAM-B). **Candlemas Island:** between lagoons and most southerly exposed lava ridge, lat. 57°03'S, long. 26°40'W, 65–100 m, fumarole vent, 8.III.1964, *Longton 572* (AAS, KRAM-B); Lucifer Hill, SE lip of main crater, 57°04'S, long. 26°42'W, 3.II.1997, *Convey 117A* (AAS, KRAM-B); SE slope of Lucifer Hill, 20 m below crater rim, 57°04'S, long. 26°42'W, *Convey 214D* (AAS, KRAM-B); Lucifer Hill, top of SE slope, 57°04'S, long. 26°42'W, 20.II.1997, *Convey 215A* (AAS, KRAM-B); Lucifer Hill, northern crater, 57°04'S, long. 26°42'W, 2.II.1997, *Convey 119B* (AAS, KRAM-B); Lucifer Hill, E rim of SW crater, 57°04'S, long. 26°42'W, *Convey 107A* (AAS, KRAM-B); same locality, SW crater, 12.II.1997, *Convey 185A* (AAS, KRAM-B); NW ridge of Lucifer Hill, 57°04'S, long. 26°42'W, *Convey 241D* (AAS, KRAM-B); W end of Breakbones Plateau, 15.II.1997, *Convey 197B, 199, 200B & 201A* (AAS, KRAM-B); Breakbones Plateau, vent mouth near fumarole, 57°04'S, long. 26°42'W, 15.II.1997, *Convey 208B & 209D* (AAS, KRAM-B); Clinker Gulch, 57°04'S, long. 26°42'W, 6.II.1997, *Convey 151B & 155C* (AAS, KRAM-B); southern edge of shallow gully above Clinker Gulch, ca. 50 m below summit, 57°04'S, long. 26°42'W, 6.II.1997, *Convey 124A, 127A, 128, 130A, 133C & 136C* (AAS, KRAM-B). **Bellingshausen Island:** near fumarole at S lip of crater, 150 m, 59°26'S, long. 27°05'W, 20.I.1997, *Convey 21 & 46C* (AAS, KRAM-B). **SOUTH SHETLAND ISLANDS.** **Deception Island:** Port Foster, Pendulum Cove, lat. 62°57'S, long. 60°38'W, on volcanic ash in the vicinity of the destroyed Chilean Station, 4 m, 20.III.1980, *Ochyra 2792/80* (AAS, KRAM-B, hb. C. M. Matteri); same locality, 2–5 m, geothermal area on beach, *R. I. Lewis-Smith 6933 & 6936* (AAS, KRAM-B); geothermal area on slopes to E and SE of Pendulum Cove, 50–100 m, on rocks with no soil, *R. I. Lewis-Smith 6919, 6922, 6923, 6925 & 6926* (AAS, KRAM-B); same locality, southern Pendulum Cove, 62°56'S, long. 60°36'W, 100 m, flat area just below the ice, on dry scoria, 8.III.1987, *R. I. Lewis-Smith 5751A* (AAS, KRAM-B); same locality, Telephon Bay, lat. 62°56'S, long. 60°40'W, en roca volcánica, 1.II.1988, *Mahu 22834* (AAS, KRAM-B).

In this study we examined all available type as well as numerous non-type collections of *Ditrichum* species described from the Southern Hemisphere and found that none of them match *D. gemmiferum*. We also studied several poorly known species with a ditrichoid appearance belonging within other genera because, from our experience, it was evident that species were often misclassified. Special attention was paid to species which were excluded from *Blindia* by Bartlett and Vitt (1986) but without indication of their true affilia-

tion. Of these, *B. maxwellii* Vitt from Campbell Island, New Zealand (Vitt 1971) appeared to be a distinct species of *Ditrichum*. The following nomenclatural correction is thus necessary:

*Ditrichum maxwellii* (Vitt) Ochyra & Lewis-Smith, *comb. nov.* Basionym: *Blindia maxwellii* Vitt, *Bryologist* 74: 468, f. 18–22. 1974. Type: New Zealand. Campbell Island, NNW slope of Mt. Honey, Vitt 2436 [Holotype: "Musci of Campbell Island. *Blindia maxwellii* Vitt Holotype. On rock ledge. On north-northwest slope of Mt. Honey near summit (1 700–1800 ft.). 31 December 1969. Dale H. Vitt no. 2436" (NY!)].

*Ditrichum maxwellii* differs from *D. gemmiferum* in its entirely smooth leaf subula, lamina cells with strongly incrassate cells and short curved setae. Slightly papillose leaf subulae occur in some austral species of *Ditrichum*, for example in *D. cylindricarpum* (C. Müll.) F. Müll. and *D. punctulatum* Mitt., but they are distinguished by their long leaf subulae which are strongly twisted about their axes when dry. Ochyra (1996b) pointed out that rhizoidal tubers were unknown in any other austral species of *Ditrichum*, except for the Deception Island plant which had been then misnamed *D. brotherusii*, and these are an important diagnostic character in the newly described species.

*Ditrichum gemmiferum* has previously been mistaken for various species. The species was first collected in 1964 by R. E. Longton on the South Sandwich Islands. Newton (1977) determined these specimens as *Distichium capillaceum* (Hedw.) B. S. G., describing peculiar gemmae on these populations which, if the determination was correct, would be the first report of the rhizoidal tubers in this genus (cf. Risse 1987). Subsequently, the species was collected by T. Seki in the Aisén Province in southern Chile and the plants were determined as *Cheilothela dubia* Dusén (Seki 1974). The moss was also collected in 1980 by Ochyra on Deception Island, but the material remained unnamed for over 15 years in the herbarium until it was eventually determined as *D. brotherusii*, and again its unique rhizoidal gemmae were described (Ochyra 1996b). H. Hertel collected *D. gemmiferum* on Marion Island (Ochyra & Hertel 1990) but, because of sterility of the plants, the specimen was not identified. Several collections of this species were made on Deception Island in 1987–1988, some of them bearing

shoots with mature sporophytes which allowed this species of *Ditrichum* to be described.

*Ditrichum gemmiferum* possesses close anatomical relationships to the group of austral species having the leaf subulae scarcely exceeding the sheathing leaf base, namely *D. buchananii* (R. Br. ter.) Broth., *D. conicum*, *D. brotherusii* and *D. austrogeorgicum*. These species clearly belong within subgen. *Aschistodon* (Mont.) Broth. which Brotherus (1901) characterized by the symmetric, cylindrical capsules and the short, hyaline and undivided peristome teeth. Seppelt (1982) rejected this infrageneric classification, pointing out the lack of correlations between capsule shape and form of the peristome. *Ditrichum gemmiferum*, with its symmetric capsules and split peristome teeth, clearly supports this rejection.

*Ditrichum gemmiferum* is easily recognized by its coarsely papillose leaf subulae and the presence of the copious rhizoidal gemmae. *Ditrichum brotherusii* differs from it in having multicellular spores and strict, unaltered leaves in the dry state; *D. conicum* is distinct by its leaf areolation of short lamina cells and undivided peristome teeth; *D. buchananii* differs in having the 3–4-stratose stem cortex and unistratose lamina cells in the subula; *D. heteromallum* has entirely smooth leaf subulae and leaf areolation of elongate-rectangular to linear cells throughout the lamina; *D. austrogeorgicum* is distinguished by its straight unaltered leaves when dry, mostly unistratose stem cortex, monoicous sex condition, asymmetric, slightly curved capsules, reddish or yellowish, obliquely striolate peristome teeth and larger spores.

The leaf subula of *Ditrichum gemmiferum* is almost identical to that in *Distichium capillaceum*, a bipolar species widely distributed in the maritime Antarctic (Newton 1977), but the leaves in *Distichium capillaceum* are strongly conduplicate and distichously arranged.

The strongly papillose subulate limbs of *Ditrichum gemmiferum* resemble those of *Dicranella cardotii*, but confusion between them in the field is unlikely, except for some areas in Patagonia where they may grow in association (cf. Seki 1974); in the Antarctic both species have not so far been found together (cf. Ochyra & Newton 1985, Schulz 1993). Some juvenile or depauperate specimens of *D. cardotii* could be mistaken for *D. gemmiferum* because of the characteristically

squarrose leaves, but the bistratose lamina in the subula and short, square leaf base widest at shoulders provide reliable distinguishing characters.

*Ditrichum gemmiferum* is a widely distributed but sparsely occurring austral species (Fig. 8). In the Antarctic, *Ditrichum gemmiferum* occurs only on heated ground on the volcanic islands of the South Sandwich Islands archipelago and on Deception Island, most often on dry scoria amongst fumarole vegetation. On subantarctic Marion Island the species was collected from soil, while the Chilean material was gathered from soil on a lake shore.

##### 5. *Ditrichum lewis-smithii* Ochyra

Ann. Bot. Fennici 33: 304, f. 1. 1996. — Type: Antarctica, South Shetland Islands, Admiralty Bay, King George Island: Admiralty Bay, Ezcurra Inlet, Pond Hill, lat. 62°10'25''S, long. 58°26'W, elev. 160 m; in moist situation on bare ground on NW-facing slope; 11.II.1980, Ochyra 1829/80 [Holotype: KRAM-B!; isotypes: AAS, BM, H].

The species was described in detail and illustrated by Ochyra (1996a). It is a very distinct and taxonomically isolated species which is at once distinguished from all other congeners by its gymnostomous capsules immersed in the perichaetial leaves. These characters might suggest the placement of this species in a separate genus of its own. However, until a generic revision of the Ditrichaceae is available we prefer to follow the traditional concept of *Ditrichum* because it is possible to provide many examples of pairs of closely related species with gymnostomous and ochyrostomous capsules in other moss genera and families.

*Ditrichum lewis-smithii* must be considered as an Antarctic endemic known from three widely separated stations on Signy Island in the South Orkney Islands, and on King George and Livingston Islands in the South Shetland Islands group (Fig. 8).

##### EXCLUDED SPECIES

*Ditrichum brotherusii* (R. Br. ter.) Broth.

This species was reported from several collections from Livingston Island by Robinson (1972) as

*Pseudoditrichum fuegianum*, which is conspecific with *Ditrichum brotherusii* (Seppelt 1982) and from the single collection from Deception Island by Ochyra (1996b). Examination of the voucher specimens revealed that all Livingston Island specimens are actually *Ditrichum austrogeorgicum*, whereas the Deception Island specimen is *D. gemmiferum*. Thus, *D. brotherusii* must be withdrawn from the Antarctic moss flora and it must be still considered as an amphipacific temperate species.

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