Ann. Bot. Fennici 33: 303–309
Helsinki 13 December 1996
ISSN 0003-3847

Ditrichum lewis-smithii (Ditrichaceae, Bryopsida), a new species from Antarctica

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Received 18 September 1996, accepted 24 September 1996

In the Antarctic botanical zone the genus *Ditrichum* Hampe (Ditrichaceae, Bryopsida) is represented by three species, *D. austro-georgicum* (Card.) Seppelt, *D. brotherusii* (R. Br. ter.) Seppelt and *D. lewis-smithii* Ochyra *sp. nov*. The latter is closely related to *D. immersum* Zanten from the sub-Antarctic. However, *D. lewis-smithii* differs in its gymnostomous capsules, smaller, erecto-patent to widely spreading leaves with flexuose subulae, bistratose lamina cells at the leaf shoulders and mostly 2–3-stratose lamina in the subula. It is an epigean moss growing on bare ground and on soil covering rock ledges and on humus in rock fissures. It has been recorded so far only from the King George and Livingston Islands in the South Shetland Islands as well as from Signy Island in the South Orkney Islands and must therefore be considered an Antarctic endemic.

Key words: Antarctica, Bryopsida, Ditrichaceae, *Ditrichum*, taxonomy

INTRODUCTION

During the course of the IV Polish Antarctic Expedition in 1979–1980 I surveyed in detail the moss flora of King George Island, the largest island of the South Shetland Islands archipelago. Special attention was paid to the Admiralty Bay area which has a well-developed and diverse cryptogamic and phanerogamic vegetation. Consequently the western shores of Admiralty Bay are designated as a Site of Special Scientific Interest (SSSI) (Bonner & Lewis-Smith 1985) and its bryophyte flora comprises at least 40 taxa of mosses and eight hepatics (Myrcha *et al.* 1991). An additional 15–20 species of mosses have been recorded in other parts of the Admiralty Bay region, some of which are unknown elsewhere in the Antarctic biome. Examples include the mosses *Schistidium falcatum* (Hook. f. & Wils.) Brem. (Ochyra & Bell 1984), *S. steerei* Ochyra (Ochyra 1987), *S. urnulaceum* (K. Müll. Hal.) Bell (Ochyra 1990) and the liverworts *Scapania obcordata* (Berggr.) S. Arn. and *Hygrolembidium ventrosum* (Mitt.) Grolle (Ochyra & Váňa 1989).

In addition to the species mentioned above I also have a number of specimens of mosses which are still unnamed and need a careful taxonomic assessment. Several of them have been found to be taxa in the genus *Ditrichum* Hampe but the unusual feature of these plants is that the capsules are immersed in the perichaetial leaves. This is a unique character in this genus and a careful sur-

vey of its species revealed that only one, *D. immersum* Zanten from the sub-Antarctic islands has similar sporophytes. Nonetheless, the Antarctic material is different from *D. immersum* in several gametophyte and sporophyte characters, which indicates that there are two species involved.

Searching for further records of this putative new species my attention was drawn to a single record from Signy Island, South Orkney Islands, which, with some doubt, was named as *Dicranoweisia immersa* Broth. by Bell (1976). Examination of the voucher collection deposited in the British Antarctic Survey herbarium (AAS) showed that this is the same species of *Ditrichum*. Finally, Schulz (1993) discovered one more specimen of this species on Hurd Peninsula, Livingston Island, South Shetland Islands.

Having examined the type collections of the most antipodal species of *Ditrichum* I came to the conclusion that the Antarctic material represents an undescribed species. It is with great pleasure that I name this moss in honour of Dr Ronald I. Lewis-Smith of the British Antarctic Survey, Cambridge, UK, who made the first collection of this moss in 1966 and who, during many research visits to the Antarctic since the mid-1960s, has collected a very large number of moss and liverwort specimens in this region and contributed much to Antarctic bryogeography and ecology.

DESCRIPTION

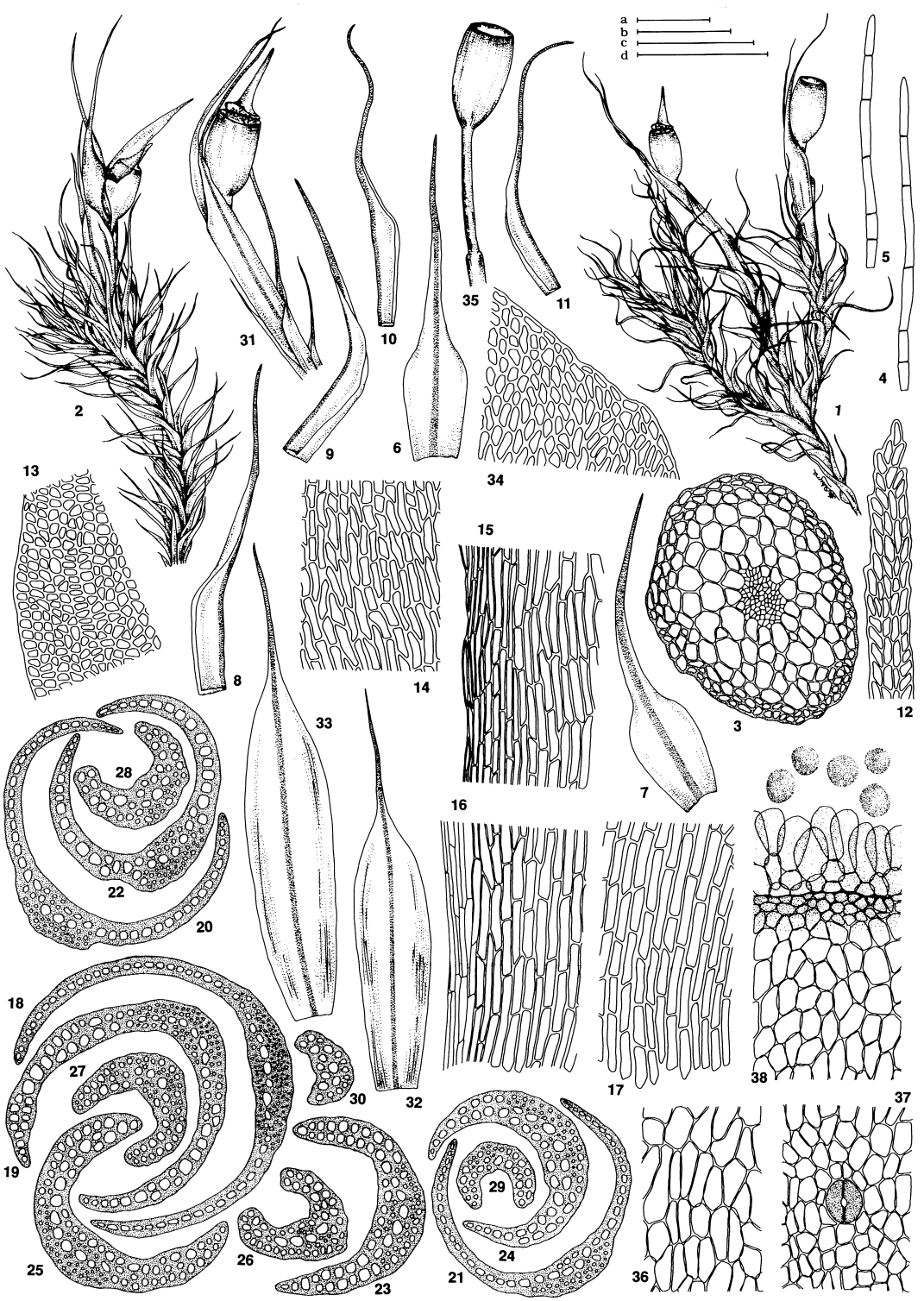
Ditrichum lewis-smithii Ochyra, *species nova* (Fig. 1)

Species distinctissima ab omnibus congeneribus peristomio nullo facillime dignoscenda. Species haec D. immerso *sub-Antarctico similis sed recedit foliis minoribus, erecto-patentibus vel patentibus flexuosisque, plantis minoribus, cellulis laminae bistratosis in parte superiore, laminis 2–3-stratosis in subula et setis longioribus.*

Type: Antarctica. South Shetland Islands, King George Island: Admiralty Bay, Ezcurra Inlet, Pond Hill, lat. 62°10´25´´S, long. 58°36´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).

Plants rather small to moderate in size, forming low turfs 1.0–1.5 high, or occasionally deeply tufted, up to 4 cm high, slightly to strongly lustrous, yellowish-brown to olive-green throughout or blackish-brown above and brown below. Stems erect or ascending, often repeatedly branched, sparsely radiculose to densely tomentose below with light brown, smooth and branched rhizoids, in transverse section oval or rounded, consisting of 2(–3) rows of the outer cortex of smaller cells with moderately thickened, brown walls surrounding 3–4 layers of large, hyaline and thin-walled medullary cells with distinct collenchymatous corner thickenings and a large and very distinct central strand; axillary hairs numerous in the apical part of the stem and branches, hyaline throughout, 5–7-celled. Leaves (1.5–)2.0–2.5(–3.2) mm long, 0.4–0.7 mm wide at the base, arranged all around the stem, from a concave, oblong-lanceolate, non-decurrent and sheathing base tapering quickly but not abruptly into the subula, erect-spreading when dry, sharply spreading from the top of the leaf base when wet; subula shining, 1.5 to 2 times as long as the lamina, narrow, strongly flexuose when dry, denticulate near the apex, subtubulose, smooth at the back; leaf margins entire, inflexed. Lamina cells smooth and thick-walled throughout; those at the shoulder region mostly irregular, varying from subquadrate, rounded or rhombic to short rectangular, 4–20 μm long, 4–8(–12) μm wide, usually bistratose and obscure, very rarely unistratose or bistratose with unistra-

Fig. 1. *Ditrichum lewis-smithii* Ochyra. — 1: Habit, dry. — 2: Habit, wet. — 3: Cross-section of the stem. — 4–5: Axillary hairs. — 6–11: Vegetative leaves. — 12: Leaf apex. — 13: Cells at the leaf shoulder. — 14: Mid-leaf cells. — 15: Mid-leaf cells at the margin. — 16: Basal leaf cells at the margin. — 17: Basal leaf cells near the costa. — 18–30: Cross-sections of the leaves, a sequence from the base to the apex. — 31: Capsule immersed in the perichaetial leaves. — 32, 33: Perichaetial leaves. — 34: Cells at the shoulder of the perichaetial leaf. — 35: Capsule with the seta. — 36: Exothecial cells in the middle of the urn. — 37: Exothecial cells at the base of the urn and stoma. — 38: Exothecial cells at the orifice, annulus and spores. — 1, 3–5, 8–9, 12–19, 25, 26, 31, 34–38 drawn from *Ochyra 1829/80*, KRAM-B (holotype); 2 from *Ochyra 1994/80*, KRAM-B; 6, 7, 24, 27, 29, 32, 33 from *Smith 689*, AAS; 10, 11, 20–23, 28–30 from *Ochyra 2009/80*, KRAM-B. — Scale bars: a: 1 mm (32, 33, 35); b: 1 mm (31); c: 1 mm (6–11) and 2 mm (1, 2); d: 100 μm (3–5, 12–30, 34, 36–38).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tose spots, becoming rectangular to linear-rectangular in the middle and near the base of the lamina, transparent, up to 90 µm long, 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 hyaline border extending from the mid-leaf to the base; angular cells not differentiated; lamina cells in the subula mostly isodiametric, rounded or elliptic, 6–16 µm long, 4–6 µm wide, 2–3-stratose, rarely unistratose, short rectangular, up to 22 µm long over the costa. Costa single, yellow–brown, subpercurrent to percurrent, 60–70 µm wide at the base, occupying most of the width of the subula and gradually and invisibly merging into the multistratose lamina cells, smooth 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 ventral cells.

Autoicous. Perigonia bud-like, about 1 mm long, sessile on the short lateral branchlets just below the perichaetium; perigonial bracts similar to the vegetative leaves but smaller, up to 1.5 mm long; antheridia few, pale brown intermingled with the filiform, pale brown paraphyses slightly exceeding them. Perichaetia terminal with solitary sporophytes; outer perichaetial leaves similar to the vegetative leaves, only somewhat larger and more abruptly narrowed into the subula; the innermost perichaetial leaves strongly modified, enlarged and clasping at the base, 6.0–7.5 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; areolation similar to that in the vegetative leaves, costa stronger, up to 120 µm wide at the base. Sporophytes terminal; setae erect, yellow–brown, not twisted when dry, about 2 mm long; vaginula ca. 1 mm long with thin-walled epidermal cells; capsules immersed in the perichaetial leaves, erect to somewhat inclined, symmetric or slightly gibbous, smooth to slightly wrinkled with age, brown, lustrous, short cylindrical, 1.3–1.5 mm long, slightly narrowed at the mouth and abruptly constricted into the seta; 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 rim, cells at the rim much smaller, forming a distinct, orange–brown strip composed of 4–6 rows of cells; exothecial 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; operculum conical, long rostrate, with a straight or somewhat slanted beak, ca. 1/2 length of the urn; calyptra cucullate, smooth; annulus present, compound, revoluble, composed of 1 outer row of large, thin-walled cells and 1 row of smaller basal cells; peristome absent. Spores 20–26 µm wide, brownish, finely papillose-verrucose.

Other specimens seen (paratypes). — **South Orkney Islands**. Signy Island, Factory Bluffs, lat. 60°43´S, long. 45°37´W, alt. 200 ft (ca. 65 m), rock crevice in north-facing cliff of quartz-mica schist, snow petrels nesting nearby; 18.II.1966, *Smith 869* (AAS, KRAM-B). **South Shetland Islands**. King George Island, Admiralty Bay: MacKellar Inlet, Wegger Peak above Crépin Point, lat. 62°05´30´´S, long. 58°32´W, elev. 310 m, on soil in crevices of andesite rocks on the western slope, 16.II.1980, *Ochyra 1994/80* (KRAM-B); same locality, elev. 320 m, on bare clayey soil atop the nunatak, 16.II.1980, *Ochyra 2006/80* (KRAM-B); same locality, elev. 320 m, on soil over the rock ledge on northern slope in slightly moist situation associated with *Herzogobryum teres*, 16.II.1980, *Ochyra 2009/80* (KRAM-B, NY). MacKellar Inlet, Crépin Point, lat. 62°05´30´´S, long. 58°28´W, elev. 10 m, in crevices of an andesite block, 16.II.1980, *Ochyra 2042/80* (KRAM-B). Livingston Island: South Bay, Hurd Peninsula, Juan Carlos I Station region, rock formation east of the base, vertical rock surface with small vertical cracks, collecting site no. 178, elev. 50 m, 14.II.1992, *Schulz s.n.* (AAS, H, KRAM-B).

DISCUSSION

Ditrichum lewis-smithii is a peculiar and unmistakable species, which occupies an isolated position in the genus *Ditrichum*. It is characterized by the following combination of diagnostic features: (1) peristome absent; (2) setae short, ca. 2 mm long; (3) capsules deeply immersed in the perichaetial leaves; (4) lamina cells mostly isodiametric to short rectangular and bistratose at the leaf shoulders; (5) leaf lamina 2–3-stratose in the subula. In its gymnostomous capsules this species differs at once from all other congeners, all other *Ditrichum* species having normally developed peristome teeth.

The immersed capsules are another strange character of *Ditrichum lewis-smithii*. The only other member of this genus with similar capsules is *D.*

immersum, a species known from the sub-Antarctic islands Îles Crozet and Marion Island (Van Zanten 1971) and recently recorded also from Heard Island [Dovers Moraine, ca. 1 km SW of Spit Bay Station, 15.III.1993, *Donaldson 241*, KRAM-B] in this region. However, this species differs from *D. lewis-smithii* in having normally developed peristome teeth. Additionally, the following characters are helpful in separating the two species: plants of *D. immersum* are large and robust; the vegetative leaves are 4–7 mm long, rigid and erect; the lamina cells at the shoulders are unistratose or bistratose only in a few rows of cells adjacent to the costa and entirely unistratose in the subula; the outer cortex of the stem consists of 3–4(–5) rows of small cells with strongly incrassate, deeply yellow walls; the perichaetial leaves are large, up to 9 mm long; the setae are shorter, 1.0–1.5 mm long. In contrast, the plants of *Ditrichum lewis-smithii* are smaller, the leaves are also smaller, 2.0–2.5 mm on the average, with flexuose, erecto-patent to widespread subulae, and the lamina cells are entirely bistratose at the shoulders, giving them an obscure appearance, whereas the lamina cells in the subula are mostly 2–3-stratose and only occasionally unistratose. The outer stem cortex is composed of only 2(–3) layers of cells with moderately incrassate walls. The perichaetial leaves are smaller, up to 7.5 mm long and the setae relatively longer reaching about 2 mm in length.

As with other species of *Ditrichum*, *D. lewis-smithii* is an epigean moss growing on bare ground, on soil covering rock ledges and on humus in rock crevices. It forms almost monospecific tufts or short turfs sometimes intermingled with tiny liverworts such as *Cephaloziella varians* (Gott.) Steph. and *Herzogobryum teres* (Carringt. & Pears.) Grolle. The species occupies dry habitats, although some samples were collected in a moist situation on King George Island.

The genus *Ditrichum* is well represented in the southern temperate region. Seppelt (1982) reported eleven species from Australia and New Zealand. On the other hand, it requires a careful taxonomic assessment in the South American and adjacent Antarctic sector of the austral region. Greene (1986) listed 15 species from southern South America, South Georgia and Antarctica, but the final number of species will probably be less since some local species are doubtless conspecific with others. For example, the South Georgian endemic *D. perporodictyon* Dix. proved to be identical with *Chorisodontium aciphyllum* (Hook. f. & Wils.) Broth. (Ochyra 1994). On the other hand, the case of *D. lewis-smithii* indicates that unexpected new discoveries like new species are still possible in this region.

In the Antarctic botanical zone which comprises all land south of latitude 60°S together with the South Sandwich Islands and Bouvetøya (cf. Greene 1964) species of *Ditrichum* are uncommon and confined only to the northern maritime Antarctic region (*sensu* Lewis-Smith 1984a). *Ditrichum austro-georgicum* (Card.) Seppelt is a quite widespread species in the South Shetland Islands including King George Island (Ochyra *et al.* 1986), Livingston Island (Schulz 1993) and Deception Island (Lewis-Smith 1984bc) and *D. brotherusii* (R. Br. ter.) Seppelt was reported by Robinson (1972, as *Pseudodistichium fuegianum* Roiv.) and Ochyra (1996) from the Livingston and Deception Islands, respectively.

Ditrichum austro-georgicum and *D. brotherusii* occasionally produce sporophytes in Antarctica, so recognition of these species from *D. lewis-smithii* is easy, because their capsules are exserted on long setae. The sterile material of these species also does not pose special problems in identification since the costa in these species is very strong, over 100 µm in width, and excurrent. Moreover, the lamina cells at the shoulders are unistratose and some sterile populations of *D. brotherusii* produce rhizoid tubers (Ochyra 1996), which are completely missing from *D. lewis-smithii*.

The Antarctic representatives of *Ditrichum* can be distinguished by the following key:

1. Costa very broad, 100–180 µm wide at the base; lamina cells unistratose at the leaf shoulders; capsule exserted on a long seta; peristome present 2
1. Costa narrow, 60–70 µm wide at the base; lamina cells bistratose at the leaf shoulders; capsule immersed in the perichaetial leaves; peristome absent .... *D. lewis-smithii*
   2. Costa broad, (140–)150–180 µm wide at the base; spores multicellular, to 80 µm in diameter .... *D. brotherusii*
   2. Costa narrow, to 120 µm wide at the base; spores unicellular, less than 30 µm in diameter .... *D. austro-georgicum*

There have been many moss species described

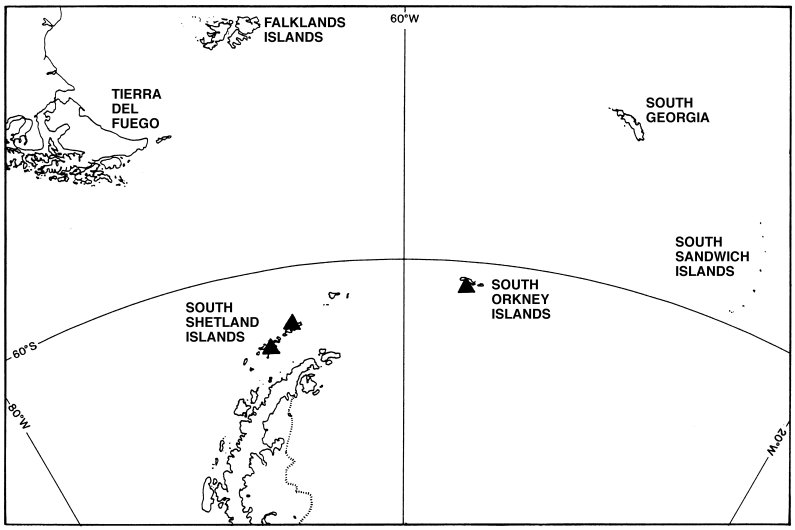

Fig. 2. Distribution map for *Ditrichum lewis-smithii* Ochyra.

as endemics from the Antarctic (Cardot 1908), but later revisions revealed them to be conspecific with species widely distributed in more northerly latitudes. A high level of moss endemism seems to be improbable in this continent and offshore archipelagoes because they were completely covered by continental glaciation during the Pleistocene, so its bryophyte flora is generally believed to have been totally eradicated. However, as more data accumulate, this concept needs a careful verification since there are some moss species which are indeed endemic to Antarctica, at least they have not been recorded hitherto from elsewhere, e.g. *Schistidium steerei* (Ochyra 1987). Now this small group of endemics has been augmented by the distinct and taxonomically isolated *Ditrichum lewis-smithii,* which has a relatively wide range covering the South Orkney and South Shetland Islands (Fig. 2).

It is also worth noting that *Andreaea gainii* Card. has not been recorded from outside the Antarctic botanical zone, and *A. depressinervis* Card., which is also a taxonomically isolated species, is known only from Antarctica and South Georgia. These data seem to support firmly a hypothesis that at least some taxa of mosses could have survived the Pleistocene glaciation in some local refuges from which they might subsequently have spread into newly ice-free terrain after recession of the ice-cap. Naturally, the chance of their discovery in more northerly areas is still possible, especially as more areas in southern South America are explored.

Acknowledgements. I am grateful to Drs Helen J. Peat and Ronald I. Lewis-Smith (British Antarctic Survey, Cambridge) and Dr Florian Schulz (Institut für Polar Ökologie, Kiel) for lending me the herbarium specimens. I also acknowledge the help of Curators and Keepers in several world herbaria, especially BM, H, PC, S, for kindly allowing me to study their collections of *Ditrichum* species. Dr Ronald I. Lewis-Smith kindly commented on the manuscript and improved the English text and his assistance is gratefully acknowledged. Finally, I would like to thank my wife, Halina Bednarek-Ochyra, for the drawings.

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