

Occurrence of the neotropical moss *Dicranella hilariana* (Mont.) Mitt. in the Antarctic

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Abstract. *Dicranella hilariana* (Mont.) Mitt., a pan-neotropical moss species, is reported for the first time from the Antarctic botanical zone. It was found on geothermally heated ground near fumaroles on Visokoi, Candlemas and Bellingshausen Islands in the volcanic archipelago of the South Sandwich Islands. *Dicranella recurvata* Ochyra, Arts & Lewis-Smith, *nom. nud.*, is reduced to synonymy with *D. hilariana*. The Antarctic plants of *D. hilariana* are briefly described and illustrated, including the rhizoidal tubers which have not previously been reported in this species. The global distribution of *D.*

hilariana is briefly reviewed and mapped. It is suggested that the species reached the Antarctic via long-distance dispersal from South America by the prevailing strong westerly winds.

Antarctica is defined by most botanists as all land south of lat. 60°S, together with the South Sandwich Islands and extremely isolated island of Bouvetøya, both of which are of relatively recent volcanic origin; the former archipelago lies

between lat. 56°18'S and 59°28'S and the latter at lat. 54°25'S. These more northerly islands share the same general climatic, glaciological and floristic features as the Antarctic continent and its offshore islands (Greene 1964, Lewis-Smith 1984a). Both the South Sandwich Islands and Bouvetøya have experienced recent volcanic activity, a phenomenon restricted to only one other maritime Antarctic island (Deception I. in

the South Shetland Islands) and three volcanoes in Victoria Land, continental Antarctica.

Volcanic activity in the Antarctic biome creates unique habitats, including geothermal substrata around fumaroles, and these are very favourable for bryophyte colonization in an otherwise inhospitable environment (Longton & Holdgate 1967, Lewis-Smith 1984b, c, 1988, 2000). Consequently, within the Antarctic some moss and liverwort species have been found exclusively in such habitats, or they attain their maximum frequency or abundance here. Examples include *Campylopus pyriformis* (K. F. Schultz) Brid. at the summit of Mt. Melbourne, Victoria Land (Broady et al. 1987, Meurk 1989), and *Philonotis acicularis* (Müll. Hal.) Kindb., *Racomitrium lanuginosum* (Hedw.) Brid., *R. heterostichoides* Card. and *Ditrichum conicum* (Mont.) Mitt. on Deception Island (Lewis-Smith 1988, Ochyra & Lewis-Smith 1998). Within the Antarctic, the most diverse and extensive bryophyte flora associated with geothermal habitats occurs on various islands of the South Sandwich Islands archipelago (Grolle 1972, Longton & Holdgate 1979, Convey et al. in press). The Antarctic distribution of several liverwort species is restricted to such sites on these islands, e.g., *Clasmatocolea rigens* (Hook. f. & Tayl.) Engel, *Lophocolea lenta* (Hook. f. & Tayl.) Gott., *Riccardia georgiensis* (Steph.) Hässel and *Triandrophyllum subtrifidum* (Hook. f. & Tayl.) Fulf. & Hatch.; also, *Cryptochila grandiflora* (Lindenb. & Gott.) Grolle is very common here and is known elsewhere in the Antarctic only on the volcanic Deception Island. Likewise, the mosses *Campylopus introflexus* (Hedw.) Brid., *C. spiralis* Dusén, *Racomitrium orthotrichaceum* (Müll. Hal.) Paris and *Ditrichum heteromallum* (Brid.) Britt. are known exclusively from this archipelago, while *Anisothecium hookeri* (Müll. Hal.) Broth. and *Ditrichum gemmiferum* Ochyra & Lewis-Smith are again known only from Deception Island. This account reports an additional moss species associated exclusively with volcanic areas in Antarctica, namely *Dicranella hilariana* (Mont.) Mitt. which has been recorded on three of the South Sandwich Islands.

The South Sandwich Islands are an isolated archipelago of eleven islands stretching over 390 km from north to south in the South

Atlantic sector of the Southern Ocean southeast of the sub-Antarctic island of South Georgia (Kemp & Nelson 1931, Holdgate & Baker 1979). Because of difficult access, the islands have rarely been visited by biologists and until the early 1960s no professional botanists had visited this region. In 1964 R. E. Longton and M. W. Holdgate (British Antarctic Survey) carried out a botanical survey and made a comprehensive collection of bryophytes and lichens. The bryophyte species of the South Sandwich Islands were listed and their ecology described by Grolle (1972) and Longton and Holdgate (1979). In 1998 a more extensive biological survey of the archipelago was conducted by P. Convey (British Antarctic Survey) when again a large collection of plants and lichens was made (Convey et al. in press). All specimens of both collections are held in the herbarium of the British Antarctic Survey, Cambridge (AAS) and duplicates of the latter are also preserved in KRAM.

The bryophytes in the latter collection were examined by the first two authors who noted an unusual specimen of *Dicranella* from Bellingshausen Island. It was characterized by having lanceolate leaves with recurved and mostly bistratose margins. The moss was sterile but frequently produced rhizoidal tubers. It was unlike any other species of *Dicranella* known from Antarctica where the genus is represented by two species. However, these are now known to belong to *Anisothecium* Mitt., a segregate of the large and heterogeneous genus *Dicranella*, namely *A. cardotii* (R. Br. ter.) Ochyra and *A. hookeri* (Ochyra 1998, Ochyra et al. 1998). Also, all sub-Antarctic species appeared to be dissimilar to the South Sandwich Islands moss, although it should be noted that *Dicranella* (incl. *Anisothecium*) is poorly represented in the sub-Antarctic region (Ochyra 1999). Consequently, the material was initially intended to be described as a new species, *Dicranella recurvata*.

During the course of our study we examined some previously undetermined mosses from the South Sandwich Islands preserved in AAS which had been collected during the 1964 survey and had not been referred to by Longton and Holdgate (1979). Several of these specimens which had been provisionally determined only as "dicranaceous moss" belonged to this putative

new *Dicranella* and some of which were collected in quantity on two other islands of the archipelago. Again, these collections consisted of only sterile plants. Detailed examination of these specimens have revealed that they belong within *Dicranella hilariana* (Mont.) Mitt., a pan-neotropical species.

***Dicranella hilariana* (Mont.) Mitt.**

(Fig. 1)

D. recurvata Ochyra, Arts & Lewis-Smith in Glowacki & Bedarek, Polish Polar Stud. 25 Int. Polar Symp. : 166. 1998, *nom. nud.* ORIGINAL MATERIAL: Antarctica, South Sandwich Islands, Bellingshausen Island: small circular heated area, knoll on crater rim W of access point, alt. 170 m., lat. 59°26'S, long. 27°05'W, 21 Jan 1997, leg. P. Convey 31 – AAS!, KRAM!

Plants small, light to yellowish-green, dull, in cushions 5–13 mm high, sometimes higher because of innovations. *Stems* simple or occasionally forked, brown, in cross-section rounded or oval, with a large and distinct central duct and consisting of an indistinct cortex of relatively large cells with slightly thickened, brown or yellowish-brown walls and 3–4 layers of large, thin-walled medullary cells. *Rhizoids* scattered at stem base, pale to dark brown, smooth, branched; *rhizoidal tubers* infrequent, pale brown to reddish-brown, consisting of a straight or little bent uniseriate row of 1–5 large subspherical swollen cells, 50–90 µm in diameter, usually with a small lenticular initiating cell at the distal end of large cells, 25–35 µm in diameter. *Axillary hairs* filiform, 3–4-celled, with 2–3 basal cells brown and elongate hyaline apical cell. *Leaves* narrowly lanceolate, erect to erect-flexuose or subsecund, 1–2 mm long, 0.3–0.5 mm wide at base, non-decurrent, gradually tapered to a narrow, blunt, subentire or bluntly serrulate apex; *margins* recurved on both sides from near the base to the apex, sometimes strongly so, bistratose almost throughout in one row of cells; *costa* strong, 40–60 µm wide at the insertion, dark yellow to yellow-brownish, subpercurrent, in cross-section strongly convex dorsally, consisting of many substereid cells surrounded by larger epidermal cells; *laminal cells* variable in shape, short-rectangular to linear, straight with truncate

apices, non-porose, pale, 5–8(–10) µm wide, (15–)20–120(–150) µm long, becoming shorter towards the apex, thin- to thick-walled, unistratose except for the margins, not differentiated at the basal angles. *Dioecious*. *Male plants* with conspicuous gemmiform, brown perigonia; outer perigonial bracts from an ovate or elliptical base abruptly contracted to a long subulate point. *Perichaetial leaves* not different from the upper vegetative leaves. *Sporophytes* not seen in Antarctic specimens.

ADDITIONAL SPECIMENS SEEN. SOUTH SANDWICH ISLANDS. VISOKOII ISLAND. Finger Point, central area of fumarole, lat. 56°41'S, long. 27°13'W, 18 Mar 1964, *Holdgate 861* (AAS, KRAM). CANDLEMAS ISLAND. By steaming lake on western shore, lat. 57°03'S, long. 26°40'W, alt. ca. 35 m; among boulders with steam rising between them, 11 Mar 1964, *Holdgate 632* (AAS, KRAM); outer rim of principal volcanic crater. south facing slope of main cone, lat. 57°03'S, long. 26°40'W, alt. ca. 200 m; on fine ash, ground hot, 11 Mar 1964, *Holdgate 621* (AAS, KRAM). BELLINGSHAUSEN ISLAND. South slopes, lat. 59°25'S, long. 27°03'W, alt. ca. 25 m; central zone of fumarole region, 9 Mar 1964, *Holdgate 813* (AAS, KRAM); south slopes of main cone, lat. 59°25'S, long. 27°03'W, alt. ca. 100 m; mixed mats on wet ground around steam vents, 13 Mar 1964, *Holdgate 411B* (AAS, KRAM).

Dicranella hilariana is a very distinct and unmistakable species, easily recognized by its recurved leaf margins which is a unique feature in *Dicranella*. The Antarctic plants perfectly match in all details plants examined by us from various neotropical stations. In fact, *D. hilariana* is a very variable species and Crum (1994) provided a list of many heterotypic synonyms which clearly confirmed its highly polymorphous nature. In particular, the leaf areolation is subject to considerable variation. Many authors in their descriptions of this species (e.g., Florschütz 1964, Crum & Anderson 1981, Lisboa 1993, Crum 1994) have reported that the maximum length of the laminal cells is ca. 75 µm. However, in all specimens we have examined from various neotropical sites there were numerous laminal cells exceeding 100 µm in length, and occasionally

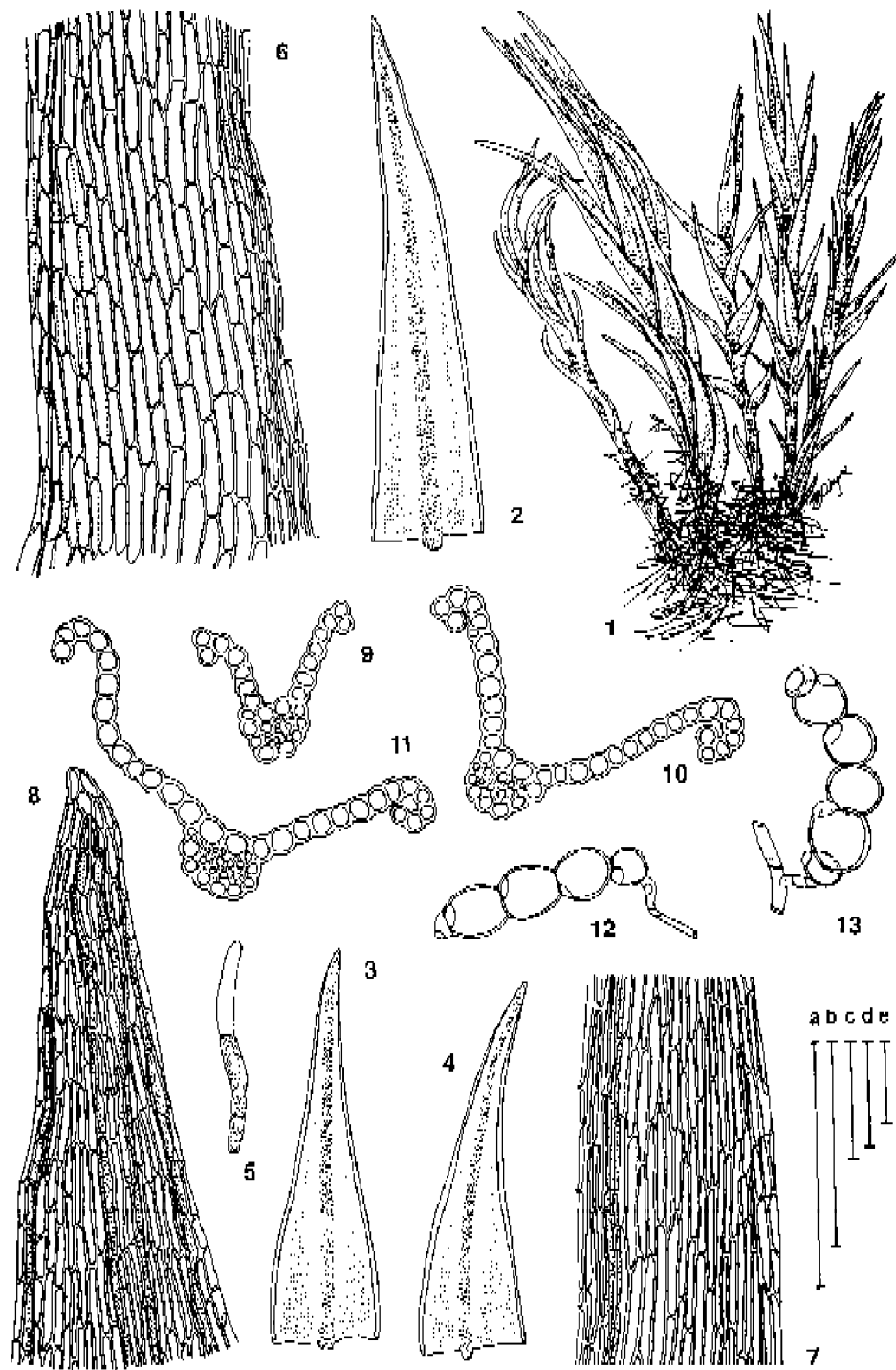


Fig. 1: *Dicranella hilariana* (Mont.) Mitt. **1:** Habit. **2–4:** Leaves. **5:** Axillary hair. **6:** Basal leaf cells. **7:** Mid-leaf cells. **8:** Leaf apex. **9–11:** Leaf cross-sections. **12–13:** Rhizoidal tubers (all drawn from Convey 31, KRAM). Scale bars: a – 100 μ m (6–8); b – 1 mm (1) and 100 μ m (5); c – 100 μ m (9–11); d – 1 mm (2–4); e – 100 μ m (12–13).

reaching 150 μm .

The rhizoidal tubers have not previously been described in *Dicranella hilariana*, but they are not exceptional in this genus. They have been described and illustrated in most European species of *Dicranella* and often they have diagnostic value (Whitehouse 1966, 1969, Risse 1986, Ochyra 1988). However, as far as we are aware, this is the first report of rhizoidal tubers in this neotropical *Dicranella*.

In the South Sandwich Islands *Dicranella hilariana* grows exclusively on moist or wet ashy soil on heated ground, on clayey soil and fine ash around steam vents on slopes of the volcanic craters. Its altitudinal range extends from 30 to 200 m a.s.l. It grows scattered among other mosses or sometimes forms compact cushions or short turfs. The most common associates are the mosses *Ditrichum hyalinum* (Mitt.) Kuntze, *Kiaeria pumila* (Mitt.) Ochyra, *Notoligotrichum trichodon* (Hook. f. & Wils.) G. L. Sm., *Pohlia nutans* (Hedw.) Lindb., *Sanionia georgico-uncinata* (Müll. Hal.) Ochyra & Hedenäs and *Brachythecium glaciale* Schimp., and liverworts *Cryptochila grandiflora* and *Marchantia berteroaana* Lehm. & Lindenb.

Dicranella hilariana is a pan-neotropical species extending from the southeastern United States in North America to Uruguay in South America (Fig. 2). Despite this very wide distribution it appears to have a rather scattered and discontinuous range. However, this may be a result of undercollecting in some regions rather than a real phenomenon. Throughout its range it is a predominantly lowland species occurring from near sea level to the lower montane belt, but reaching its highest elevation at 2700 m in Colombia (Churchill et al. 1995). It grows on clay and sandy soil, usually on disturbed habitats such as roadbanks and the sides of ditches.

In the United States *Dicranella hilariana* extends from South Carolina south to Florida (Crum & Anderson 1981, Reese 1984) and west to eastern Texas (Whitehouse & McAllister 1954). In Central America it ranges from southern Mexico (Crum 1994) to Costa Rica (Allen 1994) on the isthmus, and it also occurs on all major islands in the West Indies, including Cuba (Duarte Bello 1997), Hispaniola (Buck & Steere 1983), Jamaica

(Crum & Bartram 1958) and Puerto Rico (Crum & Steere 1958). In South America it is widely distributed in all countries north of the Tropic of Capricorn including the Guianas (Florschütz 1964), Venezuela (Pursell 1973), Colombia (Churchill et al. 1995), Ecuador (Steere 1948; Churchill 1994) including the Galapagos Islands (Gradstein & Weber 1982), Peru (Menzel 1992), Bolivia (Hermann 1976), and Brazil (Yano 1981, 1989, 1995; Lisboa 1993; Churchill 1998), and Uruguay (Gibert 1873; Herter 1933).

Thus, the discovery of *Dicranella hilariana* in the South Sandwich Islands in the Antarctic botanical zone represents a major range extension of this species towards the south and east. It is the first instance of the occurrence of a typically tropical moss in the Antarctic biome where the moss flora comprises predominantly bipolar and austral cool temperate species (Ochyra 1998; Ochyra et al. 1998). There are, however, some Antarctic moss species which occur in the northern Andes, for example *Schistidium falcatum* (Hook. f. & Wils.) Bremer, *Holodontium strictum* (Hook. f. & Wils.) Ochyra, *Brachythecium austrosalebrosus* (Müll. Hal.) Kindb. and *Anisothecium cardotii* (R. Br. ter.) Ochyra but, in general, they are austral cool temperate species penetrating far into the tropics along the Andean cordillera and usually occurring at high elevations. Conversely, *D. hilariana* is a typically lowland neotropical species which has hitherto not been recorded beyond lat. 35°S.

The exceptional occurrence of *Dicranella hilariana* in Antarctica has almost certainly been possible because of the special environmental criteria prevailing in some parts of the South Sandwich Islands. The unstable, moist and geothermally warmed sites provide conditions similar to those of its typical tropical habitats in which this species successfully thrives. As is the case with most Antarctic mosses, *D. hilariana* reached the South Sandwich Islands via long-distance dispersal. The islands lie in the path of the strong prevailing westerly winds which could readily transport spores from southern South America (see, for example, Lewis Smith 1991). Furthermore, it is possible that populations could be successfully established by its rhizoidal tubers, as these could also be transported by air currents



Fig. 2: Global geographical distribution of *Dicranella hilariana* (Mont.) Mitt.

from South America and subsequently germinate in ecologically favourable niches near the fumaroles.

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