MORPHOLOGICAL VARIATION AND TAXONOMIC INTERPRETATION IN THE MOSS GENUS *BRYUM* IN ANTARCTICA

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Abstract: The potential for morphological variation in Antarctic species of *Bryum* is evaluated and related to problems associated with taxonomic interpretation based on specimens from the Sôya Coast, Mac. Robertson Coast, Vestfold Hills and Knox Coast.

B. argenteum HEDW. has been positively determined for Continental Antarctica from six localities on the Sôya Coast and from Ross Island, southern Victoria Land. Specimens from the Vestfold Hills and Knox Coast considered with some reservation as this species are here referred to *B. pseudotriquetrum* (HEDW.) GAERTN, MEYER et SCHERB.

B. pseudotriquetrum is widespread in the Antarctic region and includes many species formerly regarded as distinct taxa. Small specimens and those with physical damage to the upper parts of leaves may confused with *B. argenteum.*

It is concluded that only two species of *Bryum*, *B. argenteum* and *B. pseudotriquetrum*, are represented in the Continental Antarctic flora, confirming H. OCHI's (Mem. Natl Inst. Polar Res., Spec. Issue, **11**, 70, 1979) taxonomic conclusion.

1. Introduction

The moss flora of Continental Antarctica is characterized by few but widespread species. The genera *Grimmia*, *Schistidium*, *Ceratodon*, *Pottia*, *Bryoerythrophyllum*, *Sarconeurum* and *Bryum* are represented in the flora.

Bryum is the most abundant and widespread genus in the flora. It is arguably the most variable in morphology and more species have been reported in this than any other genus.

DIXON and WATTS (1918) recognized that specimens determined as *Bryum antarcticum* HOOK. f. et WILS., showed considerable variation in morphological characters. He regarded *B. austropolare* CARD., *B. filicaule* BROTH., *B. gerlachei* (CARD.) CARD., *B. inconnexum* CARD., and possibly *B. algens* CARD., as synonyms of *B. antarcticum*. Later, BARTRAM (1938) also considered *B. austropolare* to be synonymous with *B. antarcticum*. HORIKAWA and ANDO (1961) considered that, based on descriptions, *B. antarcticum*, *B. filicaule* and *B. gerlachei* resembled each other and that they differed from *B. inconnexum* and *B. austropolare*. They also regarded *B. austropolare* and *Webera racovitzae* CARD. var. *laxiretis* CARD. as synonyms of *B. inconnexum*, and furthermore, they described *B. ongulense* and *B. inconnexum* var. *fragile* as new, which differed from *B. inconnexum* and *B. antarcticum*, and distinguished *B. perangustidens*

CARD., *B. imperfectum* CARD., and *B. crateris* DIX. specifically from *B. ongulense*. Later, however, HORIKAWA and ANDO (1967) were inclined to regard these taxa as morphological variants of *B. inconnexum*.

NAKANISHI (1979) studied morphological variation in leaves of *B. inconnexum* and admirably demonstrated the potential for phenotypic plasticity in Antarctic moss species and thus the potential for taxonomic confusion or misinterpretation.

OCHI (1979) reviewed the taxonomy of much of the genus *Bryum* in Antarctica. He recognized only two species, namely *B. argenteum* HEDW. and *B. pseudotriquetrum* (HEDW.) GAERTN., MEYER et SCHERB., also recognizing many indeterminable specimens. He reduced *B. amblyolepis* CARD. to synonym of *B. argenteum* and considered *B. siplei* BARTR. to be possibly conspecific with *B. argenteum*. He also reduced *B. inconnexum*, *B. crateris*, *B. perangustidens* and *B. ongulense* to synonymy with *B. pseudotriquetrum*. He (OCHI, 1970) previously had reduced *B. gerlachei* and *B. austropolare* to synonymy with that species. Although the type specimens of *B. filicaule* and *B. imperfectum* were not located by him, CLIFFORD (1957) treated the former species as a synonym of *B. antarcticum*. KANDA (1981a) considered the type material of *B. antarcticum* collected from Cockburn Island to be *Pottia heimii* (HEDW.) HAMPE. It is conceivable that during the earlier studies by CARDOT (1907), DIXON and WATTS (1918), BARTRAM (1938) and possibly others, all material of *Bryum* may have removed from what was possibly a mixed collection of *Bryum* and *Pottia*.

SAVICZ-LJUBITSKAJA and SMIRNOVA (1959) described an aquatic species *B. korotkevicziae* and later (SAVICZ-LJUBITSKAJA and SMIRNOVA, 1960) a variety *hollerbachii*, both from Bunger Hills region. KASPAR *et al.* (1982) reported an aquatic moss from Lake Vanda and inferred that *B. korotkevicziae* and its var. *hollerbachii* were an ecological morphotype of *B. algens*. Independently, SEPPELT (1983) concluded that *B. korotkevicziae* and its var. *hollerbachii* should be considered synonymous with *B. algens*.

There is an increasing interest in taxonomic, biogeographic, ecological and physiological studies of the Continental Antarctic flora. The taxonomy of such species is thus becoming critical to these studies. The present study has been undertaken in order to evaluate the potential for morphological variation in Antarctic species of *Bryum* and to relate this variation to taxonomic interpretation. Over many years we have made detailed field observations and collections of mosses from coastal Continental Antarctica extending from 38°E to 111°E. Additional studies have also been made with collections from Victoria Land, and from King George Island in the Maritime Antarctic region.

Collections we have made are currently housed in herbaria at the Antarctic Division, Kingston, Tasmania, Australia and the National Institute of Polar Research (NIPR), Tokyo.

2. Results and Discussion

2.1. *Distribution and morphological variation of Bryum argenteum in the Sôya Coast area*

Bryum argenteum is known from a number of collections and localities in the

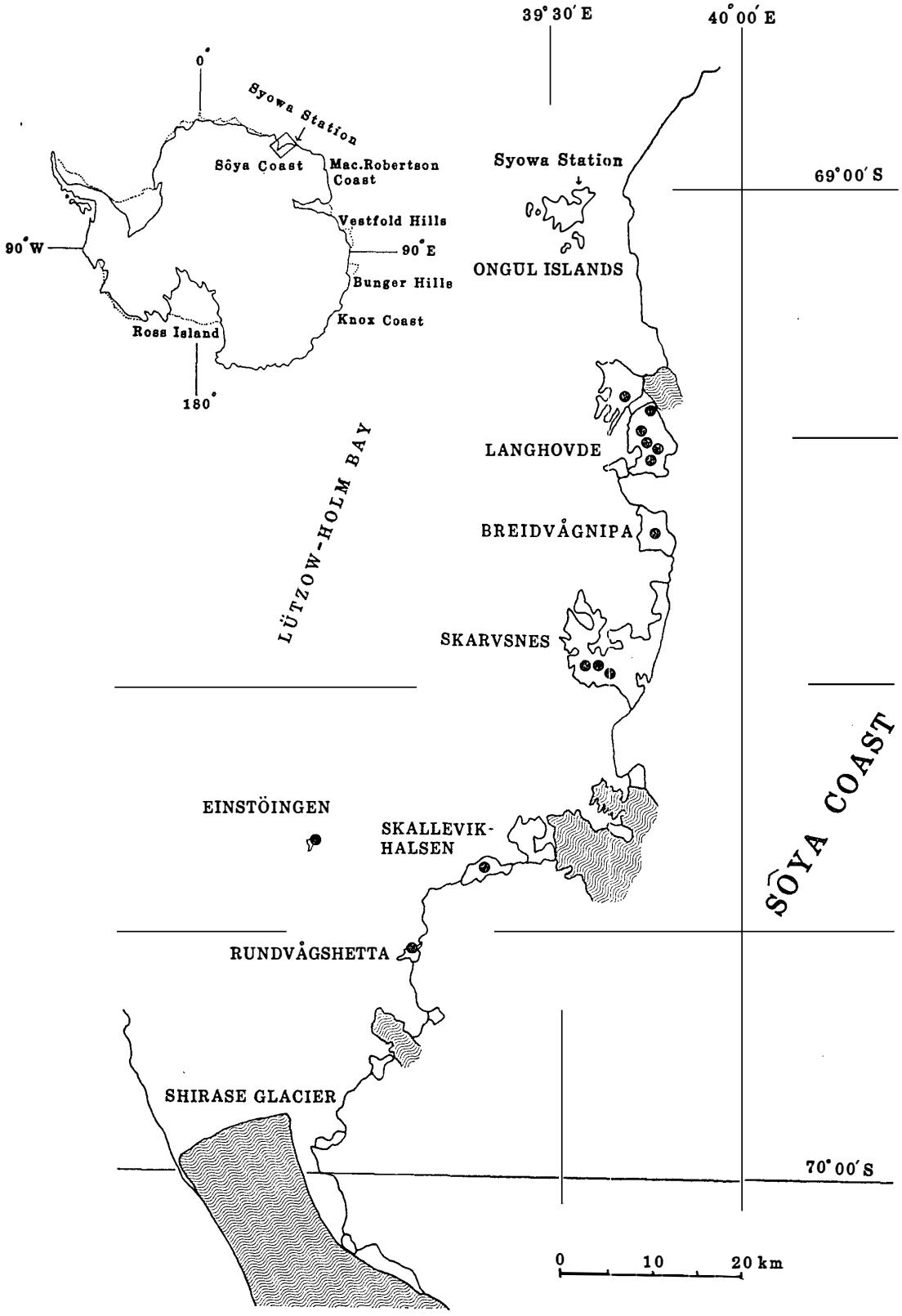

Fig. 1. Distribution of Bryum argenteum *Hedw. in ice-free areas along the Sôya Coast.* ● *Collection localities.*

Sôya Coast area (Fig. 1). Of the specimens studied, 41 collections were determined as this species. These collections have been compared with specimens of *B. argenteum* from King George Island (Maritime Antarctic), Macquarie Island (Subantarctic), and Canada (Kamloops, British Columbia).

HORIKAWA and ANDO (1961) studied three collections made by the early expedition of the Japanese Antarctic Research Expedition during 1957–1960 from East Ongul and West Ongul Islands. They observed leaves with the characteristically obtuse apex and with the costa ceasing below the apex of the leaf. From a determination of the chromosome number in this species by TATUNO (1963), the species was considered to be synoicous and a diploid form of ordinary *B. argenteum* which was observed in specimens from temperate regions. However, HORIKAWA and ANDO (1967) considered that the Ongul Islands plants of *B. argenteum* may be more appropriately treated as a variety or possibly even as a separate species. Furthermore, NAKANISHI (1977) mentioned that the Antarctic plants of *B. argenteum* reported by HORIKAWA and ANDO (1961) might be a morphotype of *B. inconnexum*, which is also synoicous and had a chromosome number of $n=20$. In the same paper, NAKANISHI first reported typical haploid plants of *B. argenteum* from some ice-free areas along Sôya Coast. These collections indicated chromosome number of $n=10$ and are dioicous (INOUE, 1976), and were confirmed as that species by OCHI (1979). In the dioicous form of *B. pseudotriquetrum*, the chromosome numbers have usually been $n=10$ or 11 except $n=20$ reported by ANDERSON and CRUM (1959). Whereas those of the synoicous form, namely *bimum* type of *B. pseudotriquetrum*, are known to be $n=20$, 22, 23 (FRITSCH, 1982). Since the chromosome number in the Antarctic *B. pseudotriquetrum* is $n=20$, it may be reasonably considered the *bimum* type of this species. As a result of determination in a modern sense, NAKANISHI (1977) and KANDA (1981b) both compiled distributions of the species in Sôya Coast and Prince Olav Coast.

We observed considerable variation in the following morphological characters in the Antarctic specimens of *B. argenteum*. Leaves are obtuse to more or less acute at the apex; they range 0.3–1.2 mm in length, 0.25–0.5 mm in width, and generally the upper 1/3–1/2 is hyaline. Median laminal cells vary considerably in size, ranging 15–75 μm long and 10–25 μm wide, and in shape, from more or less rhomboid to rectangular to hexagonal to elongated hexagonal. Costa length ranges as about 1/2–3/4 as the whole leaf length. In some leaves, the costa is much shorter and occasionally it is almost lacking. The lower marginal cells of the leaf are scarcely inflated and are weakly reddish pigmented, both features being characteristic of Antarctic specimens of *B. pseudotriquetrum*. Such smaller specimens could be misdetermined as *B. argenteum*.

The specimens from Sôya Coast were collected from various sites near the sea level to 265 m altitude. Their habitats contain the coast near the sea to higher peaks, somewhat distant from the coast, and often near nesting sites of snow petrels (*Pagodroma nivea*). Morphological variation in *B. argenteum* at different localities is discussed below.

In the specimens from Yukidori Valley and Koke Strand, Langhovde (Fig. 2:

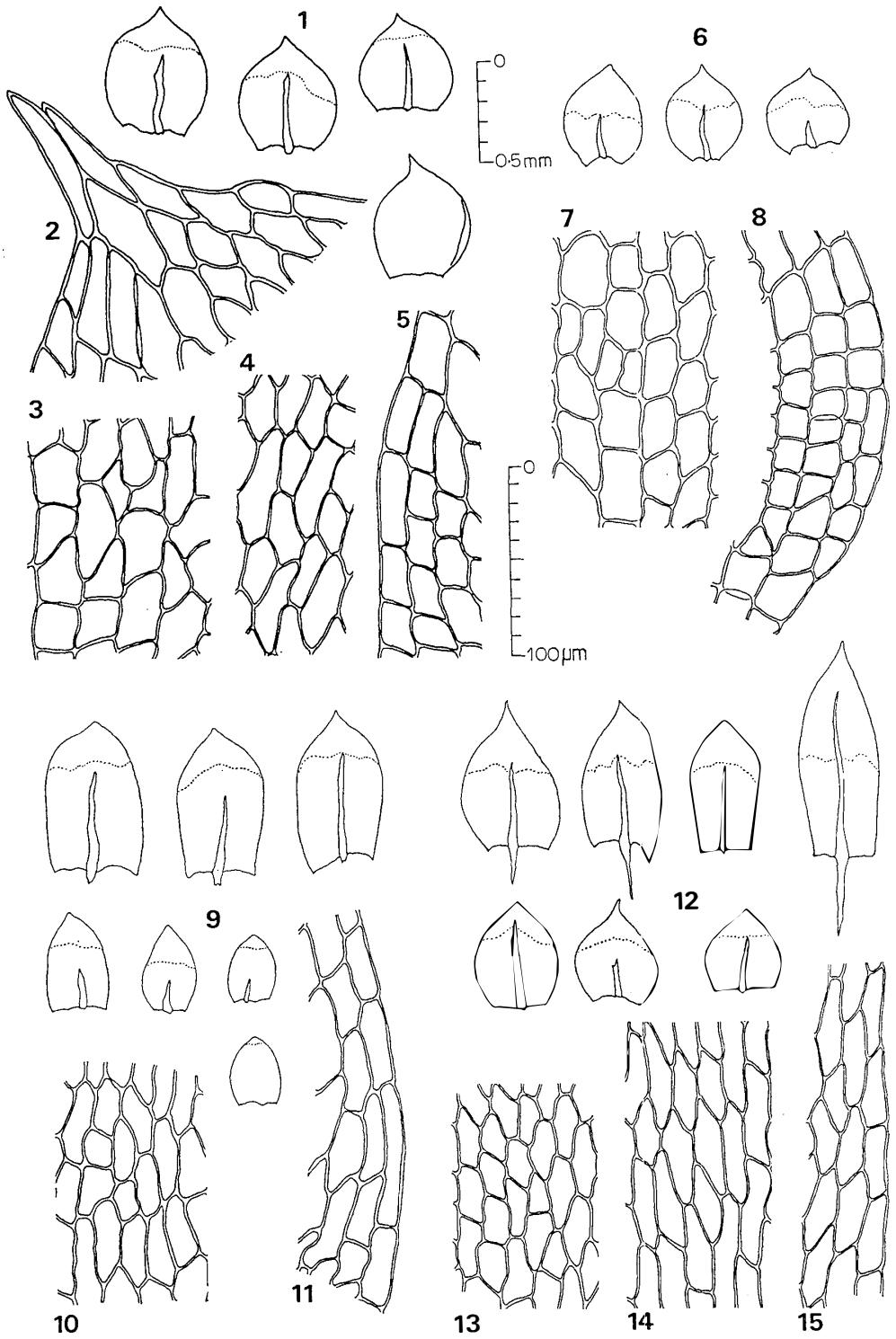

Fig. 2. Bryum argenteum *HEDW. collected from Sôya Coast. 1, 6, 9, 12: Leaves; 2: Cells of leaf apex; 3, 4, 7, 10, 13, 14: Median laminal cells; 5, 11, 15: Marginal cells in median lamina; 8: Cells from near leaf base. 1–5 drawn from* 761101–011 (Shimizu 23); *6–8:* 800705–021 (Nakanishi B41); *9–11:* 800710–081 (Nakanishi D4); *12–15:* 800704–004 (Nakanishi A72).

1–8), the stem leaves are smaller, 0.4–0.5 mm in length. The apex is obtuse with a mucro. In specimens from Mt. Suribati, Skarvsnes (Fig. 2: 9–11), there is a considerable variation in leaf length and costa length. In some of the smaller leaves the costa is lacking or, if present, reaches only about 1/3 of the laminal length. Leaves range 0.35–0.8 mm in length. Median laminal cells are very variable in size and shape, ranging 20–60 μm in length and 10–22 μm in width. Similarly, in Yotuike Valley, Langhovde (Fig. 2: 12–15), the leaves are variable in size and shape, ranging 0.4–1.2 mm in length and 0.35–0.5 mm in width. The leaf apex is obtuse to acute. The leaves exhibit a range of morphology characteristic of many specimens of *B. argenteum* collected from other regions of the world.

In Antarctica, the hyaline upper part of the leaf, the leaf base which is weakly or not red-pigmented, basal-marginal cells not inflated, and leaf shape should readily distinguish this species from even the smallest form of *B. pseudotriquetrum* with which it has often been confused.

Under more extreme climatic conditions, leaves tended to become shorter and more obtuse. This has been clearly demonstrated in cultured material from Macquarie Island (SEPPELT and SELKIRK, 1984) where deciduous shoots cultured at 4°C under continuous light produced new shoots with ecostate, rounded orbicular leaves with all cells chlorophyllous while at 21°C and in continuous light the leaves developed an acute apex, were costate, and the cells of the upper 1/3 to 1/2 became hyaline and resembled typical leaves of specimens from temperate latitudes.

Continental Antarctic specimens from Sôya Coast were compared with those from Macquarie Island, King George Island, and from Canada. The specimen from Sandy Bay, Macquarie Island (Fig. 3: 1–6) shows similar variations in leaf morphology such as shape, costa length, lacking of the costa in some leaves, but are more concave in section than Antarctic specimens. There is little difference in leaf cell shape in Continental Antarctic specimens from the Sôya Coast. Specimens from Kamloops, British Columbia, Canada (Fig. 3: 7–10) and Potter Cove, King George Island closely resemble the Macquarie Island specimens in leaf shape, median laminal cell and marginal cell morphology.

B. argenteum has been previously reported from several localities at higher latitude in Antarctic Continent. CARDOT (1907) reported it from Mount Erebus (77°40′S) in Ross Sea. BARTRAM (1938, 1957) also reported it from King Edward VII Land (77°40′S) and Mt. Patterson (78°02′S) in Rockfeller Mountains as *B. siplei*. Grayish compact low turf composed of somewhat julaceous stems and smaller leaves with hyaline apices are characteristic in this species, but these characters are often indistinct. OCHI (1979) reduced *B. amblyolepis* to a synonym of *B. argenteum* and considered *B. cephalozioides* CARD. to be better to named merely *Bryum* sp., although they may possibly belong also to *B. pseudotriquetrum*. As CARDOT (1906) recognized the similarity of *B. cephalozioides* with *B. amblyolepis*, the authors assumed the type specimen of *B. cephalozioides* is more related to *B. argenteum* than to *B. pseudotriquetrum* by the smaller round leaves without costa and recurved margins of obtuse leaf apex.

Collections of *Bryum argenteum* HEDW., from the Sôya Coast and other specimens examined. **Sôya Coast area**. *Langhovde. 761108-011* (*Shimizu 304*), Yukidori

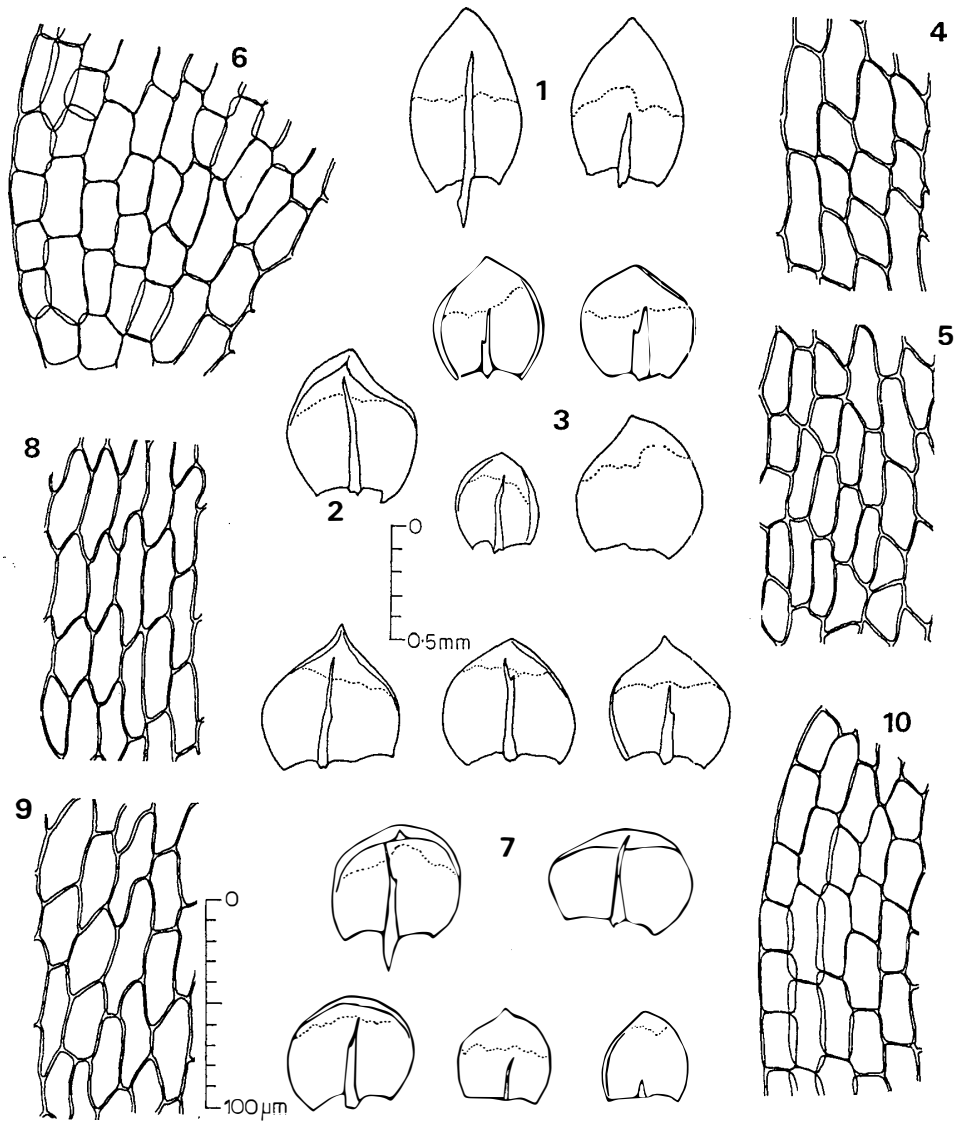

Fig. 3. Bryum argenteum *Hedw. collected from Macquarie Island and Kamloops, Canada. 1–3, 7: Leaves; 4, 5, 8, 9: Median laminal cells; 6, 10: Cells from leaf base. 1–6 drawn from Seppelt 9; 7–10:* 801017–083 (Kanda 209).

Valley, *P04-8* (*Nakanishi*, 75 m alt.), Naka-no-tani Valley, *761029-009* (*Shimizu 253*), Yatude Valley, *761101-011*, *-022* (*Shimizu 23*, *25*), *761108-001* (*Shimizu 50*), *800717-007* (*Nakanishi 92*, 40 m alt.), *80717-015* (*Nakanishi A26*, 195 m alt.), Yotuike Valley, *800703-001* (*Nakanishi A64*, 75 m alt.), *800704-004* (*Nakanishi A72*, 115 m alt.), *800704-029* (*Nakanishi A67*, 90 m alt.), *800704-032* (*Nakanishi A66*, 75 m alt.), *800704-041* (*Nakanishi A73*, 115 m alt.), Kami-kama, *800704-056* (*Nakanishi B22*, 80 m alt.), *800704-077* (*Nakanishi*, 15 m alt.), *800704-081* (*Nakanishi B14*, 25 m alt.), Koke Strand, *800705-021* (*Nakanishi B41*, 5 m alt.), *800705-025* (*Nakanishi B83*, 55 m alt.). *Skarvsnes. 761026-040* (*Shimizu 80*), *761029-029* (*Shimizu 211*), *761109-014*, *-031* (*Shimizu 73*, *234*), Mt. Tenpyô, *761108-003* (*Shimizu 194*), *761109-058* (*Shimizu*), *761109-073* (*Shimizu 198*), Mt. Suribati, *800710-037* (*Nakanishi C90*, 110 m alt.), *800710-075* (*Nakanishi C94*, 110 m alt.), *800710-081* (*Nakanishi D4*, 100 m alt.),

Torinosu Cove, *800711-022* (*Nakanishi D79*, 100 m alt.), *800711-023* (*Nakanishi D83*, 115 m alt.), *800712-018* (*Nakanishi D58*, 100 m alt.), Oyako Lake–Mt. Sirasuso, *800712-002* (*Nakanishi D45*, 265 m alt.), *Breidvågnipa. 761108-030* (*Shimizu 36*). *Skallevikhalsen. 761109-020* (*Shimizu 140*, 15 m alt.), *Rundvågshetta. 840907-008* (*Kanda 664*, 10 m alt.), *840907-033*, *-035* (*Kanda 709*, *711*, 20 m alt.), *Einstöingen. 840912-009*, *-011* (*Kanda 13*, *15*, 50 m alt.). **Prince Olav Coast area.** *Cape Ryûgû. 780812-065* (*Kanda 11*, 125 m alt.), **South Shetland Islands.** *King George Island.* Potter Cove, *790609-104* (*Kanda*, 30 m alt.), Admiralty Bay (*Ochyra 972-80*, 10 m alt.). **Macquarie Island.** *Sandy Bay. Seppelt 15347*, 5 m alt., *Seppelt 9*, 15 m alt. **Canada.** *British Columbia.* Kamloops, *801017-075*, *-077* (*Kanda 207*, *209*, 700 m alt.).

2.2. *Morphological variation in Antarctic populations of B. pseudotriquetrum*

Bryum pseudotriquetrum is widespread in the Antarctic region and includes many species formerly considered as distinct taxa (OCHI, 1979). Under miserable environmental condition in the Antarctic, morphology, as indicated by OCHI, is extremely variable. This variation, induced by subtle variations in microclimate and habitat, has led to a confusion in determining the species and resulted in many taxa being described from the Antarctic regions.

In many plants stem leaves show physical damage near the apex, resulting in the presence of hyaline cells and possible confusion with *B. argenteum*. The apical part of the leaf, particularly in the upper stem leaves, is often badly broken. In many specimens from drier habitats there is often seen fungal development over these damaged leaves.

We have examined in detail only a small proportion of the total number of specimens attributable to *B. pseudotriquetrum* that have been collected between 38°E and 111°E, along the Sôya Coast and other localities from the Mac.Robertson Coast, Ingrid Christensen Coast, Bunger Hills and Knox Coast.

2.2.1. *Bryum pseudotriquetrum* from the Sôya Coast area

The specimen from Skarvsnes (Fig. 4: 1–4) had previously been determined as *B. argenteum*. Leaves have hyaline apices and some are badly broken. This might have been caused by both physical damage and fungal attack. In other stems (Fig. 4: 4) leaves are intact and do not have hyaline apices. The costa ceases shortly below the apex. Leaves range 0.7–1.2 mm in length and 0.5–0.7 mm in width. There is considerable variation in shape and size of median laminal cells with cells ranging 25–75 μm in length and 15–25 μm in width. Marginal cells in median lamina are either less differentiated from adjacent laminal cells or narrower and more elongate forming an indistinct and often discontinuous border. Basal marginal cells are inflated and the walls are pigmented.

Such morphological variation in median laminal cells and the marginal cells in median lamina as seen in this specimen has been observed in many other collections studied. Some leaves have an apparent border of elongate cells narrower than adjacent laminal cells, but in many leaves this is indistinct and would appear to be an unreliable taxonomic character.

In all specimens we have examined the basal cells have pigmented cell walls and this character is useful in distinguishing small shoots of *B. pseudotriquetrum* (par-

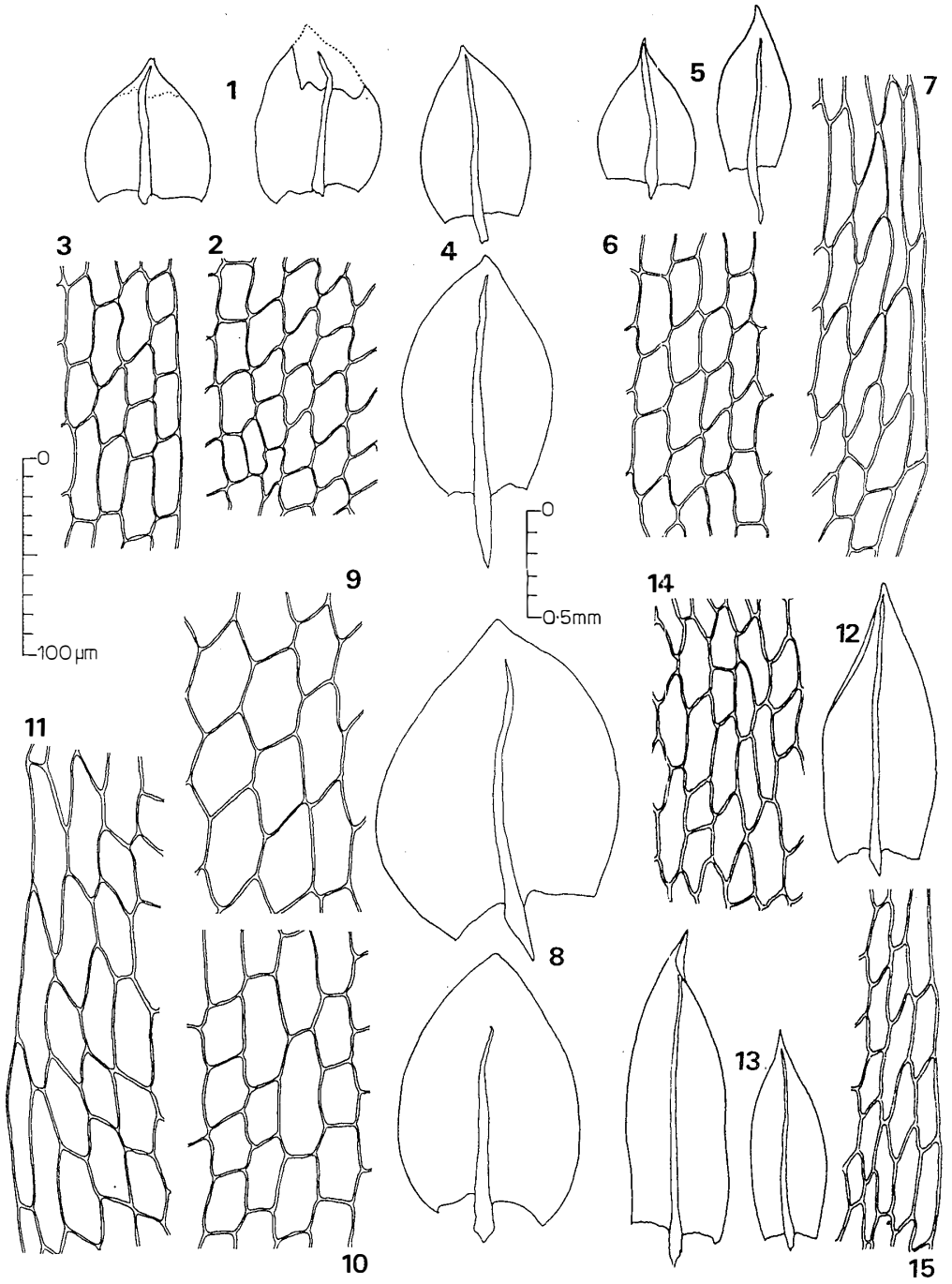

Fig. 4. Bryum pseudotriquetrum (*HEDW.*) *GAERTN, MEYER et SCHERB. collected from Sôya Coast. 1: Leaves showing fungus-damaged upper portion; 4: Undamaged leaves; 5, 8, 12, 13: Leaves; 2, 6, 9, 10, 14: Median laminal cells; 3, 7, 11, 15: Marginal cells in median lamina. 1–4 drawn from* 761025–029 (Shimizu 90); *5–7:* 761026–037 (Shimizu 257); *8–11:* 761029–002 (Shimizu 257); *12–15:* 780821–003 (Kanda 3).

ticularly those with hyaline apices on the leaves) specifically from Antarctic collections of *B. argenteum.*

A specimen from West Ongul Island (Fig. 4: 5–7) bears leaves with acute apices and the costa ceases at about 3/4 lamina length or in the apex. Median laminal cells

range 25–85 μm in length and 10–20 μm in width. Marginal cells in the median lamina are narrow-elongate and distinct from adjacent laminal cells.

In contrast, leaves of the specimen from Lake Nurume, Langhovde (Fig. 4: 8–11) have obtuse apices and the costa ceases well below the apex. The leaves are larger ranging 1.2–1.5 mm in length and 0.8–1.2 mm in width. Median laminal cells of these comparatively broad leaves are hexagonal or rhomboid to rather rectangular, 30–70 μm in length and 15–30 μm in width.

Length and stoutness of the costa, leaf shape, and serrulation and revolution of the margins in *B. pseudotriquetrum* are also very variable. When HORIKAWA and ANDO (1961) studied the genus *Bryum* collected from Syowa Station, the most predominant bryaceous species there was regarded as *B. inconnexum* endemic to Antarctica. The type specimen, according to HORIKAWA and ANDO (1967), usually shows a comose habit and has long acuminated leaves with a stronger usually excurrent costa, more frequently recurved margins and more or less elongated laminal cells. However, OCHI (1979) reduced *B. inconnexum* to a synonym of a *bimum* type of *B. pseudotriquetrum* in view of the wide range of the variability in Antarctica. He hesitated to determine *B. inconnexum* var. *tomemtosum* CARD. and *Webera racovitzae* var. *laxiretis* CARD., which were cited as synonyms of *B. inconnexum* by HORIKAWA and ANDO (1961), for the reasons of sterile, less developed stems without sexual organ and indistinct serrulation at the uppermost part of leaf. The specimen we have studied from Cape Ryûgû (Fig. 4: 12–15) closely resembles their specimens illustrated by HORIKAWA and ANDO (1961). Our studies support OCHI's (1979) view suggesting that *B. inconnexum*, and several others, might be synonyms of *B. pseudotriquetrum*.

One of the studies on the significance of the morphological variation of moss leaves in relation to taxonomic interpretation of the Antarctic species of *Bryum* is the study by NAKANISHI (1979) with *B. inconnexum*. NAKANISHI demonstrated how leaf length as well as leaf shape and position of termination of the costa may vary depending on the position of the leaves on a stem, that is, their sequence relating to the growing season. NAKANISHI further showed that ". . . leaf size is smaller and more diversified in the dry habitats than in the moister habitats."

All the specimens studied exhibit a range of different leaf size and shape, cell size and shape, position of termination of the costa, and differentiation of the marginal (border) cells of the leaf. All these specimens, however, are referable to *B. pseudotriquetrum*, based on a combination of leaf characters, and our findings support OCHI's (1979) taxonomic conclusions. We have had the added benefit of many seasons of extensive field work.

Representative collections of *Bryum pseudotriquetrum* GAERTN., MAYER et SCHERB., from the Sôya Coast and other specimens examined. **Sôya Coast area.** *West Ongul Island. 761025-007* (*Shimizu 1*), *761026-037* (*Shimizu 183*). *Langhovde.* Lake Nurume, *761029-002* (*Shimizu 257*), Yukidori Valley, *761101-025* (*Shimizu 3*), Yukidori Valley–Naka-no-tani Valley, *800717-019* (*Nakanishi A29*, 15 m alt.), Koke Strand, *800705-021* (*Nakanishi B41*, 5 m alt.), *Skarvsnes. 761025-029* (*Shimizu 90*), *761029-031* (*Shimizu 51*), Oyako Lake, *800705-030* (*Nakanishi C18*, 5 m alt.), Mt. Suribati, *800710-080* (*Nakanishi C99*, 110 m alt.), *800711-080* (*Nakanishi*, 120 m alt.). *Skallen. 761104-001* (*Shimizu 186*), Magoke Point, *780822-029* (*Kanda 143*, 0 m alt.).

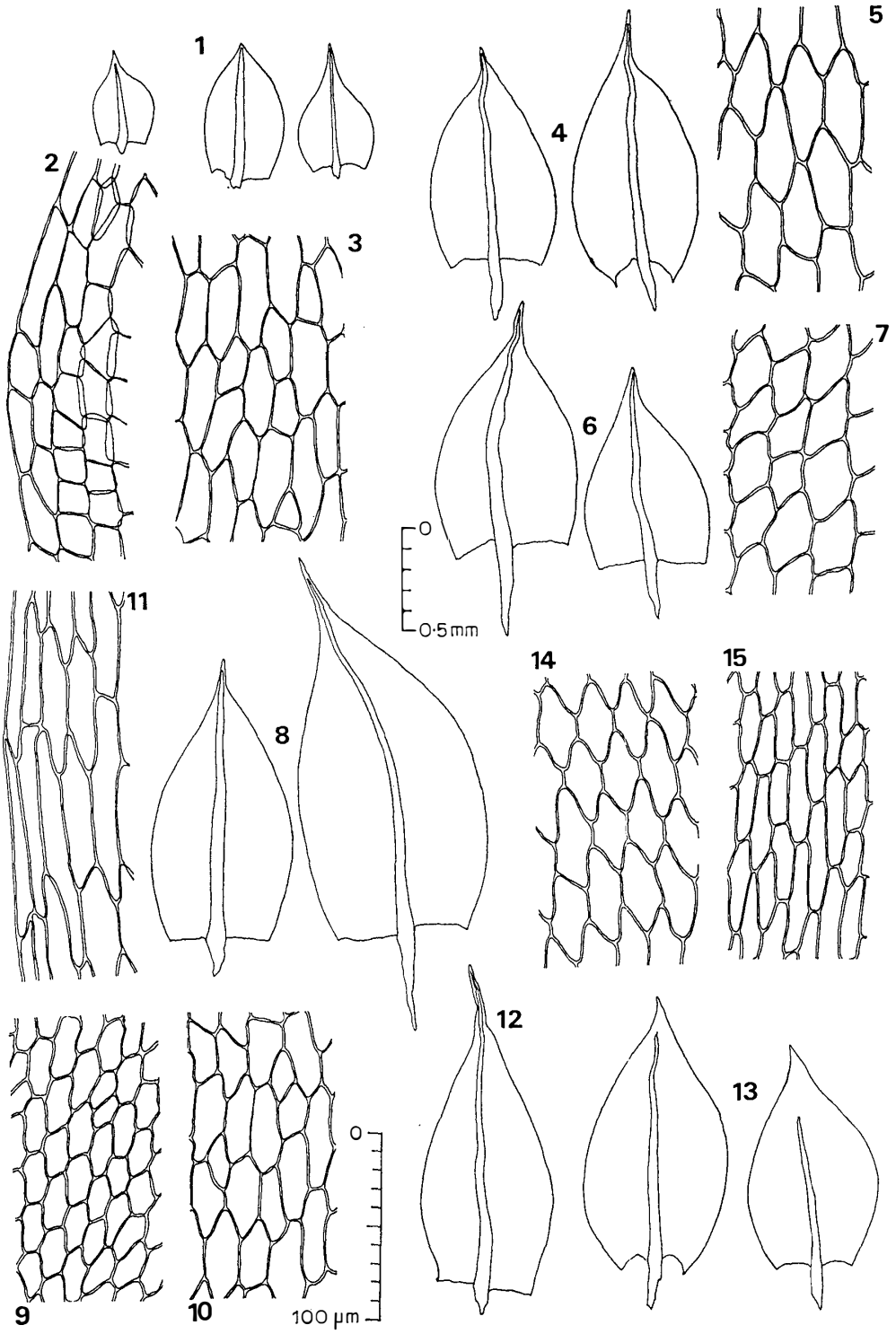

Fig. 5. Bryum pseudotriquetrum (*Hedw.*) *Gaertn., Meyer et Scherb. collected from other localities of Continental Antarctica. 1, 4, 6, 8, 12, 13: Leaves; 3, 5, 7, 9, 10, 14, 15: Median laminal cells; 2, 11: Marginal cells in median lamina. 1–3 drawn from* Seppelt s.n., Walkabout Rocks; *4, 5:* Seppelt 8789; *6, 7:* Seppelt 8466; *8–11:* Seppelt s.n., Mawson Station; *12–15:* Seppelt s.n., Forbes Glacier.

Rundvågshetta. 761109-017 (*Shimizu 9*), *840907-007* (*Kanda 663*, 10 m alt.). **Prince Olav Coast area.** *Cape Ryûgû. 780821-003* (*Kanda 3*), *780822-029*, *-071* (*Kanda 143*, *241*). **South Shetland Islands.** *King George Island.* Potter Cove, *790607-039* (*Kanda 43*, 10 m alt.), *790608-019* (*Kanda*, 20 m alt.), *790609-040* (*Kanda*, 6 m alt.), *790609-115* (*Kanda*, 30 m alt.).

2.2.2. *Bryum pseudotriquetrum* from the Vestfold Hills, Princess Elizabeth Land

The Vestfold Hills area is a coastal ice-free oasis of 400 km^2 area. Both *B. argenteum* and *B. algens* have been reported there (SEPPELT, 1984). Elongated stems attributable to *B. korotkevicziae* but referred by SEPPELT (1983) and PICKARD and SEPPELT (1984) to *B. algens* have also been reported from fresh water to brackish water bodies and as Holocene subfossils. Specimens previously determined as *B. algens* are now considered by us referable to *B. pseudotriquetrum*, although the identity based on the type specimen of the former species is taxonomically not established. *B. argenteum* has yet to be positively confirmed for the region, with specimens previously determined with some reservations as *B. argenteum* now being considered as *B. pseudotriquetrum*.

As in other localities, size of the plants is determined largely by water availability and shelter.

In a specimen from Walkabout Rocks, 68°22′S, 78°32′E (Fig. 5: 1–3), leaves are small, ranging 0.4–0.7 mm in length and 0.3–0.4 mm in width. Median laminal cells ranged 20–60 μm in length and 10–18 μm in width. Specimens collected from less exposed habitats have longer leaves and cells. In a specimen from a sheltered valley near Lichen Valley, 68°29′S, 78°25′E (Fig. 5: 4, 5), the leaf apices are acute, the costa ceases shortly below the apex, the leaf bases are sometimes shortly decurrent, and median lamina cells 35–65 μm in length and 15–20 μm in width. Specimens from near Lake Zvezda, 68°32′S, 78°27′E (Fig. 5: 6, 7) have similar morphology to those from vicinity of Lichen Valley. Both sites are comparatively sheltered and irrigated by an abundant supply of snow fall as well as drift snow for water.

2.2.3. Comparison with *Bryum pseudotriquetrum* from the Mac.Robertson Coast

A specimen from Mawson Station, 67°36′S, 62°47′E (Fig. 5: 8–11), like many collected along the Mac.Robertson Coast, consists of comparatively large stems and the leaves range 1.0–2.0 mm in length, with acute apices and the costa ceases shortly below the apex. Median laminal cells are very variable in size and shape. In some leaves the cells are comparatively small and 15–35 μm in length, but in some others they are longer, elongate-hexagonal or irregular in shape and 25–50 μm in length. There is a considerable variation in the length of the marginal cells in median lamina and in differentiation of the border.

Specimens from Forbes Glacier, 67°35′S, 62°25′E (Fig. 5: 12–15) have leaves similar in size and shape to those from Mawson Station. The leaves range 0.8–1.8 mm in length, 0.5–0.75 mm in width, and the costa is rather variable in length, ceasing in or shortly below the apex or at about 3/4 laminal length. Median laminal cells are generally hexagonal but sometimes rounded elongate-rectangular.

2.2.4. Comparison with fruiting specimens of *Bryum pseudotriquetrum*

Fruiting specimens of *Bryum* (as *B. algens*) were for the first time recorded from Continental Antarctic localities by FILSON and WILLIS (1975). The specimens were

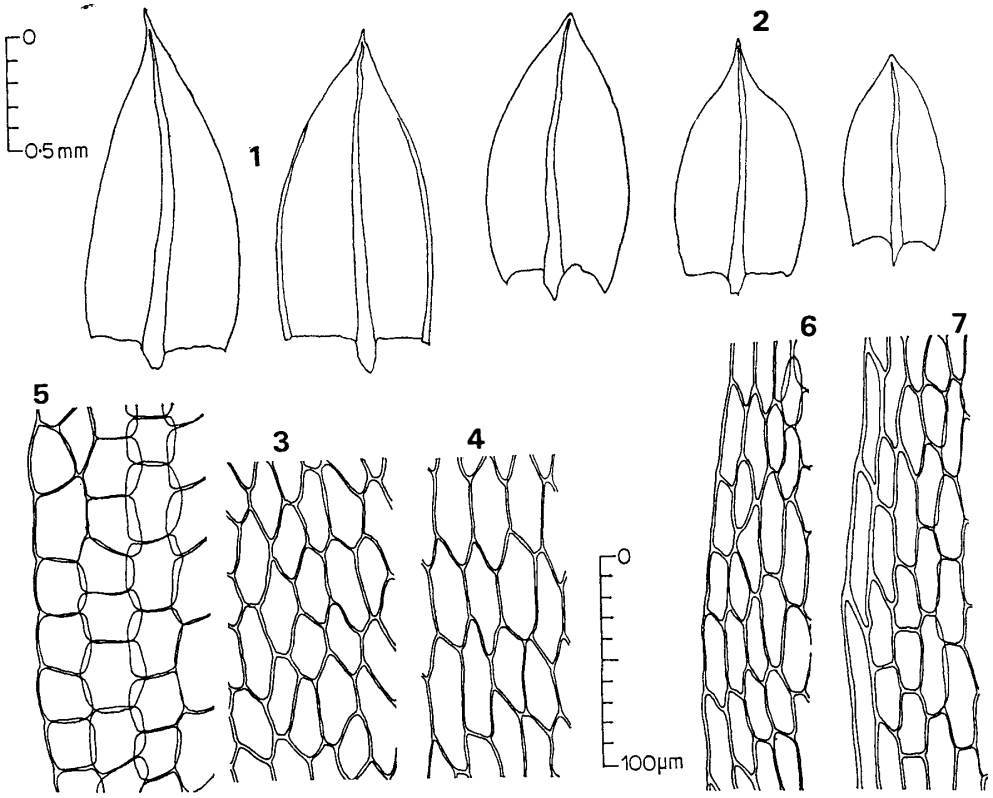

Fig. 6. Stem leaves of Bryum pseudotriquetrum (*HEDW.*) *GAERTN., MEYER et SCHERB. with sporophytes collected from Kemp Land. 1, 2: Leaves; 3, 4: Median laminal cells; 5: Cells from near leaf base; 6, 7: Marginal cells in median lamina. Drawn from* Seppelt s.n., Stillwell Hills.

collected from Fold Island, Kemp Land. Fruiting plants, leaf, and laminal cells were illustrated. RASTORFER (1971) had earlier reported (as *B. antarcticum*) the development of sporophytes under laboratory conditions. Additional natural occurrences of fruiting specimens are now known from Continental Antarctica. One of the authors (KANDA) has collected fruiting specimens from four localities on the Sôya Coast area: Langhovde, Einstöingen, Rundvågshetta and Strandnibba (KANDA, 1986; KANDA and OCHI, 1986). Two localities are known in Kemp Land: Fold Island and Kemp Peak in the Stillwell Hills (SEPPELT unpublished data). Stem leaves and leaf cells of the Kemp Peak specimen are illustrated in Fig. 6.

In vegetative plants from Kemp Peak, (Fig. 6: 1–7), the stem leaves range 0.8–1.8 mm in length and 0.45–0.7 mm in width. Median laminal cells are hexagonal to elongate-hexagonal and range 25–65 μm in length and 10–20 μm in width. Toward the margin the cells are more elongate and narrower and in some leaves the marginal cells are differentiated as a border from adjacent cells, while in others they are scarce.

In fruiting specimens from Sôya Coast studied, the stem leaves are of similar shape but may be up to 2.0 mm long and the perichaetial leaves up to 2.5 mm in length. Laminal cells are also similar to those of fruiting specimens from Kemp Peak, as are marginal laminal cells in the specimens from Rundvågshetta (NIPR *840907-021*), the margins are more distinctly bordered by more elongate cells and occasionally

towards the apex of the leaf there is a very small serrulation. The margins of the leaves in the specimens from Sôya Coast tend to be more distinctly recurved than in those specimens we have studied elsewhere.

Stem leaves of fruiting specimens collected in Continental Antarctica have a similar morphology to stem leaves of nonfruiting *B. pseudotriquetrum*. However, the exact identification should be based on the features of the sporophyte, and fully mature sporophyte with undamaged peristomes are yet to be found in the Antarctic.

3. Concluding Remarks

Subtle variations in microclimate and habitat have a marked influence on growing behavior and morphological variation in moss species from Continental Antarctica. The many species in the genus *Bryum* which have been reported or described from the Antarctic Continent could be indicative of this variation.

We have studied many specimens over a wide geographic range of Continental Antarctica. We have compared specimens deliberately selected from extremes of habitats.

From our studies we so far concluded that only two species of the genus *Bryum*, namely *B. argenteum* and *B. pseudotriquetrum* are recognized in the Continental Antarctic flora. These species can be distinguished by a combination of vegetative characters, despite the range of variation exhibited by, in particular, *B. pseudotriquetrum*. *B. argenteum* has been positively identified from a few collections from localities along the Sôya Coast and also from near Ross Island, southern Victoria Land, on Continental Antarctica. Its distribution may be wider. As both the Sôya Coast and Ross Island sites are near to manned stations it is also conceivable that *B. argenteum* has been accidentally introduced to both regions by the activities of man.

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