

THE MOSS GENUS *TORTULA* FROM THE ANTARCTIC BOTANICAL ZONE

P. J. LIGHTOWLERS

*Institute of Terrestrial Ecology, Natural Environment Research Council, Bush Estate,
Penicuik, Midlothian EH26 0QB, Scotland*

ABSTRACT. *Tortula* is represented by three species in the Antarctic botanical zone: *T. filaris* (C. Muell.) Broth., *T. princeps* De Not. and *T. saxicola* Card. Notes on the variation and distribution of these species are given and reports of other species are discussed. *T. princeps* var. *conferta* (Bartr.) Lightowlers is reduced to synonymy with *T. princeps* var. *princeps*. Full lists of specimens examined are provided.

INTRODUCTION

In the Antarctic, the genus *Tortula* is common only in the northern maritime region of the Antarctic Peninsula, particularly in the South Orkney and South Shetland islands. In the Antarctic botanical zone (Greene, 1964), there are three species: the hair-pointed *T. princeps* De Not. and the non-hair pointed *T. filaris* (C. Muell.) Broth. and *T. saxicola* Card. These can be identified using the key and descriptions given by Lightowlers (1985) for South Georgian specimens. However, additional notes on the variation, distribution and taxonomy of Antarctic material are provided here, and some erroneous reports in the literature are corrected. Full lists of specimens examined are given, most of which were collected by British Antarctic Survey staff and have been distributed from the BAS bryophyte herbarium (AAS) currently located at the Institute of Terrestrial Ecology, Bush Estate, Penicuik, Midlothian. Major holdings of these specimens are kept in AAS and BM but duplicates have also been sent to ALTA, B, BA, CHR, H, KRAM, LE, MEL, NIPR, NY, O, PC, PRE, S and TNS. All herbarium abbreviations used in this paper follow Holmgren and others (1981).

OBSERVATIONS AND NOTES

T. filaris (C. Muell.) Broth.

This species was first described from the Antarctic botanical zone by Cardot (1906) as *T. excelsa* Card. This and other synonym has been reported by Lightowlers (1985).

Some Antarctic specimens have oblong leaves which are broader than the lanceolate or oblong-lanceolate leaves typical of South Georgian specimens. Many Antarctic specimens also have few teeth on the upper leaf margin, and, in the most extreme cases, the leaves have no teeth, but the upper margin is crenulate or irregular. This variation may lead to some difficulty in using the key given by Lightowlers (1985), but *T. filaris* can easily be distinguished from the other non-hair-pointed species, *T. saxicola*, by its acute rather than finely acuminate leaf apex, its larger, less densely papillose cells, and its characteristic areolation at the leaf apex (see Lightowlers, 1985).

In the Antarctic, *T. filaris* is restricted to Bouvetøya, the South Orkney Islands and the South Shetland Islands. Its most southerly locality appears to be Deception Island. No fertile specimens have been recorded from the Antarctic botanical zone.

Specimens examined

Bouvetøya: Zanten 25a (AAS ex herb. Zanten)

South Orkney Islands. Coronation Island: McManmon 24, 54; R. Smith 39, 150b, 441, 559, 583. *Gosling Islands*: McManmon 29, 35, 43, 49. *Lynch Island*: Lindsay 948, 990a; R. Smith 522. *Matthews Island*: R. Smith 169a, 182a. *Signy Island*: Holdgate 62, 82, 143, 749g, 765b, 766c, 767d, 776b; Longton 834, 856; R. Smith 17a, 403, 410, 504, 646b, 1818.

South Shetland Islands. Clarence Island: Allison 2h. *Deception Island*: R. Smith 3621, 3648; Taylor 8, 243. *Elephant Island*: Allison 104, 208a. *King George Island*: Ochyra 4953/79, 5222/79, 5251/79, 322/80, 569/80, 1396/80, 1720/80 (AAS ex KRAM); R. Smith 722. *Livingston Island*: Lindsay 55a, 91, 115a, 266, 284, 346, 354, 452; R. Smith 3775. *Nelson Island*: Skottsberg 447 (BM). *O'Brien Island*: Baylis 20. *Robert Island*: R. Smith 916.

T. princeps De Not.

T. princeps has been reported from the Antarctic botanical zone under many names, including *T. conferta* Bartr. (Bartram 1957), *T. fuegiana* (Mitt.) Mitt. (Gepp, 1902; Cardot, 1908), *T. grossiretis* Card. (Dixon, 1920), *T. heteroneura* Card. (Cardot, 1911) and *T. monoica* Card. (Cardot, 1906; 1908). All of these names are now regarded as synonyms of *T. princeps*, or as varieties of it (Lightowlers, 1985). Although variation in South Georgian *T. princeps* was discussed in that paper, further consideration of Antarctic material is necessary.

Four provisional infra-specific taxa of *T. princeps* were recognized on South Georgia:

(i) var. *princeps*. Relatively robust plants having leaves with hyaline hair-points, recurved or revolute margins and leaves which are plane or recurved in profile. Sporophytes occasionally produced.

(ii) var. *magellanica* (Mont.) Lightowlers. Plants smaller than the var. *princeps* with leaves with hyaline hair-points and which are cucullate in profile. Plants occasionally producing sporophytes.

(iii) var. *conferta* (Bartr.) Lightowlers. Slender plants with small leaves with plane and short hair-points, the nerve frequently disappearing in the upper leaf before reaching the leaf apex. Sporophytes unknown.

(iv) red hair-pointed taxon. Plants usually smaller than the var. *princeps*, with leaves which are recurved in profile and have a red hair-point. Sporophytes unknown.

Specimens belonging to the last group were referred to the var. *princeps* because, unlike the other taxa, they had not previously been regarded as a distinct species, and growth experiments suggested that typical var. *princeps* or var. *magellanica* plants could produce the red hair-pointed phenotype under certain growth conditions.

In the Antarctic botanical zone, counterparts of the four South Georgian taxa occur, but they are more difficult to distinguish. There are particular problems in distinguishing the var. *magellanica* and var. *princeps*, and in distinguishing the var. *conferta* and the var. *princeps*. It is also apparent that there are many more small specimens, similar to the var. *conferta*, in the Antarctic than have been collected on South Georgia. The difficulty in separating the var. *princeps* and the var. *magellanica* may be due to the preponderance of smaller, less well developed specimens in the Antarctic. Larger specimens can usually be assigned to one or other taxon but the majority of the material is small compared with South Georgian specimens, and is

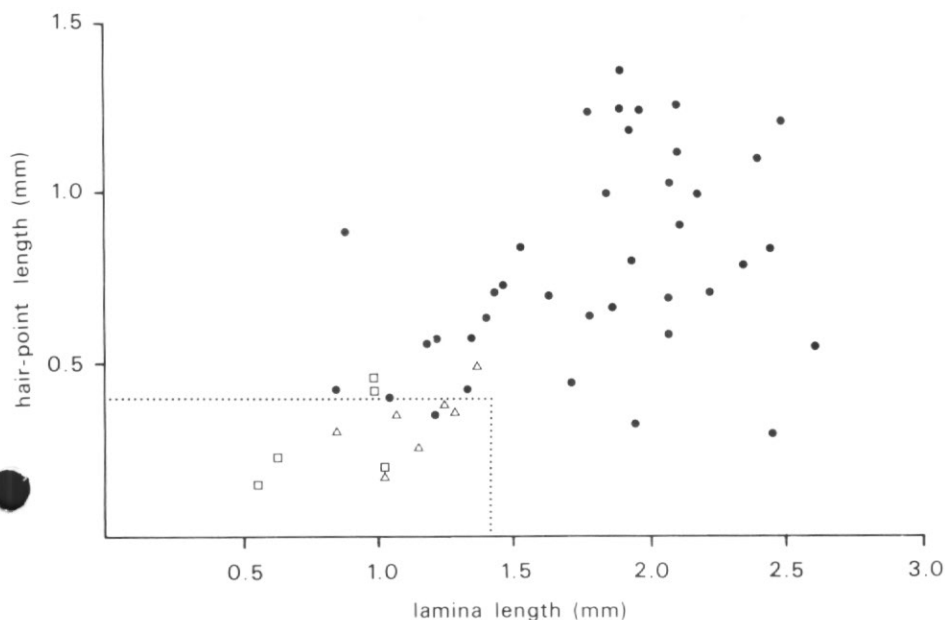


Fig. 1. Scatter diagram of mean lamina length against mean hair-point length of 5 leaves from each of 50 specimens of Antarctic *T. princeps*. The dotted lines represent the size limits of the var. *conferta* given by Lightowlers (1985). Squares: specimens with at least some leaves with plane margins and some leaves in which the nerve disappears before reaching the apex. Triangles: specimens with some leaves with plane margins but with nerves continuous to the leaf apex in all leaves. Filled circles: specimens with recurved leaf margins and nerves continuous to the leaf apex in all leaves.

difficult to place in either variety. The form of the leaves, i.e. plane, recurved or cucullate, and the height of the stems, are poorly correlated in Antarctic specimens, and because sporophytes are only occasionally produced, the var. *magellanica* cannot be reliably distinguished. The most practical solution to this problem appears to be to refer all material from the Antarctic botanical zone to the var. *princeps*.

Variation in leaf size in Antarctic material was studied by taking fifty specimens at random and measuring from each the width and length of five mature leaves and the length of their hair-points. The measurements were averaged and plotted as a scatter diagram (Fig. 1). This shows that variation in lamina length and hair-point length is continuous, and that specimens with incompletely developed nerves or plane leaf margins (the key characters of the var. *conferta*) are the smallest, or are among the smallest examined. However, they do not form a discrete group and the delimitation of the var. *conferta* given by Lightowlers (1985) appears to be arbitrary. *T. princeps* var. *conferta* is therefore considered to be a synonym of the var. *princeps*.

T. princeps is the most widely distributed species of the genus in the Antarctic. It is found throughout the Antarctic Peninsula region and at favourable sites, on the coasts of the Antarctic Continent.

Specimens examined

Antarctic Peninsula. Adelaide Island: Fenton 70a; Killingbeck 143b; Longton 911; R. Smith 92, 722, 2259. *Alectoria Island:* Brading, 14. *Alexander Island:* Light & Heywood 24, 34, 80, 88. *Andrée Island:* R. Smith 4010. *Anvers Island:* Longton 1223;

R. Smith 1942, 1943, 1944, 1955. *Avian Island*: Longton 936. *Cockburn Island*: Hooker 2 (BM). *Consort Island*: R. Smith 3587. *Cormorant Island*: Scott 10, 39, 41, 43. *Danco Coast*: Cameron & Kennett 55. *Darboux Island*: R. Smith 3319, 3320. *Dundee Island*: R. Smith 5302a. *Galindez Island*: B. G. L. E. 134b (BM-Dix.); Corner 406, 522, 562; Longton 1244, 1324; R. Smith 757, 3291; Taylor 423a. *Goudier Island*: R. Smith 731. *Graham Coast*: Corner 635b. *Green Island*: B. G. L. E. 1083 (BM-Dix.). *Hermit Island*: R. Smith 871, 872. *Horseshoe Island*: Longton 1267; R. Smith 1900. *Joinville Island*: R. Smith 3733. *Jubin Islands*: R. Smith 1980, 2009. *Laggard Island*: Longton 1312. *Lambda Island*: Siple 345.1 (FH). *Litchfield Island*: Corner 384; R. Smith 1969a, 1970. *Neny Island*: R. Smith 793b, 827. *Omega Island*: Siple 335.12 (FH). *Petermann Island*: Gain 175 (BM), 211 (BM, H, PC); Longton 1350; Scott 105b. *Pfaff Island*: Killingbeck 178b. *Torgersen Island*: Webb 231. *Trinity Peninsula*: Brading 30b, 39; Longton 42. *Uruguay Island*: Corner 596b; R. Smith 955.

Bouvetøya. Zanten 25b (AAS ex herb. Zanten).

Continental Antarctic. *Victoria Land*: Borchegrevink s.n. (BM). Greene (1967) provided an Antarctic distribution map of *T. conferta* which extends the continental range reported here.

South Orkney Island. *Coronation Island*: R. Smith 442, 443, 582. *Lynch Island*: R. Smith 706. *Matthews Island*: R. Smith 170a. *Powell Island*: R. Smith 213b, 214, 265. *Signy Island*: Holdgate 148c, 155c, 164a, 765f; Longton 841, 1188a; R. Smith 381, 600, 625, 647, 660b, 665, 666, 691f, 1815d, 1815f, 3149, 3156, 3167, 3170; Taylor 404a; Webb 88b.

South Sandwich Islands. *Bellinghausen Island*: Holdgate 823d. *Freezeland Rock*: Holdgate 808.

South Shetland Islands. *Aspland Island*: Baylis 67a. *Clarence Island*: Allison 2g; Chuter 42, 44, 46, 49, 51, 52, 59, 62a. *Deception Island*: Bennett 10a, 27a, (BM-Dix.); Killingbeck 18a, 20b, 27b, 69b, 75b; Longton 11, 883, 889a; Olstad 10 (BM-Dix.); Robius 488 (BM-Dix.); R. Smith 82, 83, 3603, 3604, 3632, 3650; Taylor 30, 166, 249, 252a. *Elephant Island*: Allison 71, 208b, 218, 223b. *Gibbs Island*: Baylis 127a, 128. *Greenwich Island*: Lindsay 543, 703, 705. *King George Island*: Lindsay 667, 691, 692b, 721, 785, 827, 833; Ochyra 990/79, 153/80, 1705/80, 1752/80, 2382/80 (AAS ex KRAM); R. Smith 721, 724; Taylor 266, 289b. *Livingston Island*: Lindsay 21, 55b, 72, 115b, 170, 187, 289, 300, 322, 347, 348, 355, 349; R. Smith 3816a. *Penguin Island*: Lindsay 809.

T. saxicola Card.

T. saxicola was first noted from the Antarctic botanical zone during ecological studies, by Gimingham (1967), Gimingham and Smith (1970, 1971), Smith (1972) etc. as *T. fuscoviridis* Card. The synonymy of *T. fuscoviridis* with *T. saxicola* was reported by Lightowlers (1985).

In the Antarctic botanical zone, this species is known only from the South Orkney Islands and the South Shetland Islands. Its most southerly locality appears to be Deception Island. Fertile specimens are rare, having been recorded mostly on Signy Island, where this moss is quite abundant.

Specimens examined

South Orkney Islands. Coronation Island: R. Smith 150a, 581; Webb 636, 170. *Matthews Island:* R. Smith 182b. *Powell Island:* R. Smith 213a, 237, 238. *Signy Island:* Holdgate 88, 155b; Longton 833, 1145, 1188b; R. Smith 396, 595, 660a, 1815b, 1815c, 3157; Webb 126.

South Shetland Islands. Aspland Island: Baylis 67c. *Clarence Island:* Allison 2k. *Deception Island:* Killingbeck 29b; R. Smith 3649. *Elephant Island:* Allison 44b, 108a, 149, 192, 219. *Gibbs Island:* Baylis 175a, 175b, 178, 216. *King George Island:* Lindsay 823; Ochyra 1578/80, 1627/80, 2796/80 (AAS ex KRAM); R. Smith 723; Taylor 259, 294. *Livingston Island:* Lindsay 321, 339; R. Smith 3804, 3816b. *O'Brien Island:* Baylis 9a, 11a, 14b, 18.

OTHER RECORDS

T. densifolia Hook. f. et Wils. was reported from the Antarctic by Wijk and others (1969). However, this report appears to be a bibliographic error, because no earlier references in the Antarctic literature have been traced, and no Antarctic specimens have been found.

Wilson (in Hooker 1847) reported *T. gracilis* Hook, et Grev. and *T. laevipila* (Brid.) Schwaeger. from Cockburn Island, Antarctic Peninsula. Original material collected by Hooker, housed in BM, has been examined. A specimen labelled *T. gracilis* (Cockburn Island No. 3, Herbarium Hookerianum 1867, BM) has been redetermined as *Didymodon gelidus* Card., and the specimen labelled *T. laevipila* (Cockburn Island No. 2, *T. laevipila* var., Herbarium Hookerianum 1867, BM) has been redetermined as *T. princeps*.

T. tenella Broth., a New Zealand species, was reported from the Antarctic by Pizzaro and Sáiz (1977). This appears to be a bibliographic error. The Antarctic *T. monoica*, which is here considered to be a synonym of *T. princeps*, was reduced to synonym with *T. tenella* by Wijk and others (1969). This was based on a remark by Dixon (1923) which was probably not intended as a formal reduction to synonym. I regard *T. tenella* and *T. monoica* as distinct species and the former is not known to occur in the Antarctic botanical zone. The report of *T. tenella* from King George Island, South Shetland Islands, appears to be based on false synonymy and refers to *T. monoica*.

ACKNOWLEDGEMENTS

I thank Sally Hill for herbarium assistance, the Directors and staff of the herbaria mentioned in the text for providing specimens, and Mr B. G. Bell for his helpful comments on the manuscript.

Received 29 January 1986; accepted 24 April 1986

REFERENCES

- BARTRAM, E. B. 1957. Mosses from the United States Antarctic service Expedition (1940-41). *Bryologist*, **60**, 139-43.
- CARDOT, J. 1906. Notice préliminaire sur les mousses recueillies par l'Expédition Antarctique Suedoise. III. Espèces de l'Antarctide. *Bulletin de l'Herbier Boissier, 2ème sér.* **6**, 13-17.
- CARDOT, J. 1908. La flore bryologique des Terres Magellaniques, de al Géorgie du Sud et de l'Antarctide. *Wissenschaftliche Ergebnisse der Südpolarexpedition 1901-03*, Bd. 4, Lf. 8, 298 pp.

- CARDOT, J. 1911. Note sur les mousses rapportées par la seconde Expédition Antarctique Française, sous le commandement du Dr. Jean Charcot. *Revue bryologique*, **38**, 124-7.
- DIXON, H. N. 1920. Contributions to Antarctic bryology. *Bryologist*, **23**, 65-71.
- DIXON, H. N. 1923. Studies in the bryology of New Zealand. *New Zealand Institute Bulletin*, No. 3, pt. 3, 75-152.
- GEPP, A. 1902. Cryptogamia: Musci. (In: *Report on the collections of natural history made in the Antarctic regions during the voyage of the 'Southern Cross', vol. 21*. London, The Trustees, British Museum (Nat. Hist.), 319.)
- GIMINGHAM, C. H. 1967. Quantitative community analysis and bryophyte ecology on Signy Island. (In SMITH, J. E. *Organiser*. A discussion on the terrestrial Antarctic ecosystem. *Philosophical Transactions of the Royal Society of London, Ser. B*, **252**, No. 777, 251-9.)
- GIMINGHAM, C. H. and SMITH, R. I. L. 1970. Bryophyte and lichen communities in the maritime Antarctic. (In HOLDGATE, M. W. *Antarctic Ecology*, 2. London, Academic Press, 752-85.)
- GIMINGHAM, C. H. and SMITH, R. I. L. 1971. Growth, form and water relations of mosses in the maritime Antarctic. *British Antarctic Survey Bulletin*, No. 25, 1-21.
- GREENE, S. W. 1964. Plants of the land. (In PRIESTLEY, R. E., ADIE, R. J. and ROBIN, G. DE Q. eds. *Antarctic Research*. London, Butterworth, 239-53.)
- GREENE, S. W. 1967. Bryophyte distribution (In BUSHNELL, V. *Terrestrial life of Antarctic*. *Antarctic Map Folio series, folio 5*. New York. American Geographical Society, 11-13.)
- HOLMGREN, P. K., KEUKEN, W. and SCHOFIELD, E. K. 1981. *Index herbariorum* Pt. 1. *The herbaria of the world*, 7th edition. *Regnum Vegetabile*, **106**, 1-452.
- HOOKE, J. D. 1847. The botany of the Antarctic voyage I. *Flora Antarctica*. Pt. 2. London, Reeve Bros., 209-574.
- LIGHTOWLERS, P. J. 1985. A Synoptic flora of South Georgian mosses: *Tortula*. *British Antarctic Survey Bulletin*, No. 67, 41-77.
- PIZZARO, C. and SAIZ, F. 1977. Estudio de la taxocenosis muscinal de la península Fildes (isla Rey Jorge, Shetland del Sur) *Serie científica, Instituto Antártico Chileno*, **5**, 81-96.
- SMITH, R. I. L. 1972. Vegetation of the South Orkney Islands with particular reference to Signy Island. *British Antarctic Survey Scientific Reports*, No. 68, 124 pp.
- WIJK, R. VAN DER, MARGADANT, W. D. and FLORSCHUTZ, P. A. 1969. *Index Muscorum, Volume 5*. Utrecht, International Association for Plant Taxonomy.