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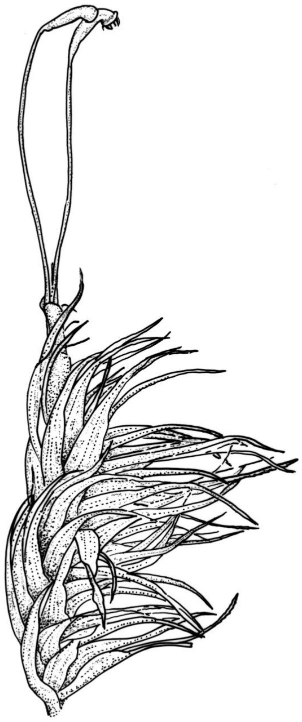

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Cover image: *Dicranoloma plurisetum*, shoot with capsules, dry. Drawn by Rebecca Wagstaff from *A.J. Fife 8581*, CHR 464928.

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This edition was published to correct the omission of the key to species in *Campylopodium* during the publication process. It is identical to the first edition, except for the inclusion of the key and the removal or updating of text associated with publishing the new nomenclatural acts.

Introduction

The Dicranaceae are a very large and taxonomically complex family of cosmopolitan distribution. An erect habit, lanceolate leaves with a well-developed single costa, usually differentiated alar cells, and a single peristome with forked, red, and vertically striolate teeth characterise most of the species in this family. Upwards of 40 genera are currently accepted world-wide, with nine genera recognised in New Zealand. *Dicranoloma*, with eight species, is the largest genus here. *Campylopus*, for which only six regional species are accepted, is the most plastic and hence most difficult genus, as it is in many regions. The species concepts presented here are necessarily moderately broad, as some of our genera have been, arguably, overly described. Representatives of the Dicranaceae are some of the most conspicuous and ecologically significant members of the N.Z. bryoflora. Species of the southern hemisphere genus *Dicranoloma*, for example, form major components of the ground cover in forests throughout the country.

Dicranaceae

Plants highly variable in size, often robust, nearly always erect but rarely creeping (as in *Sclerodontium*), mostly forming tufts or turves. **Stems** simple or forked, with a central strand, usually tomentose. **Leaves** broadly to narrowly lanceolate, secund, spreading, or erect, sometimes sheathing below, mostly acute to acuminate at apices; **mid and upper laminal cells** variable in shape, smooth or less often papillose, often porose; **cells of leaf base** elongate; **alar cells** mostly differentiated. **Costa** single, narrow to very wide, ending near the apex or excurrent.

Setae elongate or rarely very short (as in *Mesotus*), straight or cygneous; **capsules** erect or inclined, stegocarpous; **operculum** mostly rostrate from a conic base. **Peristome** teeth16, flat, mostly divided c. halfway to base into segments of unequal width, usually vertically papillose-striolate below. **Calyptra** cucullate, smooth, entire or rarely fringed at base.

Taxonomy: The Dicranaceae are a very large and taxonomically complex family of cosmopolitan distribution. Goffinet et al. (2009) included 41 genera in the family, while nine genera are accepted from N.Z. The largest genera worldwide are *Campylopus*, *Dicranum*, *Dicranoloma*, and *Dicranella*. Given its size and diversity the family is difficult to characterise. *Campylopus* and genera closely allied to it are often segregated in a subfamily Campylopodioideae (Frahm. et al. 1985). According to the introduction (authorship uncertain) to the family in the Mexican moss flora (Sharp et al. 1994, p. 111) “long, narrow, tapered leaves with a well-developed, single costa, differentiated alar cells, and flat, forked, vertically pitted-striolate peristome teeth” characterise most members of the family.

In the N.Z. species distribution summaries, Land Districts (L.D.) for which specific localities are not cited signify that the species under discussion has been documented from many sites (usually three or more). If more than three localities per L.D. are cited, the distribution within that L.D. is considered to be of particular interest, often because it constitutes a major proportion of the overall N.Z. distribution.

The following key includes genera (*Leucobryum*, *Pseudephemerum*, and *Wilsoniella*) that were placed by Sainsbury (1955a) in the Dicranaceae but placed in different families here.

1 **Leaves** composed of both chlorophyllose and dead cells, in cross-section at mid leaf and above consisting of a single layer of chlorophyllose cells (chlorocysts), enclosed both abaxially and adaxially by one or more layers of dead cells (hyalocysts); **lamina** very narrow and inconspicuous; **plants** nearly white when dry .... *Leucobryum* (Leucobryaceae)

1' **Leaves** composed entirely of living cells (except on adaxial surface of some *Campylopus* sp.), in cross-section at mid leaf lacking abaxial and adaxial layers of dead cells (hyalocysts); **lamina** usually obvious and extending to mid leaf or higher (except in some *Campylopus* spp.); **plants** not white (but sometimes pale) when dry 2

2 **Alar cells** not or very weakly differentiated, **plants** mostly small 3

2' **Alar cells** well differentiated, either inflated and thin-walled or compact and ± quadrate, **plants** mostly robust but variable in size 6

3 **Vegetative leaves** 0.7–1.3 mm; **laminal cells** thin-walled and lax; **capsules** cleistocarpous, immersed; **setae** c. 0.2 mm; **plants** suggestive of a *Pleuridium* .... *Pseudephemerum* (Ditrichaceae)

3' **Vegetative leaves** mostly longer; **laminal cells** firm-walled; **capsules** opening by a differentiated operculum, exserted or emergent; **setae** longer (except in *Mesotus*); **plants** not suggestive of a *Pleuridium* 4

4 **Setae** short (usually <6 mm), cygneous when moist, stout or slender, dextrorse when dry .... *Campylopodium*

4' **Setae** elongate (usually >6 mm, except in *Mesotus*), not cygneous, flexuose or erect when moist, slender, dextrorse or sinistrorse when dry 5

5 **Vegetative leaves** either sheathing at base or, if not sheathing, moderately secund; operculum stoutly rostrate and curved, shorter than the capsule, not bright orange; **peristome teeth** mostly 300–400 µm, mostly divided c. ½ or occasionally nearly to base, the entire tooth in surface view appearing vertically papillose-striolate or papillose throughout .... *Dicranella*

5' **Vegetative leaves** not sheathing, strongly secund to circinate when moist; **operculum** slenderly rostrate and c. 1.5 times the capsule length, bright orange even in dried material; **peristome teeth** extremely long, 400–550 µm, completely or incompletely divided into two very slender forks and coarsely baculate throughout .... *Wilsoniella* (Ditrichaceae)

6 **Mid laminal cells** with either single multifid papillae or multipapillose 7

6' **Mid laminal cells** lacking papillae, smooth or mammillose 8

7 **Mid laminal cells** with a single but multifid papilla; **leaves** not dimorphic, those of the branches erect-spreading and straight when moist, often with short and white hair points, with a **border** extending nearly to apex; **branches** appearing ± stellate in end view; **capsules** exserted; **plants** nearly always epilithic .... *Sclerodontium*

7' **Mid laminal cells** pluripapillose; **leaves** dimorphic, those of the branches wide-spreading and sigmoidally curved when moist, lacking hair points, with a **border** disappearing about mid leaf; **branches** appearing like a pin-wheel in end view; **capsules** immersed; **plants** nearly always corticolous .... *Mesotus*

8 **Costa** ⅓ or more the width of the lower leaf; **setae** cygneous; **stomata** absent from capsule base; **calyptra** usually fringed at base .... *Campylopus*

8' **Costa** ¼ or usually less the width of the lower leaf; **setae** not cygneous; **stomata** present in capsule base; **calyptra** not fringed at base 9

9 **Leaves** with a distinct border extending from near the alar cells to mid leaf or more, or with indistinct border and then with leaves greater than 9 mm long; **plants** more robust and mostly on forest floor .... *Dicranoloma*

9' **Leaves** both lacking a distinct border and <6 mm long (except in *Holomitrium trichopodum*); **plants** usually medium-sized and mostly not of forest floor 10

10 **Plants** restricted to high elevation bogs; **leaves** erect-appressed both moist and dry (in N.Z. species) .... *Dicranum*

10' **Plants** not occurring in high elevation bogs; **leaves** various but not erect-appressed 11

11 **Plants** with microphyllous shoots often present in axils of upper leaves; **leaves** strongly contorted and inrolled (occasionally cork-screwed) when dry; **peristome teeth** undivided or weakly divided to about ⅓ their length and not cribose .... *Holomitrium* (*perichaetiale*)

11' **Plants** lacking microphyllous shoots; **leaves** not or slightly contorted when dry; **peristome teeth** either divided for ½ or more of their length or cribose 12

12 **Leaves** mostly 5–10 mm long; **setae** slender and flexuose, (17–)20–40(–50) mm; **capsules** 2.0–3.0 mm .... *Holomitrium* (*trichopodum*)

12' **Leaves** less than 3.5 mm long; **setae** relatively stout, not flexuose, <15 mm; **capsules** shorter, 1.0–1.5 mm .... *Kiaeria*

Excluded Taxa: *Chorisodontium aciphyllum* (Hook.f. & Wilson) Broth. This South American species was reported from N.Z. by Bartlett & Frahm (1983), based on two Denniston Plateau collections. On the strength of determinations by J.-P. Frahm and the subsequent joint report, *C. aciphyllum* was accepted for many years as part of the N.Z. flora. However, compared to the Bartlett Denniston Plateau collections, South American and South Shetland I. plants of *C. aciphyllum* (including the Hermite I. type in BM-Wilson!) are more robust, with leaves coarser in texture, longer (c. 7–9 mm), and not secund, and with costae much broader (mostly 250–350 µm in lower leaf). Also, in most, but not all, South American *C. aciphyllum* the abaxial surface cells of the costa at mid leaf (viewed in cross-section) are strongly and densely mamillose; such cells do not occur in the Bartlett collections. In my opinion, all records of *C. aciphyllum* from N.Z. are based on Bartlett misidentifications of aberrant and epilithic material of the usually epiphytic *Holomitrium trichopodum* and are discussed further under that species.

Leucobryum Hampe was treated as a member of the Dicranaceae by Sainsbury (1955a) and by Scott & Stone (1976), but is here treated in the Leucobryaceae.

Pseudephemerum (Lindb.) I.Hagen was included in the Dicranaceae by Sainsbury (1955a) but is placed in the Ditrichaceae in this work.

Trichodontium (Dixon) Fife is treated here as a taxonomic synonym of *Kiaeria*, as is its basionym *Dicranum* subgen*. Trichodontium* Dixon.

Wilsoniella Müll.Hal. was included in the Dicranaceae by Sainsbury (1955a) but is placed in this work in the Ditrichaceae.

Campylopodium (Müll.Hal.) Besch., *Ann. Sci. Nat., Bot. sér. 5,* 18: 189 (1873)

≡ *Aongstroemia* sect. *Campylopodium* Müll.Hal., *Syn. Musc. Frond. 1,* 429 (1848)

Type taxon: *Campylopodium euphorocladum* (Müll.Hal.) Besch. = *Campylopodium capillaceum* (Hook.f. & Wilson) Fife

Plants small, on mineral soil. **Stems** short or rarely elongate, branching by innovation or forking, often with multiple perichaetia, in cross-section with central strand weak or lacking, sparsely beset with smooth brown rhizoids below. **Leaves** often sheathing at base and distinctly shouldered, with a long subula nearly filled by the costa, little altered when dry, the lower vegetative leaves grading quickly into the perichaetial leaves in fruiting plants, entire or serrulate above, unistratose or with bistratose margins. **Laminal cells of leaf base** (in leaves from below perichaetium) narrowly rectangular, firm-walled, c. 30–60 µm in N.Z. species. **Upper laminal cells** (in leaves from below perichaetium) short-rectangular or oblong, incrassate, and smooth; **alar cells** not differentiated. **Costa** (in leaves from below perichaetium) occupying c. ⅙–¼ the leaf base, percurrent or short-excurrent, usually not filling the subula, in cross-section (mid leaf) projecting and rounded on abaxial surface, with median guide cells, and both adaxial and abaxial stereid groups.

Dioicous or **paroicous. Perichaetia** often >1 per stem. **Setae** stout or rather slender, cygneous when moist, flexuose and strongly dextrorse when dry; **capsules** emergent (not or scarcely exceeding ♀ leaves), broadly ovoid or weakly obovoid, mostly weakly asymmetric at base, weakly sulcate when moist, strongly 8-ribbed and constricted below mouth when dry; **exothecial cells** in alternating thin- and firm-walled bands (not well illustrated here); **stomata** superficial, restricted to capsule base; **annulus** of 1–2 rows of vesicular cells, not revoluble, falling with the operculum; **operculum** curved-rostrate from a conic base. **Peristome teeth** red-brown, inserted at mouth, split c. half-way to base, papillose-striolate below. **Calyptra** cucullate, not fringed at base. **Spores** coarsely baculate-insulate.

Taxonomy: A genus of two species recorded by Giese & Frahm (1986a) from N.Z., Tasmania, Malesia, Polynesia including Hawai‘i, The Philippines, Taiwan, Japan, New Caledonia, Chile, and Puerto Rico. Both species occur in N.Z. The lack of records from mainland Australia seems peculiar and is perhaps a collection artefact.

The treatment of *Campylopodium* as a genus of two species by Giese & Frahm (1986a) is followed here, with the exception of one name change (*C. capillaceum* replacing *C. medium* for reasons discussed below). Wijk et al. (1959) treated 11 species in the genus, but most of these were placed in the genus *Microcampylopus*, many as synonyms, by Giese & Frahm (1986b). Giese and Frahm (1986b) recognised *Campylopodium* and *Microcampylopus* as distinct genera; no species which they assigned to *Microcampylopus* occurs in N.Z. *Campylopodium* is the earlier of the two names. However delimited, *Campylopodium* is closely allied to *Dicranella*.

Campylopodium shares more features with *Dicranella* than with *Campylopus*. Indeed, Giese & Frahm (1986a, p. 126) noted that it is “distinguished from *Dicranella* only by the curved setae. The leaf morphology and anatomy is exactly that of *Dicranella*.” Features suggestive of *Dicranella* include the nature of the laminal cells, the absence of differentiated alar cells, costal morphology, capsule form (being similar to those species of *Dicranella* with symmetric capsules), the nature of the peristome teeth, and the presence of stomata in the capsule base. The boundary between *Campylopodium* and the northern hemisphere genus *Cynodontium* is unclear but not discussed here.

When fruiting, the strongly cygneous setae coupled with short stems, relatively narrow costae, and subulate, often sheathing leaves make this genus recognisable regionally. When sterile the plants are strongly suggestive of a *Dicranella*.

Etymology: The generic name refers to the cygneous or bent "foot" of the capsule.

1 **Paroicous**; **leaves** not sheathing, with an ovate base gradually contracted to a ± linear subula; **margins** bistratose; **capsules** broadly ovoid .... *C. lineare*

1' **Dioicous**; **leaves** sheathing, with an oblong base suddenly contracted to a long subula; **margins** unistratose; **capsules** ovoid to short-cylindric .... *C. capillaceum*

Excluded Taxa: *Campylopodium buchananii* (Stirt.) Paris [Index Bryol. Suppl. 88, 1900]. Isotype material in CHR (*J. Buchanan 65* from Wellington, CHR 543123A!) is *C. capillaceum*. This material was correctly named by Brotherus as *Campylopus flexipes*, an earlier heterotypic synonym. However, Dixon (1914, p. 71) and Giese & Frahm (1986a) both included *Campylopodium buchananii* and its homotypic synonyms in the synonymy of *Campylopodium lineare*. It is likely that the Buchanan collection is mixed and that a lectotype needs to be selected in order to clarify the application of this name.

Campylopodium capillaceum (Hook.f. & Wilson) Fife, *Fl. New Zealand Mosses 42*, 1 (2019)

≡ *Campylopus capillaceus* Hook.f. & Wilson, *London J. Bot.* 3: 543 (1844)
Type material: N.Z., Bay of Islands, *J.D. Hooker 322* [herb. Wilson 322], BM 000079658 *pro parte*!

= *Didymodon medius* Duby in Moritzi et al., *Syst. Verz. [Moritzi et al.]* 134 (1846)
≡ *Campylopodium medium* (Duby) Giese & J.-P.Frahm in Frahm. et al., *Acta Bot. Fenn.* 131: 68 (1985)
Type: Java. Not seen.

= *Aongstroemia euphoroclada* Müll.Hal., *Syn. Musc. Frond. 1,* 429 (1848)
≡ *Campylopodium euphorocladum* (Müll.Hal.) Besch., *Ann. Sci. Nat., Bot. sér. 5,* 18: 189 (1873)
Type: Java, *Zollinger 411*. Not seen.

= *Dicranum holomitrium* Müll.Hal., *Syn. Musc. Frond. 1,* 389 (1848)
≡ *Campylopus holomitrium* (Müll.Hal.) A.Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1870–1871: 421 (1872)
Type: N.Z., Bay of Islands, *J.D. Hooker 322* [herb. Wilson 322], BM 000079658 pro parte!

= *Dicranodontium proscriptum* Hook.f. & Wilson in Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II,* 67 (1854)
Type: N.Z., Bay of Islands, *J.D. Hooker 322* [herb. Wilson 322], BM 000079658 pro parte!
(Placed in synonymy of *C. euphorocladum* by Dixon 1914, p. 70.)

= *Dicranodontium flexipes* Mitt. in Hooker, *Handb. New Zealand Fl.* 413 (1867)
≡ *Campylopodium flexipes* (Mitt.) Broth., *Nat. Pflanzenfam. [Engler & Prantl] 1(3),* 312 (1901)
Probable type: N.Z., Bay of Islands, *J.D. Hooker 322* [herb. Wilson 322], BM 000079658 pro parte! Giese & Frahm (1986a) cited *Hooker 322* as one of several syntypes of this name; no useful purpose would be served by questioning their selection.

= *Campylopus gulliveri* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 472 (1897) – as gulliverii
Type: N.Z., near Greymouth, West Coast, 1896, *W.J. Gulliver s.n.*, CHR 335662!

Plants bright green, often becoming brown in older herbarium material. **Stems** variable in length, commonly c. 2–6 mm, but sometimes to c. 40 mm. **Leaves** sheathing at base and shouldered. **Lower leaves** mostly c. 2.0–2.5 mm, sheathing at base, tapered abruptly from an oblong base to a narrow subula that is ⅔ or more the total leaf length, acuminate at apex, entire or finely denticulate at apex, channelled below, unistratose. **Upper (including perichaetial) leaves** c. 3–6.5 mm, strongly sheathing, in shape as the lower leaves, the subula c. ⅔ the total leaf length and nearly filled by the costae above (lamina at mid subula c. 4 cells wide). **Upper laminal cells** (in leaves from below perichaetium, mid leaf) absent or to 6 cells wide, 12–18(–21) × c. 6 µm, and unistratose at margins. **Costa** (in leaves from below perichaetium) occupying c. ⅙ the width and ± poorly defined in leaf base, sometimes appearing to fill the upper subula.

Dioicous. **Perichaetia** often multiple and sequentially overtopped by innovations, with leaves as above. **Perigonia** often inconspicuous. **Setae** c. 2.5–4(–6) mm, yellow-brown; capsules emergent (not or scarcely exceeding perichaetial leaves), ovoid to short-cylindric, 0.8–1.2(–1.5) mm, slightly asymmetric at base, with a variably developed sterile neck and usually weakly strumose; **exothecial**

cells and **annulus** as per genus; **stomata** superficial, restricted to capsule base; **operculum** c. 0.5 mm. **Peristome** as per genus. **Spores** 22–29 µm.

Illustrations: Plate 1. Giese & Frahm 1986a, figs. 1–22; 37–41.

Distribution: NI: N Auckland including offshore islands (LB, GB), S Auckland, Gisborne (Panikau), Hawke's Bay (Wairoa), Taranaki (Tāngarākau Gorge), Wellington; SI: Nelson, Canterbury (Arthur's Pass), Westland, Otago (several localities near Dunedin), Southland; St.

Anomalous. Tasmania*, Java*, Samoa*, Tahiti*, Austral Is.*. Also reported from Sumatra, Celebes, Malaysia, Philippines, New Guinea, Fiji, Hawai'i, New Caledonia, Taiwan, Japan, Chile, and Puerto Rico by Giese & Frahm (1986a).

Habitat: On mineral soil, especially clay, in a wide range of vegetation types. Very often on vertical sides of drainage ditches and track- or road-side banks, but also on ± bare soil patches. Occasionally on thermally heated soil, on soil at lake or stream margins, and in pākihi. Apparently avoiding calcareous (or nutrient enriched?) sites. On the North I. from near sea level (Okura Bush, N Auckland L.D.) to at least 1036 m (Table Top in Tararua Range, Wellington L.D.) and on South I. from near sea level (Punakāiki area, Nelson L.D.) to 1400 m (Scarlett Range, Nelson L.D.).

Notes: Although most often a small plant with stems <6 mm, *C. capillaceum* is extremely variable, particularly in regard to stature and the capsule shape and dimension. Capsule length can vary considerably, even in single populations. The extent of the sterile neck tissue and the associated weakly developed struma at the capsule base is also highly variable. Forms with elongate stems (20–40 mm or greater) are usually from thermally heated sites or subject to seepage. In these conditions, stems sometimes proliferate repeatedly by subperichaetial or subperigonial innovations.

Like Sainsbury (1955a, p. 98), I have not seen the type of *Campylopodium euphorocladum* var. *thermophilum* Dixon & Thér. *in* Dixon & Sainsbury [J. Bot. 71: 215, 1933] but have studied the same Allison collection (*K.W. Allison 608*, CHR 543122A) from Rainbow Mountain that Sainsbury cited. It falls within the continuous range of variability for the species in all features except stem length, and I do not consider it worthy of taxonomic recognition. The type collection of the variety was collected at "Rainbow Hill" in Sept. 1929 by *A. Meebold*.

The name *Campylopus capillaceus* Hook.f. & Wilson is an earlier valid name for what has been termed *Campylopodium medium* (Duby) Giese & Frahm (Giese & Frahm 1986a). A packet of type material of *Campylopus capillaceus* Hook.f. & Wilson, containing several fruiting plants, is present *in herb.* Wilson (as "W. 322"). It is annotated by Wilson as "*Campylopus capillaceus* Mitt." and accompanied by Wilson pencil sketches. It is attached with several other duplicates of the collection *J.D. Hooker 322* (from Bay of Islands) to BM sheet 000079658.

In *Flora Novae-Zelandiae* (Wilson 1854, p. 67) Hooker material from the Bay of Islands is referred to, under the genus *Dicranodontium*, as "*D. proscriptum* Hornsch. var. β". The allegedly earlier name mentioned by Wilson, *Cynodon proscriptus* Hornsch. [Horae Phys. Berol. 60: 357, 1820], was based on material from St Helena. It was excluded from *Campylopodium* by Giese & Frahm (1986a, p. 133) and is not considered further here.

Both *Campylopodium medium* (Duby) Giese & J.-P.Frahm and *C. euphorocladum* (Müll.Hal.) Besch. appear to be based on segregates of a single Javanese collection made by H. Zollinger (see Giese & Frahm 1986a).

Giese & Frahm (1986a, p. 128) discussed Japanese material of *Campylopodium capillaceum* (as *C. medium*) in which the peristome teeth are "either entire or the forks are imperfectly divided." Material from Mt Owen (*J.K. Bartlett 22102*, CHR 360613) is rather poor material of *C. medium*, having peristome teeth appearing undivided and coarsely striate throughout. All other features of this sparse collection point convincingly to its referral to this common and widespread species, rather than a new species of *Dicranella*, as Bartlett proposed (*in herb.*).

Recognition: Confusion sometimes occurs between *C. capillaceum* and the relatively rare *Dicranella dietrichiae*, with sterile material being especially confusing. *Campylopodium capillaceum* has longer (c. 3–6.5 mm vs c. 4 mm) and more slender upper and perichaetial leaves that are not contorted when dry compared to the shorter and much-contorted dry leaves of *D. dietrichiae*. When fertile, the shorter, stouter, and distinctly cygneous setae of *C. capillaceum* preclude confusion. Finally, stomata in *C. capillaceum* are conspicuous and phaneropore, while in *D. dietrichiae* stomata appear to be absent.

Confusion with *Dicranella cardotii* is less likely, with differences in plant stature, colour, and leaf shape helping to distinguish *C. capillaceum*. Microscopically the mid leaf laminal cells of *C. capillaceum* are unistratose and smooth, compared to the mostly bistratose and bulging-mammillose cells of *D. cardotii*. *Dicranella cardotii* is also largely confined to stream margins and seepages, at least in N.Z.

Some collections of small forms of *Campylopus pyriformis* named as *C. capillaceum/medium* have been seen. *Campylopodium capillaceum medium* has narrower costae with adaxial stereids, shorter and stouter setae, larger spores, non-fringed calyptrae, and conspicuous stomata in the capsule neck. Stomata are absent in *Campylopus pyriformis*, as they are in all members of that genus.

Etymology: The species epithet refers to the leaf shape ("*follis dissitis patulis e basi dilatata vaginante longe capillaceis flexuosus*"). The meaning of the disused epithet *medium* is not obvious.

Campylopodium lineare (Mitt.) Dixon, *Bull. New Zealand Inst.* 3: 71 (1914)

≡ *Dicranodontium lineare* Mitt. in Hooker, *Handb. New Zealand Fl.* 413 (1867)
Probable isotype: N.Z., Nelson, *s. loc.*, *H.H. Travers*, CHR 543121!

Plants yellow-green when fresh, becoming brown when dry and old. **Stems** c. 2–5 mm. **Leaves** neither sheathing nor strongly shouldered. **Lower leaves** mostly 1.5–3 mm, narrowly ovate-lanceolate, acuminate, serrulate above, entire or crenulate below, keeled, mostly unistratose but bistratose at margins. **Upper leaves (including perichaetial)** c. 4–7.5 mm, lanceolate-subulate, gradually tapered from a narrowly ovate base c. ⅕–¼ the total leaf length, with a slender and keeled subula that is nearly filled by the costa. **Upper laminal cells** (in leaves from below perichaetium), short-rectangular, rounded at corners, mostly 12–15(–21) × c. 6 µm and (1–)2–3:1, those at margin bistratose and projecting at upper ends. **Costa** (in leaves from below perichaetium) occupying c. ¼ the width of the leaf base and well defined, not filling the upper subula, spinose abaxially near apex by projecting cell ends.

Paroicous. **Perichaetia** often >1 per stem. **Perigonia** on short stalks immediately below the perichaetia, the outer bracts acute and often with 1–2 inner bracts much reduced and obtuse. **Setae** 2.5–5 mm, cygneous when moist; **capsules** emergent (not or scarcely exceeding perichaetial leaves), broadly ovoid, 0.8–1.2 mm, slightly asymmetric at base, with a small and weakly strumose sterile neck; **exothecial cells** and **annulus** as per genus; **stomata** superficial; **operculum** c. 0.6 mm. **Peristome** as per genus. **Spores** 21–24 µm.

Illustrations: Plate 1. Giese & Frahm 1986a, figs. 23–36, 42.

Distribution: NI: Taranaki (Mt Egmont), Wellington (Mt Ruapehu, Akatarawa Range, Mt Bruce); SI: Nelson (Little Wanganui River, *s. loc.*), Canterbury (Avalanche Peak, Bealey Glacier Track), Westland (Ōtira Gorge, Waiuta, Clarke River), Southland (Stuart Range).

Probably Australasian. Reported from Tasmania by Giese & Frahm (1986a), and accepted from that island by Dalton et al. (1991). According to Lyn Cave (pers. comm., 12 Oct. 2017) there are several Tasmanian collections in HO.

Habitat: On mineral earth, occasionally on accumulated soil over wood; usually in southern beech forest. From near sea level (Little Wanganui River) to c. 1200 m (Mt Ruapehu).

Notes: *Campylopodium lineare* remains a poorly documented species with collections known from only two North I. L.D. and from scattered South I. localities near to or west of the Main Divide.

The protologue cites an H.H. Travers collection from an unlocalised Canterbury locality, but no such collection can be located in N.Z. herbaria. An unlocalised Travers collection from Nelson is present in CHR (543121!), and this specimen may be a portion of the type. Giese & Frahm's (1986a, p. 131) citation of a Hutton & Kirk collection as the type is incorrect.

Type material of *Cynodontium tasmanicum* Broth. & Rodway, which was placed in synonymy with the present species by Giese & Frahm (1986a), has not been available for study. Some Tasmanian material named as *Cynodontium tasmanicum* in AK is referable to *C. medium*.

Sainsbury suggested (1955a, p. 100) that *C. lineare* could be accommodated in the predominantly north-temperate genus *Cynodontium* Schimp., and its similarity to that genus is emphasised by bistratose leaf margins and paroicous sexuality. However, *C. lineare* would be anomalous in *Cynodontium* by its smooth laminal cells (Ireland 1994a) and by its geographic distribution; it is retained here in *Campylopodium*.

Recognition: Confusion with several species occurs; that with *C. capillaceum* (=*C. medium*) being the most frequent. The leaves in the present species have an ovate base gradually contracted to the narrow subula, while those of *C. capillaceum* have an oblong and shouldered base abruptly tapered to the subula. The nature of the leaf margin and sexuality also differ.

Campylopodium lineare is sometimes confused with *Orthodontium lineare* but can be readily distinguished by the nature of its single dicranaceous peristome, its shorter (2.5–5 mm) and cygneous setae, and its short capsules. By contrast *O. lineare* has a double peristome in which the pale endostome segments are longer than the teeth and conspicuous when dry, much longer and flexuose setae, and longer (mostly 2.0–2.5 mm) capsules, as well as many other features. Confusion also sometimes occurs between *C. lineare* and both *Amphidium cyathicarpum* (q.v.) and *Campylopus pyriformis*.

Etymology: The species epithet refers to the shape of the leaf, which Mitten considered to be linear-lanceolate.

Campylopus Brid., *Muscol. Recent. Suppl. 4,* 71 (1818)

Type taxon: *Campylopus flexuosus* (Hedw.) Brid.

The following generic description is modified from Frahm (1994b).

Plants erect in loose to compact tufts or turves, variable in height, mostly uniformly foliate, rarely comose, sometimes fragmenting. **Stems** simple or seldom forked, in cross-section with a central strand, densely or sparsely beset with rhizoids. **Leaves** mostly lanceolate, lacking a distinct shoulder, mostly acuminate or acute, occasionally rounded or cucullate, erect or curved, straight or ± flexuose; **upper laminal cells** quadrate, short-rectangular, weakly elongate, or rhombic; **cells of the leaf base** enlarged, with thin or thick walls, sometimes porose, sometimes elongate at margins; **alar cells** absent or conspicuously differentiated, hyaline or red-brown, often extending to the costa. **Costa** broad, usually more than ½ the width of the leaf base, distinctly or weakly differentiated from the lamina, lacking oil-inclusions, percurrent or excurrent, often ending in a hyaline apex, in mid leaf cross-section with 0, 1, or 2 stereid bands, often ribbed and sometimes toothed on the abaxial surface, with or without enlarged cells (hyalocysts) on the adaxial surface.

Dioicous. **Perichaetia** terminal but often overtopped by innovations, with **perichaetial leaves** broader than vegetative leaves, sheathing in N.Z. species. **Setae** elongate, nearly always cygneous; **capsules** erect or inclined, ovoid to short-cylindric, strumose or not, often furrowed, especially when dry; **annulus** well differentiated, vesicular and revoluble in N.Z. species; **stomata** absent; **operculum** rostrate. **Peristome teeth** 16, deeply divided, vertically pitted-striolate below. **Calyptra** cucullate, smooth, usually fringed at base. **Spores** mostly less than 20 µm, smooth.

Taxonomy: *Campylopus* is a large genus found in all parts of the world except polar regions, with most species growing on acidic or nutrient-depleted soil. It is most diverse in the Americas. It is taxonomically a very difficult genus in all parts of its range due to its morphological plasticity; Crum & Anderson (1981) characterised it as “one of the most difficult genera of mosses”. *Campylopus* and some closely allied genera are sometimes isolated within the Dicranaceae into a subfamily Campylopodioideae (Frahm 1985a) on the basis of their cygneous setae, lack of stomata, broad costae, and frequent presence of enlarged cells on the adaxial surface of the costa. Some authors (Goffinet et al. 2009) have placed *Campylopus* in the Leucobryaceae, but this is not done here.

Little reliance can be given to the few published estimates of the number of species in the genus. For a very rough scale, Brotherus (1924) estimated it might contain about 500 species worldwide, while an even larger figure of c. 750 species is given by Corley (in Smith 2004). Frahm (1994a) accepted 25 species from Australia, but his species concepts seem excessively narrow. N.Z. material, like that from many parts of the generic range, can be extremely difficult to name with confidence even when broad species concepts are applied.

Campylopus is mostly readily recognisable by its terrestrial habitat and erect habit with very broad costae (more than ½ the width of the basal part of the leaf) and often conspicuously differentiated alar cells. It rarely fruits, but capsules when present have cygneous setae and calyptrae that are usually fringed at the base. Stomata are universally absent in the genus.

The genus is traditionally divided into three subgenera (Brotherus 1924) on the basis of costal anatomy, which is best seen in cross-sections made at mid leaf. Some recent regional treatments do not make use of these subgeneric distinctions (Frahm 1994a; 1994b; Allen 1994) while recent treatments for eastern North America (Crum & Anderson 1981) and the British Isles (Corley *in* Smith 2004) assign species to subgenera. Regardless, all treatments require observations on costal anatomy for specimen identification.

Despite the modest number (six) of species accepted here, their great plasticity and the rarity of capsule production frequently make confident identifications difficult. Some collections will remain unnameable. Sadly, but inevitably, these unnameable collections include some type specimens.

Some N.Z. authors have liberally described taxa on the basis of arguably aberrant collections of known species. Brown (1897c), for example, described 15 N.Z. species in one paper; the types of only a few are available in N.Z. herbaria. Carl Müller (especially in Müller & Brotherus 1900) likewise described many N.Z. *Campylopus* taxa, mostly based on material collected by H. Schauinsland. Many of Brown's names were treated as synonyms by Dixon (1923) and/or by Robinson (1975). Many of the types of these names are not accessible, and Dixon's and Robinson's synonymies are not questioned here. Robinson placed eight Robert Brown (bis) names in the synonymy of *C. clavatus* and four others in the synonymy of *C. appressifolius* (itself considered here a synonym of *C. clavatus*). Brown's inclination to describe trivial variants as new species is well documented (Dixon (1913). Müller, particularly in the latter part of his career, was also known for basing new species on minor variants of described taxa. In the single 1900 paper he described six new *Campylopus* species based on N.Z. (including Chatham I.) material.

The German bryologist J.-P. Frahm published numerous papers on *Campylopus* in Australasia and other regions between 1981 and 1994. In a N.Z. context, he described several taxa that are not recognised here, and recorded taxa that were originally described from outside Australasia (e.g., *Campylopus catarractilis*). Some of these records are not accepted in this treatment. Although the illustrations in Bartlett & Frahm (1983) are useful in the recognition of N.Z. species, the often contradictory opinions expressed in Frahm's several publications limit their value in the interpretation of our taxa.

This treatment employs broader species concepts than have been applied to N.Z. *Campylopus* by previous authors. It is presented here, warts and all, as a "state-of-current-knowledge" treatment rather than a definitive one.

Etymology: The generic name is derived from Greek and refers to the bent "foot" or seta.

In the key and the descriptions that follow, all costal sections are taken at mid leaf unless specifically stated otherwise. The phrase "upper laminal cells" likewise refers to cells at mid leaf. Leaf sections are best taken by isolating 2–3 representative leaves in a small water drop and cutting numerous sections using a single-edge razor blade. This can be done under a stereoscope while pinning the leaf to the slide, convex side up, with a pair of jeweller's forceps. If basal costal sections are required, these can usually be cut from the same leaf, at the approximate upper limit of the alar cells, before a cover slip is applied. The basal costal sections can nearly always be readily differentiated by their size and outline from the mid costal sections.

1 **Apices of some or all vegetative leaves** cucullate 2

1' **Apices of vegetative leaves** not cucullate (cucullate leaves may occur on propagula, as in *C. purpureocaulis*) 3

2 **Shoots** often serially comose; costa usually with short lateral spurs, not filling the upper subula, in **mid leaf cross-section** lacking adaxial hyalocysts, with a few small and thick-walled adaxial cells and median guide cells; **basal laminal cells** thick-walled and porose to insertion or very nearly so .... *Campylopus kirkii*

2' **Shoots** not serially comose; **costa** lacking lateral spurs, often filling the upper subula, in **mid leaf cross-section** with exposed adaxial hyalocysts; **basal laminal cells** forming a distinct group of thin-walled and non-porose cells near insertion .... *Campylopus bicolor*

3 **Costa in cross-section** (mid leaf) with stereids exposed on adaxial surface 4

3' **Costa in cross-section** (mid leaf) with hyalocysts exposed on adaxial surface 5

4 **Propagula** (apical plantlets) distichous; **upper laminal cells** (at mid leaf) small and irregular, at least some subquadrate, incrassate, not porose; **costal cross-section** (mid leaf) with well developed stereid bands on both sides of a median layer of guide cells, the adaxial stereid layer of 2–3 or more cell layers; **capsules** ovoid, curved and sulcate when dry, smooth at base; **peristome teeth** vertically striate below, split c. ⅔ their length .... *Campylopus purpureocaulis*

4' **Propagula** (apical plantlets) stellate; **upper laminal cells** (at mid leaf and upwards) mostly elongate-rhombic or rounded-rectangular, sometimes irregularly elongate, weakly to strongly porose, ± obliquely oriented; **costal cross-section** (mid leaf) with a single layer of exposed adaxial stereids; **capsules** subcylindric, suberect, and smooth or nearly smooth when dry, scabrid at base; **peristome teeth** coarsely and irregularly lirate throughout, split nearly to base .... *Campylopus clavatus*

5 **Leaves of upper shoots** mostly ending in a squarrose, hyaline or yellow hair point; **plants** lacking deciduous falcate leaves, comose (often serially) when fertile; **upper laminal cells** mostly rhombic and ± rounded at corners, obliquely oriented; **costa in cross section (mid leaf)** with 1-celled abaxial ridges (rarely merely crenulate); **rhizoids** ± brown…. .... *Campylopus introflexus*

5' **Leaves of upper shoots** not squarrose, concolourous at apex or with a short hyaline tip; **plants** often with masses of pale and strongly falcate deciduous leaves, not comose when fertile; **upper laminal cells** mostly quadrate or short-rectangular, not obliquely oriented; **costa in cross-section (mid leaf)** lacking abaxial ridges; **rhizoids** brick-red .... *Campylopus pallidus*

Excluded Taxa: *Campylopus* and *Thysanomitrium*

C. acuminatus Mitt. [J. Linn. Soc., Bot. 12: 90 (1869)] has been recorded from N.Z. by Frahm (1994a, and elsewhere) from Hermite I. is not accepted here as a N.Z. plant for reasons discussed under *C. kirkii*.

Campylopus capillaceus Hook.f. & Wilson [London J. Bot. 3: 543 (1844)] is an earlier name for what has been termed *Campylopodium medium* (Duby) J.-P.Frahm & Giese, but which is treated in this eFlora as *Campylopodium capillaceum* (Hook.f. & Wilson) Fife, *comb. nov.* The name *Campylopus capillaceus sensu* Fife 1995 is a misapplication of *C. capillaceus* Hook.f. & Wilson, and the more appropriate name for such material is *C. pallidus*, q.v.

Campylopus catarractilis (Müll.Hal.) Paris [Index Bryol. Suppl. 90 (1900)] is a South African species recorded from the Poor Knights Is (Beever 1986; Beever et al. 1992), based on determinations by J.-P. Frahm. However, re-examination of the relevant material shows that this material is a form of *C. introflexus*, q.v.

Campylopus distractus Müll.Hal. in Müll.Hal. & Broth. [Abh. Naturwiss. Vereins Bremen 16(3): 495 (1900)] Type: N.Z., W. Walker (Herb. Levier). There is no material in H-Br. fide Frahm (1998, p. 31). Dixon (1923, p. 85) indicated that he saw the type of “Dicranum distractum Müll.Hal.” [Hedwigia 36: 350 (1897)]. This type was collected by W. Walker, s. loc., in 1875, and cited by Müller as being in the Levier herbarium. Müller’s name was transferred to Campylopus by Paris (1900, p. 91). It is not discussed further here.

Campylopus flavoviridis Dusén [Ark. Bot. 4(13): 2 (1905)], see *C. incrassatus*, below.

Campylopus holomitrium sensu Sainsbury 1955a. See discussion under *C. pallidus*.

Campylopus incrassatus Müll.Hal. [Linnaea 18: 686 (1845)]. This South American species is recorded from N.Z. by Frahm (1987), who cited an earlier report of *C. flavoviridis* Dusén by Bartlett & Frahm (1983). I have seen two collections from the North I. named as *C. incrassatus* by J.-P. Frahm; both are clearly referable to *C. pallidus*. No material named as *C. flavoviridis* appears to be present in any N.Z. herbarium. Neither *C. incrassatus* nor *C. flavoviridis* is accepted here as N.Z. species.

Campylopus kirkii var. *pilosus* J.-P.Frahm [Lindbergia 7: 30, 1981] is rejected here for reasons discussed under *C. kirkii*.

Campylopus leptodus Mont. [Ann. Sci. Nat., Bot., sér. 3, 4: 111 (1845)] was recorded (as a *Thysanomitrium*) and discussed by Dixon (1923, p. 91). The original material of *Campylopus leptodus* is Chilean. Dixon apparently saw material from “principally near Auckland” and collected by both Colenso and Knight. He considered it to differ from nearly all other N.Z. *Campylopus* species, with the notable exception of *C. purpureocaulis*, by having both ventral and dorsal stereid bands (Palinocrapsis costal anatomy). Dixon differentiated the Colenso and Knight material from *C. purpureocaulis* (cited as *C. arboricola*) by having "larger, longer leaves which (except the comal, floral ones) do not end in the distinct white hair-point which is a marked character of that plant", as well as its large inflated alar cells.

Some collections referable to *C. purpureocaulis* (e.g., *G.O.K. Sainsbury 1999* from Mt Taranaki, CHR 566304) have predominantly concolorous, non-hair-pointed leaf apices. Also, *C. purpureocaulis* usually has well-differentiated, inflated, and pigmented alar cells, although these are often obscured by the abundant rhizoids. Dixon's observations on leaves of the Colenso and Knight material suggest that it represented slightly aberrant *C. purpureocaulis*. His suggestions that the material, when fruiting, had a "longly fringed calyptra and [a] narrow, smooth, symmetrical capsule" is more suggestive of *C. clavatus*, a species with a similar costal structure, and one often placed in the genus (or subgenus) *Thysanomitrium*. Material named as *C. leptodus* in the Beckett collection belongs to the unrelated *Saelania glaucescens* and is not pertinent. *Campylopus leptodus* has not, to my knowledge, been considered in any work on Australasian *Campylopus* since that of Dixon. On the balance of the limited available evidence it is likely that the specimens cited by Dixon (1923) as *Thysanomitrium leptodus* are referable to either *C. purpureocaulis* or *C. clavatus*. Neither *C. leptodus* nor *Thysanomitrium leptodus* are considered further in this treatment.

Campylopus paludosus J.-P.Frahm & J.K.Bartlett *in* J.K.Bartlett & J.-P.Frahm [J. Bryol. 12: 376 (1983)]. Although I am unable to refer type material from near Jacksons [Westland L.D., *J.K. Bartlett 63*, AK 221722] to any N.Z. species known to me, I am reluctant to conclude, as did Bartlett & Frahm, that this collection deserved description as a new species. *C. paludosus* is here considered as *nom. dub.* and not discussed further in this eFlora. Bartlett's illustration (Bartlett & Frahm, 1983, fig. 8) is an accurate representation of the Jacksons collection.

Campylopus pyriformis var. *hamatus* J.-P.Frahm & J.K.Bartlett *in* J.K.Bartlett & J.-P.Frahm [J. Bryol. 12: 378, 1983]. The type collection is from the Denniston Plateau (Nelson L.D., *J.K. Bartlett 59,* Holotype: WELT M007126; Isotype: AK 221721). I concur with Bartlett & Frahm (1983) that the nature of upper laminal cells and the costal cross-section indicate a probable relationship to *C. pallidus* (*C. pyriformis*). However, I am reluctant to conclude that this collection deserves recognition as a variety of the parent species and it is likely just aberrant material of that species. The var. *hamatus* is not discussed further in this eFlora. Bartlett's illustration (Bartlett & Frahm 1983, fig. 10) is an accurate representation of the type.

Campylopus vesticaulis Mitt. *in* Melliss [St. Helena 359 (1875)] was described from the island of St. Helena; it is not accepted as part of the NZ flora. This name was apparently first used in a N.Z context by Beever et al. (1992), on advice of J.-P. Frahm, to replace *C. paludosus*. *Campylopus vesticaulis* was included in Fife (1995). Frahm did not apply this name consistently to N.Z. material and the occurrence of this species in N.Z. is deemed phytogeographically unlikely. The only specimen seen, apart from the type of *C. paludosus* (see above), named by Frahm as *C. vesticaulis* (*Frahm 22-15* from Mt Ruapehu, CHR 504783) is referable to *C. clavatus*. It is not discussed further here.

Campylopus xanthophyllus Mont. [Ann. Sci. Nat., Bot., sér. 3, 4: 111, 1845)] is a South American species recorded from two N.Z. localities by Wilson (1854, p. 68). Dixon (1923, p. 91) opined that the species was not adequately documented here and that it should be excluded from our flora. It is not discussed further here.

Campylopus bicolor (Müll.Hal.) Hook.f. & Wilson in Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II,* 69 (1854)

≡ *Dicranum bicolor* Müll.Hal., *Syn. Musc. Frond. 1,* 392 (1848)
Type: Australia ("Nova Hollandiae"), *Sieber*. Not seen. (According to Catcheside (1980) the type collection is from Port Jackson, N.S.W.)

= *Campylopus bicolor* var. *intermedia* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 472 (1897)
Lectotype: N.Z., Stewart I., March 1892, *R. Brown s.n.*, CHR 335670!

= *Campylopus stewartii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 472 (1897)
Lectotype: N.Z., Stewart I., summit of Mount Thomson, March 1892, *R. Brown s.n.*, CHR 335656!

= *Campylopus ericeticola* Müll.Hal. in Müller & Brotherus, *Abh. Naturwiss. Vereins Bremen* 16: 496 (1900) – as ericeticolus

≡ *Campylopus bicolor* var. *ericeticola* (Müll.Hal.) Dixon, *Bull. New Zealand Inst.* 3: 87 (1923) – as ericeticolus

Type: N.Z., Chatham Islands, *H. Schauinsland 27*. Not seen.

Plants yellow- to brown-green, mostly dark brown to nearly black below, forming dense tufts in wet habitats. **Stems** (5–)20–55 mm, not branched, in cross-section with a weakly defined central strand and thick-walled cortical cells; rhizoids absent or sparse on lower stem, brown. **Leaves** erect or erect-spreading, stiff, not altered when dry, not or only weakly comose, mostly linear-lanceolate, scarcely narrowed at base, subtubulose, variable at apex (mostly rounded, cucullate, and lacking a hair-point, sometimes acute and concolorous, and sometimes with a hyaline hair-point), entire or denticulate at apex (cucullate forms are entire except for projecting cell ends at extreme apex), with a very weak border that is scarcely visible above mid leaf, 3.0–6.5 × c. 1 mm (flattened); **basal laminal cells** thin-walled, not porose, hyaline, oblong or rectangular, mostly c. 30 µm, with an abrupt upper limit; **mid and upper laminal cells** incrassate, vermicular or linear-rhombic, variably porose, mostly c. 30–60 × 4–5 µm, mostly obliquely oriented; **alar cells** not forming a well-defined group; **marginal cells** narrower, forming a very weak and poorly defined border that ends far below apex. **Costa** c. 475–500 µm and mostly ≥80% of the leaf base width, filling the upper leaf (for c. ¼ the leaf length), percurrent or excurrent, lacking lateral spurs, in abaxial surface view cells linear and incrassate, in adaxial surface view cells linear-oblong and thin-walled, in cross-section (mid leaf) with c. 4 cell layers, with a single layer of median guide cells, a single adaxial layer of large and thin-walled hyalocysts, and 1–2 layers of abaxial stereids, lacking abaxial ridges. **Propagula** absent.

Dioicous. Perichaetial leaves strongly sheathing, narrowly acute from an oblong base, to c. 5 mm. **Setae** strongly cygneous, c. 8 mm; **capsules** ovoid, non-strumose, sulcate when dry, c. 1.3 mm; **stomata** absent, **annulus** strongly differentiated and revoluble; **operculum** rostrate from a conic base. **Peristome teeth** orange and vertically striolate below, hyaline above, split c. half-way to base. **Calyptra** fringed at base. **Spores** c. 18–21 µm, smooth.

Illustrations: Plate 2. Dixon 1923, pl. 7, fig. 9; Catcheside 1980, fig. 41; Bartlett & Frahm 1983, fig. 2 a–g; Frahm 1987, fig. 3; Meagher & Fuhrer 2003, p.139 (as *C. bicolor* var. *bicolor*).

Distribution: NI: N Auckland, including offshore islands (TK, GB), South Auckland (Rotorua, near Ātiamuri), Gisborne (Lake Waikareiti), Wellington (Mt Ruapehu); SI: Nelson (Pūponga, Bainham, Cobb Valley, Scarlett Range, Denniston Plateau, Paparoa Range, Victoria Range, Matiri Plateau), Canterbury (Lewis Pass, Alford Range, Mt Sebastopol), Otago, Southland (Ōtāpiri, Mavora Lakes, Te Ānau, Percy Saddle, Lake Manapōuri); St; Ch.

Australasian. Tasmania*, mainland Australia* including W.A. and N.S.W.; Scott & Stone (1976) reported it from other Australian states.

Habitat: On peat, less commonly directly on rock, usually in acidic areas of impeded drainage (pākihi, bogs, over rock pavements, etc.) or seasonal waterlogging; sometimes forming extensive turves. Ranging in elevation from 10 m (Karikari Peninsula, N Auckland L.D.) to at least 1230 m (Scarlett Range, Nelson L.D.). A large fraction of the collections are from N Auckland L.D. *Campylopus introflexus* is frequently associated with *C. bicolor*. Catcheside (1980, p. 113) considered *C. bicolor* to occur “chiefly on wet rocks in gorges” in South Australia, while Meagher & Fuhrer (2003) considered it to be “often the dominant species on damp, flat granite outcrops, forming large mats of stiffly upright shoots” in southern Australia.

Notes: Well-developed forms of *C. bicolor* are distinctive and readily recognised, by virtue of the stiff, non-comose leaves, which have rounded and cucullate apices, vermicular or linear-rhombic and porose mid laminal cells, hyaline basal laminal cells, and inconspicuous alar cells; the costa occupies c. 80% of the leaf base, nearly fills the upper leaf, lacks spurs, and at mid leaf has a single adaxial layer of large, thin-walled hyalocysts. In abaxial surface view (using the compound microscope) the cells of the mid leaf costa lack ridges and have uniformly elongate cells, while in adaxial view the hyalocysts can be viewed.

However, this is a highly variable species, which varies greatly in leaf form, particularly apical shape and the degree of hair-point development. *Campylopus bicolor* is widely distributed in N.Z. but sporophytes are extremely rare. Capsules have been observed only in a *W. Martin* collection from Fraser Peak Flats, Stewart I. (CHR 449100).

The var. *ericeticola* (Müll.Hal.) Dixon is not recognised here. A significant fraction of populations of *C. bicolor* show transition from concolorous, ± cucullate leaves, to concolorous and acute leaves, to hyaline-tipped and piliferous leaves. The frequency of these intermediates and the many populations showing the full range of variability indicate that the var. *ericeticola* is untenable. Bartlett & Frahm (1983, p. 369) refer to the var. *ericeticola* as “at best a weak taxon.” Frahm (1994a, p. 315) discussed the variability of *C. bicolor* but drew no firm conclusions regarding the variety’s status. He stated initially that specimens with “both cucullate leaves and leaves with hair-points from the same plants” led “to the conclusion that the different leaf apices are the result of modification”, and then stated that culture experiments (and a mixed N.S.W. collection) caused him to believe that the two alleged varieties represented different phenotypes. He claimed that the perigonial leaves were hair-pointed in both var. *ericeticola* and what he would have termed var. *bicolor*. Given the large fraction of herbarium collections showing transition from concolorous leaves to piliferous ones, his arguments in support of var. *ericeticola* are neither conclusive nor compelling.

Collections in which cucullate and piliferous leaves occur on the same shoots include material from Lake Waikareiti, Lewis Pass, and the Port Pegasus area of Stewart I.

Distinguishing between *C. bicolor* and *C. introflexus* can be exceedingly difficult, particularly when both piliferous and hyaline-tipped leaves are present; much herbarium material is incorrectly named. Populations of *C. bicolor* and *C. introflexus* can also grow inter-mixed. The two cannot always be differentiated in the field, although populations with abundantly piliferous and strongly reflexed leaf apices can assuredly be recognised as *C. introflexus*. The converse does not always hold true. Critical material can only be differentiated using a compound microscope.

The most useful distinctions are provided by the abaxial surface view (at ×320, using the fine focus) of the mid leaf costa. In *C. bicolor* the abaxial cells are uniformly linear and the costa surface lacks ridges, while in *C. introflexus* the cells of the ridges appear as ranks of short-rectangular or quadrate cells alternating with more elongate cells of the separating grooves. Secondly, the mid and upper laminal cells are vermicular to linear-rhombic and ± porose in *C. bicolor*, while in *C. introflexus* the mid and upper laminal cells are (at least partially) rounded-quadrate to rounded-oblate and lack pores. In both these species the alar cells are not or weakly differentiated. The hyaline basal laminal cells in *C. bicolor* are mostly shorter (c. 30 µm) and collectively have a less abrupt and less V-shaped transition to the mid laminal cells, while in *C. introflexus* the hyaline basal laminal cells are narrowly rectangular, commonly c. 45–105 µm, with a more abrupt V-shaped transition.

A notable growth form occurs on Mt Maungatua (Otago L.D.) in which the stems are elongate (to c. 50 mm) and the leaves 4–5 mm, evenly tapered from an oblong base to an acute or slightly rounded and subcucullate apex. In some Mt Maungatua material the formation of cucullate leaves near the stem apex and in bands along the stems facilitates recognition, but in many collections no cucullate leaves are present. In much of the Maungatua material the mid leaf laminal cells are shorter (c. 25–40 µm) than representative material for *C. bicolor*.

I agree with Bartlett & Frahm (1983, p. 369) that the tendency here to produce hair-points appears to be a response to periodic or seasonal desiccation, with broader and ± cucullate leaves produced during wetter periods or in wetter habitats. There is a tendency for hyaline-tipped leaves to have narrower-than-representative costae and less distinctly vermicular upper laminal cells. Frahm’s (1994a) assertion that ♂ leaves are invariably hair-pointed cannot be confirmed.

Frahm’s (1987, 1994a) discussions of the alleged variety *ericeticola* are mutually inconsistent. Additionally, a proposed subspecies, *C. bicolor* subsp. *atroluteus* (Müll.Hal.) J.-P.Frahm (combination made in Frahm 1985a) from South Africa was subsequently rejected by Frahm (1994a). Because of the uncertainty surrounding both the variety *ericeticola* and the African subspecies, neither the autonym *C. bicolor* subsp. *bicolor* nor *C. bicolor* var. *bicolor* are employed in this treatment.

Recognition: This species is most likely to be confused with *C. kirkii*, q.v.

Etymology: The specific epithet probably refers to the sometimes abrupt transition in colour of the shoots, from yellow-green above to mostly dark-brown or nearly black below.

Campylopus clavatus (R.Br.) Hook.f. & Wilson in Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II,* 69 (1854)

≡ *Dicranum clavatum* R.Br. in Schwägrichen, *Sp. Musc. Frond. Suppl. 3(2),* 255a (1829)
Type: Tasmania, *R. Brown & G. Sieber*. Not seen.

= *Campylopus appressifolius* Mitt. in Hooker, *Handb. New Zealand Fl.* 414 (1867)
Type: N.Z., *s. loc.*, *Jupp*. Not seen.

= *Campylopus arcuatus* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 474 (1897)
Type: N.Z., Stewart Island, marshy ground, *R. Brown*, March 1892, CHR 335665!

= *Campylopus arenarius* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 475 (1897)
Type: N.Z., Stewart Island, wet sand, *R. Brown*, March 1892, CHR 335666!

= *Campylopus cylindrothecum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 473 (1897)
Type: N.Z., Bruce's Creek near the Bealey River, *R. Brown*, Feb. 1886, CHR 542162!

= *Campylopus ellipticothecum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 473 (1897)
Type: N.Z., Stewart Island, *R. Brown*, March 1892, CHR 335663!

= *Campylopus otaramaii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 474 (1897)
Type: N.Z., north side of Mount Torlesse, near Otarama, Canterbury, *R. Brown*, March 1896, CHR 335659!

= *Campylopus rarus* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 470 (1897)
Type: N.Z., near Lake Te Ānau, *R. Brown*, January 1890?, CHR 335661!

= *Dicranum sulphureoflavus* Müll.Hal., *Hedwigia* 36: 352 (1897)
≡ *Campylopus sulphureoflavus* (Müll.Hal.) Paris, *Index Bryol. Suppl.* 98 (1900) – as sulphureo-flavus
Type: N.Z., near Greymouth, *R. Helms 74*, CHR 542161!

= *Campylopus traillii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 468 (1897)
Type: Stewart Island, *R. Brown*, March 1892, CHR 335657!

= *Campylopus walkerii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 469 (1897)
Type: N.Z., Stewart Island, *R. Brown 10*, March 1892, CHR 335658!

Plants yellow- or brown-green to nearly black, usually brown below, often forming extensive turves. **Stems** (10–)20–55(–90) mm, not or sparsely branched, in cross-section with a central strand and 3–5 layers of thick-walled cortical cells, apparently lacking a hyaloderm; rhizoids red or often becoming nearly white, smooth, densely covering the lower stem and some arising from the abaxial surface of the costae. **Leaves** erect spreading when moist, somewhat more erect but otherwise not altered when dry, evenly distributed on lower stem, often aggregated and more spreading at stem apex in both male and female plants (but not comose), subulate-lanceolate and evenly tapered to a subulate apex, strongly concave or subtubulose, concolorous or with a hyaline hair-point, denticulate at apex, entire below, very weakly bordered for ⅓ or less of leaf length, mostly 4.5–6.0 × 0.55–0.7 mm (flattened); **basal laminal cells** elongate-rectangular, forming an area of variable size, mostly 30–65 µm, thin-walled, not porose, weakly pigmented, lacking a sharply defined upper limit; **laminal cells of upper base** (c. 650–1100 µm above leaf base, depending on leaf length) extremely variable in form, wall thickness and porosity, usually rhombic or elongate-rhombic, ± obliquely oriented, and usually ± sinuate; occasionally regular and short-rectangular; cells adjacent to costa usually more elongate and porose; **upper laminal cells** (at c. mid leaf and upwards) mostly elongate-rhombic or rounded-rectangular but often irregularly elongate and incrassate, variably porose, often strongly so; **alar cells** strongly inflated and pigmented, forming a large, slightly auriculate group, rarely weakly differentiated; **marginal cells** scarcely differentiated. **Costa** c. 285–350 wide and 50–60% of the leaf base width, usually difficult to see at mid leaf due to concavity, filling the upper subula and appearing excurrent, lacking lateral spurs, usually with rhizoids arising from lower abaxial surface, in both abaxial and adaxial surface view the cells linear; in cross-section (mid leaf) with a single central layer of guide cells, 1 layer of exposed adaxial stereids, and 2(–3) layers of abaxial stereids, which are usually interspersed with larger cells (± same diameter as the guide cells); the abaxial surface smooth, undulate or with low and ill-defined single-celled ridges; in cross-section (at leaf base) the adaxial layer of exposed cells enlarged. **Propagula** often present in sterile plants, consisting of deciduous, stellate shoot fragments.

Dioicous. Perichaetial leaves weakly sheathing, with a more distinct ± oblong base but otherwise not differentiated. **Setae** cygneous, 7–10 mm, dark brown to nearly black; **capsules** subcylindric, erect, non-strumose, smooth or nearly so when dry, scabrid at base, c. 2 mm; **operculum** rostrate, c. half the length of the capsule. **Peristome teeth** orange below, pale above, coarsely and irregularly lirate throughout, forked nearly to base. **Calyptra** fringed at base. **Spores** 9–15 µm, smooth.

Illustrations: Plates 3, 4. Catcheside 1980, fig. 42; Frahm 1984, figs. 9–14; Frahm 1987, fig. 6; Meagher & Fuhrer 2003, p. 107.

Distribution: NI: K; N Auckland including offshore islands (TK, HC, LB, GB), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington; S: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St; Ch; A; Ant; C; M.

Australasian or Austral. Tasmania*, mainland Australia*. Reported from Chile by Robinson (1975).

Habitat: Occupying diverse terrestrial habitats, on soil of a wide range of texture and nutrient content and tolerant of a range of both moisture and insolation. Occasionally on thermally heated soil; also on rock and occasionally on logs. Virtually ubiquitous throughout N.Z. From near sea level (Waikuku Flat near North Cape, N Auckland L.D.) to at least 1550 m (Bruce Road, Wellington L.D.) on the North I. and at least 1550 m (Corner Peaks, Southland L.D.) on the South I.

Notes: *Campylopus clavatus*, as interpreted here, is a highly variable species in many respects, including overall habit, degree of hair-point development, the extent of the basal laminal cells, and the form of the laminal cells. The extreme variability of the species, in particular in leaf characters, makes this species difficult to delimit satisfactorily and is reflected in the large number of taxonomic synonyms.

In addition to the synonyms given above, Robinson (1975) considered *C. persimplex* Müll.Hal. [Abh. Naturwiss. Vereins Bremen 16(3): 496 (1900)] to be *C. clavatus*. The type is *H. Schauinsland 226* from French Pass (Nelson L.D.). It has not been seen but might be sought in the Bremen or the Helsinki herbarium.

When plants are fertile, the subcylindric, non-sulcate capsules with scabrid necks and peristome teeth, which are split nearly to their base and coarsely lirate, clearly distinguish this species from all its N.Z. congeners. The scabrous capsule neck and deeply divided peristome teeth (and their coarse, non-striolate ornamentation) are among the features used by Frahm (1984) to define the subgenus *Thysanomitrion*, which has only the single representative in N.Z.

The relationship between environmental factors and the morphological variability of this species, and especially the form and porosity of the laminal cells, is poorly understood. It is possible that a detailed morphometric or molecular study might permit the recognition of some of the variants of this species, but to recognise them at the present state of knowledge would be of little value. As in many unrelated moss species, very dark, sometimes ± black plants are associated with irrigated habitats.

Both male and female plants usually have the stem apices expanded and terminated by large numbers of antheridia or archegonia. The leaves subtending the sex organs, however, differ little in size from leaves on the non-expanded portion of the stem, and hence the plants cannot be considered comose. Sterile plants are uniformly foliate and not expanded apically. The frequent production of stellate shoot fragments facilitates recognition of sterile material. Also the rhizoids here often assume a white colour on the lower portions of the stem; when present a pale mat of rhizoids is unique among N.Z. *Campylopus* species.

In one of the most distinctive and widespread growth forms of *C. clavatus* (the so-called *C. appressifolius*), the leaves are markedly erect-appressed and stems are elongate and expanded apically only in gametangial plants. These features are correlated with the microscopic features of incrassate, strongly porose, and relatively elongate upper laminal cells that extend basally nearly to the alar cells. There is a tendency for such material to bear low and poorly developed abaxial costal ridges at mid leaf. While a case could be made for recognition of the *appressifolius* growth form at the varietal rank, this is not done here as many populations show a morphological transition from representative *C. clavatus* to the *appressifolius* growth form. Such material (e.g., *G. Brownlie 305* from Charleston, Nelson L.D., CHR 425962) often has a small group of short, rectangular cells present between the basal laminal cells and the relatively elongate and porose upper laminal cells and weakly developed abaxial costal ridges. Dixon’s (1923, p. 84) observation that the *appressifolius* growth form (cited as *C. appressifolius*) has a costa “usually less than half width of the leaf-base” and often long hair points does not agree with my own.

Frahm’s (1984, p. 586) statement that all members of the subgenus *Thysanomitrion* have a hyalodermis is not supported by my observations on *C. clavatus*.

Robinson (1975) suggested that *C. clavatus* is closely related to *C. richardii* Brid. of tropical America, a statement that I strongly endorse. This synonymy is not made here partly because only limited material of South American and West Indian *C. richardii* is available for comparison. The available material, however, suggests a similar wide range of morphological variability in the American taxon. Although some collections of *C. richardii* have elongate, thick-walled, and porose laminal cells extending basally to the alar group (cf. Frahm 1994b, fig. 97), in other collections a small, poorly defined area of elongate, thinner-walled, non-porose cells occurs immediately above the alar cells; this is similar to the condition in the majority of N.Z. material. I have seen Colombian and Antiguan material of *C. richardii*, which, if collected in N.Z., I would unhesitatingly refer to *C. clavatus*.

Recognition: *Campylopus clavatus* can sometimes be difficult to distinguish from *C. purpureocaulis*. Several differences are cited under the discussion of the latter species, including substrate preferences, propagulae form, upper laminal cells features (often the easiest feature to observe), as well as sporophytic differences. Occasionally sectioning of the costa is required to separate these two species. *Campylopus purpureocaulis* is the only other N.Z. species of the genus having stereids exposed on the adaxial surface at mid leaf. In *C. clavatus* these adaxial stereids are in a single layer, while in *C. purpureocaulis* there are two to several layers of adaxial stereids. In *C. clavatus* abaxial costal ridges at mid leaf are mostly absent, while in *C. purpureocaulis* crenulations or low ridges are often present (see Plate 8, fig. E, and Malcolm & Malcolm 2006, p. 286). The two also differ in a cross-section of the costa taken just above the upper limit of the alar cells. In *C. clavatus* such a basal costal cross-section shows the exposed adaxial cells to be inflated and thin-walled (hyalocysts, see Catcheside 1980, fig. 42d), while in *C. purpureocaulis* the exposed adaxial cells are small and incrassate.

Etymology: The epithet *clavatus* means club-shaped, but nothing in Schwägrichen's protologue (neither text nor illustration) of *Dicranum clavatum* provides any hint as to its meaning. It may refer to a vaguely club-like form of gametangial plants.

Campylopus introflexus (Hedw.) Brid., *Muscol. Recent. Suppl. 4,* 72 (1818)

≡ *Dicranum introflexum* Hedw., *Sp. Musc. Frond.* 147 (1801)
Type: Nova Hollandia, *s.loc. et s.coll.*, G. Not seen. See notes below.

= *Dicranum leptocephalum* Müll.Hal., *Bot. Zeitung (Berlin)* 9: 551 (1851)
Type: N.Z., inter Waitemata et Kaipara River, *S. Mossman 722*. Not seen; see notes below.

Plants yellow-green or rarely dark brown above, usually brown or ± black below, wider above in both ♂ and ♀ plants and appearing ± comose, forming dense turves on soil or decaying wood. **Stems** highly variable in height, c. 5–35 (–60) mm, mostly branched by innovation, in cross-section with a central strand, several layers (c. 5–7) of thick-walled cortical cells and no hyaloderm, beset below with smooth, orange-brown rhizoids. **Leaves** erect spreading and variably reflexed apically when moist, tightly appressed at base and with some leaves strongly squarrose-reflexed apically when dry, usually more crowded (± comose) near stem apices, often serially comose in fertile material, gradually subulate from an oblong base, strongly concave to subtubulose, mostly ending in a long hyaline, toothed, and usually squarrose-reflexed hair-point but occasionally concolourous at apex, not bordered above base, mostly 3.5–5 × c. 0.5(–0.8) mm (flattened); **basal laminal cells** thin-walled and hyaline, narrowly rectangular, variable in length but commonly c. 45–105 µm long, with a ± abrupt V-shaped transition to shorter, more rhombic cells above; **upper laminal cells** mostly short-rhombic or quadrate, rounded at corners, incrassate, not porose, some oblate and obliquely oriented (especially a short distance above the boundary with the basal laminal cells; further up the lamina frequently becoming more irregular to rhombic), mostly 12–24 × 6–12 µm; **alar cells** usually indistinct, not or weakly inflated, hyaline or pigmented; **marginal cells** at mid leaf more quadrate or oblate in several ill-defined rows, not forming a distinct border. **Costa** c. 290–380(–500) µm wide and c. 50–70% of the leaf base width, at mid leaf well defined and c. 210–280 µm wide, filling the upper subula and excurrent in a hyaline, toothed hair-point, which is usually squarrose when dry, lacking lateral spurs (unbranched); in abaxial surface (mid leaf or above) view appearing as ranks of short-rectangular to quadrate cells which alternate (some fine focusing required) with ranks of more elongate cells in the grooves; in adaxial view (mid leaf) the cells appearing uniformly elongate (mostly >150 µm long), ± thin-walled, and with oblique terminal walls; in cross-section (mid leaf) with a moderately distinct median layer of guide cells, a single layer of large (c. 8–14 µm in greater diam.), thin-walled, and exposed adaxial hyalocysts, and 3–5 abaxial layers of stereids (including cells of abaxial ridges), with numerous 1-celled abaxial ridges. **Propagula** usually absent.

Dioicous. Perichaetia clustered (to at least 10) in a terminal cluster, each giving rise to a single fruit; **perichaetial leaves** after fertilisation strongly sheathing the setae, longer and narrower than vegetative leaves. **Perigonia** aggregated in a terminal cluster, each surrounded by broadly ovate, concave, and pigmented bracts. **Setae** strongly cygneous, c. 8 mm; **capsules** ovoid, variably strumose, sulcate when dry, c. 1.8 mm; **exothecial cells** elongate and vermicular, with thick and strongly sinuous walls; **stomata** absent; **annulus** well-developed and apparently remaining attached to the fallen operculum; **operculum** long-rostrate from a conic base, c. 0.8 mm and half the capsule length. **Peristome teeth** orange and vertically striolate below, hyaline and baculate above, divided c. half-way to base. **Calyptra** fimbriate. **Spores** 12–14 µm, smooth.

Illustrations: Plate 5. Catcheside 1980, fig. 43; Beever 1986, fig. 2 (as *C. catarractilis*); Beever et al. 1992, fig. 23, b; Frahm 1987, fig. 12; Malcolm & Malcolm 2003, p. 12; Meagher & Fuhrer 2003, p. 107; Seppelt 2004, fig. 51.

Distribution: K; NI: N Auckland including offshore islands (TK, PK, HC, LB, RT), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St; Ch; Sol; A; Ant; C; M.

Austral. Tasmania*, mainland Australia*, Argentina*, Falkland Is.* Material which appears to be correctly named has been seen from Rapa and the Austral Is and Whittier (1976, p. 83) recorded it from the Society Is, New Caledonia, and New Guinea. Frahm (1987) described its range as "widespread throughout the southern hemisphere and introduced in western North America and Europe as an aggressive spreading species of open habitats". Gradstein & Sipman (1978, fig. 3) mapped the distribution on a world scale.

Habitat: Forming turves of up to several square metres in extent on mineral or humic soils, duff, peat, rotten or burnt wood. Often abundant in disturbed situations, such as at roadsides, and following fire, but also occurs in a wide variety of undisturbed vegetation types including bogs, kānuka, and mānuka scrub, exotic plantations, and coastal dunes. Sometimes occurring on exposed roots or fence posts. *C. introflexus* is a weedy species of wide environmental tolerance occurring throughout N.Z. Accordingly, it co-occurs with a wide range of weedy species, including other species of *Campylopus*. From near sea level (Waikuku Flat, North Auckland L.D.) to 1280 m (Mangawhero Falls on Mt Ruapehu, Wellington L.D.) on the North I., and to c. 1580 m (Arnaud Range, Nelson L.D.) on the South I.

Notes: In most instances *C. introflexus* is readily recognisable when dry by its conspicuous and strongly reflexed hyaline hair-points. Frequently the reflexed hair-points are visible only on comal leaves or, in sterile material, only in leaves at the stem apex. In Tasmania fertile shoots can be quite long and nearly the upper stem length cited above, and then the shoots take on the more club-shaped appearance (R.D. Seppelt, pers. comm., 18 Oct. 2017). The hair-points can rarely appear yellow in herbarium collections. Sterile material tends to be more elongate and have shoots much narrower (c. 0.6 mm diam. when dry) than plants bearing sex organs. The abrupt V-shaped transition from the thin-walled and hyaline basal laminal cells to upper laminal cells is also a characteristic feature, especially when viewed in combination with the short-rhombic, quadrate, or oblate and very compact upper laminal cells, which are rounded at the corners, incrassate, not porose, with some oblate and obliquely oriented. Male plants are often produced in abundance and are conspicuous when colonies are viewed from above. Unusually for the genus, this species, although dioicous, commonly produces abundant capsules.

The abaxial costal ridges in mid leaf cross-sections are usually very distinct but only a single cell in height; these likewise aid in recognition. In highly magnified abaxial surface view the ridges appear as ranks of short-rectangular or quadrate cells, which alternate (some fine focusing required) with ranks of elongate cells in the grooves. The abaxial ridges, in well-developed material, can thus often be visualised in surface view. Catcheside's (1980) fig. 43, f, is informative and accurate. In sections from near the leaf insertion, the ridges are mostly completely lacking (cf. Catcheside, 1980, fig. 43, e), while a section from just below the hair-point base usually differs little from that at mid leaf. At mid leaf the adaxial hyalocysts are conspicuous in cross-section.

Sometimes otherwise representative plants (e.g., *K.W. Allison 613* from Kaingaroa Plains, CHR 545967) give rise to propagulae in which the reduced leaves are apically concolourous and ± cucullate, and usually have poorly developed abaxial costal ridges. According to J.E. Beever (pers. comm., 18 Aug. 2017), the leaves of the propagula of *C. introflexus* are shorter and more or less erect compared to those of *C. clavatus*, and this feature can be used to distinguish the two in the field.

There is some confusion around the typification and type locality of *Dicranum introflexum* Hedw. Hedwig (1801) gave the type locality as "Insularum meridionalium incola" and cited no collector. Richards (1963) seems to have been the first modern author to attempt to identify a potential type and to clarify the application of the name *C. introflexus* to British and western European collections. However, Richards did cite an earlier study by Giacomini (which has not been seen). Most significantly in an Australasian context, Richards provided notes on potential type material of *Dicranum introflexum* Hedw. in the Hedwig-Schwägrichen herbarium at Geneva. He based his notes on photographs of the three herbarium sheets in that herbarium, filed under the name *C. introflexus*, rather than examination of the actual specimens. He cited "one of the specimens on sheet 1(labelled 'A') [as] "certainly *C. introflexus* (Hedw.) Brid. as understood by Giocomini". There seems no doubt that this material was collected in Australia ("Nova Holl."). Richards's notes strongly suggest (but do not specifically state) that this material was collected by Sieber. His notes have been cited by subsequent authors (e.g., Gradstein & Sipman 1978; Frahm 1987) and the particular specimen he mentioned has been considered type material, if not an actual lectotype. There seems to be no potential type material of *Dicranum introflexum* Hedw. in Australasian herbaria. The consensus concerning the type of

D. introflexum is not discussed further in this treatment; the controversy concerning its occurrence in Britain and Europe is discussed very briefly below.

Dixon (1923, p. 89) listed only one heterotypic synonym of *C. introflexus* that is based on a N.Z. type. Definite type material of *Dicranum leptocephalum* Müll.Hal. has not been located but there seems no reason to question Dixon's judgement. Material named as *D. leptocephalum* in Beckett's herbarium (CHR 642104) that is either a portion of Mossman's type collection or collected by R. Helms near Greymouth is correctly referred to *C. introflexus*.

Campylopus novae-zealandiae E.B.Bartram & Dixon *in* Dixon & E.B. Bartram [Bot. Not. 1937: 72, 1937] is a probable synonym here. The Southland L.D. type was collected at Bluff between Invercargill and Winton by S. Berggren in 1874. An isotype (WELT M009420!) is extremely sparse, consisting of four stems each less than 15 mm long. The leaves have a short base abruptly tapered to a long and slender acumen that is entire except for moderate toothing at its extreme apex. On the basis of both its areolation and costal morphology it is best to tentatively refer this material to *C. introflexus*, despite its lack of squarrose hyaline leaf tips. Examination of more ample type material would probably confirm this placement.

The Australian *Campylopus pudicus* (Hornsch.) A.Jaeger was accepted as a N.Z. species by Dixon (1923, p. 90) but the single Southland L.D. collection made by J. Meiklejohn (WELT M 001238) and cited by Dixon is *C. introflexus*. I have also seen one Berggren collection from Taupō (CHR 544543) named (by Sainsbury?) as *C. pudicus* and consider it referable to *C. introflexus*.

Campylopus catarractilis (Müll.Hal.) Paris [Index Bryol. Suppl. I, 90 (1900)], a South African species, was recorded from littoral rocks on the Poor Knights Is by Beever (1986, see also Beever et al. 1992 and Fife 1995), based on determinations by J.-P. Frahm. However, re-examination (including independently by J.E. Beever) of the relevant Poor Knights collections shows that this material is a depauperate, turf-forming, coastal seepage form of *C. introflexus*, with reduced abaxial costal ridges but no other significant microscopic differences from this species. In the most ample collection referred by Frahm to *C. catarractilis* (*J.E.Beever 30-18c*, AK 206141), the majority of the plants have blunt to slightly rounded, scabrid, and concolorous leaf apices, some of which are weakly cucullate. However, plants are also present in which the upper leaves have a short, reflexed, hyaline hair-point. Plants with/without hair-points are indistinguishable in their mid laminal cell shape and dimensions, costal cross-sections, and the nature of their basal laminal cells, and in all these features are representative of *C. introflexus*. Similar material, with mostly concolourous but acute leaf apices, has been seen from the Hen and Chicken Islands (N. Auckland L.D.) and from the Black Rocks (Bay of Islands, N. Auckland L.D.), collected by L.B. Moore and Jessica Beever, respectively.

There is a large literature concerning the occurrence of *C. introflexus* in Britain and Europe, where it is considered an invasive adventive. Richards (1963) seems to have been the first to try to clarify this confusion in a British context. According to Smith (2004), the first collection of *C. introflexus* in Britain was made in 1941 and the first in Ireland in 1942. Confusingly, however, the name *C. introflexus* was applied to British material much earlier by Dixon & Jameson (1896), as well as in other 19th century British/European literature. The confusion seems due to the difficulty in distinguishing the adventive *C. introflexus* from the indigenous *C. pilifer* Brid. (=*C. polytrichoides* De Not.). This problem is beyond the ambit of this Flora; it has been discussed by several authors, including Frahm (1972) and Gradstein & Sipman (1978).

Recognition: In N.Z., the distinction between *C. introflexus* and *C. bicolor* can be difficult and the two species can grow intermixed. The two cannot always be differentiated in the field, although populations with abundantly piliferous and strongly reflexed leaf apices can assuredly be recognised as *C. introflexus*. Features useful for the separation of these two species are discussed under *C. bicolor*.

Etymology: The epithet *introflexus* apparently refers to the subtubulose nature of the leaves. Given the epithet, it is potentially confusing that a characteristic feature is the strongly *reflexed* nature of the hyaline hair-points.

Campylopus kirkii Beckett, *Trans. & Proc. New Zealand Inst.* 26: 280 (1894)

≡ *Campylopus acuminatus* var. *kirkii* (Beckett) J.-P.Frahm, *J. Bryol.* 14: 702 (1987)

Lectotype: N.Z.: Golden Bay, Nelson, Jan. 1888, *L. Boor s.n.*, CHR 564014! Isolectotypes: AK 012139!; CHR 564000!; WELT M 004916!

= *Campylopus kirkii* var. *pilosus* Frahm, *Lindbergia* 7: 30 (1981)

Lectotype: N.Z.: N Auckland L.D., “Kaiiwi swamp, sea level, in peat bog, 36 deg. 12' S", *J.K. Bartlett s.n.*, 14 Sep.1978, CHR 540508!

Plants yellow- to brown-green, usually dark brown below, forming dense tufts or turves in wet habitats. **Stems** (c. 5–)40–100 mm, not or sparsely branched, in cross-section with a central strand, and one to several layers of thick-walled cortical cells; rhizoids absent or sparse. **Leaves** erect-spreading when moist, somewhat contorted and often weakly rugose when dry, often serially comose, mostly broadly lanceolate, weakly narrowed to insertion, occasionally narrowly lanceolate in some sectors of the shoots, strongly concave to subtubulose, nearly always rounded and cucullate at apex, lacking a hair-point, entire or very weakly toothed in upper half, with c. 10–12 strongly projecting cells at the back of the cucullate apex, weakly bordered, 3.8–4.7(–6.0) × (0.5–)1–1.3 mm; **upper laminal cells** obliquely oriented, linear-rhomboid, variably porose, mostly 36–75 × 6–9 µm; **basal laminal cells** incrassate and strongly porose, pigmented (not hyaline), linear-rhomboid to short-vermicular, mostly 45–90 µm; **alar cells** well differentiated, strongly inflated or occasionally subquadrate, hyaline or pigmented, forming a large, slightly auriculate group, sometimes merging with the lower laminal cells through a small triangular group of non-inflated hyaline cells; **marginal cells** linear, forming a weak border 1–3 cells wide, extending ± to apex. **Costa** c. 350–460 µm wide and <60% of the leaf base width, becoming ill-defined and c. 210–230 µm at mid leaf, often with short lateral spurs (especially in broadly lanceolate leaves), percurrent; in both abaxial and adaxial surface view the cells linear; in mid leaf cross-section ill-defined and lacking abaxial ridges, with a single layer of enlarged (c. 10 µm diam.) cells (which could be interpreted as guide cells) usually partially covered adaxially by few to many stereid-like cells, with 1–2(–4) layers of abaxial stereids. **Propagulae** absent.

Dioicous. Perichaetia leaves strongly sheathing, lanceolate from an oblong base, c. 5 mm. **Setae** strongly cygneous, c. 10 mm; **capsules** ovoid, non-strumose, sulcate when dry, c. 2 mm; **stomata** absent; **annulus** strongly differentiated, revoluble; **operculum** short-rostrate from a conic base. **Peristome teeth** orange and vertically striolate below, hyaline above, split c. half-way to base. **Calyptra** not seen. **Spores** 15–18 µm, smooth.

Illustrations: Plate 6. Beckett 1894, pl. 30; Bartlett & Frahm 1983, fig. 7 (as *C. kirkii*, including some as var. *pilosus*); Frahm 1987, fig. 1.

Distribution: NI: N Auckland (Te Paki, Mōkaikai Scenic Reserve, Taipā, Ahipara Plateau), including offshore islands (GB), S Auckland, Wellington? (*s. loc.*); SI: Nelson (Golden Bay, near Wanganui Inlet, Darby Pond, Stockton Plateau, Denniston Plateau, Westport, Charleston), Westland (Lake Hochstetter, Kūmara, Arawhata River and vicinity), Southland; St (Freshwater Flats, Port Pegasus); Ch.

Australasian. Tasmania*. Reported from mainland Australia (Qld, N.S.W., Vic., and S.A.) by Frahm (1994a) and from a slightly different range of states by Scott & Stone (1976).

Habitat: On peat or sand in nutrient-depleted wetlands, often those with hardpan or bedrock impeded drainage such as kauri-gumlands, pākihi, or peatlands developed over sandstone platforms; sometimes submerged. The best-documented North I. collections are from c. 160 (Te Paki) to c. 250 m (Ahipara Plateau), although some material from the vicinity of Cambridge (S Auckland L.D.) appears to be from lower elevations; on the South I. from near sea level (Awarua Bog, Southland L.D.) to 1030 m (Darby Pond) elevation. *Campylopus introflexus* is a frequent associate.

Notes: The variation in N.Z. material is insufficient to justify recognition of more than the single variety.

When well developed, the yellow- to brown-green coloration of the plants, with often comose leaves that are strongly concave to subtubulose and cucullate apically, facilitates recognition. The comose habit is due to leaves of contrasting shape (some more broadly lanceolate) developing on different sectors of the shoots. Microscopically, the costa, which is usually c. 60% the width of the leaf base near the insertion, often gives rise to short lateral spurs (sometimes visible under stereoscope), and in mid leaf cross-section has few to many adaxial stereid-like cells that (in surface view) obscure the larger cells beneath them. Well-developed adaxial hyalocysts occur only in the basal portion of the costa. The basal laminal cells are characteristically incrassate, linear-rhomboid, porose, and non-hyaline; the alar cells are mostly strongly inflated (but sometimes subquadrate) to form a large and slightly auriculate group. Sporophytes are very rare.

The protologue of *Campylopus kirkii* Beckett cites two syntypes: one collected by T. Kirk on Great Barrier Island, the other collected by Dr L. Boor in Golden Bay (Nelson L.D.). The Kirk syntype is represented in the Beckett herbarium (CHR 564015) by a few sterile plants. The Boor syntype is represented in the Beckett herbarium (CHR 564014) by ample fruiting material; part of this collection is also present at AK and WELT. The illustration in the protologue was executed by Beckett from the Boor syntype. For these reasons the Boor collection was designated as the lectotype by Fife (2019).

Much uncertainty surrounds the type and status of *Campylopus kirkii* var. *pilosus* J.-P. Frahm. The varietal protologue states the type was collected on 14.1.1978 (14 Jan. 1978) at 800 feet elevation in a "swamp near the junction of Kaiiwi Lake and Taharoa Lake" (N Auckland L.D.). However the specimen provided by Frahm to CHR on 14 Feb. 2001 (CHR 540508) as the "original specimen received from John Bartlett" bears notes by Bartlett indicating it was collected on 14.9.1978 at sea level in "Kaiiwi swamp". The vegetative leaves in the bulk of the shoots are bronze-green to nearly black, narrowly linear-lanceolate, c. 6 mm long; exceedingly few leaves are piliferous as illustrated in the protologue (Frahm 1981, fig. 1, 1–2). The costa in cross-section at mid leaf consists of 4–5 layers of mostly incrassate cells with the exposed adaxial layer somewhat enlarged (but not hyaline). No abaxial projections are present. Near the insertion the costae are wider (c. 80% of the leaf width) and more distinctly delimited than those representative of *C. kirkii*; no lateral spurs are visible. Near the insertion there is a strong layer of enlarged adaxial cells (± hyalocysts) over 3–4 layers of smaller, thick-walled cells; abaxial ridges are lacking. The basal laminal cells are rhombic, thick-walled, and strongly porose, and there is a distinct group of hyaline, inflated alar cells. More significantly, however, there are several broken shoot fragments and at least one intact shoot in which the predominantly linear-lanceolate leaves grade abruptly into broader leaves with ± rounded apices and indistinct, spurred costae. These leaves, including their costal structure and laminal cell detail, agree in every significant way to representative *C. kirkii*.

A similar gradation from narrowly lanceolate leaves to broadly lanceolate ones with ± rounded apices and laminal and costal structures clearly assignable to *C. kirkii* occurs in many other herbarium specimens. In no specimen examined are the vegetative leaves as narrowly lanceolate as in the lectotype of *C. kirkii* var. *pilosus*. However, the existence of shoots with variable leaf forms in some herbarium specimens (in addition to the lectotype, see *L. Visch s.n.*, 19 Nov. 1990 from Lake Monowai in Southland L.D., CHR 478137 and *E.W.E. Butcher s.n.* from Moanatuatua Swamp in S Auckland L.D., CHR 105297). The variation in leaf form may be a response to fluctuating water levels. Such material and the presence of representative leaves/shoot sectors in the type of *Campylopus kirkii* var. *pilosus* makes the placement of the latter in synonymy inevitable.

Frahm (1987, 1994a) subsequently reduced *C. kirkii* to a variety of the Fuegian *C. acuminatus* Mitt. [J. Linn. Soc., Bot. 12: 90, 1869], a synonymy that is rejected here. He also (Frahm 1987, 1994a) treated his own *C. kirkii* var. *pilosus* as a synonym of *C. acuminatus* Mitt. *var. acuminatus* and recorded this latter taxon from both N.Z. and Australia.

Recognition: *Campylopus kirkii* is a readily recognisable species growing in a distinctive habitat throughout N.Z. and parts of Australia. It is typified by an ample fruiting collection present in three N.Z. herbaria. On these bases, the application of the name *C. kirkii* Beckett at the species rank to Australasian material is readily justified. *Campylopus acuminatus* Mitt. is rejected as a N.Z. species.

Campylopus bicolor var. *γ*, mentioned by Brown [Trans. & Proc. New Zealand Inst. 29: 472, 1897c] has no nomenclatural standing as it is unnamed according to Article 9.1 of the International Code of Nomenclature.

The costal spurs, thick-walled and porose basal laminal cells (extending to insertion or nearly so), and often serially comose nature of the shoots (sectors of broadly lanceolate leaves alternating with more narrowly lanceolate leaves) of *C. kirkii* serve to prevent its confusion with *C. bicolor*. The latter species has much stiffer leaves, costae lacking lateral spurs, thin-walled and hyaline basal laminal cells, and non-comose shoots. The nature of the mid costal cross-section also distinguishes the two species.

Etymology: The species epithet honours Thomas Kirk (1828–1898), an influential N.Z. botanist, forester, and author of *Forest Flora of New Zealan*d (1889).

Campylopus pallidus Hook.f. & Wilson in Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II,* 68 (1854)

Lectotype: N.Z., Northern Island, Auckland, *Sinclair*, BM 000517611! The Sinclair collection, one of two syntypes cited in the protologue is fertile and ample. Frahm (*in herb.* BM) has annotated this specimen "chosen as lectotype" with an illegible date (1981?). A published statement of this lectotypification cannot be located and in Frahm (1987) he stated that he had not seen type material.

= *Campylopus torquatus* Mitt. in Wilson, *Bot. Antarct. Voy. III. (Fl. Tasman.) Part II,* 173 (1859)
Type: Tasmania, West-end Rivulet, Cheshunt, *Archer*, NY-Mitten!

= *Campylopus ohingaitii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 470 (1897)
Type: N.Z, "bed of River Otahapi, a tributary of the Rangitikei, North Island", *R. Brown s.n.*, CHR 335660!

= *Campylopus sparksii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 467 (1897)
Lectotype: N.Z., Horse-shoe Lake, near Christchurch, March 1883, *R. Brown s.n.*, CHR 335667! Isolectotype: BM 000517614!

= *Campylopus lonchochaete* Müll.Hal. in Müller & Brotherus, *Abh. Naturwiss. Vereins Bremen* 16: 495 (1900)
Lectotype: N.Z., Waiotapu, *H. Schauinsland 164*, H-Brotherus 888002! (Designated by Frahm 1998).

Misapplications: *Campylopus holomitrium sensu* Sainsbury 1955a, *non C. holomitrium* (Müll.Hal.) A.Jaeger. See notes below.

Plants yellow- or pale-green above, usually red-brown below, forming dense turves, often with masses of deciduous, pale, strongly falcate leaves above. **Stems** usually branched by innovation, (5–)10–40 mm, in cross-section with a large central strand, several layers of thick-walled subcortical cells and an outermost layer of thin-walled cells, densely matted with brick-red smooth rhizoids. **Leaves** usually erect-spreading or loosely secund when moist, little altered or contorted (especially near the shoot tips) when dry (see supplementary notes below), not or weakly comose, lanceolate from an oblong and pale base, rather abruptly narrowed to a long subula, strongly concave to subtubulose, lacking a hair-point but may be weakly hyaline at apex, entire below, mostly serrulate near apex, not bordered, mostly 3–6(–7.5) × c. 0.5–0.7 mm; **basal laminal cells** thin- to moderately firm-walled, hyaline, oblong or rectangular, not abruptly differentiated from the upper laminal cells, mostly 25–60 µm long; **upper laminal cells** mostly quadrate or short-rectangular but some irregular, neither oblate nor obliquely oriented, not porose, mostly 9–15(–30) × (6–)7–9 µm; **alar cells** not or weakly differentiated; **marginal cells** not differentiated. **Costa** c. 290–350 µm wide and c. 60–70% of the leaf base width, c. 140–180 µm wide and well defined at mid leaf (but mostly obscured by concavity of the leaf), filling the upper subula and excurrent, lacking lateral spurs; in abaxial surface view the cells rectangular, firm-walled, and c. 5 µm wide; in adaxial surface view the cells long-rectangular and thin-walled, c. 60–120 × 12–15 µm; in cross-section (mid leaf) c. 5–7 cell layers thick, with a median layer of guide cells, a single layer of exposed adaxial hyalocysts, and 2–3 layers of abaxial stereids, lacking abaxial ridges. **Propagulae** often present, consisting of deciduous, reduced, pale, and strongly falcate leaves scattered among the upper vegetative leaves.

Dioicous. Perichaetial leaves loosely sheathing, longer and more narrowly subulate than vegetative leaves. **Perigonia** aggregated in a terminal coma, surrounded by broadly ovate, concave, and ± pigmented bracts. **Setae** strongly cygneous, c. 7–9 mm; **capsules** erect and symmetric, ovoid, non-strumose, sulcate when dry, c. 1.0–1.5 mm; **stomata** absent; **annulus** well differentiated, revoluble; **operculum** rostrate from a conic base. **Peristome teeth** orange and vertically striolate below, hyaline above, split c. half-way to base. **Calyptra** strongly fringed at base. **Spores** 12–14 µm, nearly smooth.

Illustrations: Plate 7. Bartlett & Frahm 1983, fig. 9.

Distribution: NI: K; N Auckland, including offshore islands (TK, PK, LB, GB, RT), S Auckland, Gisborne (Lake Waikaremoana, Huiarua Range), Hawke's Bay (Wairoa), Taranaki (Mt Messenger, Stratford Track on Mt Taranaki, Hawera), Wellington; SI: Nelson, Marlborough (Queen Charlotte Sound, Kenepuru, Kaikōura, Mt Fyffe), Canterbury (Arthur's Pass, Banks Peninsula), Westland, Otago, Southland; St; Sn; A; Ant; C.

Austral. Tasmania*, mainland Australia*, Antarctica*. Reported from New Caledonia, southern South America, south-east North America, Europe, and China by Frahm (1994*a*, as *C. pyriformis*).

Habitat: Most often on stumps, rotten wood, and humic soil (including peat) in a wide range of forest or open habitats; rarely on trunks and branches of recently fallen trees (and apparently sometimes epiphytic). Much less commonly on mineral soils. Also occurring as a robust thermophilic growth form (sometimes termed *Campylopus holomitrium sensu* Sainsbury) in association with geothermal fumaroles in the central North I. The species is widespread throughout N.Z. but there are relatively few records from eastern regions of both main islands. The large number of collections from both peat and epiphytic habitats in *Olearia lyallii* scrub on Snares I. suggests that this is a widespread species on that island. Vitt (1979, as *C. pallidus*) indicated it to be present "only near areas of disturbance and colonization by man" and "disturbed peat surfaces" on Auckland Is. On the North I. ranging to at least 1300 m (Stratford Track, Taranaki L.D.) and on the South I. from near sea level (Awarua Bog, Southland L.D.) to at least 910 m (Old Man Range, Otago L.D.).

Notes: No material of *C. pallidus* has been confirmed from Macquarie I, although Seppelt (2004) recorded *C. pyriformis* from numerous sites on that island. His description, habitat notes, and fig. 52 suggest that the Macquarie material he illustrated is referable here. His fig. 52, 5, shows short-rectangular and non-obliquely oriented mid laminal cells, albeit with perplexing elongate marginal cells. Seppelt's other illustrations, including his costal cross-sections, and his habitat notes are likewise suggestive of *C. pallidus*, a species that is documented from Auckland and Campbell Is.

This species is morphologically variable and occupies a range of substrates. The rather finely subulate, homomallous or slightly secund leaves, the abundant brick-red rhizoids, and the pale overall coloration give most collections of *C. pallidus* a characteristic habit. The colour of the rhizoids often fades in herbarium specimens. Microscopic examination (including a cross-section of the mid leaf costa) to confirm the quadrate or short-rectangular upper laminal cells, the absence of a well-defined alar group, and the nature of the costal cross-section are often required for confident identification. Non-representative growth forms are discussed below.

Propagule-like reduced shoots (mostly ≤5 mm long) with contorted leaves can be present near the apex of the main shoots. Each of these propagule-like plantlets can bear numerous pale, strongly curved ("boomerang"), and deciduous leaves. Both the propagule-like shoots and deciduous leaves appear to be most abundant on plants on rotten wood and subject to water stress. In some populations these shoots are numerous and grow directly on rotten wood; they may constitute most or all of the population. The leaves of the reduced shoots are smaller (usually <4 mm long) than leaves of more representative material and there is no clear size distinction between them and the falcate deciduous leaves. When present, deciduous leaves provide a reliable field character for the species; the deciduous leaves have firm-walled cells to their base and costae less well developed than in vegetative leaves. Reduced-stature (and propagule-like) plants almost certainly function as propagulae, as do fragmenting plantlets in other species of *Campylopus*.

The evidence for applying the European name *C. pyriformis* (Schultz) Brid. [Bryol. Univ. 1: 471 (1826)] to N.Z. material is not convincing. The application of this name by several authors in Australasia dates from a brief publication by Corley & Frahm (1982). That publication outlined some confusion around the type of the basionym (*Dicranum pyriforme* Schultz) and confusingly stated that material described from the Azores as *C. azoricus* Mitt. "must be regarded as the typical form of *C. pyriformis*". Corley & Frahm placed the Australasian *C. pallidus* Hook.f. & Wilson in the synonymy of *C. pyriformis*. The situation is rendered even more perplexing by their subsequent statement that the species in question is an Austral or Australasian species that may have been introduced to Europe in "pre-botanical" times.

Subsequent publications, many authored by Frahm, have repeatedly cited the conclusions presented by Corley & Frahm (1982). Firmer evidence that Australasian material is conspecific with a European (Azorean?) species is required before the name *C. pyriformis* can be confidently applied to the N.Z. material. It is preferable to utilise the earliest Australasian name that can be typified for this widespread (in N.Z., Tasmania, and mainland Australia) and variable species. The name *C. pallidus* Hook.f. & Wilson is based on ample fruiting material from N.Z., and this name is applied here. The application of this name agrees with that favoured by Scott & Stone (1976), but is at odds with the use of *C. torquatus* Mitt. *in* Wilson by both Dixon (1923) and Sainsbury (1955a).

The taxonomic status and the correct name for what has been named *C. holomitrium auct*. has long been a source of confusion in N.Z. The name *C. holomitrium auct*. [including *sensu* Sainsbury 1955a but specifically excluding *C. holomitrium* (Müll.Hal.) A.Jaeger, which is *Campylopodium capillaceum*] has been applied by N.Z. workers to a growth form of *Campylopus pallidus* associated with geothermal fumaroles in the central North I. This thermophilic growth form is usually darker or more yellow-green than representative material of *C. pallidus*. In the thermophilic growth form the stems are commonly longer, 40–60(–120) mm. Vegetative leaves are longer (c. 6–7.5 mm), the area of hyaline basal laminal cells is reduced, there is a tendency for the alar cells to become enlarged and pigmented, and the mid laminal cells are somewhat more elongate (to c. 30 × 6 μm) The larger stature seems predictable in populations growing in a constantly very warm and hypermoist environment. A few propagulae can occasionally be found on the upper stems of herbarium specimens of the thermophilic growth form. The propagulae often occur in very compact terminal clusters. J. Beever (*in litt*., 9 Jan. 1998) reported that curved brood leaves could be found at Karapiti (e.g., CHR 413398, Wellington L.D.) on "individual stems which are taller than those surrounding them, or when chunks of the moss have been dislodged from the sward some months previously and are lying loose." J. Beever suggested (*in litt*., 9 Jan. 1998) that *C. holomitrium sensu* Sainsbury is merely a robust form of what she termed *C. pyriformis*. Her interpretation is accepted here, albeit with the appropriate name difference.

The ecology of the vegetation at Te Kopia geothermal field (Wellington L.D.), where the thermophilic growth form of *C. pallidus* is a dominant component of the geothermal vegetation, has been discussed by Burns (1997). At this site *C. pallidus* (cited as *C. capillaceus*) was the most abundant groundcover on sites with soil temperature of >50 deg. C at a depth of 15 cm. Low soil pH and high concentrations of aluminium were also significant edaphic factors in explaining vegetation patterns at Te Kopia.

Type material of *Dicranum distractum* Müll.Hal. has not been seen. It was collected by either *H. Schauinsland* or *W. Wacker* in N.Z., with no further locality data in the protologue. It was included in the synonymy of *C. holomitrium* (Müll.Hal.) A.Jaeger by Dixon (1923) and likely belongs in the synonymy of *C. pallidus*.

The name *Dicranum holomitrium* Müll.Hal. [Syn. Musc. Frond. 1: 389 (1848)] and its homonym *Campylopus holomitrium* (Müll.Hal.) A.Jaeger are synonyms of *Campylopodium capillaceum* (Hook.f. & Wilson) Fife, *comb. nov.* (in this publication). The name *Campylopus capillaceus* Hook.f. & Wilson [London J. Bot. 3: 543 (1844)] is an earlier name for what has often been termed *Campylopodium medium* (Duby) J.-P.Frahm & Giese.

Recognition: *Campylopus pallidus* frequently grows with *C. introflexus* and can occasionally be difficult to separate from forms of the latter that lack a hair-point. The ± quadrate upper laminal cells and the smooth abaxial surface of the costa (at mid leaf) contrast with the more rhombic and often oblate cells and the abaxial costal ridges of *C. introflexus*. The mid leaf adaxial costal hyalocysts in *C. pallidus* are less regular in size and shape than those of *C. introflexus*. *Campylopus pallidus* is occasionally confused with *Campylopodium lineare*, but that species has narrower costae with adaxial stereids, longer upper laminal cells, larger spores, and a non-fringed calyptra.

Etymology: The species epithet *pallidus* is an obvious reference to the pale colour of the plants. The disused epithet *torquatus* makes reference to contorted leaves, presumably those of the often present reduced and propagula-like shoots.

Campylopus purpureocaulis Dusén, *Ark. Bot.* 4(13): 11 (1905)

Presumed type: Chile, Isla Desolarion [Desolacion?], Puerto Angusto, 27.3.1896, *P. Dusén 279*, CHR 4390!

= *Campylopus arboricola* Cardot & Dixon in Dixon, *Bull. New Zealand Inst.* 3: 90 (1923)
Syntypes: N.Z., Te Aroha Mountain, Auckland. Not seen; see notes below.

Plants bright yellow-green above, brick-red below due to dense rhizoids, forming tufts or turves, mostly on wood. **Stems** 10–c. 50 mm, mostly branched by innovation below sex organs or below a terminal cluster of brood bodies, in cross-section with a central strand, and one to several layers of thick-walled cortical cells, no hyaloderm; rhizoids densely covering the lower stems, brick-red and strongly contorted. **Leaves** erect-spreading or weakly secund when moist, more erect but little altered when dry, often ± comose immediately below masses of distichous propagula (often mixed with sex organs), narrowly lanceolate, not or only slightly narrowed at base, concave, finely acuminate at apex, with a well-developed hyaline hair-point (at least in upper leaves) or occasionally with concolorous tips, entire except for a few projecting cells near apex of hair-point, with a very weak border which does not extend above the leaf base, c. (2–)3–6 × c. 0.5–0.7 mm; **upper laminal cells** (mid leaf and above) not or slightly obliquely oriented, small and irregular, at least some subquadrate and some oblate, firm-walled, not porose, mostly (6–)12–21 × 6–10(–12) µm; **basal laminal cells** hyaline, firm-walled, not porose, variable in length, mostly oblong or elongate-oblong and 30–60 µm, grading gradually into the upper laminal cells; **alar cells** inflated, pigmented, forming a large but non-auriculate group, usually obscured by adherent rhizoids; **marginal cells** more elongate in <5 rows, forming a weak border confined to the base of the leaf. **Costa** c. (315–)350–400 µm wide and c. 40–50% of the leaf base width, clearly defined at mid leaf, excurrent or merging with hair-point, lacking lateral spurs, usually with rhizoids arising from the lower abaxial surface, in both abaxial and adaxial surface views the cells linear and thick-walled; in cross-section (mid leaf) with a median layer of guide cells, completely lacking hyalocysts (“Palinocrapsis” in anatomy), and c. 8 (–12) cell layers thick, with 3–5 layers of adaxial stereids and 2–3 layers of abaxial stereids, which are interspersed with larger cells (± the same diameter as the guide cells), the abaxial surface crenulate or with very low and single-celled ridges; in basal cross-section (just above the upper limit of the alar cells), the exposed adaxial cells small and incrassate. **Propagula** usually present, terminal and often clustered, c. 3 mm long and strongly distichous, consisting of modified shoots with c. 8–10 closely imbricate leaves, which are strongly cucullate and scabrid at apex.

Dioicous. Perichaetial leaves strongly sheathing, lanceolate from an oblong base, c. 5–6 mm. **Perigonia** terminal, often overtopped by innovations and then appearing lateral, sometimes mixed with propagula. **Setae** strongly cygneous, c. 8 mm; **capsules** ovoid, strumose or not (best seen when dry), curved and sulcate when dry, ± erect and smooth when moist, c. 1.5 mm; **stomata** absent;

annulus well differentiated, revoluble; **operculum** rostrate from a conic base. **Peristome teeth** orange and vertically striolate below, hyaline above, split c. ⅔ to base. **Calyptra** not seen. **Spores** 15–18 µm, finely papillose.

Illustrations: Plate 8. Bartlett & Frahm 1983, fig. 1 (as *C. arboricola*); Malcolm & Malcolm 2006, pp. 88, 197, 222, 286.

Distribution: NI: N Auckland including offshore islands (LB, GB), S Auckland (Moehau), Gisborne (Manuoha Trail, Lake Waikaremoana, Hautapu River), Hawke's Bay (Tarawera), Taranaki (Mt Taranaki), Wellington (Mt Hauhungatahi, Ruahine Range, Tararua Range); SI: Nelson, Marlborough (Ōkaramio Saddle), Canterbury (near summit of Arthur's Pass), Westland (Ōtira, Lake Ellery), Otago (Haast Pass), Southland; St; A; C.

Austral. Chile*, Marion I.* Also reported from Tasmania, mainland Australia (N.S.W.) and Juan Fernandez Is by Frahm (1994a, p. 323).

Habitat: On rotten wood, logs, horizontal branches, and on tree trunks; at higher elevations (as in the Paparoa Range of Nelson L.D.) and on Auckland and Campbell Is this species occurs on humus over rock outcrops. Such occurrences mirror the behaviour of many predominantly lignicolous species at the extremity (or maximum elevation) of their ranges. On the North I. from 720 m (Lake Waikaremoana, Gisborne L.D.) to 1150 m (Manuoha Trail, Gisborne L.D.) and on the South I. from 20 (Jackson Bay, Westland L.D.) to 1300 m (Round Lake, Nelson L.D.) elevation.

According to Frahm (1994a, p. 323), *C. purpureocaulis* occurs, outside of Australasia, primarily in "swampy heathlands" and occurs on rotten wood only in N.Z. and Tasmania. He suggested that this unusual habitat (for a *Campylopus*) may be related to occurrence in hyper moist habitats.

Notes: This species is characterised in the field by its lignicolous substrate and by having distichous propagula bearing two rows of imbricate, bluntly cucullate and scabrid leaves. The propagula are borne apically and are often clustered, sometimes mixed with perigonia or perichaetia, and usually overtopped by lateral innovations. The dense brick-red rhizoids, which envelop the lower stems, and the bright yellow-green coloration of the upper, mostly hair-pointed, leaves are characteristic in a N.Z. context. It grows most frequently on decaying wood but also occurs as an epiphyte on a wide range of forest trees, including species of southern beech. The epiphytic and lignicolous habitat facilitates recognition in N.Z. Microscopically, the upper laminal cells are compact and ± subquadrate; this feature, as noted by Bartlett & Frahm (1983), assists in distinguishing the present species from *C. clavatus*, particularly in the absence of propagulae. The nature of the costal cross-section, with stereids on both abaxial and adaxial surfaces, is also highly characteristic.

The synonymy of the N.Z. name *C. arboricola* Cardot & Dixon with the Fuegian *C. purpureocaulis* Dusén is accepted here on the authority of Frahm (1985b; 1985a, p. 158; 1994a, p. 323). Probable type material of *C. purpureocaulis* has been examined, but no type material of *C. arboricola* (with syntypes from Te Aroha, S Auckland L.D.) has been seen. The two syntypes of the latter were collected by Leland & Chase and D. Petrie, and neither collection is represented in any N.Z. herbarium.

Recognition: The "Palinocrapsis" nature of the costal mid leaf cross-section, with median guide cells surrounded by abaxial and adaxial stereid bands and lacking hyalocysts, distinguishes *C. purpureocaulis* from all but *C. clavatus* in the N.Z. flora. These two species can usually be distinguished by their substrate (*C. purpureocaulis* predominantly lignicolous; *C. clavatus* predominantly on soil or rock), by the form of their propagulae (*C. purpureocaulis* strongly distichous; *C. clavatus* stellate) and by the nature of their upper laminal cells (*C. purpureocaulis* small and irregular, ± subquadrate and some oblate, not porose; *C. clavatus* mostly elongate-rhombic or rounded-rectangular, variably but often strongly porose). If capsules are present, the ovoid, sulcate capsules with peristome teeth spilt c. 2/3 to their base in *C. purpureocaulis* contrast with the subcylindric, non-sulcate capsules with peristome teeth that are split nearly to their base in *C. clavatus*.

Etymology: The epithet *purpureocaulis* aptly alludes to the "purple" (in the same sense that *Ceratodon purpureus* is "purple" in the British, but not the American sense) or brick-red colour of the rhizoids, which densely clothe the lower stem. The disused epithet *arboricola* is equally apt and refers to the frequently arboreal habitat of this species.

Dicranella (Müll.Hal.) Schimp., *Coroll. Bryol. Eur.* 13 (1856)

≡ *Aongstroemia* sect. *Dicranella* Müll.Hal., *Syn. Musc. Frond. 1,* 430 (1848)

Type taxon: *Dicranella heteromalla* (Hedw.) Schimp.

Plants mostly small, turf forming. **Stems** erect, unbranched or branching by innovation, in cross-section with a central strand, mostly sparsely beset with smooth, brown rhizoids. **Leaves** mostly reduced on lower stem and larger above, mostly wide-spreading, lanceolate or subulate, gradually tapered or abruptly tapered from a well-differentiated, oblong base (especially on upper stem), sheathing or not, entire or variably toothed near apex; **laminal cells** mostly oblong-rectangular, firm-walled, smooth or occasionally mammillose; **alar cells** not differentiated. **Costa** with stereid groups present, or rarely absent. **Tubers** present or absent.

Dioicous. **Perichaetia** terminal but often overtopped by innovations. **Perigonia** terminal, with numerous filiform, yellow paraphyses and bracts, larger and more concave than adjacent vegetative leaves. **Setae** elongate, flexuose or straight, red-brown or yellow; capsules erect or inclined, symmetric or asymmetric, short-cylindric, ovate, ± obovoid (rarely ± globose in non-N.Z. species), furrowed or smooth, often contracted below the mouth when dry; **exothecial cells** variable in shape, firm-walled, arranged in distinct columns or not; **stomata** absent or sometimes present and superficial; **annulus** absent or present and well differentiated; **operculum** rostrate and curved. **Peristome teeth** 16, red-brown below and usually hyaline above, mostly divided c. ½ or occasionally nearly to base, the forks free or occasionally ± anastomosing, the outer surface of the lower part of tooth bearing fine (often difficult to see) or rarely coarse trabeculae traversing the full width of the tooth, the inner surface with a zig-zag line that divides the tooth vertically into asymmetric segments, the entire tooth in surface view appearing vertically papillose-striolate below or papillose throughout, or rarely diagonally striate. **Calyptra** cucullate. **Spores** spherical, mostly 15–35 µm.

Taxonomy: A large genus, probably of c. 100 species. Occurring in all parts of the world but in tropical areas mainly restricted to high elevations. Nearly all the species occur on mineral soils. The majority of N.Z. species are either austral or Australasian in distribution, and treatments of northern hemisphere species are therefore of limited utility here. Two species shared with South Georgia were treated by Newton (1977). Six species are treated here, while a seventh is known from one record as a glasshouse weed.

Dicranella is treated here in a broad sense so as to include *Anisothecium*. *Anisothecium* is sometimes recognised as a distinct genus, mostly on the basis of the presence of a differentiated but non-revoluble annulus, the presence of a basal peristomal membrane, and stomata present at the capsule base.

Material that is not referable to any of the *Dicranella* species discussed below has been collected from a glasshouse in Christchurch (*M.F. Sinclair s.n.*, CHR 532377). This material is characterised by short, inclined, strumose capsules and entire linear-lanceolate leaves with ± excurrent costae. It appears to be the northern hemisphere *D. cerviculata* (Hedw.) Schimp.

Species of *Dicranella* with markedly shouldered and sheathing leaves are easily confused with species of *Ditrichum*, particularly such species as *Ditrichum punctulatum* or *D. strictum*. However, both these species have leaf subulae twisted around their own axis when dry and shorter cells at the leaf shoulder. In general, the narrowing (where it occurs) from the leaf base to the subula is more abrupt in *Dicranella* than in species of *Ditrichum*. Peristome differences also serve to distinguish all species of *Ditrichum* from those of *Dicranella*.

Because of the likelihood of confusion, the genus *Campylopodium* is included in the following key.

1 **Setae** short (mostly <5 mm, rarely to 6 mm), cygneous when moist, stout or slender, dextrorse when dry .... *Campylopodium*

1' **Setae** elongate (nearly always >5 mm), flexuose or erect when moist, slender, sinistrorse or dextrorse when dry 2

2 **Vegetative leaves** sheathing and squarrose; **capsules** erect and symmetric 3

2' **Vegetative leaves** neither sheathing nor squarrose (perichaetial leaves may be); **capsules** erect or inclined 5

3 **Capsules** sulcate with a well-differentiated, persistent annulus; **stems** short, mostly 7–15 mm; **costa** well-defined in leaf base; **plants** not associated with stream margins, often associated with thermally heated soil .... *D. dietrichiae*

3' **Capsules** not sulcate and lacking a well-defined annulus; **stems** longer, mostly >15 mm and often to 70 mm or more); **costa** ill-defined in leaf base; **plants** mostly occurring at stream margins in N.Z. 4

4 **Leaf apices** crenulate (appearing entire under stereoscope); **costa** not filling the limb, a distinct bistratose lamina present at middle of limb; **exothecial cells** differentially thickened, the longitudinal walls much thicker than the transverse walls; **peristome teeth** split ⅔ or less to base, the lower portion appearing in surface view irregularly and very finely papillose (not papillose-striolate), the upper portions lacking diagonal striations .... *D. cardotii*

4' **Leaf apices** irregularly toothed (teeth clearly visible under stereoscope); **costa** ± filling the limb, usually with no distinct lamina present at middle of limb; **exothecial cells** uniformly thickened; **peristome teeth** split nearly to base, the individual forks in surface view appearing coarsely diagonally striate and baculate to apex .... *D. vaginata*

5 **Vegetative leaves** serrulate in upper third or more; **costa** long, excurrent, and filling the subula, occupying c. ⅓ of leaf base; **setae** pale, yellow-brown; poorly documented and known only from N Auckland and Wellington L.D. .... *D. heteromalla*

5' **Vegetative leaves** sinuate or entire; **costa** percurrent, mostly not filling the subula, occupying c. ⅕ of the leaf base; **setae** red-brown or pale brown; widespread throughout the main islands 6

6 **Setae** red-brown, weakly sinistrorse; **exothecial cells** arranged in ± distinct columns and with thinner transverse walls; **capsules** usually weakly strumose, asymmetric and inclined to nearly erect; **leaves** erect-spreading or loosely secund when moist; **upper laminal cells** 3–4:1 and mostly <21 µm long .... *D. schreberiana*

6' **Setae** pale brown, dextrorse; **exothecial cells** neither arranged in columns nor with thinner-walled transverse walls; **capsules** not strumose, symmetric and erect; **leaves** distinctly secund when moist; **upper laminal cells** 5–7:1 and >45 µm long .... *D. gracillima*

Excluded Taxa: *Dicranella egmontensis* Dixon [Bull. New Zealand Inst. 3: 363, 1929] is considered here to be a synonym of *Kiaeria pumila* (Mitt.) Ochyra.

Dicranella perfalcata E.B.Bartram & Dixon [Bot. Not. 1937: 70, 1937] was described from a Berggren collection from Ōtira Gorge, Westland L.D. The type collection is referred here to synonymy within *Ditrichum brevirostre* (R.Br.bis) Broth.

Dicranella temperata Allison [Trans. & Proc. Roy. Soc. New Zealand 78: 93 (1950)] was described from a single rather poor specimen from Lake Te Ānau in Southland L.D. In his decision to describe this species as a *Dicranella*, Allison was perhaps overly influenced by comments from Bartram (to whom a portion of the collection was apparently sent), indicating that it represented a species of *Microdus* unknown to him. The type collection is doubtfully dicranaceous, despite having peristome teeth that are either split into two unequal forks or elongately perforated c. ⅓ to base. The teeth appear to be paired and, in somewhat immature capsules, are completely smooth. The gametophytes are also anomalous with respect to *Dicranella* and are suggestive of the Pottiaceae or *Zygodon* (the costal cross-sections lack stereids and exhibit ± uniform cells throughout, in a manner suggestive of a *Zygodon*). No stomata are present in the erect, striate capsules. This name is not considered further.

Dicranella vaginata var. *longifolia* Dixon & Sainsbury *in* Sainsbury [Trans. & Proc. Roy. Soc. New Zealand 75: 171, 1945] is synonymous with *Ditrichum punctulatum* Mitt.

Dicranella cardotii (R.Br.bis) Dixon, *Bull. New Zealand Inst.* 3: 77 (1923)

≡ *Dicranum cardotii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 35: 329 (1903)
≡ *Anisothecium cardotii* (R.Br.bis) Ochyra, *Moss Fl. King George Island Antarctica* 114 (1998)
Holotype: N.Z., tributary of the River Hāpuka, near Kaikōura, *R.Brown s.n.*, BM 000671677!
Probable isotype: NY!

= *Dicranella wairarapensis* Dixon, *Bull. New Zealand Inst.* 3: 65 (1914)
Holotype: N.Z., Mauriceville, Wairarapa, *W. Gray 27*, Dec. 1908, BM 000671682!

Plants medium to large, bright yellow-green, forming dense turves. **Stems** from c. 10 to at least 70 mm, in cross-section with a distinct central strand and 2–3 layers of firm-walled cortical cells. **Leaves** abruptly wide-spreading from an erect and sheathing base, contorted when dry, abruptly tapered from an oblong base to a narrowly triangular, spreading, and bistratose limb, with a very strongly defined shoulder, broadly acute or rounded at apex, crenulate at margins due to bulging cells, (1.1–)1.3–2.6(–3.5) × 0.6–0.7 mm, broadly U-shaped in cross-section, plane at margins; **cells of mid limb** short-rectangular, c. 4–6 µm wide and 1.5–3:1, firm-walled, mostly bistratose, bulging-mammillose (mammillae mostly 2 per cell and located at cells ends); **cells of leaf base** oblong-rectangular, variable in length (commonly c. 40–75 × 5–7 µm), smooth. **Costa** occupying c. ⅕ of the leaf base, well-defined, subpercurrent, not filling the limb, in cross-section with median guide cells and small abaxial and adaxial stereids groups, the adaxially exposed cells mammillate and more elongate than adjacent laminal cells. **Tubers** occasionally (mostly in depauperate populations) present on rhizoids, brown, spherical, 75–180 µm diam.

Dioicous. Perichaetia often several per stem, with leaves enlarged. **Setae** (6–)10–20 mm, flexuose and stout, sinistrorse, red-brown; **capsules** erect, short-cylindric, 1.0–1.3 mm, not strumose, constricted below the mouth and very weakly furrowed when dry (due to thickened longitudinal cell walls); **mouth** transverse; **exothecial cells** ± rectangular or quadrate, arranged in distinct columns, with incrassate longitudinal walls and relatively thin transverse walls; **stomata** not seen; **annulus** apparently absent; **operculum** obliquely rostrate, (0.7–)1.0–1.5 mm. **Peristome teeth** inserted c. 90 µm below rim, c. 300 × 75 µm, connate in basal 75–90 µm, each tooth divided ½ to ⅔ to the base into 2 uneven forks, which are often irregular in outline and ± anastomosed (adjacent teeth also occasionally anastomosed), often irregularly perforate, the outer surface of the lower tooth bearing fine trabeculae traversing the full width of the tooth, the inner surface with a zig-zag line that divides the tooth vertically into asymmetric segments, the lower tooth in surface view appearing irregularly and very finely papillose (not papillose-striolate) below. **Calyptra** as per genus. **Spores** (21–) 24–36 µm, green, smooth.

Illustrations: Plate 9. Dixon 1914, pl. 6, fig. 15 (as *D. wairarapensis*).

Distribution: NI: S Auckland (Mt Maungapōhatu, Wairākei Valley), Hawke's Bay (Waikari Gorge, Tarawera), Taranaki, Wellington; SI: Nelson, Marlborough (Isolated Creek, Waimā River), Canterbury, Westland (Blacks Point), Otago, Southland; St; A; C; M.

Australasian or austral. Tasmania*. Reported from mainland Australia by Scott & Stone (1976, p. 148). This species almost certainly is widespread in southern South America, but there is considerable confusion surrounding several closely allied species, and their names. Until the confusion is eliminated it is expedient to consider *D. cardotii* as an Australasian species. Material that is morphologically highly similar to N.Z. material has been examined from Tierra del Fuego, Chile, and South Georgia.

Habitat: Forming turves, often extensive (to at least 1 m × 1 m) on rocks, gravel, sand or humic soil at stream margins or in irrigated areas. *Dicranella cardotii* forms distinctive and often extensive yellow-green turves at stream margins and irrigated ledges in the eastern ranges of the South I. It is poorly documented in Westland and wetter parts of Southland and relatively few collections have been seen from the North I. Frequently associated species include *Bryum laevigatum*, *Ochiobryum blandum*, *Philonotis pyriformis*, and *Tridontium tasmanicum*. On the South I. ranging from near sea level (Fox River, Nelson L.D.) to c. 1650 m (Temple Basin, Canterbury L.D.).

Notes: The lower ½ or more of the peristome teeth in *D. cardotii* appear very finely papillose (with papillae <1 µm diam.) under the compound microscope. The upper ½ of the teeth appear ± striate. The papillae in the lower ½ of the teeth are irregularly arranged (e.g., as in *J. Child 1563* from Herbert, Otago L.D., CHR 429080A), rather than regularly and vertically arranged (papillose-striolate) as they are in most *Dicranella* spp.

Rhizoidal tubers have been seen in few collections of *D. cardotii* (e.g., *A.J. Fife 4679* from Four Mile River, Nelson L.D., CHR 103571). Tubers appear to be rarely produced in this species and have not been observed in well-developed populations. Plants in which the leaves exceed 2.6 mm are relatively rare and are usually associated with submerged habitats.

Dicranella cardotii R.Br.bis. has been listed by Ochyra et al. (2008) as a synonym of *Dicranella campylophylla* (Taylor) A.Jaeger [Basionym: *Dicranum campylophyllum* Tayl., London J. Bot. 7: 281, 1848]. *Dicranella campylophylla* (Taylor) A.Jaeger is based on an 1847 W. Jameson collection from Mt Pichincha in Ecuador, of which a portion is present in the Mitten herbarium (NY 267969). The application of the name *D. campylophylla* is much confused and clarity is required concerning its taxonomic and nomenclatural relationships with other South American taxa. These include, particularly, the species originally named as *Aongstroemia hookeri* Müll.Hal. [Syn. Musc. Frond. 2: 607, 1851], *Anisothecium jamesonii* Mitt. [J. Linn. Soc., Bot. 12: 39, 1869], and *Aongstroemia persquarrosa* Dusén [Ark. Bot. 4(1): 11, 1905; Syntype: Chile, Patagonia occ., valle fluminio Rio Aysén, in rupibus irrosatis, *P. Dusén*, Feb. 1897, NY 267998!]. All three of these names have combinations in *Dicranella* and, together with *D. campylophylla*, are certainly easily confused and could be synonymous with *D. cardotii*. However, the taxonomic and nomenclatural morass surrounding these South American names is beyond the ambit of this treatment, and requires a large-scale regional revision.

Some notes on the pertinent South American types may suggest pathways for future work.

Ochyra et al. (2008) provided a detailed description and illustration of his concept of *Dicranella campylophylla* and indicated that *D. cardotii* was synonymous. They distinguished *Dicranella campylophylla* and *D. hookeri* on the basis of laminal cell ornamentation, but this distinction is unconvincing. Hermite I. isotype material (NY 00012531!) of *Aongstroemia hookeri* Müll.Hal., collected by J.D. Hooker, has prorate laminal cells, conflicting with Ochyra's statement that this species has laminal cells "smooth throughout". If the Hermite I. collection were from N. Z., I would not hesitate to name it as *Dicranella cardotii* R.Br.bis.

Anisothecium jamesonii Mitt. [J. Linn. Soc., Bot. 12: 39, 1869] is based on five syntypes from widely separated South American localities. Four of five syntypes of this name have been examined. They have strongly sheathing and shouldered vegetative leaves and short, nearly erect capsules, strongly suggestive of N.Z. *D. cardotii* and Ochyra's concepts of both *D. campylophylla* and *D. hookeri*. The syntype from "loco Huambato in paludo, 9000 ped.", *R. Spruce 34* (NY 12527!, CHR 461362!), if collected in Australasia, would unhesitatingly be referred to *D. cardotii*.

The misapplication of the name *D. jamesonii* (Mitt.) Broth. to the plant that is in this Flora termed *D. schreberiana* (Hedw.) H.A.Crum & L.E.Anderson appears to date from the discussion of Dixon (1914, p. 66).

The variability, taxonomy, and nomenclature of South American species of *Dicranella* with strongly sheathing and abruptly shouldered leaves and short, nearly erect capsules need to be clarified in a monographic context, but this is beyond the ambit of this Flora; once this is done, the name applied to this N.Z. species may change. Until that time it is preferable to apply an unambiguous and typifiable name to N.Z. material; *Dicranella cardotii* R.Br.bis is thus used in this Flora.

Recognition: In a N.Z. context, *D. cardotii* is most likely to be confused with *D. vaginata*. *Dicranella cardotii* has a narrow costa, which does not entirely fill the limb and crenulate leaf apices (the projections of the mammillate cells are not visible under the stereoscope), in contrast to a stouter costa that wholly or nearly fills the limb and few to many large and irregular teeth near the leaf apex (visible under the stereoscope) in *D. vaginata*. The peristome teeth in *D. cardotii* are split ½ to ⅔ their length, while those of *D. vaginata* are split nearly to their base. Mature capsules of *D. cardotii* appear weakly furrowed when dry (due to the exothecial cells being arranged in vertical ranks and having thickened longitudinal walls), while those of *D. vaginata* are not furrowed when dry and lack differentially thickened cell walls. *Dicranella cardotii* is more widespread and extends to higher elevations regionally than does *D. vaginata*.

Dicranella cardotii has leaves more strongly sheathing and spreading when dry than does the superficially similar *Chrysoblastella chilensis*. The leaves of *C. chilensis*, by contrast, are more erect-appressed when dry and firmer in texture; in cross-section the bistratose lamina and the strongly bulging-mammillose laminal cells of *C. chilensis* are unmistakeable. *Dicranella cardotii* is a plant of wet, often shaded sites whereas *C. chilensis* occurs in drier and more insolated habitats.

Etymology: The epithet *cardotii* commemorates the French bryologist J. Cardot (1860–1934), who contributed much to our knowledge of southern hemisphere mosses. Among Cardot's (1908) publications were the highly significant *La Flore bryologique des Terres magellaniques, de la Géorgie du Sud et de l'Antarctide* and, together with V.F. Brotherus, a summary of the bryological results of a major Swedish expedition to Patagonia and Terre del Fuego (Cardot & Brotherus 1923).

Dicranella dietrichiae (Müll.Hal.) A.Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1870–1871: 381 (1872)

≡ *Aongstroemia dietrichiae* Müll.Hal., *Linnaea* 35: 617 (1868)

Type: Australia, Queensland, Brisbane River, *Amalie Dietrich*, date illegible, herb. Hampe, annotated by Müller, BM 000671659!

Misapplications: *Dicranella tricruris sensu* Sainsbury (1955a, p. 108)

Plants rather small, yellow-green, forming thin or dense turves. **Stems** c. 7–15 mm, in cross-section with a weak central strand and 3–4 layers of thick-walled cortical cells. **Leaves** wide-spreading from an erect and sheathing base, contorted when dry, abruptly tapered from an oblong base to a ± subulate and spreading limb, with well defined shoulders, acute or rounded at apex, entire below, at apex crenulate on all surfaces due to projecting cells, mostly c. 2.0–2.5 mm long immediately below perichaetium, and reduced to c. 1 mm on lower stem, broadly U-shaped in cross-section, plane at margins or ± reflexed at shoulders; **cells of mid limb** short-rectangular, obscure, c. 6 µm wide and 2–4:1, firm-walled, unistratose, smooth but becoming bulging at upper end of cells near apex; **cells of leaf base** oblong-rectangular, mostly 15–45 × 6–9 µm, smooth, becoming shorter and ± quadrate at shoulders. **Costa** occupying ⅕–¼ of the leaf base, well-defined, percurrent, not filling the limb, in cross-section (at mid limb) with median guide cells and abaxial and adaxial stereid groups; the cells on the adaxial surface more elongate than adjacent laminal cells. **Tubers** apparently absent.

Dioicous. Perichaetia with leaves to c. 4 mm but otherwise not differentiated. **Perigonia** not seen. **Setae** 5–10 mm, straight or slightly flexuose, dextrorse, pale brown or yellow; **capsules** erect, ovate-cylindric, narrowed below the mouth when dry, c. 1–1.2 mm, not strumose, sulcate when dry; **mouth** transverse; **exothecial cells** irregular, not in distinct columns, uniformly thick-walled; **stomata** apparently absent; **annulus** differentiated, falling with the operculum or with fragments persisting; **operculum** slenderly rostrate, c. 1 mm. **Peristome teeth** c. 325 × 50–60 µm, divided c. ½ to base into two ± equal forks (but some teeth undivided or unequally divided), strongly striolate-papillose in lower half, with coarse trabeculae on outer surface. **Calyptra** as per genus. **Spores** 21–27 µm, yellow-brown, densely insulate, with individual insula c. 1.5–2.5 µm diam.

Illustrations: Plate 10. Scott & Stone 1976, pl. 23.

Distribution: NI: N Auckland (West Russell State Forest, near Whakapara on road to Helena Bay), S Auckland (Whale I., Rotorua, Waimangu Valley, Ōrākei-kōrako).

Australasian. Mainland Australia* (Qld, N.S.W.). Reported from Tasmania by Dalton et al. (1991).

Habitat: This poorly documented species favours finely textured (clayey) soil. The initial N.Z. collection (*K.W. Allison 631*, CHR 532232) came from thermally heated soil at Ōrākei-kōrako on the Waikato River, as did material from Rotorua and sterile material from Whale I. It also occurs sometimes on non-heated clay in open pasture (*A.J. Fife 5812*, CHR 104142). Associates can include *Campylopus pallidus*, *Entosthodon radians*, and *Philonotis tenuis*. All confirmed records are from relatively low elevations, but precise elevation data are lacking. Scott & Stone (1976) describe it as a “common species in the coastal forest of N.S.W., where it is a soil-binder on the fresh crumbly clay-loams”.

Notes: The erect, sulcate capsules with well-differentiated annuli, and gametophores with wide-spreading leaves with sheathing bases, distinguish *D. dietrichiae* from its N.Z. congeners. The slenderly rostrate operculum is very unusual in *Dicranella*. Its preference for geothermally heated soil also facilitates its recognition here, but not in Australia.

Recognition: In *Dicranella* only *D. vaginata* and *D. cardotii* share the features of sheathing leaf bases and distinctly shouldered leaves. However, both these taxa have non-sulcate capsules with poorly differentiated annuli and normally occupy streamside habitats. The N.Z. range of *D. dietrichiae* overlaps considerably with that of *D. vaginata*, but the latter species has very distinctive robust and rigid subulae (limbs) completely filled by the costae. There is little range overlap between the northern and lowland *D. dietrichiae* and the more southern and higher-elevation *D. cardotii*.

Recognition of sterile material sometimes poses difficulties. Sterile material is sometimes confused with *D. schreberiana*, but *D. dietrichiae* has more distinctly sheathing and more-shouldered vegetative leaves. Occasional specimens, however, cannot be placed with confidence.

Confusion sometimes occurs with *Campylopodium capillaceum*, but that species has longer vegetative leaves (mostly 3–6.5 mm on upper stems), much stouter, more flexuose setae, and conspicuous phaneropore stomata.

Sterile material of *D. dietrichiae* could also easily be confused with *Trichodon cylindricus*, q.v. It is best separated from this species by being a larger plant with smooth laminal and costal cells (vs prorate cells in *T. cylindricus*). Their documented N.Z. ranges do not overlap.

Etymology: The species epithet commemorates the Queensland collector Amalie Dietrich, who gathered the type specimen near Brisbane.

Dicranella gracillima (Beckett) Paris, *Index Bryol.* 329 (1896)

≡ *Anisothecium gracillimum* Beckett, *Trans. & Proc. New Zealand Inst.* 26: 287 (1894)

Lectotype: N.Z., North Canterbury, near Pattersons Creek, Kowai Bush, April 1892, *T.W.N. Beckett 396*, CHR 532397! Isolectotype: CHR 532244!

Plants small, yellow-green. **Stems** 3–7 mm, in cross-section with a central strand and 2–3 layers of firm-walled cortical cells. **Leaves** secund, not sheathing, more erect and ± contorted when dry, ovate-lanceolate, lacking distinct shoulders, acute, on lower stems mostly 0.5–0.8 × c. 0.25 mm, ± concave, sinuate and plane at margins; leaves on fertile stems becoming larger (to c. 1.0 mm immediately below perichaetium); **upper** to **mid laminal cells** oblong-rectangular, (45–)54–75 × 6–9 µm and 5–7:1, firm-walled, unistratose, smooth, somewhat wider (to c. 15 µm) but otherwise little differentiated near insertion. **Costa** occupying c. ⅕ the width of the leaf base, well-defined, percurrent, mostly not filling the subula, in cross-section lacking guide cells and with stereids poorly developed or absent; the cells on the adaxial surface scarcely more elongate than adjacent laminal cells. **Tubers** not seen.

Dioicous. Perichaetia one per stem, not overtopped by innovation; with perichaetial leaves non-sheathing, c. 1.3–1.5 mm, rather abruptly narrowed (but not shouldered) to subula, with costae nearly filling the subulae and often appearing excurrent. **Setae** 4–8 mm, flexuose, dextrorse, pale brown; **capsules** erect, symmetric, short-cylindric, smooth and narrowed below the mouth when dry, (0.4–)0.5–0.8(–1.0) mm, not strumose; **mouth** transverse; **exothecial cells** ± oblong, not in distinct columns, firm-walled (transverse walls not notably thinner-walled); **stomata** absent; **annulus** apparently absent; **operculum** rostrate, c. 0.6 mm. **Peristome teeth** inserted c. 50 µm below the capsule mouth, c. 300–325 × 45 µm (including basal fused portion), connate at base for c. 60–90 µm, divided c. ½ to base into two uneven forks, the outer surface of the lower tooth bearing rather coarse trabeculae traversing the full width of the tooth, the inner surface with a zig-zag line that divides the tooth vertically into asymmetric segments, the entire tooth in surface view appearing vertically papillose-striolate below. **Calyptra** as per genus. **Spores** 12–15 µm, brown, often persisting as tetrads in deoperculate capsules.

Illustrations: Plate 11. Beckett 1894, pl. 30C.

Distribution: NI: S Auckland (Waiotapu, Ātiamuri, Murupara), Wellington (Ōhakune); SI: Nelson (Graham Valley, Kawatiri), Canterbury (Kowai Bush), Otago (Berwick, Swampy Summit, Fraser's Gully, Waihola, Pine Hill, Wānaka). Collections from Marlborough (Waimā River and Maude I.) in WELT have not been verified, but are plausible given the known distribution.

Apparently endemic.

Habitat: Occurring on clay, silt, or occasionally sand at the margins of streams or drainage ditches, usually shaded. The highest elevation recorded on the North I. is c. 600 m at Ōhakune. On the South I. ranging in elevation from near sea level (Berwick) to c. 700 m (Swampy Summit). *Philonotis tenuis* and *Fissidens asplenioides* are commonly associated species.

Notes: The small stature, secund leaves, and erect capsules distinguish this species. Neither the vegetative nor the perichaetial leaves are sheathing, and the leaves on the lower portions of fruiting stems are decidedly reduced. The peristome teeth are connate at their base and bear prominent transverse trabeculae on their outer surface. The elongate mid laminal cells and the complete or near absence of costal stereids corroborate identifications in difficult collections. Sterile material of this species cannot be named with confidence.

The transverse trabeculae on the outer surface of the peristome teeth appear to be coarser and more prominent (well seen in *K.W. Allison 3634* from Berwick State Forest, Otago L.D., CHR 532245) in *D. gracillima* than in any other N.Z. species of *Dicranella*.

Dicranella gracillima is allied to *D. rufescens* of the northern hemisphere and monographic study may eventually show them to be conspecific. However, the name *D. gracillima* is retained here since the capsules here are more variable in size and generally somewhat larger than in *D. rufescens*.

Beckett's (1894) protologue cites the Kowai Bush material and W. Bell collection from Pine Hill, Otago L.D. as syntypes. Beckett's original drawings, from which the plate in the protologue is derived, are in his herbarium and clearly marked as representations of the Kowai Bush syntype, which was therefore designated as the lectotype by Fife (2019).

Recognition: In N.Z. confusion is most likely with *D. schreberiana*. In addition to differences in capsule symmetry, leaf set and stature, spore dimensions, the longer laminal cells, lack of distinct ranks of exothecial cells, and the direction of the seta twisting serve to differentiate *D. gracillima*. The transverse trabeculae on the outer surface of the peristome teeth appear to be coarser and more prominent in *D. gracillima* than in any other N.Z. species of *Dicranella*.

Etymology: The species epithet *gracillima* means most slender.

Dicranella heteromalla (Hedw.) Schimp., *Coroll. Bryol. Eur.* 13 (1856)

≡ *Dicranum heteromallum* Hedw., *Sp. Musc. Frond.* 128 (1801)
Type: Europe. Not seen.

The following description is based on N.Z. material. As this is a widely distributed species in the northern hemisphere, more detailed descriptions may be found in many regional Floras.

Plants medium-sized, bright yellow-green. **Stems** c. 4–7 mm, in cross-section with a large central strand and 1–2 layers of firm-walled cortical cells. **Leaves** loosely secund, lacking a sheathing base, little altered when dry, evenly tapered from a lanceolate base to a long, acuminate, costa-filled subula, serrulate in upper half or more, c. 2.0 × 0.15–0.25 mm, plane at margins; **mid laminal cells** c. 2–3 on each side of the costa, narrowly rectangular, 15–21(–45) × c. 6 µm, mostly 2–4:1, firm-walled, smooth; **cells of leaf base** mostly 36–52 × 4–6 µm. **Costa** occupying ⅓–½ of the leaf base, well defined, long, excurrent and filling the subula, in cross-section with median guide cells and both abaxial and adaxial stereid groups, and with the cells on the adaxial surface more elongate than adjacent laminal cells. **Tubers** not seen.

Dioicous. Perichaetial leaves not differentiated. **Perigonia** terminal; bracts sheathing at base, abruptly tapered to a wide (c. 0.25 mm), oblong and pigmented base; the innermost bract short and lacking a subula. **Setae** pale, yellow-brown, c. 6 mm; **capsules** curved and asymmetric, c. 1.0–1.5 mm, lacking a struma, pale brown, mostly furrowed when dry.

Illustrations: Plate 11. Crum & Anderson 1981, fig. 72 e–i; Noguchi 1987–1994, fig. 59.

Distribution: NI: N Auckland (Puketi), including offshore islands (Moturoa I.), Wellington (Wainuiomata).

Probably adventive. Tasmania*, widespread in the northern hemisphere. Cited from Europe including Britain, the Faeroes, Iceland, Caucasus, Turkey, Lebanon, Himalayas (“and northwards”), Malaysia, Macaronesia, Kenya, North America, and Bolivia by Smith (2004).

Habitat: The Moturoa I. (Bay of Islands) collection (*J.E. Beever 52-13a*, CHR 462056) was made from soil on the vertical side of an intermittent watercourse beneath mānuka. Jessica Beever (pers. comm., 23 Aug. 1990) considered the population was “highly likely introduced”. It was collected from “a recently fenced forest remnant surrounded by pasture, in a water course which drains in from the pasture”. The Puketi collection (*J.E. Beever 62-57*, CHR 611200) came from vertical damp clay at a track margin, among the exotic subshrub *Ageratina* sp. and dicot herbs at the disturbed margin of *Agathis australis* forest. The Wainuiomata collection (*P. Beveridge HA-9*, WELT M040506) was collected from a “trackside soil mound under *Eucalyptus* sp.”. All collections are from low-elevation sites.

Notes: The non-sheathing leaf bases, together with the loosely secund, serrulate and evenly tapered leaves with excurrent costae, distinguish this species from its congeners. The perigonia are representative of *Dicranella*, being terminal with bracts, which are more differentiated and wider (c. 0.25 mm) at their bases than vegetative leaves. The innermost bract is short and lacks a subula. The Moturoa and Puketi collections lack sporophytes, but the more recent Wainuiomata collection bears a few older capsules on yellowish setae. The pale setae with sulcate, asymmetric, and non-strumose capsules are consistent with plants from the northern hemisphere. This inconspicuous species will likely prove to be more widespread in N.Z.

Recognition: *Dicranella heteromalla* is superficially similar to *Ditrichum brevirostre*, but the latter species, despite having falcate-secund leaves, differs by having generally longer leaves, entire margins and percurrent costae. According to R.D. Seppelt (pers. comm., 17 Oct. 2017), in Tasmania the present species when fresh is darker in coloration than the more yellow-green *D. brevirostre*.

Etymology: The species epithet, according to Crum & Anderson (1981, p. 176), refers to leaves spreading in all directions and seems inappropriate for the species.

Dicranella schreberiana (Hedw.) Hilf. ex H.A.Crum & L.E.Anderson, *Mosses E. N. Amer.* 169 (1981)

≡ *Dicranum schreberianum* Hedw., *Sp. Musc. Frond.* 144 (1801)
Type: Germany. Not seen.

= *Aongstroemia subredunca* Müll.Hal., *Hedwigia* 37: 114 (1898)
Type: N.Z., Fendalton, on damp clay in grass field, Sep. 1890, *T.W.N. Beckett 255*, CHR 532390!

Plants small and delicate, yellow-green, forming turves. **Stems** 5–15 mm, in cross-section with a distinct central strand and 2–3 layers of firm-walled cortical cells. **Leaves** on sterile stems and lower portion of fertile stems wide-spreading or loosely secund, weakly contorted when dry, lanceolate or ovate-lanceolate, neither shouldered nor sheathing (lacking a differentiated base), acuminate, entire or with a few small teeth at extreme apex, mostly 0.8–1.5 × c. 0.3–0.6 mm, ± concave throughout, plane at margins; leaves of fertile stems becoming larger (to c. 2.0 mm immediately below the perichaetium), shouldered and distinctly sheathing the upper stems; **upper laminal cells** short-rectangular, c. 15–21 × 5–8 µm and 3–4:1, firm-walled, unistratose, smooth, becoming somewhat larger (c. 30 × 12 µm) near leaf base. **Costa** occupying c. ⅕ of the leaf base, well defined, percurrent, not filling the subula, in cross-section with median guide cells and abaxial and adaxial stereid groups all weakly differentiated, with the cells on the adaxial surface more elongate than adjacent laminal cells. **Tubers** rare, globose, brown, c. 110–135 µm diam.

Dioicous. Perichaetia usually more than one per stem, with leaves considerably longer (2–3 mm), and more distinctly shouldered and sheathing than vegetative leaves. **Perigonia** terminal, gemmiform. **Setae** c. 7–10(–14) mm, rather slender, weakly sinistrorse, red-brown; **capsules** inclined or suberect when fresh or moist, becoming more strongly inclined when dry, weakly to distinctly asymmetric, short-obovoid and constricted below the mouth when dry, c. 0.8–1.5 mm, weakly strumose, minutely furrowed when dry (due to columnar arrangement of exothecial cells); **mouth** slightly oblique to ± transverse; **exothecial cells** rectangular, quadrate or ± irregular, with the longitudinal much thicker than the transverse walls and the cells arranged in ± distinct columns; **stomata** absent; **annulus** absent; **operculum** rostrate and curved, slightly shorter than the urn. **Peristome teeth** variable in length (240–)300–380 × c. 60 µm, unequally divided c. ½ to base, adjacent teeth occasionally anastomosing below, not perforate below the forks, the outer surface of the lower tooth bearing fine trabeculae traversing the full width of the tooth, the inner surface with a zig-zag line that divides the tooth vertically into asymmetric segments, the entire tooth in surface view appearing papillose-striolate. **Calyptra** as per genus. **Spores** (15–)18–21(–25) µm, smooth or nearly so.

Illustrations: Plate 12. Crum & Anderson 1981, fig. 70, h–m.

Distribution: NI: N Auckland (Waiwera, Russell to Whangārei Road, Tāheketītī, near Wellsford), S Auckland, Gisborne (Mt Hikurangi, Waikaremoana), Hawke's Bay (numerous localities, mostly near Wairoa), Taranaki (Mt Messenger), Wellington (Ōhakune, near Raetihi, Mauriceville and vicinity); SI: Nelson (Parapara, Kōhaihai Bluff), Marlborough (Mt Fyffe), Canterbury (Black Range, Bealey River, Cave Stream, Porter River, Selwyn River, Christchurch), Westland (Greymouth), Otago (many localities).

Apparently bipolar. According to Smith (2004) this species is "circumpolar boreo-temperate" in distribution. He considers it common in lowland areas of Britain and to occur also in "Europe north to Fennoscandia, Iceland, Caucasus, Siberia, Korea, Azores, N. America, Australasia".

No other southern hemisphere localities can be confirmed here. Scott & Stone (1976), quoting *Index Muscorum*, recorded this species from Tasmania. Reports of so-called *Dicranella jamesonii* from Tasmania (e.g., Dalton et al. 1991, based on an earlier but tentative report by Sainsbury 1955b) and mainland Australia (Streimann & Klazenga 2002) are perhaps based on *D. schreberiana*. Likewise, Streimann & Klazenga (2002) recorded *D. jamesonii* from N.S.W., S.A., and Vic.; Other mainland Australia records of putative *D. jamesonii* were cited by Scott & Stone (1976) and by Catcheside (1980).

Habitat: This is an inconspicuous and "weedy" species, which often grows on moist clay or silt banks, shaded by riparian willows. It ranges from near sea level (Wairoa) to at least 600 m (Ōhakune) on the North I. and to c. 800 m (Porter River) on the South I. *Ceratodon purpureus* and *Pohlia tenuifolia* are occasional associates.

Notes: The non-sheathing vegetative leaves that gradually merge into the larger, more sheathing and distinctly shouldered perichaetial leaves facilitate recognition. All the leaves have a distinct lamina throughout, smooth cells and entire (except for sometimes a few small apical teeth) margins. There is considerable variability in capsule length, with short-capsuled forms (in some populations all capsules are c. 0.8 mm) having the struma weakly developed and capsules less distinctly inclined than populations with longer capsules. The capsules are weakly to distinctly asymmetric, and inclined or suberect when fresh, but more strongly inclined upon drying. Dixon (1914, p. 67, as *D. jamesonii*) opined that the immature capsules form a "substrumose ring" on drying. There is also marked variation in the length of the peristome teeth.

The earliest mention of this species in N.Z. literature was made by Wilson (1854, p. 65, as *Dicranum schreberi* Hedw.) in reference to a J.D. Hooker collection from the Bay of Islands. Wilson noted that the Hooker collection had completely entire leaves and thus approached the European *Dicranella grevilleanum* (Brid.) Schimp. [Coroll. Bryol. Eur., 1856]. The name *Dicranum schreberi* Hedw. was also used in Hooker's (1867) *Handbook*. Crum & Anderson (1981, p. 169) have clarified some of the early nomenclature of this taxon, and their synonymy is not repeated here.

The first published suggestion that N.Z. material might be referred to the South American *Dicranella jamesonii* was made by Beckett (1894) who, quoting Mitten, cited *T. Kirk 299* (CHR 532392) from Lake Whangapē (S Auckland L.D., cited as Whangapehatu) as *Anisothecium jamesonii*. The Kirk collection has a few minute apical teeth and is referred here to *D. schreberiana*.

Almost certainly at Mitten's urging, Beckett cited several South American syntypes of "*Anisothecium jamesonii*" and "*Angstroemia hookeri*" to illustrate his synonymy and his species concept. However, the Kirk collection is assuredly not the same species as syntypes of *Anisothecium jamesonii* Mitt. The status of the South American *Dicranella*/*Anisothecium jamesonii* and taxa confused with it are briefly discussed here under *D. cardotii*; the resolution of the taxonomic and nomenclatural morass surrounding *D. jamesonii* is beyond the scope of this work. The common and widespread N.Z. species first collected by J.D. Hooker in the Bay of Islands is most appropriately named *D. schreberiana*.

Dixon (1914, p. 66) indicated that the N.Z. *Aongstroemia redunca* Müll.Hal. [Hedwigia 37: 115, 1898] belongs in the synonymy of the misunderstood *D. jamesonii*, but no type material of this name has been identified or seen. Müller's protologue gives no indication of a type for *A. redunca*.

Rhizoidal tubers have been seen only in a collection from Canterbury L.D. (*P.J. Garnock-Jones 245* from Selwyn River headwaters, CHR 267609) and in a scant collection from Ātiamuri, S Auckland L.D. (*K.W.* Allison *114*, CHR 532345B). Both these collections have shorter than usual capsules.

Recognition: The entire (save a few small teeth at apex) leaf margins, the narrower and percurrent costae, and red-brown setae distinguish *D. schreberiana* from *D. heteromalla*.

When sterile, *D. schreberiana* could be confused with members of the Ditrichaceae, particularly with the poorly documented *Trichodon cylindricus*, which has more strongly toothed leaf margins and costae that fill the upper subulae. *Trichodon* is not known to fruit in N.Z. and usually produces pyriform tubers. *Dicranella schreberiana* could also be confused with *Wilsoniella blindioides*, but the latter species has a less distinct central strand, no mid costal guide cells, much longer laminal cells, and lacks sheathing vegetative leaf bases.

Etymology: The species is named in honour of J.C.D. von Schreber (1739–1810), a German naturalist and Professor at the University of Erlangen. Von Schreber is best known for his illustrations and descriptions of mammals. The well-known boreal moss *Pleurozium schreberi* (Brid.) Mitt. is also named after him.

Dicranella vaginata (Hook.) Cardot, *Wiss. Ergebn. Schwed. Südpolar-Exped. [1901-1903] 4(8),* 60 (1908)

≡ *Dicranum vaginatum* Hook., *Pl. Crypt.* Pl. 3B (1816)
≡ *Anisothecium vaginatum* (Hook.) Mitt., *J. Linn. Soc., Bot.* 12: 39 (1869)
Type: Venezuela?: "In convallibus Andium Granatensium inter Almaguar et Pasto, altit. 1200–1500 hexapod., *Humboldt & Bonpland*", BM 000671697!

= *Dicranum clathratum* Hook.f. & Wilson, *London J. Bot.* 3: 542 (1844)

≡ *Dicranella clathrata* (Hook.f. & Wilson) A.Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1870–1871: 382 (1872)

≡ *Anisothecium clathratum* (Hook.f. & Wilson) Broth., *Nat. Pflanzenfam., ed. 2 [Engler & Prantl] 10,*177 (1924)

≡ *Dicranella vaginata* var. *clathrata* (Hook.f. & Wilson) Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 103 (1955)

Type: N.Z., no locality, *J.D. Hooker s.n.* ("Wilson 336"), BM 000671667! See notes below.

Plants medium-sized to large, yellow-green to dark brown to nearly black, forming dense turves. **Stems** orange or red, erect or creeping, branching by both innovation and forking, (7–)12–150 mm, in cross-section with a weak central strand and 2 layers of firm-walled cortical cells. **Leaves** wide-spreading from a strongly sheathing and pale base when moist, slightly more erect, spreading (or wide-spreading) and not contorted dry, abruptly tapered from the oblong and sheathing base to a rather broad and untwisted limb, with strongly defined shoulders, broadly rounded, obtuse, or broadly acute and with a few to many rather large, irregular teeth near apex, mostly (1.8–)2.0–2.6(–3.5) × c. 0.5–0.7 mm, weakly concave above, plane throughout or reflexed at shoulders; **laminal cells at mid limb** absent or obscure and short-rectangular, c. 3–5 µm wide and 1–2:1, firm-walled, smooth; **cells of leaf base** narrowly oblong-rectangular, variable in length (commonly c. 75–95 × 6–9 µm), smooth, becoming short-rectangular to quadrate at shoulder. **Costa** occupying c. ⅕ the width and ill-defined in leaf base, percurrent, stout and filling the limb (no lamina visible in cross-section of mid limb), in cross-section with median guide cells and small abaxial and adaxial stereid groups and with the cells on the adaxial surface more elongate than adjacent laminal cells. **Tubers** apparently absent.

Dioicous. Perichaetia with leaves to c. 4 mm. **Perigonia** terminal but often overtopped by innovations. **Setae** 9–14 mm, flexuose, weakly sinistrorse, red-brown; **capsules** erect, short cylindric, not constricted below the mouth when dry, 1.3–1.8 mm, neither strumose nor furrowed when dry, red-brown to nearly black and lustrous when dry; **mouth** transverse; **exothecial cells** oblong-hexagonal, firm-walled (longitudinal walls not differentially thickened); **stomata** superficial at capsule base; **annulus** poorly differentiated or absent; **operculum** long and finely rostrate from a conic base, 1.5–2 mm long. **Peristome teeth** c. 370 × 65 µm, divided nearly to base into two unequal forks (rarely with a third), occasionally narrowly perforate nearly to base, the outer surface of the lower tooth bearing fine trabeculae traversing the full width of the tooth, zig-zag line on inner surface not apparent, the lower tooth in surface view appearing nearly smooth or irregularly and very finely papillose (not papillose-striolate), the individual forks (upper ⅔ or more of the tooth) coarsely diagonally striate (apparently on both surfaces) and sometimes becoming baculate near apex. **Spores** 21–30 µm, green, smooth.

Illustrations: Plate 13.

Distribution: NI: N Auckland including offshore islands (GB, LB), S Auckland, Gisborne (Lake Waikaremoana, Wairoa), Taranaki (Otūmangahū Landing on Whanganui River, Mt Taranaki), Wellington (Mangapurua Landing on Whanganui River, Tongariro Forest Park, Mauriceville); SI: Nelson, Westland, Southland (Lake Manapōuri, Mosquito Creek near Riverton); St.

Austral-Andean. Ecuador* and Venezuela*. Cardot (1908, p. 60) recorded it from Colombia, while Crum (1994) recorded it from additional localities, mostly in Central America and the West Indies.

Habitat: Stream banks, sometimes at the margins of cascades and often partially submerged. Occasionally in roadside ditches. Occurring on a variety of substrates, including sand (sometimes derived from granite or gneiss), granite, limestone, mudstone, and sandstone. At the middle reaches of the Whanganui River (forming the boundary between Wellington and Taranaki L.D.). *D. vaginata* forms turves of many square metres on papa (mudstone) and appears to be a dominant plant species on papa banks below the river flood level. On the North I. ranging from c. 15 m (Wairoa) to at least 275 m (Lake Rotoiti, S Auckland L.D) elevation; on the South I. ranging from 15 m (near Haast, Westland L.D) to c. 830 m (Herbert Range, Nelson L.D.) elevation. On the South I. this species is distributed exclusively in western regions. *Ochiobryum blandum* appears to be the most consistent associate; others include *Blindia magellanica,* irrigated forms of *Distichophyllum pulchellum*, *Fissidens rigidulus*, and *Tridontium tasmanicum*.

Notes: The pale sheathing leaf bases and stout, widely spreading limb, which is completely or nearly filled by the costa and coarsely toothed at its apex (with the teeth visible under the stereoscope), combined with the turf-forming habit and streamside habitat, characterise *D. vaginata*. The coarse diagonal striations conspicuous on the upper peristome teeth do not occur in any other N.Z. species of *Dicranella*. The diagonally striate-baculate nature of the peristome tooth forks are probably what Dixon (1914) had in mind when he stated "the filiform branches are densely and very highly cristate with close papillae, so that their internal structure is entirely hidden". This feature can be clearly observed in *K.W. Allison 1798* from Waipoua Forest (CHR 532213).

Apart from type material of the tropical South American *Dicranum vaginatum* Hook. (1816), relatively little South American material has been examined. (The original protologue has been unavailable, and only the protologue in Hooker's *Musci Exot. 2*: 141, 1820 has been seen.) One of the five South American specimens of *Anisothecium vaginatum* (Hook.) Mitt. cited by Mitten (1869, p. 39) is present in CHR: R. Spruce 36, collected at "Andes Quitensis, ad fl. Pastasa infra Banos, 5500 ped." (CHR 461364). Neither of these specimens seems distinguishable from N.Z. material in any meaningful way, including peristome structure.

The type material of *Dicranum clathratum* and the several combinations based on it bears no locality data beyond "New Zealand" and no reference to the "falls of the Kidi-Kidi River" (probably Kerikeri River, N Auckland L.D.) mentioned in the protologue. Nevertheless, there can be little doubt that the specimen cited above was used by Wilson in the preparation of the species description.

Both Dixon's (1914, p. 65) and Sainsbury's (1955a, p. 103) comments concerning the nature of the peristome are confusing, and at least in Dixon's case may have been influenced by his confusion of the present species (cited as *D. clathrata*) with *D. campylophylla* (cited as *D. cardotii*). Their observations do not accord with mine, and Sainsbury's (1955a, pl. 17, fig. 1) illustration is particularly misleading. The N.Z. material examined has peristome teeth divided nearly to the base into two unequal forks. Only in rare instances (e.g., *A.J. Fife 6024b* from Nile River, Nelson L.D., CHR 405664) do individual teeth occur with a third rudimentary projection. Perforations are relatively uncommon, occur in only a small fraction of the individual teeth in a single peristome, and are usually narrow and restricted to the basal c. 125 µm of the tooth. The N.Z. name *Dicranum clathratum* and its various combinations are unworthy of separation from the South American *D. vaginata*.

Dixon's understanding of the relationship between the present taxon, *Dicranum cardotii* R.Br.bis, and *Dicranum cockaynii* R.Br.bis is confusing. Dixon (1914, p. 64; see also 1923, p. 77) cited six names, which he considered conspecific (or provisionally conspecific) with his concept of *Dicranella clathrata*. This synonymy is not quoted here.

Dicranella vaginata var. *longifolia* Dixon & Sainsbury *in* Sainsbury [Trans. R. Soc. N.Z. 75: 171, 1945] is synonymous with *Ditrichum punctulatum* Mitt., q.v.

Recognition: Although *D. vaginata* is sometimes confused with *D. cardotii* (which occupies similar habitats), in the majority of instances the two species can be distinguished in the field by the nature of the limb, which in the present species is stouter, stiffer, and completely or very nearly completely filled by the excurrent costa; other differences are detailed under *D. cardotii*.

Dicranella vaginata can also be confused with *D. dietrichiae*. The latter species is rarer, occupies mainly non-riparian habitats, and has a more restricted and northern distribution. It differs morphologically from *D. vaginata* by having shorter stems, much-less-pronounced shoulders, a leaf apex that is toothed by cells projecting on all surfaces of the percurrent costa, and sulcate capsules with a well-differentiated and persistent annulus.

Dicranella vaginata has been at times confused with *Ditrichum strictum*. *Dicranella vaginata* is a smaller and usually brighter-green plant, with leaves spreading to widely spreading and untwisted in both moist and dry conditions. By contrast, *Ditrichum strictum* is generally a larger and darker (dark or olive-green to black) plant with leaves ± erect and homomallous to weakly secund in both wet and dry conditions. Its leaves are mostly weakly twisted (spiralled) when dry. The leaves of *Dicranella vaginata* are shorter, mostly 2.0–2.6 mm long, while those of *Ditrichum strictum* are mostly 6–7 mm long. The narrowing at the shoulder is more abrupt, the sheathing nature of the leaf base more conspicuous in both fresh and dried conditions, and the lower costae ill-defined and narrow in *Dicranella vaginata*, while in *Ditrichum strictum* the narrowing of the leaf is more gradual, the sheathing nature of the leaf base less obvious, and the lower costae are clearly defined and broader (c. ⅓ the leaf base in width) in the lower leaf. *Dicranella vaginata* is dioicous while *D. strictum* is frequently (or always?) autoicous. When fruiting the spores are mostly smaller in *D. vaginata* (21–30 vs mostly 27–45 µm). The peristome is better developed here, with teeth c. 370 µm long and persistent vs c. 210–240 µm long and fugacious in *Ditrichum strictum*. The annulus in *D. vaginata* is poorly differentiated or absent, while in *Ditrichum strictum* the annulus is compound and revoluble. *Dicranella vaginata* occurs over a wide elevation range (from near sea level upwards), while *Ditrichum strictum* is not known below c. 950 m elevation on the main islands.

Etymology: The epithet *vaginata* means sheathing and refers to the nature of the leaf bases. The disused epithet *clathrata* means latticed, and in reference to the peristome teeth seems inappropriate to the taxon.

Dicranoloma (Renauld) Renauld, *Rev. Bryol.* 28: 85 (1901), nom. cons.

≡ *Leucoloma* subgen. *Dicranoloma* Renauld, *Prodr. Fl. Bryol. Madagascar* 61 (1898)

Type taxon: *Dicranoloma platyloma* (Besch.) Renauld

Plants mostly robust, variable in colour when fresh, becoming gold-brown when dry, forming cushions or turves. **Stems** erect or occasionally trailing, branching by subperichaetial innovation and also usually by forking, in cross-section with an ill-defined central strand, matted with tangled, smooth, pale-brown or whitish rhizoids. **Leaves** falcate-secund or wide-spreading and ± straight, smooth or variably plicate or rugose, ovate-lanceolate, ovate, or linear-lanceolate, usually acuminate, obtuse or rounded apically, with a well-defined border (limbidium) of linear cells at least in the lower portion, spinose-serrate, serrate, or entire, clasping or not at insertion, strongly concave or subtubulose, plane at margins; **mid laminal cells** elongate or short, thick-walled, porose or not, a group adjacent to costa rarely differentiated and shorter; **alar cells** abruptly differentiated, inflated but firm-walled, unistratose. **Costa** narrow or robust, mostly well-defined for its entire length, usually percurrent or short-excurrent, occasionally fading in leaf base, variable in cross-section.

Dioicous (nearly always pseudautoicous). **Perichaetia** terminal, becoming lateral by innovation, the leaves sheathing and strongly concave, obovate or elliptic, often aristate. **Dwarf males** gemmiform, embedded in rhizoids of sterile or ♀ plants. **Setae** aggregated or single, elongate and straight, not twisted; **capsules** exserted or emergent, curved, cylindric, constricted below the mouth (when dry), strumose or not, smooth with moist, sulcate or smooth when dry; **exothecial cells** firm-walled, oblong-hexagonal or ± irregular; **stomata** restricted to neck, superficial; **annulus** weakly differentiated, not revoluble; **operculum** curved-rostrate from a conic base, ± equal to the capsule. **Peristome teeth** inserted at mouth, red-brown, divided c. halfway to base into segments of unequal width, papillose-striolate below, mostly baculate near apex. **Calyptra** cucullate, smooth. **Spores** spherical, nearly smooth.

Taxonomy: Klazenga (2003) has provided an invaluable revision of *Dicranoloma* for Australasia, which followed an earlier (1999) revision of the Malesian species. Klazenga (2003) estimated that this predominantly southern hemisphere genus contained 35–40 species, with greatest species diversity in Malesia, followed by Australia, N.Z., and islands of the south-western Pacific. His key to species is useful for the identification of N.Z. material. He recorded 10 species from N.Z., compared to only 8 species accepted here. *Dicranoloma trichopodum* (Mitt.) Broth. is treated here in *Holomitrium* (following Klazenga 2006), and *D. eucamptodontoides* (Broth & Geh.) Paris is here excluded from the N.Z. flora for reasons detailed under *D. obesifolium*.

Klazenga's circumscription of *Dicranoloma* is adapted here. An alternative view, placing the New Guinean species of *Dicranoloma* into *Dicranum*, was adopted by Norris & Koponen (1990). A broad circumscription of *Dicranum* was also followed by Fife (1995), but Klazenga's subsequent publications have led to an alteration of this view. Features that distinguish *Dicranoloma* from the one species of *Dicranum* accepted in the N.Z. flora are discussed under the latter genus. A number of synonyms of *Dicranoloma* species have been accepted in this treatment without further investigation, many of them on the basis of Klazenga's (1999, 2003) regional revisions.

Considerable emphasis has traditionally been placed (since Renauld 1909) on the systematic value of the structure of the costa viewed in cross-section. Renauld described four characteristic types: toxoneuron, leptoneuron, heteroneuron, and cyrtoneuron. Dixon (1913, p. 8–9, pl. IV) both defined and illustrated Renauld's costal types and commented that "the different types of nerves described by Renauld, while of much value in the determination of species, and of no slight taxonomic importance, must not be looked upon as representing clearly defined and distinct groups of species, but rather as marked points in an intergrading series of types of structure." Sainsbury (1955a, p. 126) expressed even greater caution about the use of the costal types to define species and noted that three of the types (excepting cyrtoneuron) "grade into each other".

In the present study, costal structure has been found to be of limited utility in delimiting species boundaries (with the exception of *D. dicarpum*, the only N.Z. species with a well-defined cyrtoneuron costal structure). An approach similar to that of Klazenga (1999) has been adopted: the costal structure for each species has been described in preference to assignment to a particular costal type.

The colour, degree of lustre, and general appearance of fresh plants are very useful features for the recognition of N.Z. species, but these features are often lost upon specimen drying. The number of setae per perichaetium and the relative length of setae to the perichaetial leaves are very useful for the recognition of some species, but sterile populations or specimens are frequently encountered. The form of the inner perichaetial leaves facilitates species definition and recognition in some instances. In

D. fasciatum the ♀ leaves are narrowly lanceolate and gradually acuminate, rather than aristate or mucronate in all other N.Z. species. Perichaetial leaf form is also useful in distinguishing between *D. robustum* and *D. billardierei*.

Dicranoloma dicarpum, *D. fasciatum*, *D. platycaulon*, *D. plurisetum*, and *D. obesifolium* are characteristically white-green and quite dull in appearance when fresh. Their colour is suggestive of, but less pale than, that of a *Leucobryum*. B. Macmillan (pers. comm.) aptly describes it as "milky". Once the characteristic colour and dullness of these plants is recognised, it is usually easy to spot even relatively small cushions of the white-green species in the field, and their fresh coloration is useful to distinguish them from sterile plants of *D. robustum*, which in its representative form is the most abundant and conspicuous *Dicranoloma* species throughout the country. In its terrestrial forms, *D. robustum* is usually yellow-green in colour and distinctly shiny.

Although the aforementioned five species cannot be distinguished from each another by colour or sheen, there are numerous characters, some readily observed in the field, that permit their separation. The dimensions (or l:w ratios) and apical form of vegetative leaves, the nature of leaf areolation, the strength of the leaf border, the nature and degree of toothing of the upper leaf, the nature of spines on the abaxial surface of the costa, the relative length of perichaetial leaves to the mature sporophytes, and the number of sporophytes per perichaetium all provide characters useful to define or identify N.Z. species.

The sexuality of all *Dicranoloma* species is dioicous, with the ♂ plants nearly always dwarfed and epiphytic on ♀ or sterile plants. Ramsay (1985) investigated the cytological and physiological relationships between ♂ and ♀ plants in *Dicranoloma*. Non-dwarf or "free-living" ♂ plants have also been recorded from *D. billardierei*, *D. dicarpum*, *D. fasciatum*, and *D. menziesii* (Ramsay 1985; Klazenga 2003).

Dicranoloma billardierei can be difficult to distinguish from *D. robustum* in the herbarium. However, in the field, *D. billardierei* is distinguishable by its more conspicuously branched upper stems, shorter leaves, and pale yellow-green coloration. There is a subtle flattening of the leaves in fresh material of *D. billardierei*, which make its branched, red-brown stems much more conspicuous than the mostly unbranched stems of *D. robustum*.

Etymology: The generic name aptly combines *Dicranum* with the root Greek *loma*, meaning bordered.

1 **Leaves** distinctly plicate to mid leaf or more when fresh or when dried material is completely moistened 2

1' **Leaves** not or indistinctly plicate when fresh or when dried material is completely moistened (*D. fasciatum* & *D. plurisetum* will key out both ways) 4

2 **Juxtacostal cells at mid leaf** clearly differentiated (shorter, more opaque and irregular, and scarcely porose) from other mid laminal cells; **costal cross-section** (mid leaf) strongly 2-winged, with several abaxial and adaxial stereid groups and a median group of guide cells; **margins** sharply spinose-serrate in upper ½ to ⅔ .... *D. dicarpum*

2' **Juxtacostal cells at mid leaf** not differentiated from other mid laminal cells; **costal cross-section** (mid leaf) not winged, with median row of guide cells and one abaxial and one adaxial stereid group, which extend the width of the costa; **margins** sharply spinose-serrate in upper ⅓ or less 3

3 **Leaves** 4–5(–6) × c. 0.8 mm; **perichaetial leaves** narrowly lanceolate (gradually tapered to a slender acumen and not aristate), extending to or exceeding the mouth of mature capsules .... *D. fasciatum*

3' **Leaves** 8–10 × c. 1.3–1.5 mm; **perichaetial leaves** abruptly tapered and aristate, extending to c. ⅓ the seta length .... *D. plurisetum*

4 **Leaf apices** obtuse or broadly rounded; **margins** entire; **plants** white-green and dull when fresh, often from above tree line .... *D. obesifolium*

4' **Leaf apices** acute or acuminate; **margins** mostly toothed; **plants** variously coloured and usually lustrous when fresh; from below tree line (or from above tree line and then yellow-green and lustrous) 5

5 **Laminal cells** in upper ⅓ of the leaf ± isodiametric to short-oblong, 1–2:1, not porose; **leaves** setaceous; **capsules** exceeded by some perichaetial or vegetative leaves .... *D. menziesii* s.l.

5' **Laminal cells** in upper ⅓ of the leaf not isodiametric, mostly elongate or irregular in outline, at least some 3:1 or longer, ± porose (usually strongly so); **leaves** not setaceous (except in “setosum” growth form of *D. robustum*); **capsules** exceeding perichaetial and upper vegetative leaves 6

6 **Leaves** transversely undulate at least when dry; **cells** at mid leaf and above highly irregular in shape (a mixture of oblong, rhombic, triangular, oval, and irregular) and arrangement, sometimes with bands of short, highly irregular cells alternating with more elongate cells .... *D. platycaulon*

6' **Leaves** not transversely undulate; **cells** at mid leaf and above mostly elongate, not highly irregular 7

7 **Capsules** mostly >1 per perichaetium (at least some plants usually with multiple capsules); **plants** dull when fresh 8

7' **Capsules** 1 per perichaetium; **plants** lustrous when fresh 9

8 **Capsules** immersed or emergent; **perichaetial leaves** extending at least to the capsule base, lanceolate and gradually tapered to a slender acumen; **vegetative leaves** 4–6.5 mm; **spines** on abaxial surface of the costa scarcely visible under a hand-lens .... *D. fasciatum*

8' **Capsules** exserted; **perichaetial leaves** ending well below the capsule base, abruptly tapered from base to a long and slender awn (arista); **vegetative leaves** 8–10 mm; **spines** on abaxial surface of the costa obvious under a hand-lens .... *D. plurisetum*

9 **Leaves** fragile .... *D. robustum* “setosum” growth form

9' **Leaves** not fragile 10

10 **Leaves** not secund, either spreading or erect and imbricate .... *D. robustum* “integrifolium” growth form

10' **Leaves** markedly secund (often falcate-secund), at least in upper portions of stems 11

11 **Upper** laminal **cells** oblong, mostly 3–5:1; **capsules** erect and scarcely curved, c. 4 mm; **costa** stout, c. 0.1 the widest part of leaf; **plants** usually red at least in part when fresh .... *D. robustum* “cylindropyxis” growth form

11' **Upper laminal cells** elongate, mostly >5:1; **capsules** distinctly curved, 3.5 mm; **costa** 0.05 or less the widest part of leaf; plants usually lacking obvious red coloration when fresh 12

12 **Stems** mostly branched a short distance below apex; **plants** pale, yellow-green when fresh; **vegetative leaves** with a definite narrowing at base of subula, length:width ratio (3.2–)4–7.6:1; **costa** at mid leaf with 3–5 guide cells; **subula** generally twisted; **inner perichaetial leaves** obtuse or retuse, mucronate (mucro sometimes to c. 0.1 the total leaf length or rarely longer) .... *D. billardierei*

12' **Stems** not or rarely branched a short distance below apex; **plants** not pale, yellow-green or darker when fresh; **vegetative leaves** evenly tapered, length:width ratio 5–13.2:1; **costa** at mid leaf with 6–12 guide cells; **subula** generally not twisted; **inner perichaetial leaves** long aristate .... *D. robustum* representative growth form

Excluded Taxa: *Dicranum diaphanoneuron* Hampe & Müll.Hal. [Linnaea 36: 515 (1870)]. There is no substantive evidence that this species occurs in N.Z. Dixon (1913, p. 13, as *Dicranoloma*) quoted Brotherus in saying that it is known from “Victoria, Tasmania, and New Zealand”. However the type specimen is from Western Australia, as are most of the collections cited by Klazenga (2003), who makes no mention of this species occurring in N.Z. This species is not discussed further here.

Dicranoloma billardierei (Brid.) Paris, *Index Bryol., ed. 2, 2,* 24 (1904)

≡ *Dicranum billardierei* Brid., *Bot. Zeitung (Regensburg)* 1: 214 (1802) – as billarderii
≡ *Leucoloma billardierei* (Brid.) Broth., *Nat. Pflanzenfam. [Engler & Prantl] 1(3),* 323 (1901)
Lectotype: Australia, *J.J.H. de Labillardière*, BM-Bescherelle. Designated by Klazenga 2003. Not seen. When designating a lectotype in BM, Klazenga (2003, p. 430) suggested that original material, in this case in the Bridel herbarium, would have been destroyed at Berlin during WWII.

= *Dicranum billardierei* var. *duriusculum* Hook.f. & Wilson in Wilson & Hooker, *Bot. Antarct. Voy. I. (Fl. Antarct.) Part I,* 129 (1845)
Type: N.Z., Lord Auckland's group, J.D. Hooker [66], BM. Cited by Klazenga 2003. Not seen.

= *Dicranum orthopyxis* Müll.Hal., *Hedwigia* 36: 362 (1897)
Type: N.Z., prov. Auckland, *G. Zürn*, 1882, *in herb.* Schliephacke. Not seen.

= *Dicranum subconfine* Müll.Hal., *Hedwigia* 36: 353 (1897) nom. illeg., non *Dicranum subconfine* Besch. 1875
≡ *Dicranum scopelloides* Paris, *Index Bryol. Suppl.* 125 (1900)
≡ *Dicranoloma scopelloides* (Paris) Paris, *Index Bryol., ed. 2, 2,* 30 (1904)
Type: N.Z., Westland, Greymouth, *R. Helms*. Not seen. No type material was seen by Klazenga (2003).

Misapplications: *Dicranoloma pungentella sensu* Dixon 1913, p. 26. See discussion below.

Plants medium-sized, pale yellow-green and lustrous when fresh, becoming gold-brown in older dried specimens, mostly forming cushions. **Stems** very conspicuous in fresh material, 30–100 mm, branched by both forking and innovation, in cross-section with 3–4 layers of thick-walled cortical cells and an ill-defined central strand, with sparse pale rhizoids in leaf axils. **Leaves** falcate-secund or erect-spreading when fresh, often twisted at apex but neither plicate nor rugose when dry, ovate-lanceolate, ± narrowed to insertion, serrate to ± entire above (usually serrate in upper ¼ or less, and teeth one-celled), entire below, (4–)5–8 × c. 1.5 mm (under cover slip), subtubulose, plane at margins; **mid laminal cells** irregular and elongate, mostly 39–75 × 4–6 µm and 8–15:1, porose, with elongate cells extending to apex; **juxtacostal cells at mid leaf** not differentiated; **border** well defined and extending from just above alar group to serrations, mostly 3–4 cells and c. 15(–24) µm wide at mid leaf; **cells of leaf base** slightly longer (to c. 105 µm) but otherwise as those of mid lamina; **alar cells** extending c. ½ to costal base and c. 10 cells up the margin, brown, not or slightly inflated. **Costa** narrow, 30–45 µm wide at mid leaf, occupying c. 1/25 or less of widest part of leaf base, the abaxial surface in c. upper ⅕ bearing a single or double row of short spines (not visible under hand-lens), in cross-section lacking wings at mid leaf, with 3–5 guide cells in 1–2 layers, with (4–)6–8 abaxial stereids in a ± single surface layer (sometimes ± divided into 2 groups by a guide cell) and 2–5 stereids on the adaxial surface.

Pseudautoicous. **Perichaetial leaves** sheathing (c. ¼ the seta length), ecostate, obtuse or retuse, mucronate (mucro sometimes to c. 0.1 the total leaf length or rarely longer). **Setae** one per perichaetium, 19–30 mm, red-brown; **capsules** exserted, strongly curved, c. 2.8–3.5 mm, strumose, smooth both when moist or dry, otherwise as per genus; **operculum** curved-rostrate from a conic base, ± equal to the capsule. **Peristome teeth** c. 350–440 × 90 µm, otherwise as per genus. **Calyptra** cucullate, smooth. **Spores** 17–21 µm.

Illustrations: Plate 14. Dixon 1913, Pl. IV, figs. 12, 14–15, 19 (variously named); Tan & Koponen 1983, figs 41–43; Beever et al. 1992, fig. 24 a–e; Klazenga 2003, figs 3 a–p & 4 a–d; Seppelt 2004, fig. 54.

Distribution: NI: N Auckland, including offshore islands (PK, LB, GB, RT), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St; Ch; A, C. Reported from M by Seppelt (2004). Relatively few collections have been confirmed from Hawke's Bay and Otago L.D.

Austral. Tasmania*, mainland Australia*, Marion I, South Africa*, Tanzania*, Argentina*. Recorded from Madagascar and southern South America by Klazenga (2003) and from Juan Fernandez Is. Robinson (1975).

Habitat: Both terrestrial and epiphytic. Growing on soil or rock hummocks, logs, stumps, and exposed roots; less often directly on rock. Terrestrial in a variety of scrub and forest types and often on duff in well-drained sites. Occurring on the forest floor of southern beech or mixed broad-leaved forest, and in

N Auckland often occurring in mānuka scrub. Very often forming a mosaic with *D. robustum*. From near sea level (Rangitoto I.) to c. 1140 m (north-western Ruahine Range, Wellington L.D.) on the North I. and from near sea level (Pororarī River, Westland L.D.) to at least 1250 m (Temple Basin, Canterbury L.D.) on the South I.

The compact cushions and the combination of stems, which are clearly visible among the leaves and much-branched, the tendency for some stems to become prostrate, and the relatively short leaves make this species distinctive, particularly in the field. The leaves are usually falcate-secund, but forms with erect-spreading leaves are not rare, particularly in boggy habitats. The conspicuousness of the stems is largely due to the much sparser production of axillary rhizoids in this species than in most of its N.Z. congeners. The absence of plications in the lower leaf helps to distinguish it from several species. Capsules, when present, are invariably one per perichaetium. The obtuse (and sometimes mucronate) nature of the innermost perichaetial leaves is distinctive and readily observed under a hand-lens. When growing terrestrially *D. billardierei* usually forms pure cushions of up to c. 0.8 m or more in diameter.

Notes: *Dicranum billarderi* var*. duriusculum* Hook.f. & Wilson was reduced to synonymy by Klazenga (2003). *Dicranum orthopyxis* Müll.Hal. and *Dicranum scopelloides* Paris were placed in synonymy by Dixon (1913, p. 23) and tentatively accepted by Klazenga (2003). These synonymies are followed here without further investigation.

The name *D. angustinerve* (Mitt.) Paris [Index Bryol., ed. 2, 2: 24, 1904)] has a Tasmanian type. It was applied by Mitten (*in herb.* Beckett) to material from Great Barrier I. Mitten's (1859) protologue described the species (as a *Dicranum*) as having inner perichaetial leaves "furnished with a bristle-like point, which seems wanting in *D. billardierei*." The Great Barrier I. material (*T. Kirk 46*, CHR 543127) indeed has strongly aristate inner perichaetial leaves but otherwise falls within the range of continuous variation for *D. billardierei* and in my opinion is referable here. Klazenga (2003) studied Tasmanian type material of Mitten's name and unequivocally placed it in the synonymy here.

The Tasmanian name *D. pungentella* (Müll.Hal.) Paris has been applied to N.Z. material by Dixon (1913, p. 26), Sainsbury (*in herb*.) and others. N.Z. material so-named has leaves more spreading and less secund and upper margins somewhat less serrate than usual for *D. billardierei*. The vegetative leaf length is usually near the lower end of the range of continuous variation for this species. In at least some instances these minor variations are associated with occurrences in boggy sites; they are not significant in terms of the overall variability of *D. billardierei*. The N.Z. material named as *D. pungentella* by Sainsbury (no material named as *D. pungentella* by Dixon has been seen) is from epiphytic habitats and sterile, and has weakly secund and weakly toothed leaves of c. 5–6 mm. This material is quite unremarkable in the context of N.Z. *D. billardierei*. Klazenga (2003) tentatively accepted Sainsbury's (1955a) treatment of *D. pungentella* (Müll.Hal.) Paris as a synonym of *D. billardierei* but he was unable to locate type material from Mt Wellington, Tasmania.

Dicranoloma integerrimum (Broth. & Geh.) Paris was likewise recorded from a single Stewart I. locality by Dixon (1913) and synonymised with *D. billardierei* by Sainsbury (1955a). However, it has been more convincingly synonymised with *D. robustum* by Klazenga (2003), who located and examined Tasmanian type material. Klazenga's placement of this name is accepted here. The Stewart I. collection (*leg.* Cockayne) has not been located.

Dixon (1913, p. 23) ascribed additional names, based on Australian types (which have not been applied to N.Z. material), to the synonymy of *D. billardierei*; some of these synonyms have been typified and confirmed by Klazenga (2003). Tan & Koponen (1983) provided additional synonymy from across a wide geographic range, including names from Malesia and South America; Klazenga (1999) agreed with Tan & Koponen in regard to Malesian and south-east Asian synonymy. Some additional synonymy was provided by Robinson (1975, p. 22), but it is unclear how many of the types he cited were examined by him.

Material of *Dicranum pelliceum* Müll.Hal. *nom. nud.* (H-Br 1201039!) and *D. turgidum* Müll.Hal., *nom. nud.* (CHR 543125!) is referable to *Dicranoloma billardierei*.

Recognition: *Dicranoloma billardierei* often grows in association with *D. robustum*. The shorter leaves, generally more branched stems, and obtuse (vs long aristate) perichaetial leaves are all useful to distinguish the two species under field conditions. *D. billardierei* colonies are nearly always paler and less yellow than those of *D. robustum*; this is a subtle difference but is obvious in the field. However, *D. billardierei* lacks the distinct white-green colour of such species as *D. dicarpum*, *D. fasciatum*, and *D. plurisetum*. According to Seppelt (2004), sterile plants of *D. billardierei* and *D. robustum* on Macquarie I. can be separated by the number of guide cells observed in a costal cross-section (presumably mid leaf): two to four in the former and three to eight in the latter; this largely accords with my observations, at least as far as "representative" material is concerned.

Some of the confusion between *D. billardierei* and *D. robustum* can be traced to Scott & Stone's (1976, p. 154) opinion that the two species were not separable.

In addition to the aforementioned features, mid leaf costal cross-sections can be used to distinguish the two species. In *D. billardierei* the costa at mid leaf has 3–5 guide cells, 6–8 abaxial stereids aligned in a single layer (which extends to the surface), 5 or fewer adaxial stereids, and seldom if ever exceeds 45 µm in width. There are no cells with larger lumens (relative to the stereids) on the abaxial surface. The costal structure corresponds to Renauld's heteroneuron (occasionally leptoneuron) costal type. In *D. robustum* the costa at mid leaf has 6–12 median guide cells with mostly two layers of stereids abaxially and adaxially, and 60–160(–225) µm wide. Sometimes the surface cells on the abaxial side are larger lumened than the adjacent stereids. The costal structure of *D. robustum* corresponds to Renauld's toxoneuron costal type. The costal structure of *D. billardierei* is more uniform than that of *D. robustum*.

In unpublished work done in 1988, R. Lewington (pers. comm.) found that the average length:width ratio of fully developed *D. billardierei* vegetative leaves ranged from 3.2–7.6:1 in contrast to a ratio of 5–13.2:1 for *D. robustum*. Lewington measured six representative leaves per herbarium specimen, and used predominantly herbarium specimens named by Sainsbury.

When sterile, *D. billardierei* is sometimes confused with *D. fasciatum*. *Dicranoloma billardierei* has serrate rather than spinose-serrate upper leaf margins. The marginal toothing and spines on the abaxial surface of the costa in *D. billardierei* are scarcely visible under the hand-lens. The leaf border in *D. billardierei* is c. 15–24 µm wide, while that of *D. fasciatum* is wider (30–75 µm) and clearly visible under the hand-lens. The lack of leaf plications in *D. billardierei* also serves to distinguish it. When fruiting the two species are unlikely to be confused.

Etymology: The epithet honours the remarkably widely travelled French botanist J.J.H. de Labillardière. The species epithet and the collector's name have been spelt in various ways in the literature. Scott & Stone (1976, p. 154) employed the spelling "billardieri", while Klazenga (2003) used "*billarderi*". The ICN, Article 60.7 (McNeill et al. 2011, viewed on line, 27 Jan. 2015) states that epithets based on de Labillardière's name should be spelt "*billardierei*", as done here.

Dicranoloma dicarpum (Nees) Paris, *Index Bryol., ed. 2, 2,* 26 (1904)

≡ *Dicranum dicarpum* Nees in Sprengel, *Syst. Veg., ed. 16 [Sprengel] 4(2),* 322 (1827) – as dicarpon
≡ *Leucoloma dicarpum* (Nees) Broth., *Nat. Pflanzenfam. [Engler & Prantl] 1(3),* 322 (1901)
Isotype: Australia, Nov. Holl., *Sieber*, NY-Jaeger!

= *Dicranum leucolomoides* Müll.Hal., *Bot. Zeitung (Berlin)* 9: 549 (1851)
≡ *Leucoloma dicranoides* Broth., *Nat. Pflanzenfam. [Engler & Prantl] 1(3),* 323 (1901) nom. illeg.
≡ *Dicranoloma dicranoides* Paris, *Index Bryol., ed. 2, 2,* 26 (1904) nom. illeg.
Isotype: N.Z., prope portum Kaipara, *S. Mossman 715*, NY-Mitten 267985! Klazenga (2003) cited NY 267974 as the lectotype of this name but that duplicate of the Mossman collection has not been seen.

= *Dicranum dicarpum* var. *spinosum* Hook.f. & Wilson in Hooker, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II,* 66 (1854)
Type: N.Z., Ship Cove, *D. Lyall 26*, BM-Wilson (Lectotype designated by Klazenga 2003.) Not seen.

Plants robust, white- or pale yellow-green when fresh, becoming gold-brown in older specimens, forming tufts, cushions, or turves. **Stems** c. 35–70(–90) mm, little or sparsely forked, in cross-section with 2–4 layers of thick-walled cortical cells and an ill-defined central strand, densely matted throughout by short, tangled, smooth, and pale brown or whitish rhizoids. **Leaves** mostly strongly secund from a spreading base, ± falcate, strongly plicate, somewhat more flexuose but otherwise little altered when dry, narrowly lanceolate, sharply spinose-serrate in upper ½–⅔, (6–)7–10 × c. 0.7–1.0 mm, keeled, plane at margins; **mid laminal cells** elongate, mostly c. (45–)60–80(–100) × 6–10 µm, strongly pigmented, porose, outermost cells linear and pale; **juxtacostal cells at mid leaf** shorter and irregular in outline, mostly 1–4:1, more pigmented, and less porose than contiguous laminal cells; **border** narrow and very pale (especially in leaf base), extending from just above the alar group to the marginal teeth, mostly of 1–4 linear cells and c. 18–30 µm wide at mid leaf; **cells of leaf base** more elongate than those at mid leaf, mostly 120–180 × 6–12 µm, thick-walled and porose; **alar cells** strongly and abruptly differentiated, unistratose, extending c. ⅔ or more to costal base and c. (6–)8–10 cells up the margin, inflated and yellow, firm-walled, the largest c. 90 × 60 µm. **Costa** occupying c. ⅛ the widest part of leaf base, nearly filling the upper ⅓ of leaf**,** the abaxial surface in upper ½ or more bearing single-celled spines (obvious under hand-lens), in cross-section strongly 2-

winged at mid leaf, with 7–10 median guide cells (with 4 often forming a central group), abaxial and adaxial stereid groups, and 2–4 ± isolated and larger cells on the abaxial surface.

Pseudautoicous. **Perichaetial leaves** sheathing (up to c. ¼ the seta length) and strongly concave, abruptly tapered from an obovate or elliptic base to a long and slender subula. **Dwarf males** gemmiform, c. 0.5–0.6 mm long, usually embedded in rhizoids of a sterile or ♀ plant, occasionally epiphytic on vegetative leaves, with few (<3?) antheridia. **Setae** aggregated, 4–6(–9) per perichaetium, c. 18 mm, straight or weakly flexuose, scarcely twisted, pale brown; **capsules** exserted, strongly curved, cylindric, 3–3.5 mm, not or weakly strumose, smooth when moist, constricted below the mouth when dry; **exothecial cells** firm-walled and oblong-hexagonal; **stomata** restricted to neck, superficial; **annulus** a single row of weakly differentiated cells, not revoluble; **operculum** curved-rostrate from a conic base, 2–3 mm. **Peristome teeth** inserted at mouth, red-brown, split c. ½ to base into unequal segments, c. 450 × 80 µm, papillose-striolate nearly throughout. **Calyptra** cucullate, smooth. **Spores** ellipsoid to spherical, 18–21 µm, nearly smooth.

Illustrations: Plate 15. Dixon 1913, pl. 8, fig. 8 a–c; Brotherus 1924, fig. 166; Norris & Koponen 1990, fig. 12 a–d (as *Dicranum dicarpum*); Klazenga 2003, fig. 11.

Distribution: NI: N Auckland (Kaipara), S Auckland, Gisborne, Hawke's Bay (Ikawetea Stream, Whirinaki River Track, Ruahine Range near Sunrise Hut), Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St.

Australasian. Tasmania*, mainland Australia*, New Guinea*. Klazenga (2003, p. 93) also recorded this species from Taiwan and Vanuatu.

Habitat: Growing mostly on litter, humus or gravel on the forest floor, but also on rotting logs and occasionally on tree trunks. Growing in a variety of native forest types, but particularly well developed and abundant in drier *Fuscospora solandri s.l.* forests, where it can be a major component of the ground cover. It is an abundant species in the drier (and often heavily deer-grazed) mid elevations of Canterbury L.D. Also occurring under exotic species including sycamore (*Acer pseudoplatanus*) and *Pinus radiata*. In wetter forests it shows a marked tendency to grow on well-drained sites and is absent from steep, damp banks. It is most abundant east of the Main Divide on the South I. but can be well developed in drier sites west of the Divide. Commonly associated with other *Dicranoloma* spp. (especially *D. billardierei*, *D. fasciatum*, and *D. robustum*) and *Ptychomnion aciculare*. On the North I. ranging from 50 m (Butterfly Creek, Wellington L.D.) to at least 1160 m (near Dawson Falls, Taranaki L.D.) and from low elevation (Coutts I., Canterbury L.D. and Pelorus Bridge, Marlborough L.D.) to at least 900 m (Magnesite Quarry on Cobb Reservoir Road, Nelson L.D).

Notes: There is a marked tendency in this species for stems to grow horizontally (as stolons) and give rise to erect secondary stems, often with elongate masses of aggregated rhizoids at branching points. Fertilisation apparently occurs in late summer, and in early winter "spear" stage sporophytes scarcely exceeding the perichaetial leaves can often be observed.

Material of this species from A.C.T., Australia (*H. Streimann 5243*, CHR 349542) has been seen in which the rhizoids give rise to masses of linear to fusiform, 6–9-celled, transversely septate gemmae. These rhizoidal gemmae are similar to those illustrated by Klazenga (1999) for several species of Malesian *Dicranoloma*. No rhizoidal gemmae have been seen in N.Z. material.

The presence of a large group of short juxtacostal cells is suggestive of the pan-tropical genus *Leucoloma*. However, in that genus the laminal cells are usually papillose and the costae have a very different structure from that observed in this species.

Dixon (1913, p. 20) treated "*Dicranoloma leucolomoides*" as a recognised species in the N.Z. flora, while Sainsbury (1955a) included this name in synonymy of *D. robustum*. The Mossman collection from Kaipara Harbour selected as the lectotype of *Dicranum leucolomoides* Müll.Hal.by Klazenga (2003) is unquestionably referable to *Dicranoloma dicarpum*. However, duplicates of three of the other specimens cited by Dixon (1913) as *D. leucolomoides* are present in the Beckett herbarium at CHR and are referable to *D. robustum*. These specimens may have generated confusion surrounding the identity of *Dicranum leucolomoides.*

Dicranum dicarpum var. *spinosum* Hook.f. & Wilson was initially placed in the synonymy of Dicranoloma dicarpum by Dixon 1913, p. 14 and confirmed by Klazenga (2003). This synonymy is accepted here.

Brotherus (*in herb*.) applied the name *Dicranum polysetum* Hampe *nom. illeg.* to N.Z. material of *Dicranoloma dicarpum*. The Australian name *Dicranum polychaetum* Mitt. has not, to my knowledge, been applied to N.Z. material. These two names are not considered further here. Dixon (1913, p. 14) cited other Australian names (and their various combinations) in the synonymy of *D. dicarpum*; Klazenga (2003) verified these synonymies and typified them to the extent that he was able.

Recognition: In the field *D. dicarpum* is highly distinctive given its grey-green colour and strongly plicate leaves; the pale coloration is often lost in older herbarium material. The very slender upper leaf with narrow laminae and densely and sharply spinose-toothed margins and costal abaxial surface provide further distinction. Under the stereoscope the width of the leaf at the insertion (when still attached to the stem) is ≤1 mm, but this is often obscured by rhizoids. Under the compound microscope an obvious juxtacostal group of short, ± opaque, irregular, and scarcely porose cells usually begins c. 1–1.5 mm above the alar cells and extends far up the leaf. The juxtacostal group of short cells can be up to one half the width of the lamina at mid leaf, and can be seen under a hand-lens; it provides a reliable character differentiating this species from its N.Z. congeners.

Dicranoloma dicarpum is sometimes confused with *D. plurisetum*, which has a similar white- or grey-green coloration when fresh. *D. dicarpum* is a generally finer plant in appearance, with narrower leaves (c. 0.7–1.0 mm wide vs c. 1.5–1.8 mm at insertion) and more conspicuously spinose-toothed leaf margins. The upper portions of leaves in *D. dicarpum* are nearly filled by the costa and scarcely concave, whereas the upper portion of leaves in *D. plurisetum* are wider, more concave, and with laminae extending closer to the leaf apex. Although both species are plicate, the plicae of *D. dicarpum* are more distinct and usually extend further up the lamina. Under the microscope the distinctly shortened juxtacostal laminal cells in *D. dicarpum* entirely preclude confusion.

Etymology: The epithet *dicarpum*, coined by T.F.L. Nees von Esenbeck for this species, refers to the multiple sporophytes usually produced by it. Nees von Esenbeck (1787–1837) was a German botanist and pharmacologist best known for his taxonomy of medicinal plants.

Dicranoloma fasciatum (Hedw.) Paris, *Index Bryol., ed. 2, 2,* 26 (1904)

≡ *Dicranum fasciatum* Hedw., *Sp. Musc. Frond.* 127 (1801)
≡ *Leucoloma fasciatum* (Hedw.) Broth., *Nat. Pflanzenfam. [Engler & Prantl] 1(3),* 322 (1901)
Lectotype: Spec. Musc. Frond., Plate 28. (Designated by Klazenga 2003, p. 447.)

= *Dicnemon obsoletinerve* Hampe & Müll.Hal., *Linnaea* 26: 496 (1855)
≡ *Dicranoloma obsoletinerve* (Hampe & Müll.Hal.) Paris, *Index Bryol., ed. 2, 2,* 28 (1904)
Lectotype: N.Z., allegedly *F. Mueller*, BM-Hampe. (Designated by Klazenga 2003, p. 447.)
Not seen, but see discussion of potential type specimen below.

Plants medium-sized, white-green when fresh, becoming gold-brown in dried specimens, forming cushions. **Stems** 20–35 mm, much branched by forking and innovation, often bearing multiple terminal perichaetia, in cross-section with a weak and ill-defined central strand, and 3–5 layers of thick-walled cortical cells; densely matted throughout by short, tangled, smooth, and pale-brown or nearly white rhizoids. **Leaves** secund, curved but not falcate, variably plicate when fresh, not rugose, ovate-lanceolate, scarcely narrowed at insertion, sharply spinose-serrate in upper ⅓ or less, 4.0–5.5(–6.5) × 0.8–1.0 mm (under cover slip), subtubulose, plane at margins; **mid laminal cells** elongate, ± irregular, 80–120 × 7–10(–13) µm and 7–12:1, thick-walled and porose, with elongate cells extending to apex; **juxtacostal cells at mid leaf** not differentiated; **border** well defined and broad, pale, extending from just above the alar group to base of the serrations, 6–8 cells and c. 30–45(–75) µm wide at mid leaf; **cells of leaf base** slightly longer but otherwise as those of mid lamina; **alar cells** strongly and abruptly differentiated, unistratose, extending c. ½ to costal base and c. 6–8 cells up the margin, inflated and yellow, firm-walled, the largest c. 75 × 40 µm. **Costa** narrow, subpercurrent or percurrent, usually extending basipetally to the insertion and c. 60 µm and c. 1/20 or less the width of the leaf base, rarely vanishing in lowest ⅓ of leaf, the abaxial surface in upper c. ¼ bearing short spines in 2 ranks (scarcely visible under hand-lens), in mid leaf cross-section not winged, c. 5 cell-layers thick, with a median layer of 4–6 guide cells and one abaxial and one adaxial stereid group, which extend the width of the costa.

Pseudautoicous (or occasionally with male not dwarfed). **Perichaetial leaves** sheathing, strongly tubulose, and with costa extremely weak or lacking, the outer leaves abruptly narrowed from a tubulose base to long arista, the innermost leaves much longer, c. 12 mm, narrowly lanceolate and gradually tapered to a slender and toothed acumen, extending to or conspicuously exceeding the mouth of mature capsules. **Dwarf males** usually gemmiform, to c. 0.7 mm long, embedded in rhizoids of sterile or ♀ plants. **Setae** 1–3(–4) per perichaetium, 8–10 mm, straight, not twisted, pale brown; **capsules** emergent from one side of the perichaetium, curved, cylindric, 1.8–3.0 mm, weakly strumose, smooth when moist, constricted below the mouth and weakly sulcate when dry; **exothecial cells** firm-walled and ± oblong-hexagonal; **stomata** restricted to neck, superficial; **annulus** weakly differentiated, not revoluble; **operculum** curved-rostrate from a conic base (poorly illustrated here), ±

equal the length of the capsule. **Peristome teeth** inserted at mouth, red-brown, split ½– ⅗ to base into segments of unequal width, 475–580 × 90–115 µm, papillose-striolate in lower c. ⅔, baculate near apex. **Calyptra** cucullate, smooth. **Spores** spherical, 15–18 µm, smooth.

Illustrations: Plate 16. Beckett 1894, pl. 30A (as *Dicnemon obsoletinerve*); Klazenga 2003, fig. 15; Malcolm & Malcolm 2006, pp. 72, 272, 295, 306.

Distribution: NI: N Auckland, including offshore islands (GB, LB, RT), S Auckland; Gisborne (Manganuku Stream, Hikurangi, Lake Waikaremoana), Hawke's Bay (Pētane, Hutchinson Domain Scenic Reserve), Taranaki (Tāngarākau Gorge, Pūniho Track, Te Maire Scenic Reserve), Wellington (Ōhakune, Tangiwai, Tararua Range); SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland (Manapōuri, Bluff); St. The report from Auckland Is by Vitt (1979) is based on misidentifications of *D. robustum*.

Endemic or Australasian. Klazenga (2003) tentatively recorded this species from a small number of scattered localities in N.S.W., Vic., and King I. These records were based on non-fruiting material that he tentatively placed here. He considered this material to "belong to *D. fasciatum* because the leaf length is the same as in New Zealand specimens of *D. fasciatum*" but treated the determinations as "not definitive".

Habitat: On rotten logs, tree bases, exposed roots, and lower trunks (e.g., of *Fuscospora fusca, Griselinia littoralis*); less commonly on duff or soil. This species is often epiphytic on tree ferns and on rotting bases of dead asteliads. Occurring in a variety of forest types, including broadleaved-podocarp and *Leptospermum scoparium*-dominated forests, as well as southern beech forest. Commonly associated with *D. menziesii* (less often with other species of *Dicranoloma*), *Leucobryum javense*, *Rhizogonium distichum*, *Wijkia extenuata*, and the hepatics *Bazzania adnexa*, *Heteroscyphus coalitus*, and *Cuspidatula monodon*. Ranging from c. 3 m (Little Barrier I., North Auckland L.D.; J.E. Beever, pers. comm., Sept. 2017) to at least 720 m (Bells Junction, Wellington L.D.) on the North I. and its associated islands, and from near sea level (at several localities) to 960 m (Cobb Valley, Nelson L.D.) on the South I.

Notes: This is a relatively uncommon species, although it is particularly well documented from localities in N Auckland, S Auckland, and Banks Peninsula. Sterile material cannot always be determined with confidence. When fertile the elongate perichaetial leaves, which extend to or well beyond the capsule mouth, are its most distinctive feature. In the field the plants are a white-green colour, similar to that in *D. dicarpum*, but they turn gold-brown in dry material. *D. fasciatum* forms cushions rather than the extensive turves formed by many of its congeners. Only *D. menziesii* has perichaetial leaves of comparable length relative to the sporophytes. *Dicranoloma fasciatum* is a much paler plant than *D. menziesii*, and it also differs by having much shorter leaves and elongate upper laminal cells.

Material of *D. fasciatum* from Hari Hari (Westland L.D., *L. Visch 510*, CHR 267056) is unusual because it has non-dwarf male plants. The ♂ plants have stems to c. 8 mm (roughly half the height of the associated ♀ stems), vegetative leaves representative of the species, and numerous lateral and terminal perigonial branches of less than 1 mm length. Each gemmiform perigonium has yellow, ovate-lanceolate bracts to 1.8 mm, numerous antheridia, and filiform, 7–8-celled paraphyses. Similar ♂ plants, approximately ⅔ the height of associated ♀ plants, have been seen from Southland (*K.W. Allison 3484*, CHR 542638).

Populations in which the costae are weak or vanish completely in the lower portion of the leaf (*B. Wormald 27* from Tararua Range, Wellington L.D., CHR 524330) are comparatively rare, and this feature is given undue emphasis by Sainsbury (1955a, p. 135) in his description.

Hedwig (1801, p. 127) cited the type locality of *Dicranum fasciatum* as "Insulae maris pacifici", and this is presumed to be N.Z. It is unclear who might have collected it prior to 1801, although A. Menzies is a possibility. Correspondence in 2000 with the then curator of the Hedwigian herbarium at Geneva, Phillipe Clerc (pers. comm., 8 June 2000), failed to locate any potential type material. Klazenga (2003, p. 447) also failed to locate type material and lectotypified *Dicranum fasciatum* Hedw. using *Spec. Musc. Frond.* Plate 28. Hedwig's illustration is a convincing rendition of the N.Z. plant, which was termed *Dicranoloma fasciatum* (Hedw.) Paris by both Dixon (1913, p. 26) and Sainsbury (1955a). There is no evidence that Dixon examined Hedwig's type of *Dicranum fasciatum*.

Dixon's (1913, p. 26) judgement that *Dicnemon obsoletinerve* Hampe & Müll.Hal. is synonymous with *Dicranum fasciatum* Hedw. was accepted by Klazenga (2003) and is accepted here. Klazenga expressed doubt concerning the collector, and by implication the collection site, of the material he selected as the lectotype. Material from Kaipara, N Auckland L.D. (*S. Mossman 712*, NY-Mitten) in 1850 and apparently determined by C. Müller as *Dicranum fasciatum*, has been examined; given its collection locality and date it could be part of the original collection apparently sent to F. Mueller (see

Klazenga 2003, p. 447). It is noteworthy that C. Müller described other species of *Dicranoloma* (e.g., *Dicranum brachypelma*) from Mossman collections.

Other collections of *Dicnemon obsoletinerve* Hampe cited by Dixon were most probably collected by T.W.N Beckett at either Fishers Bush, near Oxford, Canterbury L.D., in March 1884 (CHR 542796) or at Studholme Bush, near Waimate, Canterbury L.D., in September 1888 (CHR 543117). Both these collections are represented in the Beckett herbarium, and portions of both were identified by C. Müller as *Dicnemon obsoletinerve*.

Recognition: The leaf plications in *D. fasciatum* are mostly weak but variable. They are most distinct in dry material and in some collections are suggestive of the weak plications that occur in *D. plurisetum*, the species with which it is most likely to be confused. The very strong leaf border (limbidium) of *D. fasciatum* is comparable in width to that in *D. plurisetum*. However, *D. fasciatum* differs from *D. plurisetum* by shorter (4–6.5 vs. 8–10 mm) vegetative leaves and by emergent rather than exserted capsules. *Dicranoloma fasciatum* also differs markedly from *D. plurisetum* by the shape of its perichaetial leaves.

Etymology: The epithet *fasciatum* probably refers to the clusters (or fascicles) of capsules arising from a single perichaetium.

Dicranoloma menziesii (Taylor) Renauld, *Rev. Bryol.* 28: 69 (1901)

≡ *Dicranum menziesii* Taylor, *Phytologist* 1: 1093 (1844)
≡ *Leucoloma menziesii* (Taylor) Broth., *Nat. Pflanzenfam. [Engler & Prantl] 1(3),* 322 (1901)
Holotype: Norfolk Island, *A. Cunningham s.n.*, BM. (Cited by Klazenga 2003). Not seen.

= *Dicranum menziesii* Hook.f. & Wilson, *London J. Bot.* 3: 541 (1844) nom. illeg.
≡ *Dicranoloma menziesii* (Hook.f. & Wilson) Paris, *Index Bryol., ed. 2, 2,* 28 (1904) nom. illeg.
Type material: N.Z., Auckland Islands, *J.D. Hooker 69*, Antarctic Expedition 1839–1843, Herb. Mitten, NY 267976!, BM!

= *Dicranum brachypelma* Müll.Hal., *Bot. Zeitung (Berlin)* 9: 550 (1851)
Type material (presumed isotype): N.Z., Wairoa R., Kaipara, 1850, *S. Mossman 714*, NY-Mitten 267997! (Lectotype in NY designated by Klazenga 2003. Not seen.)

= *Dicranum menziesii* var. *rigidum* Hook.f. & Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II,* 67 (1854)
≡ *Dicranoloma menziesii* var. *rigidum* (Hook.f. & Wilson) Paris, *Index Bryol., ed. 2, 2,* 28 (1904)
Probable types: N.Z., Dusky Bay, *A. Menzies*, BM 000671644! NY-Mitten!

= *Dicranum trichophyllum* Hampe, *Linnaea* 37: 515 (1872)
Type: N.Z., Chatham Islands, [sent by] *F. Mueller*. Not seen.

= *Dicranum fulvum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 462 (1897) nom. illeg.
Type: N.Z., West Oxford, *R. Brown*, 1885 (Not seen by either Dixon 1913 or Klazenga 2003.)

= *Dicranodontium australe* Dixon, *Bull. New Zealand Inst.* 3: 92 (1923)
Lectotype: N.Z., Great Barrier Island, *Hutton & Kirk 63*, NY. (Designated by Klazenga 2003.) Not seen. Probable isolectotype: T. Kirk, Nov. 1864, CHR 542644!

Plants robust, dark green or yellow-green and dull when fresh, becoming gold-brown in older dried specimens, forming loose cushions or extensive turves. **Stems** (10–)35–50 mm, branching by subperichaetial innovation and by forking, in cross-section with a weak and ill-defined central strand and several ill-defined layers of cortical cells; matted throughout by short, tangled, smooth, and pale brown to nearly white rhizoids. **Leaves** mostly weakly secund, sometimes rigid and erect, occasionally falcate, neither plicate nor rugose, linear-lanceolate from a short ± oblong base, to a long-setaceous apex, which is ± filled by the costa and often fragile, sparsely and weakly serrate in upper ½ or less, 9–11(–14 or greater) × 0.7–0.9(–1.2) mm (under cover slip), subtubulose below, carinate above, plane at margins; **mid laminal cells** isodiametric, short-rectangular or short-oblong, mostly 8–12 × 6–8 µm and 1:1–2, thick-walled, not porose; **juxtacostal cells at mid leaf** often bistratose but not otherwise differentiated; **border** ill-defined, consisting of 1–3 weakly differentiated rows of ± elongate cells or sometimes lacking; **cells of leaf base** mostly elongate (30–55 µm) but sometimes shorter, usually porose; **alar cells** strongly and abruptly differentiated, unistratose, extending to costal base and c. 6–12 cells up the margin, inflated but firm-walled, mostly rectangular, yellow-brown or hyaline. **Costa** broad, filling c. ⅕–⅓ the widest part of leaf base, the abaxial surface with cell ends weakly projecting (to c. mid leaf), the resultant weak spines not visible under the hand-lens, in cross-section lacking wings at upper end of leaf base, c. 8–10 cell layers thick, with a median layer (–2 layers) of c. 10–12 guide cells, well-developed abaxial and adaxial stereid groups, which extend the width of the costa, and a single layer of slightly larger-lumened cells on both surfaces (sometimes with 1–3 isolated larger cells amongst the abaxial stereid group).

Pseudautoicous (♂ plants occasionally not dwarfed). **Perichaetial leaves** sheathing and strongly concave, abruptly tapered from an elliptic base to an obtuse or rounded apex, with costa present in base and excurrent to form a long and slender arista that is usually 1–2 times the length of the base (the outer ♀ leaves often with aristae up to 4 times the base length). **Dwarf ♂ plants** embedded in rhizoids of sterile or ♀ plants; non-dwarf males occasionally seen. **Setae** 1 per perichaetium, 4.5–6(–10) mm, straight, not twisted; **capsules** strongly curved, ± cylindric, 2–2.5 mm, not or weakly strumose, ± smooth when moist, constricted below the mouth and sulcate when dry; **exothecial cells** firm-walled and oblong-hexagonal; **stomata** restricted to neck, superficial; **annulus** not seen; **operculum** curved-rostrate from a conic base, ± equal to the capsule. **Peristome teeth** inserted at mouth, red-brown, split c. ½ to base into segments of unequal width, c. 465–525 × 100 µm, longitudinally striolate in lower ½ or more, baculate near apex. **Calyptra** cucullate, smooth. **Spores** spherical, 15–18 µm, nearly smooth.

Illustrations: Plate 17. Wilson & Hooker 1845, pl. 58, IV (as *Dicranum menziesii*); Klazenga 2003, fig. 19; Meagher & Fuhrer 2003, p. 143.

Distribution: NI: N Auckland, including offshore islands (PK, HC, LB, GB), S Auckland, Gisborne, Hawke's Bay (Puketītiri), Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St; Ch; Sol; Sn; A; C.

Austral. Tasmania*, mainland Australia*. Recorded from Lord Howe I., southern South America, and New Caledonia by Klazenga (2003).

Habitat: Exposed roots, tree trunks, stumps and logs, rock, occasionally on soil or duff (but not forming extensive turves on duff). Occurring on trunks of a wide variety of coniferous and broad-leaved trees, shrubs, and tree ferns in virtually all kinds of forest types from near sea level to the subalpine. As an epiphyte forming cushions up to at least 40 cm diameter. From near sea level (Tī Point, N Auckland L.D.) to at least 1160 m (Mt Pihanga near Turangi, Wellington L.D.) on the North I. and from near sea level (several localities) to at least 1210 m (Waterfall Creek near Maruia Springs, Nelson L.D.) on the South I.

Dicranoloma menziesii is exceedingly widespread and is common in most forest types; it is highly variable, particularly with respect to the length and orientation of its leaves, the relative fragility of the leaves, and the coloration of fresh plants. The most consistently useful field recognition feature is the short sporophyte, which is exceeded in length by both the vegetative and outer perichaetial leaves. The inner perichaetial leaves are much shorter and sheathe the setae to variable heights. The very narrow leaves with broad and thick costae and fine setaceous apices are generally sufficient to distinguish it from its congeners, with the exception of the "setosum" growth form of *D. robustum*. *D. menziesii* is the only N.Z. species of its genus with ± isodiametric mid to upper laminal cells.

Notes: Non-dwarf male plants, equal in stature to associated female plants, occur in this species (e.g., *D. Petrie s.n.,* 20 Nov. 1896 from Waingaro, S Auckland L.D., CHR 543118). The perigonia here are terminal on stems and branches, have bracts much reduced relative to the vegetative leaves, and enclose numerous filiform paraphyses. Ramsay (1985), in an investigation of the cytological and physiological factors involved in sexual differentiation in *Dicranoloma*, also reported non-dwarf male plants in this species.

No type material of *Dicranum menziesii* Taylor from Norfolk I. has been seen. Taylor's publication of this name precedes the previously accepted name *D. menziesii* Hook.f. & Wilson by one month according to Klazenga (2003), whose dates and consequent nomenclature are accepted here. The two isotypes of *Dicranum menziesii* Hook.f. & Wilson seen are both sterile and consist of single stems with leaves very weakly secund and 7–10 mm.

Two probable isotypes of *Dicranum menziesii* var. *rigidum* have been examined. One is filed as *Dicranum fasciatum* in NY-Mitten and is labelled "Dusky Bay, New Zealand, *leg. & comm. A. Menzies*" in what is apparently Menzies's script. That in BM is filed under *Dicranoloma menziesii*, lacks varietal designation, bears a "type" stamp, and is labelled simply "New Zealand, *Menzies*". Both these specimens have sporophytes and very fine, non-fragile, and slightly secund leaves of 8–9 mm.

Some synonyms of *Dicranoloma menziesii* are included in this treatment based on work of earlier authors. *Dicranum trichophyllum* Hampe and *Dicranum fulvum* R.Br.bis, *hom. illeg.* were synonymised by Dixon (1913)and subsequently confirmed, in one case tentatively, by Klazenga (2003); they are accepted here.

Dicranodontium australe Dixon [Bull. New Zealand Inst. 3(3): 92, 1923] was initially synonymised with *Dicranoloma menziesii* by Sainsbury (1946). Klazenga (2003) proposed a lectotype from Great Barrier

I. A probable isolectotype (CHR 542644!) has been studied and Sainsbury's synonymy is affirmed here on this basis.

Dicranum calymperoideum Müll.Hal. [Hedwigia 36: 359, 1897] was proposed as a synonym by Robinson (1975, p. 22). It is based on a Beccari collection from the Titirangi Range near Auckland and was not confirmed by Klazenga (2003). It is excluded from the list of synonyms here.

Populations in which the leaves are rigidly erect and sometimes fragile have been termed var. *rigidum*. In some populations the erect leaves can exceed the length cited in the description, reaching c. 22 mm. Due to the very high number of morphological intermediates between rigid-leaved populations and those with loosely secund leaves, the var. *rigidum* is considered here to be a growth form of *D. menziesii*; this accords with the taxonomy of Klazenga (2003).

Dicranoloma menziesii occasionally forms detached "moss balls". J.S. Thomson (*in litt.* to L.B. Moore, 18 June 1941, filed with CHR 263240) described seeing "some 50 specimens" from Stewart I. Most of the unattached "moss balls" occurred in a "more or less open space about 12 ft. in diameter on the floor of [forest]… at the head of Paterson's Inlet. The largest specimen observed measured about 8" in diam., but the majority were about 4", 5", or 6" in diameter." Similar "moss balls" of *D. menziesii* have been found in the Kakeahua Valley on the same island by R. Buckingham (cf. CHR 242724). R. Buckingham suggested (pers. comm.) that they may be caused by "disturbance associated with feeding or display activities of birds".

Recognition: *Dicranoloma menziesii*, in particular the "rigidum" growth form, is likely confused with the "setosum" growth form of *D. robustum*. However, in all instances the consistently shortly rectangular (<2:1) or quadrate subula cells of *D. menziesii* differentiate it from *D. robustum* "setosum" growth form, in which the laminal cells in the mid portion of the subula are seldom less than 30 µm long, nor less than 4-5:1. The non-porose nature of the mid laminal cells in *D. menziesii* also contrasts with the porose cells in the *D. robustum* "setosum" growth form. The difference in laminal cell shape can generally be seen under the stereoscope, but microscopic examination can be necessary for certain identification.

Etymology: The epithet *menziesii* honours the Scottish naval surgeon and botanist Archibald Menzies (1754–1842), who accompanied Vancouver on his 4 ½-year circumnavigation of the world. The Vancouver expedition visited Dusky Sound in Fiordland in late 1791. Although Taylor's (1844) protologue clearly stated the type collection to have been made by Allan Cunningham in Norfolk I., he also stated that he "received the same from Mr Menzies from New Zealand, and named it after him, in 1814".

Dicranoloma obesifolium (R.Br.bis) Broth., *Nat. Pflanzenfam., ed. 2 [Engler & Prantl] 10,* 209 (1924)

≡ *Dicranum obesifolium* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 462 (1897)
≡ *Braunfelsia obesifolia* (R.Br.bis) Dixon, *Bull. New Zealand Inst.* 3: 79 (1923)
Lectotype: N.Z., Westland, Kelly's Hill, *R. Brown*, BM-Dixon! (Designated by Klazenga 2003.) There is apparently no type material of this name in N.Z. herbaria.

= *Eucamptodon petriei* Broth., *Öfvers. Finska Vetensk.-Soc. Förh.* 40: 161 (1898)
≡ *Braunfelsia petriei* (Broth.) Broth., *Nat. Pflanzenfam. [Engler & Prantl] 1(3),* 321 (1901)
Isotypes: N.Z., Westland, Taramakau Valley, *D. Petrie s.n.*, BM!, CHR 567564! (Holotype in H cited by Klazenga 2003; Image seen online, JSTOR Global Plants, accessed 27 Sep. 2017.)

Plants robust, pale yellow-green and dull or rarely black when fresh, becoming gold-brown in older dried specimens, forming cushions or loose turves. **Stems** 30–120 mm, usually branched by forking, sometimes growing horizontally and functioning as stolons, in cross-section with 2–3 layers of cortical cells, rather firm-walled medullary cells, and a weak and ill-defined central strand, sparsely matted throughout by short, tangled, smooth, and pale brown or nearly white rhizoids, or sometimes rhizoids appearing absent. **Shoots** c. 12 mm wide (when leaves are wide-spreading) or narrower, 3–7 mm wide (when leaves are erect-appressed) when moist, variably cuspidate (sometimes strongly and sharply so). **Leaves** mostly widely spreading, occasionally closely erect-appressed, not secund, neither plicate nor rugose, little altered when dry, ovate, rounded or broadly acute at apex, clasping and ± auriculate at insertion, entire, (4.0–)6–8 × 1–5–3 mm (under cover slip), tubulose; **mid laminal cells** elongate and irregular, mostly (50–)90–120 × c. 12–15 µm and 5–8:1, thick-walled and highly porose, with highly irregular cells at extreme apex; **juxtacostal cells at mid leaf** not differentiated; **border** narrow but well defined, extending from alar cells nearly to apex, c. 3–4 cells and 12 µm wide at mid leaf; **cells of leaf base** scarcely differentiated except for 3–4 rows of pigmented cells at insertion; **alar cells** abruptly differentiated, auriculate, extending c. ⅔ or more to costal base and c. 8–10 cells up the margin, mostly oblong, subquadrate, or somewhat irregular, unistratose, weakly inflated, brown, yellow, or hyaline, thin- or firm-walled, not collenchymatous, the largest c. 50–60 × 35 μm, often with some cells at the upper limit of the alar group very strongly porose and with a primordial utricle). **Costa** narrow and weak (variable in a single shoot and sometimes appearing absent), occupying c. 1/40 to 1/15 the widest part of leaf, ending far below the apex or percurrent, smooth abaxially, in mid leaf cross-section completely lacking wings, 3–5 cell layers thick and c. 60–75 μm wide, with 4–6 guide cells in 1(–2) layers, and c. 8–12 abaxial and c. 5 adaxial stereids each in ± single layers.

Pseudautoicous. **Perichaetial leaves** sheathing (c. ⅓ the seta length) and strongly concave, elliptic, broadly rounded or truncate at apex, with costa extremely weak and not forming an arista. **Dwarf males** embedded in rhizoids of sterile or ♀ plants. **Setae** single, c. 22–27 mm, straight, not twisted, red-brown; **capsules** curved, cylindric, 3.0–3.5 mm, strumose, smooth when moist, non-sulcate and constricted below the mouth when dry; **exothecial cells** firm-walled and elongate, variable in shape. **Peristome teeth** c. 640–700 × 120 μm, papillose-striolate in lower ½–⅔, baculate near apex. **Spores** 18–21 μm.

Illustrations: Plate 18. Klazenga 2003, fig. 21.

Distribution: NI: Hawke's Bay or Wellington (Ruahine Ranges); SI: Nelson (Little Wanganui River, Cobb Valley, Mt Arthur Range, Lake Peel, Mt Mantell), Canterbury (Lewis Pass, Arthur's Pass, Godley River, Little Mt Peel), Westland (Northern Olivine Range, Ōtira Valley, Kelly Range, Rahu Saddle), Otago (Mt Shrimpton), Southland (Nancy Sound, Gertrude Valley, Cozette Burn, Mt Burns, Takahē Valley, Tākitimu Range, Eyre Mountains).

Probably endemic.

Habitat: Apart from a single poorly documented collection from the Ruahine Ranges by A.P. Druce (WELT M014859), this species is restricted to areas west of or close to the Main Divide on the South I. Occurring most commonly in alpine *Chionochloa* grassland (often *C. rubra* or *C. pallens* dominated) or shrubland, and often in sheltered, damp depressions beneath tussocks or shrubs or at the base of rock outcrops. Also occurring at the margins of boggy tarns or lakes, and there often in association with *Schoenus pauciflorus*, and occasionally submerged. On the Mt Arthur Range, *D. obesifolium* occurs on the sides of limestone dolines and it also occurs in *Lophozonia menziesii* dominated southern beech forest developed over marble bedrock. *Dicranoloma obesifolium* is (with *D. robustum*) one of only two species in the genus that commonly occurs above the tree line. *Breutelia elongata*, *D. robustum*, *Racomitrium crispulum s.l.*, *R. pruinosum*, *Rhacocarpus purpurascens* and *Sphagnum* are often associated. Ranging from 885 m (Little Wanganui River) to 1650 m (Temple Basin in Arthur's Pass) elevation.

Notes: The presumed holotype (BM) consists of a single, branched, and sterile stem.

The spreading and apically rounded leaves together with the dull yellow-green fresh coloration of representative material of this species make it unlikely to be confused with any of its congeners. There is a tendency in *D. obesifolium* for stems to grow horizontally (as stolons) and give rise to erect secondary stems. *Dicranoloma obesifolium* is the only N.Z. species of the genus in which the dry mature capsules are not plicate. The struma at the capsule base is more pronounced here than in any of its N.Z. congeners. A small number of short, broadly ovate and strongly spreading leaves are normally present at the base of the perichaetium.

However, *D. obesifolium* is a variable species, and one Southland collection (*J.K. Bartlett 23190*; CHR 447752 & WELT M007491from Percy Saddle) has been referred by both Bartlett & Frahm (1983) and Klazenga (2003) to the Tasmanian *D. eucamptodontoides*. This collection, in addition to *D. Glenny 5133* (CHR 454197 & WELT M029309) from Symmetry Peaks in the Eyre Mountains (Southland L.D.) and *A.J. Fife 10057* (CHR 532469) from the Kelly Range (Westland L.D), is problematic. All these collections compare well to Tasmanian material of *D. eucamptodontoides* housed at WELT. Type material of *D. eucamptodontoides* (Broth. & Geh.) Paris [Index Bryol. ed., 2, 2: 26 (1904)] has also been seen in NY (267975!).

One feature separating the two species, according to Klazenga (2003), is the relative length of the costae. Klazenga considered that the costae end far below the leaf apex in *D. obesifolium* but are percurrent in *D. eucamptodontoides*. However, numerous N.Z. collections of *D. obesifolium* have percurrent costae in some or most of their leaves (e.g., CHR 428940, *J. Child 4383* from Gertude Saddle). Klazenga also considered the alar cells of *D. eucamptodontoides* to be uniquely collenchymatous. However, the interpretation of the alar cells here is problematic, and my interpretation of both *J.K. Bartlett 23190* and *D. Glenny 5133* is that the cells at the upper limit of the alar group are very strongly porose and some have their contents strongly pulled away from the cell walls when dry (thus exhibiting a “primordial utricle”). I would not interpret the N.Z. material to have collenchymatous alar cells; in this regard, this material matches the two Tasmanian collections studied.

The black coloration and the distinctly cuspidate shoot apices of the Southland and the Kelly Range material are striking features which contrast with the distinctive pale yellow-green and dull (when fresh) and gold-brown (when dry) and weakly or non-cuspidate shoots of more representative *D. obesifolium*. In both these features the Southland and the Kelly Range material agree with Tasmanian *D. eucamptodontoides*. The marginal border of the Southland and the Kelly Range material is much less conspicuous above mid leaf, and the alar groups appear to be less auriculate than in most *D. obesifolium*.

On balance it seems better to apply the name *D. obesifolium* (R.Br.bis) Broth. to these aberrant collections and to exclude *D. eucamptodontoides* from the N.Z. flora. If *D. obesifolium* and *D. eucamptodontoides* are eventually proven to be conspecific, the Tasmanian name would have nomenclatural priority.

Recognition: Apart from its problematic Tasmanian congener, *D. obesifolium* is most often confused with *Pulchrinodus inflatus*. The two species differ in numerous gametophytic features, of which the more readily observed are the non-rugose, singly costate, and apically rounded nature of the vegetative leaves in *D. obesifolium*. In *P. inflatus* the vegetative leaves are strongly rugose, ecostate or inconspicuously doubly costate, and have a small, reflexed acumen. Also, *D. obesifolium* is a high-elevation plant which frequently fruits, while *P. inflatus* occurs at lower elevations and has not been found bearing sporophytes.

Etymology: The species epithet *obesifolium* refers to the broad and tubulose leaves.

Dicranoloma platycaulon Dixon, *Bull. New Zealand Inst.* 3: 15 (1913)

Isolectotype: N.Z., Mt. Cargill, *W. Bell s.n.*, CHR 543119! Lectotype at BM designated by Tan 1989. Paratypes: N.Z., Taranaki, *Jupp*, NY 267995!; Westland, *A.R. Bloxham*, 1872, NY 267996!

Plants robust, white-green when fresh, becoming gold-brown in older dried specimens, forming cushions or turves. **Stems** c. 35–75 mm, mostly sparsely forked, in cross-section with several layers of poorly differentiated but firm-walled cortical cells and a weak central strand, beset throughout by short, tangled, smooth, pale brown rhizoids. **Leaves** secund, weakly or strongly falcate, rugose, not plicate, becoming flatter and appearing wider but otherwise little altered when dry, ovate-lanceolate and ± narrowed to a clasping base, toothed (but not spinose) in upper ⅓ or less, mostly 8–9(–11) × 1.4–1.5 mm (under cover slip), subtubulose, plane at margins; **mid laminal cells** highly irregular in shape (a mixture of oblong, rhombic, triangular, oval, and irregular) and arrangement, mostly <c. 30 µm long and c. 12 µm wide, thick-walled and moderately porose, with short and irregular cells extending to apex; **juxtacostal cells at mid leaf** not differentiated; **border** well defined and extending from just above alar group to base of teeth, c. 8 cells and 36–42(–60) µm wide at mid leaf, gradually narrowing above; **cells of leaf base** elongate, mostly 45–90 µm, extremely porose; **alar cells** strongly and abruptly differentiated, unistratose, extending c. ¾ or more to costal base and c. 10 cells up the margin, inflated and yellow, firm-walled, the largest c. 90 × 40 µm. **Costa** narrow, occupying c. 1/15 of widest part of leaf base and c. 100 µm wide, mostly excurrent, the abaxial surface in upper ¼ or less bearing 2 rows of weak spines (not obvious under hand-lens), in cross-section lacking wings at mid leaf, with a median layer of c. 6 guide cells and one abaxial and one adaxial stereid group, which extend the width of the costa.

Pseudautoicous. **Perichaetial leaves** strongly sheathing (c. ½ the seta length) and tubulose, elliptic, rapidly tapered to a rounded apex, with the costa narrow and long-excurrent to form a slender arista c. ⅓ to ½ the length of the base. **Dwarf males** gemmiform, embedded in rhizoids of sterile or ♀ plants. **Setae** aggregated, (1–)2–4 per perichaetium, 10–11 mm, straight, not twisted, pale or red-brown; **capsules** exserted, curved, cylindric, 2.9–3.4 mm, weakly strumose, smooth when moist, constricted below the mouth and weakly sulcate when dry; **exothecial cells** firm-walled and oblong-hexagonal; **stomata** restricted to neck, superficial; **annulus** weakly differentiated, not revoluble; **operculum** curved-rostrate from a conic base, ± equal to the capsule. **Peristome teeth** inserted at mouth, red-brown, split c. ½ to base into segments of unequal width (often with 1–2 elongate perforations at the base of the division), c. 525–640 × 100 µm, papillose-striolate in lower ½ to ⅔, baculate near apex. **Calyptra** cucullate, smooth. **Spores** spherical, firm-walled, 18–22 µm, nearly smooth.

Illustrations: Plate 19. Dixon 1913, pl. 2, figs. 10a–d; Tan 1989, figs. 15–18; Malcolm & Malcolm 2006, pp. 103, 107, 158, 162, 171, 244, 247.

Distribution: NI: N Auckland (Tūtāmoe Range), S Auckland (Moehau, Pirongia), Gisborne (Mt Maungapōhatu, Lake Waikaremoana, Manuoha Ridge), Taranaki (Mt Taranaki), Wellington; SI: Nelson, Marlborough (Kenepuru Valley), Canterbury (Arthur's Pass), Westland, Otago, Southland; St.

Australasian. Tasmania*, mainland Australia (Victoria*). Reported from Borneo and New Guinea by Tan (1989), but these reports are doubted by Klazenga (1999, pp. 57 & 122, and, by omission, Klazenga 2003). However, as suggested by Tan, the occurrence of a predominantly Australasian species at high elevations in Malesia seems phytogeographically plausible.

Habitat: On duff or rock (granite or greywacke) on forest floor and on tree roots and bases. Usually forming cushions (to c. 30 cm diam.) on soil or rock hummocks, but also forming relatively small turves. Occurring mostly in forest with one or more species of southern beech. Also occurring as an epiphyte on trunks of *Fuscospora solandri s.l.*, *Lophozonia menziesii*, *Weinmannia racemosa*, and the tree fern *Dicksonia squarrosa*. On the North I. no low elevation occurrences have been documented but ranging to 1220 m (Manuoha Ridge) and on the South I. from near sea level (Punakāiki River and Lake Moeraki, both Westland L.D.) to 1350 m (Glasgow Range, Nelson L.D.). Occurrences below c. 500 m elevation are primarily epiphytic. Frequently associated with *Dicranoloma plurisetum*, *D. robustum*, *Leptotheca gaudichaudii*, as well as *Bazzania adnexa*, and *Lepidozia* spp.

Notes: In the field the pale coloration and the distinctly rugose aspect of the leaves are distinctive. Microscopically, the laminal cells, from c. mid leaf to the apex, are highly irregular in form, and the orientation of one cell usually bears little relationship to that of adjacent cells. The resultant confused jumble of cells gives the lamina a highly distinctive microscopic appearance unlike any other N.Z. *Dicranoloma*. The distance to which the randomly oriented and highly irregular cells extend towards the leaf base varies considerably between populations. In the type, the highly irregular cells of the upper lamina extend downward to mid leaf or lower. In much material the laminal cells are in alternate, vaguely defined transverse bands of randomly oriented irregular cells and more uniformly oriented and more uniformly shaped cells. The cell bands appear to be related to the characteristic leaf undulations. The leaves in this species become less concave (and hence appear broader) at the base when dry.

Epiphytic forms from lower elevations in Nelson L.D. (e.g., *A.J. Fife 6041* from Punakāiki River, CHR 405710) have larger (c. 11 mm × ≥2.0 mm wide) and more setaceous leaves, with cells in mid lamina and above longer (mostly 27–42 µm) and more porose than in type material. The upper leaves are ± more sharply toothed than in terrestrial populations, and the leaves are often brittle and fragile. However, in these forms the leaves are strongly undulate and have bands of highly irregular laminal cells interspersed in the upper half or more of the leaf. Such large-leaved epiphytic forms are best referred to *D. platycaulon* and can be considered analogous to the so-called "setosum" growth form of *D. robustum*.

Considerable confusion surrounds the publication and typification of the name *D. platycaulon*. The epithet *platycaulon* was first applied, *in herb*., by Müller Hal. to *R. Helms 71* from Westland. Beckett (1899) published "*Dicranum platycaulon*" but his "protologue" combined Müller's name with a diagnosis written by Brotherus using another specimen (*T.W.N. Beckett 494* from Patterson's Creek, Canterbury L.D., CHR 585951). Wijk et al. (1962, p. 91) interpreted "*Dicranum platycaulon* Müll.Hal. *in* Beckett" as a *nom. nud*.; their interpretation is accepted here. A portion of *R. Helms 71* is present in the Beckett herbarium (CHR 585951), and it is clearly referable to *D. plurisetum* Dixon. Two of the other six syntypes (*leg*. Jupp, Bloxam) cited by Dixon are correctly referable to *D. platycaulon*.

Dixon (1913, p. 15) provided the first valid publication of *D. platycaulon*. Dixon's reference to Müller's *nom. nud.* as a basionym is both superfluous and confusing. *Dicranoloma platycaulon* should be attributed to Dixon alone, as done by both Wijk et al. (1962, p. 47) and Klazenga (2003). However, Dixon's designation of a type is confusing. He cited a "type *in herb.* C. Müll., in Mus. Bot. Berolin." but in a footnote stated that he had not seen "the Greymouth specimen" (a reference to *R. Helms 71*) and that his "description and figures are drawn up from Bell's Mount Cargill plant, sent me by Dr Brotherus." W. Bell routinely sent his Otago moss collections to Beckett, who then forwarded them to other bryologists, including Müller and Brotherus. Tan's (1989) designation of the Mt Cargill material as the lectotype is accepted here. His illustration of the Bell collection leaves no doubt as to the taxonomic identity of the material he examined, and the lectotypification preserves current usage.

An apparent isolectotype is CHR 543119, as *herb. Beckett 640*. Although the specimen is labelled in Beckett's hand as collected by D. Petrie, it also bears a handwritten citation "Mt. Cargill" in W. Bell's hand, suggesting that Bell was probably the actual collector. The specimen is ample and fruiting.

Recognition: *Dicranoloma platycaulon* is a relatively uncommonly collected species. It is most often confused with *D. plurisetum*, which has a similar pale white-green colour when fresh. The leaf undulations, the decidedly less strongly toothed upper margins, and the irregularly shaped and oriented upper laminal cells in the present species are sufficient to preclude confusion. The relative flatness of the leaf base in dry material of *D. platycaulon* also aids in its separation from *D. plurisetum*. According to J.E. Beever (pers. comm., 1 Aug. 2017) *D. platycaulon* has red, immature setae, while those of *D. plurisetum* are green or yellow.

Etymology: The derivation of the species epithet *platycaulon*, meaning “flat-stemmed”, is hinted at by Müller’s (1901, p. 290) statement in *Genera Muscorum Frondosorum*: “Alle diese neuen Arten, von denen das Letztere [*D. platycaulon*] nach Höhe und Breite seiner Stengel ein wahrer Riese Aller ist, kamen mir fast in einer einziger Sendung von R. Helms in Greymouth auf der Süd-Insel zu”. Müller’s statement translates as “All these new species, the last of which [*D. platycaulon*], according to the height and breadth of its stems, is a true giant, came to me as the result of almost a single shipment from R. Helms in Greymouth on the South Island”.

Dicranoloma plurisetum Dixon, *Bull. New Zealand Inst.* 3: 22 (1913)

≡ *Dicranum plurisetum* (Dixon) Fife, *Bryologist* 98: 315 (1995)

> Lectotype: N.Z., Southland, Lake Te Anau, *D. Petrie s.n.*, BM (Designated by Klazenga 2003, not seen) Isolectotype: CHR 642116! Other paratypes cited in Dixon’s protologue are represented at CHR.

Plants robust, pale yellow-green or white-green and dull when fresh, becoming gold-brown in older dried specimens, forming cushions or turves. **Stems** (30–)50–75(–95) mm, usually branched by forking, in cross-section with 2–3 layers of thick-walled cortical cells and an ill-defined central strand, rather sparsely matted throughout by pale brown or nearly white rhizoids. **Leaves** usually falcate-secund, not or weakly plicate when fresh, becoming moderately plicate to mid leaf when dry, not or rarely weakly rugose, ovate-lanceolate and ± narrowed to a clasping insertion, sharply spinose-serrate in upper ⅓ or less, 8–9(–10) × (1.3–)1.4–1.5 mm (under cover slip), subtubulose, plane at margins; **mid laminal cells** elongate and irregular, (45–)60–105(–120) × 8–10(–15) µm and 5–12:1, thick-walled and highly porose, with elongate cells extending ± to apex; **juxtacostal cells at mid leaf** not differentiated; **border** well defined and extending from just above the alar group to serrations (usually c. ¾ leaf length), 6–8 cells and c. 20–35(–60) µm wide at mid leaf; **cells of leaf base** becoming longer (–150 or occasionally 180 µm) but otherwise as those of mid lamina; **alar cells** abruptly differentiated, unistratose, extending c. ½ to costal base and c. (6–)8–10 cells up the margin, inflated, yellow or brown, firm-walled, the largest c. 70 × 35 µm. **Costa** narrow, occupying c. 1/20 of widest part of leaf base, the abaxial surface in upper ⅓–½ bearing rows of short spines (obvious under hand lens), in cross-section (at mid leaf) lacking wings, with a median layer of c. 6–8 guide cells and abaxial and adaxial stereid groups which extend the width of the costa (or sometimes with 1–3 isolated larger cells among abaxial stereid group).

Pseudautoicous. Perichaetial leaves sheathing (to c. ⅓ the seta length) and strongly concave, abruptly tapered from an obovate or elliptic base to an obtuse or rounded apex, with costa extremely weak and often vanishing in leaf base, long excurrent to form a long and slender arista that is usually c. ⅕ the length of the leaf base. **Dwarf males** gemmiform, c. 0.35 mm long, embedded in rhizoids of sterile or ♀ plants. **Setae** aggregated, 1–6(–9) per perichaetium, 8–15 mm, straight, not twisted, pale brown; **capsules** exserted, curved, cylindric, 2.5–2.8 mm, mostly strumose, smooth when moist, constricted below the mouth and mostly sulcate when dry; **exothecial cells** firm-walled and oblong-hexagonal; **stomata** restricted to neck, superficial; **annulus** weakly differentiated, not revoluble; **operculum** curved-rostrate from a conic base, ± equal to the capsule. **Peristome teeth** inserted at mouth, red-brown, split ½–⅗ to base into segments of unequal width (and often with 1–2 elongate perforations at base of division), c. 640 × 100 µm, papillose-striolate in lower ½–⅔, baculate near apex. **Calyptra** cucullate, smooth. **Spores** spherical, 16–19 µm, nearly smooth.

Illustrations: Plate 20. Dixon 1913, pl. 2, figs 7a, 7c, 7d and pl. 3, fig. 7b; Klazenga 2003, fig. 25; Malcolm & Malcolm 2003, p. 22; Malcolm & Malcolm 2006, pp. 90, 149, 195.

Distribution: NI: N Auckland (Waipoua Forest, Waitakere Range), S Auckland, Gisborne, Hawke’s Bay, Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St. Endemic.

Habitat: On duff, most often in forest with one or more species of southern beech; less often in forest lacking southern beech or in subalpine or other scrub. This species is best developed on steep soil banks, such as shaded, moist track margins, and can form turves up to several square metres in extent. Occurring also on soil or rock hummocks, exposed tree roots, and occasionally on rotten logs or tree trunks. On hummocks it can form compact cushions to at least 40 cm diameter. *Dicranoloma plurisetum* is a common and widespread forest floor species, most abundant in areas of higher rainfall; it nearly always grows in association with *D. robustum*. Other commonly associated species include *Dendroligotrichum dendroides*, *Dicranoloma billardierei*, and *Ptychomnion aciculare*, as well as *Bazzania* and *Lepidozia* spp. On the South I. this species is most abundant west of or near the Main Divide. Only rarely occurring above the tree line. Ranging from 60 m (Rimutaka Range, Wellington L.D.) to 1300 m (Mt Maungapōhatu, Gisborne L.D.) on the North I., and from near sea level (several localities) to at least 1250 m (near Lake Harris, Southland L.D.) on the South I.

Notes: A more detailed description of *D. plurisetum* is provided by Klazenga (2003).

Material of *Dicranum pallidosplendens* Müll.Hal., *nom. nud.* (*R. Helms s.n.* from the Paparoa Range, NY!) is referable to *D. plurisetum*.

Recognition: When fresh the dull white-green plants of *D. plurisetum* strongly contrast with the shiny yellow-green *D. robustum*, but this colour difference is lost in dry, especially older, herbarium material. The leaves of *D. plurisetum* are obviously spined in two ranks on the abaxial surface of the upper costa, and the plants are also more compact and neater in appearance, in part due to the shorter leaves and the tendency of the stems to branch a few millimetres below the apex. When fresh the weak plications of the lower half of the leaf of *D. plurisetum* can be inconspicuous, but in dried material these plications become more prominent and are visible under the hand-lens. The leaf plications, the spinose upper costae, the sharply spinose-serrate upper leaf margins, and a stronger border (all visible under a hand-lens) all serve to distinguish *D. plurisetum* from *D. robustum*.

Dicranoloma plurisetum is frequently confused with *D. dicarpum* and *D. platycaulon*, which are both similar in colour (white-green or pale yellow-green and dull) when fresh. In the field the shorter, broader leaves with weaker laminal plications and wider laminae distinguish it from *D. dicarpum*; *D. plurisetum* also tends to grow in damper and more deeply shaded sites. The plications of the lower leaves, the lack of laminal undulations, and the more sharply spinose-serrate teeth of the upper leaf margins are normally sufficient to distinguish *D. plurisetum* from *D. platycaulon*. Other differences are detailed under those species. Occasional specimens of *D. plurisetum* (e.g., *P.J. Brownsey s.n.* from Waipoua Forest, WELT M030059) can exhibit distinct leaf undulations; such material can most easily be separated from *D. platycaulon* on the basis of the upper laminal cell outlines. Confusion when sterile is also possible with *D. fasciatum*, but that is generally a much smaller plant than *D. plurisetum*.

Etymology: The species epithet *plurisetum* is an obvious reference to the multiple (as many as nine) capsules arising from a single perichaetium.

Dicranoloma robustum (Hook.f. & Wilson) Paris, *Index Bryol., ed. 2, 2,* 29 (1904)

≡ *Dicranum robustum* Hook.f. & Wilson, *London J. Bot.* 3: 542 (1844)
Type (holotype?): Hermite I, *J.D. Hooker 100b*, Herb. Wilson, BM 00671616!

= *Dicranum pungens* Hook.f. & Wilson, *London J. Bot.* 3: 541 (1844)
≡ *Dicranoloma pungens* (Hook.f. & Wilson) Paris, *Index Bryol., ed. 2, 2,* 29 (1904)
Isotype: Lord Auckland's Islands, *J.D. Hooker*, Herb. Mitten, NY 267974! (Holotype in BM cited by Klazenga 2003.)

= *Dicranum setosum* Hook.f. & Wilson, *London J. Bot.* 3: 541 (1844)
≡ *Dicranoloma setosum* (Hook.f. & Wilson) Paris, *Index Bryol., ed. 2, 2,* 30 (1904)
≡ *Dicranoloma robustum* var. *setosum* (Hook.f. & Wilson) Sainsbury, *Bryologist* 34: 74 (1931)
Lectotype: Lord Auckland's Islands, *D. Lyall*, Herb. Hooker, BM 00671632! (Designated by Klazenga 2003.) Paratype: Campbell Island, *J.D. Hooker* ("Wilson 26b"), BM!, NY 267993!

= *Dicranum setosum* var. *attenuatum* Hook.f. & Wilson, *Bot. Antarct. Voy. I. (Fl. Antarct.) Part I,* 129 (1845)
≡ *Dicranoloma setosum* var. *attenuatum* (Hook.f. & Wilson) Paris, *Index Bryol., ed. 2, 2,* 30 (1904)
Holotype: Campbell's Island, *J.D. Hooker* ("*Wilson 26*"), Herb. Hooker, BM 00671627!
Isotype: NY-Mitten 267994!

= *Dicranoloma chrysodrepaneum* Dixon, *Bull. New Zealand Inst.* 3: 19 (1913)
Lectotype: near Lake Wakatipu, *J. Meiklejohn*, L (Designated by Klazenga 2003.) Not seen.
Paratype: Greymouth, *R. Helms s.n.*, CHR 642602! *ex herb.* Helms.

= *Dicranoloma cylindropyxis* Dixon, *Bull. New Zealand Inst.* 3: 21 (1913)
Lectotype: N.Z., Paparoa Range, c. 500 mtr. höhe, *R. Helms*, NY 267972! (Designated by Klazenga 2003.) Isolectotype: CHR 536478! Paratype: N.Z., Kellys Range, "*Beckett 166*" CHR 543126A!

= *Dicranoloma grossialare* Dixon, *Bull. New Zealand Inst.* 3: 18 (1913)
Probable type: N.Z., Nelson, Mt Arthur Plateau, alt. 4000 ft., *T.F. Cheeseman 68* (*168*?), AK 12159!

= *Dicranoloma integrifolium* Dixon, *Bull. New Zealand Inst.* 3: 362 (1929)
Type: N.Z., South Island, *R. Brown*, BM. (Cited by Klazenga 2003.) Not seen, but see notes below.

Plants robust, usually yellow-green and ± lustrous when fresh. **Stems** (20–)80–120 mm, sparsely branched by forking, in cross-section with 3–5 layers of cortical cells and a central strand; rather sparsely matted by pale rhizoids. **Leaves** falcate-secund or erect spreading, neither plicate nor rugose when fresh, little altered when dry, narrowly lanceolate, weakly toothed (not spinose) in upper ¼ to ⅓ or entire, (10–)12–14(–22) × c. 2.0 mm (under cover slip), clasping and ± auriculate at base, tubulose and plane at margins, often with tips fragmenting; **mid laminal cells** elongate and ± irregular, (45–)60–90(–12) × 9–12 µm and 5–14:1, thick-walled and highly porose, with elongate cells extending ± to apex; **juxtacostal cells at mid leaf** not differentiated; **border** mostly narrow (somewhat variable in width), extending from just above the alar group to lower limit of teeth (usually c. ¾ the leaf length), mostly 2–4 cells and 8–12(–15) µm wide at mid leaf; **cell of leaf base** longer, mostly 95–150 µm but otherwise as those of mid lamina, highly porose; **alar cells** strongly and abruptly differentiated, unistratose, ± auriculate, extending c. ⅔ to costal base and extending 15–20 cells up the margins, inflated and yellow-brown, firm-walled, the largest c. 70–90 × 45 µm. **Costa** narrow, occupying 1/20 or less of the widest part of leaf base, 90–105(–150) µm wide, weakly spinose abaxially above, in cross-section (at mid leaf) lacking wings, with a median layer (rarely 2 layers) of 6–8(–10) guide cells, a unistratose abaxial stereid group, a bistratose (often of 12–20 cells) adaxial stereid group (both extending the width of the costa), and a single layer of thinner-walled and often opaque cells (lumens c. 6 µm) on the abaxial surface.

Pseudautoicous. **Outer perichaetial leaves** weakly costate or ecostate, with an oblong and strongly sheathing base abruptly tapered to an arista that is mostly equal to or longer than the base; **inner perichaetial leaves** ecostate, sheathing the bottom ⅓–½ (rarely more) of the seta, mostly 8–14 mm (including arista), gradually or abruptly tapered to a long arista (not formed by a costa) that is mostly 0.8–2.2 mm long. **Dwarf males** gemmiform, embedded in rhizoids of sterile or ♀ plants. **Setae** 1 per perichaetium, 14–27(–30) mm; straight, not twisted, pale brown; **capsules** exserted, curved, 2.3–3.5 mm, weakly to distinctly strumose, mostly smooth or nearly so and weakly constricted below the mouth when dry; exothecial cells incrassate, mostly oblong or elongate but some irregular, mostly 35–90 µm long; **stomata** restricted to neck, superficial; **annulus** weakly differentiated, not revoluble; **operculum** curved-rostrate from a conic base but often fragmenting, ± equal to the capsule. **Peristome teeth** inserted at mouth, red-brown, split ½–⅗ to base into segments of unequal width, c. 700 × 110 µm papillose-striolate in lower ½–⅔, baculate near apex. **Calyptra** cucullate, smooth. **Spores** spherical, 16–21 µm, nearly smooth.

Illustrations: Plates 21, 22, 23, 24. Klazenga 2003, fig. 27; Seppelt 2004, figs 55–56; Malcolm & Malcolm 2006, p. 131.

Distribution: NI: N Auckland, offshore islands only (LB), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St; Sol; A; Ant; C; M.

Austral. Tasmania*, mainland Australia*, Argentina*.

Habitat: Mostly on duff and humus in southern beech forest and often forming extensive turves of many square metres. Also occurring on exposed roots, logs, tree trunks, and rock (and then usually as the "setosum" growth form), and occasionally on damp or waterlogged peat. In moist subalpine forest (such as at Arthur's Pass), *D. robustum* is often the most conspicuous bryophyte and a dominant component of terrestrial bryophyte groundcover (but often mixed with various other species of *Dicranoloma*). Commonly extending into grasslands and into alpine habitats; *D. robustum* and the less common *D. obesifolium* are the only species of the genus commonly occurring in alpine grasslands. In lowland areas (below c. 400 m elevation) often associated with kānuka or mānuka forest scrub or on exotic trees such as poplars, eucalypts, or pines. The wide ecological tolerance of this species means that it associates with a wide range of other moss species, but most commonly, on forest floors, with other *Dicranoloma* spp. (especially *D. billardierei*, *D. plurisetum*, and *D. dicarpum*), *Distichophyllum* *pulchellum*, and *Ptychomnion aciculare*. In grasslands it very commonly occurs in association with the lichen *Cladia aggregata*.

Notes: *Dicranoloma robustum* is among the most widely distributed, common, and variable moss species in the N.Z. flora. Its apparent absence from N Auckland L.D., with the exception of occurrence on Little Barrier I., is curious. The description above applies to the most common forest floor growth form occurring on duff and humus through much of the country and conforms to the Hermite I. type. This representative growth form is a readily recognisable species by virtue of its robust habit, non-plicate and markedly secund leaves, solitary sporophytes, and long-aristate inner perichaetial leaves. In this most common growth form, the internal structure of the mid leaf costa is fairly constant and conforms to the above description, as well as to Renauld's (1909) "toxoneuron" type. A single description attempting to encompass its full range of variability would require so many qualifications as to render it of little use.

Dicranoloma robustum is disturbingly variable and is necessarily interpreted broadly here. The broad concept employed here is unsatisfying and there is a lingering sense that the species is a taxonomic complex, which might be further resolved with a detailed study of patterns of morphological variation. However, both past and present efforts to do so have met with little success. A disturbingly large number of specimens/populations are morphologically intermediate between the most distinctive growth forms (discussed below) of this species. The large number of intermediates suggest they are environmentally induced growth forms, and they are here considered to be unworthy of taxonomic recognition.

Costal anatomy and leaf shape, size, degree of fragility, and toothing, all vary in apparent response to substrate and other environmental factors. Several variations, considered here to be growth forms, have been taxonomically described. The most distinctive of the growth forms, and the most commonly applied names, are described briefly below.

The name *D. robustum* var. *setosum* (Hook.f. & Wilson) Sainsbury, in its various combinations, has been widely applied to N.Z. populations. The material so-named in N.Z. herbaria are plants with erect-spreading, non-secund, narrowly setaceous, fragile leaves 7-15 mm long. Such material usually occurs on exposed roots, logs, tree trunks, and rock rather than on organic debris. Costal internal structure and width are quite variable in the "setosum" growth form, as is the degree of marginal toothing and border development. Populations in which the leaves are setaceous and fragile but markedly secund are common and widespread. Both Dixon (1913, p. 17) and Sainsbury (1955a, p. 130) noted that in many populations of the "setosum" growth form, the number of layers of stereids surrounding the median guide cells (in mid leaf cross-section) is reduced to a single abaxial and single adaxial layer, and the costa projects only weakly on the abaxial surface, thus corresponding to the "heteroneuron" costal type of Renauld (1909). In the majority of N.Z. populations of the "setosum" growth form, the costa at mid leaf is 90-110 µm wide, with (6-)8 median guide cells, but populations with narrower costae and as few as 4-5 guide cells also occur. There are no clear morphological boundaries that distinguish the "setosum" growth form from more typical populations of *D. robustum*. What is treated here as the "setosum" growth form is found throughout the full N.Z. geographic range of *D. robustum*.

When well developed, the "setosum" growth form has a very distinctive facies and it has been accorded both species and varietal rank. This taxon was described (as *Dicranum setosum* Hook.f. & Wilson) using syntypes from Auckland and Campbell Is. gathered by members of the Erebus & Terror Expedition of 1839-1843. There are three (or doubtfully four) such collections in the Hooker herbarium. The protologue includes a description of the sporophytes and leaves ("*foliis erecto-patentibus strictis longissimis lanceolato-setaceis fragilibus apice serrulatis nervo latiusculo subexcurrente*"). The fruiting syntype that best conforms to the protologue (and which, fortuitously, most closely conforms to the concept applied by Dixon (1913) to N.Z. material) was collected by D. Lyall in the Auckland Is.; this material was designated as the lectotype by Klazenga (2003). The lectotype has fragile, narrowly lanceolate-setaceous and weakly toothed leaves, mostly 9-12 mm long with mid laminal cells mostly 39-105 µm long; a border 12-15 µm wide; and a costa at mid leaf c. 120 µm wide, with 8-10 median guide cells, and ± unistratose stereids.

Dicranum pungens Hook.f. & Wilson was correctly placed in the synonymy of *D. robustum* by Sainsbury (1948) and confirmed by Klazenga (2003). Sainsbury noted Dixon's (1913, p. 21) earlier comments that he had "felt very doubtful about retaining this as a species". The type collection from the Auckland Is. consists of robust plants with stems to c. 80 mm and secund, non-fragile leaves mostly c. 10 mm. The costae are more weakly developed than in more representative *D. robustum*, being at mid leaf c. 75 µm wide, with 6 median guide cells and abaxial and adaxial stereid bands that are 1(-2) cell layers thick. The single layer of thinner-walled and often opaque cells on the abaxial surface that is often present in *D. robustum* is absent. Dixon (1913, p. 21) indicated the costa in *D.*

pungens to be "heteroneuron" in structure. I concur with Sainsbury's (1955a, p. 21) observations that the costae in *D. robustum* can sometimes be narrower and have reduced stereid bands ("heteroneuron" as opposed to "toxoneuron" anatomy).

There are numerous collections *in herb. Beckett* (CHR) named as *Dicranum subpungens* Hampe [Linnaea 30: 629, 1860] by Brotherus. According to Klazenga (2003) this name has several Victorian syntypes, from which he selected a lectotype. Klazenga's placement of this name in synonymy is not questioned here.

Dicranoloma cylindropyxis Dixon was accepted at the species level by Sainsbury (1955a, p. 132) and Beever et al. (1992, p. 47), but rejected by Klazenga (2003). It is rejected here. When well developed, this growth form of *D. robustum* is distinctive by its red coloration, long (c. 4 mm), nearly erect, cylindric, and scarcely strumose capsules, short (mostly <30 µm and c. 2-5:1) and weakly porose upper laminal cells, stout costa (c. 0.1 the width of the lower leaf) and rather narrow (c. 1.0 mm) leaves. In the type of *D. cylindropyxis* the perichaetial leaves sheath c. ⅔ of the seta length. The "cylindropyxis" growth form of *D. robustum* appears to be best developed and most common at mid elevations in Nelson and Westland L.D. However, all the above cited features appear to vary independently and no clear boundary can be discerned between the "cylindropyxis" growth form and the representative growth form of *D. robustum*.

Dixon (1913) cited two syntypes for *D. cylindropyxis* Dixon from the Müller herbarium; this material is probably non-extant. Neither of the two syntypes (*Helms s.n.* and *Beckett 166*) are present in the Dixon herbarium, although several paratypes are present there. A portion of the original fruiting Helms Paparoa Range collection in NY labelled "*Dicranum cylindropyxis* C.Müll. n.sp.", apparently in Helms's script, was designated the lectotype by Klazenga (2003). There is ample fruiting material of *T.W.N. Beckett 166* (from the Kelly Range, Westland L.D.) in the Beckett herbarium.

Type material of *Dicranoloma grossialare* Dixon was not found by Klazenga (2003, p. 467). Dixon clearly cited *T.F. Cheeseman 66* from the Mt Arthur Plateau (Nelson L.D.) in the Müller herbarium at Berlin as the type. The holotype was probably destroyed in the WW2 bombing of the Berlin herbarium, and an attempt to borrow type material from BM has failed. There are two fruiting Mt Arthur specimens *in herb. Cheeseman* (AK 12159, AK 12161) under the name *D. grossialare*, both originally named as *Dicranum robustum* and later revised by Sainsbury. One bears the poorly legible Cheeseman number 68 (or 168?). Neither of the AK specimens fully agrees with the collection details in Dixon's protologue and there is no evidence that either Müller or Dixon examined either. It seems likely that Dixon misquoted the collection number in his protologue. The habit and associated species of these two specimens suggest that they are duplicates of a single collection. AK 12159 is unremarkable given the variation of *D. robustum.* In the absence of material precisely agreeing with the protologue it is considered as likely type material. The penicillate nature of the upper leaves, cited in both the protologue and by Sainsbury (1955a, p. 133), is only weakly developed in this specimen. The leaves are c. 15 mm long, tubulose, and finely subulate in a manner suggestive of the "setosum" growth form of *D. robustum*. The mid laminal cells are mostly 45-60(-90) × 6-8 µm, thick-walled, and porose. The costa at mid leaf is c. 90-100 µm wide, with seven guide cells, and with well-defined two-layered stereid bands and larger-lumened abaxial cells. The tubulose nature of the leaves obscures the costa in some leaves, and this may have influenced Dixon's description of the costa as "*basin versus tenuis, saepe indistincta*". In cross-sectioned leaves, however, the lower costa is c. 100 µm wide. The supposed indistinct nature of the lower costa is emphasised as a diagnostic feature by Sainsbury (1955a, p. 132). A collection from Mt Hauhungatahi (Wellington L.D., *G.O.K. Sainsbury 489*, CHR 545962), named by Dixon as *D. grossialare*, and cited by Sainsbury (1955a, p. 133), is likewise referable to *D. robustum*. This material more clearly exhibits the faint lower costa cited by Dixon, but the shoots are not apically penicillate. The lower costa here is wide (c. 90 µm), indistinct, and "heteroneuron" in structure. The variability of costal structure in these specimens thus mirrors that in *D. robustum*, especially in the "setosum" growth form.

Dicranoloma integrifolium Dixon was initially synonymised by Sainsbury (1948) and confirmed by Klazenga (2003). This name has been applied to N.Z. collections of *D. robustum* in which the leaves are decidedly less secund, shorter (c. 5-8 mm), less strongly bordered, and more weakly toothed than representative material. Such populations are widespread and common. Type material of this name in BM was cited by Klazenga (2003) but has not been seen for this study; there appears to be none of the relevant R. Brown collection in any N.Z. herbarium. However, examination of non-type material named by Dixon (e.g., *G.O.K. Sainsbury 590* from Mt Arthur, Nelson L.D., CHR 541110) corroborates Sainsbury's (1948; 1955a, p. 129) opinion that this name belongs in synonymy. In this collection the leaves are mostly erect-spreading but become weakly secund at the stem apex, c. 5-6 mm, and weakly serrate to almost entire above. The mid laminal cells are relatively short (mostly 30-45 µm), thick-walled, and porose; the border c. 12 µm wide; the costa is excurrent and in mid leaf cross-section c. 100-120 µm wide, with eight guide cells, and with the stereid bands usually associated with

D. robustum. I concur with Sainsbury (1955a, p. 129) that populations of *D. robustum* with leaves only weakly toothed are not uncommon throughout its N.Z. range, and that such material is best considered an environmentally induced growth form. This growth form appears to be related to high levels of insolation and to occur on thin soil over rock and on dry peaty soils. On these bases *D. integrifolium* Dixon is included as a synonym here.

The name *Dicranum integerrimum* Broth. & Geh. *in* Broth. [Öfvers. Finska Vetensk.-Soc. Förh. 37: 152, 1895], based on Tasmanian material from Sprent River, was applied to N.Z. material by Dixon (1913, p. 27). This name was typified and placed in synonymy of *D. robustum* by Klazenga (2003, p. 460).

Klazenga's (2003) rejection of Sainsbury's (1948) placement of *Dicranum leucolomoides* Müll.Hal. in the synonymy of *Dicranoloma pungens* is accepted here. Type material of *Dicranum leucolomoides* Müll.Hal. is referable to *Dicranoloma dicarpum* (Nees) Paris.

Recognition: Differences between *Dicranoloma robustum* and *D. billardierei* are discussed under the latter species.

Etymology: The specific epithet is an obvious reference to the size of this, our largest species of *Dicranoloma*.

Dicranum Hedw., *Sp. Musc. Frond.* 126 (1801)

Type taxon: *Dicranum scoparium* Hedw.

Taxonomy: No attempt is made here to provide a generic description of this large genus, which is diverse in the northern hemisphere. *Dicranum*, in its modern sense, is represented in N.Z. by only a single species. The members of *Dicranum* are often robust cushion-forming plants with lanceolate and often secund leaves. Crum & Anderson (1981, p. 196) emphasise the unevenly split and vertically pitted-striolate peristome teeth (the members of the genus are thus sometimes referred to as "fork mosses") and slenderly lanceolate leaves with differentiated alar cells and "well-defined stereids and guide cells" as features characterising the genus. More detailed generic descriptions can be found in the northern hemisphere Floras cited below.

I have elsewhere (Fife 1995) included N.Z. species of *Dicranoloma* in a broadly conceived *Dicranum*. A similar concept of *Dicranum* was employed by Norris & Koponen (1990) in their treatment of the Dicranaceae from the Huon Peninsula, P.N.G. However, Klazenga (1999) has considered the distinction between *Dicranum* and *Dicranoloma* using morphological characters. He concluded that both *Dicranum* and *Dicranoloma* are paraphyletic as they are traditionally circumscribed, and that the "best solution would be to split these large paraphyletic genera 'into smaller, monophyletic groups', but that the results of his analysis were insufficiently conclusive to support this radical taxonomic change". Klazenga's (1999, 2003) views on the distinction between Australasian *Dicranum* and *Dicranoloma* are adapted here. Alar cells in N.Z. material of *Dicranum leioneuron* (and representative northern hemisphere species) are partially bistratose, in contrast to the unistratose alar cells in Australasian species of *Dicranoloma*. According to Klazenga (1999, p. 23), "all the species of *Dicranum* that can be possibly confused with *Dicranoloma* have multi-layered alar cells". A cross-section of the alar group under the stereoscope is usually required to demonstrate this feature convincingly. In a N.Z. context the absence of a differentiated leaf border or limbidium in *D. leioneuron* also provides a helpful distinction.

The presence of a conspicuous group of non-pigmented, non-porose, and rather thin-walled cells at the leaf base (between the alar group and the costal base) is also a constant feature of N.Z. *Dicranum*; a basal group of non-pigmented cells does not occur in N.Z. species of *Dicranoloma*. The presence of such a cell group is widespread in *Dicranum*, but it is unclear to me whether the presence/absence of a non-pigmented basal group distinguishes *Dicranum* and *Dicranoloma* in all parts of their ranges.

Dicranum, as it is circumscribed by modern authors, is a genus of more than 50 species predominantly distributed in the northern hemisphere. Smith (2004) treated 14 species for the British Isles; Crum & Anderson (1981) 15 species for eastern North America; and Noguchi (1987–1994) approximately 20 species for Japan.

Etymology: The generic name derives from the Greek *dikranos*, meaning two-pronged fork, and describes the characteristic bifurcated peristome teeth (Meagher 2011).

Excluded Taxa: *Dicranum aucklandicum* Dixon is considered here a synonym of *Kiaeria pumila* (Mitt.) Ochyra.

Dicranum scoparium Hedw. The N.Z. material treated under this name by Sainsbury (1955a) is here considered as *D. leioneuron*.

Dicranum trichopodum Mitt. *in* Hook.f. is treated here as *Holomitrium trichopodum* (Mitt.) Klazenga.

Dicranum leioneuron Kindb. in Macoun, *Bull. Torrey Bot. Club* 16: 92 (1889)

Type: Canada, Nova Scotia. Not seen.

Plants yellow-green to golden when fresh, becoming yellow-brown when dry, forming dense cushions to at least 150 mm diam. **Stems** erect, aggregated and self-supporting, (30–)50–70(–90) mm, branched by forking, in cross-section with firm-walled cortical cells and a very weak central strand (in N.Z. material), beset with pale brown, smooth rhizoids. **Leaves** erect-appressed, both moist and dry, ovate-lanceolate and narrowly tapered to an acute or slightly rounded apex, unbordered, concave below, broadly tubulose above, entire or with a few weak teeth at extreme apex; plane or weakly inrolled at margins, (2.8–)3.5–5.8 × 1.1–1.3 mm (well-developed leaves under cover slip); **mid laminal cells** elongate, mostly rectangular-vermiculate, incrassate, strongly porose, mostly 48–78 × 9–12 µm, becoming more irregular near apex; **alar cells** partially or predominantly bistratose, forming a large orange-brown group, separated from the costa by a group of basal cells that are ± thin-walled, oblong-rectangular, non-porose, and mostly unpigmented. **Costa** 0.1–0.125 the width of the widest part of the leaf, percurrent, not toothed abaxially (in N.Z. material), at mid leaf with a central layer of (3–) 4–6 guide cells and two stereid bands (sometimes poorly developed, as in Plate 25, fig. D) and with a few large-lumened cells on the abaxial surface, in upper leaf cross-section rounded or weakly ridged abaxially.

Probably pseudautoicous. **Sex organs** and **sporophytes** not known from N.Z.

Illustrations: Plate 25. Sainsbury 1955a, pl. 21, fig. 1 (as *D. scoparium*); Ireland 1982, pl. 89; Smith 2004, fig. 59, 4–6, 9; Hallingbäck et al. 2006, p. 343.

Distribution: SI: Otago (St Bathans Range, Remarkable Range, Old Man Range, Old Woman Range, Rock & Pillar Range, Lammermoor Range, Garvie Range).

Apparently bipolar. Widespread in cool and oceanic regions of the northern hemisphere.

Habitat: Forming dense cushions in cushion bogs, weak flushes, or boggy areas in tussock grasslands in subalpine and alpine areas of the Otago Ranges. Ranging in elevation from c. 980 m (Lammermoor Range) to at least 1700 m (Old Woman Range) elevation. Often associated with *Oreobolus pectinatus*, straight-leaved growth forms of *Dicranoloma robustum*, and *Sphagnum cristatum*. *Polytrichum juniperinum*, *Straminergon stramineum*, and *Warnstorfia sarmentosa* are less frequent associates.

Notes: Sainsbury (1955a, p. 123) recorded *D. scoparium* from the Rock & Pillar Ra. (Otago L.D.), based on material collected by K.W. Allison; he reported this material as a “variety or form” of *D. scoparium* [*D. scoparium* var. *orthophyllum* Brid., Muscol. Recent. Suppl. 1: 173, 1806]. Although the name *D. scoparium* has been applied to Otago L.D. material since Sainsbury’s report (e.g., Fife 1995 and various workers *in herb*.), its application here is misleading. The Otago high-elevation material invariably has erect-appressed ovate-lanceolate leaves that are entire or nearly so, and with costae lacking both abaxial spines and ridges. Representative *D. scoparium* from the northern hemisphere has mostly secund and strongly serrate leaves with costae markedly ridged abaxially. On morphological grounds the Otago material is most similar to *Dicranum leioneuron* Kindb., a species with a Nova Scotian type. Smith (2004) considered it in Britain to be an occupant of “*Sphagnum* tussocks on raised and blanket bogs and in drier habitats under heather and in thin turf over boulders”. Otago material compares very well morphologically to descriptions in Smith (2004) and in Ireland (1982), as well as to Newfoundland material. Our material occupies boggy sites not unlike those described for Europe.

The geographic isolation of the Otago populations of *Dicranum* could be used to argue that they represent an undescribed species. The recognition of a northern hemisphere species in N.Z. on morphological bases alone is certainly open to criticism, and molecular investigations could help to clarify the relationships of the Otago material. However, with present knowledge it is unjustified to describe the Otago material and it is deemed preferable to apply the Canadian name *D. leioneuron* to it, especially given the lack of representative (i.e. “typical”) *D. scoparium* in N.Z.

Dicranum scoparium var. *orthophyllum* Brid. was recorded from mainland Australia (N.S.W.) by Streimann & Klazenga (2002), but no additional information about this record has been located. The south-east Asian *D. psathyrum* Klazenga [J. Hattori Bot. Lab. 87: 118, 1999] is a predominantly epiphytic species that, judging from Klazenga's (1999) illustration, is certainly not conspecific with the Otago collections.

N.Z. material does not constantly produce flagelliferous branches, but these are present in some collections (e.g., *J. Child 6032* from Old Man Range, CHR 429009). Flagelliferous branches are an inconstant feature of British populations of *D. leioneuron* (Smith 2004, p. 202). Neither sporophytes nor sex organs have been found in N.Z. collections and they are likewise unknown from Britain (Smith 2004). Hallingbäck et al. (2006, p. 343) report that dwarf males occur in Scandinavian material and that sporophytes are "relatively rare" in this species generally.

The bistratose nature of the alar cells in N.Z. material is often inconspicuous but, with care, can be observed under the compound microscope. A hand section of the alar region is readily accomplished and then the partially or predominantly bistratose nature of the alar group is obvious under either a stereoscope or compound microscope. The presence of a conspicuous group (not illustrated here) of non-pigmented, non-porose, and rather thin-walled cells between the alar group and the costa base is also a constant feature of N.Z. *D. leioneuron*.

Recognition: Confusion is most likely in N.Z. with entire-leaved forms of *Dicranoloma robustum*, but the presence of the unpigmented cells at the leaf base (absent in *D. robustum*) and the nature of the alar cells provide reliable distinctions. Such forms of *D. robustum* seem also to invariably have widely spreading leaves.

Etymology: The epithet *leioneuron* (from Greek) means smooth-nerved.

Holomitrium Brid., *Bryol. Univ. 1,* 226 (1826), nom. cons.

as "Olomitrium"

Type taxon: *Holomitrium perichaetiale* (Hook.) Brid.

Elements in the following description are taken from Ireland (1994b).

Plants medium-sized to robust, bright green, yellow-green, or red-tinged, forming cushions or tufts, often with terete microphyllous branches in leaf axils, in cross-section with a few thick-walled outer cell layers and a distinct central strand (in N.Z. species). **Stems** unbranched or branched by forking, densely tomentose. **Leaves** variably oriented when moist, contorted or not when dry, acuminate from an ovate or oblong base, entire or weakly toothed, tubulose below and U-shaped or keeled above; **mid laminal cells** irregularly rounded, quadrate, or rectangular, smooth or bulging, mostly incrassate, sometimes sinuose or pitted; **cells of the leaf base** rectangular or linear, thick-walled and ± porose; **alar cells** strongly differentiated and pigmented, inflated, often extending to the costa. **Costa** variable in width, percurrent or nearly so, or sometimes filling the upper leaf, smooth or toothed on abaxial surface, in mid leaf cross-section with 2 stereid bands. **Tubers** lacking. **Axillary filaments** not seen in N.Z. species.

Dioicous (nearly always pseudautoicous). **Perichaetia** strongly sheathing, the leaves usually with long setaceous apices. **Setae** elongate and slender; **capsules** erect and symmetric or ± curved, not strumose, smooth, pale brown or yellow; **mouth** transverse; **annulus** not differentiated; **operculum** rostrate. **Peristome teeth** paired (in N.Z. species), undivided and perforate, or divided ± to base, papillose-baculate throughout. **Calyptra** cucullate and smooth. **Spores** spherical or ovoid.

Taxonomy: A genus of some 50–70 species distributed mainly in tropical regions, and most diverse in tropical America. The genus is characterised by having erect and ± cylindric capsules with papillose peristome teeth, which are mostly not or only weakly split (except in *H. trichopodum*, where they are deeply divided). The presence of dwarf ♂ plants epiphytic upon the ♀ plants (pseudautoicy) and the frequent occurrence of microphyllous branches in most species are also a feature of the genus (Ireland 1994b). The majority of species occur on tree trunks or rocks. Allen (1990) has discussed the genus for tropical America. The traditional concept of *Holomitrium* was expanded by Klazenga (2006), who has argued for the transfer of the systematically problematic Australasian species *Dicranum trichopodum* Mitt. to *Holomitrium*, despite its possession of unequally divided peristome teeth. Klazenga's generic assignment is followed here and discussed further below.

Etymology: The generic name refers to the entire calyptra.

1 **Microphyllous shoots** often present in axils of upper leaves; **leaves** strongly contorted and inrolled when dry, ± abruptly tapered from an obovate-elliptic base to a tubulose upper leaf and a narrowly acuminate apex, entire throughout or crenulate to weakly toothed at shoulder; **costa** filling c. ⅙ or less of the leaf base and not filling the upper leaf; **peristome teeth** undivided or weakly divided for c. ⅓ their length .... *H. perichaetiale*

1' **Microphyllous shoots** lacking; **leaves** not contorted when dry, narrowly ovate-lanceolate, evenly tapered to a long subulate and ± tubulose acumen, usually with a few ± spinose teeth at apex; **costa** filling c. ⅓ the leaf base and filling the upper half of leaf; **peristome teeth** unequally divided nearly to their base .... *H. trichopodum*

Holomitrium perichaetiale (Hook.) Brid., *Bryol. Univ. 1,* 227 (1826)

as "Olomitrium perichaetiale"
≡ *Trichostomum perichaetiale* Hook., *Musci Exot. 1,* pl. 73 (1818)
≡ *Sprucea perichaetialis* (Hook.) Hook.f. & Wilson, *Bot. Antarct. Voy. I. (Fl. Antarct.) Part I,* 128 (1845)
≡ *Symblepharis perichaetialis* (Brid.) Hook.f. & Wilson in Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II,* 60 (1854)
Holotype: N.Z., Dusky Bay, 1791, *A. Menzies 63*, BM-Hooker! Isotype: BM-Wilson!

= *Trichostomum moretonii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 483 (1897)
Lectotype: N.Z., Lake Te Ānau, head of South Fiord, January 1890, *R. Brown*, CHR 335717!

Plants medium-sized, bright yellow-green, forming cushions. **Stems** branched by sparse forking and by subperichaetial innovation, c. 8–25(–35) mm, often with microphyllous shoots in axils of upper leaves, in cross-section with a small central strand, densely tomentose with pale brown, smooth, strongly contorted and branched rhizoids. **Leaves** moderately twisted and ± inrolled from an erect and weakly sheathing base when moist, strongly contorted and inrolled (occasionally cork-screwed) when dry, slightly but distinctively lustrous when dry, rather abruptly tapered from an obovate-elliptic base to an acuminate apex, entire throughout or crenulate to very weakly toothed at shoulder, c. 3.0–4.5 × c. 0.9 mm, weakly sheathing below, U-shaped in cross-section above, plane at margins, with lamina at mid leaf distinct; **mid laminal cells** short and rounded, distinct in surface view, mostly 5–12 × 5–8 µm and 1–1.5:1 (but often some cells oblate, especially near margins), incrassate, smooth, mostly unistratose but bistratose at upper margins and often completely bistratose near apex; in cross-section with cell walls bulging on both surfaces, transitioning gradually to the cells of the leaf base; **cells of the leaf base** linear or narrowly oblong, incrassate and porose; **alar cells** yellow-brown, forming a large, well-defined group extending c. 6–8 cells up the margin and ± to the costa, oblong, inflated but firm-walled. **Costa** filling c. ⅙ or less of the leaf base, percurrent or nearly so, not filling the upper leaf, in mid leaf cross-section rounded on abaxial surface, with c. 5 median guide cells and large abaxial and adaxial stereid groups, with cells of the exposed adaxial layer (at mid leaf & below) similar to contiguous stereids and lacking a distinct lumen; in adaxial surface view (at mid leaf) cells elongate.

Dioicous (usually pseudautoicous). **Perichaetial leaves** sheathing the setae, each with a long, strongly sheathing oblong base and abruptly tapered to a narrow subula c. ½ or less the total leaf length, weakly costate, c. 5.5–7(–9) mm. **Dwarf males** frequent in leaf axils of ♀ plants, c. 0.5–1 mm, often with multiple perigonia (♂ plants rarely normally developed). **Setae** c. 15–30(–40) mm, ± straight, pale brown or yellow; **capsules** erect or slightly curved, oblong-cylindric, slightly narrowed to mouth, 2.0–2.6 mm, smooth, straw-coloured; **exothecial cells** irregular in outline, not in distinct columns, with moderately and uniformly thickened walls; **stomata** few at extreme base of capsule, superficial; **operculum** long rostrate, equal to or somewhat longer than the capsule. **Peristome teeth** inserted c. 75 µm below the rim, paired, undivided or weakly divided to about ⅓ of their length, c. 150–180 × c. 40 µm, mostly blunt at apices, strongly papillose-baculate throughout (apparently on both surfaces). **Calyptra** c. 5 mm, clasping at base. **Spores** 14–21 µm, spherical, thick-walled, finely papillose.

Illustrations: Plate 26. Hooker 1818, pl. 73 (as *Trichostomum perichaetiale*); Ramsay 1986, figs. 1–22; Meagher & Fuhrer 2003, p. 157; Malcolm & Malcolm 2003, p. 34; Klazenga 2006, fig. 2 c–d.

Distribution: NI: N Auckland, including offshore islands (PK, HC, LB, GB), S Auckland, Gisborne, Taranaki (Mt Messenger, Mt Egmont), Wellington; SI: Nelson, Marlborough (Kenepuru Sound, Pelorus Bridge Scenic Reserve), Canterbury, Westland, Otago, Southland; St; Ch; A; C.

Australasian. Tasmania*, eastern mainland Australia*, New Caledonia*.

Habitat: On trunks and branches of a wide range of coniferous and dicotyledonous trees, including the genera *Agathis*, *Dacrydium*, *Dacrycarpus*, *Halocarpus*, and *Podocarpus*, as well as *Coprosma*, *Dracophyllum*, *Fuchsia*, *Fuscospora*, *Hoheria*, *Leptospermum*, *Lophozonia*, *Pseudowintera*, *Sophora*, and *Weinmannia*. Also commonly occurring on rock, rotting logs, and occasionally on humus. Epilithic populations form loose cushions or turves to at least 12 cm diam. and are found mainly at higher elevations (above c. 1000 m). A wide range of epiphytic and epilithic bryophyte species commonly grow in association with this species. From near sea level to at least 1200 m (Mt Ruapehu, Wellington L.D., and Mt Owen, Nelson L.D.) on both main islands.

Notes: The dry plants have a slight but distinctive lustre, which, combined with the strongly contorted leaves and conspicuous (but not shiny) costa, make the species easy to recognise, in the both field and the herbarium. When present, the sheathing and abruptly setaceous perichaetial leaves and ± erect cylindric capsules with short and paired peristome teeth provide further distinction.

Unsurprisingly, given its wide geographic range and substrate tolerance, *H. perichaetiale* shows considerable variability. In most populations the upper leaf lamina is unistratose, except for a narrow bistratose border. However, the uppermost 300–400 µm is often entirely bistratose, and areas of bistratose lamina can be observed at mid leaf in many populations. Rarely, specimens are seen in which the upper half of the lamina is predominantly bistratose (e.g., *W. Martin 260.20* from Carterton, CHR 532209). Some populations (particularly on Stewart I. and the Auckland Is) have leaves less distinctly shouldered than usual for the species. Plant stature also varies considerably. Ramsay (1986) published observations on variability in *H. perichaetiale* based on N.S.W. material, paying particular attention to leaf and stem dimensions.

The microphyllous shoots can be very abundant, often occurring in clusters of 10–12 in the axils of adjacent leaves. Individual microphyllous shoots are mostly 2–4 mm long and bear acute leaves c. 1–2 mm long. Microphyllous shoots are most common and best developed in populations from above 1000 m.

Dwarf, epiphytic ♂ plants are readily seen in fruiting collections of *H. perichaetiale*. In one fruiting N.Z. specimen (*B.H. Macmillan 77/25* from Donald Creek, Nelson L.D., CHR 267524), ♂ plants equal in size to ♀ plants have been observed. In other respects this material is representative of the species. A single specimen from New Caledonia (*M.R. Crosby 14025*, NY) with ♂ plants equal in size to ♀ plants has also been seen. In a cytological study of *H. perichaetiale*, Ramsay (1986) investigated the factors affecting the production of dwarf ♂ plants. She reported a chromosome number of n = 10 and the presence of a large and “slightly dimorphic” bivalent, which disjoined early in meiosis, similar to that occurring in some pseudautoicous species of *Dicranum* and *Dicranoloma*. She found only dwarf males in *H. perichaetiale*.

Dixon (1923, p. 78) tentatively suggested that the Queensland *H. muelleri* Hampe [Linnaea 36: 514 (1870)] should be considered synonymous with *H. perichaetiale.* Dixon’s suggested synonymy was accepted by Wijk et al. (1962) and by Streimann & Klazenga (2002). Type material from Rockingham Bay collected by *F. Mueller* (NY-Jaeger!) has mid leaf margins 3–4 cells thick and distinctly winged in cross-section. A second specimen from Ballina, N.S.W. (*W.W. Watts*, CHR 642129) has similar leaf margins. These observations suggest that *H. muelleri* deserves recognition.

Holomitrium perichaetiale has been recorded from Lord Howe I. (Brotherus & Watts 1915; Streimann & Klazenga 2002), but material from there is different in a number of ways from N.Z. material and it might profitably be compared to Polynesian *H. vaginatum* (Hook.) Brid. Material of *H. perichaetiale* var. *robustum* Broth. & Watts [Proc. Linn. Soc. New South Wales 40: 365 (1915)] has not been studied.

Recognition: The contorted leaves of *H. perichaetiale* give it a very different aspect, both when moist and when dry, than *H. trichopodum*, and these two species are unlikely to be confused; they may be distinguished by many features cited in the key above.

Holomitrium perichaetiale could be confused with *Dicranoweisia antarctica*, particularly when the *Holomitrium* occurs on rock. The *Holomitrium* has broader, more distinctly shouldered leaves, which are generally inrolled towards the stem when dry, while in *Dicranoweisia antarctica* the narrower leaves lack a distinct shoulder and are twisted in a corkscrew manner when dry. *Holomitrium perichaetiale* normally has epiphytic dwarf ♂ plants, while *D. antarctica* is autoicous. Both species have perichaetial leaves sheathing the setae, but those of *H. perichaetiale* are longer (mostly 5.5–7 mm) and very abruptly tapered to a setaceous apex, while those of *D. antarctica* are c. 2.5 mm and gradually tapered. The absence of cuticular striations in *H. perichaetiale* can be useful in difficult instances.

Confusion sometimes occurs between *H. perichaetiale* and species of *Tortella*, but all species of the latter genus have very shiny costae when dry. These contrast sharply with the matt green lustre of both the costae and the laminae in *H. perichaetiale*. Also, the gradual transition between the cells of the leaf base and the mid laminal cells of *H. perichaetiale* are distinct from the usually abrupt and V-shaped boundary between the basal and mid laminal cells in *Tortella*. In the present species the mid to upper laminal cells are distinct and smooth in surface view, while in species of *Tortella* mid to upper laminal cells are obscure and pluripapillose. The normally epiphytic substrate of *H. perichaetiale* contrasts with the usually terrestrial or rock substrate of species of *Tortella*.

Etymology: The species epithet *perichaetiale* refers to the strongly differentiated and sheathing perichaetial leaves that are such a distinguishing feature of this species.

Holomitrium trichopodum (Mitt.) Klazenga, *J. Hattori Bot. Lab.* 100: 301 (2006)

≡ *Dicranum trichopodum* Mitt. in Hooker, *Handb. New Zealand Fl.* 411 (1867)
≡ *Dicranoloma trichopodum* (Mitt.) Broth., *Nat. Pflanzenfam., ed. 2 [Engler & Prantl] 10,* 209 (1924)
Type material (probable holotype): N.Z., Otago, 1864, *Hector*, Herb. Mitten, NY 267987! The specimen cited here was annotated as the holotype by B.C. Tan in 1987; it is apparently not the same sheet cited by Klazenga (2003).

Misapplications: *Chorisodontium aciphyllum sensu* Bartlett & Frahm (1983)

Plants medium-sized, bright or yellow-green, often turning brown when dry, forming cushions. **Stems** often branched by forking, commonly c. 10–50 mm, lacking microphyllous axillary shoots, in cross-section with a few thick-walled outer cell layers and a distinct central strand, tomentose with pale brown, smooth, and strongly contorted rhizoids. **Leaves** loosely to strongly secund when moist, not contorted when dry, narrowly ovate-lanceolate, evenly tapered to a long subulate and ± tubulose acumen, entire except for a few ± spinose teeth at apex, (3–)5–10(–16) × c. 0.4–0.7 mm (under cover slip), scarcely sheathing below, strongly concave to tubulose throughout, with lamina at mid leaf narrow and indistinct; **mid laminal cells** mostly rounded-oblong, mostly c. 8–15 × 4–6 µm and c. (1–)2–3:1, never oblate, often obscure in surface view, firm-walled or incrassate, smooth or weakly mammillate abaxially, non-porose, transitioning gradually to the cells of the leaf base, those in upper subula obscure and apparently not bistratose; **cells of leaf base** narrowly oblong to ± linear, incrassate, becoming strongly porose and ± pigmented near insertion; **alar cells** strongly pigmented, yellow-brown, enlarged, oblong or subquadrate, incrassate, forming a large group extending nearly to the costa and usually extending >8 cells up the margin. **Costa** filling c. ⅓ the leaf base width, filling the upper half of leaf, cross-section in mid leaf with a single layer of median guide cells and large abaxial and adaxial stereid groups with cells of the exposed adaxial layer (at mid leaf and below) similar to the enclosed cells and lacking a distinct lumen; in adaxial surface view (at mid leaf) cells elongate.

Pseudautoicous. **Perichaetial leaves** sheathing the setae, strongly shouldered, abruptly tapered from an oblong and sheathing base to a slender and spreading subula, weakly costate, mostly 7–8 mm. **Dwarf males** rarely observed, c. 2 mm, sometimes innovated and with multiple (–4 or possibly more) perigonia. **Setae** mostly (17–)20–40(–50) mm, slender and flexuose, pale brown or yellow; **capsules** erect, cylindric, scarcely constricted at the transverse mouth when dry, c. 2.0–2.5(–3.0) mm, smooth, straw-coloured; **exothecial cells** irregular in outline, not in distinct columns, with moderately and uniformly thickened walls; **stomata** few at extreme base of capsule, superficial; **operculum** long rostrate, nearly equal the capsule in length. **Peristome teeth** inserted near the rim, paired and often partially conjoined by extensions of lateral trabeculae near their base, red-brown, unequally divided from c. ⅔ their length or ± to the base (the segments sometimes anastomosing), c. 180–200 × 40 µm, strongly papillose-baculate throughout (apparently on both surfaces). **Calyptra** c. 4 mm. **Spores** c. 18 µm, spherical, smooth or nearly so.

Illustrations: Plate 27. Klazenga 2003, fig. 29; Klazenga 2003, fig. 2 a–b (both as *Dicranoloma trichopodum*).

Distribution: NI: N Auckland (Tūtāmoe) including offshore islands (LB, GB), S Auckland (numerous localities), Gisborne (Te Waitī Valley, Lake Waikaremoana area), Wellington (numerous localities); SI: Nelson, Marlborough (Editor Hill, Mt Stokes), Canterbury (Arthur's Pass area), Westland, Otago (Haast Pass, Catlins River), Southland; St. Reported from the Kermadec Is by de Lange & Beever (2015). The record from Little Barrier I. is based on a 1942 collection by *L.B. Moore* (WELT M015650!) and that from Great Barrier I. on a 19th century collection made by *W. Colenso* (*2709*; WELT M030988!) The lack of Taranaki L.D. records is probably a collection artefact.

Australasian. Recorded from Tasmania by Dalton et al. (1991) and Klazenga (2003) (both as *Dicranoloma trichopodum*). According to Lyn Cave (pers. comm., 12 Oct. 2017) there are numerous Tasmanian collections in HO, filed under *D. trichopodum*.

Habitat: Mostly on tree trunks and larger branches, often those that are sloping or nearly horizontal. It is most common on various species of southern beech (*Fuscospora* and *Lophozonia*), but also occurs on *Beilschmiedia tawa*, *Elaeocarpus hookerianus*, *Ixerba brexioides*, *Weinmannia sylvicola*, *Halocarpus biformis*, and *Libocedrus bidwillii*, as well as on tree ferns. It is often found on fallen branches in beech forest, suggesting that this species is well developed in the forest canopy. At Lake Paringa (Westland L.D.) material fallen from the forest canopy has been seen persisting as an ellipsoid "moss-ball" on the forest floor, in mixture with *Cladomnion ericoides*, *Mesotus celatus*, and *Papillaria flavolimbata*. *Holomitrium trichopodum* also occurs on rock (granite, gneiss, sandstone, and probably greywacke) at higher elevations, and rarely occurs on leaf duff. This species is common on rock at the Stockton and Denniston Plateaux (Nelson L.D.), where it forms loose cushions up to c. 8 cm diam.

Holomitrium trichopodum is largely confined to high rainfall areas. On the South I. it occurs primarily near or west of the Main Divide; it also appears to be absent from drier parts of the North I. Its N.Z. distribution mirrors its predominantly western distribution in Tasmania (Klazenga 2003).

Occurring to at least 975 m (but recorded from 1400 m at Mt Manuoha, Gisborne L.D.) on the North I. and from near sea level to at least 1190 m (Mt Euclid, Nelson L.D.) on the South I. This species can be associated with a wide variety of epiphytic/epilithic species, with *Dicnemon* spp. and *Holomitrium perichaetiale*, and the hepatics *Herbertus alpinus* and *Lepicolea scolopendra*, the most frequent. *Cladomnion ericoides*, *Dicranoloma menziesii*, *Ditrichum punctulatum*, *Leptostomum inclinans*, *Pyrrhobryum mnioides*, *P. pennatum*, *Wijkia extenuata*, and *Chandonanthus squarrosus* are less frequent associates.

Notes: As in *H. perichaetiale*, the ♂ plants are normally nanandrous (dwarfed). However, I have seen fully developed (large stature) ♂ plants in a herbarium specimen from Pegasus Bay (Stewart I., *B.A. Fineran 211*, CHR 609464), as well as what appeared to be a single, weakly dwarfed (5 mm long) ♂ plant in material from Kellys Creek (Westland L.D., *W. Martin 155.17*, CHR 609453).

The generic placement of this species is problematic. Sainsbury (1955a) retained this species in *Dicranum*, where it was originally described by Mitten; Fife (1995) followed this placement. Brotherus (1924) made a new combination in *Dicranoloma*, the genus in which it was retained by Klazenga (2003). Klazenga noted a gametophytic resemblance to *D. menziesii* but also (p. 467) expressed doubt that the species should remain in *Dicranoloma*. More recently Klazenga (2006), using both nuclear and chloroplast spacer sequence data and peristome morphology, argued for placement of this species in *Holomitrium*. Although neither of his molecular-data-derived cladograms showed the *Holomitrium* clade to be strongly supported (and in one case critical parts are unresolved), Klazenga argued that the congruence of results from two molecular data sets added weight to this conclusion. Klazenga (2003) discussed the *H. trichopodum* peristome in detail, and subsequently (Klazenga 2006) he discussed the variation in peristome structure in both the New World and Old World members of the *Holomitrium* complex. While conceding that the divided peristome teeth of *H. trichopodum* are aberrant in *Holomitrium*, Klazenga argued that divided teeth have been recorded from two other species (including *H. perichaetiale*) in this genus. Klazenga's generic assignment is reservedly followed here. Klazenga (2006, p. 301) stated, "because of its apparently isolated position in the *Holomitrium*-clade, its lack of many morphological features that characterised the rest of the clade, and its sharing of other morphological features with the related *Dicranum*- and *Dicranoloma*-clades, *Holomitrium trichopodum* may have an important role to play in the resolution of the phylogenetic relationships and the study of character evolution within the *Holomitrium* clade."

Recognition: In the field *Holomitrium trichopodum* is unlikely to be confused with *H. perichaetiale*, although the two often grow intermixed.

Confusion has arisen concerning the identity of aberrant *H. trichopodum* from the Stockton and Denniston Plateaux (Nelson L.D.). Some specimens have been reported (Bartlett & Frahm 1983) as belonging to the South American *Chorisodontium aciphyllum* (Hook.f. & Wilson) Broth., and a modest number of specimens have been subsequently placed in N.Z herbaria as this species by other workers, including me. However, numerous collections (in CHR), made by D. Glenny & K.A. Ford from those plateaux, as part of a survey specifically aimed at clarifying the N.Z. status of *C. aciphyllum*, demonstrate the variability of epilithic populations of *H. trichopodum* there. These collections, together with Bartlett's original collections (in AK and CHR) in some instances have some vegetative leaves extremely short (c. 3–4 mm) for *H. trichopodum.* However, in such populations leaves from the upper shoots that are longer and more slenderly lanceolate (and hence more representative of the species) have in all instances the areolation and costal structure representative of *H. trichopodum*. Several collections from the plateaux also have either setae or intact sporophytes representative of *H. trichopodum*. *Chorisodontium aciphyllum* is rejected here as a member of the N.Z. flora. Two syntypes of the basionym of *C. aciphyllum* (*Dicranum aciphyllum* Hook.f. & Wilson, London J. Bot. 3: 541 [1844]) have been seen in the Mitten herbarium (NY 267989! & NY 267990!).

When sterile, *H. trichopodum* can be difficult to distinguish from *Dicranoloma menziesii* without microscopic examination, but *H. trichopodum* normally has a brighter green coloration. While similar in shape, the leaves in *H. trichopodum* are narrower (usually 0.4–0.7 mm vs. 0.7–0.9 mm wide under a cover slip). In *H. trichopodum* the spine-like marginal teeth are strongly restricted to the apex and project at varying angles from the leaf axis. By contrast, *D. menziesii* is sparsely serrate (not spinose), with the teeth smaller, more numerous, and sometimes extending for as much as ½ the leaf length. In *H. trichopodum* the mid leaf laminal cells are mostly 2–3:1, while those of *D. menziesii* are mostly isodiametric. The abaxial surface of the costa in *H. trichopodum* is smooth or weakly mammillate, while that of *D. menziesii* is spinose by projecting cell ends. In cross-section the adaxial surface layer of costal cells (at mid leaf & below) of *H. trichopodum* are stereid-like and lack a distinct lumen, while the adaxial surface layer of costal cells of *D. menziesii* have a distinct lumen and are clearly differentiated from the adjacent stereids. The elongate nature of the adaxial surface costal cells in *H. trichopodum* can usually be seen in surface view. When fruiting, these two species are distinguished by numerous sporophytic features, including seta length and capsule orientation, and they are unlikely to be confused.

Holomitrium trichopodum can also be confused with *Kiaeria pumila* (=*Dicranum aucklandicum* Dixon). Compared to the latter species, *H. trichopodum* is a larger plant with longer stems, longer leaves (usually c. 6–10 mm), broader costae (c. ⅓ the width of the leaf base) with two stereid bands, shorter upper laminal cells (c. 3–5:1 and ± oblong), pseudautoicous sexuality, very long and fine setae (mostly 20–30 mm) and erect, elongate (2.0–3.0) mm), and cylindric capsules. By contrast, *Kiaeria pumila* is a smaller plant with shorter stems (c. 6–13 mm), shorter (c. 3 mm) leaves, narrower costae (c. ⅙ the width of the leaf base), which lack stereid bands, elongate upper laminal cells, autoicous sexuality, shorter setae (c. 8–11 mm), and shorter (c. 1.0–1.3 mm), slightly curved, oblong-cylindric capsules.

Etymology: The epithet *trichopodum* (Greek *tricho*, hair-like), and *podum*, foot) refers to the slender and elongate nature of the setae and is apt for this species.

Kiaeria I.Hagen, *Kongel. Norske Vidensk. Selsk. Skr. (Trondheim)* 1914(1): 109 (1915)

= *Dicranum* subgen. *Trichodontium* Dixon, *Bull. New Zealand Inst.* 3: 81 (1923)
≡ *Trichodontium* (Dixon) Fife, *Bryologist* 98: 315 (1995)

Plants lustrous or dull, forming tufts or turves. **Stems** not or sparsely forked, in cross-section with a central strand, thin-walled medullary cells, and firm-walled cortical cells. **Leaves** lanceolate, tubulose, secund or erect-spreading, contorted or not when dry; **mid laminal cells** elongate, rectangular or ± quadrate, firm-walled, smooth (in N.Z. species) or ± mammillate; **cells of leaf base** more regular and elongate, often ± prorate, sometimes porose; **alar cells** usually well differentiated. **Costa** narrow, mostly filling the upper part of the leaf and appearing excurrent, in cross-section with stereids and guide cells either lacking (in N.Z. species) or weakly differentiated. **Tubers** absent.

Autoicous or **polygamous**. **Perichaetial leaves** sheathing. **Perigonia** terminal on short or elongate innovative branches arising below the perichaetia, or sessile below the perichaetia. **Setae** elongate and erect, dextrorse in upper portion; **capsules** nearly erect or inclined, smooth (in N.Z. species) or weakly furrowed, strumose or not, constricted below the ± transverse mouth when dry; **stomata** few and restricted to extreme capsule base; **annulus** well differentiated, compound, and revoluble; **operculum** rostrate, curved. **Peristome teeth** inserted at or below the mouth, deeply divided, pigmented at base or throughout, striolate or striate either at base or throughout. **Calyptra** cucullate, smooth, not fringed at base.

Taxonomy: *Kiaeria* is closely allied to *Dicranum* but differs from it by its lack of costal stereid bands and by its autoicous sexuality, with perigonia that are terminal on innovative branches. The capsules are erect or somewhat curved and have deeply divided, typically dicranoid peristome teeth. *Kiaeria* is a small genus of about six species, with four species having an arctic-alpine distribution in the northern hemisphere. A type species has apparently not been designated. As recognised here it is bipolar.

Etymology: The generic name commemorates the Norwegian bryologist Franz Caspar Kiaer (1835–1893).

1 **Plants** lustrous, on rock; **leaves** strongly falcate-secund and not contorted when dry, mostly 2.8–3.2 mm; **mid laminal cells** elongate; **spores** 15–19 µm; common and widespread on rock .... *K. pumila*

1' **Plants** dull, corticolous; **leaves** loosely secund and slightly contorted when dry, 2–2.7 mm; **mid laminal cells** shorter, mostly oblong or subquadrate, sometimes short-rectangular; **spores** 21–24 µm; rarely collected and epiphytic .... *K. spenceri*

Kiaeria pumila **(Mitt.) Ochyra, *Fragm. Florist. Geobot.* 38: 79 (1993)**

≡ *Symblepharis pumila* Mitt. in Hooker, *Handb. New Zealand Fl.* 405 (1867)
≡ *Holomitrium pumilum* (Mitt.) A.Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1870–1871: 449 (1872)
Lectotype: N.Z., Otago, dry ground, 1863, *Hector 10*, Herb. Mitten, NY 002677! (Designated by Ochyra, 1993.)

= *Trichostomum falcatum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 29: 480 (1897)
≡ *Holodontium falcatum* (R.Br.bis) Wijk & Margad., *Taxon* 190 (1960)
≡ *Trichodontium falcatum* (R.Br.bis) Fife, *Bryologist* 98: 316 (1995)
Lectotype: N.Z., Lake Te Ānau, South Fiord, December 1889, *R. Brown s.n.*, CHR 335708!

= *Dicranum aucklandicum* Dixon, *Bull. Torrey Bot. Club* 42: 94 (1915)
≡ *Holodontium aucklandicum* (Dixon) Broth., *Nat. Pflanzenfam., ed. 2 [Engler & Prantl] 10,* 199 (1924)
Type: N.Z., Auckland Island. Not seen. Placed in synonymy by Ochyra 1993, p. 79.

= *Dicranella egmontensis* Dixon, *Bull. New Zealand Inst.* 3: 363 (1929)
Type: N.Z., Mt. Egmont, Jan. 1926, *G.O.K. Sainsbury 353*, CHR 539830!

= *Ditrichum falcifolium* E.B.Bartram & Dixon, *Bot. Not.* 1937: 66 (1937)
Type: N.Z., Kelly's Hill, South I., 1874, *S. Berggren 21*, CHR 539946!

Misapplications: *Dicranum aucklandicum sensu* Sainsbury (1955a)

Plants golden, lustrous, and turf-forming. **Stems** 6–13 mm, in cross-section with 1–2 layers of firm-walled cortical cells and a central strand, with extremely sparse, smooth, brown rhizoids below. **Leaves** strongly falcate-secund, little altered when dry, narrowly lanceolate, mostly 2.8–3.2 mm, ± entire or with a few teeth at extreme apex; **mid laminal cells** elongate and somewhat irregular, mostly 3–7:1, firm-walled, smooth; **basal cells** oblong, rounded and slightly projecting at ends, mostly 24–60 µm and 4–7(–10):1, firm-walled; **alar cells** forming a rather large but poorly defined group of subquadrate cells surrounding a few weakly inflated and weakly pigmented cells in extreme angles. **Costa** c. ⅙ the width of the leaf base, filling about the distal ⅓ of the leaf, in cross-section (mid leaf) lacking stereids.

Autoicous. **Inner perichaetial leaves** c. 3.8 mm, abruptly tapered from a strongly sheathing base to a stout subula c. ½ the total leaf length. **Perigonia** terminal on elongate innovations. **Setae** c. (6–)8–11 mm; **capsules** erect or nearly so, slightly curved, oblong-cylindric, 1.0–1.3(–1.5) mm, not strumose, nearly smooth; **exothecial cells** mostly 3–5:1, firm-walled, irregular; **stomata** few and restricted to extreme capsule base; **annulus** well differentiated, revoluble; **operculum** nearly equal to the capsule. **Peristome teeth** inserted c. 60 µm below mouth, c. 300 × c. 35 µm, divided ½–⅔ their length and regular (not cribose), trabeculate on outer surface and a zig-zag line on inner surface, orange-brown below, hyaline above, striolate at base, coarsely baculate for at least ¾ their length. **Spores** 15–19 µm, minutely papillose.

Illustrations: Plate 28. Dixon 1915, pl. 9, fig. 2 (as *Dicranum aucklandicum*). The material illustrated by Malcolm & Malcolm 2003, p. 38, does not appear to be representative.

Distribution: NI: Gisborne (Kaweka Range, Ruahine Range), Wellington (Ruapehu, Tongariro, Tararua Range), Taranaki (Mt Taranaki); SI: Nelson, Marlborough, Canterbury (widespread but mostly near the Main Divide), Westland (Ōtira Valley, Olivine Range), Otago, Southland; St; A. Reported from C by Vitt (1974, as *Holodontium falcatum*).

Austral? Argentina*.

Habitat: Occurring on rock, mostly granite, gneiss, and greywacke, and occasionally scoria. Mostly in subalpine and alpine regions and often associated with late snow beds. *Dicranoloma robustum*, *Dicranoweisia antarctica*, *Racomitrium crispulum s.l.*, and *Schistidium apocarpum* as well as the hepatic *Jamesoniella colorata* are frequently associated. Its elevation range on the North I. is poorly documented, but ranging there at least from 1370 (Mt Taranaki) to 1700 m (Kāweka Range). On the

South I. ranging from c. 600 m (Flagstaff Hill, Otago L.D.) to c. 1900 m (Murchison Glacier, Canterbury L.D.). Documented from elevations less than c. 850 m only from southern parts of the South I., and on Stewart and Auckland Is.

Notes: There are considerable nomenclatural and taxonomic difficulties associated with *Kiaeria pumila*. The type of *Symblepharis pumila* Mitt. is from Otago L.D., permitting the application of this name and its later combinations to New Zealand material with confidence. Only one South American specimen (Tierra del Fuego: Ushuaia, *H. Roivainen 1549*, NY) has been confirmed as *Kiaeria pumila*.

The name most readily confused with *Kiaeria (Symblepharis) pumila* (Mitt.) Ochyra is the later and heterotypic *Dicranum pumilum* Mitt. [J. Linn. Soc., Bot. 12: 64, 1869], which has a Hermite I. type. Sainsbury (1955a, p. 124) contributed to the confusion by citing *Hector 10* (the type of *Symblepharis pumila*) under his discussion of what he termed "*Dicranum pumilum* Mitt.". No type material of *Dicranum pumilum* Mitt. has been available for examination. However, five specimens named as *D. pumilum* from Fuegia and Marion I. (in CHR; mostly determined by C.M. Matteri) are not conspecific with *Kiaeria pumila* (Mitt.) Ochyra, or with any species known to occur in N.Z. The features that distinguish this Fuegian material from *K. pumila* include a more robust habit and leaves that are markedly twisted when dry, longer (3–4 mm), and erect-spreading. The costae have distinct stereid groups and the capsules are longer (c. 2 mm) and more narrowly cylindric than in *K. pumila*.

Ochyra (1993) considered the relationships (and the synonymy) of *Kiaeria (Symblepharis) pumila* in a paper largely devoted to the genus *Holodontium*. His placement of the present species in the largely northern hemisphere genus *Kiaeria* is accepted here. However, in view of the above, Ochyra's (1993) placement of *Dicranum pumilum* Mitt. and the homotypic *Holodontium pumilum* (Mitt.) Broth. as heterotypic synonyms of *Kiaeria pumila* needs re-evaluation. This is beyond the ambit of this treatment.

Recognition: *Kiaeria pumila* (Mitt.) Ochyra (=*Dicranum aucklandicum* Dixon) is sometimes confused with *Holomitrium trichopodum* (=*Dicranum trichopodum* Mitt.). Compared to the latter, *K. pumila* is a smaller plant with shorter stems, shorter (c. 3 mm vs c. 6–13 mm) leaves, a narrower costa (c. ⅙ the leaf base width) which lacks stereids, more elongate mid and upper laminal cells, autoicous rather than pseudautoicous sexuality, much shorter (c. 6–11 mm vs mostly 20–40 mm) setae and capsules (c. 1.0–1.3 vs mostly 2.0–2.5 mm), and differing peristome teeth.

In a N.Z. context, *Kiaeria pumila* could also be confused with *Ditrichum brevirostre*, especially when sterile. *Kiaeria pumila* differs from the *Ditrichum* by having longer vegetative leaves (c. 2.8–3.2 mm vs c. 1.0–1.8 mm), differentiated alar cells, a narrower costa that lacks stereids, autoicous vs dioicous sexuality, as well as sporophytic features. *Kiaeria pumila* might also be confused with members of *Blindia*, but it is generally a smaller plant with shorter leaves than N.Z. species of this genus. The *Kiaeria* also lacks the abruptly differentiated alar group that characterises most of our *Blindia* spp., and has a very different capsule.

Etymology: The epithet *pumila* means small or dwarf, and refers to the small stature of this species relative to other species of *Symblepharis*, the genus in which it was initially placed.

Kiaeria spenceri (Dixon & Sainsbury) Fife, *Fl. New Zealand Mosses 42*, 1 (2019)

≡ *Dicranoweisia spenceri* Dixon & Sainsbury in Sainsbury, *Trans. & Proc. Roy. Soc. New Zealand* 75: 171 (1945)

Holotype: N.Z., bark of scrub and small trees, Waihōhonu, Mt Ruapehu, 24 Feb. 1942, *G.O.K. Sainsbury 975*, WELT M029498! and M005693! Isotypes: AK 305020! CHR 535550!, 535552!, 535554!, BM-Dixon!

Plants yellow- or brown-green, dull, corticolous. **Stems** mostly c. 5–7 mm, in cross-section with a rather large central strand and one layer of thick-walled cortical cells; with sparse, smooth, pale brown rhizoids below. **Leaves** erect to loosely secund when moist, slightly contorted when dry, narrowly lanceolate, entire throughout or sometimes crenulate at extreme apex, c. 2.1–3.1 mm; **mid laminal cells** mostly oblong or subquadrate, sometimes short-rectangular, c. 6 µm wide, incrassate, unistratose (at mid leaf) but becoming bistratose towards apex, smooth, becoming gradually more elongate and more irregular towards base; **basal cells** oblong to long-rectangular, mostly c. 27–45(–60) × 8–12 µm (some longer near costa), non-porose, some projecting weakly at upper ends; **alar cells** differentiated in a medium-sized group of c. 6–8 moderately inflated cells, extending about halfway to costa and 3–5 cells up the margin, grading gradually into basal laminal cells. **Costa**

occupying c. ⅙ the width of the leaf base, filling the upper c. ⅙ or more of the leaf (which is predominantly bistratose), in cross-section lacking stereids.

Mostly paroicous. **Inner perichaetial leaves** c. 1.0–1.5 mm, abruptly tapered from an oblong and tubulose base to a short and stout cusp c. ⅕ or less the total leaf length, ecostate; the outer perichaetial leaves abruptly tapered to a slender acumen. **Antheridia** axillary at base of outer perichaetial leaves or in perigonial buds at base of the perichaetia. **Setae** 6–10 mm, ± straight, slender, pale yellow-brown; **capsules** erect, cylindric, 1–1.5 mm, not strumose, smooth (but empty capsules weakly sulcate when dry); **exothecial cells** thin-walled and irregular in outline; **annulus** differentiated, not revoluble; **operculum** c. two-thirds the capsule length. **Peristome teeth** inserted at mouth, c. 180–240 µm long (variable in single capsule), mostly divided c. ⅔ their length (occasionally divided only to ⅓ or rarely ± irregular in outline and cribose), with a clear zig-zag line on inner surface, red-orange at base, pale above, distinctly but irregularly striate below, baculate-striate above. **Spores** spherical, 18–24 µm, finely papillose.

Illustrations: Plate 29. Sainsbury 1955a, pl. 20, fig. 3.

Distribution: NI: Wellington (Waihōhonu, old Ōhakune Hut, Silica Springs Track, Whakapapanui Stream), Taranaki (Fanthams Peak Track); SI: Canterbury (Mt Cassidy).

Endemic.

Habitat: An earlier collection (*G.O.K. Sainsbury 5434,* CHR 535054, apparently not present at WELT) from the Waihōhonu type locality was collected from southern beech (unspecified species) bark; peristome details are more easily observed in this collection than in the type. Fanthams Peak material is from "bark of subalpine scrub". Material from west-facing slopes (Con's Track) on Mt Cassidy grew on a bole c. 25 cm above the base of a *Fuscospora solandri s.l.* growing within 15 vertical metres of the tree limit. It there forms corticolous cushions from 25 to 50 mm diam.

On the North I. ranging at least from c. 1100 m (Waihōhonu) to c. 1370 m (near the old Ōhakune Hut). A collection from Fanthams Peak on Mt Taranaki is from c. 1220 m. At Mt Cassidy it has been found only very close to the tree line at 1200 m.

Notes: Collections made in 2011 from Mt Cassidy include *Dicranoloma robustum* ("setosum" growth form), *Leptostomum inclinans*, and *Rhaphidorrhynchium amoenum*, as well as the hepatics *Frullania colliculosa*, *Plagiochila deltoidea*, and *Radula splendida* growing in close association. At the base of the beech trunk *Dicranoloma robustum*, *Leptostomum inclinans*, and *Chandonanthus squarrosus* occurred abundantly. Other herbarium collections include *D. robustum* ("setosum" growth form), *R. amoenum*, *Ulota lutea*, *U. viridis*, *Jamesoniella monodon*, and various species of *Frullania* and Lejeuneaceae in mixture.

During a focused search on Mt Cassidy in 2011 two collections (from a single trunk of dwarfed *Fuscospora solandri* tree growing within 15 vertical metres of the tree limit (*A.J. Fife 13206 & 13207*, CHR) were made before searching was stopped because of fading light. The species appears to be rare at this site, but the habitat does not seem in any way distinctive compared to other tree-line sites in the Arthur's Pass area. Approximately 4 hours were spent in favourable conditions searching both corticolous and terrestrial habitats (via Con's track) from c. 1050 m to 1220 m (the latter elevation being slightly above the tree line). Two of the 4 hours were spent in immediate proximity to the tree line. With the exception of these recent collections, all known collections of this species were made prior to 1947. The rarity of collections probably reflects the inconspicuous nature of the species and its lack of readily observable field characters; the species may be more common in exposed subalpine habitats than the collections suggest. *Kiaeria spenceri* (cited as *Dicranoweisia spenceri*) is given a N.Z. conservation status of "Nationally Endangered" by Rolfe et al. (2016).

Dixon & Sainsbury's protologue (Sainsbury 1945) clearly indicated *Sainsbury 975 in herb*. Sainsbury as the type, and consequently WELT M029498 and M005693 should collectively be considered as the Holotype. This conforms with the concept of holotype outlined in the ICN (Melbourne Code), especially the example of a holotype consisting of more than one fragment of a single collection given in Art. 8.3. (McNeill et al. 2012). Ochyra (*in herb*.) cited the duplicate of *Sainsbury 975* in the Dixon herbarium as a lectotype, and referred it to *Kiaeria pumila* (Mitt.) Ochyra. Neither his choice of lectotype nor his synonymy are accepted here.

The present species is clearly misplaced in the genus *Dicranoweisia*. *Kiaeria spenceri* has dicranaceous and persistent peristome teeth, which are striate-baculate throughout, with a distinct zig-zag line on the inner surface, and unevenly divided for c. ⅔ their length; these peristome features clearly distinguish it from the genus *Dicranoweisia* (and *D. antarctica* in particular), in which the teeth are fugacious, lack a zig-zag line, are undivided, and very coarsely baculate (but not striate) throughout on both surfaces. The presence of a well-differentiated but non-revoluble annulus, the presence of conspicuous stomata in the capsule neck, the absence of costal stereids, and the thin-walled nature of the stem medullary cells further distinguish *K. spenceri* from species of *Dicranoweisia*.

Sainsbury (1955a, p. 120) is, however, correct to state that sterile material of *K. spenceri* is difficult to distinguish from *D. antarctica*. On Mt Cassidy the two species were found growing within c. 25 m of each other, the former on bark, the latter on greywacke. The gametophytes were a similar yellow-green when fresh, but the leaves of *K. spenceri* were c. 2.5 mm, weakly secund, and not contorted when fresh. In the upper laminal cells of *K. spenceri* (*A.J. Fife 13206*, CHR 624868) there is a slight suggestion of the cuticular ridges that characterise the genus *Dicranoweisia*. However, in Mt Cassidy *D. antarctica* (*A.J. Fife 13203*, CHR 624865) the cuticular ridges are much more strongly developed and occur through most of the lamina, the leaves are longer (c. 4 mm) and obviously contorted when fresh. The capsules of *K. spenceri* at Mt Cassidy were narrower, cylindric, 1.5 × 0.45 mm while those of the *D. antarctica* were broader, obovoid, c. 1.6 × 0.75 mm, and peristome differences distinguish them.

Kiaeria spenceri appears to have little resemblance to the eastern Australian *Dicranoweisia microcarpa* (Hook.f. & Wilson) Paris.

Etymology: The epithet *spenceri* commemorates H.M. Spencer, a friend of G.O.K. Sainsbury.

Mesotus **Mitt. in Hooker,** ***Handb. New Zealand Fl.*** **461 (1867)**

Type taxon: *Mesotus celatus* Mitt.

Mesotus is monotypic, with the features of the type species, described below.

Taxonomy: Allen (1987) proposed that *Mesotus* should be removed from the Dicnemonaceae, where it was placed by Brotherus (1924), and placed it in a monogeneric subfamily, Mesotoideae, within the Dicranaceae. He emphasised the following defining features for the subfamily: “immersed capsules, mitriform calyptrae, conic opercula, rhizoids associated with leaf cells, massive endosporic protonemata, and reduced peristome teeth in which the dorsal trabeculae are more heavily thickened than the ventral trabeculae”. However, in a re-examination of the concept of the Dicranaceae based on chloroplast DNA sequence data, La Farge et al. (2002) concluded that the Dicnemonaceae (including *Mesotus*) are nested within traditional members of the Dicranaceae, and that the Dicranoideae (including *Mesotus*) forms a robust monophyletic clade. *Mesotus* is retained in the Dicranaceae here.

Etymology: The generic name probably refers to a perceived (by Mitten) intermediate systematic position of the genus. The obscure meaning of this generic name—derived from *mesotes* (middle or central position) has been discussed by both Allen (1987) and Meagher (2011).

Mesotus celatus **Mitt. in Hooker,** ***Handb. New Zealand Fl.*** **462 (1867)**

Isotype: N.Z., Otago, *J. Hector 39*, 1863, BM-Hooker! (Holotype in NY cited by Allen 1987)

= *Mesotus arcutus* Mitt., *Trans. & Proc. Roy. Soc. Victoria* 19: 52 (1882)
Type: doubtfully from Australia, NY. Not seen.

= *Holomitrium undulatulum* Müll.Hal., *Hedwigia* 36: 365 (1897)
Isotype: N.Z., *s. loc.*, collector unknown, BM 000866719 (Cited by Allen 1987; image seen online, JSTOR Global Plants, accessed 2 Oct. 2017.)

Plants robust, grey- or pale green, creeping, with erect branches. **Primary stems** prostrate, elongate (to at least 100 mm), beset with dense yellow-brown, smooth, and much-branched rhizoids. **Stem leaves** widely spreading from a sheathing base, short-acuminate from the very broadly ovate base, costate, (1.7–)1.9–2.8 × 0.9–1.2 mm, with scattered rhizoids arising from nematogon cells in the lower base. **Branches** (secondary stems) straight, at or nearly at right angles from substrate, variable in length (commonly 20–60 mm), in cross-section lacking a central strand and the outermost 3–5 layers of cells strongly incrassate and pigmented, central cells often with large, dark inclusions when dry. **Branch leaves** lanceolate and evenly tapered or lanceolate from an oblong base, sigmoidally curved and rugose when moist (the intact shoots appearing like a pin-wheel in end view when fresh due to the curvature of the leaves), slightly narrowed near insertion, bordered in the basal ⅓ to ½, deeply concave and with numerous mostly abaxial rhizoids below, keeled above, sharply serrate above, concolourous at apex, 4.0–6.5 × 1.0–1.3 mm (under cover slip), spirally twisted, contorted, and rugose when dry; **mid** and **upper laminal cells** highly irregular in outline and orientation, strongly incrassate, with multiple rounded papillae obscuring the lumen (the papillae becoming smaller toward the leaf apex), mostly 10–14 µm in greater dimension and 0.5–2:1; **marginal cells** elongate, smooth, paler than adjacent laminal cells, and strongly porous, forming a broad border extending to about mid leaf; **cells of the leaf base** elongate, thick-walled, smooth, very strongly porose, mostly orange, filling nearly the whole ovate base and transitioning rapidly into the upper laminal cells, intermixed with numerous shorter, oblong, and non-pigmented "nematogonous" cells, which give rise to adaxial (and fewer abaxial) rhizoids; **alar cells** strongly differentiated, pigmented, mostly oblong, smooth, scarcely porose, and forming a large elliptic group extending c. 6–10 cells up the margin and c. ½ to the costa base. **Costa** lustrous in surface view, convex and protruding abaxially, c. 0.1 the widest part of the leaf, subpercurrent, papillose abaxially near apex, smooth below, in mid leaf cross-section with scattered guide cells and abaxial and adaxial stereid groups.

Pseudautoicous. **Perichaetia** terminal on erect branches, overtopped by lateral innovations (but often with clusters of lateral archegonia 1 mm or less below the base of mature capsules), the inner leaves apparently expanding after fertilisation, becoming abruptly narrowed from an oblong and ± plicate base to a long subula, paler than adjacent vegetative leaves, c. 6 mm (at capsule maturity). **Dwarf male plants** minute and difficult to locate, c. 0.4–0.6 mm, embedded in axillary tomentum of vegetative leaves, the ♂ leaves c. 250–370 µm, serrate, mostly broadly acute, ecostate, with the cells papillose in upper portions. **Setae** single, <0.5 mm; **capsules** immersed and inconspicuous, symmetric, oblong-cylindric or broadly obovoid, c. 2.5 mm, brown-green or brown, smooth when moist, weakly wrinkled/sulcate and constricted at mouth when dry; **exothecial cells** mostly oblong but variable in length, firm-walled (with transverse walls thinner than longitudinal); **stomata** apparently absent; **annulus** of 1–2 rows of inflated quadrate cells, not falling; **operculum** short rostrate-conic, c. 0.8 mm; **columella** stout. **Peristome teeth** inserted c. 100 µm below the rim, yellow-brown, undivided, irregularly divided, or perforate in uppermost ⅓, broadly lanceolate, c. 300–400 × 90–110 µm, with conspicuous irregularly thickened trabeculae on outer surface and very faint abaxial vertical striolations and a faint zig-zag line on the inner surface. **Calyptra** mitrate, lobed at base, c. 1 mm. **Spores** dimorphic, some (apparently aborted) 12–25 µm, irregular in shape and lacking chlorophyll, the remainder multicellular (to c. 20-celled) due to endosporic germination, variably spherical, ellipsoid, to trapezoidal in a single capsule, chlorophyllose, mostly 75–135 µm in greater dimension, with age becoming extremely irregular in outline, larger, and often forming cohesive masses that adhere to the columella.

Illustrations: Plate 30. Brotherus 1924, fig. 170; Allen 1987, figs 1–3; Beever et al. 1992, fig. 25, pl. 8; Malcolm & Malcolm 2003, p. 43; Malcolm & Malcolm 2006, p. 281.

Distribution: NI: S Auckland (Waihāhā River), Gisborne (Hikurangi, Lake Waikaremoana, Mt Whakapunake), Hawke's Bay (Te Āpiti), Wellington (Taurewa, Erua, Tararua Range); SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland.

Probably endemic. A doubtful early record from mainland Australia or Tasmania is discussed below.

Habitat: Primarily on trunks and larger branches of southern beech (especially *Lophozonia menziesii*, but also on *Fuscospora fusca* and *F. solandri s.l.*); less often on other tree species, including *Coprosma* cf. *propinqua*, *Griselinia littoralis*, *Hoheria* sp., *Myrsine divaricata*, *Pseudopanax anomalus*, and *Weinmannia racemosa* as well as *Dacrycarpus dacrydioides* and *Dacrydium cupressinum*. One epilithic collection from an "exposed boulder in open part of [*Fuscospora truncata*] forest" at Mt Furneaux in Marlborough L.D. (*P.J. Brownsey s.n*., 2 Jan 1992, WELT M028208) has been confirmed. On the South I. this species ranges from near sea level (Lake Paringa, Westland L.D.) to c. 1200 m (Mt Richmond, Marlborough L.D.). It is frequently associated with a wide range of epiphytic taxa, including *Cladomnion ericoides*, *Dicnemon calycinum*, *D. semicryptum*, *Holomitrium perichaetiale*, *H. trichopodum*, *Lepyrodon australis*, *Macromitrium longipes*, *Papillaria flavolimbata*, *Weymouthia cochlearifolia*, as well as *Herbertus alpinus*, *Jamesoniella monodon*, *Lepicolea scolopendra*, *Paraschistochila tuloides*, *Plagiochila* spp., and *Porella elegantula*.

Notes: The few records of *M. celatus* from the North I. seem to accurately reflect its occurrence there. *Mesotus celatus* is a widespread and relatively common species throughout Nelson, Marlborough, Westland, Otago, and Southland L.D.; it is relatively infrequent in Canterbury, with the exception of a few localities (e.g., Lewis Pass) near the Main Divide. The absence of records from Stewart I. probably reflects the absence of southern beech species on that island.

Mitten (1882, p. 52) described *M. acutus*, providing a confusing diagnosis emphasising the dense areolation and the more strongly serrulate ("*magis serrulatis*") margins relative to *M. celatus*. No collector or locality data (apart from "Australia") is given for the type specimen, which has not been examined. Although Allen designated a holotype for *M. acutus* Mitt. in NY (*ex herb.* Borrer) and placed it in the synonymy of *M. celatus* (his placement is followed here), the uncertainty concerning the type's provenance and the question of whether *M. celatus* occurs (or occurred) on either mainland Australia or Tasmania remains uncertain. There are apparently no modern collections of *Mesotus* from either region. Dalton et al. (1991) placed *M. acutus* in their "doubtful and excluded records" for Tasmania. Dalton has also (pers. comm., July 2008) specifically and unsuccessfully searched for *Mesotus* on that island. Streimann & Klazenga (2002, p. 116) considered the occurrence of *Mesotus* on either mainland Australia or Tasmania doubtful. *Mesotus celatus* is here considered a N.Z. endemic genus and species.

The perichaetia in this species were interpreted as terminal and subtended by an innovation by Lindberg (1872). Allen (1987, p. 446) opined that the terminal perichaetia are "laterally displaced by branch innovations". Lindberg (1872) also interpreted the innovation as arising from the axil of the uppermost vegetative leaf and termed the fruit "pseudolateral". Clusters of lateral archegonia that are not associated with any modified leaves often occur a short distance (c.1 mm) below the base of the seta.

Epiphytic dwarf ♂ plants in this species are, in my experience, extremely difficult to locate. The few calyptrae seen have weak multiple lobes at their base, but are not "deeply four-lobed" as described by Allen (1987). In more mature capsules the germinated and multicellular "spores" tend to form cohesive protonemal masses, which are often adherent to the columella. The shapes of these cell masses become highly irregular (rather than spherical to trapezoidal when the capsules are green), and in some cases the boundaries between the spore-derived cellular clusters become obscured.

The species that is most likely confused with *M. celatus* is *Sclerodontium pallidum*, which has a similar overall habit, coloration, and bordered and rugose leaves with papillose cells. In the field, *M. celatus* branches exhibit a very distinctive pin-wheel-like aspect in end view due to the sigmoid curvature of the individual leaves. *Mesotus celatus* leaves lack hair-points, while in *S. pallidum* some hair-pointed leaves are nearly always present. The immersed and inconspicuous capsules, the multicellular spores, and the multiple and unbranched nature of the laminal papillae of *Mesotus* also serve to distinguish it, as do its epiphytic habitat and more southern distribution.

Mesotus shares a creeping habit with species of *Macromitrium*, but no N.Z. *Macromitria* has the pin-wheel aspect of the branches, dimorphic leaves, immersed capsules, or robust stature of *Mesotus*.

Etymology: The epithet means hidden or concealed, and refers to the immersed and very inconspicuous capsules.

Sclerodontium Schwägr., *Sp. Musc. Frond. Suppl. 2(1),* 124 (1824)

= *Dicnemoloma* (Renauld) Renauld, *Rev. Bryol.* 28: 86 (1901)

Type taxon: *Sclerodontium pallidum* (Hook.) Schwägr.

The description of the type species applies to the genus as a whole.

Taxonomy: *Sclerodontium* was reviewed by Crum (1986), who considered it to fit "comfortably into the Dicranaceae owing to asymmetrically forked peristome teeth marked by vertical pit-striation and long, narrow leaves with colourful groups of differentiated alar cells. A most interesting feature, anomalous in the Dicranaceae, is the pleurocarpous habit of growth and the abundance of branches in an arrangement one associates with a *Grimmia* or a *Rhacomitrium*". The genus was retained in the Dicranaceae by Goffinet et al. (2009).

Crum (1986) considered the genus to consist of two species, one of which he treated as two regional subspecies. The genus is predominantly Australasian, with outliers in southern Brazil and Indonesia. The best known and most widely distributed taxon is the Australasian type *S. pallidum* (Hook.) Schwägr. subsp. *pallidum*. The second species, *S. clavinerve* (Müll.Hal.) H.A.Crum, allegedly differs from *S. pallidum* by having ultimate branches that are more curved, leaves that are more secund when dry, and the presence of conspicuous, dark green deciduous leaf tips that serve as asexual gemmae. Crum (1986) found no sporophytes in *S. clavinerve*, which he records from eastern Australia and southern Brazil.

Etymology: The generic name derives from *skleros* (Gr. hard or rough) and *odontos* (Gr. toothed) and alludes to the roughened surface of the peristome teeth (Meagher 2011).

Sclerodontium pallidum (Hook.) Schwägr., *Sp. Musc. Frond. Suppl. 2(1),* 124 (1824)

≡ *Leucodon pallidus* Hook., *Musci Exot. 2,* Pl. 172 (1820)
≡ *Dicnemoloma pallidum* (Hook.) Wijk & Margad., *Taxon* 9: 50 (1960)
Type material: Nova Hollandia *s. loc. et s. coll.*, “Mr. Dickson 4, herb. H[ooker] 2143”, BM 000671582! See notes below.

= *Dicranum sieberianum* Hornsch. ex Spreng., *Syst. Veg., ed. 16 [Sprengel] 4(2),* 322 (1827)
≡ *Dicnemoloma sieberianum* (Spreng.) Broth., *Nat. Pflanzenfam., ed. 2 [Engler & Prantl] 10,* 212 (1924)
Type material: Australia, “N.H. [Nova Hollandia] *s. loc.*, *S[ieber] 16*, herb. H[ooker] 1138”, BM 000671583!

= *Dicranum incanum* Mitt. in Hooker, *Handb. New Zealand Fl.* 410 (1867)
Type material: N.Z., North I., *Sinclair*, NY 267983! (Cited and synonymised by Crum 1986.)

Etymology: The species epithet *pallidum* refers to the pallid, often grey-green tint of the leaves. The disused epithet *sieberianum* honours Franz W. Sieber, a widely travelled Czech plant collector who visited Port Jackson (Sydney region) in N.S.W. in 1823.

Sclerodontium pallidum (Hook.) Schwägr., *Sp. Musc. Frond. Suppl. 2(1),* 124 (1824) subsp. *pallidum*

Plants medium-sized to robust, yellow- or grey-green, creeping, forming mats with dense masses of short branches. **Stems** prostrate, mostly <25 mm, wiry, giving rise to numerous short, erect branches, in cross-section of incrassate cells throughout, a poorly defined central strand apparently present, and the outermost 2–3 cell layers very incrassate and pigmented, with very sparse, thick-walled, smooth, and red-brown rhizoids. **Branches** fasciculate, self-supporting and erect, not or weakly curved when moist, curved away from the substrate or less often nearly straight when dry. **Leaves of branches** uniform in shape, narrowly ovate-lanceolate, slightly narrowed to insertion, bordered, uniformly tapered from widest point to apex, deeply concave below, becoming tubulose above, ± rugose and contorted when dry, entire or with a few weak teeth at extreme apex, concolorous throughout or with a short, white hair-point, 2.3–2.8 × 0.45–0.70 mm (under cover slip); **mid laminal cells** irregular in outline, mostly 8–15 × 7–8 µm and 1–2:1, strongly incrassate, with a single, large and much-branched papilla on the abaxial surface and smooth to moderately papillose on adaxial surface; toward leaf apex not differentiated (but the abaxial papillae often becoming longer and curved here), becoming elongate-rectangular, smooth, and porose at leaf base; **cells of leaf border** linear and smooth; the border usually (2–)3–4 cells wide at the widest part of leaf, tapering upwards and disappearing just below leaf apex; **cells of the hair point** elongate, lacking chlorophyll, often projecting at upper ends; **cells at insertion** strongly orange-pigmented in several rows, those near the costa linear-rectangular, smooth, and with strongly porose walls, those near the margin shorter and ± papillose; **alar cells** strongly differentiated, forming a large triangular group, orange or orange-brown, short-rectangular or subquadrate, with thin transverse walls and very thick and porose longitudinal walls. **Costa** lustrous in abaxial surface view, protruding abaxially, 0.1–0.125 the widest part of the leaf, disappearing below the leaf apex (obscure in upper part of leaf), in mid leaf cross-section with a central layer of guide cells and abaxial and adaxial stereid groups.

Apparently dioicous. **Perichaetia** lateral, the outer leaves little differentiated, the innermost shouldered, sheathing, hyaline for much of their length and with a strongly developed hair-point. **Perigonia** scattered on stems, conspicuous in moist material, the antheridia mixed with numerous brown filiform paraphyses. **Setae** one per perichaetium, elongate and straight, weakly sinistrorse, (7–)10–14 mm; **capsules** curved, nearly erect to strongly inclined, asymmetrically oblong-cylindric, 1.0–1.5(–1.8) mm, smooth both moist and dry, constricted below the mouth when dry (poorly illustrated here); **exothecial cells** subquadrate to ± irregular, firm-walled (transverse walls thinner than longitudinal walls); **stomata** not seen; **annulus** nil; **operculum** long-rostrate from a conic base. **Peristome teeth** inserted at mouth, red-brown, divided c. ½ to base into unequal segments, vertically papillose-striolate. **Calyptra** cucullate, smooth. **Spores** spherical, unicellular, green, mostly 25–39 µm.

Illustrations: Plate 31. Hooker 1819–1820, tab. 172 (as *Leucodon pallidus*); Brotherus 1924, fig. 167 f–h (as *Dicnemoloma sieberianum*); Crum 1986, figs 1–8; Malcolm & Malcolm 2003, p. 62; Meagher & Fuhrer 2003, p. 81.

Distribution: NI: N Auckland (many localities) including offshore islands (HC, GB, LB, RT, Waiheke I.) S Auckland (Hauturu (Clark's) I., Karangahake Gorge, Waikato River (site now submerged by Lake Karapiro), near Ātiamuri), Gisborne (Kawakawa Bay, Te Araroa); SI: Marlborough (without locality); Ch.

Australasian. Tasmania*, mainland Australia* (all mainland states, but apparently not NT). The only material seen from Tasmania is a specimen without locality or collector in the Mitten herbarium at NY. The species is accepted from Tasmania by Dalton et al. 1991 (as *Dicnemoloma pallidum*). Reported from Lord Howe I., New Caledonia, and Kerguelen by Crum (1986). The last locality seems phytogeographically highly unlikely and is based on an early (J.D. Hooker) collection in one herbarium.

Notes: *Sclerodontium pallidum* has a strongly northern distribution in N.Z. and is a widespread and common species in N Auckland L.D., becoming much rarer outside this L.D. It favours exposed boulders or outcrops of relatively base-rich but typically non-calcareous rocks (especially lava, basalt, and andesitic conglomerates). It is often in very dry sites that are sometimes in proximity to watercourses and perhaps rarely subject to flooding. A Chatham I. record (*P.J. de Lange & P.B. Heenan CH983,* AK 301023; CHR 592090) is unusual as it grew on limestone. It came from a dry, sunny site and grew in association with *Pellaea rotundifolia* and *Camptochaete deflexa*. Material has been seen from pōhutukawa (*Metrosideros excelsa*) roots among petrel burrows on Hauturu (Clark's) I. near Whangamatā, S Auckland L.D. (*P.J. de Lange 8305*, CHR 587407), and there are a small number of records from pōhutukawa (*Metrosideros excelsa*) from Rangitoto and Great Barrier Is (collected by both J.E. Beever and J.K. Bartlett). Material recorded from a *Cladium* [*Baumea*] swamp without further information [*K.W. Allison 403* (CHR 609473A, 609473B)] is, however, associated with *Rosulabryum billardierei* and *Frullania falciloba*, suggesting an epilithic origin. A collection from a mangrove lagoon on Rangitoto I. also was epilithic (*L.B. Moore s.n*., CHR 104954). The only South I. material seen is a *J. McMahon* collection from Marlborough L.D., without detailed locality data. In Australia *S. pallidum* grows most often on siliceous rock, especially sandstone.

On the North I. this species ranges from near sea level (Tī Point, North Auckland L.D.) to at least 400 m (Whangārei Heads, North Auckland L.D.). The above-mentioned corticolous collection from Mt Hobson is from 610 m elevation. Frequent associates include *Breutelia pendula*, *Campylopus introflexus*, *Hypnum cupressiforme*, and *Rosulabryum billardierei* as well as the lichens *Cladia aggregata* and *Parmotrema reticulata*.

Sclerodontium pallidum is an easily recognisable plant, which forms dense, pale, and creeping mats over rock. The upright branches are usually curved away from the substrate when dry, and the leaves are pale (due to their laminal papillae), tubulose, usually weakly hair-pointed, and finely rugose with dry. The lustrous and abaxially protruding costa contrasts sharply with the lamina, due to its smooth and elongate abaxial cells. The laminal cell papillae are large, flat-topped, and multifid at their apex. The abaxial laminal papillae are more robust than the adaxial and are best observed on the edge of a folded leaf under the microscope. In surface view the papillae appear stellate. The papillae near the leaf apex, particularly in leaves lacking a hair-point, are usually curved acropetally.

A second subspecies, *S. pallidum* subsp. *celebesiae* (Broth.) H.A.Crum, is restricted to Indonesia and, *fide* Crum (1986), is differentiated by "geographic separation, uniformly slender stature, and uniformly narrow leaf bases". The autonymic subspecies designation [*Sclerodontium pallidum* subspecies *pallidum*], dictated by the International Code of Nomenclature, is given at the top of this discussion, but the Australasian material of this species is so widespread, common, and distinctive that the repeated application of a subspecies name to N.Z. collections would seem pedantic.

Type material in the Hooker herbarium of *Leucodon pallidus* Hook. bears extensive notes in the script of Wilson: "I have reason to believe this to be the original of *Leucodon pallidus* Hook., Musc. Exot. T. 172. (*Dicranum hypnoides* Brown) of which no named authentic specimen exists in the Hookerian Herbarium. W. Wilson. April 4, 1845." The several plants in this specimen are unquestionably referable to *Sclerodontium pallidum* and no purpose would be served by questioning Wilson's assessment. One of the mounted plants bears a strong resemblance to the habit drawing included in Musc. Exot. Tab. 172 (Hooker 1819–1820), and the annotation "Mr. Dickson" on the specimen corroborates the statement "a Dicksono et Hobsono receptus" in the protologue. The Hookerian herbarium mentioned by Wilson is presumably the W.J. Hooker herbarium of 1845, rather than the Herbarium Hookerianum incorporated into the Kew herbarium in 1867. Crum (1986) indicated that the type of *Leucodon pallidus* was collected at Port Jackson; the material at BM supporting this has not been seen.

Recognition: Because of its overall habit, pale coloration, and bordered and rugose leaves with papillose cells, confusion is most likely with *Mesotus celatus*. When moist, plants of *S. pallidum* lack the sigmoidally spiralled leaves of *M. celatus*. *Sclerodontium pallidum* nearly always has some hair-pointed leaves, while these do not occur in *Mesotus*. The sporophytes of *Sclerodontium* are strongly exserted, while those of *Mesotus* are immersed. Under the microscope the multifid and single laminal papillae in *S. pallidum* contrast with the unbranched and multiple papillae of *M. celatus*. The spores in *S. pallidum* are unicellular, while those of *M. celatus* are multicellular. The northern distribution and mostly epilithic substrate of *S. pallidum* contrasts with the N.Z.-wide distribution and epiphytic substrate of *M. celatus*.

Confusion seems less likely with *Racomitrium crispulum s.l.* that occurs in similar dry epilithic habitats. *Racomitrium crispulum s.l.* is a darker plant with plane or reflexed leaf margins, a single well-developed plica in the lower leaf and non-papillose upper laminal cells with strongly sinuose walls.

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Conventions

Abbreviations and Latin terms

Abbreviations	**Meaning**
A	Auckland Islands
A.C.T.	Australian Capital Territory
aff.	allied to (*affinis*)
agg.	aggregate
Ant	Antipodes Islands
a.s.l.	above sea level
auct.	of authors (*auctorum*)
B	Bounty Islands
C	Campbell Island
c.	about (*circa*)
cf.	compare with, possibly the species named (*confer*)
c.fr.	with fruit (*cum fructibus*)
Ch	Chatham Islands
comb. nov.	new combination (*combinatio nova*)
D'U	D'Urville Island
et al.	and others (*et alia*)
et seq.	and following pages (*et sequentia*)
ex	from
fasc.	fascicle
fide	according to
GB	Great Barrier Island
HC	Hen and Chicken Islands
Herb.	Herbarium
hom. illeg.	illegitimate homonym
I.	Island
ibid.	in the same place (*ibidem*)
incl.	including
in herb.	in herbarium (*in herbario*)
in litt.	in a letter (*in litteris*)
inter alia	among other things (*inter alia*)
Is	Islands
K	Kermadec Islands
KA	Kapiti Island
LB	Little Barrier Island
L.D.	Land District or Districts
leg.	collected by (*legit*)
loc. cit.	in the same place (*loco citato*)
l:w	length:width ratio
M	Macquarie Island
Mt	Mount
nec	nor
NI	North Island
no.	number
nom. cons.	conserved name (*nomen conservandum*)
nom. dub.	name of doubtful application (*nomen dubium*)
nom. illeg.	name contrary to the rules of nomenclature (*nomen illegitimum*)
nom. inval.	invalid name (*nomen invalidum*)
nom. nud.	name published without a description (*nomen nudum*)
non	not
N.P.	National Park
N.S.W.	New South Wales
N.T.	Northern Territory (Australia)
N.Z.	New Zealand
op. cit.	in the work cited (*opere citato*)
pers. comm.	personal communication

PK	Poor Knights Islands
P.N.G.	Papua New Guinea
pro parte	in part
Qld	Queensland
q.v.	which see (*quod vide*)
RT	Rangitoto Island
S.A.	South Australia
s.coll.	without collector (*sine collectore*)
s.d.	without date (*sine die*)
sect.	section
SEM	scanning electron microscope/microsopy
sensu	in the taxonomic sense of
SI	South Island
sic	as written
s.l.	in a broad taxonomic sense (*sensu lato*)
s.loc.	without location (*sine locus*)
Sn	Snares Islands
s.n.	without a collection number (*sine numero*)
Sol	Solander Island
sp.	species (singular)
spp.	species (plural)
s.s.	in a narrow taxonomic sense (*sensu stricto*)
St	Stewart Island
stat. nov.	new status (*status novus*)
subg.	subgenus
subsect.	subsection
subsp.	subspecies (singular)
subspp.	subspecies (plural)
Tas.	Tasmania
TK	Three Kings Islands
U.S.A.	United States of America
var.	variety
vars	varieties
Vic.	Victoria
viz.	that is to say (*videlicet*)
vs	versus
W.A.	Western Australia

Symbols

Symbol	**Meaning**
µm	micrometre
♂	male
♀	female
±	more or less, somewhat
×	times; dimensions connected by × refer to length times width
>	greater than
<	less than
≥	greater than or equal to
≤	less than or equal to
=	heterotypic synonym of the preceding name
≡	homotypic synonym of the preceding name
!	confirmed by the author
*	in distribution statements, indicates non-N.Z. localities from which material has been confirmed by the author

In general, technical terms conform to Malcolm, B.; Malcolm, N. 2006: *Mosses and other Bryophytes: an Illustrated Glossary*. Edition 2. Micro-Optics Press, Nelson. The few terms that are not defined there, or which are used here in a markedly different sense, are defined below.

Abbreviations for Herbaria follow the standard abbreviations listed in *Index Herbariorum*

Supplementary Glossary for Dicranaceae

Term	**Definition**
baculate	rod-shaped, used to describe rod-shaped projections on either peristome teeth or spore surfaces
insulate	island-like, used to describe broad and flat-topped projections on spore surfaces
lirate	ridge-like, used to describe elongate and usually non-linear projections with slanted or rounded sides on either peristome teeth or spore surfaces
trabeculae	projecting cross-bars (horizontal anticlinal cell walls) that transverse the full width of a peristome tooth. In the Dicranaceae, trabeculae occur on the outer (abaxial) tooth surface, while in many moss families trabeculae occur on the inner (adaxial) tooth surface. (adj.: trabeculate)

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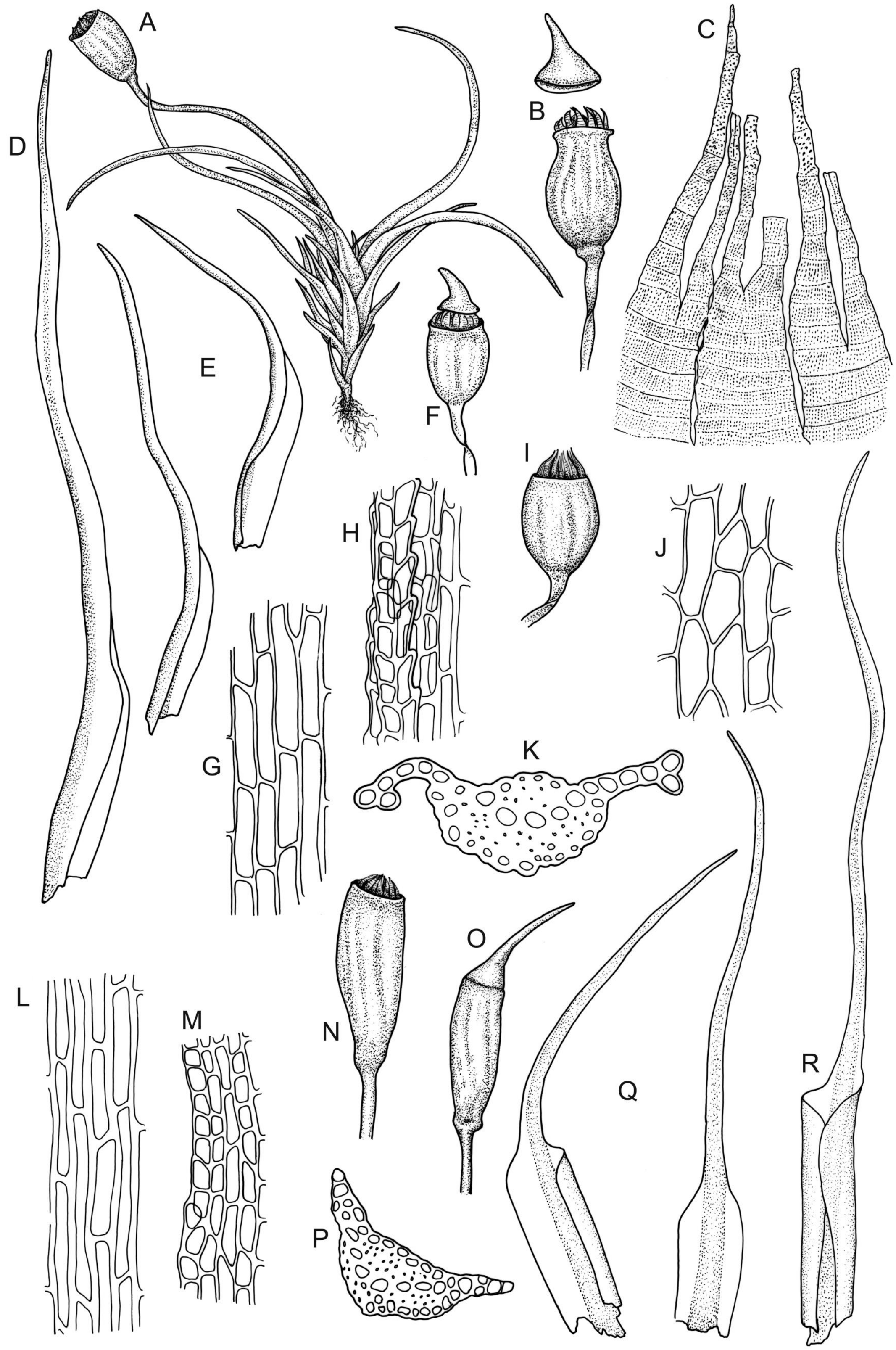


Plate 1: ***Campylopodium*****. A–K: *C. lineare*.** A, habit with capsule. B, capsule with operculum, dry. C, peristome detail. D, perichaetial leaf. E, leaves from just below perichaetium. F, capsule with operculum, dry. G, laminal cells of leaf base. H, mid laminal cells showing margin. I, capsule, moist. J, exothecial cells. K, cross-section of mid laminal cells including costa. **L–R: *C. capillaceum***. L, laminal cells of leaf base. M, mid laminal cells. N, capsule, moist. O, capsule with operculum, dry. P, cross-section of mid laminal cells including costa. Q, leaves from just below perichaetium. R, perichaetial leaf. *C. lineare*: A–E, G–H, J–K drawn from *W. Bell 618*, CHR 515999; F, I drawn from *B.H. Macmillan 84/63*, CHR 266242. *C. capillaceum* drawn from *D. Petrie s.n.*, Sept. 1896, CHR 608252.

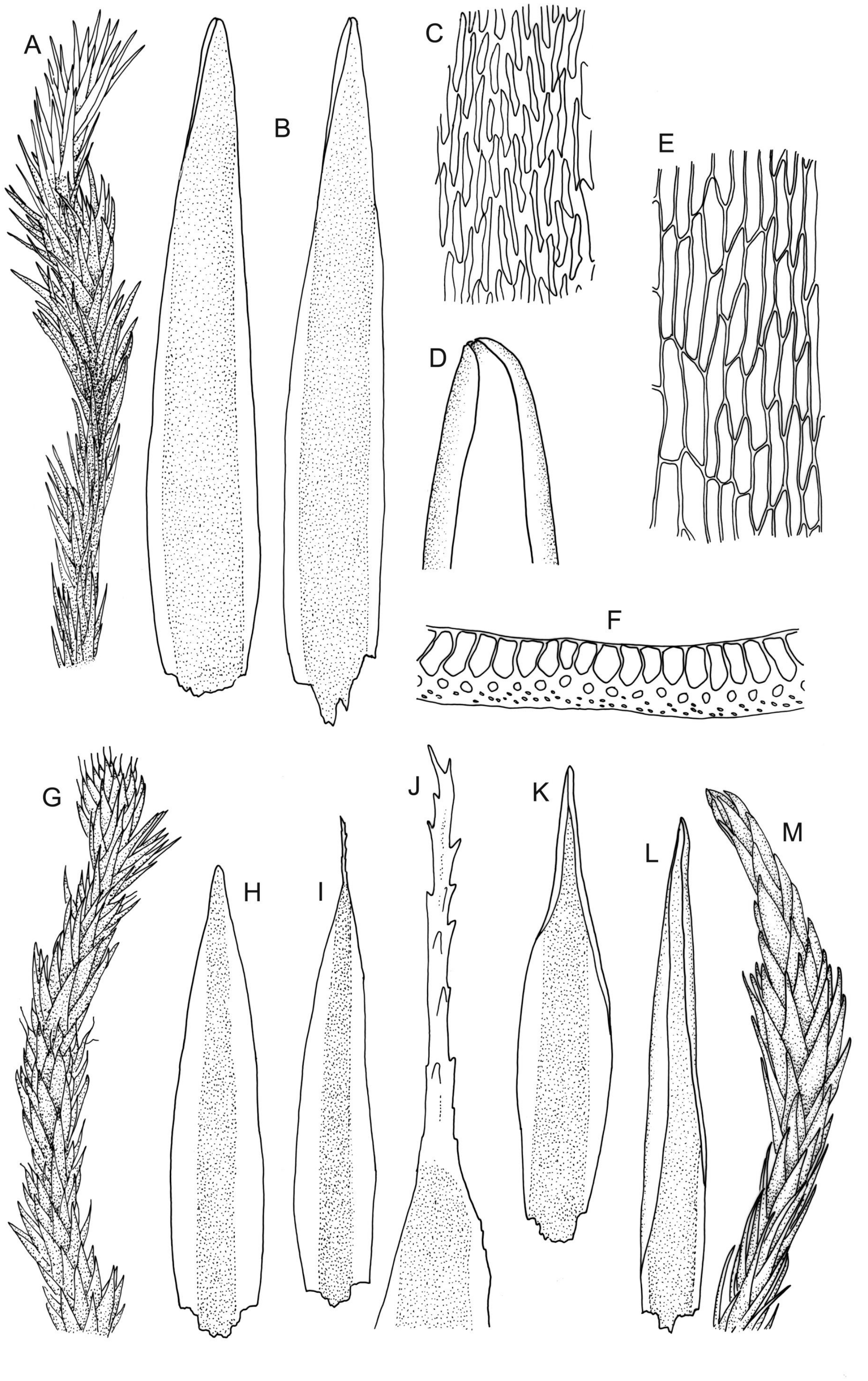


Plate 2: ***Campylopus*****. A–M:** ***C. bicolor***. A, shoot, moist. B, leaves. C, upper laminal cells. D, leaf apex. E, laminal cells c. 800 µm above insertion. F, costa cross-section, mid leaf. G, shoot, moist. H, leaf from mid shoot. I, leaf with hair-point from mid shoot. J, leaf apex with hair-point. K, leaf from upper shoot. L, leaf from mid shoot. M, sterile shoot, moist. A–F drawn from *W. Martin 101.10*, CHR 449100; G–J drawn from *C.J. Burrows s.n.*, Mar. 1971, CHR 544545; K–M drawn from *G. Simpson & J.S. Thomson A55*, CHR 544546.

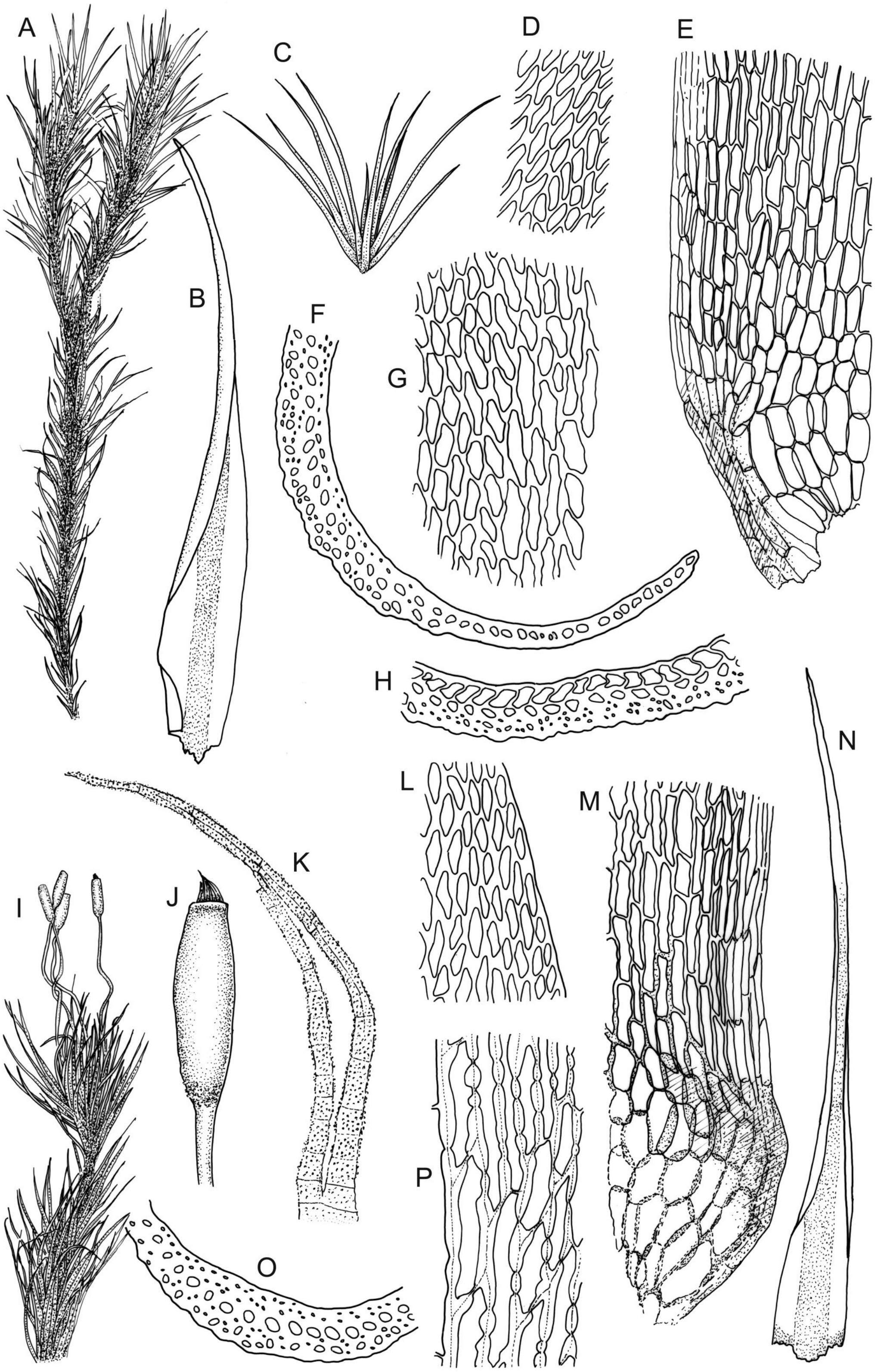


Plate 3: ***Campylopus*. A–P: *C. clavatus***. A, shoot, moist. B, leaf. C, detail of propagulum. D, laminal cells of upper leaf base. E, alar cells. F, cross-section of mid laminal cells with costa. G, laminal cells c. 800 µm above insertion. H, basal costa cross-section. I, shoot with capsules, dry. J, capsule detail, moist. K, peristome tooth detail. L, upper laminal cells at margin, c. 2000 µm above insertion. M, alar cells. N, leaf. O, costa cross-section, mid leaf. P, laminal cells, c. 800 µm above insertion. A–H drawn from *A.J. Fife 6327*, CHR 103424; I–P drawn from *T.W.N. Beckett 1047*, CHR 608250.

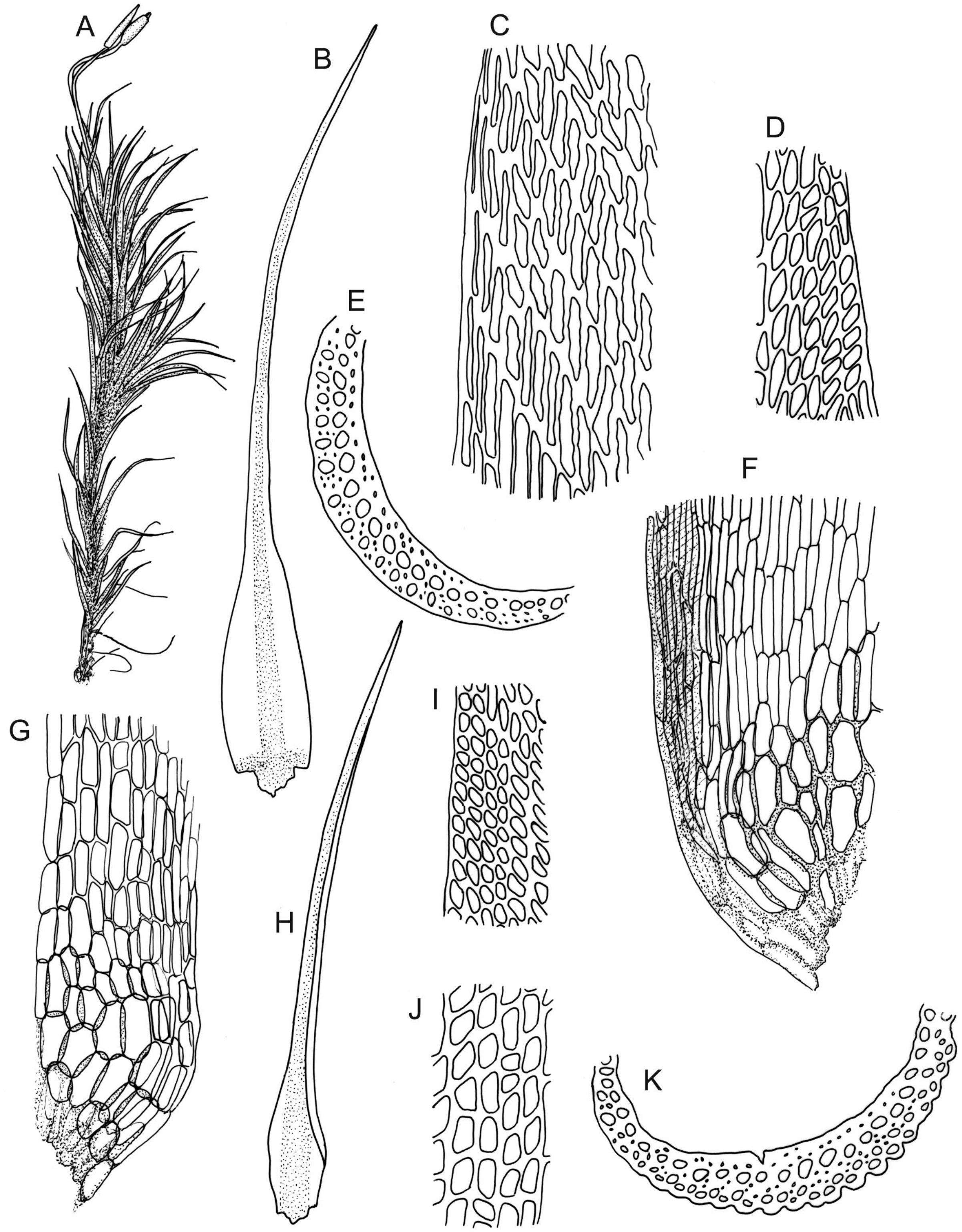


Plate 4: ***Campylopus*. A–K: *C. clavatus***. A, shoot with capsule, moist. B, leaf. C, laminal cells at margin, c. 800 µm above insertion. D, laminal cells at margin, c. 2000 µm above insertion. E, costa cross-section, mid leaf. F–G, alar cells. H, leaf. I, upper laminal cells at margin, c. 2000 µm above insertion. J, laminal cells, c. 650 µm above insertion. K, costa cross-section, mid leaf. A–F drawn from *A.J. Fife 4689*, CHR 170800; G–K drawn from *J.E. Beever 46-60f*, CHR 461838.

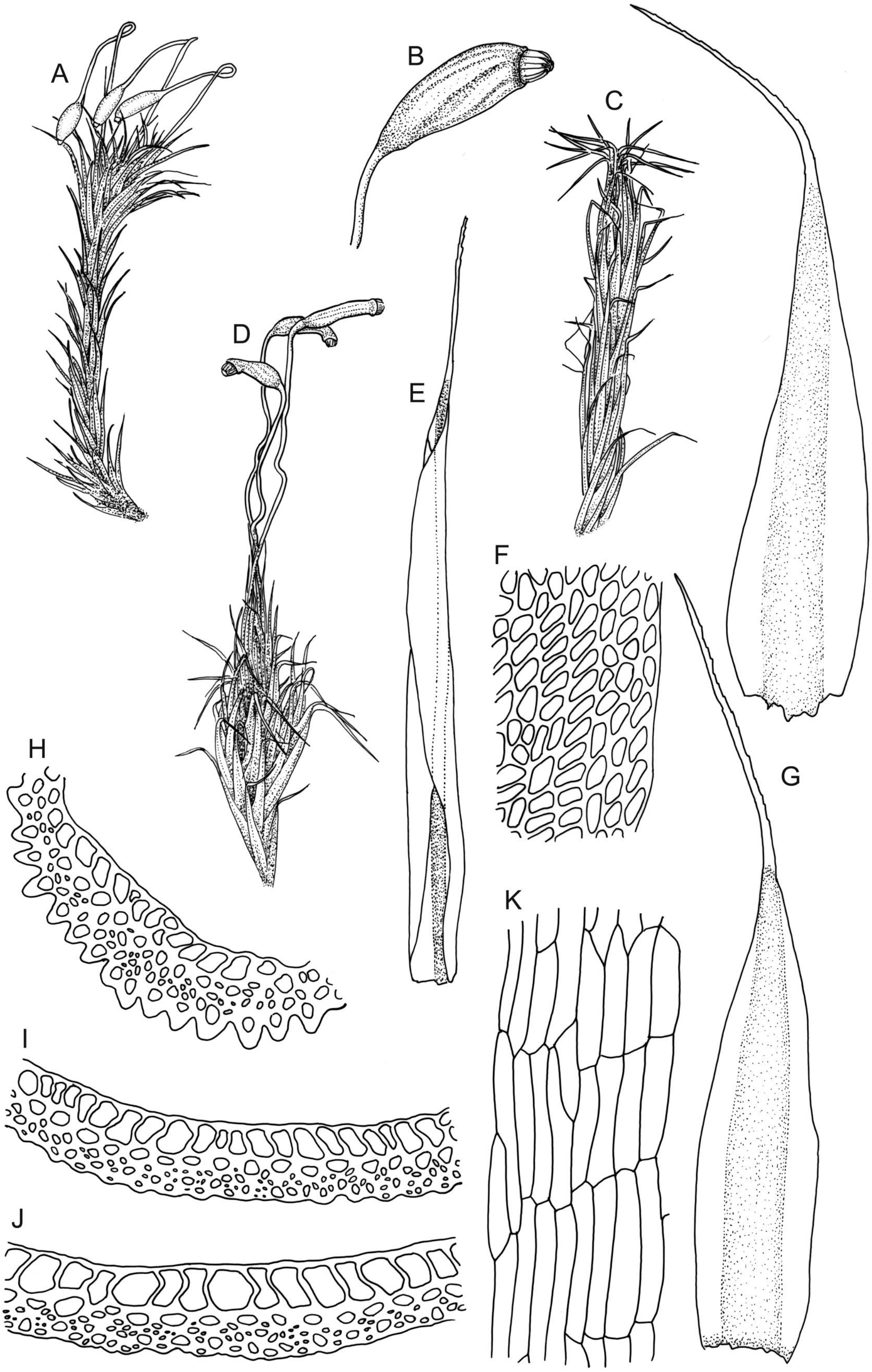


Plate 5: ***Campylopus*** **A–K:** ***C. introflexus***. A, shoot with capsules, moist. B, capsule detail, dry. C, shoot apex detail, dry. D, portion of shoot with capsules, dry. E, perichaetial leaf. F, laminal cells at margin, c. 2000 µm above insertion. G, leaves. H, upper costa cross-section. I, costa cross-section, mid leaf. J, costa cross-section, c. 800 µm above insertion. K, laminal cells c. 800 µm above insertion. Drawn from *J.E. Beever 57–53*, CHR 461823.

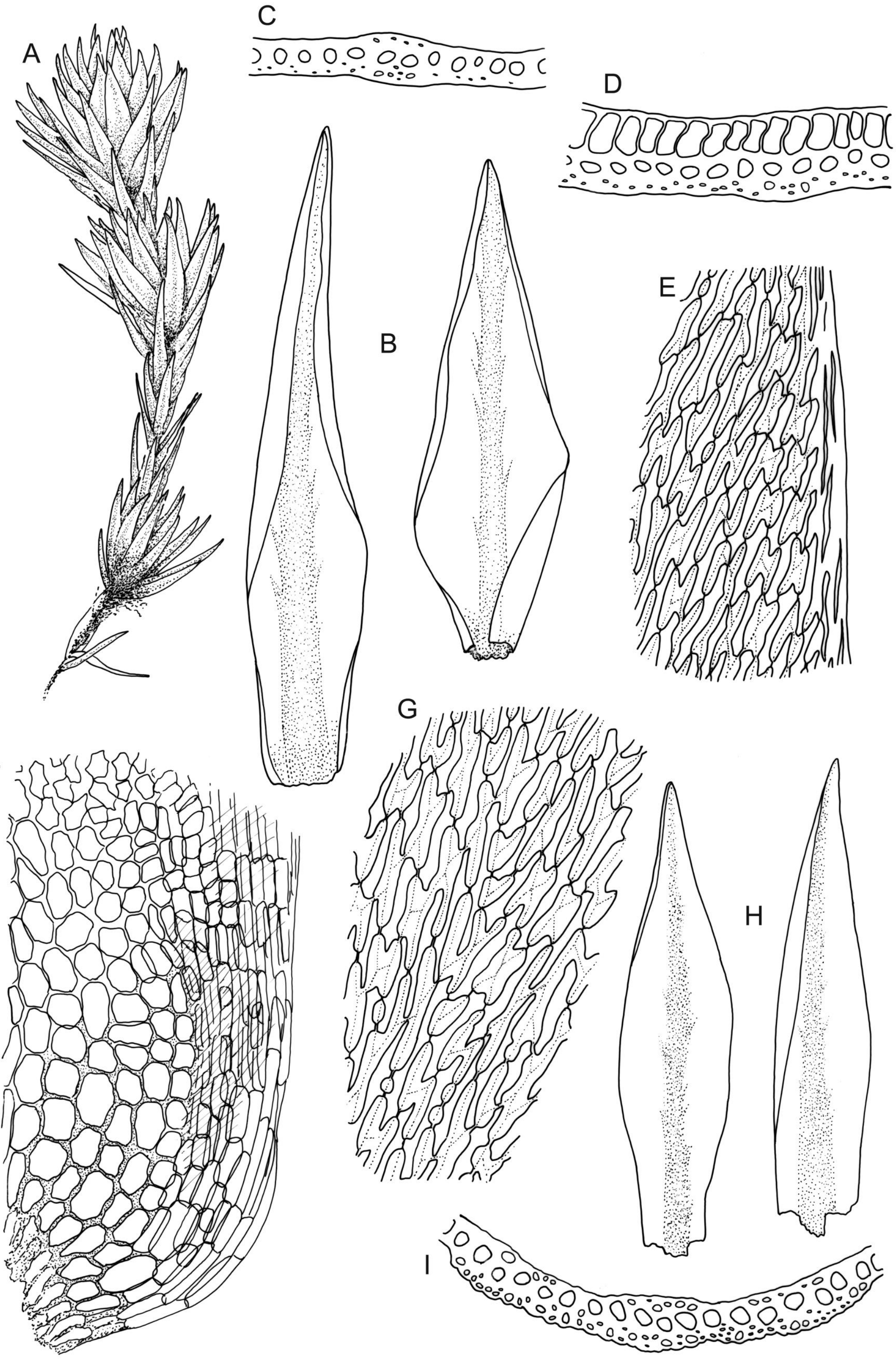


Plate 6: ***Campylopus*. A–I: *C. kirkii***. A, shoot, moist. B, leaves. C, costa cross-section at mid leaf. D, costa cross-section, c. 800 µm above insertion. E, upper laminal cells and margin. F, basal laminal and alar cells. G, laminal cells c. 800 µm above insertion. H, leaves. I, costa cross-section at mid leaf. A–G drawn from lectotype, *L. Boor s.n.*, Jan. 1888, CHR 564014; H–I drawn from *J.E. Beever 40-32*, CHR 438767.

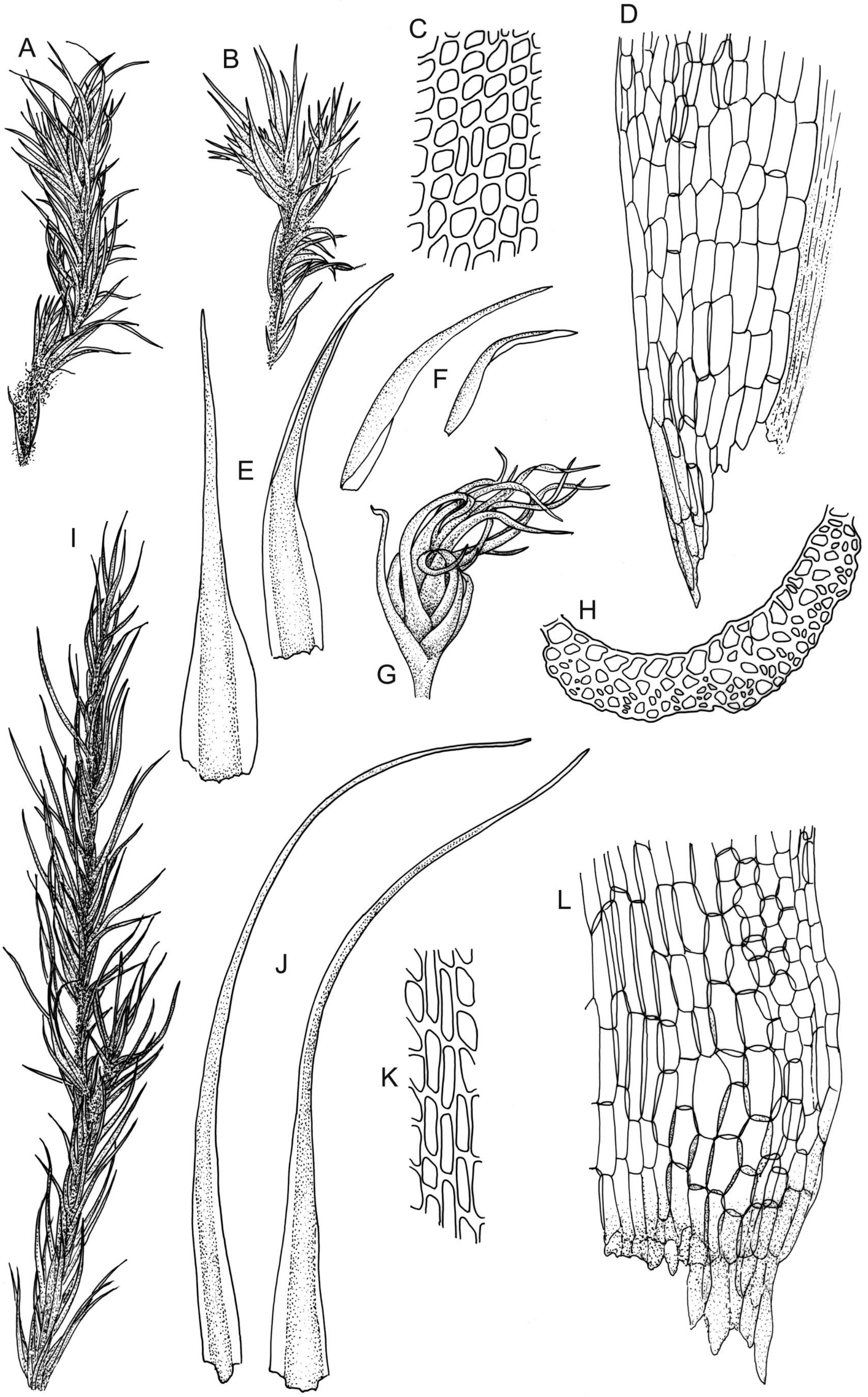


Plate 7: ***Campylopus*****. A–H:** ***C. pallidus*** **representative growth form**. A, shoot, moist. B, shoot with propagulae, moist. C, laminal cells, c. 2000 µm above insertion. D, alar cells. E, leaves. F, leaves from propagulum. G, propagulum, dry. H, costa cross-section, mid leaf. **I–L:** ***C. pallidus*** **thermophilic growth form**. I, shoot, moist. J, leaves. K, upper laminal cells. L, alar cells. A–H drawn from *A.J. Fife 9602*, CHR 477581; I–L drawn from *K.W. Allison 2529*, CHR 544548.

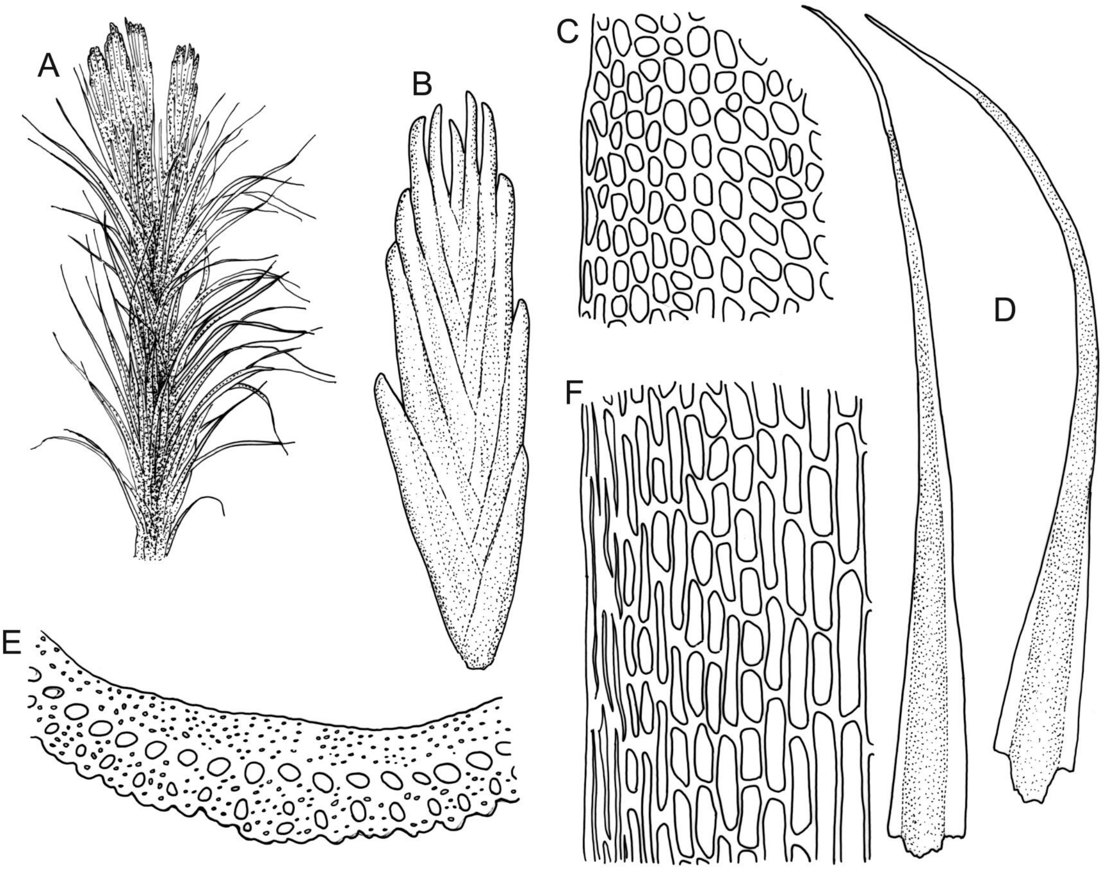


Plate 8: ***Campylopus* A–F: *C. purpureocaulis***. A, shoot with propagulae, moist. B, propagulum detail. C, upper laminal cells at margin, c. 2000 µm above insertion. D, leaves. E, costa cross-section, mid leaf. F, lower laminal cells, c. 800 µm above insertion. Drawn from *A.J. Fife 7828*, CHR 266362.

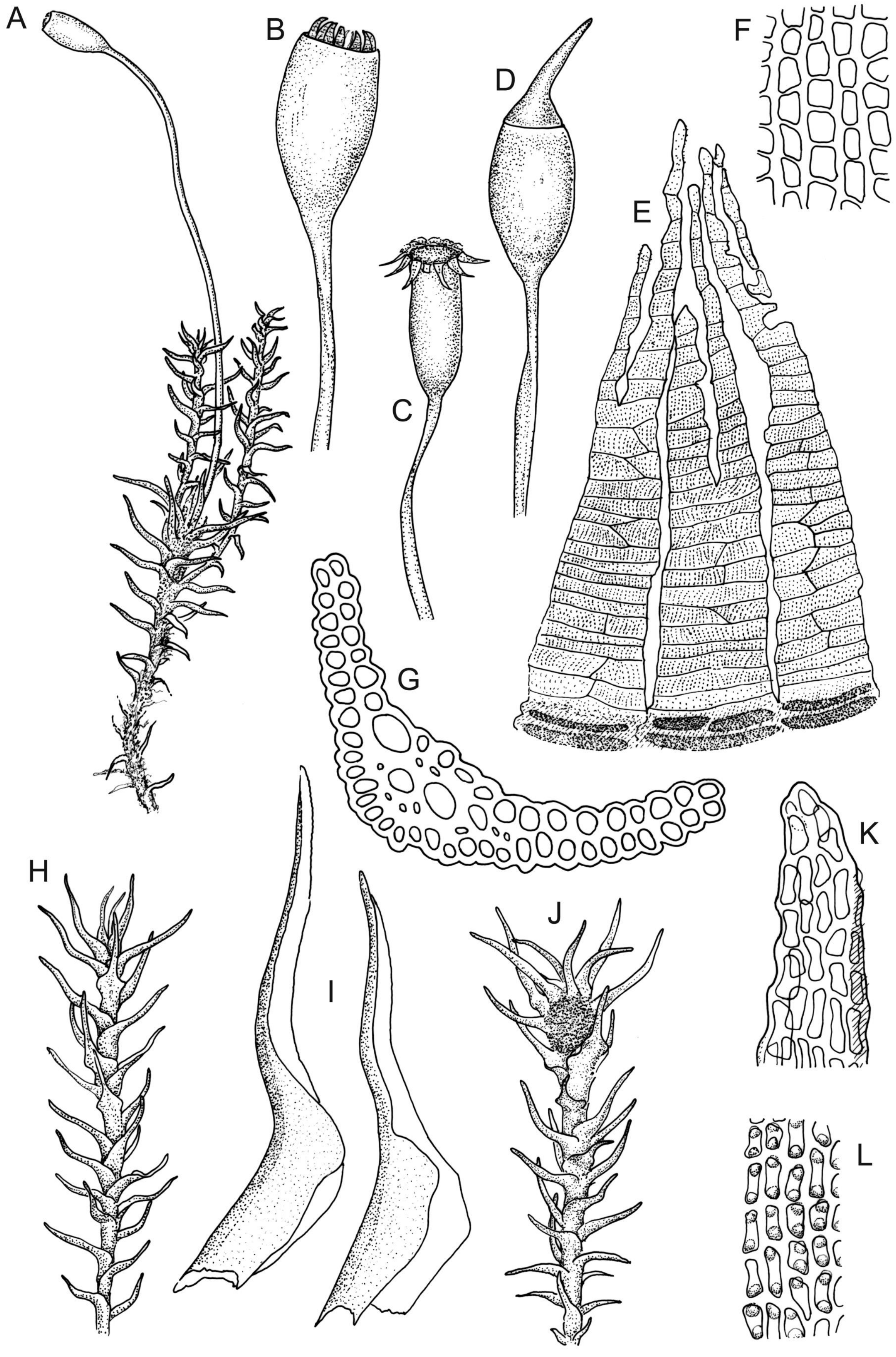


Plate 9: ***Dicranella*. A–L: *D. cardotii***. A, shoot with capsule, moist. B, capsule, moist. C, capsule, dry. D, capsule with operculum, dry. E, peristome detail, outer surface. F, exothecial cells. G, cross-section of limb. H, portion of sterile shoot, moist. I, leaves. J, upper portion of male shoot, moist. K, leaf apex. L, laminal cells at mid limb. A–C, F–L drawn from *A.J. Fife 8302*, CHR 459773; D–E drawn from *J. Child 1563*, CHR 429080A.

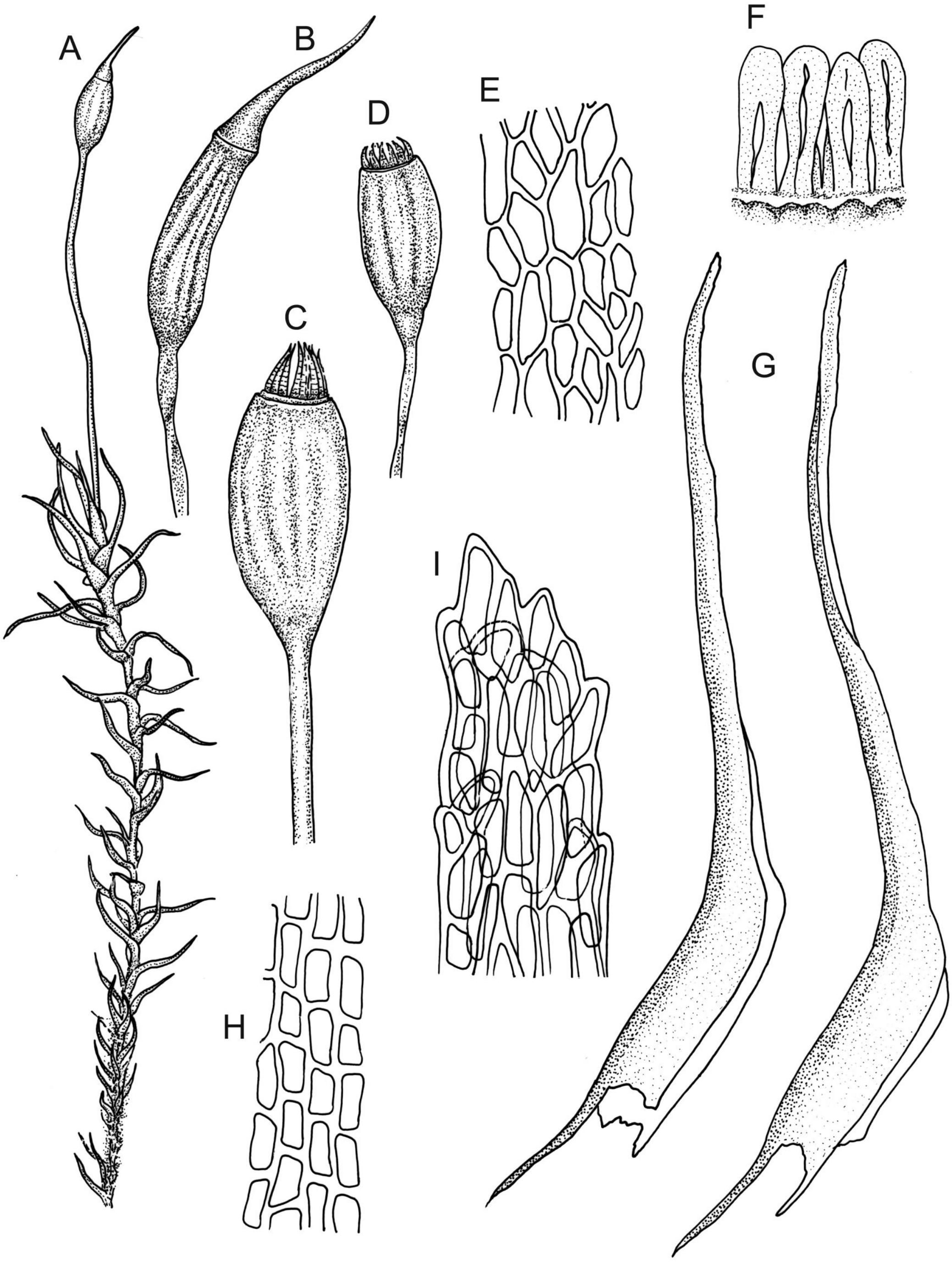


Plate 10: ***Dicranella*. A–I: *D. dietrichiae***. A, shoot with capsule, moist. B, capsule with operculum, dry. C, capsule, moist. D, capsule, dry. E, exothecial cells. F, annulus. G, leaves. H, laminal cells at mid limb. I, leaf apex. Drawn from *K.W. Allison 631*, CHR 532232.

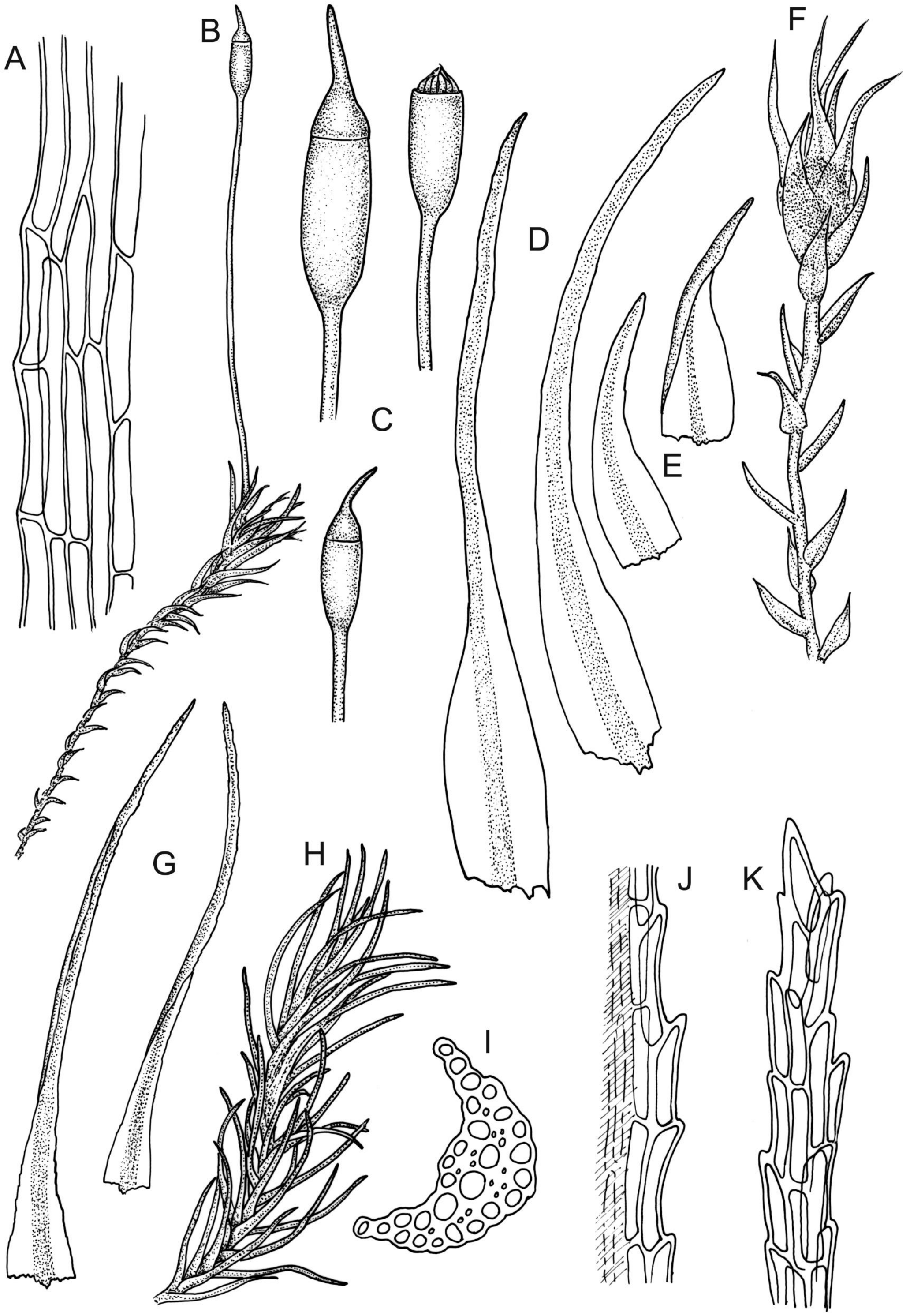


Plate 11: ***Dicranella*. A–F: *D. gracillima***. A, mid laminal cells at margin. B, shoot with capsule, moist. C, capsules, moist. D, perichaetial leaves. E, leaves. F, male shoot, moist. **G–K: *D. heteromalla***. G, leaves. H, portion of shoot, moist. I, cross-section of laminal cells and costa, mid leaf. J, upper laminal cells at margin. K, leaf apex. *D. gracillima* drawn from *K.W. Allison 2623*, CHR 532234. *D. heteromalla* drawn from *J.E. Beever 52-13a*, CHR 462056.

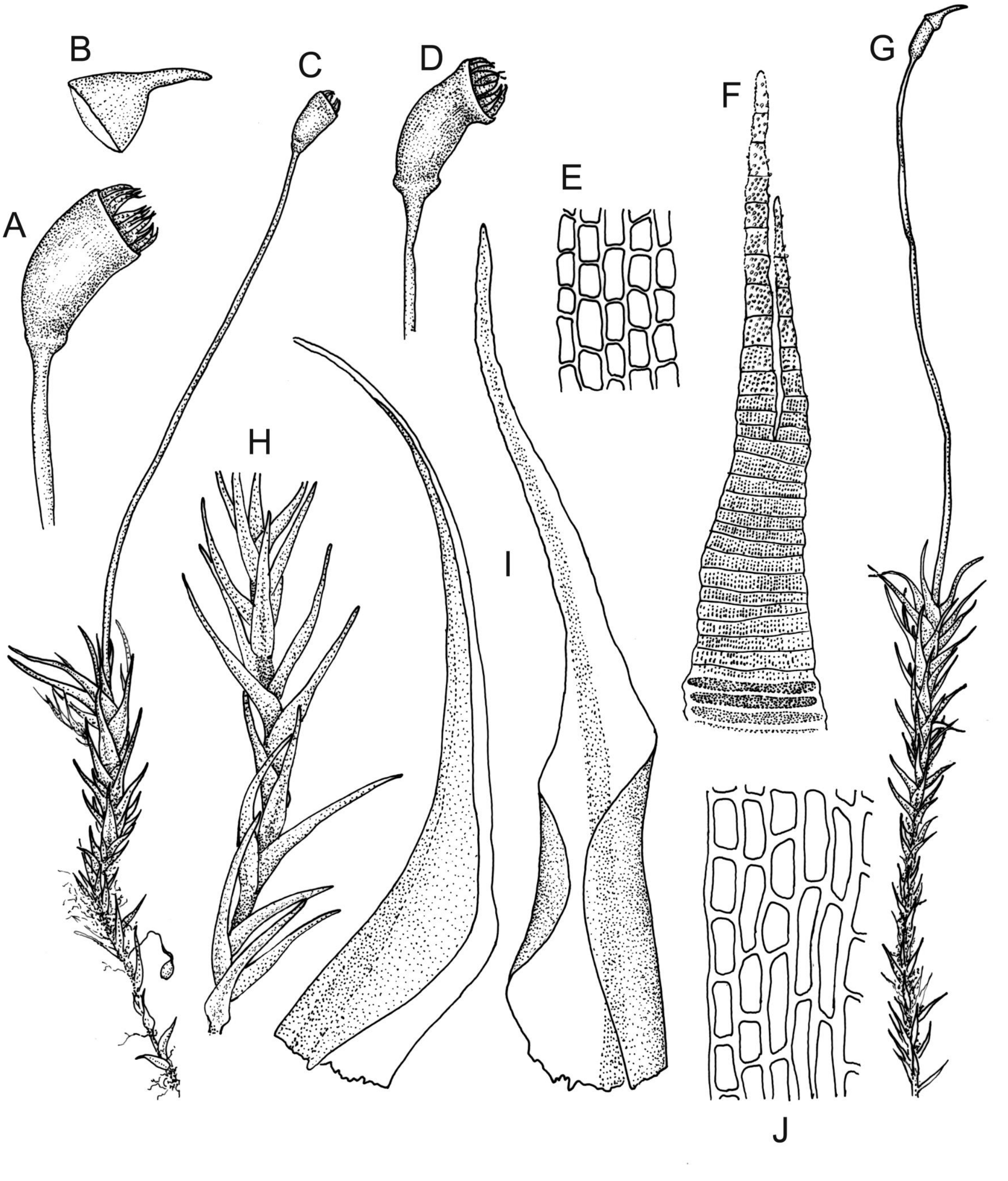


Plate 12: ***Dicranella*. A–J: *D. schreberiana***. A, capsule, moist. B, operculum, moist. C, shoot with capsule, dry. D, capsule, dry. E, exothecial cells. F, peristome tooth, outer surface showing trabeculae and striolations. G, shoot with capsule, moist. H, portion of shoot, moist. I, subperichaetial leaves. J, mid laminal cells at margin. A–F, H–J drawn from *J.T. Linzey 3145*, CHR 532366; G drawn from *P.J. Garnock-Jones 245*, CHR 267609.

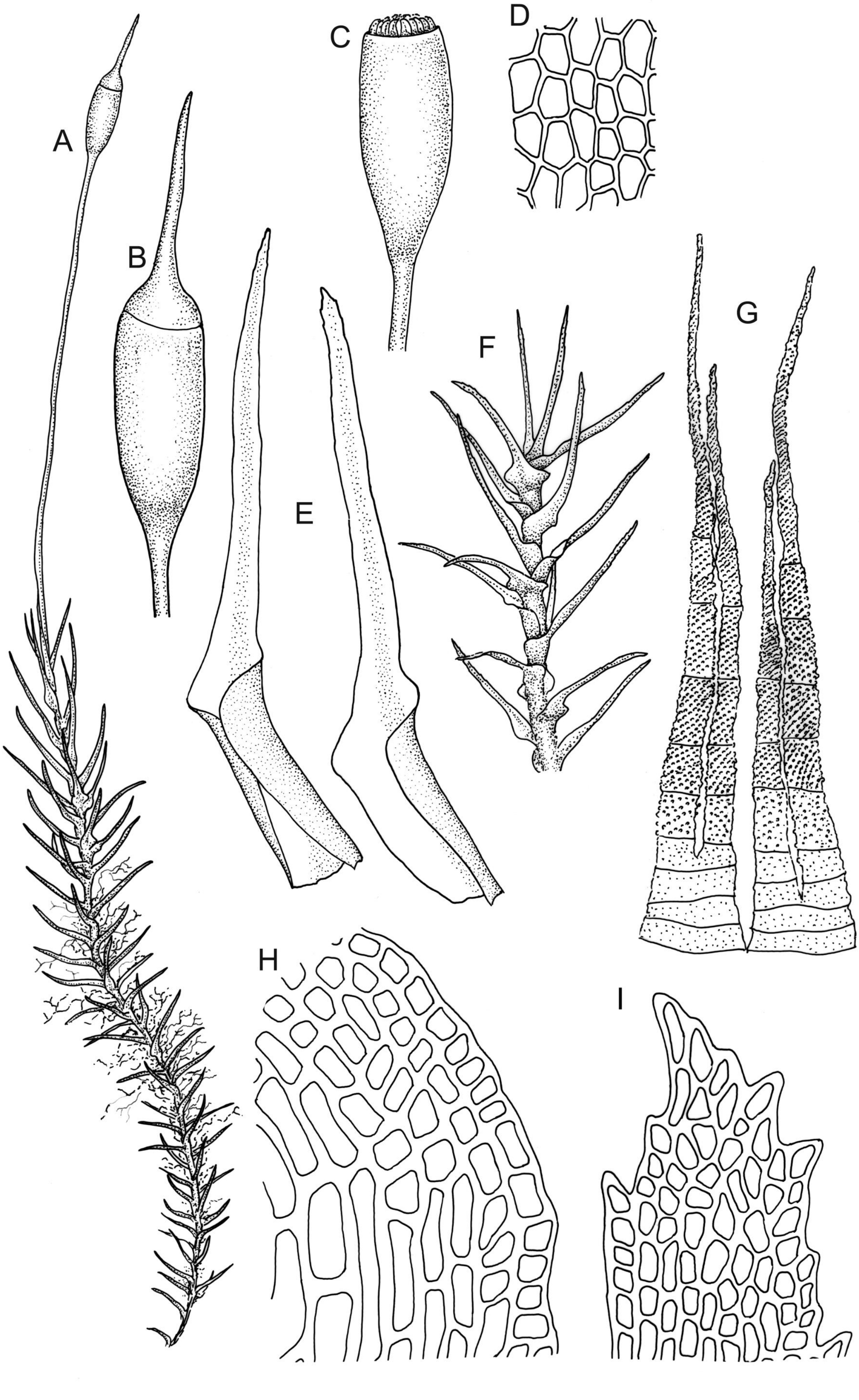


Plate 13: ***Dicranella*. A–J: *D. vaginata***. A, shoot with capsule, moist. B, capsule with operculum, moist. C, capsule, moist. D, exothecial cells. E, leaves. F, portion of shoot, moist. G, peristome teeth. H, laminal cells at shoulder. I, leaf apex. Drawn from *A.J. Fife 6024b*, CHR 405664.

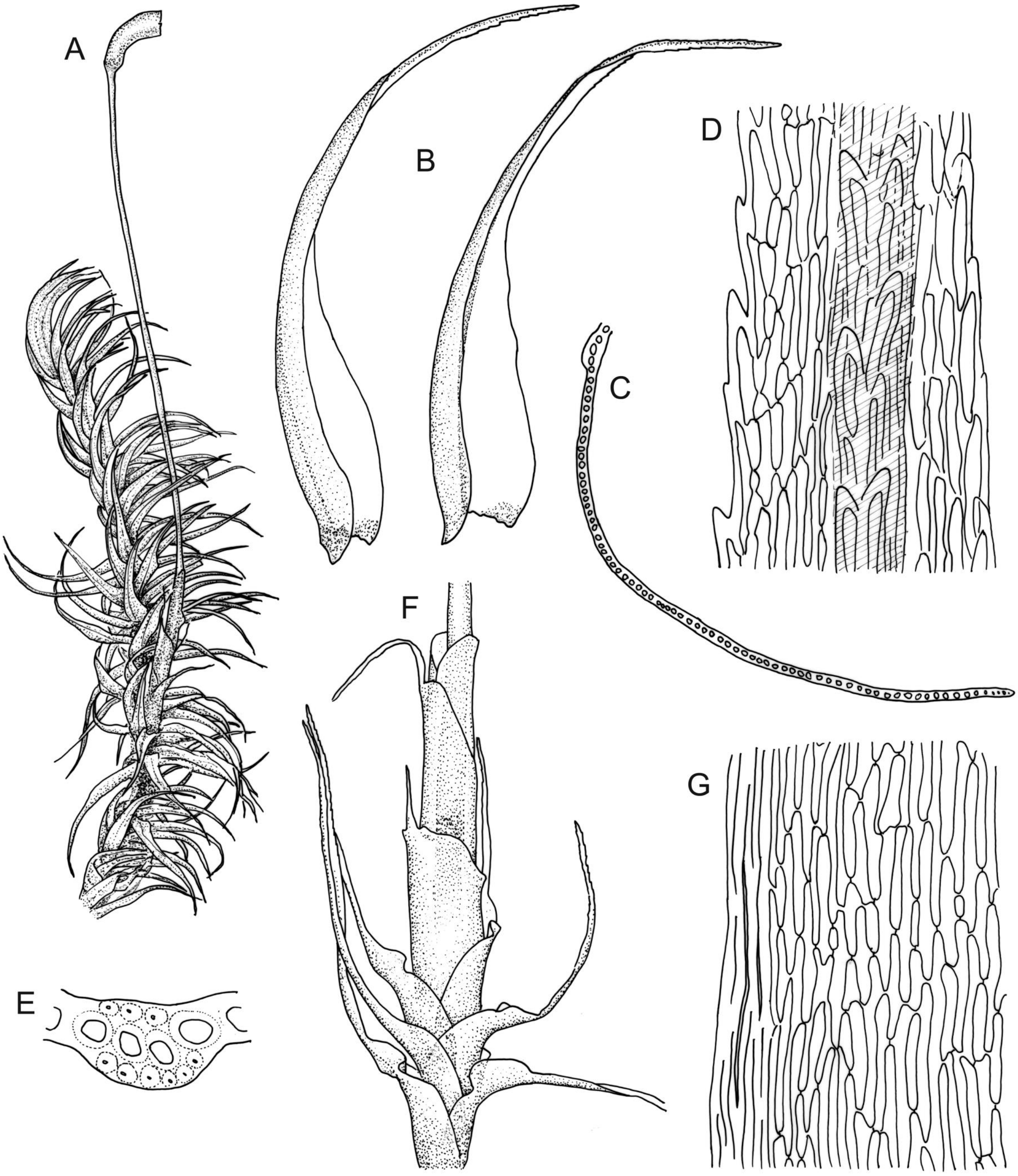


Plate 14: ***Dicranoloma*. A–G: *D. billardierei***. A, shoot with capsule, moist (peristome broken off). B, leaves. C, cross-section of laminal cells including costa, c. 1 mm above insertion. D, upper laminal cells showing margins and costa, c. ¼ below leaf apex. E, costa cross-section, mid leaf. F, perichaetium. G, mid laminal cells at margin. Drawn from *D. Petrie s.n.*, Sept. 1895, CHR 608251, and *A.J. Fife 8671*, CHR 460787.

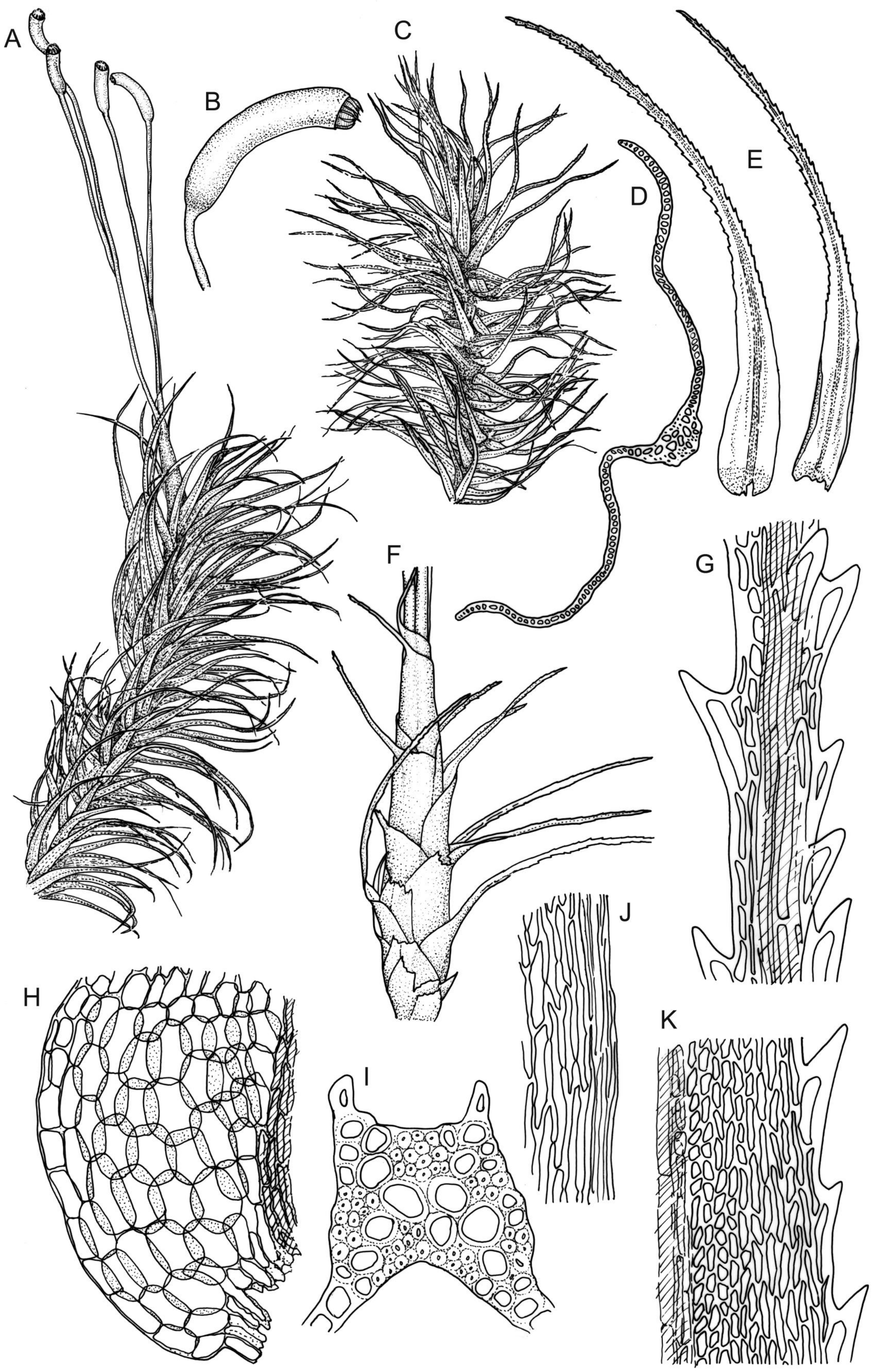


Plate 15: ***Dicranoloma*. A–K: *D. dicarpum***. A, shoot with capsules, moist. B, capsule, moist. C, portion of shoot, dry. D, cross-section of laminal cells, with costa, c. 1 mm above insertion. E, leaves. F, perichaetium. G, upper laminal cells showing margins and costa, c. ¼ below leaf apex. H, alar cells. I, costa cross-section, mid leaf. J, lower laminal cells at margin. K, mid laminal cells at margin. Drawn from *A.J. Fife 7277*, CHR 405869, and *S. McLennan s.n.*, 28 Jan. 1985, CHR 466336.

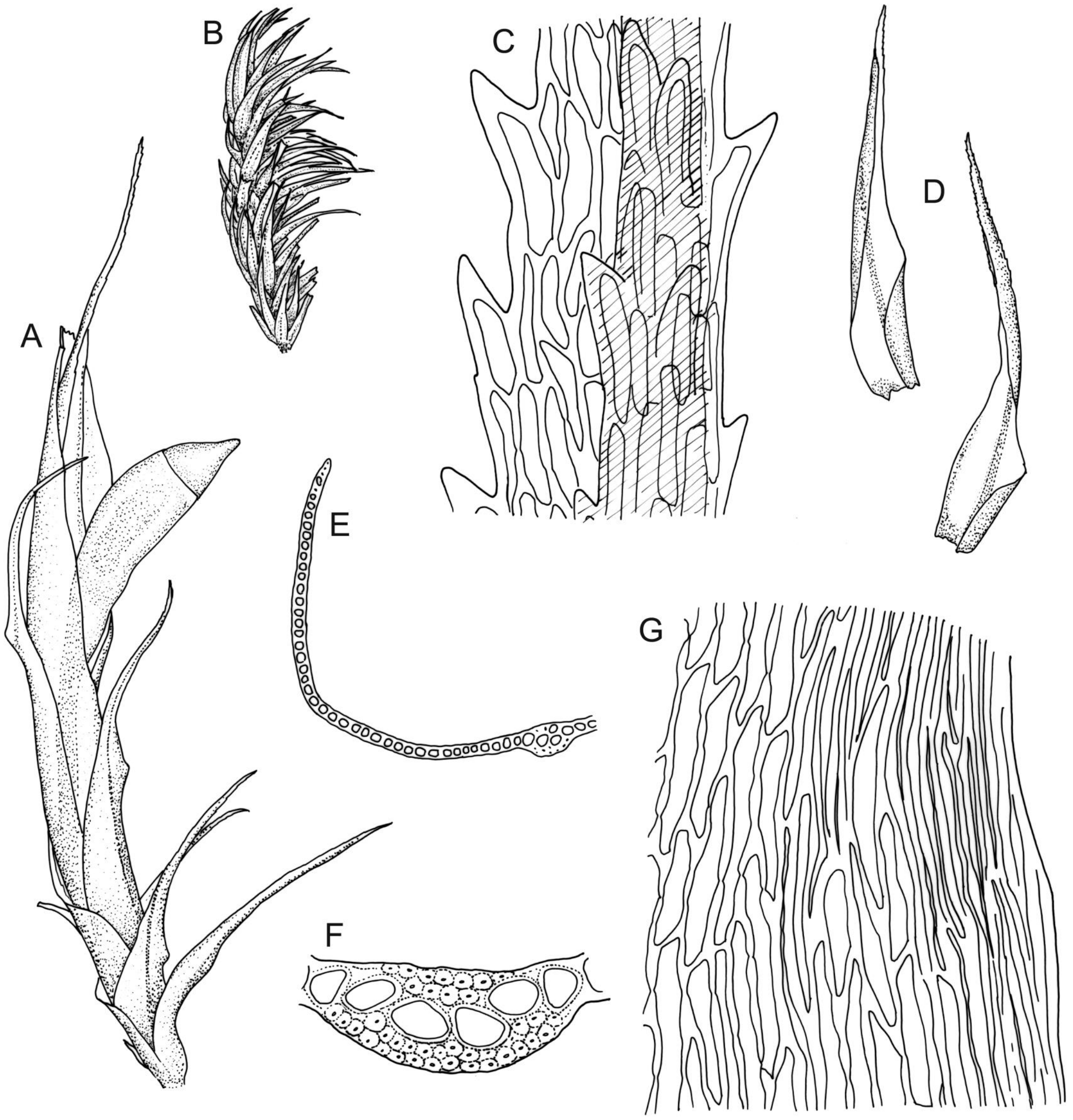


Plate 16: ***Dicranoloma*. A–G: *D. fasciatum***. A, perichaetium with capsule, moist. B, portion of sterile shoot, moist. C, upper laminal cells showing margins and costa, c. ¼ below leaf apex. D, leaves. E, cross-section of basal laminal cells including costa. F, costa cross-section, mid leaf. G, laminal cells at shoulder. Drawn from *A.J Fife 9158*, CHR 476980.

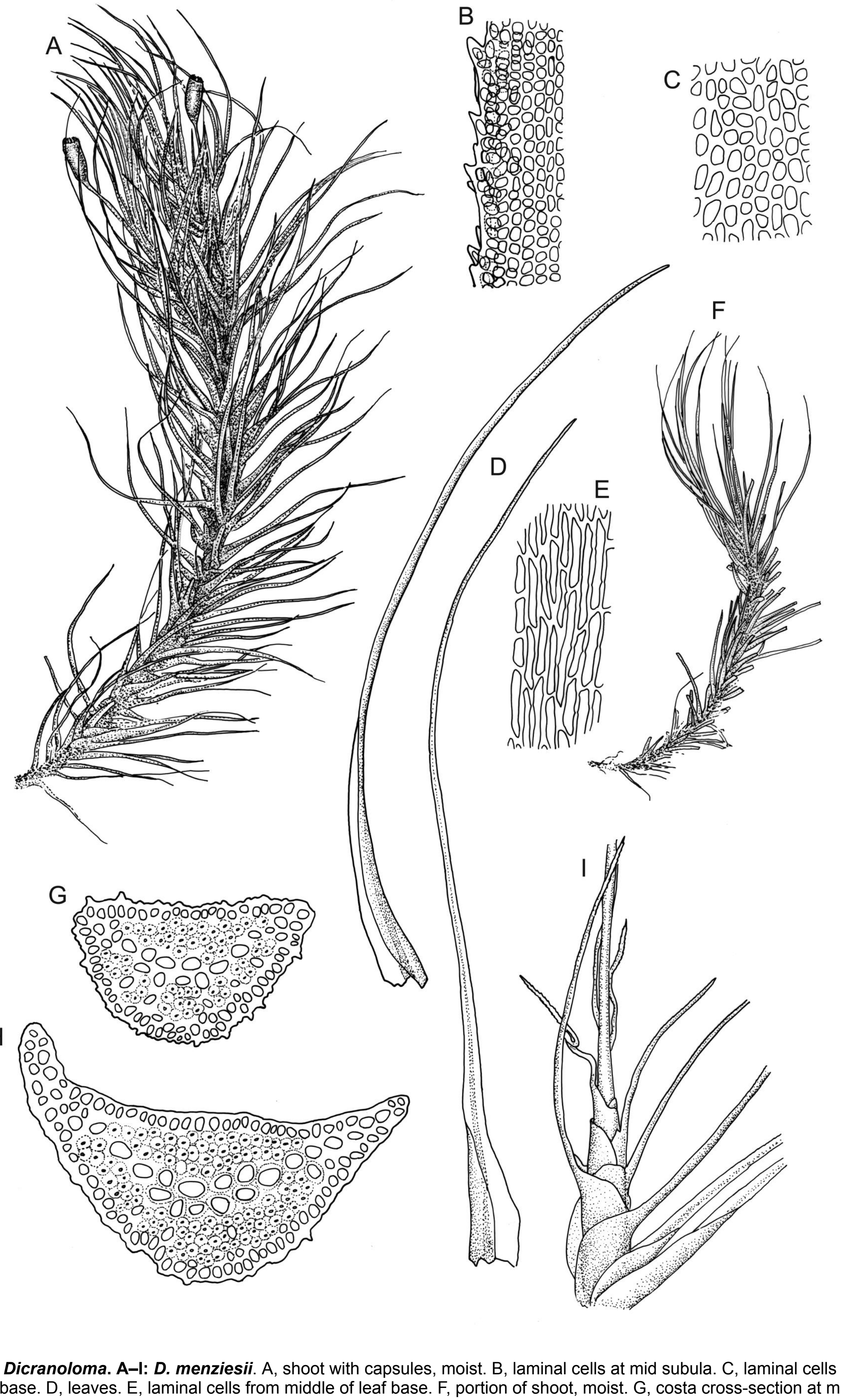


Plate 17: ***Dicranoloma*. A–I: *D. menziesii***. A, shoot with capsules, moist. B, laminal cells at mid subula. C, laminal cells of upper leaf base. D, leaves. E, laminal cells from middle of leaf base. F, portion of shoot, moist. G, costa cross-section at mid subula. H, cross-section of laminal cells and costa from upper leaf base. I, perichaetium. A–E, G–I drawn from *A.J. Fife 6080*, CHR 103447; F drawn from *B.H. Macmillan 72/1089*, CHR 164817.

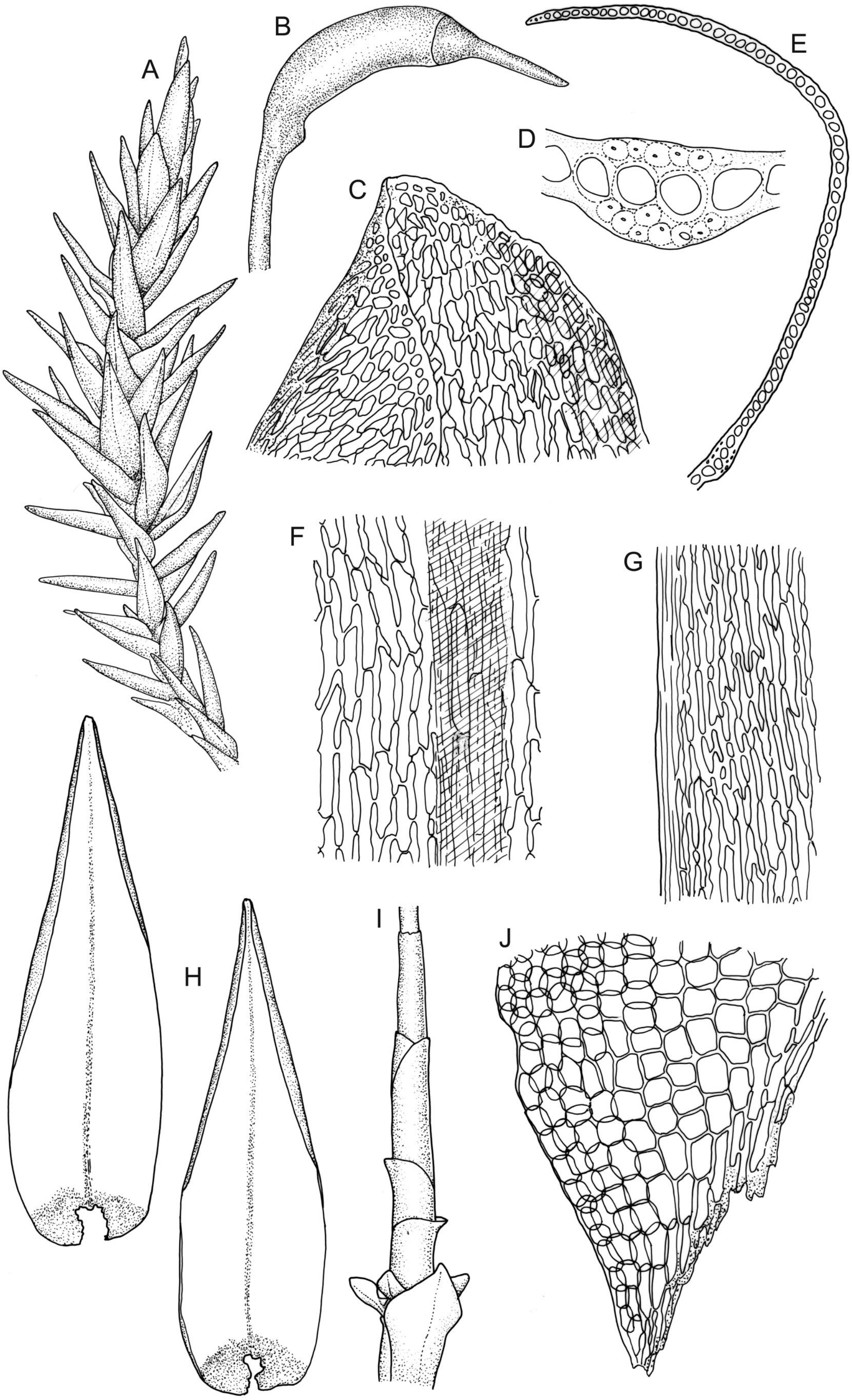


Plate 18: ***Dicranoloma*. A–J: *D. obesifolium***. A, portion of shoot, moist. B, capsule with operculum, moist. C, leaf apex. D, costa cross-section, mid leaf. E, cross-section of laminal cells with costa, c. 1 mm above insertion. F, upper laminal cells adjacent to costa, c. ¼ below apex. G, mid laminal cells at margin. H, leaves. I, perichaetium. J, alar cells. Drawn from *A.J. Fife 8434*, CHR 464665, and *W. Martin 550.1*, CHR 528805.

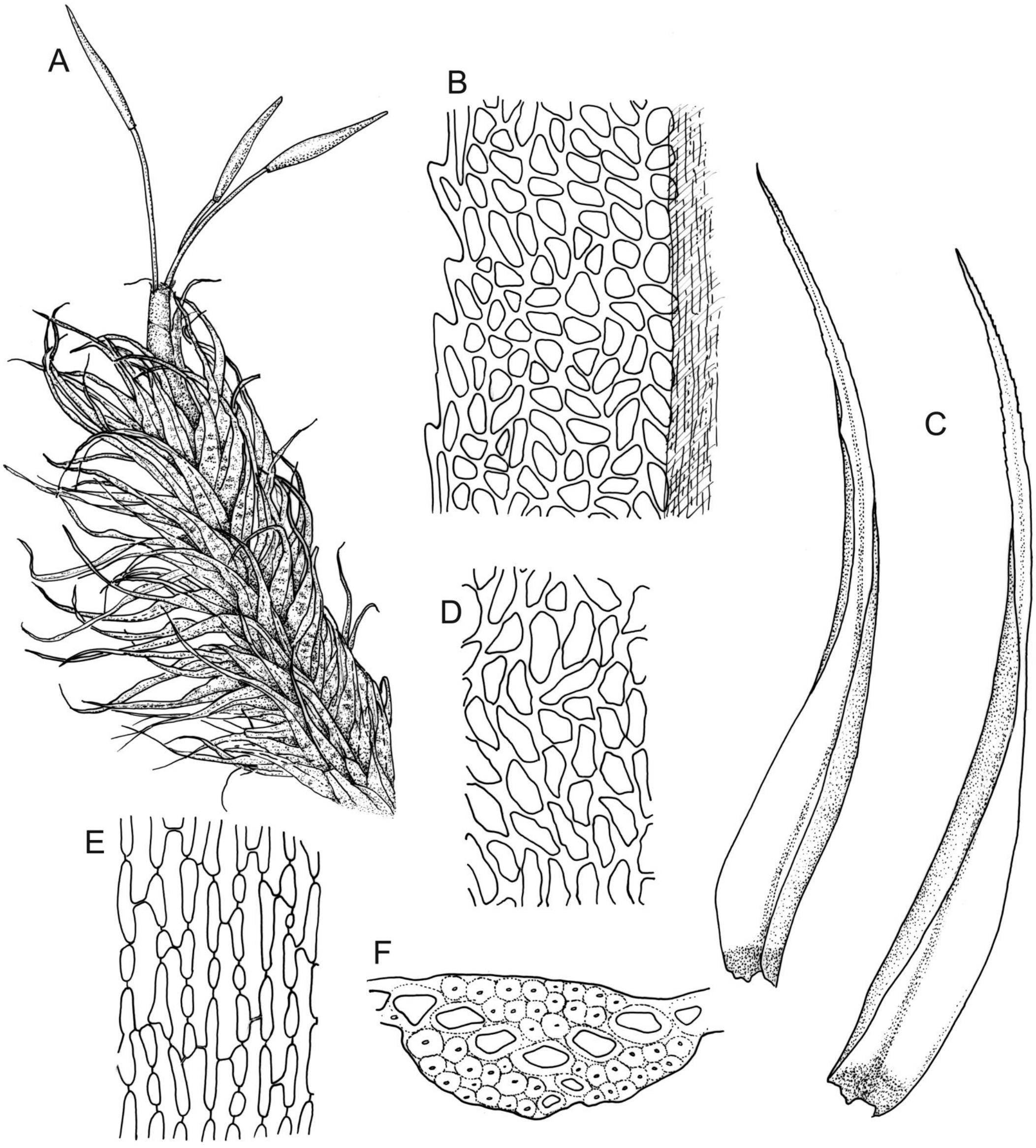


Plate 19: ***Dicranoloma*. A–F: *D. platycaulon***. A, shoot with capsules, dry. B, upper laminal cells at margin, c. ¼ below apex. C, leaves. D, mid laminal cells. E, laminal cells from middle of leaf base. F, costa cross-section, mid leaf. Drawn from isolectotype, *W. Bell s.n.*, CHR 543119.

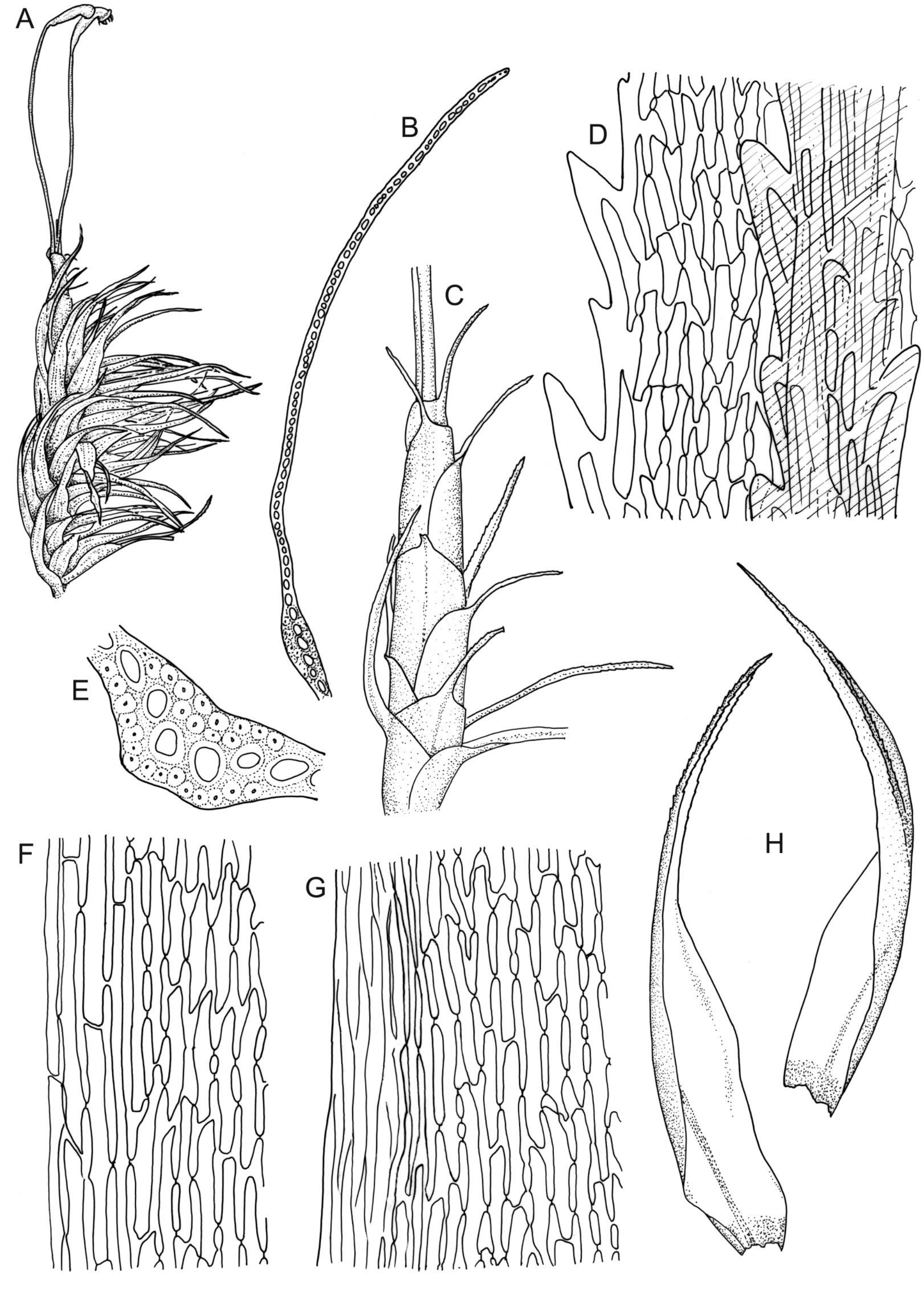


Plate 20: ***Dicranoloma*. A–H: *D. plurisetum***. A, shoot with capsules, dry. B, cross-section of laminal cells including costa, c. 1 mm above insertion. C, perichaetium. D, upper laminal cells from costa to margin, c. ¼ below apex. E, costa cross-section, mid leaf. F, mid laminal cells adjacent to costa. G, mid laminal cells at margin. H, leaves. Drawn from *A.J. Fife 8581*, CHR 464928.

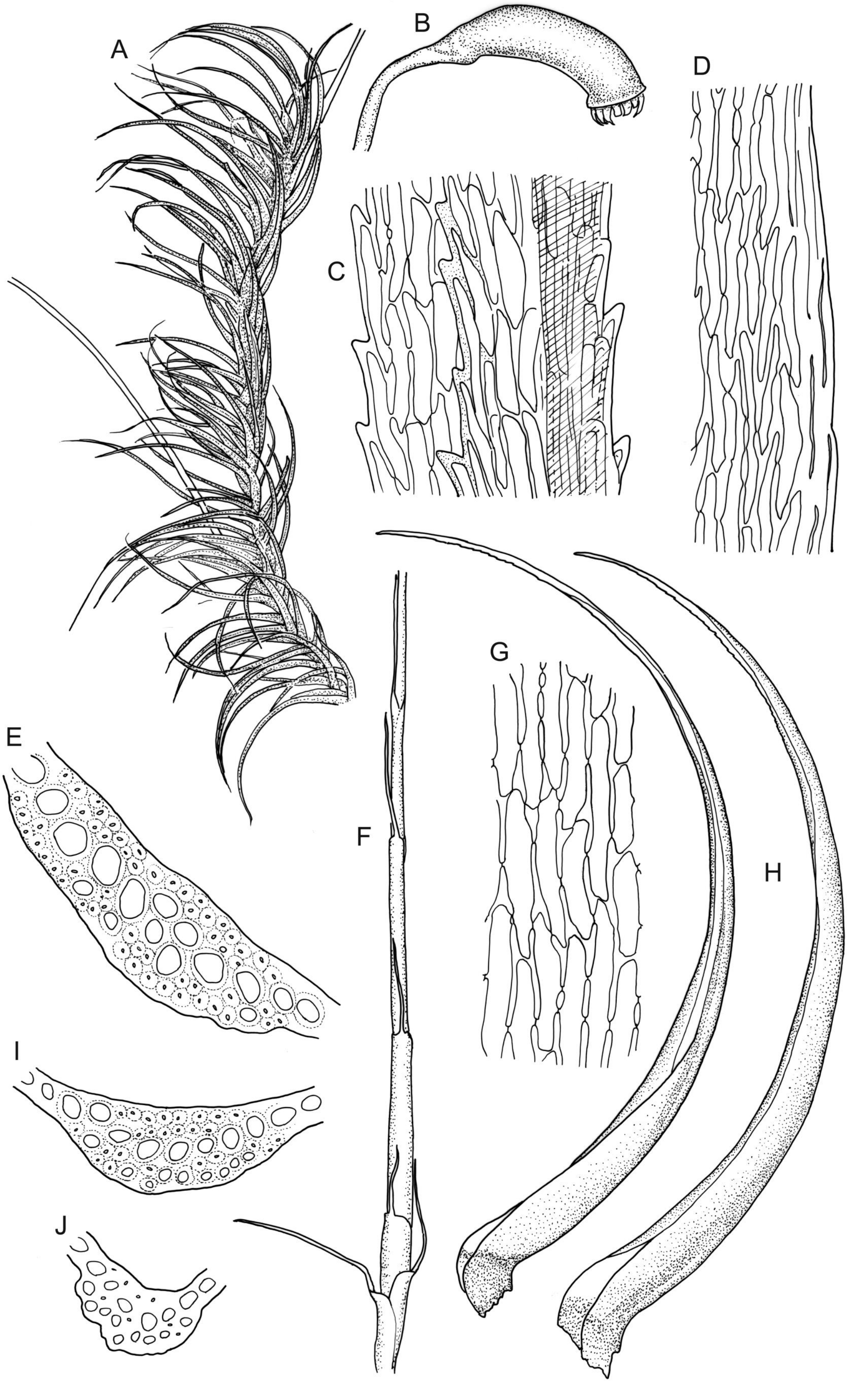


Plate 21: ***Dicranoloma*. A–J: *D. robustum* representative growth form**. A, shoot with setae, moist. B, capsule, dry. C, upper laminal cells from costa to margin, c. 2 mm below apex. D, mid laminal cells at margin. E, lower costa cross-section. F, perichaetium. G, mid laminal cells. H, leaves. I, costa cross-section, mid leaf. J, upper costa cross-section. Drawn from *R.P. Buxton 434*, CHR 436824, *A.J. Fife 8402*, CHR 460630, and *A.J. Fife 7526*, CHR 406908.

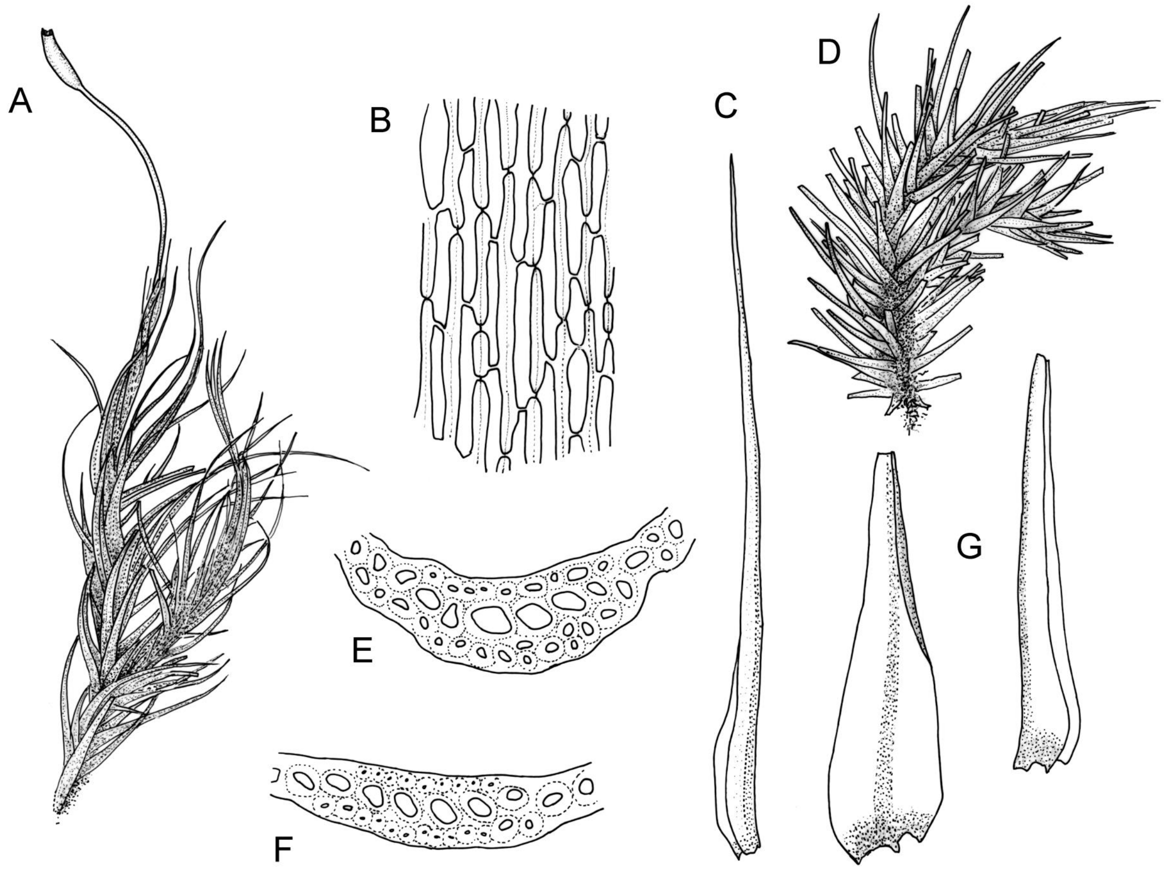


Plate 22: ***Dicranoloma*. A–G: *D. robustum* "setosum" growth form**. A, shoot with capsule, moist. B, laminal cells from fragmented leaf, just below break. C, unbroken leaf. D, portion of shoot, moist. E, costa cross-section from fragmented leaf just below break. F, lower costa cross-section. G, fragmented leaves. Drawn from *A.J. Fife 5516*, CHR 461698, and *A.J. Fife 8288*, CHR 459394.

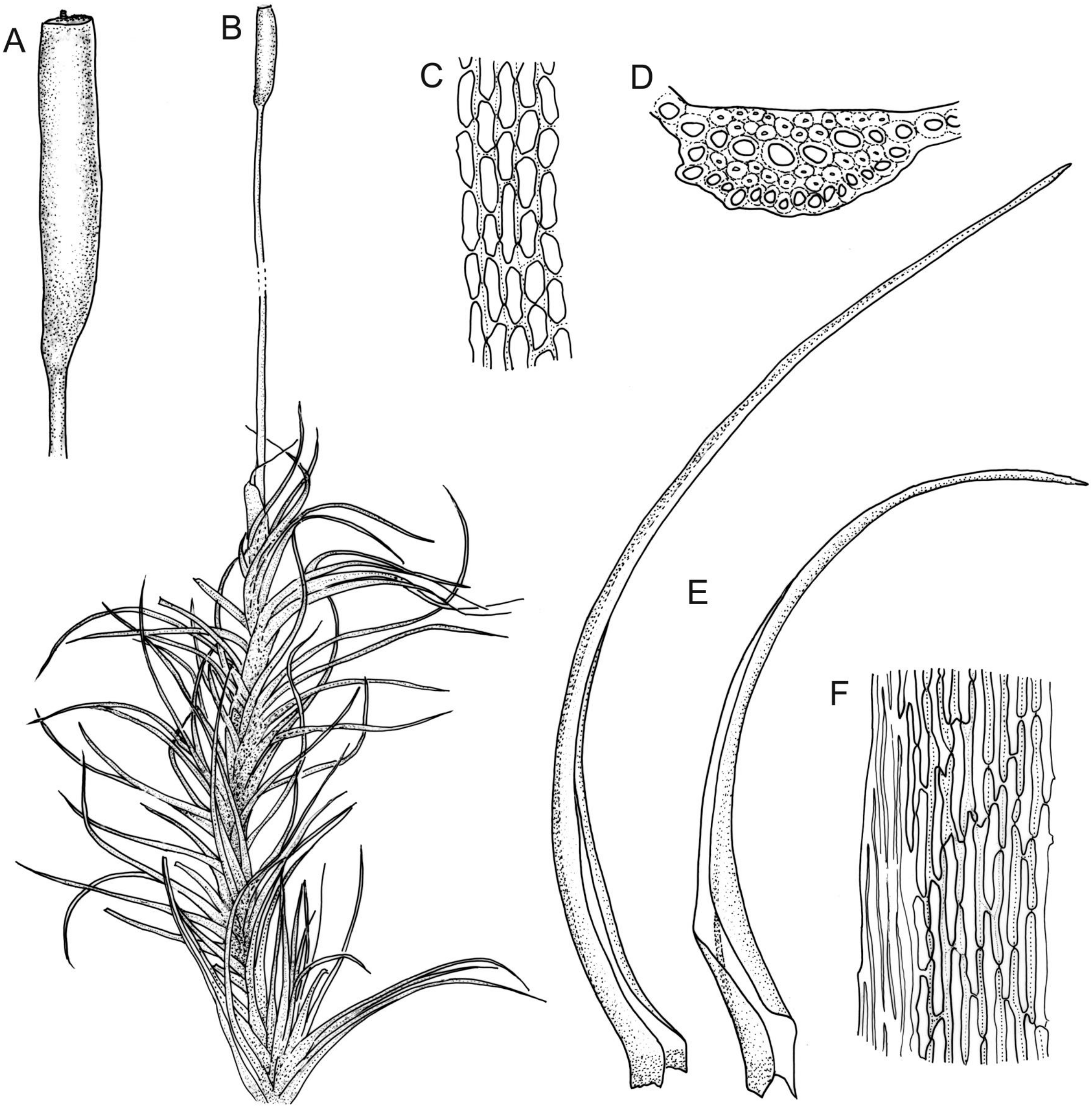


Plate 23: ***Dicranoloma*. A–F: *D. robustum* "cylindropyxis" growth form**. A, capsule, moist. B, shoot with capsule, moist. C, upper laminal cells. D, costa cross-section, mid leaf. E, leaves. F, lower laminal cells at margin. Drawn from isolectotype, *R. Helms 62*, CHR 536478.

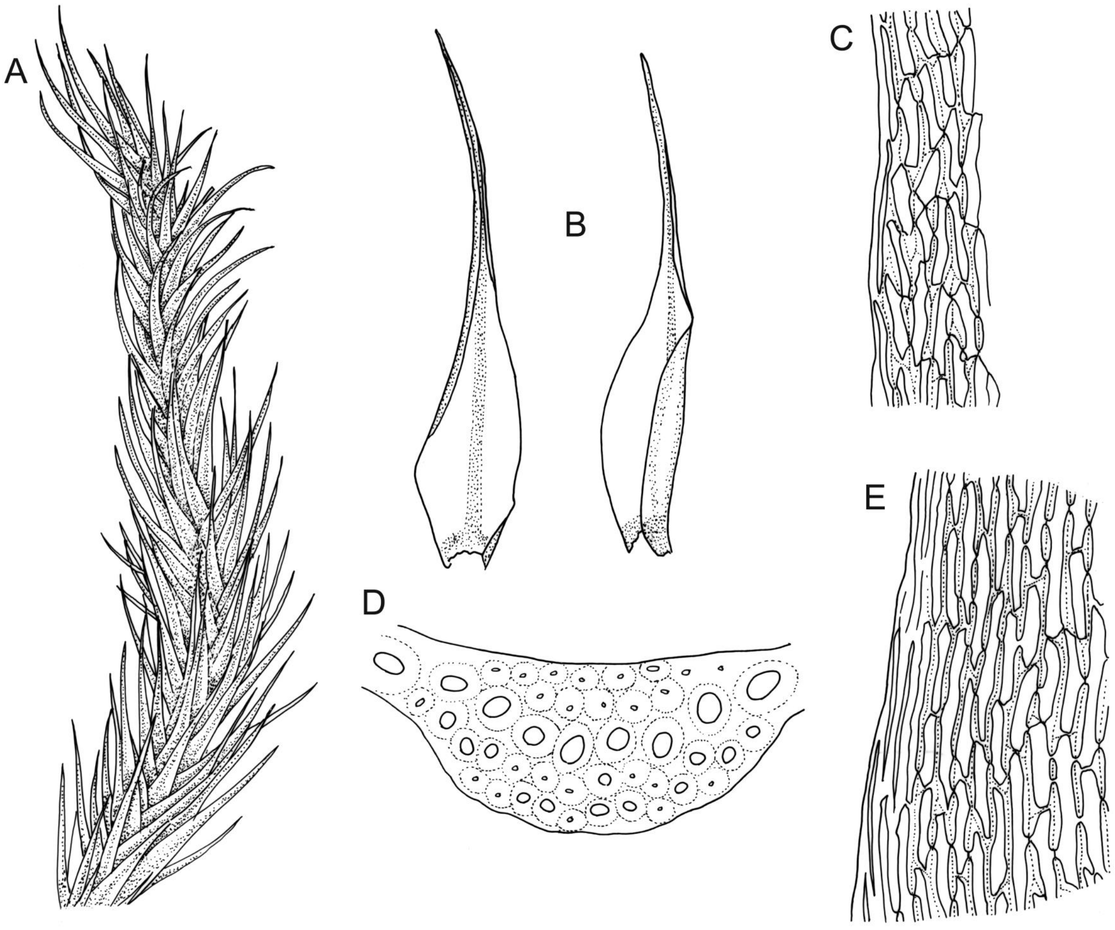


Plate 24: ***Dicranoloma*. A–E: *D. robustum* “integrifolium” growth form**. A, shoot, moist. B, leaves. C, upper laminal cells at margin. D, costa cross-section, mid leaf. E, lower laminal cells at margin. Drawn from *G.O.K. Sainsbury 590*, CHR 541110.

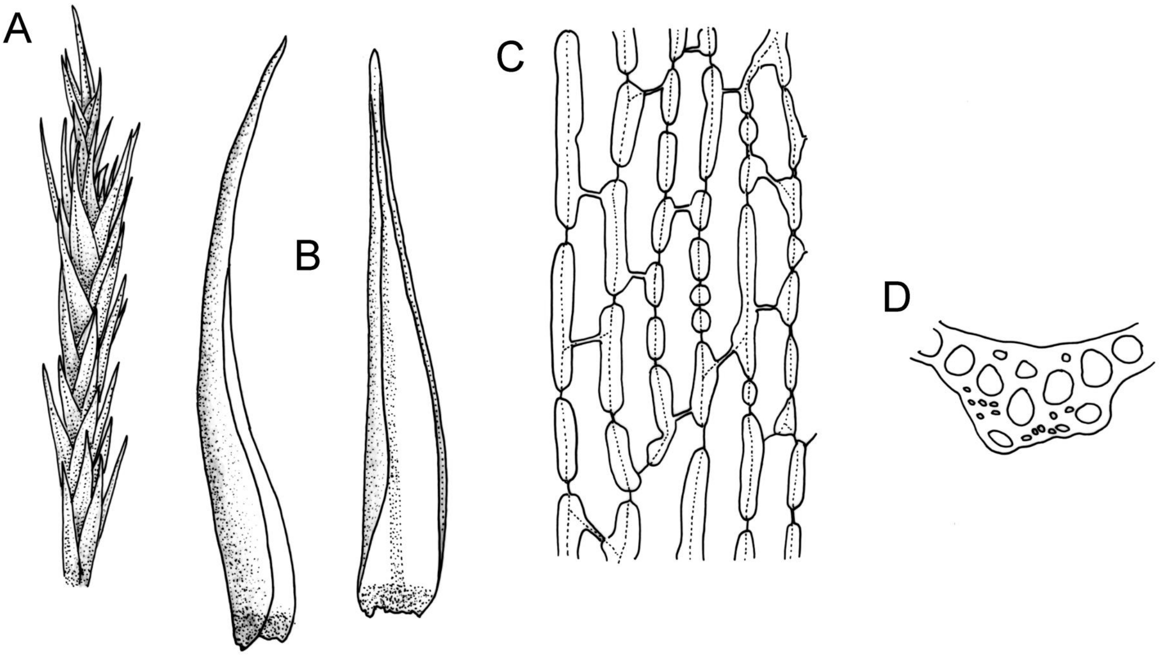


Plate 25: ***Dicranum*. A–D: *D. leioneuron***. A, portion of shoot, moist. B, leaves. C, upper median laminal cells. D, costa cross-section, mid leaf. Drawn from *A.J. Fife 11431*, CHR 567566.

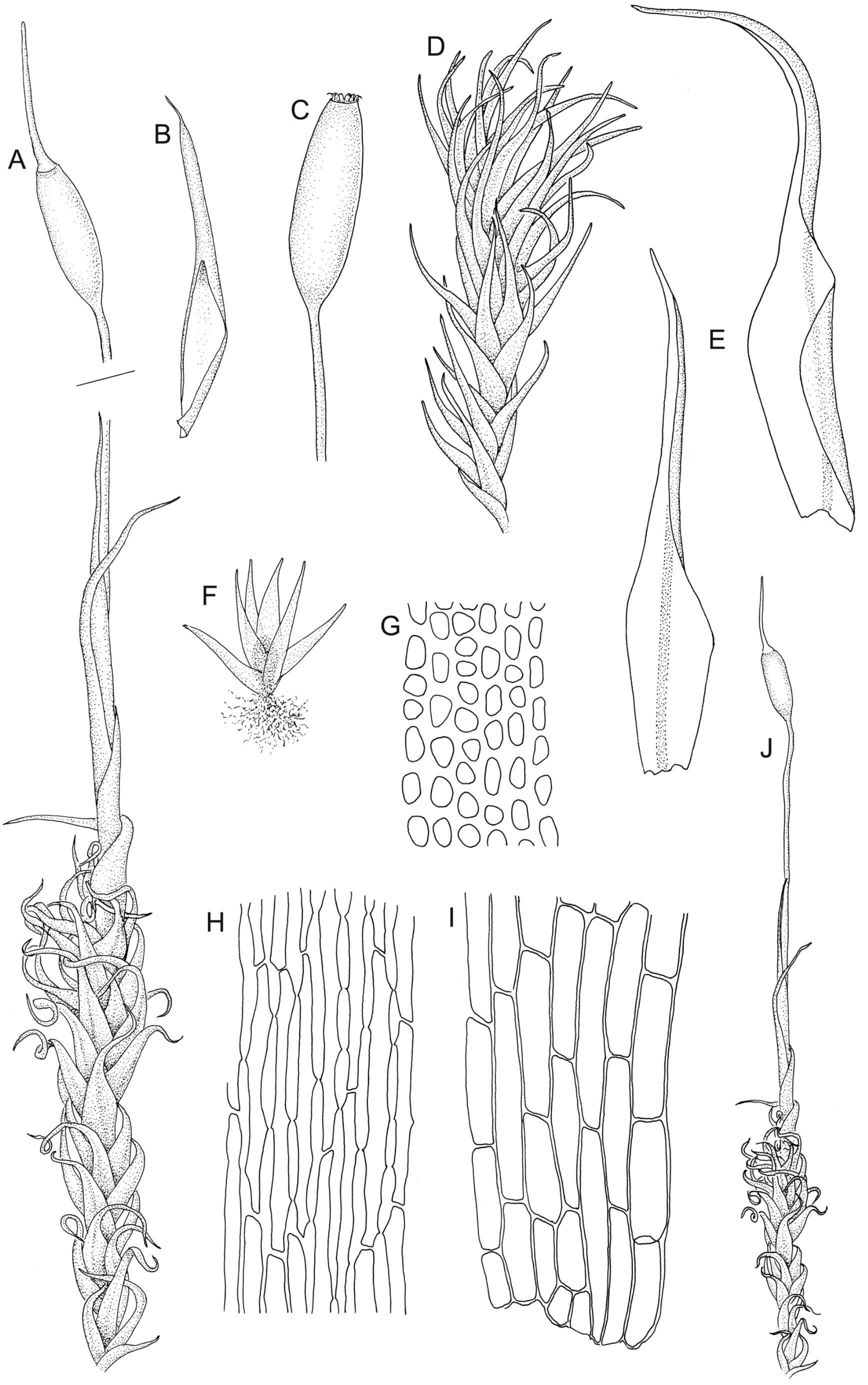


Plate 26: ***Holomitrium*. A–J: *H. perichaetiale***. A, shoot with capsule, dry. B, calyptra. C, capsule, moist. D, portion of sterile shoot, moist. E, leaves. F, perigonium. G, upper laminal cells. H, lower laminal cells. I, alar cells. J, shoot, dry. Drawn from *A.J. Fife 7473*, CHR 406880.

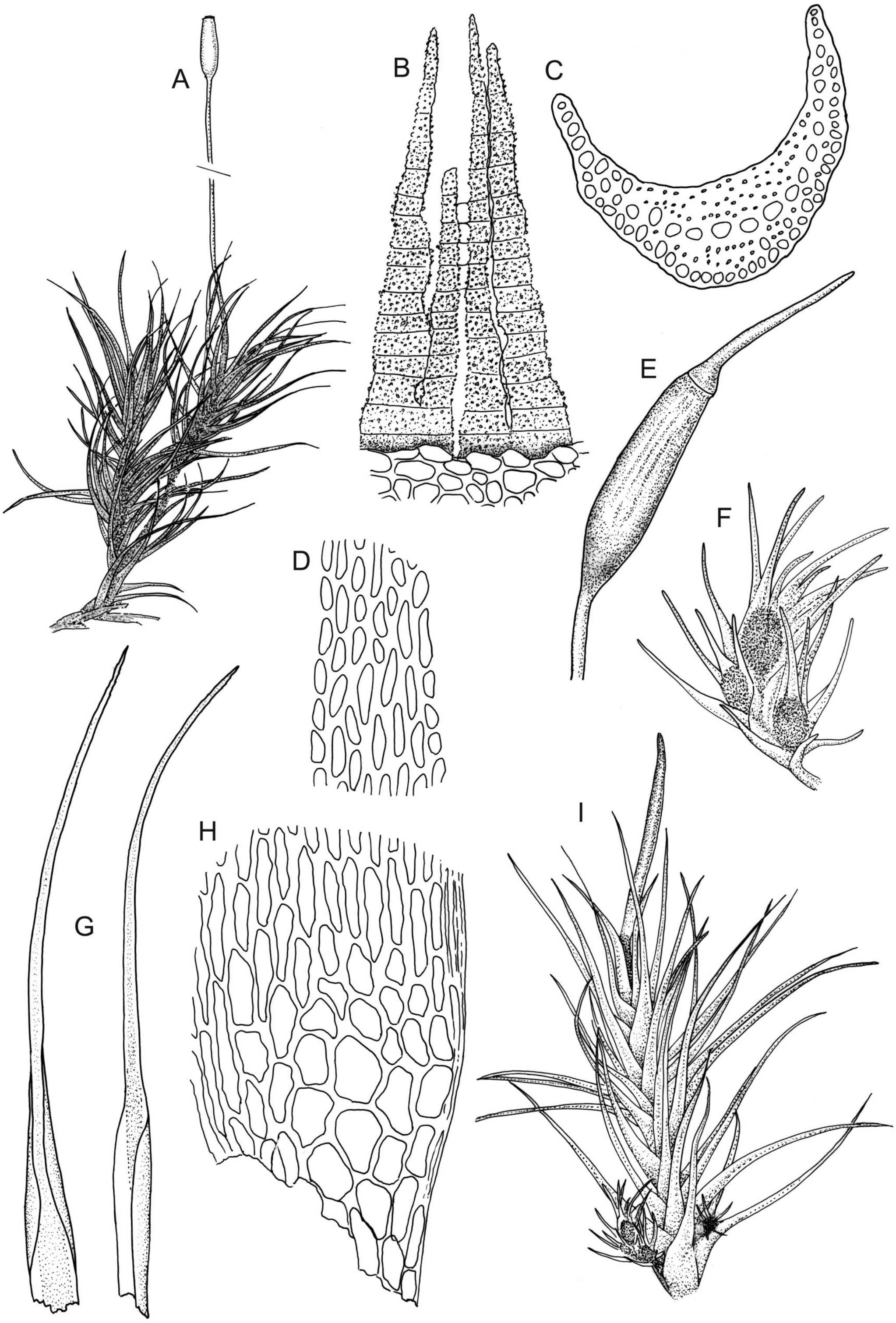


Plate 27: ***Holomitrium*. A–I: *H. trichopodum***. A, shoot with capsule, moist. B, peristome detail. C, cross-section of lower laminal cells including costa. D, mid laminal cells. E, capsule with operculum, moist. F, dwarf male, detail. G, leaves. H, alar cells. I, portion of shoot with perichaetium and dwarf epiphytic males, moist. A–D, F–I drawn from *B.H. Macmillan 89/83*, CHR 385643; E drawn from *W. Martin 155.12*, CHR 564036.

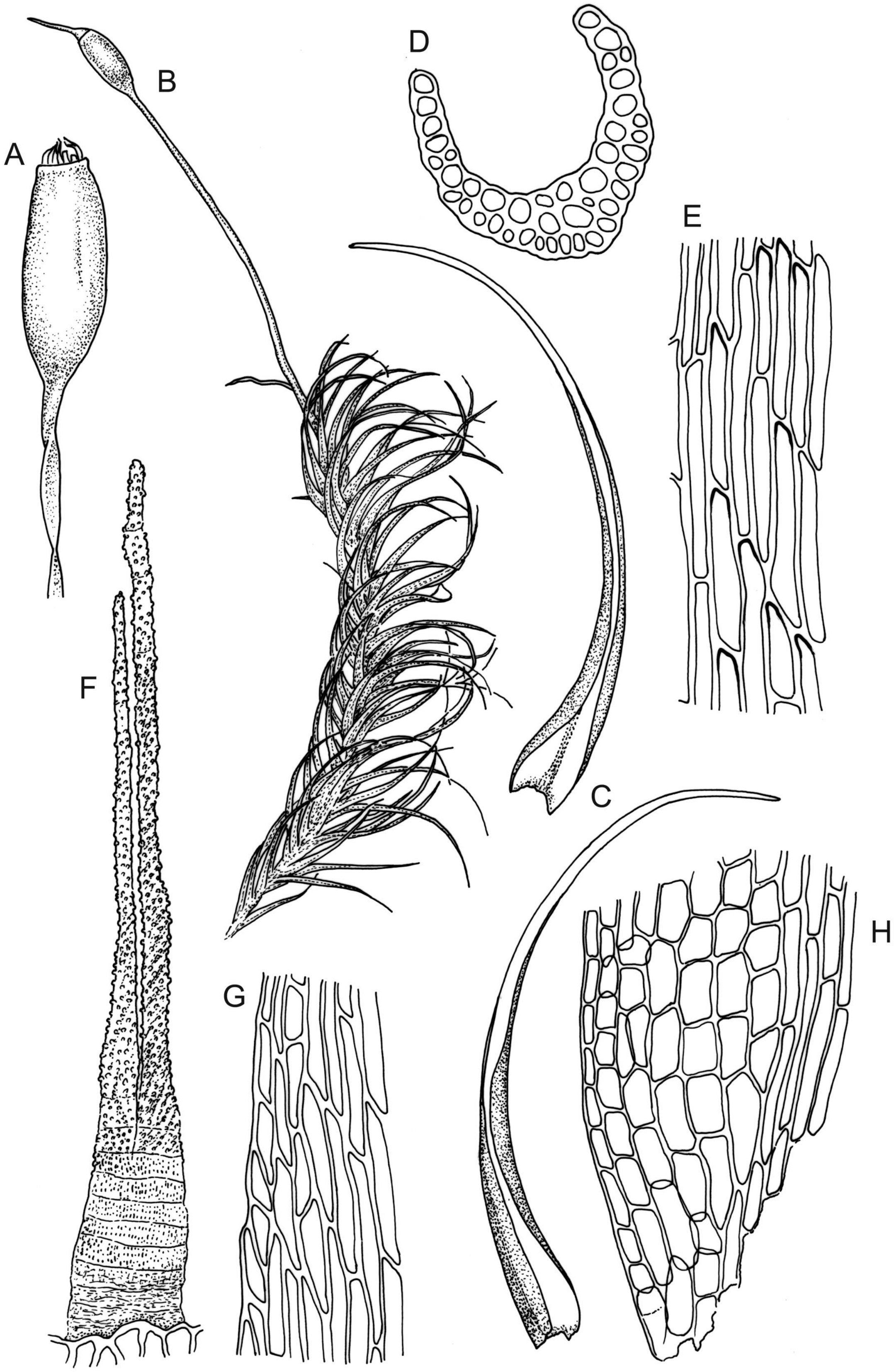


Plate 28: ***Kiaeria*. A–H: *K. pumila*.** A, capsule, moist. B, shoot with capsule, moist. C, leaves. D, cross-section of mid laminal cells including costa. E, laminal cells of leaf base, c. 300 µm above insertion. F, peristome tooth, outer surface showing trabeculae. G, mid laminal cells at margin. H, alar cells. Drawn from *A.J. Fife 7312*, CHR 406479.

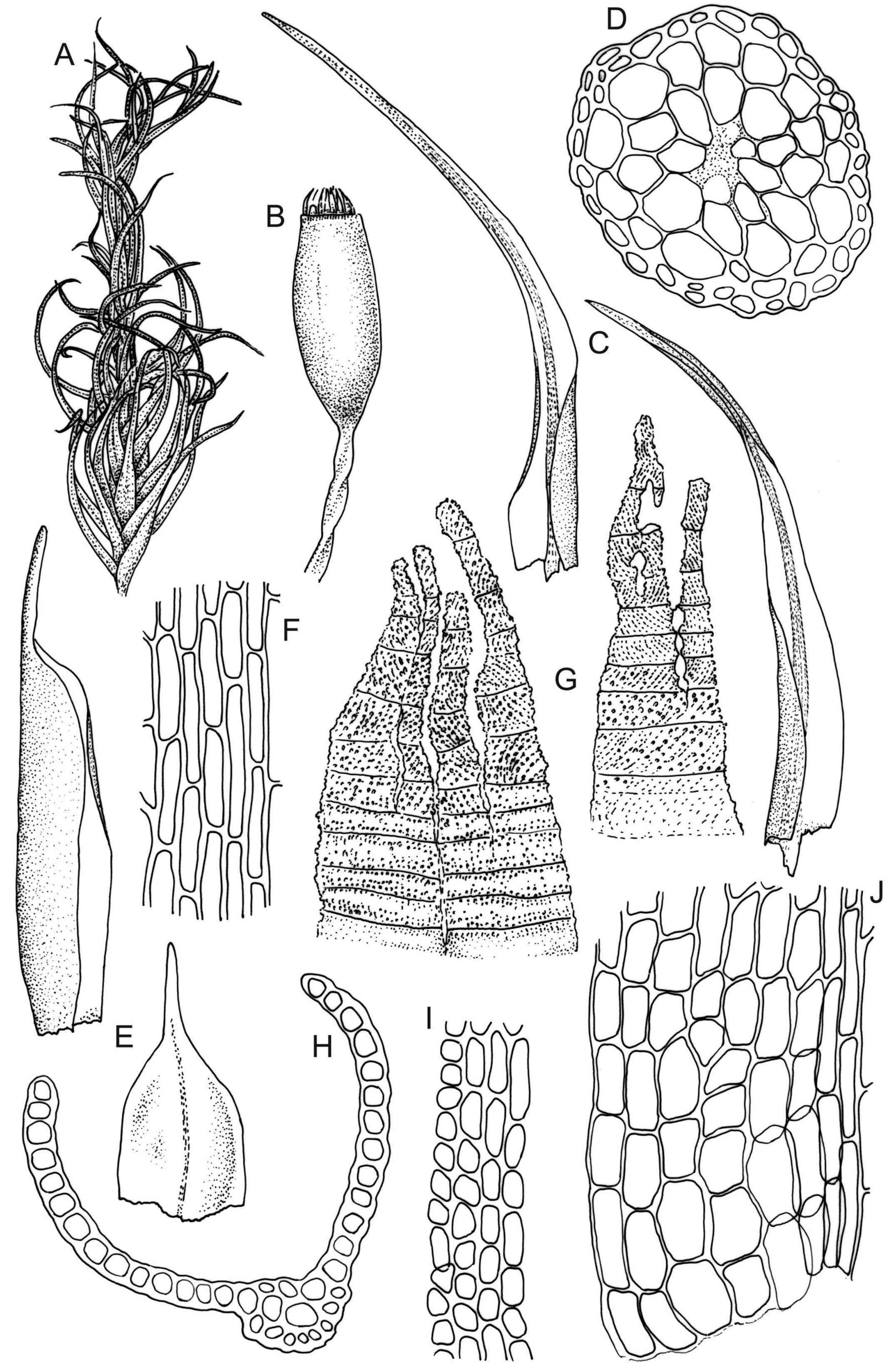


Plate 29: ***Kiaeria*. A–J: *K. spenceri***. A, portion of sterile shoot, dry. B, capsule, moist. C, leaves. D, stem cross-section. E, perichaetial leaves. F, lower laminal cells. G, peristome teeth, outer surface showing variation and trabeculae. H, cross-section of mid laminal cells including costa. I, mid laminal cells. J, alar cells. Drawn from *G.O.K. Sainsbury 5434*, CHR 535054.

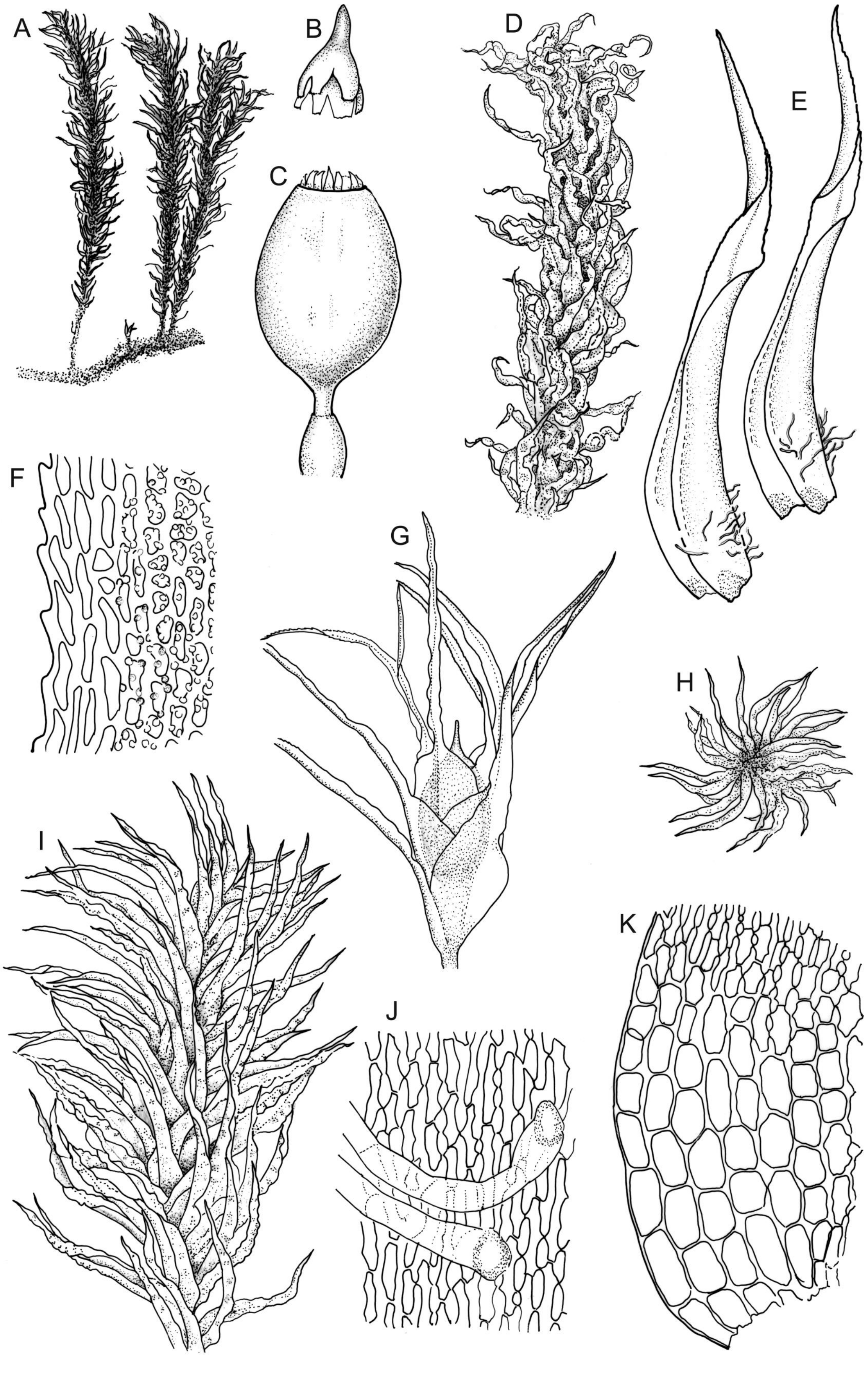


Plate 30: ***Mesotus*. A–K: *M. celatus***. A, habit, moist. B, calyptra, moist. C, capsule, moist. D, portion of shoot (branch), dry. E, branch leaves. F, laminal cells from mid limb of branch leaf, at margin. G, perichaetium with capsule. H, shoot apex, from above, moist. I, portion of shoot, moist. J, cells near insertion of branch leaf, with “nematogonous” cells and rhizoids. K, alar cells of branch leaf. Drawn from *A.J. Fife 9700*, CHR 477662, *A.J Fife 6497*, CHR 104768, and *B.H. Macmillan 97/52*, CHR 514737.

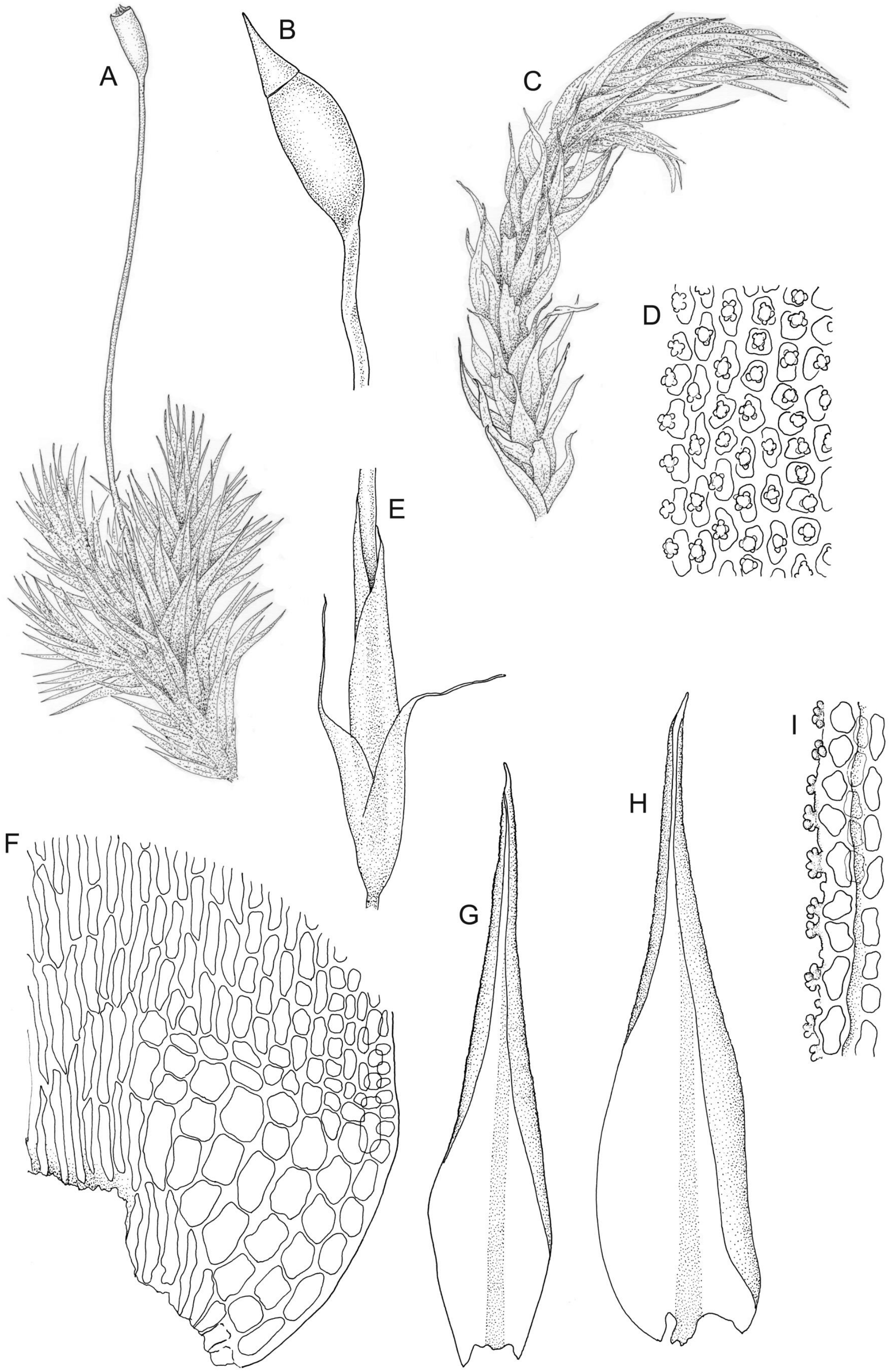
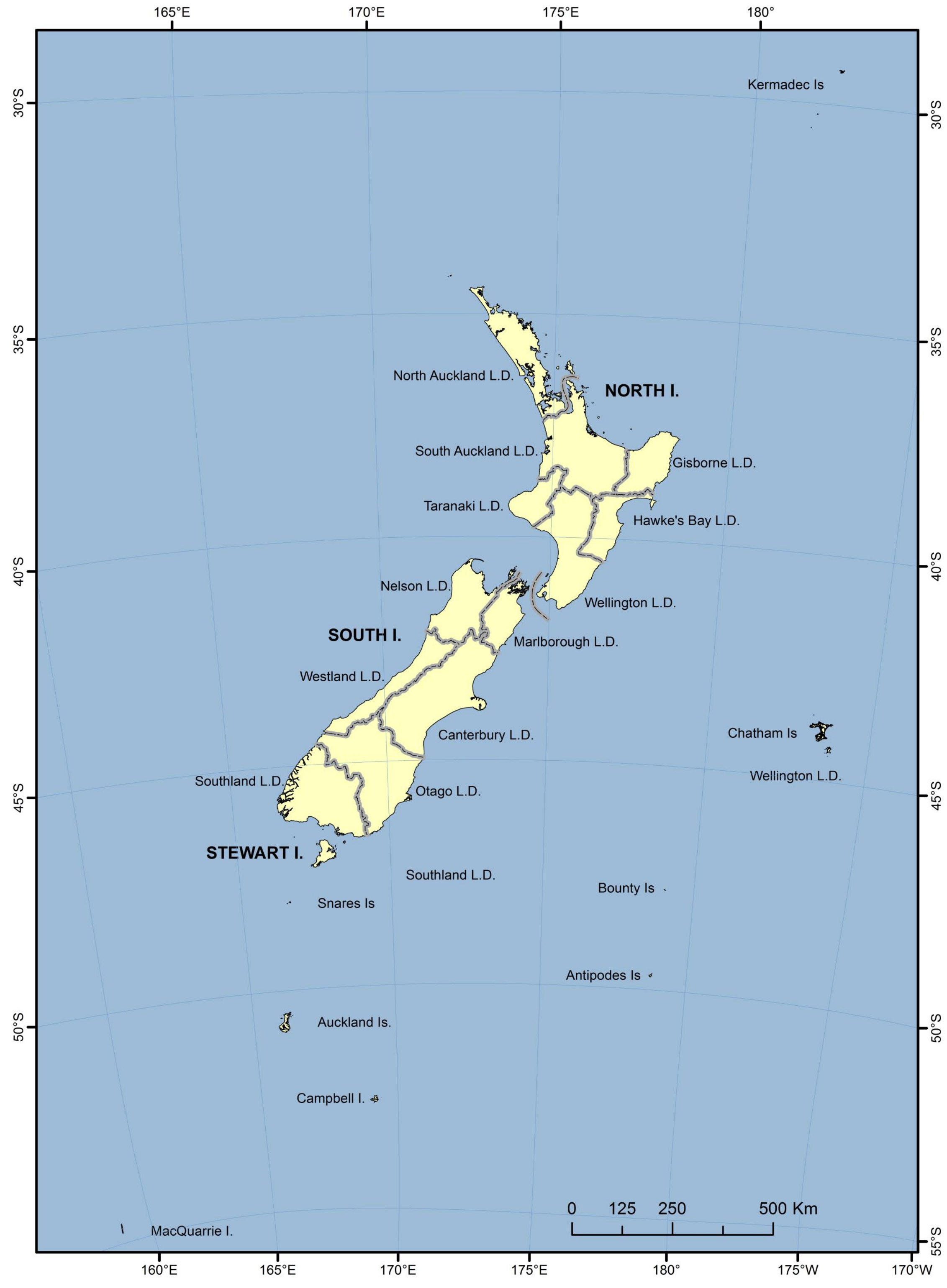
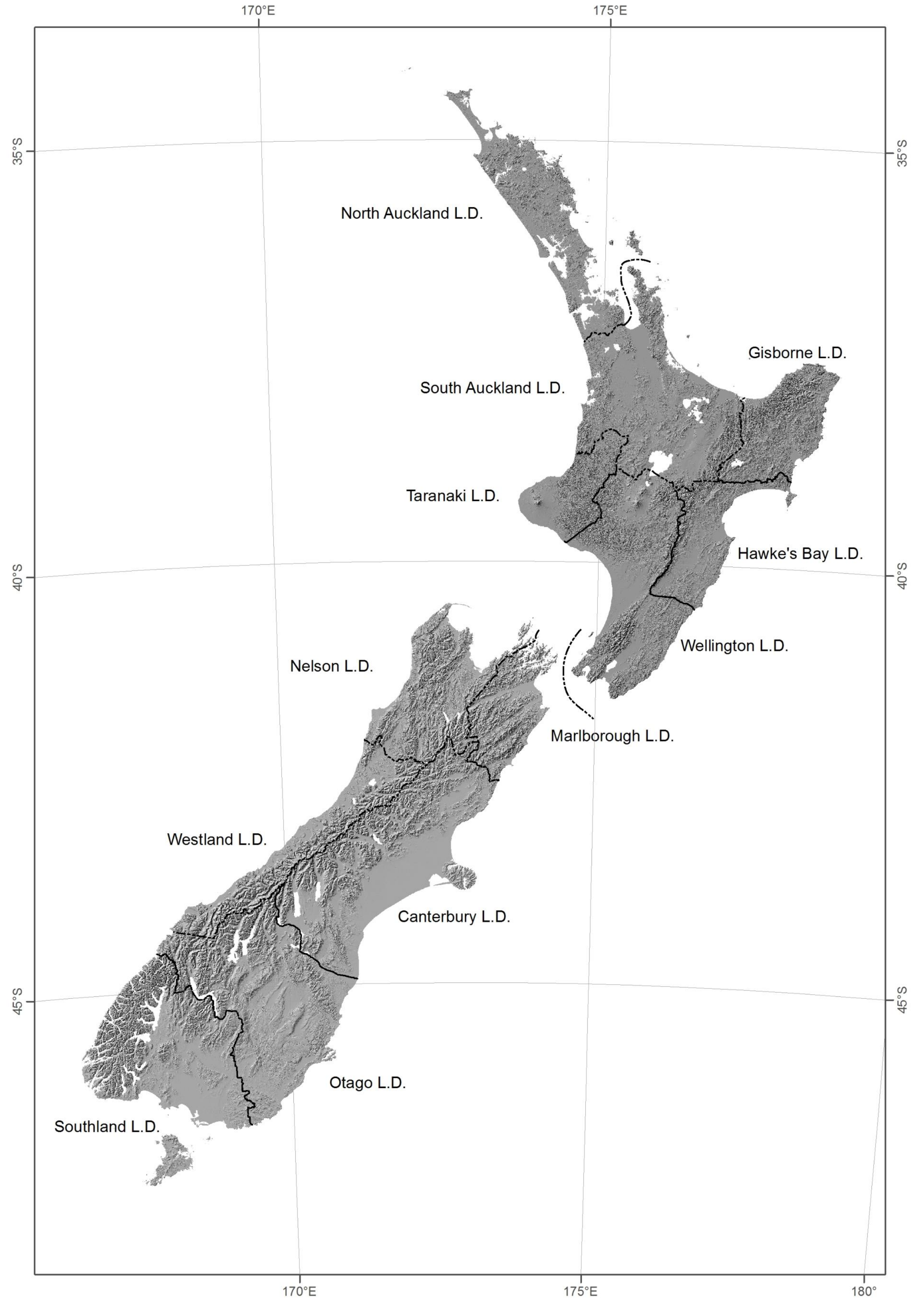


Plate 31: ***Sclerodontium*****. A–I:** ***S. pallidum***. A, portion of shoot (branch) with capsule, moist. B, capsule, dry. C, portion of shoot (branch), dry. D, upper laminal cells of branch leaf. E, perichaetium and seta base. F, alar cells of branch leaf. G, branch leaf. H, stem leaf. I, upper margin of branch leaf showing papillae. Drawn from *J.E. Beever 22-64*, CHR 104668.



Map 1: Map of New Zealand and offshore islands showing Land District boundaries



Map 2: Map of main islands of New Zealand showing Land District boundaries

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Anisothecium cardotii (R.Br.bis) Ochyra *27*
Anisothecium clathratum (Hook.f. & Wilson) Broth. *34*
Anisothecium gracillimum Beckett *30*
Anisothecium vaginatum (Hook.) Mitt. *33*
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