



FLORA OF NEW ZEALAND
MOSESSES

ORTHOTRICHACEAE



A.J. FIFE

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Cover image: *Orthotrichum assimile*, habit with capsules, moist. Redrawn by Rebecca Wagstaff with permission from Lewinsky (1984).

Contents

Introduction.....	1
Typification.....	1
New Names.....	1
Taxa	
<i>Orthotrichaceae</i>	2
<i>Leratia</i> Broth. & Paris	4
<i>Leratia obtusifolia</i> (Hook.) Goffinet	5
<i>Macrocoma</i> (Müll.Hal.) Grout	6
<i>Macrocoma tenue</i> (Hook. & Grev.) Vitt	7
<i>Macrocoma tenue</i> (Hook. & Grev.) Vitt subsp. <i>tenue</i>	7
<i>Macromitrium</i> Brid.	8
<i>Macromitrium brevicaule</i> (Besch.) Broth.	12
<i>Macromitrium gracile</i> (Hook.) Schwägr.	13
<i>Macromitrium grossirete</i> Müll.Hal.	15
<i>Macromitrium helmsii</i> Paris	17
<i>Macromitrium incurvifolium</i> (Hook. & Grev.) Schwägr.	18
<i>Macromitrium ligulaefolium</i> Broth.	19
<i>Macromitrium ligulare</i> Mitt.	20
<i>Macromitrium longipes</i> (Hook.) Schwägr.	21
<i>Macromitrium longirostre</i> (Hook.) Schwägr.	22
<i>Macromitrium longirostre</i> (Hook.) Schwägr. var. <i>longirostre</i>	23
<i>Macromitrium longirostre</i> var. <i>ramsayae</i> (Vitt) Fife comb. nov.	24
<i>Macromitrium microstomum</i> (Hook. & Grev.) Schwägr.	25
<i>Macromitrium orthophyllum</i> Mitt.	26
<i>Macromitrium prorepens</i> (Hook.) Schwägr.	28
<i>Macromitrium retusum</i> Hook.f. & Wilson	30
<i>Orthotrichum</i> Hedw.	31
<i>Orthotrichum angustifolium</i> Hook.f. & Wilson	34
<i>Orthotrichum assimile</i> Müll.Hal.	35
<i>Orthotrichum aucklandicum</i> (Vitt) Goffinet	37
<i>Orthotrichum calvum</i> Hook.f. & Wilson	37
<i>Orthotrichum crassifolium</i> Hook.f. & Wilson	39
<i>Orthotrichum crassifolium</i> Hook.f. & Wilson subsp. <i>crassifolium</i>	39
<i>Orthotrichum cupulatum</i> Brid.	40
<i>Orthotrichum cyathiforme</i> R.Br.bis	41
<i>Orthotrichum graphiomitrium</i> Müll.Hal. ex Beckett	43
<i>Orthotrichum hortense</i> Bosw.	44
<i>Orthotrichum rupestre</i> Schwägr.	45
<i>Orthotrichum rupestre</i> var. <i>papillosum</i> Lewinsky	46
<i>Orthotrichum rupestre</i> Schwägr. var. <i>rupestre</i>	47
<i>Orthotrichum sainsburyi</i> Allison	48
<i>Orthotrichum tasmanicum</i> Hook.f. & Wilson	49
<i>Orthotrichum tasmanicum</i> var. <i>parvithecum</i> (R.Br.bis) Lewinsky	50
<i>Orthotrichum tasmanicum</i> Hook.f. & Wilson var. <i>tasmanicum</i>	51
<i>Schlotheimia</i> Brid.	52
<i>Schlotheimia campbelliana</i> Müll.Hal.	53
<i>Schlotheimia knightii</i> Müll.Hal.	54
<i>Ulota</i> D.Mohr	55
<i>Ulota lutea</i> (Mitt. in Wilson) Mitt.	57
<i>Ulota membranata</i> Malta	59
<i>Ulota perichaetialis</i> (Sainsbury) Goffinet	60
<i>Ulota phyllantha</i> Brid.	61
<i>Ulota viridis</i> Venturi	62
<i>Zygodon</i> Hook. & Taylor	63
<i>Zygodon gracillimus</i> M.Fleisch.	65
<i>Zygodon hookeri</i> Hampe	66
<i>Zygodon intermedius</i> Bruch & Schimp.	67
<i>Zygodon menziesii</i> (Schwägr.) Arn.	69
<i>Zygodon minutus</i> Müll.Hal. & Hampe	71
<i>Zygodon rufescens</i> (Hampe) Broth.	72
References	74
Conventions	79

Acknowledgements	82
Plates	83
Maps	109
Index	111
Image Information	113

Introduction

The Orthotrichaceae are one of the largest and most diverse of moss families, with up to 27 genera and perhaps as many as 600 species worldwide. The plants are xerophytes and mostly grow on bark or on rock. The family is cosmopolitan in distribution, but most diverse in tropical and temperate regions. Regionally, many common species can be readily identified in the field by easily observed features, while others require detailed microscopic examination. Not all material can be named with confidence, particularly when sporophytes are absent.

The Orthotrichaceae have undergone a great deal of systematic and taxonomic change in recent years. In the late twentieth century, the New Zealand Orthotrichaceae were studied in detail by world authorities in the family and the taxonomic revisions of many of our taxa by D.H. Vitt and the late Jette Lewinsky and their co-workers provide the foundation on which this treatment is based. Recent phylogenetic treatments (mostly by Goffinet and co-workers) support dividing the family into two subfamilies, each including two tribes. Some intra-familial relationships, particularly involving the smaller but sometimes critical genera, remain poorly understood despite the application of molecular methods. Seven genera (*Leratia*, *Macrocoma*, *Macromitrium*, *Orthotrichum*, *Schlotheimia*, *Ulota*, and *Zygodon*) and 40 species are accepted as occurring in N.Z., with the largest genera, *Macromitrium* and *Orthotrichum*, each including 12 species regionally.

New Names

The following new combination is made in accordance with the International Code of Nomenclature for Plants, Algae and Fungi.

***Macromitrium longirostre* var. *ramsayae* (Vitt) Fife comb. nov.**

BASIONYM: *Macromitrium ramsayae* Vitt, J. Hattori Bot. Lab. 54: 14 (1983)

HOLOTYPE: N.Z., Chatham Is., *Gilpin*, June 1942, WELT M005321! Isotype: CHR 618658!

Typification

The following typifications are designated in accordance with the International Code of Nomenclature for Plants, Algae and Fungi.

***Bryodixonia perichaetialis* Sainsbury, Trans. & Proc. Roy. Soc. New Zealand 75(2): 177 (1945)**

Lectotype (designated here): N.Z., Mt Egmont, Fanthams Peak Track, 16 Jan. 1945, *G.O.K. Sainsbury* 6005, WELT M005688! Isolectotype (designated here): CHR 570720!

***Ulota breviseta* Malta, Acta Horti Bot. Univ. Latv. 7: 9 (1933)**

Lectotype (designated here): N.Z., "Mungatui," [Maungatua?] Jan. 1888, *W. Bell*, H-Brotherus 433701!

The *W. Bell* collection is apparently the only one of three syntypes present in the Brotherus herbarium and is the source of most of Malta's illustrations.

***Ulota dixonii* Malta, Acta Horti Bot. Univ. Latv. 7: 19 (1933)**

Lectotype (designated here): Tasmania, Hartz Mtns, on limbs of tree, alt. 3000 ft. 7 Jan. 1908, *W.A. Weymouth* 2299, H-Brotherus 4336006 *pro parte*!

***Ulota laticiliata* Malta, Acta Horti Bot. Univ. Latv. 7: 11 (1933)**

Lectotype (designated here): Tasmania, S.E. Coast, Recherche Bay, Moss Glen, at sea level, on apple trees, 17 Jan. 1911, *W.A. Weymouth* 2487, H-Brotherus 4336012! Isolectotype (designated here): HO 71749!

***Ulota viridis* var. *adpressa* Mitt. ex Malta, Acta Horti Bot. Univ. Latv. 7: 22 (1933)**

Lectotype (designated here): N.Z., Otago, Mt Bonpland, Jan. 1890, *W. Bell*, H-Brotherus 4337001!
Isolectotype (designated here): CHR 570721!

Orthotrichaceae

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

Plants small to robust, mostly dull, forming dark green, red-brown, green-brown, or yellow-green tufts, cushions, or mats on bark or rock. **Stems** erect and often forked or creeping and giving rise to numerous erect, simple, or forked branches, in cross-section lacking a central strand. **Leaves** crowded, erect-spreading to squarrose-recurved when moist, erect, spirally twisted, crisped, or flexuose when dry, sometimes undulate or rugose, \pm keeled, lingulate, ovate-lanceolate, or linear-lanceolate, at apex acute, rounded-obtuse, or occasionally acuminate, apiculate, or hair-pointed; **margins** plane to revolute or rarely incurved; **upper laminal cells** mostly rounded-hexagonal, rarely elongate, thick-walled, usually papillose but less often smooth, unistratose to multistratose; **marginal cells** rarely differentiated by shape but often bistratose; **basal cells** linear, subquadrate, rectangular, sometimes pigmented, smooth, bulging, papillose, prorate, or tuberculate; **alar cells** rarely differentiated. **Costa** single and strong, ending near the apex or excurrent. **Gemmae** occasional, either in leaf axils, on abaxial surface of lamina or on an excurrent extension of the costa. **Paraphyllia** absent.

Sexuality variable. **Perichaetia** terminal on branches or stems; **perichaetial leaves** sometimes enlarged. **Perigonia** gemmiform, terminal or lateral, sometimes produced by dwarf male plants. **Setae** very short to elongate, mostly smooth, rarely papillose; **capsules** immersed to exserted, erect and symmetric, broadly ovoid to narrowly cylindrical, sometimes 8- or 16-ribbed; **mouth** transverse, often constricted when dry; **exothecial cells** rectangular, mostly firm- or thick-walled, often differentiated in bands; **stomata** 2-celled, immersed or superficial, restricted to neck or occurring over urn; **annulus** none or variably developed; **operculum** mostly rostrate. **Peristome** double, single, rudimentary, or absent; **exostome teeth** 16 but usually united in pairs, erect or reflexed when dry, thick, \pm lanceolate, densely papillose or striate, sometimes with adherent preperistome fragments, often reduced to a low membrane; **endostome** variable and sometimes absent, with 0, 8, or 16 narrow and hyaline segments arising from a low membrane; **cilia** none. **Preperistome** occasionally present. **Calyptra** mostly mitrate, sometimes cucullate, usually covering most of the capsule, often plicate, smooth or papillose, hairy to naked. **Spores** 1- or occasionally many-celled, sometimes variable in size, finely to coarsely papillose.

Taxonomy: Vitt (1994, p. 591), who has revised several of the New Zealand (N.Z.) genera, provided these summary comments on the family in his treatment for the Flora of Mexico: "The Orthotrichaceae are diplolepideous in peristome structure. The outer plates of the exostome teeth are thicker than the inner. The endostome segments are linear and hyaline, free at the base and alternate with or opposite to the teeth. The capsules are erect, often ribbed, and generally short-stalked. The perichaetia are terminal. The leaves have mostly thick-walled, rounded-hexagonal upper cells that are commonly bulging or papillose. The alar cells are rarely differentiated. The calyptrae are mitrate (except *Drummondia*, *Zygodon*, and *Amphidium*). The plants are mostly xerophytes, growing on bark or rock surfaces." His Mexican treatment provides an overview of the family, although there is little overlap at the species level with the N.Z. flora.

The Orthotrichaceae are one of the largest and most diverse of moss families, with up to 27 genera and perhaps as many as 600 species worldwide. The family is cosmopolitan in distribution, but most diverse in tropical and temperate regions. The plants are xerophytes and mostly grow on bark or on rock.

The Orthotrichaceae have attracted a great deal of systematic and taxonomic attention in recent years. Some intra-familial relationships remain inadequately resolved, although molecular methods have contributed to a clearer understanding of these. Goffinet & Vitt (1998, p.146 et seq.) presented a classification of the Orthotrichaceae based on morphological characters and molecular (chloroplast rbcL) sequences in which they restricted the family to 20 genera distributed between two subfamilies (Orthotrichoideae and Macromitrioideae) each with two tribes.

Subfamily Orthotrichoideae

Tribe Zygodontae with seven genera including *Zygodon* Hook. & Taylor and *Leratia* Broth. & Paris, as well as two genera not accepted here (*Codonoblepharon* Schwägr. and *Bryomaltaea* Goffinet)

Tribe Orthotrichaeae with five genera including *Ulota* Mohr and *Orthotrichum* Hedw. (incorporating *Muelleriella* Dusén)

Subfamily Macromitrioideae

Tribe Schlotheimieae with one genus, *Schlotheimia* Brid.

Tribe Macromitrieae with nine genera, including *Macromitrium* Brid. and *Macrocoma* (Müll.Hal.) Grout.

While the concepts of the larger genera in the Orthotrichaceae have remained relatively stable in recent years, several smaller genera have either been recently proposed or resurrected after many decades or more of disuse, with some being segregates of much larger genera. Many of these changes have involved taxa placed by Goffinet & Vitt (1998) in the subfamily Orthotrichoideae, particularly the tribe Zygodontae. The proposed changes have relied on data from both reassessments of morphological features and molecular data, and many of these proposed taxonomic modifications have involved species occurring in N.Z. Some of the proposed changes seem strongly supported by data, while others seem to have been made prematurely or to make little sense viewed in a N.Z. context.

Among recent changes relevant to the N.Z. flora:

Goffinet & Vitt (1998) transferred the N.Z. endemic species *Bryodixonia perichaetialis* Sainsbury to *Ulota* as *Ulota perichaetialis* (Sainsbury) Goffinet in Goffinet & Vitt. This transfer is supported by both molecular and morphological data and is followed here.

Goffinet et al. (2004) proposed the inclusion of the species traditionally (Brotherus 1925) placed in *Muelleriella* Dusén within *Orthotrichum*. This synonymy is strongly supported by molecular data and is followed here.

Goffinet & Vitt (1998) proposed the resurrection of the genus *Codonoblepharon* Schwägr. for two species of *Zygodon* with smooth laminal cells. The two species they considered to belong to *Codonoblepharon* were *Zygodon menziesii* (Schwägr.) Arn. (with a N.Z. type) and *Z. pungens* Müll.Hal. (with a Venezuelan type). Goffinet et al. (2004) subsequently made the combination *C. forsteri* (With.) Goffinet in Goffinet & Vitt for a European species. Matcham & O'Shea (2005) subsequently proposed combinations in *Codonoblepharon* for several additional species of *Zygodon*, including two occurring in N.Z. In a N.Z. context this expanded concept of *Codonoblepharon* is not wholly convincing and a conservative approach is taken here: *Zygodon menziesii* and its purported allies are retained in the genus *Zygodon*, as proposed by Lewinsky (1990).

Goffinet & Vitt (1998) also suggested the creation of a monotypic genus *Bryomaltaea* Goffinet in Goffinet & Vitt for the widespread *Zygodon obtusifolius* Hook. (with a N.Z. type). Goffinet et al. (2004) subsequently suggested, primarily on the basis of molecular data, that *Z. obtusifolius* Hook. be incorporated within an expanded concept of the genus *Leratia* Broth. & Paris, typified by *Leratia neocaledonica*. The transfer of *Z. obtusifolius* to the genus *Leratia* is accepted here.

Plášek et al. (2015) proposed the creation of a monotypic genus *Plenogemma* Plášek, Sawicki, & Ochyra to accommodate the dioicous, gemmae-producing, and essentially northern hemisphere *Ulota phyllantha* Brid. (which in the N.Z. region occurs only on Macquarie I.). The transfer of *U. phyllantha* to this newly described genus is not accepted here.

Thus, seven genera of Orthotrichaceae (*Leratia*, *Macrocoma*, *Macromitrium*, *Orthotrichum*, *Schlotheimia*, *Ulota*, and *Zygodon*) are discussed here as part of the N.Z. flora. *Amphidium*, which was treated in this family by Sainsbury (1955), is treated in the Rhabdoweisiaceae.

1	Primary stems erect; simple, sparingly, or occasionally repetitively branched, the branches mostly formed by innovation (associated with perichaetia)	2
1'	Primary stems creeping; producing numerous erect-ascendant branches that are not associated with perichaetia	7
2	Laminal cells smooth	3
2'	Laminal cells papillose or mammillose (but mammillae often visible only with sectioning in <i>U. viridis</i>)	4
3	Calyptra cucullate; capsules clearly exerted; axillary gemmae mostly present, fusiform, and septate; laminal cell walls KOH positive yellow	Zygodon
3'	Calyptra mitrate; capsules immersed, emergent, or weakly exerted; axillary gemmae absent; laminal cell walls KOH negative	Orthotrichum
4	Basal marginal cells hyaline, quadrate, with strongly thickened transverse walls and forming a multi-seriate border distinct from the inner basal laminal cells; upper laminal cells mammillose	Ulota
4'	Basal marginal cells not differentiated from adjacent basal laminal cells; upper laminal cells papillose	5

5	Calyptra cucullate and smooth; laminal cells walls KOH positive yellow or red	6
5'	Calyptra mitrate and usually pilose; laminal cell walls KOH negative	<i>Orthotrichum</i>
6	Cells on the abaxial surface of the costa not differentiated from laminal cells; basal laminal cells not differentiated; leaf apices obtuse or rounded	<i>Leratia</i>
6'	Cells on the abaxial surface of the costa elongate, clearly differentiated from laminal cells; basal laminal cells differentiated, rectangular or linear, thinner-walled, often ± yellow; leaf apices acute to acuminate (very rarely obtuse in <i>Z. menziesii</i>)	<i>Zygodon</i>
7	Basal marginal cells hyaline, quadrate, with strongly thickened transverse walls and forming a multi-seriate border distinct from the inner basal cells	<i>Ulota</i>
7'	Basal marginal cells neither with strongly thickened transverse walls nor forming a multi-seriate border	8
8	Leaves straight and not or scarcely contorted when dry; basal laminal cells short; peristome in N.Z. species consisting of two papillose, pale membranes only a few cells high	<i>Macrocoma</i>
8'	Leaves contorted when dry, usually ± twisted around the stems; basal laminal cells mostly elongate; peristome variably developed (mostly well-developed but weak or absent in some <i>Macromitrium</i> spp.)	9
9	Calyptra enclosing the entire developing capsule, neither plicate nor hairy, with 4–6 broadly triangular and clasping lobes and constricted at base; plants forming dense brick-red (especially in lower parts of stems) mats on bark; laminal cells smooth; peristome double and well-developed; phylloidioicous	<i>Schlotheimia</i>
9'	Calyptra enclosing only the upper portion of the developing capsule, mostly plicate and hairy (occasionally lacking hairs in N.Z. taxa), lacking triangular lobes and not constricted at base; plants variably green or brown-green, not brick-red; laminal cells mostly papillose or bulging, occasionally smooth; peristome variably developed (sometimes appearing absent); mostly dioicous or autoicous (only rarely phylloidioicous or pseudautoicous)	<i>Macromitrium</i>

***Leratia* Broth. & Paris in Brotherus, Öfvers. Finska Vetensk.-Soc. Förh. 51A(17): 14 (1909)**

= *Zygodon* sect. *Obtusifolii* Malta, *Latv. Univ. Raksti* 6: 282 (1923)

= *Bryomaltaea* Goffinet in Goffinet & Vitt, *Bryol. Twenty-first Cent.* 151 (1998)

Type taxon: *Leratia neocaledonica* Broth. & Paris

Taxonomy: *Leratia* is a small genus with a New Caledonian type, considered by Goffinet et al. (2004) to encompass three geographically disparate species. Because no material of the New Caledonian type has been available for study, no attempt is made to supply a description of the genus here. Brotherus (1925, p. 27–28) provided a detailed description and illustration of the type species (cited as *Leratiella neocaledonica*). A description of only the single N.Z. species is given here.

A commentary on *Leratia* is provided by Goffinet & Vitt (1998, p. 151), who at that time considered it to be monotypic, but who also noted many similarities to what they then termed *Bryomaltaea obtusifolia* (Hook.) Goffinet. *Bryomaltaea* is here considered a heterotypic synonym. Although *Leratia neocaledonica* is the type of the genus *Leratia*, the genus *Bryomaltaea* is typified by *Zygodon obtusifolius* Hook., which is founded on a Nepalese collection by Gardner, and not a N.Z. collection by Knight, as suggested by Goffinet.

The lamina-like cells on the abaxial surface of the costae and the lack of differentiated basal cells are significant defining features of *Leratia*. Goffinet et al. (2004), using data from four gene loci, convincingly demonstrated that the New Caledonian type, the Asian and Australasian *L. obtusifolia*, and the predominantly North American *L. exigua* (Sull.) Goffinet [*Orthotrichum exiguum* Sull.] belong to an isolated and strongly supported clade, to which they applied the generic name *Leratia*. Their taxonomic and nomenclatural conclusions are followed here, representing a departure from the treatment of *Zygodon* presented by Lewinsky (1990).

Etymology: The generic name commemorates Auguste-Joseph and Louise Le Rat, “les explorateurs zélés de l’île intéressante ou ils demeurent.”

***Leratia obtusifolia* (Hook.) Goffinet in Goffinet et al., *Monogr. Syst. Bot. Missouri Bot. Gard.* 98, 286 (2004)**

≡ *Zygodon obtusifolius* Hook., *Musci Exot.* 2, 159 (1819)

≡ *Bryomaltaea obtusifolia* (Hook.) Goffinet in Goffinet & Vitt, *Bryol. Twenty-first Cent.* 151 (1998)

Lectotype: Nepal, *Gardner*, BM. (Designated by Lewinsky 1990.) Not seen.

= *Zygodon neglectus* Müll.Hal., *Hedwigia* 37: 133 (1898)

Lectotype: N.Z., *C. Knight*, BM. (Designated by Lewinsky 1990.) Not seen. Isotype: H-

Brotherus 3300498, image seen online, JSTOR Global Plants, accessed 27 June 2015. No duplicate of the Knight collection has been found in any N.Z. herbarium.

The following species description is modified from Lewinsky (1990).

Plants small, mostly less than 5 mm, occasionally to 10 mm, densely tufted, dark to light olive-green or brown-green above and brown to black below, dull. **Stems** much branched, curved when dry, in cross-section with small incrassate cortical cells and lacking a central strand; **rhizoids** present and often dense on lower stems, much branched, pale brown, finely papillose. **Leaves** appressed and erect when dry, spreading when moist, ligulate or ovate-oblong, obtuse or rounded, entire (but crenulate from projecting papillae), not decurrent, moderately keeled (and the costae obscured in adaxial surface view), mostly 0.6–1.0 × 0.2–0.3 mm; **margins** recurved to revolute below; **upper laminal cells** ± isodiametric, subquadrate, oval, or irregular, not arranged in rows, unistratose, moderately bulging, with several (to c. 4) strongly projecting papillae on both surfaces, mostly 9–12 µm in greater diam.; **basal cells** similar in shape or somewhat more oblate, less papillose; **alar cells** not differentiated. **Costa** stout and scarcely tapered, ending several cells below the leaf apex, olive-green or yellow-green, c. 45–60 µm wide in lower leaf, obscured in adaxial surface view by laminal cells, the cells on the abaxial surface subquadrate or short-oblong, not differing from the adjacent laminal cells. **Gemmae** axillary, clavate, green, with (3–)4–6 transverse septa and 75–120 µm long. **Laminal and costal KOH colour reaction** mostly positive red (occasionally KOH negative).

Autoicous. Perichaetia terminal, usually overtopped by 1 or more innovations, with leaves larger than adjacent vegetative leaves but otherwise not differentiated. **Perigonia** terminal on short branches arising immediately below the perichaetia or terminal on normal branches, c. 0.3–0.4 mm long, orange-brown; perigonal bracts broadly ovate, enclosing filiform paraphyses and fewer than 10 antheridia. **Setae** 2–4 mm, sinistrorse, smooth, dark red; **capsules** exserted, narrowly obovoid-cylindric, becoming more cylindrical with age, deeply 8-furrowed throughout when dry, dark red at maturity, 1.0–1.5 mm; **exothelial cells** irregular in outline, in distinct thick-walled and thin-walled bands; **stomata** restricted to neck, superficial; **annulus** not seen; **operculum** obliquely rostrate from a conic base. **Peristome** double; sometimes with a fragmentary preperistome; **exostome** of 8 pairs of teeth, pale, strongly reflexed when dry, transversely striate below and longitudinally striate above (apparently on both surfaces), c. 180 × 90 µm; **endostome** with 8 (sometimes 16 *fide* Lewinsky) lanceolate, pale, and papillose-striate segments arising from a very short and striate membrane; the segments c. $\frac{2}{3}$ the height of the exostome. **Calyptra** cucullate, often weakly papillose near the apex by protruding cell ends. **Spores** globose, finely papillose, (10–)12–15 µm.

Illustrations: Plate 1. Lewinsky 1990, figs 35–54 (as *Zygodon obtusifolius*); Vitt 1994, fig. 449 (as *Z. obtusifolius*); Calabrese 2006, figs. 1e, 2c, 6–7 (as *Z. obtusifolius*).

Distribution: NI: N Auckland (Mangamuka Gorge, Waiwera, Papakauri, Leigh, Waipoua Forest, Waitakere Ranges) including offshore islands (LB, GB, Waiheke I.), S Auckland (Puaiti Bush, Pukeatua, Pukerimu Bush near Taupō), Wellington (Silverstream); SI: Nelson (Wangapeka River), Marlborough (Kenepuru), Westland (near Kūmara); Ch.

Recorded from a small number of other localities by Lewinsky (1990) but only records from Waikōpiro, Wairoa, and Dannevirke (all in Hawke’s Bay L.D.) extend the range significantly (mostly eastward) on the North I. Lewinsky’s citation of a Gillespies Beach (Westland L.D.) collection by *J. Child* represents the most southerly N.Z. record and is significant given the paucity of South I. records; it has not been seen.

Anomalous. Reported from Tasmania, Mexico, Central and South America, Africa, and Asia by Lewinsky (1990).

Habitat: Usually on bark, but the host species are poorly documented. Lewinsky (1990) recorded it from *Beilschmiedia*, *Weinmannia*, and *Dacrydium*. The one Chatham I. collection is from the trunk of

Olearia telmatica. Also on exposed roots, rotten logs, and rarely on rock. A collection from Great Barrier I. is recorded from “old fungal growth on a dead kāmahi” (*Weinmannia*). It is usually found in fairly exposed positions at low elevations. *Zygodon gracillimus* and *Haplohymenium pseudotriste* are sometimes associates. On the North I. from near sea level (Waiwera) to at least 760 m (Pukerimu Bush near Taupō); few elevational data are available from the South I.

Notes: Most, but not all, specimens of *L. obtusifolia* exhibit a marked positive red reaction in a 10% KOH solution, visible in the laminal cell walls, costa, and the stem cortex.

No N.Z. species of *Zygodon* has such rounded vegetative leaves. In the absence of calyptra, *L. obtusifolia* might be mistaken for a small species of *Orthotrichum* but the very small (mostly 0.6–1.0 × 0.2–0.3 mm) leaves should preclude confusion, as should the distinctive gemmae and the usual KOH positive red colour reaction. New Zealand species of *Orthotrichum* with rounded leaf apices (e.g., *O. assimile*) either have immersed stomata or occur primarily on rock, or both.

Etymology: The epithet *obtusifolius* refers to the leaf shape, which is distinctive relative to species traditionally placed in *Zygodon*.

***Macrocoma* (Müll.Hal.) Grout, *Bryologist* 47: 4 (1944)**

≡ *Macromitrium* sect. *Macrocoma* Müll.Hal., *Bot. Zeitung (Berlin)* 3: 522 (1845)

Type taxon: *Macrocoma orthotrichoides* (Raddi) Wijk & Margad.

The following generic description is modified from Vitt 1994; it does not encompass the variation of the subgenus *Trachyphyllum*.

Plants slender, dull, forming loose and often extensive mats on bark. **Stems** creeping and elongate, irregularly to subpinnately branched. **Stem leaves** appressed when dry, weakly spreading when moist. **Branch leaves** equal or slightly shorter than stem leaves, appressed, and not contorted when dry, erect-spreading or rarely (in N.Z. material) squarrose when moist, not fragile, keeled; **margins** entire, plane or recurved; **upper laminal cells** small and rounded, isodiametric to short-elliptic, flat or bulging, singly papillose or smooth, unistratose; **inner basal laminal cells** short, bulging and singly papillose. **Costa** single, prominent, usually percurrent, sometimes producing abaxial rhizoids (in non-N.Z. species), with abaxial surface mostly covered with lamina-like cells. **Gemmae** rare.

Sexuality autoicous (in N.Z. material) or dioicous (and then male plants well-developed). **Perichaetial leaves** enlarged. **Perigonia** lateral, often on short branches. **Setae** elongate, smooth; **capsules** ± cylindrical-ellipsoid, plicate at mouth or throughout. **Stomata** superficial, restricted to the neck and lower portion of the urn, the guard cells sometimes poorly differentiated; **operculum** rostrate from a conic base. **Peristome** double, single, or lacking, often double and reduced as in N.Z. species. **Calyptra** enclosing the entire capsule, plicate, densely hairy, and often with 1 deep slit. **Spores** rather large for the family, 1-celled and isosporous.

Taxonomy: Vitt (1980a) recognised nine species of *Macrocoma*. The genus is most diverse in Central and South America, but there are endemic species in eastern and southern Africa, and in the Himalayan region. Two widespread species (*M. orthotrichoides* and *M. tenue*) account for much of the geographic distribution of the genus. The one species occurring in N.Z. is variable and broadly distributed here.

The type of *Macrocoma* was designated by Vitt (1980a) to be *M. filiforme* (Hook. & Grev.) Grout. However Vitt (1994) subsequently indicated this name to be illegitimate and synonymous with the Brazilian *M. orthotrichoides* (Raddi) Wijk & Margad. *Macrocoma orthotrichoides* is considered by Tropicos (accessed 18 Jan. 2016) to be the generic type.

The concept of *Macrocoma* was broadened by Vitt (1980a) to include two exclusively South American species previously treated as *Macromitrium* subgenus *Trachyphyllum* Broth. *Macrocoma* subgenus *Trachyphyllum* (Broth.) Vitt is distinguished by, *inter alia*, squarrose to widely recurved leaves, elongate cells on the abaxial costal surface, and naked calyptrae.

In a companion publication, Vitt (1980b) performed a morphometric study of the “*Macrocoma tenue*-*M. sullivantii* species complex”, sampling such features as leaf length variation, the number of cells in the leaf apex, and apical cell length from collections from up to ten geographic regions. He divided *M. tenue* (Hook. & Grev.) Vitt into subsp. *tenue* from N.Z., eastern Australia, and eastern Africa and subsp. *sullivantii* from the southern Appalachian Mountains, eastern Asia including Japan, Central and South America, and Hawai'i. Since Vitt's study is the most detailed of *Macrocoma*, his taxonomy is followed here. According to Vitt, the subsp. *tenue* is “based on the presence of a peristome reduced to

a low, double membrane, and non-fragile branch leaves that are differentiated from the stem leaves and have incurved tips and flat, uniform upper cells”.

Etymology: The generic name derives from *makros* (large) + *coma* (hair of the head) and alludes to the long and dense hairs on the calyptra of *M. sullivanii*, a widespread northern hemisphere taxon (Meagher 2011).

***Macrocoma tenue* (Hook. & Grev.) Vitt, Rev. Bryol. Lichénol., n.s. 39: 217 (1973)**

≡ *Orthotrichum tenue* Hook. & Grev., *Edinburgh J. Sci.* 1: 120 (1824)

≡ *Macromitrium tenue* (Hook. & Grev.) Brid., *Bryol. Univ.* 1, 740 (1826)

Lectotype: South Africa. (Designated by Vitt 1980a.) Not seen.

= *Macromitrium eucalyptorum* Hampe & Müll.Hal. in Müller & Hampe, *Linnaea* 26: 500 (1855)

Lectotype: South Africa. (Designated by Vitt 1980a.) Not seen.

= *Macromitrium recurvulum* Müll.Hal., *Hedwigia* 37: 143 (1898)

≡ *Macromitrium eucalyptorum* var. *recurvulum* (Müll.Hal.) Sainsbury, *Trans. & Proc. Roy. Soc. New Zealand* 75: 179 (1945)

Neotype (designated by Vitt 1980a, p. 429): Ongaroto Road, Ātiāmuri, south of Rotorua, *K.W. Allison 404*, CHR 343076!

= *Macromitrium barbatum* Mitt. in Dixon, *Bull. New Zealand Inst.* 3: 187 (1926) nom. inval.

Misapplications: *Macromitrium microphyllum sensu* Allison & Child (1971)

Etymology: The epithet *tenue* means slender and presumably refers to the overall appearance of the plants in relation to species of *Orthotrichum* (the genus in which it was originally described). The obsolete epithet *eucalyptorum* can be loosely translated as “completely enclosed by the calyptra” and seems particularly apt, but unfortunately it is a synonymized name for this distinctive species.

Macrocoma tenue* (Hook. & Grev.) Vitt, Rev. Bryol. Lichénol., n.s. 39: 217 (1973) subsp. *tenue

Minor elements in the following description are from Vitt (1980a).

Plants gold-brown to dark green, forming loose and often extensive mats on bark. **Stems** creeping and elongate (c. 10 to >50 mm in N.Z. material), apparently lacking rhizoids, in cross-section with thick-walled outer cells and no central strand. **Stem leaves** weakly spreading when moist, appressed when dry, broadly ovate, acute, c. 1 mm. **Branches** weakly ascendant, mostly short (<7 mm), curved or straight when dry, simple or branching by innovation and forking. **Branch leaves** erect-imbricate or rarely squarrose when moist, not contorted when dry, oblong-ovate, acute (sometimes broadly), not fragile, weakly keeled above, strongly concave in the juxta-costal basal region, mostly 1.0–1.3 mm (but becoming progressively larger below perichaetia); **margins** entire and plane; **upper laminal cells** rounded, isodiametric to short-elliptic, firm-walled, not bulging, smooth, unistratose, c. 6–10 µm in greater dimension, becoming gradually strongly bulging and often ± oblate at mid leaf; **inner basal laminal cells** rounded-rhombic (never elongate), with a single strong and rounded projection but otherwise smooth, sometimes weakly nodose near the costa, mostly c. 12–18 × 8–10 µm; **marginal basal cells** usually more compact. **Costa** single, prominent, mostly fading in the apex or sometimes percurrent, the abaxial superficial cells in the upper half short and similar to laminal cells, in cross-section lacking guide cells and with cells ± uniform throughout. **Gemmae** absent.

Cladautoicous in N.Z. material. **Perichaetial leaves** enlarged (with the transition from vegetative leaves gradual). **Perigonia** gemmiform and often on short branches, readily found in fruiting material. **Setae** 3–6 mm, smooth, straight, weakly dextrorse or less often sinistrorse; **capsules** narrowly cylindrical-ellipsoid, from a long but ill-defined neck, smooth throughout or becoming 8-sulcate below the mouth when dry and old, 1.5–2.0 mm; **exothecial cells** thick-walled, the longitudinal walls ± thicker than the transverse, mostly oblong and less than c. 45 µm, becoming smaller and forming indistinct bands of thicker-walled cells at the mouth; **stomata** superficial, restricted to the neck and lower portion of the urn; **annulus** not seen; **operculum** rostrate from a conic base, c. 0.8 mm. **Peristome** double, reduced to two low membranes, the exostomal membrane coarsely papillose. **Calyptra** large, plicate, densely hairy, enclosing the entire capsule and often slit on one side. **Spores** 1-celled, isosporous, round, thick-walled, 21–39 µm diam., papillose.

Illustrations: Plate 2. Scott & Stone 1976, p. 43 (as *Macromitrium tenue*); Meagher & Fuhrer 2003, p. 67 (as *Macrocoma tenuis* subsp. *tenuis*); Vitt et al. 1995, fig. 4 a–k.

Distribution: K; NI: N Auckland, including offshore islands (GB), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington. SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland.

Anomalous. Eastern mainland Australia*. Reported from Tasmania and several countries of southern and eastern Africa by Vitt (1980a, p. 425). Vitt et al. (1995) recorded it from P.N.G.

Habitat: Epiphytic on a wide range of indigenous dicot trees and shrubs (at least 22 genera, and at least 3 species of southern beech) as well as *Cordyline australis*, and some podocarps. It is an abundant species on upper branches in montane *Fuscospora* forest in the eastern mountains of the South I. and probably elsewhere. It also occurs on a range of adventive tree genera, especially *Populus* and *Salix*. Usually occurring in strongly insolated sites such as forest margins, adjacent to light gaps, or in the forest canopy. On the South I. it occurs over a wide altitudinal range and equally commonly on both sides of the Main Divide. It occurs rarely on rock.

On the North I. from c. 10 m (Western Lake Road, Wellington L.D.) to at least 750 m (near Erua, Wellington L.D.); on the South I. from near sea level (Goose Bay, Marlborough L.D.) to c. 1200 m (Billies Knob, Nelson L.D., and Mt Alfred, Otago L.D.) Its most frequent associate is *Calyptopogon mnioides*, but the diversity of host species is reflected in a wide range of bryophyte associates, which include *Leptostomum inclinans*, *Macromitrium* spp. (including *M. microstomum* and *M. prorepens*), *Orthotrichum graphiomitrium*, *Papillaria flavolimbata*, *Rhaphidorrhynchium amoenum*, *Syntrichia papillosa*, and *Tortula abruptinervis*).

Notes: Rare N.Z. populations having widely spreading or squarrose dry branch leaves led to Müller's (1898) description of *Macromitrium recurvulum* from "North Canterbury" using a Beckett collection. This taxon was accepted at the species level by Dixon (1926, p. 182) and at varietal level by Sainsbury (1955, p. 229). Vitt (1980a) found no type material in the Beckett herbarium and designated a neotype with distinctly squarrose dry branch leaves for this name. I concur with Vitt's observation that leaf set often varies in single plants and that *M. recurvulum* Müll.Hal. deserves no taxonomic recognition.

All the N.Z. material of *M. tenue* studied was cladautoicous; I have not observed material with perigonia occurring immediately below the perichaetium (gonioautoicous) such as reported by Vitt (1980a, p. 427). Nor have I observed incurved branch leaf tips in N.Z. material such as recorded by him.

Recognition: In a N.Z. context, *M. tenue* could only be confused with a species of *Macromitrium*. However, it is usually easily recognised in the field by its epiphytic creeping stems with appressed and straight dry leaves and the frequently produced, large, and densely hairy calyptra enclosing the capsule on a relatively short seta. Additionally, the short, rounded-rhombic basal laminal cells (only the northern and epilithic *Macromitrium brevicaulis* has basal laminal cells of a comparable shape) and a peristome reduced to two pale, low membranes provide further distinction. No species of N.Z. *Macromitrium* combines this unique suite of characters.

***Macromitrium* Brid., *Muscol. Recent. Suppl.* 4, 132 (1818)**

Type taxon: *Macromitrium pallidum* (P.Beauv.) Wijk & Margad.

The following generic description is modified from Vitt (1983) and Vitt & Ramsay (1985a).

Plants slender to robust, yellow-green, olive-green or rust-brown above, darker below, in dense or loose, spreading, tomentose mats on bark or rock. **Stems** creeping, with numerous ascendant, simple or forked branches, rather sparsely beset below with much-branched, usually red-brown, and papillose rhizoids, in cross-section with thick-walled outer cells and no central strand. **Branch leaves** contorted, spirally-twisted, or crisped-flexuose, rarely loosely erect-appressed, apices inrolled to twisted when dry, erect-spreading to squarrose-recurved when moist, linear-lanceolate, ligulate, oblong, ovate-oblong, or lingulate, rounded-obtuse, acute, to long-acuminate, sometimes cuspidate, apiculate, subulate, or long-awned, rarely (but frequently in N.Z. species) with fragile tips, keeled; **margins** erect, plane, or reflexed-recurved, entire, crenulate to serrate; **upper laminal cells** rounded to rectangular-elliptic, flat to strongly bulging, smooth to multi-papillose, usually with conical or rounded papillae, ± thick-walled, c. 6–14 µm in greater diam.; **basal cells** usually differentiated, elongate or rarely short-rectangular, often thick-walled, smooth or tuberculate, sometimes with sinuose lumina. **Costa** single, prominent, excurrent or ending near or in the apex. **Gemmae** rare.

Sexuality various (autoicous, dioicous, or pseudautoicous). **Perichaetia** terminal on short to well-developed lateral branches; **perichaetial leaves** often longer than vegetative leaves. **Perigonia** gemmiform, axillary or on short branches, often produced on epiphyllous and dwarf male plants. **Setae** elongate or less often short, smooth or papillose, erect to flexuose, either dextrorse or sinistrorse; **capsules** exserted (in all N.Z. species) or rarely immersed, ovate, elliptic, or cylindrical, erect and becoming slightly curved when old, smooth or ribbed, usually not constricted below the mouth, abruptly to gradually contracted to the setae by a short neck; **exothecial cells** thick-walled; **stomata** superficial, restricted to the lower portion of capsule, often with guard cells poorly differentiated; **annulus** usually of 1–3 rows of thin-walled cells; **operculum** rostrate from a conic base. **Peristome** diplolepidous, double, single, or lacking; **exostome teeth** 16 and sometimes paired, rarely membranaceous, mostly densely papillose or papillose-striate, erect or recurved when dry; **endostome** when present consisting of a delicate, sparsely papillose membrane, rarely divided into segments. **Calyptra** mitrate, rarely splitting along one rib, hairy or naked, covering more than $\frac{3}{4}$ of the capsule, plicate or lacinate. **Spores** 1-celled, isosporous or anisosporous, papillose.

Taxonomy: A very large genus of perhaps more than 400 spp. distributed mostly in tropical and subtropical regions. Thirteen species and one variety (*M. longirostre* var. *ramsayae* (Vitt) comb. nov.) are accepted here in the N.Z. flora, including a single species (*M. incurvifolium* (Hook. & Grev.) Schwägr.) that is recorded only from the Kermadec Is.

The N.Z. species have been treated in detail by Vitt (1983) with further information provided by Vitt & Ramsay (1985a; 1985b). The taxonomic concepts and species descriptions presented here are largely derived from these publications. In general I have agreed with (and verified) Vitt's descriptions but have altered their format and simplified them. I have generally not altered Vitt's peristome descriptions.

Despite the availability of Vitt's revision, *Macromitrium* in N.Z. remains a difficult genus and some collections, particularly if sterile, defy confident identification. The limits and variability of *M. prorepens* and *M. longirostre* are particularly intractable. The variation of some other species (e.g., *M. gracile*) is great and often confusing. The allied and distinctive pair of *M. ligulare* and *M. ligulaefolium* are, in my opinion, nameable to species only when fertile. On the other hand, species such as *M. brevicaule*, *M. grossirete*, *M. longipes*, and *M. orthophyllum* are well delimited and easily recognised, even in the field, with or without capsules. The species distributions given for the genus are derived from confirmed specimens and by reference to Vitt's (1983) maps.

The ornamentations of the laminal cells in this genus are often more easily observed under the microscope after the leaves have been soaked in lactic acid for 15–30 minutes and then mounted in water.

Vitt & Ramsay (1985a) used a cladistic analysis based on morphological features to assign the Australasian species to seven groups (see pp. 327 and 444–447). Their analysis remains the most detailed of the relationships of Australasian *Macromitrium* spp. and it is summarised below (including only the N.Z. taxa), following their Table I. For comparability *M. ramsayae* and *M. submucronifolium* are cited at the rank given to them by Vitt & Ramsay.

Macromitrium Brid.

Macromitrium longirostre group

Macromitrium longirostre (Hook.) Schwägr. (accepted here)

Macromitrium ramsayae Vitt (treated here as variety of *M. longirostre*)

Macromitrium retusum Hook.f. & Wilson (accepted here)

Macromitrium microstomum group

Macromitrium microstomum (Hook. & Grev.) Schwägr. (accepted here)

Macromitrium longipes (Hook.) Schwägr. (accepted here)

Macromitrium orthophyllum Mitt. (accepted here)

Macromitrium ligulare group

Macromitrium ligulaefolium Broth. (accepted here)

Macromitrium ligulare Mitt. (accepted here)

Macromitrium aurescens group

Macromitrium brevicaule (Besch.) Broth. (accepted here)

Macromitrium hemitrichodes group (s.l.)

Macromitrium grossirete Müll.Hal. (accepted here)

Macromitrium submucronifolium Müll.Hal. & Hampe (not accepted here)

Macromitrium prorepens (Hook.) Schwägr. (accepted here)

Macromitrium angulatum Mitt. (not accepted here)

Macromitrium subulatum group

(no N.Z. species)

Macromitrium gracile group

Macromitrium incurvifolium (Hook. & Grev.) Schwägr. (accepted here)
Macromitrium gracile (Hook.) Schwägr. (accepted here)
Macromitrium helmsii Paris (accepted here)

Etymology: The generic name refers to the large and mitrate calyptrae.

1	Upper laminal cells papillose, the papillae large and obvious, or if small and inconspicuous, then walls strongly bulging	2
1'	Upper laminal cells smooth, flat or slightly bulging (sometimes moderately so in <i>M. longirostre</i> but then lacking papillae and ± bistratose above)	9
2	Branches penicillate; immature leaves sharply contracted to a long, linear, erect, fragile, and usually straight arista; mature leaves always with arista broken off, mostly retuse and ± asymmetric; plants either sterile or ♀ and sporophytes unknown	<i>M. helmsii</i>
2'	Branches not penicillate; immature leaves obtuse, acute, acuminate, or gradually contracted to a subulate, decurved, and often fragile arista; mature leaves either broken or with their subulae intact and, if broken, usually with an irregular edge; plants often fruiting	3
3	Perichaetial leaves much longer than branch leaves and conspicuously sheathing the setae (obvious in the field or in dried material); branch leaves usually with a fragile subula and then with the broken edge irregular or with leaves whole, lanceolate, and acute	<i>M. gracile</i>
3'	Perichaetial leaves equal to or shorter than adjacent branch leaves, not conspicuously sheathing the setae; branch leaves whole, with apex always intact, lanceolate to ± ligulate or oblong, with a blunt, apiculate, or cuspidate-mucronate apex	4
4	Setae dextrorse; peristome absent; calyptrae split on one side by 1–3 deep lacerations, densely hairy; papillae of upper laminal cells tall (to c. 18 µm) and mostly visible at mid leaf with dissecting microscope	<i>M. grossirete</i>
4'	Setae sinistrorse; peristome present (but sometimes rudimentary or fugacious); calyptrae not conspicuously split on one side by 1–3 deep lacerations, hairy or naked; papillae of upper laminal cells shorter and not visible at mid leaf with dissecting microscope	5
5	Leaves tightly and stiffly spiralled around branches when dry; inner basal cells oblong-rectangular or elliptic, mostly 9–18 µm long; costa in cross-section consisting almost entirely of stereids (including 3–5 rows of abaxial stereids), and with only 3–4 poorly developed guide cells; gemmae often present on adaxial surface or in axils of leaves; calyptrae naked; plants coastal and northern, restricted to northern North I. and associated offshore islands, Chatham Is, and Kermadec Is	<i>M. brevicaule</i>
5'	Leaves variously twisted but not tightly and stiffly spiralled around branches when dry; inner basal cells longer; costa in cross-section with both stereids and obvious guide cells; gemmae absent; calyptrae hairy or naked; plants widespread, neither exclusively northern nor exclusively coastal	6
6	Leaves weakly twisted around the branch, with apices usually decurved (never strongly inrolled) when dry; costa usually short excurrent to form an apiculus, rarely percurrent	<i>M. prorepens</i>
6'	Leaves irregularly and strongly flexuose-twisted and with apices strongly inrolled and obscured when dry; costa ending a few cells below leaf apex or percurrent (in <i>M. incurvifolium</i>)	7

7	Branch leaves lanceolate, acute; costa percurrent; upper leaf margins entire; upper laminal cells in distinct longitudinal ranks, very weakly bulging, with many small and inconspicuous papillae; calyptrae hairy; rare and known only from Kermadec Is	<i>M. incurvifolium</i>
7'	Branch leaves ± lingulate, broadly rounded or obtuse and apiculate; costa short excurrent in best-developed leaves; upper leaf margins distinctly crenulate by projection of strongly bulging cell walls; upper laminal cells not distinctly ranked, strongly bulging, with small (single or multiple) but conspicuous papillae; calyptrae naked or occasionally with a few hairs; widespread on main islands	8
8	Capsules distinctly 8-plicate and puckered at mouth when dry; peristome a low basal membrane; rare on North I. and not recorded from South I. (not confidently identifiable unless fertile)	<i>M. ligulaefolium</i>
8'	Capsules not plicate but sometimes narrowed at mouth when dry; peristome of 16 erect teeth; common and widely distributed on North I. and South I.	<i>M. ligulare</i>
9	Branches penicillate; young leaves sharply contracted to a linear, erect, and fragile arista; mature leaves always with arista broken off and retuse	<i>M. retusum</i>
9'	Branches variably acute, not penicillate; young leaves acute or acuminate-cuspidate; mature leaves whole, never retuse	10
10	Branch leaves nearly straight, non-twisted, loosely erect-appressed, and slightly curved to one side when dry; spores anisosporous, 16–42 µm diam.; dwarf male plants often present; largely restricted to drier portions of the main islands	<i>M. orthophyllum</i>
10'	Branch leaves strongly twisted when dry; spores not anisosporous, 25–66 µm diam.; dwarf male plants not present; widespread on the main and offshore islands	11
11	Branch leaves not funiculate when moist, strongly spirally twisted around stem and usually with outwardly curved apices when dry; costa with abaxial and adaxial stereids; upper laminal cells often partially bistratose; setae stout, and dextrorse; capsules plicate for most of their length when dry; restricted to areas exposed to salt spray	12
11'	Branch leaves distinctly funiculate when moist, each leaf twisted-flexuose and with apices decurved to recurved-twisted when dry; costa with abaxial stereids only; upper laminal cells unistratose (or sometimes a few bistratose in mid lamina in <i>M. longipes</i>); setae slender and sinistrorse; capsules plicate only at mouth when dry; widespread and not restricted to areas exposed to salt spray	13
12	Branches variable in length, mostly 3–12 mm but sometimes to c. 35 mm; branch leaves slenderly acuminate to narrowly long-cuspidate, keeled throughout; upper laminal cells with conspicuous bistratose patches (visible both in surface view and in cross-section); inner basal cells ± elongate-rectangular, mostly c. 20–40 × 8–10 µm; setae 2.5–8(–11) mm; spores 25–38 µm	<i>M. longirostre</i> var. <i>longirostre</i>
12'	Branches mostly short, 3–7(– 8) mm; branch leaves mostly acute or shortly cuspidate, becoming flattened near apices, deeply keeled below; upper laminal cells unistratose except in distal 200 to c. 750 µm and there usually bistratose; inner basal cells rounded-subquadrate to elliptic (often with a few oblate or shortly rectangular), mostly 9–15(–21) × c. 9–11 µm setae shorter, 2.5–4 mm; spores 20–28 µm	<i>M. longirostre</i> var. <i>ramsayae</i>
13	Plants robust, gold-green to bronze-brown; branch leaves 1.5–3.0 mm; mid laminal cells very unevenly thick-walled and with the lumina elongate and strongly curved or sigmoid; perichaetial leaves sharply and broadly acute to acuminate-apiculate; dioicous	<i>M. longipes</i>
13'	Plants often slender, olive-green; branch leaves 1.2–2.0 mm; mid laminal cells firm and ± evenly thick-walled and with the lumina straight or only slightly curved; perichaetial leaves slenderly acuminate to sharply and finely cuspidate; autoicous	<i>M. microstomum</i>

Excluded Taxa: *Macromitrium pusillum* Mitt. (1859) is a name that has been applied to N.Z. herbarium material of *M. ligulare* by some authors, including Sainsbury. Vitt & Ramsay (1985a, p. 406; see also Vitt 1983, p. 74) considered the type of the Mitten name to be an Archer Tasmanian collection and *M. pusillum* Mitt. to be a taxonomic synonym of the widespread Australian (including Tasmania) endemic *M. archeri* Mitt. in Hook.f. *Macromitrium pusillum* is not discussed further here.

Macromitrium submucronifolium Müll.Hal. & Hampe (1855) is treated here as inseparable from *M. prorepens* for reasons discussed below.

Macromitrium ramsayae Vitt (1983) is reduced here to a variety of *M. longirostre* for reasons discussed below.

Macromitrium wellingtonianum Vitt (1983, p. 61) is rejected from the N.Z. flora. The identity and status of this species in N.Z. has been problematic since its description. Vitt cited a type collected by Balázs at “Tararua Range, 60 km North of Wellington, 800 metres elev.,” on 28 Dec. 1972. Dr. Dénes Balázs was a Hungarian geographer who collected bryophytes for the EGR herbarium. In 1972–73 Balázs travelled in the Philippines, New Guinea, eastern mainland Australia and N.Z. (T. Pócs, pers. comm., 5 May 2011). Vitt & Ramsay (1985a, p. 411) subsequently placed *M. wellingtonianum* in the synonymy of *M. angulatum* Mitt., a species with a Samoan type. *Macromitrium wellingtonianum/angulatum* has not been re-found in N.Z. for over 40 years, despite it being a morphologically distinctive species in a N.Z. context. The Tararua Range has been assiduously collected in recent years by capable collectors. Rodney Lewington has made dedicated but unsuccessful trips to relocate *M. wellingtonianum* at its type locality. The most likely explanation for the alleged Tararua collection is that it is an incorrectly labelled specimen gathered elsewhere (probably in P.N.G.) during Balázs’s 1972–73 travels. Dale Vitt (pers. comm., 5 May 2011) considers N.Z. to be “well out of the range of the *angulatum* group” and believes that the Tararua Range is a “mistaken locality”.

***Macromitrium brevicaule* (Besch.) Broth., Nat. Pflanzenfam. [Engler & Prantl] 1(3) 486 (1903)**

≡ *Micromitrium brevicaule* Besch., *Ann. Sci. Nat., Bot. sér. 5*, 18: 211 (1873)

Lectotype: New Caledonia, *Vieillard 1734*, BM-Bescherelle (Designated by Vitt & Ramsay 1985a.) Not seen.

= *Macromitrium watsii* Broth., *Öfvers. Finska Vetensk.-Soc. Förh.* 40: 169 (1898)

Lectotype: New South Wales, *W.W. Watts 329*, H-Brotherus (Designated by Vitt & Ramsay 1985a.) Not seen.

= *Macromitrium subfragile* Dixon & Sainsbury in Sainsbury, *Trans. & Proc. Roy. Soc. New Zealand* 75: 178 (1945)

Lectotype: N.Z., North Cape, *L.H. Millener 781*, BM-Dixon (Designated by Vitt 1983). Not seen. Isolectotype: CHR 615872!

Plants small and compact, dull, yellow-green to bright green above, olive-green or brown below.

Branches short, <1.0–3.0(–7) mm, ascendant, simple or forked below sex organs. **Stem leaves** erect-twisted when dry, spreading when moist, 0.8–1.2 mm, broadly lanceolate to ovate-lanceolate, bluntly acute or narrowly obtuse. **Branch leaves** tightly and stiffly spiralled around branch and with apices ± subcucullate to incurved when dry, erect-spreading, straight, and not funiculate when moist, oblong-ligulate to broadly oblong, obtuse, often mucronate, moderately keeled, with a single plication below, 1.0–1.8 mm; **margins** entire or slightly crenulate above, plane; **upper laminal cells** mostly rounded-subquadrate, firm-walled, obscured by dense, low, simple or forked papillae, bulging, unistratose, 6–9(–12) µm wide, with 1–2 rows at margins sometimes less obscure; **mid laminal cells** similar in shape and size, less strongly papillose and less obscure, becoming progressively more oblong and smoother towards base; **inner basal cells** oblong-rectangular or elliptic, thick-walled, clear, flat, and smooth, mostly 9–18 × 3–6 µm; **marginal basal cells** thinner-walled, ± hyaline, forming a short, indistinct border. **Costa** percurrent or short-excurrent as a mucro, stout (c. 40–45 µm wide in lower leaf and scarcely tapered), shiny and protruding on abaxial surface when dry, the abaxial superficial cells elongate and smooth throughout, in cross-section consisting almost entirely of stereids (including 3–5 rows of abaxial stereids), and with 3–4 poorly developed adaxial guide cells. **Gemmae** often present on adaxial laminal surface or in axils of leaves, linear, uniseriate, papillose, brown, composed of c. 13–22 quadrate cells and c. 270–360 µm long.

Pseudautoicous. **Perichaetial leaves** similar to vegetative. **Dwarf male plants** axillary. **Setae** 3–5 mm, smooth, straight or flexuose, moderately thick, weakly sinistrorse; **capsules** ovate-elliptic and weakly sulcate throughout when moist, narrowly ovate to ovate-cylindric with 8 weak grooves and narrowed at mouth when dry, 1.3–1.7(–2.0) mm; **exothecial cells** firm-walled (with bands of firmer-

walled cells corresponding to ridges), mostly oblong or rounded-rectangular and 30–60 µm long, becoming shorter and thicker-walled at mouth; **stomata**, **annulus**, and **operculum** as per genus. **Peristome** single; **exostome teeth** 16, erect or inflexed dry or moist, irregular, blunt, pale, finely papillose to papillose-striate, c. 60–160 µm; **endostome** absent. **Calyptra** fimbriate and often pale at base, smooth, plicate, naked, c. 1.5–2.5 mm. **Spores** variable in diameter and indistinctly anisoporous, thick-walled, 12–24 µm, finely papillose to nearly smooth.

Illustrations: Plate 3. Vitt 1983, figs 145, 149–150, 179–188; Beever et al. 1992, fig. 36h.

Distribution: K; NI: N Auckland, including offshore islands (TK, PK, HC, LB, GB, RT), S Auckland (Coromandel Peninsula, near Tauranga); Ch.

Australasian. Recorded from eastern mainland Australia, Lord Howe Island, Norfolk Island, and New Caledonia by Vitt & Ramsay (1985a, p. 382).

Habitat: Occurring on both rock and tree trunks in the salt spray zone and often very conspicuous in suitable northern habitats. It occurs on a variety of rock types including rhyolite, basalt, breccia, and ultramafics. Epiphytic populations occur mostly on *Metrosideros excelsa* but the species is also documented from *Corynocarpus laevigatus* (on Kermadec Is) and *Cordyline kaspar* (on Poor Knights Is). Ranging from sea level to c. 120 m elevation (at Surville Cliffs, N Auckland L.D.) on the North I.

Macromitrium brevicaule is fairly frequent along the North I. coast north of Tauranga Harbour on the east coast and Manukau Harbour on the west coast. Peter de Lange (*in herb.*) considers it to be “easily the most common *Macromitrium*” on Raoul Island (in the Kermadecs). There is no reason to question Vitt’s (1983) suggestion that it is a relatively recent arrival to N.Z. by long-distance dispersal from eastern Australia; nor is there any reason to consider it adventive here.

Notes: Occasional collections (*E.K. Cameron 2457a* from Three Kings Is, CHR 104729; *L.B. Moore s.n.* from Poor Knights Is, CHR 398315) have leaves that are strongly eroded, in extreme cases nearly reduced to only costae. Vitt (1983) described the spores here as “indistinctly anisoporous, variable”; I have seen spores only between 12–24 µm but I concur that they are variable in size and appear to be anisoporous. Although male plants and the pseudautoicous sexuality of this species are described by Vitt, I have been unable to find male plants. Lactic acid is useful to clear the very opaque upper laminal cells prior to microscope examination.

The combination of broad leaves with distinctly multipapillose upper cells and short basal cells distinguishes this species from all other N.Z. congeners. Recognition is also facilitated by its compact habit, and oblong-ligulate and obtuse leaves stiffly spiralled around the short branches, as well as its presence in northern and coastal habitats. It frequently fruits and its relatively short, left-twisting setae and naked and plicate calyptrae provide further distinction.

This Australasian species is the only species in N.Z. placed by Vitt & Ramsay (1985a) with three other predominantly Australian species in their “*M. aurescens* group”.

Recognition: *Macromitrium longirostre* s.l., often in coastal situations, also has dry leaves spirally twisted around the branches and sometimes has short basal cells. It is differentiated from *M. brevicaule* by having smooth and often partially bistratose upper laminal cells and leaf apices usually reflexed when dry. The two species appear to overlap in distribution only on Chatham Is.

Etymology: The epithet refers to the short branches of this species.

***Macromitrium gracile* (Hook.) Schwägr., Sp. Musc. Frond. Suppl. 2(1), 39 (1823)**

≡ *Orthotrichum gracile* Hook., *Musci Exot.* 1, 27 (1818)

≡ *Leiotheca gracilis* (Hook.) Brid., *Bryol. Univ.* 1, 730 (1826)

Holotype: N.Z., Dusky Bay, A. Menzies, 1791, BM-Hooker (Cited by Vitt 1983.) Not seen.

= *Macromitrium mossmanianum* Müll.Hal., *Bot. Zeitung (Berlin)* 9: 561 (1851)

Lectotype: N.Z., Wairoa River, near Kaipara, S. Mossman 735, NY-Mitten (Designated by Vitt 1983.) Not seen.

= *Macromitrium gracile* var. *proboscideum* Dixon, *Bull. New Zealand Inst.* 3: 366 (1929)

Holotype: N.Z., Lake Waikaremoana, G.O.K. Sainsbury 48, Jan. 1924, BM-Dixon (Cited by Vitt 1983.) Not seen.

Plants medium-sized to moderately robust, slender, stiff, not lustrous, usually light green, yellow-green, or bronze above, olive-green or brown below. **Branches** usually 5–20(–40) mm, erect, stiff, often once-branched by subperichaetial innovation. **Stem leaves** erect-flexuose when dry, spreading-

recurved moist, ovate-lanceolate, 0.8–1.0 mm. **Branch leaves** precisely twisted, indistinctly funiculate, and with upper portions incurved (usually to one side) or decurved when dry, \pm wide-spreading-flexuose and clearly funiculate when moist, lanceolate from an oblong or ovate base, gradually narrowed to a subulate or ligulate apex, keeled, frequently with apices broken off below but with some intact near branch apices, 1.8–2.8 mm (when intact); **margins** entire, broadly reflexed at mid leaf; **upper laminal cells** \pm quadrate, thick-walled, \pm bulging, densely pluripapillose and often obscure, arranged in indistinct longitudinal rows, 6–8(–10) μ m wide, sometimes becoming larger (to c. 15 μ m in greater dimension), more irregular, and \pm bistratose in subula; **mid laminal cells** slightly larger and more distinctly ranked, transitioning gradually with the inner basal cells; **inner basal cells** elongate, thick-walled, nearly smooth or tuberculate, mostly 20–50 \times 8–10 μ m (lumina c. 2–3 μ m wide; curved or nearly straight); **marginal basal cells** longer, but not forming a distinct border. **Costa** ending in or just below apex (in intact leaves), the abaxial superficial cells elongate and smooth, in cross-section with one adaxial row of c. 4 guide cells and 2–3 rows of abaxial stereids. **Gemmae** absent.

Pseudautoicous. Perichaetial leaves clearly differentiated and mostly distinctly larger than vegetative, erect and sheathing, lanceolate to oblong-lanceolate, usually with intact apices, 2.2–3.0 mm. **Dwarf male plants** epiphyllic, with stems to c. 1 mm and sometimes with multiple (to 3) perigonia, the perigonial bracts spreading. **Setae** 2.5–7 mm, smooth, \pm straight or moderately flexuose, sinistrorse; **capsules** 1.0–1.7(–2.2) mm, ovate, (becoming more broadly ovate with age), smooth or weakly 8-sulcate; **exothecial cells** short and rather irregular, elliptic to rhombic-rectangular, thick-walled, mostly 20–40 μ m long sometimes with bands of longer (30–60 \times c. 6–8 μ m) cells, shorter and thicker-walled at rim; **stomata** and **annulus** as per genus; **operculum** erect, c. 1 mm. **Peristome** single; **exostome teeth** 16, well-developed, inflexed-erect when dry, pale to white, c. 200 μ m, coarsely papillose on both surfaces, often fragile with age. **Calyptra** c. 3 mm, deeply and evenly lacerate, shiny, golden, strongly plicate, naked or nearly so. **Spores** indistinctly anisosporous, 16–40, finely papillose.

Illustrations: Plate 4. Vitt 1983, figs 98–114; Beaver et al. 1992, fig. 36g.

Distribution: K; NI: N Auckland, including offshore islands (TK, PK, HC, LB, GB, RT), S Auckland, Gisborne (Lake Waikaremoana), Hawke's Bay, Taranaki (Mt Taranaki), Wellington; SI: Nelson, Marlborough, Canterbury (Arthur's Pass, Banks Peninsula), Westland, Otago (Mt Cargill, Tautuku), Southland; St; Ch.

Endemic.

Habitat: *Macromitrium gracile* is particularly frequent on *Carpodetus serratus*, but it occurs on a wide variety of native flowering tree species including *Aristolelia serrata*, *Coprosma* spp., *Fuchsia excorticata*, *Griselinia lucida*, *Lophomyrtus bullata*, *Melicactus ramiflorus*, *Metrosideros excelsa*, *M. umbellata*, *Neomyrtus pedunculata*, *Olearia ilicifolia*, *Pseudowintera colorata*, and *Vitex lucens*, as well as the native gymnosperms *Dacrydium cupressinum*, *Podocarpus totara*, *Prumnopitys ferruginea*, and *P. taxifolia*, and the introduced genera *Cupressus* and *Berberis*. It occurs infrequently on southern beech, but it has been recorded from *Fuscospora solandri* s.l., *F. fusca*, and *Lophozonia menziesii*. On the Chatham Is this species is also recorded from *Corynocarpus laevigatus*, *Dracophyllum arboreum*, and *Myrsine coxii*. It rarely occurs on rock (as at D'Urville I., Marlborough L.D., J.E. Beaver 46–58b, CHR 461786). Observations on recently fallen trees and branches suggest that *M. gracile* is more abundant in the forest canopy than it is on the lower trunks of forest trees.

Frequently associated mosses include *Calyptopogon mnioides*, *Camptochaete arbuscula*, *Cyrtopus setosus*, *Dicranoloma menziesii*, *Holomitrium perichaetiale*, *Leptostomum inclinans*, *Lopidium concinnum*, *Macrocoma tenue*, *Macromitrium retusum*, *M. helmsii*, *M. longirostre*, *M. orthophyllum*, *M. longipes*, *Orthorrhynchium elegans*, *Papillaria crocea*, *Tetraphidopsis pusilla*, and *Trachyloma planifolium*. A wide variety of hepatics including species of *Frullania*, *Lepicolea*, *Plagiochila*, *Plagiochilion*, *Porella*, and *Radula* also occur with it. On the North I. occurring from sea level (at Whangārei, N Auckland L.D.) to 950 m (Mt Ruapehu, Wellington L.D.) and on the South I. from sea level (Dusky Sound, Southland L.D.) to at least 550 m (at Mt Cargill, Otago L.D.).

Macromitrium gracile is found in all forested and scrub areas on the North I., but is more common at lower elevations. On the South I. *M. gracile* is a very common epiphyte in the Marlborough Sounds and at Pelorus Bridge in Marlborough L.D., at many localities in Westland L.D. including Lake Kaniere, Kellys Creek and the Ōtira Valley, and at Tautuku in the Catlins region of Otago. It is a common species on both Stewart and Chatham Is. It is a rare species east of the main divide on the South I. Vitt (1983, fig. 115) mapped an occurrence near Lake Pūkaki (Canterbury L.D.), but I have seen no specimen from there.

Notes: In the field and in its most common form, the usually long and stiff branches, the shape and set of the leaves (mostly turned to one side and incurved in their lower portions but apically decurved and

indistinctly funiculate when dry), together with the often-produced and clearly enlarged and sheathing perichaetial leaves make this species easily recognisable. When plants are dry, the leaves often appear (because of their inrolled set) to be intact but when moist and widely spreading their truncated apices are easily seen.

I concur with Vitt (1983, p. 42) that *M. gracile* is a variable species, which “exists in several intergrading phenotypes”. Paraphrasing Vitt (1983), all of these forms exhibit lanceolate leaves, stiff, wiry branches with branching usually single beneath perichaetia, a distinctive leaf set (with each leaf incurved or inrolled with apices curved to one side) and leaf insertion spirally arranged, obscure and densely pluripapillose upper leaf cells in longitudinal rows, elongate basal cells, sheathing and conspicuous perichaetial leaves, smooth setae sinistrorse, and ovate, non-puckered capsules with well-developed peristomes.

Recognition: The upper lamina forms a long, flattened bistratose subula, which is fragile in many plants but, when intact, becomes conspicuously decurved giving a distinct appearance to the plants. Often the intact leaves are restricted to the branch tips and this combines with the other features cited above to give the plants a distinctive habit. I agree with Vitt (1983) that populations with extended fragile leaf apices and those with acute, mostly non-fragile apices grow together and do not appear to be differently distributed.

Specimens with short, intact apices sometimes occur and these can be confused with *M. microstomum* or *M. prorepens*. Such material of *M. gracile* is distinct by having truly lanceolate leaves, obscure and pluripapillose upper leaf cells, stiff branches, and single innovative branches below the perichaetia.

Confusion sometimes occurs with the related *M. helmsii*. However, in forms of *M. gracile* with protracted leaf apices, these are present in at least some fully mature leaves, gradually tapered to the apex, and decurved. In *M. helmsii*, by contrast, the protracted leaf apices extend beyond the stem apex in the same axis as the stem “in apical tufts”, and (as explained well by Vitt 1983, p. 47) the aristae reach their “mature length first, and then lamina development [takes] place secondarily. Thus mature aristae [terminate] short immature leaf laminae and once the laminae reach full length, the aristae are broken off.” The irregular nature of the broken leaf edge in *M. gracile* contrasts with the retuse leaf edge in *M. helmsii*. These features, once seen, are easily recognised.

Macromitrium gracile is readily distinguished from *M. longipes*, which also has elongate perichaetial leaves, by plants being dull in appearance (due to the papillose laminal cells), the less strongly funiculate and frequently broken leaves, and the strongly sheathing perichaetial leaves. By contrast, *M. longipes* is lustrous (due to smooth laminal cells), more strongly funiculate (readily seen in dried material), and has unbroken leaves and less sheathing perichaetial leaves.

Vitt & Ramsay's (1985a) “*M. gracile* group” includes five species in Australasia. *Macromitrium gracile* and *M. helmsii* are N.Z. endemics. *Macromitrium incurvifolium* is predominantly distributed in the tropical Pacific and eastern Asia and occurs in the Kermadec Is.

Etymology: The epithet *gracile* means slender and presumably refers to the slender and relatively long branches of this species.

***Macromitrium grossirete* Müll.Hal., *Hedwigia* 37: 153 (1898)**

Lectotype: N.Z., South I., Waimakariri Gorge, Patterson's Creek, *T.W.N. Beckett* 395, 1892, CHR 622464! (Designated by Vitt 1983.)

= *Macromitrium rigescens* Broth. & Dixon in Dixon, *J. Linn. Soc., Bot.* 40: 446 (1912)

Isotype: N.Z., Mt. Cook district, *J. Murray* 69, WELT M000913!

Plants robust but with short branches, dull, yellow- to olive-green above, rust- or chocolate-brown below, mostly on bark. **Branches** short, to 10 mm, ascendant, simple or forking below perichaetia. **Stem leaves** erect-flexuose when dry, wide-spreading-recurved when moist, broadly lanceolate, gradually acuminate, 1.6–2.0 mm. **Branch leaves** neither funiculate nor spiralled around the branch, strongly and irregularly twisted when dry, often twisting 360° or more in upper portions, spreading and ± flexuose when moist, ovate- or lanceolate-ligulate, abruptly acute-cuspidate or broadly acuminate, keeled and usually with a single plication below, 2.5–4.5 mm; **margins** broadly reflexed on one margin below (obvious when dry), subentire to crenulate, sometimes with irregular but shallow indentations near apex; **upper laminal cells** isodiametric and rounded, firm-walled and slightly thickened at corners, strongly bulging, both surfaces with one strong central papilla, unistratose, 10–16 µm diam. (lumina c. 9–12 µm diam.); **papillae** tall (to c. 15–18 µm high) and usually rounded distally, simple or irregular or weakly branched at their apices; **mid laminal cells** similar to upper or more elliptic, to

c. 18 µm long, extending basally with little change in shape very far toward the leaf base (usually to within c. 500–800 µm of the leaf insertion) and there transitioning rapidly into the inner basal cells; **inner basal cells** elongate, with thick and ± pitted walls, golden, irregularly linear, smooth or tuberculate, c. (15–)20–40 µm long, with lumina mostly 3–5 µm wide; **marginal basal cells** not differentiated. **Costa** ending a few cells below apex, with abaxial superficial cells elongate, but obscured by short and papillose cells in upper portion, in mid leaf cross-section with 2–3 rows of abaxial stereids and 3–4 adaxial guide cells. **Gemmae** absent.

Pseudautoicous. Perichaetial leaves slightly smaller and more ovate than branch leaves, not sheathing, surrounding a densely hairy vaginula. **Male plants** dwarf and epiphytic. **Setae** 2.5–4.5 mm, smooth, erect or flexuose, strongly dextrorse; **capsules** oblong-elliptic, smooth below, strongly narrowed and 8-plicate at mouth, the plicae sometimes extending downwards to the upper $\frac{1}{3}$ of the capsule with age, erect, dark-brown and ± shiny, 1.5–2.0 mm; **exothecial cells** oblong or irregularly elliptic, thick-walled, mostly 20–60 µm long, shorter, rounded and thicker walled near rim; **stomata** sparse; **annulus** and **operculum** as per genus. **Peristome** absent. **Calyptra** large, c. 3.0–3.5 mm (excluding the apical hairs), splitting by 1–3 deep slits, smooth, covered with dense, long, and smooth yellow hairs. **Spores** anisosporous, 18–40(–50) µm, finely papillose, smaller spores thin-walled, larger spores moderately thick-walled.

Illustrations: Plate 5. Vitt 1983, figs 123–133, 219–220, 222–223, 226.

Distribution: NI: N Auckland (near Auckland), S Auckland (near Tauranga, near Rangitāiki), Wellington (Hauhungatahi, Kiwi Mouth Hut, Ruahine Range, near Wellington); SI: Nelson, Marlborough (Richmond Range, Black Birch Range, near Kēkerengū), Canterbury (including Banks Peninsula), Westland, Otago, Southland (Lake Manapōuri, Lake Hauroko); Ch.

Endemic.

Macromitrium grossirete is poorly documented and apparently uncommon on the North I.; Vitt (1983) records it from five widely scattered localities and specifically confirms its occurrence in gallery forest near the tree line on Mt Ruapehu. The only North I. fertile collection I have seen is from near Kiwi Mouth Hut in the Kaweka Range (*L. Perrie & L. Shepherd s.n.*, 11 Dec. 2003, WELT M036174). I have seen little material from Marlborough and none from coastal areas of Otago, but it is recorded from these localities by Vitt (1983). This is the commonest *Macromitrium* in the montane southern beech forest east of the Main Divide in Canterbury.

Habitat: Occurring primarily on trunks and larger branches of *Fuscospora cliffortioides*, *F. solandri*, and *Lophozonia menziesii*. Infrequent host species include *Coprosma parviflora*, *Dracophyllum uniflorum*, *Griselinia littoralis*, *Kunzea ericoides*, *Leptospermum scoparium*, *Lophomyrtus obcordata*, *Pittosporum tenuifolium*, *Phyllocladus alpinus*, *Podocarpus laetus*, and *Populus* sp. This species also occasionally occurs on rock. Frequently associated epiphytes include *Calyptopogon mnioides*, *Dicnemon semicryptum*, *Hypnum cupressiforme* var. *filiforme*, *Leptostomum inclinans*, *Macrocoma tenue*, and *Orthotrichum tasmanicum*. It ranges in elevation from near sea level (Chaney's, Canterbury L.D.) to 1200 m (Nelson Lakes National Park, Nelson L.D.) on the South I., with the majority of collections from above c. 400 m in montane regions.

Notes: *Macromitrium grossirete* is a very distinctive species characterised gametophytically by robust but shortly branched plants, long and irregularly twisted leaves, strongly singly papillose upper laminal cells, an abrupt transition between the mid laminal cells and the elongate inner basal cells (which extend a relatively short distance above the leaf base), a percurrent costa, and a hairy vaginula. Sporophytically, gymnostomous capsules that are strongly narrowed and 8-plicate at the mouth, dextrorse setae, and calyptrae with only two or three or sometimes one major slit, and slender, dense, non-papillose hairs provide further distinction. I agree with Vitt (1983) that the extremely large mid leaf papillae can be seen with a stereoscope in this species, and this further facilitates recognition.

Despite the frequent production of capsules in this species, I have not located male plants in any herbarium material, despite targeted searching (especially in CHR 462846 and 592170, both of which are amply fruiting) and must accept Vitt's (1983) observations that this species has dwarf male plants.

Vitt & Ramsay (1985a) included *M. grossirete* in their "*M. hemitrichodes* group" along with *M. prorepens*, *M. submucronifolium* (which is not recognised here), *M. angulatum* (excluded here from the N.Z. flora), and three Australian endemics.

Recognition: *Macromitrium grossirete* is frequently confused with *M. prorepens* but the latter species has branched papillae, 4-plicate capsules, a peristome, excurrent costae and lacerate, hairy calyptrae. Papillose upper leaf cells are also found in *M. ligulare*, which is best differentiated by very small, simple papillae on the bulging upper leaf cells and naked calyptrae. These two species have

sinistrorse setae, in contrast to the dextrorse setae of *M. grossirete*. Other species with dextrorse setae include *M. longirostre* and *M. retusum*, which, however, have ± smooth upper laminal cells.

Etymology: The meaning of the species epithet is obscure; it may refer to the unusually large laminal cell papillae.

***Macromitrium helmsii* Paris, *Index Bryol. Suppl.*, 238 (1900)**

≡ *Macromitrium appendiculatum* Müll.Hal., *Hedwigia* 37: 156 (1898) nom. illeg. non *Macromitrium appendiculatum* (Renauld & Cardot) Paris 1897

Lectotype: N.Z., South I., near Greymouth, *R. Helms s.n.*, 1885, H-Brotherus (Cited by Vitt 1983.) Not seen.

Plants slender to moderately robust, ± dull, olive-green to yellow-brown above, dark green or brown below. **Branches** wiry and often long, to 25 mm, erect, mostly simple, penicillate at apices. **Stem leaves** erect-flexuose when dry, recurved-squarrose when moist, lanceolate-acuminate. **Branch leaves** spiralled around the branch and with apices twisted to one side or recurved when dry, spreading from a ± erect base and neatly funiculate when moist, broadly ligulate to oblong-lanceolate at maturity, usually ± broader below, retuse or obtuse and often asymmetric at apex, strongly keeled, (1.2–)1.5–2.5 mm; immature leaves with a linear, stiffly flexuose, and deciduous arista c. 1.0–2.0 mm long; **margins** entire, plane or weakly recurved on one side; **upper laminal cells** irregularly rounded-quadrate, thick-walled, in longitudinal rows, bulging, obscured by low, multiple papillae, unistratose, mostly 5–9 µm diam. (lumina c. 5–6 µm across); **mid laminal cells** thick-walled and mostly ± rectangular, usually sparsely papillose, mostly 7–14 × 7–8 µm; **inner basal cells** long-rectangular to elongate, irregularly thick-walled, with lumina straight or nearly so, smooth or with low, conical papillae, mostly 20–40 µm long, (lumina (2–)4–6 µm wide); **marginal basal cells** scarcely differentiated. **Costa** excurrent to form an arista (present only in immature leaves), the abaxial superficial cells elongate in mature leaves (covered by laminal cells on arista), in cross-section with c. 4–5 guide cells in 1–2 layers, 1–2 layers of abaxial stereids, and few or no adaxial stereids. **Gemmae** absent.

Dioicous. Perichaetial leaves similar to branch leaves, but more gradually narrowed to a persistent arista. **Male plants** and **sporophytes** not seen.

Illustrations: Plate 5. Vitt 1983, figs 44, 116–121.

Distribution: NI: N Auckland (recorded from one locality by Vitt 1983), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington; SI: Nelson (near Upper Tākaka, St Arnaud, Lake Rotoroa, Punakaikī and vicinity, near Greymouth), Marlborough (Pelorus Bridge Scenic Reserve), Canterbury (Port Hills), Westland (Kellys Creek, Lake Kaniere), Otago (eastern parts only), Southland; St (*vide* Vitt 1983); Ch.

Endemic.

Habitat: Epiphytic on tree trunks and larger branches in lowland podocarp-broadleaf forest, particularly in shrubby forests at road and track margins. This species is especially common on *Carpodetus serratus* and *Leptospermum scoparium*, while other host species may include *Aristotelia serrata*, *Coprosma pseudocuneata*, *Fuscospora solandri s.l.*, *Lophomyrtus bullata*, *Melicytus ramiflorus*, *M. chathamicus*, *Parsonsia* sp., *Pseudopanax* sp., *Sophora* sp., and *Dacrydium cupressinum*. Also occurring on the introduced *Cupressus macrocarpa* and rarely on rock. Associated epiphytic bryophytes include *Calyptopogon mnioides*, *Cladomnion ericoides*, *Glyphothecium sciuroides*, *Leptostomum inclinans*, *Lepyrodon australis*, *Macrocoma tenue*, *Macromitrium gracile*, *M. longipes*, *M. prorepens*, *Neckera hymenodonta*, *Tetraphidopsis pusilla*, and *Porella elegantula*. On the North I. occurring from near sea level (near Wanganui, Wellington L.D.) to at least 760 m (Lake Waikaremoana, Gisborne L.D.), and on the South I. from near sea level (Punakaikī, Nelson L.D.) to at least 600 m (St Arnaud, Nelson L.D.).

Notes: Vitt (1983) observed that *M. helmsii* is more frequent on the North I. than on the South I. He stated it to be “not uncommon from the Hamilton-Rotorua area south to Wellington” and this is corroborated by collections made since his revision. W. Martin (*in herb.*) stated that it is the “commonest species on trees” at Mt Bruce (Wellington L.D.).

On the South I. it is more scattered in distribution and appears to be most frequent in the Nelson L.D., where it has a considerable elevational range, and in eastern Otago. There are no records from Fiordland (Southland L.D.) and the few records from Canterbury L.D. (see Vitt 1983, fig. 122) require clarification.

Only female plants are known for *M. helmsii*. The obscurely papillose upper laminal cells and leaves abruptly narrowed to mostly fragile, penicillate aristae characterise the species. The first of these features, together with sparsely papillose and elongate basal laminal cells, a characteristic leaf set, and wiry branches, clearly ally *M. helmsii* with the *M. gracile* complex. Confusion occurs with fragile-leaved forms of the related *M. gracile*; distinctions between *M. helmsii* and *M. gracile* are detailed under the latter species. Vitt & Ramsay's (1985a) "*M. gracile* group" includes *M. helmsii*, *M. gracile*, *M. incurvifolium*, and two other Australian species.

Recognition: *Macromitrium retusum* has similar fragile and penicillate aristae, but is readily differentiated by smooth upper leaf cells, and ligulate to oblong leaves spiralled around the branch.

Etymology: The species epithet commemorates the collector of the type, Richard Helms (1842–1914). German-born Helms was a remarkably talented naturalist of broad interests who collected widely in Australia and N.Z. He was resident in Greymouth in the 1870s and 1880s and collected extensively in the Greymouth area, including the Paparoa Range. As well as plants, he collected invertebrates, and a number of N.Z. beetles and molluscs are named in his honour.

***Macromitrium incurvifolium* (Hook. & Grev.) Schwägr., *Sp. Musc. Frond. Suppl.* 2(2), 144 (1827)**

≡ *Orthotrichum incurvifolium* Hook. & Grev., *Edinburgh J. Sci.* 1: 117 (1824)

Lectotype: Indonesia, Island of Ternate, "Received from Mr. Dickson," E-Greville (Designated by Vitt & Ramsay 1985a.) Not seen.

Plants robust. **Branch leaves** irregularly and strongly flexuose-twisted and with apices strongly inrolled and obscured when dry, widely spreading, flexuose, and not funiculate when moist, lanceolate, acute, c. 2.5 mm; **margins** entire; **upper laminal cells** in distinct longitudinal ranks, rounded-quadrate to subquadrate or oblate, 5–8 µm wide, slightly bulging, finely pluripapillose; **mid laminal cells** similar in size and shape but smooth; **inner basal cells** long-rectangular, with narrow and curved or weakly sigmoid lumina. **Costa** percurrent. **Gemmae** absent.

Pseudautoicous (*vide* Vitt & Ramsay 1985a). **Perichaetial leaves** shorter than adjacent vegetative leaves, with long excurrent costae. **Dwarf males** not seen. **Setae** c. 5 mm, sinistrorse; **capsules** obovoid in N.Z. material, smooth or weakly 8-plicate, c. 1.5 mm. **Peristome** single, often fallen in dried material. **Calyptra** deeply and evenly lacerate, strongly plicate and hairy. **Spores** anisosporous, 15–39 µm.

Illustrations: Not illustrated. Vitt & Ramsay 1985a, figs 268–269, 271–273, 275–284; Vitt et al. 1995, figs 16 a–j.

Distribution: K: Raoul I. (Prospect Hill).

Apparently Polynesian or Western Pacific. Vitt et al. (1995) considered this to be a "widespread South Pacific, Pacific, Australian, and East Asian species" and outlined its distribution in detail.

Notes: Known from only a single, but ample and fruiting, collection (*P. de Lange* K588, AK 327888) from a fallen Kermadec Is pōhutukawa (*Metrosideros kermadecensis*) at c. 450 m elevation on Raoul I. The Kermadec Is material compares well to collections from Fiji.

The strongly crisped leaves are suggestive of the related *M. gracile*. However, in *M. incurvifolium* the inner perichaetial leaves are shorter than the adjacent vegetative leaves (the perichaetia are not obvious under a stereoscope), the branch leaves are consistently unbroken and lanceolate with inrolled and obscured apices when dry, and the calyptrae are hairy. In *M. gracile*, the perichaetial leaves are much longer than the adjacent leaves (and the perichaetia obvious), the branch leaves are usually fragmented, with decurved apices (if intact) when dry, and the calyptrae are naked or nearly so. The small upper and mid laminal cells that are arranged in very distinct longitudinal ranks also give *M. incurvifolium* distinction, but this is a feature that it shares with *M. gracile*. The two species overlap in distribution only on the Kermadec Is.

Vitt & Ramsay's (1985a) "*M. gracile* group" includes five species in Australasia, including *M. incurvifolium*, *M. gracile*, and *M. helmsii*.

Recognition: The difference in their leaf shape and the nature of their laminal cells make confusion between *M. incurvifolium* and the superficially similar *M. ligulare* and *M. ligulaefolium* unlikely.

Etymology: The species epithet alludes to the leaves with inrolled and thus obscured dry leaf apices.

***Macromitrium ligulaefolium* Broth., Öfvers. Finska Vetensk.-Soc. Förh. 40: 170 (1898)**

Holotype: Australia, New South Wales, near Sydney, *W.W. Watts 178*, H-Brotherus. Isotype: NSW-Watts. (Cited by Vitt 1983.) Not seen.

Plants slender to medium-sized, dull or lustrous, olive-green above, dark green to dark brown below. **Branches** to c. 10 mm. **Stem leaves** flexuose-erect when dry, widely spreading and recurved when moist, broadly to narrowly ovate-lanceolate, obtuse, 1.3–1.5 mm. **Branch leaves** flexuose-twisted, with upper portion strongly inrolled and apices obscured when dry, flexuose-spreading with weakly inflexed apices when moist, not funiculate, linear-lanceolate to ligulate, rounded-obtuse to broadly acute in N.Z. material, strongly keeled, mostly 1.5–2.5(–3) mm; **margins** minutely crenulate above, plane to reflexed and entire below; **upper laminal cells** ± isodiametric and rounded-subquadrate, thin- or firm-walled and with ± thickened corners, strongly bulging, smooth or with 1–4 small papillae, 8–12 µm wide, often slightly oblate in a single row at margins; **mid laminal cells** ± similar to upper, extending basally with little change far toward the leaf base and then transitioning rapidly into the inner basal cells; **inner basal cells** rectangular to moderately elongate, 20–33(–50) × c. 8 µm (lumina 2–3 µm wide), thick-walled, scarcely porose, mostly smooth, and extending for up to ¼ the leaf length; **marginal basal cells** not forming a distinct border. **Costa** subpercurrent, percurrent, or short-excurrent to form a minute apiculus (variable on single branch), shiny and smooth abaxially with elongate cells exposed (except near apex), in cross-section with 2–3 guide cells and 1–2 rows of abaxial stereids. **Gemmae** absent.

Pseudautoicous. **Perichaetial leaves** smaller than adjacent vegetative leaves, ± lanceolate, slenderly acute, 1.3–1.6 mm. **Male plants** dwarf, axillary, bulbiform. **Setae** 5–6 mm, smooth, flexuose-erect, slender, sinistrose; **capsules** narrowly ovate to elliptic, smooth below, becoming strongly 8-plicate below the dark, constricted, and plicate mouth, 1.4–1.5 mm; **exothecial cells** moderately thick-walled, irregularly elliptic to short-rectangular, 19–50 × 12–20 µm, darker, mostly short-rectangular or short-elliptic, and forming distinct longitudinal bands at rim; **stomata** and **annulus** as per genus; **operculum** with an erect rostrum. **Peristome** single, reduced, or absent; **exostome** when present a low, partially divided, papillose membrane 1–few cells high and very inconspicuous. **Calyptra** lobed at base, divided by 1–5 long slits and mitrate, or split by one conspicuous slit and ± cucullate, smooth or weakly plicate, naked or with few hairs above. **Spores** indistinctly anisosporous, 15–25 µm, finely papillose.

Illustrations: Plate 6. Vitt 1983, figs 208–218, 221, 224–225; Vitt & Ramsay 1985a, figs 91–97.

Distribution: K; NI: N Auckland, including offshore islands (LB), S Auckland (Hākarimata Range), Wellington (Eastbourne).

Australasian. Tasmania*, mainland Australia*.

Notes: Little is known about the habitat of this rarely collected species in N.Z. Material has been confirmed from near sea level to 520 m (both on Little Barrier I.) elevation. Confirmed specimens were epiphytic (on *Beilschmiedia tawa*, *Knightia excelsa*, *Kunzea ericoides*, or *Prumnopitys ferruginea*).

Vitt & Ramsay (1985a) documented this species on the Australian east coast from Cairns to Tasmania and considered it to be common or abundant in several parts of its range (including the Sydney–Narooma area and the Blue Mountains of N.S.W.). It grows both as an epiphyte and on rock in Australia. They also recorded the species from New Caledonia and predicted it may be found to be more widespread in Oceania. They placed this species in their “*M. ligulare* group” with *M. ligulare*, *M. incurvifolium*, and two Australian endemic species.

Recognition: The most reliable diagnostic characters distinguishing *M. ligulaefolium* from its close ally *M. ligulare* are the sporophytic features cited in the key; in my opinion, sterile material cannot be reliably named.

For those wishing to attempt to name sterile material or to further investigate the relationship between *M. ligulaefolium* and *M. ligulare*, Vitt (1983) suggested that most populations of *M. ligulaefolium* have narrower and more sharply pointed leaves with more variable costa lengths than *M. ligulare*, and that the inner basal laminal cells of *M. ligulaefolium* extend further from the leaf insertion (up to c. ¼ the leaf length). These features are indeed observable in some N.Z. collections of *M. ligulaefolium*, but they do not seem consistent enough to allow for confident determination. Also according to Vitt, plants of *M. ligulaefolium* have branches rarely exceeding 5 to 10 mm. The total number of N.Z. collections of *M. ligulaefolium* is very small.

Etymology: The epithet describes the ligulate leaf shape.

***Macromitrium ligulare* Mitt., J. Proc. Linn. Soc., Bot. 4: 78 (1859)**

Lectotype: N.Z., Waikeki [Waiheke?], *Dr Sinclair*, NY-Mitten (Cited by Vitt 1983.) Not seen.

Plants slender, dull, yellow- to olive-green above, dark green or brown below. **Branches** to c. 17 mm, usually less. **Stem leaves** flexuose-erect dry, widely spreading and recurved when moist, lanceolate to broadly lanceolate, acuminate or acute, 1.0–1.3 mm. **Branch leaves** flexuose-twisted, with upper portion strongly inrolled and apices obscured when dry, flexuose-spreading with weakly inflexed apices when moist, not funiculate, ligulate to lanceolate-ligulate, rounded-obtuse to broadly acute, often with a 1-celled apiculus, strongly keeled, 1.5–2.5 mm; **margins** crenulate above, plane to ± reflexed and entire below; **upper laminal cells** isodiametric and rounded-subquadrate, thin-walled sometimes with weakly thickened corners, strongly bulging, usually with 1–4 small, conical papillae, unistratose, 9–15 µm wide, often smaller and transversely elliptic to rounded at margins; **mid laminal cells** similar, extending basally with little change far toward the leaf insertion (to within c. 0.1–0.25 of leaf length) and then transitioning abruptly into the inner basal cells; **inner basal cells** short-rectangular, 14–33 × c. 9 µm, (lumina c. 4–6 µm wide), ± thick-walled, porose, and mostly smooth; **marginal basal cells** not forming a distinct border. **Costa** ending a few cells below apex, shiny and smooth abaxially with elongate cells exposed (except near apex), in cross-section with 2–3 guide cells and 1–2 rows of abaxial stereids. **Gemmae** absent.

Pseudautoicous. **Perichaetial leaves** smaller than adjacent vegetative leaves, ovate-lanceolate, gradually acuminate or acute, not sheathing, 1.1–1.7 mm. **Dwarf male plants** axillary, bulbiform. **Setae** 2–8 mm, smooth, flexuose-erect, slender, sinistrorse; **capsules** narrowly oblong-ovate to cylindrical-oblong, gradually contracted to the seta through a long, wrinkled neck, smooth, not plicate at mouth, usually with mouth darker and moderately constricted with age, c. 1.5–2.0 mm; **exothecial cells** thin-walled, ± elliptic-oblong to long-rectangular, 40–85 × 10–22 µm, more elongate and with thicker longitudinal walls at mouth; **stomata** and **annulus** as per genus; **operculum** erect-rostrate. **Peristome** single and apparently fugacious; **exostome teeth** 16, inflexed when dry, pale, blunt, transversely papillose-striate, c. 100 µm. **Calyptra** ± plicate, nearly entire or lobed at base, divided by 1–3 long slits, mitrate or approaching cucullate, not lacerate, smooth, naked. **Spores** anisosporous, 14–34 µm, finely papillose.

Illustrations: Plate 6. Vitt 1983, figs 190–206.

Distribution: NI: N Auckland, including offshore islands (LB, GB), S Auckland, Gisborne, Hawke's Bay, Wellington; SI: Nelson (Nelson Lakes area including Travers Valley), Marlborough (Picton, Hāpuku River, Mt Fyffe), Canterbury, Westland (near Greymouth, Lake Kaniere, near Haast), Otago (eastern regions only); St.

Australasian. Mainland Australia*.

Vitt's statement that this species is "infrequently collected north of Auckland" needs amendment, as there are numerous post-1983 collections from this region, mostly made by J.E. Beever. However, the paucity of material from near Mt Ruapehu and an apparent complete lack of records from Taranaki L.D. remain.

Habitat: *Macromitrium ligulare* is most frequent in the lower-elevation podocarp-broadleaf forests of the central North I. Host species include *Coprosma arborea*, *C. parviflora*, *Corynocarpus laevigatus*, *Leucopogon fasciculatus*, *Fuscospora solandri* s.l., *Knightia excelsa*, *Litsea calicaris*, *Myoporum laetum*, *Vitex lucens*, and *Podocarpus laetus*. It also occasionally occurs on *Cupressus macrocarpa* and on rock (as at Trotters Gorge, Otago L.D.). Bryological associates include *Calyptopogon mnioides*, *Cryphaea* sp., *Leptodon smithii*, *Neckera hymenodonta*, *N. laevigata*, *Macrocoma tenue*, *Macromitrium gracile*, *Papillaria flexicaulis*, and *Zygodon hookeri*. On the North I. ranging from near sea level in coastal forest (North Cape, N Auckland L.D.) to c. 900 m (Paeroa Range, S Auckland L.D.) and on the South I. from near sea level (Hāpuku River, Marlborough L.D.) to c. 850 m (Banks Peninsula, Canterbury L.D.).

Notes: When well-developed this is a distinctive species. According to Vitt (1983, p. 71) *M. ligulare* can be distinguished from other N.Z. *Macromitria* by a number of characters. These include: (1) "branch leaves [that] are inrolled with the apices hidden in the inrolled part and not curved to the side as in other species; (2) the strongly bulging, rather thin-walled upper leaf cells [that] are without large papillae and continue well below mid leaf and restrict the shortly elongate basal cells to the lower to ¼ (or less) of the leaf; (3) perichaetial leaves [that] are shorter than the vegetative leaves, but differ in shape; and (4) the completely smooth, delicate capsules that possess a peristome but that are collapsed at the mouth when mature. The exothecial cells are delicate and thin-walled in the body of the urn, but become thickened longitudinally at the rim, forming a distinct dark-brown rim associated with the collapsed area." The calyptrae are naked and split by one or two long slits. Vitt & Ramsay's

(1985a) “*M. ligulare* group” includes the present species, *M. ligulaefolium*, *M. incurvifolium*, and two Australian endemics.

Recognition: A capsule that is peristomate, yet collapsing at the mouth and without plications, is unique among N.Z. *Macromitria*. Closely related to *M. ligulare* is the very rare (in N.Z.) *M. ligulaefolium*, which can be distinguished, when fruiting, by having capsules strongly 8-plicate in the upper portion and having no peristome. I have not confirmed the differences in the exothecial cells (shortened above and not extensively longitudinally thickened in *M. ligulaefolium*) described by Vitt (1983). He also suggested that *M. ligulaefolium* could be distinguished by having an excurrent costa that in most leaves forms a slender apiculus. In my opinion, and that of J.E. Beever (pers. comm., 2012), these two species cannot be distinguished in the absence of well-developed capsules.

Etymology: The epithet describes the ligulate leaf shape.

***Macromitrium longipes* (Hook.) Schwägr., *Sp. Musc. Frond. Suppl.* 2(1), 147 (1824)**

≡ *Orthotrichum longipes* Hook., *Musci Exot.* 1, 24 (1818)

Holotype: N.Z., Dusky Bay, A. Menzies, 1791, BM-Hooker (Cited by Vitt 1983.) Not seen.

= *Macromitrium lonchomitrium* Müll.Hal., *Hedwigia* 37: 148 (1898)

Isotype: N.Z., Greymouth, R. Helms, 1885, [Herb. Helms no. 77] CHR 622463! Holotype in E-Helms cited by Vitt (1983).

= *Macromitrium pseudohemitrichodes* Müll.Hal., *Hedwigia* 37: 150 (1898)

Lectotype: N.Z., North I., F.M. Reader, 1882, H-Brotherus (Designated by Vitt 1983.) Not seen.

Plants robust, lustrous, gold-green to bronze-brown above, chestnut-brown below, mostly on bark.

Branches variable in length, mostly <25 (often <10) mm, ascendant, simple or forking below sex organs. **Stem leaves** twisted-flexuose when dry, ovate-lanceolate, gradually tapered to broadly subulate apices, 1.5–2.0 mm. **Branch leaves** in spiral ranks and with recurved-twisted or decurved apices when dry, slightly curved, funiculate, and spiralled when moist, broadly-lanceolate to ligulate-lanceolate, ± acute, strongly keeled throughout, with a single, usually strong plication below; 1.5–3.0 mm; **margins** entire, recurved on one or both sides below; **upper laminal cells** isodiametric and rounded to subquadrate, usually very thick-walled, flat or slightly bulging, smooth, unistratose, mostly 7–9 µm diam. (lumina 3–8 µm diam.); **mid laminal cells** rectangular, unevenly thick-walled, with elongate and strongly curved to sigmoid lumina, smooth, clear; 15–30(–40) × 8–12 µm (lumina c. 2–3 µm wide); **inner basal cells** elongate-rectangular, more evenly thick-walled, with the lumina straight to sinuose; 16–55(–60) × 8–12 µm (lumina 2–4 µm wide); **marginal basal cells** longer and narrower, not forming a distinct border. **Costa** ending few cells below apex, curving to one side above, the abaxial superficial cells elongate throughout, in cross-section with one layer of 3–5 guide cells and 2–3 rows of abaxial stereids. **Gemmae** absent.

Dioicous. Perichaetial leaves larger than vegetative but otherwise little differentiated, oblong-lanceolate, acute to acuminate-apiculate, erect, straight, and weakly sheathing the lower setae when moist, 3–4 mm. **Male plants** well-developed (not dwarfed); **perigonia** usually inconspicuous, terminal and sometimes multiple at swollen tips of branches, the inner bracts ovate-acute and c. 1 mm, antheridia and paraphyses numerous. **Setae** very long, (7–)10–25 mm, smooth, straight or flexuose, slender, sinistrorse; **capsules** broadly elliptic-ovate to fusiform-cylindric, smooth below, becoming 8-plicate beneath mouth, dark brown and ± shiny, 1.3–2.5 mm; **exothecial cells** thick-walled, irregularly rounded to long-rectangular; mostly 14–40(–55) µm long; **stomata** and **annulus** as per genus; **operculum** c. 1–1.5 mm. **Peristome** single; **exostome teeth** 16, well-developed, inflexed when dry, lanceolate, pale, c. 120–200 µm, coarsely papillose on transverse striae of the inner surface, finely and ± evenly papillose on outer surface. **Calyptra** very large and tightly clasping the developing capsule, to 5 mm, deeply and evenly lacerate, strongly plicate and naked. **Spores** isosporous, 26–66 µm diam. (varying up to 15 µm diam. in single capsule), sparsely papillose, mostly thick-walled.

Illustrations: Plate 7. Sainsbury 1955, pl. 37, fig. 2; Vitt 1983, figs 70–82, 85; Beever et al. 1992, fig. 36 a–f; Malcolm & Malcolm 2003, p. 43.

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

Endemic.

Although known from all South I. L.D., in Canterbury it is known only from near the Main Divide, extending eastwards to about Cass, and this reflects its general rarity in drier parts of the South I. However, it does occur in forest remnants in the drier eastern parts of the North I.

Habitat: It is most often collected from southern beech (especially *Lophozonia menziesii*, but also from *Fuscospora fusca*, *F. solandri s.l.*, and *F. truncata*) and in wetter regions it is often abundant on both trunks and canopy branches. Additionally, it occurs on a very wide range of native angiosperms (including *Archeria traversii*, *Beilschmiedia tarairi*, *Coprosma parviflora*, *Coriaria* sp., *Dracophyllum arboreum*, *D. filifolium*, *D. longifolium*, *Knightia excelsa*, *Leptospermum scoparium*, *Leucopogon fasciculatus*, *Myrsine chathamica*, *Olearia colensoi*, *O. ilicifolia*, *Pittosporum umbellatum*, *Pseudowintera colorata*, *Weinmannia racemosa*, and *W. silvicola*) and gymnosperms (including *Agathis australis*, *Dacrycarpus dacrydioides*, *Dacrydium cupressinum*, *Phyllocladus alpinus*, and *Podocarpus totara*) as well as some introduced woody species (e.g., *Alnus glutinosa* and *Ulex europaeus*). It occasionally also grows on rock (including volcanics, greywacke, and limestone). It is sometimes recorded from rotten logs but such occurrence probably reflects persistence on fallen branches rather than actual colonisation. It rarely grows where it is subject to salt spray. In some subalpine areas it forms the dominant component of the epiphytic flora, especially in *Lophozonia menziesii*-dominated forests. Ranging from c. 100 m (Waipoua Forest, N Auckland L.D.) to c. 1450 m (Mt Ruapehu, Wellington L.D.) elevation on the North I. and from sea level (Papatōwai, Otago L.D. & Resolution I., Southland L.D.) to at least 1150 m (Mt Euclid, Nelson L.D.) on the South I.

Its wide range of host species is reflected in a range of bryophyte associates including *Cladomnion ericoides*, *Dicnemon calycinum*, *D. semicryptum*, *Holomitrium perichaetiale*, *Macromitrium prorepens*, *Mesotus celatus*, *Ulota lutea*, *Chandonanthus squarrosus*, and *Jamesoniella monodon*.

Notes: *Macromitrium longipes* is placed by Vitt & Ramsay (1985a) in their “*M. microstomum* group” with the widespread *M. microstomum* and the N.Z. endemic *M. orthophyllum*. Four Australian endemic species are also placed here.

Recognition: *Macromitrium longipes* is the largest and arguably the most common species of its genus in N.Z. It is readily distinguished from all other species except *M. microstomum* and *M. orthophyllum* by the smooth (non-papillose) and flat upper laminal cells and the strongly funiculate set of the branch leaves. The predominance of chestnut-brown and red tones, and large size of the plants is often sufficient for recognition of the species in the field. However, small plants and those without the distinctive coloration can be confused with *M. microstomum*. Such smaller-than-usual plants are best differentiated by the sigmoid, highly curved mid laminal cell lumina of *M. longipes* as compared to the nearly straight lumina of *M. microstomum*. Also, *M. longipes* is dioicous and its perichaetial leaves are broadly acute and rather stout, whereas *M. microstomum* is autoicous and its perichaetial leaves are slenderly acuminate and delicate. Features distinguishing *M. longipes* from the related *M. orthophyllum* are mentioned under the latter species.

The spores of *M. longipes* are isosporous, but in a single capsule usually vary c. 15 µm in diam. from smallest to largest. Between-population spore variability is also great, some being very thick-walled and others thin-walled, but uniform within a single capsule. Setae vary in length from 7 to 25 mm but most other structural features are generally not variable, making *M. longipes* one of the most distinctive species of its genus in N.Z.

Etymology: The species epithet means long-footed and refers to the unusually long setae of this distinctive species.

***Macromitrium longirostre* (Hook.) Schwägr., Sp. Musc. Frond. Suppl. 2(1), 38 (1823)**

≡ *Orthotrichum longirostre* Hook., *Musci Exot.* 1, 25 (1818) — as *longirostrum*

Holotype: N.Z., Dusky Bay, A. Menzies, 179l, BM-Hooker (Cited by Vitt 1983.) Not seen.

= *Orthotrichum acutifolium* Hook. & Grev., *Edinburgh J. Sci.* 1: 118 (1824)

≡ *Macromitrium acutifolium* (Hook. & Grev.) Brid., *Bryol. Univ.* 1, 735 (1826)

≡ *Macromitrium longirostre* var. *acutifolium* (Hook. & Grev.) Hook.f. & Wilson in Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II* 78 (1854)

Lectotype: Tasmania, Spence & Neill, E-Greville (Cited by Vitt 1983.) Not seen.

Plants variable in size, small to robust, lustrous or dull, light olive-green, yellow-green or rich green above, darker or chestnut-brown below. **Branches** mostly 3–12 mm, but sometimes to c. 35 mm, ascendant, often forked below perichaetia. **Stem leaves** erect-flexuose when dry, erect-spreading when moist, lanceolate or ovate-lanceolate, gradually tapered to narrowly acuminate apices,

c. 1.0–2.0 mm. **Branch leaves** loosely or tightly spiralled around the branch and with upper portions reflexed when dry, erect-spreading and straight or weakly flexuose when moist, not funiculate, narrowly to ovate-lanceolate or oblong, variable at apex, narrowly acuminate, long-cuspidate, or broadly acute, keeled throughout or \pm flattened at apex, (1.6–)2.3–4.0 mm; **margins** entire, plane above, plane or recurved on one side at mid leaf when dry, less conspicuously recurved when moist; **upper laminal cells** rounded-quadrate to oblong-elliptic (a few sometimes oblate), thick-walled, bulging or plane, smooth, usually bistratose in patches in upper third of lamina, less often bistratose only at extreme apex, 5–12(–16) \times 4–10 μ m (lumina 3–5 μ m wide), often smaller at margins; **mid laminal cells** differing little from upper, in \pm distinct longitudinal rows, c. 10–15 \times 8–10 μ m; **inner basal cells** highly variable in shape and length (sometimes variable in a single plant) \pm elongate-rectangular or rounded-subquadrate to elliptic, very thick-walled and evenly or irregularly thickened, mostly 9–40 \times 8–10 μ m, with lumina mostly 5–8 μ m wide, sometimes more irregular near costa; **marginal basal cells** not forming a distinct border. **Costa** ending a few cells below the leaf apex to excurrent as a narrow cusp, the abaxial superficial cells elongate except at extreme tip where covered by \pm quadrate cells, in mid leaf cross-section with 1–2 rows of guide cells, 2–3(–4) abaxial rows of stereids, and 1–2 rows of adaxial stereids. **Gemmae** absent.

Dioicous. **Perichaetial leaves** similar or smaller than vegetative leaves, ovate, acute. **Perigonia** bulbiform, terminal on branches, c. 0.8 mm diam., the inner bracts lingulate, c. 1.5 mm. **Setae** 2.5–8(–11) mm, smooth, straight or slightly flexuose, very thick, dextrorse; **capsules** narrowly ovate or fusiform-cylindric, not strongly constricted at mouth, moderately ribbed or rarely smooth for entire length when dry, yellow-brown to dark red-brown, (1.0–)1.5–2.9(–3.5) mm; **exothelial cells** thick-walled (more strongly so on ribs), elongate-sinuose to elliptic, variable in length but mostly 40–60 μ m, becoming round-oblate near mouth; **stomata** and **annulus** as per genus; **operculum** 1–1.5 mm. **Peristome** double; **exostome teeth** 16, pale, erect-recurved when dry, incurved when moist, irregular and often broken, blunt, coarsely papillose, often very thick outwardly and \pm smooth below, often absent in older capsules; **endostome** an irregular, papillose membrane 1–3 cells high. **Calyptra** deeply lacerate, strongly plicate, naked. **Spores** isosporous, (20–)25–38 μ m, papillose, thick-walled.

Notes: *Macromitrium longirostre* is treated here in a broader sense than by Vitt (1983), with *M. ramsayae* Vitt reduced to varietal rank within it. While the more extreme Chatham Is populations can be distinguished into two groups using Vitt's criteria (and the criteria used in the above key to species), at least six of the 18 collections in CHR are intermediate by some of these criteria. Given the high number of morphological intermediates and overlapping geographic ranges, varietal rank is appropriate. As conceived here, the var. *ramsayae* is characterised by having shorter branches (and hence a more compact habit) than var. *longirostre*, branch leaf apices usually broader and less cuspidate, costae more often subpercurrent, bistratose portions of the upper lamina restricted to the extreme distal portion of the leaf, shorter inner basal cells, shorter setae, and smaller spores.

South I. and Stewart I. populations of *M. longirostre* var. *longirostre* invariably have irregular and often extensive bistratose patches of cells in the upper third of the lamina, while Chatham Is. populations are more variable and intergrading.

Vitt & Ramsay's (1985a) "*M. longirostre* group" includes the present species, "*M. ramsayae*", and the N.Z. endemic *M. retusum*. The lack of fragile leaf tips and the gradually narrowed leaves distinguish both varieties of *M. longirostre* from *M. retusum*.

Distribution and ecology as for the varieties, which are keyed out above.

Etymology: The species epithet refers to form of the operculum in this species.

Macromitrium longirostre* (Hook.) Schwägr., Sp. Musc. Frond. Suppl. 2(1), 38 (1823) var. *longirostre

Branches variable in length, mostly 3–12 mm but sometimes to c. 35 mm. **Branch leaves** erect-spreading and straight or weakly flexuose when moist, strongly spiralled around the branches and with upper portions strongly reflexed when dry, narrowly to ovate-lanceolate, slenderly acuminate to narrowly long-cuspidate, keeled throughout; (1.6–)2.3–4.0 mm; **upper laminal cells** rounded-quadrate to oblong-elliptic (a few sometimes oblate), with conspicuous bistratose patches; **inner basal cells**, \pm elongate-rectangular, very thick-walled and irregularly thickened; mostly c. 20–40 \times 8–10 μ m (occasionally shorter or longer), usually shorter and more irregular near costa. **Costa** mostly ending at or near the leaf apex, rarely excurrent to form a narrow cusp, often nearly filling the acumen. **Setae** 2.5–8(–11) mm; **capsules** (1.0–)1.5–2.9(–3.5) mm. **Spores** isosporous, 25–38 μ m.

Illustrations: Plate 8. Vitt 1983, figs 1–15, 47–50 (as *M. longirostre*); Seppelt 2004, fig. 81 (as *M. longirostre*).

Distribution: NI: Wellington (near Cape Terāwhiti); SI: Nelson (Kōhahai Bluff, near Cape Foulwind, Punakaikī), Westland (Jackson Bay), Otago (coastal areas), Southland (coastal areas); St; Ch; Sol; Sn; A; Ant; C; M.

Austral. Recorded by Vitt & Ramsay (1985a) from Tasmania and King I. and Wilsons Promontory (Victoria) and southern South America.

Habitat: On the South I. occurring exclusively in the salt spray zone both as an epiphyte and on calcareous and non-calcareous coastal rocks. The variety is not uncommon on Stewart I., and it occurs north to Jackson Bay and Dunedin. Further north it is known only from Cape Foulwind to Punakaikī (where it is common), at Kōhahai Bluff, and near Wellington. It is very common on the southern offshore islands. Occurring from sea level to c. 30 m on the South I. but extending to higher elevations on southern offshore islands (to c. 500 m on Stewart and Auckland Is). Collections by W. Martin from higher elevations on Stewart I. are from Pryse Peak and the summit of the Tin Range, and were probably subject to salt spray despite the relatively high elevation.

When epiphytic, *M. longirostre* var. *longirostre* occurs on species of *Coprosma* and *Pittosporum* as well as on *Corynocarpus laevigatus*, *Dracophyllum longifolium*, *Griselinia littoralis*, *Veronica elliptica*, *Metrosideros umbellata*, *Myrsine chathamica*, *Olearia oporina*, *Ozothamnus leptophyllus*, *Brachyglottis rotundifolia*, and *Weinmannia racemosa*. It is also well-developed on both coastal limestone and granite. Epilithic collections at CHR are more numerous than epiphytic ones. Frequent associates (when epiphytic) include *Calyptopogon mnioides*, *Macrocoma tenue*, *Macromitrium retusum*, *M. gracile*, and *Schlotheimia campbelliana*. When epilithic, the variety usually forms pure or nearly pure mats.

Notes: Definitive features of *M. longirostre* var. *longirostre* include branch leaves that are spirally twisted and reflexed at their apices when dry, slightly bulging and smooth leaf cells, rather narrowly lanceolate leaves with conspicuous bistratose upper portions, and a costa ending in a keeled, acuminate-cuspidate apex. Collections from exposed rock surfaces usually have most of their upper $\frac{1}{3}$ bistratose, while epiphytic collections often have only 2–5 rows of cells nearest the costa bistratose. Epilithic populations are also generally more compact and have shorter branches than those that are epiphytic. The stout dextrorse setae, elongate, thick-walled exothecial cells, isosporous spores, and lacerate, naked calyptrae also facilitate its recognition. Capsule shape and length are quite variable. I agree with Vitt (1983, p. 13) that male plants seem uncommon given the frequent production of capsules. I have seen males only in *T. Kirk s.n. ex Campbell I.* (CHR 629486). I consider perigonia to be inconspicuous, while Vitt (1983, p. 10) described them as large and bulbiform.

Recognition: Of all the N.Z. *Macromitria*, *M. longirostre* var. *longirostre* has the upper laminal cells most conspicuously bistratose. Only *M. gracile*, *M. longipes*, and *M. longirostre* var. *ramsayae* also have areas of bistratose laminal cells, but in all cases the patches are smaller and less conspicuous.

***Macromitrium longirostre* var. *ramsayae* (Vitt) Fife comb. nov.**

≡ *Macromitrium ramsayae* Vitt, *J. Hattori Bot. Lab.* 54: 14 (1983)

Holotype: N.Z., Chatham Is, *Gilpin*, June 1942, WELT M005321! Isotype: CHR 618658!

Branches mostly short, 3–8 mm. **Branch leaves** erect-spreading and nearly straight when moist, loosely to tightly spiralled around the branch and with the upper portions flexuose and recurved when dry, narrowly oblong to broadly lanceolate-oblong, mostly acute or shortly cuspidate, deeply keeled below, becoming flattened near apices, 1.6–2.5 mm; **upper laminal cells** rounded-quadrate to rounded-rectangular, a few sometimes oblate, unistratose except at extreme apex (uppermost c. 200 to c. 750 μm of leaf) and there usually bistratose; **inner basal cells** rounded-subquadrate to elliptic (often with a few oblate or shortly rectangular), very weakly bulging, mostly evenly thick-walled, 9–15(–21) \times c. 9–11 μm . **Costa** mostly ending a few cells below apex, the abaxial superficial cells elongate except at extreme tip, the adaxial superficial cells not observed (due to deeply keeled leaves). **Perichaetial leaves** smaller than branch leaves, c. 1.3–1.8 mm, ovate, acute. **Setae** 2.5–4 mm; **capsules** 1.2–2.3 mm. **Spores** isosporous, 20–28 μm .

Illustrations: Plate 8. Vitt 1983, figs 17–24, 26–29 (as *M. ramsayae*).

Distribution: Ch (Te Whanga Lagoon, Waterfall Creek, Rangaika Scenic Reserve, Pitt I., Rangatira I.).

Endemic.

Habitat: On basalt and tree trunks in areas exposed to salt spray. Host species include *Corynocarpus laevigatus*, *Cyathodes* sp., *Myrsine chathamica*, and *Cupressus macrocarpa*. Ranging from near sea level to at least 250 m elevation. While frequently forming extensive and nearly pure mats, this taxon is often associated with *Lembophyllum divulsum* and *Zygodon hookeri*.

Notes: Vitt (1983, p. 18) differentiated *M. ramsayae* from *M. longirostre* by its dull, olive-green coloration; oblong leaves sharply narrowed to acute or bluntly cuspidate, flattened apices (never as slenderly acuminate as in *M. longirostre*, except in the lowest branch leaves); unistratose, thin-walled and obscure upper laminal cells; and the short, mostly rounded, basal leaf cells. He seemed to have been concerned by variation and intergradation in the shape of the basal laminal cells, the differentiating feature he most emphasised in his key to species (p. 8).

In CHR there are c. 12 collections of "*M. ramsayae*" made since 1983. Although extreme forms of *M. longirostre* s.l. indeed give the impression of being distinct, when the full range of Chatham Is material is examined no morphological discontinuity can be demonstrated, indicating that reduction to varietal rank is warranted.

Etymology: The varietal epithet honours the Australian bryophyte taxonomist and cytologist Helen P. Ramsay.

***Macromitrium microstomum* (Hook. & Grev.) Schwägr., Sp. Musc. Frond. Suppl. 2(2), 130 (1827)**

≡ *Orthotrichum microstomum* Hook. & Grev., *Edinburgh J. Sci.* 1: 114 (1824)

Lectotype: Tasmania, Spence, E-Greville (Designated by Vitt 1983.) Not seen.

= *Macromitrium weymouthii* Broth., *Öfvers. Finska Vetensk.-Soc. Förh.* 37: 161 (1895)

Lectotype: Tasmania, Macquarie Harbour, W.A. *Weymouth 574*, H-Brotherus (Designated by Vitt 1983.) Not seen.

= *Macromitrium flaccidisetum* Müll.Hal., *Hedwigia* 37: 147 (1898)

Lectotype: N.Z., South I., near Greymouth, *R. Helms*, H-Brotherus (Designated by Vitt 1983.) Not seen.

Plants slender, dull or lustrous, mostly olive-green or dark yellow-green above, darker and brown or olive-green below. **Branches** 4–12(–15) mm, ascendant, simple or forking below sex organs. **Stem leaves** flexuose-twisted when dry, recurved-twisted when moist, ovate-lanceolate, gradually contracted to acuminate-subulate apices, 1.2–1.5 mm. **Branch leaves** strongly spiralled around the branch, irregularly twisted, and with apices incurved or decurved when dry, weakly to strongly funiculate and erect to erect-spreading when moist, ligulate to ligulate-lanceolate, ± acute, strongly keeled throughout, with a single plication below on one side, 1.2–2.0 mm; **margins** entire, plane above, recurved on one side below; **upper laminal cells** mostly rounded and isodiametric but some usually oblate, firm-walled, flat, smooth, unistratose, c. 8–10 µm wide (lumina 5–8 µm wide); **mid laminal cells** elliptic to rectangular, thick-walled and smooth, with straight lumina, 10–20 × 8–10 µm (lumina c. 6 µm wide); **inner basal cells** elongate-rectangular, evenly thick-walled or slightly nodose, with ± straight lumina, smooth, (18–)24–55 × 7–8 µm (lumina 2–4 µm wide); **marginal basal cells** not nodose, not forming a distinct border. **Costa** slender and curving weakly to one side above, ending in or a few cells below the leaf apex, the abaxial superficial cells elongate throughout, in cross-section with 2–3 guide cells and 2–4 abaxial layers of poorly differentiated stereids. **Gemmae** absent.

Autoicous. Perichaetial leaves ± straight and weakly sheathing the setae, oblong-lanceolate to ovate-oblong, narrowly acuminate-cuspidate, 1.5–2.1 mm. **Perigonia** bulbiform, terminal on short branches, often a short distance below the perichaetium. **Setae** (3–)4–18 mm, smooth, ± straight or flexuose, slender, sinistrorse; **capsules** narrowly ovate to oblong, smooth, usually sharply narrowed to a puckered, 8-plicate, and darker mouth, 1.0–1.7(–1.9) mm; **exothecial cells** thick-walled, irregular in outline and size, shorter, darker, and thicker-walled near rim; **stomata**, **annulus**, and **operculum** as per genus. **Peristome** single; **exostome teeth** 16, pale, inflexed when dry, narrowly lanceolate, finely and evenly papillose on inner surface, coarsely papillose on transverse striae of outer surface, c. 180 µm. **Calyptra** tightly clasping the developing capsule, c. 2–2.5 mm, usually not deeply lacerate, mitrate or cucullate, plicate, naked. **Spores** isosporous, 30–54 µm diam., thick-walled, irregularly papillose.

Illustrations: Plate 9. Vitt 1983, figs 52–61, 63–68; Vitt 1994, fig. 470; Vitt et al. 1995, fig. 21 a–j.; Meagher & Fuhrer 2003, p. 69.

Distribution: NI: N Auckland (near North Cape, near Mangōnui, near Warkworth), S Auckland, Gisborne, Hawke's Bay, Taranaki (Mt Taranaki), Wellington; SI: Nelson, Marlborough (*s. loc.*), Canterbury, Westland (Ōtira), Otago, Southland.

Anomalous (more or less pantropical but extending to temperate latitudes in Australasia). Tasmania*, mainland Australia*, Pacific Islands including Hawai'i, Java, New Guinea, Borneo, and Central America (*fide* Vitt & Ramsay 2006a).

Vitt (1983) considered this species to be "infrequent" north of the latitude of Hamilton. The paucity of collections from Taranaki L.D. is perhaps a collection artefact. The species appears to be genuinely infrequent in the drier regions of the South I.

Habitat: Epiphytic on canopy branches and less often on tree trunks in areas of higher rainfall and on scrub vegetation at tree line. While Vitt (1983) considered it to be abundant in montane rain-forest dominated by southern beech, *M. microstomum* is generally less abundant than *M. longipes* in such forests. Occurring from near sea level (e.g., near Carterton, Wellington L.D.) to c. 1200 m (Mt Ruapehu, Wellington L.D.) on the North I. The highest confirmed South I. elevation is c. 990 m (Hope Range, Nelson L.D.).

In addition to species of southern beech (*Fuscospora fusca*, *F. solandri s.l.*, and *Lophozonia menziesii*), this species occurs on the native woody dicots *Aristolelia serrata*, *Coprosma* spp., *Dracophyllum* spp., *Gaultheria* sp., *Kunzea ericoides*, *Leptospermum scoparium*, *Olearia nummularifolia*, and *Weinmannia racemosa* as well as podocarps (e.g., *Lepidothamnus intermedius* and *Podocarpus totara*). It has also been recorded from *Quercus* sp. (at Rotorua). Associated species include *Dicnemon calycinum*, *D. semicryptum*, *Hampeella alaris*, *Leptostomum inclinans*, *Macromitrium grossirete*, and *M. longipes*.

Notes: *Macromitrium microstomum* is placed by Vitt & Ramsay (1985a) in their "*M. microstomum* group". The other species placed here are the N.Z. endemics *M. longipes* and *M. orthophyllum*, as well as four eastern Australian endemics.

The combination of smooth (non-papillose), flat upper leaf cells and a distinctly funiculate leaf set distinguishes *M. microstomum* and *M. longipes* from all other N.Z. species of *Macromitrium*. The funiculate appearance of the branches, with each leaf twisted on itself and positioned in a spiral insertion, is usually quite evident, but is sometimes more obvious when the plants are moist.

Recognition: *Macromitrium microstomum* is likely to be confused only with its ally *M. longipes*, but the two species differ in many ways, including size, colour, the nature of their lower laminal cells, perichaetial leaf shape, and sexuality. *Macromitrium microstomum* is a smaller, olive-green plant, with branches usually less than 12 mm and branch leaves 1.2–2.0 mm, while *M. longipes* is a larger, distinctly chestnut-coloured plant, with branches often c. 20–30 mm and branch leaves 1.5–3.0 mm. In *M. microstomum*, the middle laminal cells of branch leaves have straight or only slightly curved lumina, and a rather abrupt transition between upper and basal cells, while in *M. longipes* the lumina are strongly S-shaped, and the transitional area is much larger. In *M. microstomum* the perichaetial leaves have a fine, delicate, and flexuose point, while in *M. longipes* these leaves are broadly and sharply acute and stiffly erect. *Macromitrium microstomum* is autoicous with the perigonia bulbiform and often conspicuous (but variable in size) at the tips of short branches near the perichaetia. Vitt (1983, p. 29) discussed other features that distinguish the two species, and the variability of seta length and leaf shape found in *M. microstomum*.

Etymology: The epithet *microstomum* refers to the sharply narrowed capsule mouth.

***Macromitrium orthophyllum* Mitt., J. Proc. Linn. Soc., Bot. 4: 79 (1859)**

Lectotype: N.Z., *s. loc.*, Kerr, NY-Mitten. (Designated by Vitt 1983.) Not seen.

Plants robust, light green to olive-green above, dark green below, on bark. **Branches** to 30 mm, ascendant, simple or forked below terminal perichaetia. **Stem leaves** ovate-lingulate to ovate, abruptly narrowed to long-acuminate and reflexed apices, widely spreading to squarrose-recurved from sheathing bases when moist, c. 1.0–1.5 mm. **Branch leaves** loosely erect-appressed, slightly curved to one side and weakly funiculate when dry, erect or slightly recurved when moist, ovate- to oblong-lanceolate, broadly or sometimes narrowly acute, strongly keeled, 2.0–3.0(–3.3) mm; **margins** entire, plane; **upper laminal cells** irregularly rounded-quadrate, but a few rounded-elliptic or elliptic-oblanceolate, mostly 5–8 × 5–8 μm, smooth, unistratose; **mid laminal cells** longer and more rectangular than upper cells, somewhat irregular, mostly 9–12(–15) × 3–7 μm; **inner basal cells** elongate-rectangular, very thick-walled, smooth, often ± sigmoid near mid leaf, 20–90 × 8–10 μm (lumina c. 2–3 μm wide),

shorter near the costa; **marginal basal cells** less irregular, often longer and narrower than adjacent cells. **Costa** percurrent to very short-excurrent, the abaxial superficial cells elongate in lower portion but rounded-quadrate above, in cross-section 3–5 layered, with stereids and guide cells not well differentiated. **Gemmae** absent.

Pseudautoicous. Perichaetial leaves differentiated, larger than vegetative, oblong to oblong-lanceolate, acuminate to acuminate-cuspidate, sheathing the lower setae, mostly 3.3–4.5 mm. **Male plants** dwarf, gemmiform, mostly less than 1 mm, the inner bracts ovate-acute, with few antheridia and apparently lacking paraphyses. **Setae** 6–13 mm, smooth, flexuose, sinistrorse; **capsules** oblong-elliptic to fusiform, smooth below, puckered, 8-plicate, and darker at mouth, mostly c. 2.0–3.0 mm; **exothecial cells** thick-walled, variably rectangular to elliptic, mostly 20–60 µm long, becoming shorter and coloured near mouth; **stomata**, **annulus**, and **operculum** as per genus. **Peristome** single; **exostome teeth** 16, a few partially fused, blunt, pale, irregularly papillose, inserted below rim. **Calyptra** deeply 2–3 lacerate, with several shallow slits and often one elongate slit, campanulate or ± cucullate, smooth, strongly plicate. **Spores** indistinctly anisoporous, papillose, 16–42 µm.

Illustrations: Plate 9. Vitt 1983, figs 83–35, 87–96; Brotherus 1925, fig. 448.

Distribution: NI: S Auckland (near Tauranga, near Tīrau), Gisborne (Lake Waikaremoana), Hawke's Bay (Wakarara Range, near Eskdale, Ruahine Range), Wellington (Puketoi Range, near Martinborough); SI: Nelson (near Upper Tākaka, near Nelson), Marlborough (Resolution Bay, Mt Fyffe, Blue Duck Scientific Reserve), Canterbury (including Banks Peninsula), Otago, Southland (Lake Hauroko). Most South I. collections are from Canterbury and Otago L.D. This species is not documented from west of the Main Divide on the South I. or from western or northern regions on the North I.

Endemic

Habitat: *Macromitrium orthophyllum* is an infrequently collected epiphytic species and many herbarium records of it lack host information. Vitt's (1983, p. 37) suggestion that it does not occur in association with southern beech forest needs qualification, since it occurs on *Fuscospora solandri* s.l. at Lake Hauroko, Southland L.D. (*A.J. Fife* 13149, CHR 617384) and Mt Thomas, Canterbury L.D. (*D. Glenny*, s.n., CHR 438727) as well as an unspecified southern beech species at Maungatua, Otago L.D. (*W. Martin* 298.2, CHR 547681). Vitt's statements that this species has a predominantly eastern distribution and that it is most frequent from podocarp-broad-leaved forests hold true. It is recorded from the trunks of the podocarps *Dacrycarpus dacrydioides*, *Dacrydium cupressinum*, *Prumnopitys ferruginea*, and *P. taxifolia*, as well as *Fuscospora solandri* s.l., *Griselinia littoralis*, *Weinmannia racemosa*, and *Cordyline australis*. It is restricted to lower elevations than most of its congeners, ranging from near sea level (Resolution Bay) to only c. 500 m (Mt Fyffe). No other *Macromitrium* species has such a predominantly eastern distribution in N.Z. Associated bryophytes include *Dicnemon calycinum*, *Leptostomum inclinans*, *Lepyrodon australis*, *Macromitrium grossirete*, *Orthorrhynchium elegans*, *Rhaphidorrhynchium amoenum*, *Weymouthia mollis*, and the lichen genus *Leptogium*.

Notes: *Macromitrium orthophyllum* is allied to *M. longipes*, and is placed with it and *M. microstomum* in a group of seven related Australasian species by Vitt & Ramsay (1985a).

Recognition: This large, robust, and exceedingly attractive species is distinguished from other N.Z. members of the genus by its yellow- to olive-green coloration, and its weakly curved and non-funiculate leaves when dry. Numerous other features also serve to distinguish *M. orthophyllum*. These include smooth, rather small upper leaf cells, smooth basal cells, enlarged perichaetial leaves that sheathe the lower setae, long and sinistrorse setae, mostly oblong-elliptic capsules that are abruptly darkened, puckered, and 8-plicate at the mouth, weakly anisoporous spores, and pseudautoicous sexual condition. The dwarf male plants can often be easily seen in this species.

Among *Macromitrium* species with smooth, flat upper laminal cells, only the much commoner *M. longipes* approaches *M. orthophyllum* in size. However, *M. orthophyllum* differs from *M. longipes* by its olive-green coloration; its branch leaves, which are only slightly curved and weakly funiculate when dry; its decidedly less sigmoid basal laminal cells; its somewhat anisoporous spores; and its dwarf male plants.

Etymology: The species epithet means straight-leaved and seems entirely appropriate in a regional context.

***Macromitrium prorepens* (Hook.) Schwägr., *Sp. Musc. Frond. Suppl.* 2(2), 62 (1826)**

- ≡ *Orthotrichum prorepens* Hook., *Musci Exot.* 2, 120 (1819)
Holotype: N.Z., Dusky Bay, A. Menzies, 1791, BM-Hooker (Cited by Vitt 1983.) Not seen.
- = *Macromitrium submucronifolium* Müll.Hal. & Hampe, *Linnaea* 26: 499 (1855)
Lectotype: N.Z., s. loc., F. Mueller, BM-Hampe (Designated by Vitt 1983.) Not seen.
- = *Macromitrium erosulum* Mitt., *J. Proc. Linn. Soc., Bot.* 4: 78 (1859)
Lectotype: N.Z., Waikeki [Waiheke?], Milne, NY-Mitten (Designated by Vitt 1983.) Not seen.
- = *Macromitrium coarctatum* Müll.Hal., *Hedwigia* 37: 153 (1898)
Lectotype: N.Z., South I., coast near Greymouth, R. Helms, 1885, H-Brotherus (Designated by Vitt 1983.) Not seen. Isotype: CHR 637689!
- = *Macromitrium oocarpum* Müll.Hal., *Hedwigia* 37: 157 (1898)
Lectotype: N.Z., South I., near Greymouth, R. Helms, 1885, H-Brotherus (Designated by Vitt 1983.) Not seen.
- = *Macromitrium papillifolium* Müll.Hal., *Hedwigia* 37: 154 (1898)
Holotype: N.Z., s. loc., collector unknown, GOET (Cited by Vitt 1983.) Not seen.
- = *Macromitrium petriei* Dixon, *Bull. Torrey Bot. Club* 42: 101 (1915)
Holotype: N.Z., Te Ānau, Clinton Valley, D. Petrie, BM-Dixon (Cited by Vitt 1983.) Not seen.
- = *Macromitrium prorepens* var. *aristata* Allison, *Trans. Roy. Soc. New Zealand* 88: 10 (1960)
Holotype: N.Z.: Little Barrier Island, J.M. Dingley, 30 Aug. 1958 (herb. K.W. Allison 6323), CHR 621038! Beever (2012) was the first to note that Dingley's collection is a mixture of *M. prorepens* and *M. gracile*, with the misleading aristate leaves on plants of *M. gracile*.

Plants slender or robust, dull, yellow- to dark olive-green above, darker or brown below, on bark. **Branches** variable in length, 3–20 mm, ascendant, simple or forking below sex organs. **Stem leaves** erect-appressed when dry, widely spreading-recurved when moist, ovate-lanceolate, 1.0–1.5 mm. **Branch leaves** irregularly twisted-flexuose to weakly twisted around the branch and often with apices decurved when dry, stiffly spreading or erect-spreading and not funiculate when moist, ovate-oblong, oblong-lanceolate, or lingulate and rounded, obtuse or broadly acute at apex, with a short, stout apiculus, keeled, often with a single plica below, 1.2–2.5(–3.0) mm; **margins** entire or weakly crenulate, recurved on one or both sides below; **upper laminal cells** mostly rounded-quadrate, thick-walled, usually obscure in surface view, ± bulging, unistratose, densely (1–)2–4 papillose (papillae often forked), (6–)8–16 µm wide; **mid laminal cells** similar in shape and size or elliptic and longer, mostly unipapillose, in distinct longitudinal rows, the transition to the basal cells gradual; **inner basal cells** elongate-rectangular, with ± uniform and thick cell walls (lumina 2–4 µm wide), smooth or with a few high and conical papillae, yellow, usually extending $\frac{1}{4}$ to $\frac{1}{3}$ the leaf length, 20–45(–60) µm; **basal marginal cells** sometimes thinner-walled and wider than adjacent cells, forming a short indistinct border. **Costa** short-excurrent and filling the apiculus or rarely percurrent, ± straight (not curving to one side above), the abaxial superficial cells elongate except at apex where obscured by quadrate cells, in cross-section with 1–3 rows of abaxial stereids and 2–4 guide cells. **Gemmae** absent.

Pseudautoicous. Perichaetial leaves not differentiated, surrounding a sparsely hairy vaginula. **Dwarf males** axillary, bulbiform, c. 0.5 mm, the bracts broadly ovate. **Setae** variable in length, 2–9 mm, smooth, sinistrorse, flexuose or erect; **capsules** oblong-ovoid, smooth below, gradually narrowed from the middle and 4-plicate and dark beneath the mouth, (0.8–)1.0–1.8 mm; **exothecial cells** irregularly elliptic to rectangular, ± thick-walled, mostly 25–70 µm, shorter, darker, and with much-thickened longitudinal walls near mouth; **stomata** and **annulus** as per genus; **operculum** as per genus, very long, c. 1.0 mm. **Peristome** single; **exostome teeth** 16, well-developed, pale, erect, ± flexuose, 130–150 µm, papillose on outer surface, papillose from transverse striae on inner surface. **Calyptra** evenly and deeply lacerate, strongly plicate, sparsely or less often densely hairy with thick, yellow, ± stiff or twisted hairs. **Spores** anisosporous, 16–44 µm, finely papillose.

Illustrations: Plate 10. Vitt 1983, figs 25, 30–32, and 152–161; Vitt 1983, figs 135–144 and 146–148 (as *M. submucronifolium*).

Distribution: NI: N Auckland, including offshore islands (PK, LB, RT), S Auckland, Gisborne, Hawke's Bay Wellington; SI: Nelson, Canterbury, Marlborough (Mataura I., Pelorus Bridge Scenic Reserve), Westland, Otago (eastern regions); Southland; St.

Endemic.

Habitat: While most common on *Lophozonia menziesii*, this species is also epiphytic on *Beilschmiedia* spp., *Carpodetus serratus*, *Coprosma* spp., *Fuscospora fusca*, *F. solandri s.l.*, *Griselinia littoralis*, *Leptospermum scoparium*, *Leucopogon fasciculatus*, *Meliclytus ramiflorus*, *Metrosideros excelsa*, *Pseudowintera colorata*, and *Weinmannia* spp., as well as the gymnosperms *Dacrycarpus cupressinum*, *Phyllocladus trichomanoides*, *Podocarpus totara*, and *Prumnopitys taxifolia*. It rarely occurs on rock. It ranges from sea level to c. 1070 m (Ruahine Range, Hawke's Bay L.D.) on the North I. and from sea level to c. 1150 m (Paparoa Range, Nelson L.D.) on the South I. It appears to occur most frequently below c. 700 m.

Frequent bryophyte associates include *Cladomnion ericoides*, *Dichelodontium nitidulum*, *Dicnemon* spp., *Holomitrium perichaetiale*, *Hypnum cupressiforme* var. *filiforme*, *Leptostomum* spp., *Lepyrodon australis*, *Macrocoma tenue*, *Macromitrium retusum*, *Mesotus celatus*, *Neckera hymenodonta*, *Papillaria flavolimbata*, *Weymouthia* spp., and the hepatics *Frullania* spp., *Jamesoniella monodon*, *Plagiochila circumdentata*, and *P. circinalis*.

Notes: *Macromitrium prorepens* is a highly variable and taxonomically troublesome species. It is given some character by branch leaves being usually weakly twisted around the branch and apically decurved when dry, densely papillose upper leaf cells, short excurrent or percurrent costae, sinistrorse setae, 4-plicate capsules, hairy and evenly lacerate calyptrae, and anisospores.

The distinction between *M. prorepens* and *M. submucronifolium* Müll.Hal. & Hampe has been a long-standing problem of N.Z. bryology. The expedient solution of placing *M. submucronifolium* in synonymy with the former is adopted here. *Macromitrium submucronifolium* has also been closely linked to a third and widely-applied N.Z. name, *M. erosulum* Mitt.

Dixon (1926, p. 185) placed *M. submucronifolium* in the synonymy of *M. prorepens* while also distinguishing *M. erosulum* Mitt. He considered *M. prorepens* to be "common throughout New Zealand" and described *M. erosulum* as "probably one of the commonest species".

Sainsbury (1955) distinguished these two closely allied species (*M. prorepens* and *M. erosulum*), but described *M. prorepens* as "a weak species [which] certainly intergrades with the latter". Sainsbury described *M. erosulum* as "a common species and [one] very variable in habit, position of the leaves when dry, and the nature and degree of the papillosity of the leaf-cells". In his revision of *Macromitrium* in N.Z., Vitt (1983) recognised both *M. prorepens* and *M. submucronifolium* (with *M. erosulum* as a synonym of the latter) but admitted considerable difficulty in distinguishing them.

Faced with a wide range of material, I have repeatedly been unable to apply Vitt's key dichotomy 9 (see his key on p. 7), which distinguished two taxa using the relative width of trabeculae and lumina of their medial leaf cells. Likewise, I have been unable to use the nature of the middle lamellae of the upper laminal cells to distinguish the two taxa. In all other characters employed by Vitt, including seta length, I find overlap between the two hypothetical taxa.

Due to my inability to confidently differentiate the two taxa, *M. submucronifolium* and *M. erosulum* Mitt. are here treated as taxonomic synonyms of the older *M. prorepens* (Hook.) Schwägr. Recognition of these taxa at an infra-specific rank would accomplish nothing and my intuition (contrary to that of Vitt) is that even a detailed morphometric study would remain inconclusive. I admit, given this broad interpretation, that *M. prorepens* is a highly variable and generally unsatisfactory species. However, distinguishing two species or infraspecific taxa within this range of variability requires making unjustifiable and arbitrary distinctions.

Vitt (1983) discussed the relationship between *M. prorepens* and *M. submucronifolium* at length. In a summary of his difficulty distinguishing them (p. 57) he stated: "variation in *M. submucronifolium* is broad enough to over-lap that in *M. prorepens*, with small plants of the former species hardly distinguishable from those of the latter." Vitt continued: "despite this over-lap in variation, I feel the typical expressions of these species are significantly different to warrant the recognition of these taxa as separate species. In this case, my [Vitt's] intuitive feeling is that this structural variation does not indicate interbreeding and genetic intergradation. Rather there are two distinct species, with the variation of one variable taxon over-lapping that of a less variable taxon". However, elsewhere (p. 56) Vitt states that he is "not totally convinced that *M. [sub] mucronifolium* can be differentiated from *M. prorepens* in all cases," and that "this seeming intergradation serves to make identification very tenuous at times". Vitt considered (p. 60) *M. prorepens* to be a "species with limited variability" and *M. submucronifolium* to be "sometimes quite variable." For students attempting to separate these two taxa using Vitt's criteria, I recommend close reading of his discussion of the problem.

Macromitrium prorepens is placed by Vitt & Ramsay (1985a) in their "*M. hemitrichodes* group" with *M. grossirete* and *M. submucronifolium* (not recognised here). Three species (including *M. hemitrichodes*) endemic to Australia and the Malesian species *M. angulatum* are also placed in this group.

Recognition: *Macromitrium prorepens* s.l. is sometimes confused with *M. ligulare*. *Macromitrium prorepens* has leaves twisted-flexuose to weakly twisted around the branches when dry, costae usually excurrent to form short apiculi, and usually hairy calyptrae, while *M. ligulare* has branch leaves irregularly flexuose-twisted when dry, subpercurrent costae, and naked calyptrae. The length and shape of the inner basal laminal cells also help to distinguish these two species. In *M. prorepens* s.l. the inner basal laminal cells are 20–45(–60) μm , elongate-rectangular, with \pm uniform and thick cell walls, and lumina 2–4 μm wide, while in *M. ligulare* the inner basal laminal cells are shortly rectangular, 14–28 μm and have lumina c. 4–6 μm wide.

Etymology: The epithet *prorepens* refers to the creeping habit.

Macromitrium retusum* Hook.f. & Wilson in Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II 79 (1854)

\equiv *Macromitrium gracile* var. *retusum* (Hook.f. & Wilson) Sainsbury, *Trans. & Proc. Roy. Soc. New Zealand* 75: 178 (1945)

Lectotype: N.Z., Northern I., *Colenso*, BM-Wilson (Designated by Vitt 1983.) Not seen.

= *Macromitrium caducipilum* Lindb., *Öfvers. Kongl. Vetensk.-Akad. Förh.* 21: 605 (1865)

\equiv *Macromitrium longirostre* var. *caducipilum* (Lindb.) W.Martin & Sainsbury in Sainsbury, *Rev. Bryol. Lichénol.*, n.s. 21: 219 (1952)

Holotype: N.Z., "Inter *Leptostomum macrocarpum* (Hedw.) e. Nova Zelandia (collect.

RALFS) paucissima specimina feminea decerpsi," H-Lindberg (Cited by Vitt 1983.) Not seen.

= *Macromitrium aristatum* Mitt. in Hooker, *Handb. New Zealand Fl.*, 432 (1867)

Lectotype: N.Z., Northern I., Auckland, *Knight*, NY-Mitten (Designated by Vitt 1983.) Not seen.

Plants slender, lustrous, bright-green to gold-green above, gold-brown below. **Branches** \pm stiff, erect, mostly simple but forking below the perichaetium in ♀ plants, penicillate, c. 6–15(–20) mm. **Stem leaves** and lowermost branch leaves erect-flexuose when dry, lanceolate-acuminate, with the costa excurrent. **Branch leaves** curved-flexuose and spiralled (usually tightly) and some leaves reflexed when dry, erect-spreading and straight or slightly flexed, not funiculate when moist, oblong or ligulate, retuse, broadly obtuse (after loss of the arista) or sometimes irregular at apices, keeled, usually with a single plication below, young leaves with a long, linear, stiffly flexuose arista which usually breaks off before leaf maturity, c. 1.4–2.0(–2.7) mm (before loss of the arista), and 1.3–2.0 mm (after loss of the arista); **margins** plane, entire (except for apical notch); **upper laminal cells** rounded-quadrate to short rectangular-elliptic, clear, smooth, bulging, and very thick-walled, unistratose; mostly 7–12(–20) μm long, with lumina 6–13 \times 6–7 μm (slightly smaller at margins); **mid laminal cells** mostly similar to upper; in distinct longitudinal rows; **inner basal cells** mostly elongate, irregularly thick-walled, with straight lumina, smooth, plane or slightly bulging; 16–27(–40) μm long (with lumina c. 2–4 μm wide); **basal marginal cells** not forming a distinct border. **Costa** long-excurrent to form an arista commonly extending c. 700–1300 μm beyond the lamina of immature leaves, the abaxial superficial cells elongate throughout; in cross-section with 1–2 layers of c. 4–6 guide cells, c. 2–3 layers of abaxial stereids, and 1–2 layers of adaxial stereids. **Gemmae** absent.

Dioicous or pseudautoicous (male plants not seen). **Perichaetial leaves** smaller than adjacent vegetative leaves, ovate-elliptic, with fragile aristae, 1.3–1.5 mm (after fall of the arista). **Perigonia** not seen. **Setae** 4.0–7.0 mm, smooth, straight or slightly flexuose, thick, dextrorse; **capsules** narrowly ovate to fusiform-cylindric, not constricted at mouth, indistinctly ribbed to almost smooth, \pm erect, c. 2.0 mm; **exothecial cells** thick-walled, elongate-sinuose to elliptic, apparently shorter and thicker-walled on ribs, variable in length (to c. 65 μm), becoming isodiametric near rim. **Peristome** probably double; **exostome teeth** 16, recurved when dry, incurved when moist, warty-granulose, linear-lanceolate, often very thick outwardly and \pm smooth below; **endostome** not seen. **Calyptra** deeply lacerate, smooth, strongly plicate. **Spores** not seen.

Illustrations: Plate 11. Sainsbury 1955, pl. 37, fig. 1 (as *Macromitrium longirostre* var. *caducipilum*); Vitt 1983, figs 34–43, 45–46.

Distribution: NI: N Auckland (Maunganui Bluff, near Auckland City), S Auckland (Mt Karioi), Gisborne (Māhia Peninsula), Wellington (Tangiwai, Karehana Bay, Tītahi Bay, Wilton's Bush); SI: Nelson (Mt Burnett, Kōhahai River, Punakaikī), Marlborough (s. *loc.*), Westland (Greymouth, Pāroa, Haast), Canterbury (near Christchurch), Otago, Southland; St; C. The Māhia Peninsula and Christchurch records are based solely on Vitt (1983).

Endemic.

Habitat: Found largely on coastal tree trunks and branches and on coastal rocks. It is rarely collected on the North I. but is frequent in coastal areas in the southern part of the South I., particularly from Dunedin south and west to at least the vicinity of Riverton (Southland L.D.). It appears to be scattered (or poorly collected) in Westland. Vitt (1983, fig. 51) annotated a small number of Westland specimens but did not include these in his distribution maps, and there are a small number of more recent Westland collections. It is common on Stewart I. (where W. Martin, *in herb.*, termed it “probably the commonest species” [of *Macromitrium*] in the north portion of that island. Vitt (1983) considered it uncommon on Campbell I., where he stated it to be found only on *Dracophyllum* in dense riparian forests, usually in association with *M. longirostre*. It occasionally occurs in inland situations on both main islands (e.g., Mt Karioi, Tangiwai, the Horse Range (Otago L.D.), and Lake Hauroko (Southland L.D.)). While primarily occurring at low elevation coastal sites, this species has been collected at elevations as high as 641 m on the South I. (Mt Burnett) and 560 m on the North I. (Mt Karioi).

Host woody species include *Brachyglottis repanda*, *Carpodetus serratus*, *Coprosma liniifolia*, *C. rotundifolia*, *Fuchsia excorticata*, *Melicytus ramiflorus*, and *Brachyglottis rotundifolia*, as well as the podocarps *Dacrydium cupressinum* and *Podocarpus totara*. It also occurs on coastal granite and dolomite. Frequently associated mosses include *Calypotropogon mnioides*, *Macromitrium gracile*, *M. longipes*, *M. longirostre*, and *Orthorrhynchium elegans*.

Notes: My observations on perichaetial leaves (seen most clearly in *W. Martin* 289.5 from Riverton, Southland L.D., CHR 629455 and *W. Martin* s.n. 25.1.49 from Stewart I., CHR 629454) differ from Vitt’s and suggest they are smaller and more ovate than the adjacent vegetative leaves, measuring c. 1.3–1.5 mm after the arista has fallen.

Vitt (1983) considered *M. retusum* to be “structurally stenotypic” albeit with “some variation of leaf set and basal cell length”. According to Vitt: “the amount of individual twisting of branch leaves is variable, with some specimens possessing uniformly non-twisted, spirally curved leaves and others having a variable number of leaves curved outward as well as spirally positioned around the branch. The basal leaf cells exhibit similar variation as those of *M. longirostre*. Most populations have elongate basal cells with only a few rows of shorter mid leaf cells extending into the basal area, particularly near the costa. However, a few populations have short (rounded-elliptic to shortly rectangular) cells extending nearly to the leaf base, and the more typical elongate basal cells are limited to the insertion, basal margins, or interspersed among the short cells”. He observed a range of basal cell shapes in single plants and did not consider this feature to be taxonomically significant.

Vitt & Ramsay (1985a) defined a “*Macromitrium longirostre* group” that included *M. retusum*, *M. longirostre*, and *M. ramsayae* (recognised at the varietal level here). The fragile leaf tips and retuse mature leaves distinguish *M. retusum* from these closely related taxa.

Recognition: *Macromitrium retusum* and *M. helmsii* are superficially similar and have been confused; both have penicillate branches, with the immature leaves abruptly contracted to a long and fragile arista, and with mature leaves almost always retuse. However, *M. retusum* is made distinct by its smooth and clear upper laminal cells, and branch leaves tightly spirally twisted around the branch (but with individual leaves often curved outward) when dry. By contrast, the branch leaves in *M. helmsii* have upper laminal cells with dense and multiple papillae and are “individually incurved-twisted with the upper portions curved outward and down when dry”. I concur with Vitt’s observation (1983, p. 46) that the leaves of *M. retusum* are more ligulate to oblong and usually not much wider in the lower portion, whereas those of *M. helmsii* are more lanceolate, widest below, and gradually narrowed upward. Vitt (1983, p. 23) clarified the previously confused nomenclature of *M. retusum* and *M. helmsii*.

Etymology: The species epithet refers to the retuse leaf apices following the fall of the aristae.

***Orthotrichum* Hedw., *Sp. Musc. Frond.*, 162 (1801)**

= *Muelleriella* Dusén, *Bot. Not.* 1905: 304 (1905)

Type taxon: *Orthotrichum anomalum* Hedw.

Plants small or robust, dark green, brown-, yellow-green, or rarely black, dull, mostly forming tufts (rarely small mats) on bark or rock. **Stems** erect, ascendant, or rarely creeping, branching by innovation or occasionally forking, in cross-section lacking a central strand, beset below with smooth, mostly brown rhizoids. **Leaves** erect, incurved or rarely contorted when dry, spreading or erect-spreading when moist, ovate-lanceolate, narrowly lanceolate, oblong-lanceolate, or rarely ligulate-lanceolate, acute, acuminate, or obtuse, plicate or not, entire; **margins** mostly recurved or revolute, rarely plane; **mid** and **upper laminal cells** rounded to ± hexagonal, ± isodiametric, thick-walled,

usually unistratose, rarely 2–(3–4)-stratose and opaque, mostly pluripapillose on both surfaces, rarely only slightly papillose or smooth; **basal interior cells** rectangular, rhomboid, or rarely \pm quadrate, thick- or thin-walled, porose or not, often coloured; **cells of basal margins** often shorter and extending up the margins, but not forming a distinct hyaline border; **alar cells** not differentiated. **Costa** mostly failing below the leaf apex, in cross-section with no differentiated guide cells or stereids. **Gemmae** occasionally present on leaves.

Autoicous (often gonioautoicous) or rarely dioicous. **Perichaetia** terminal, with **perichaetial leaves** not or slightly larger than vegetative leaves. **Perigonia** often gemmiform and immediately below the perichaetia. **Setae** one to several per perichaetium, straight, slender to stout, very short to elongate, smooth; **capsules** emergent, immersed, or exerted, erect and symmetric, ovoid-cylindric, subcylindric, broadly ovoid, or rarely nearly globose, mostly striate and furrowed (especially when dry) but sometimes smooth; **exothecial cells** often in alternating bands of thick- and thin-walled (the thicker-walled cells corresponding with ribs in dry capsules) and variably pigmented cells, with several rows \pm oblate and thicker-walled at mouth; **stomata** superficial or immersed, variably distributed in the capsule wall (not restricted to neck); **annulus** absent or poorly developed; **operculum** short-rostrate (rarely obliquely so) from a conic or convex base. **Peristome** double, single, or rarely absent, with 16 (but often paired) teeth which are variably papillose or striate, and recurved, spreading, or almost erect when dry; **preperistome** present or absent; **endostome**, if present, lacking a basal membrane and composed of 8 or 16 filiform segments which alternate with the teeth. **Calyptra** campanulate-mitrate, hairy or naked. **Spores** extremely variable, either isosporous or anisosporous, unicellular or multicellular, variable in shape and size.

Taxonomy: *Orthotrichum* is a large genus of temperate distribution in both northern and southern hemispheres. Lewinsky (1993) considered it to consist of 116 species distributed in seven subgenera (but she did not fuse *Muelleriella* with *Orthotrichum*). The genus is interpreted more broadly here to include the species placed by Sainsbury (1955) and by Vitt (1976) in the genus *Muelleriella*. Twelve species (six endemic) and two varieties (both endemic) are accepted as part of our flora. *Orthotrichum cupulatum* var. *austro-cupulatum*, which Lewinsky recognised, is not accepted here.

Orthotrichum is a taxonomically difficult genus growing on trees and shrubs and on rock. With a few exceptions, the N.Z. species of *Orthotrichum* cannot be confidently recognised without microscopic examination. Characterisation of the stomata (whether superficial or immersed, etc.) is facilitated by making a longitudinal section of a mature capsule in 95% ethanol. The ethanol will serve as a spore dispersant and facilitate visualisation of the stomata. Transferring the sectioned capsule between ethanol and water repeatedly will further disperse the spores. Until one is very well acquainted with the regional flora, microscopic examination of the stomata is recommended, as species with superficial and immersed stomata can be very similar in appearance.

Orthotrichum (in a traditional taxonomic sense) was masterfully treated by Lewinsky (1984) for Australasia. However, for reasons given below, the genus is treated here in a broader sense than by Lewinsky. For most of the included species, the treatments here are derived, with permission, from Lewinsky's elegantly illustrated revision. In CHR and WELT Lewinsky typically named and isolated all the species found in single collections. Her meticulously annotated segregates within single herbarium specimens are a valuable resource for anyone seriously wishing to come to grips with this difficult genus regionally.

Lewinsky (1984, p. 395) stated that the Australasian *Orthotrichum* flora differed from that of North America and Europe by having a smaller fraction (only three of the 11 taxa treated by her) of taxa with immersed stomata; by contrast 11 of 19 British species recognised by Smith (2004) have immersed stomata. Lewinsky-Haapasaari & Ramsay (2006a) noted that of the five species occurring in Australia, all those with immersed stomata have the chromosome number $n = 6$, while those with superficial stomata have $n = 11$.

Lewinsky (1984) provided detailed distribution maps and a summary of the substrate preferences (see her Table 1) for all taxa. Among the introduced woody plant genera *Fraxinus*, *Populus*, and *Salix* support the greatest diversity of species. The N.Z. distributions and ecological notes presented by Lewinsky form the basis of those given below, but they have been confirmed and expanded where possible using herbarium specimens in AK, CHR, and WELT. Many of Lewinsky's records seem to be derived from her painstaking determinations of multiple species within herbarium collections. The species descriptions below are largely modified from those of Lewinsky (1984).

Goffinet et al. (2004) used molecular data from four ribosomal, mitochondrial, and nuclear loci to evaluate relationships among the subfamily Orthotrichoideae; *Orthotrichum* is presented here in the broader sense dictated by their conclusions. The species traditionally placed in the segregate genus *Muelleriella* (Brotherus 1925) can be distinguished from *Orthotrichum* s.s. by several morphological features, including multicellular spores, a single peristome with a well-developed preperistome,

multistratose leaf lamina, and nearly black colour. These species are also specialised in terms of habitat and are almost exclusively found on coastal rocks, often those exposed to extensive salt spray, in austral regions. Lewinsky (1993) argued in favour of the continued recognition of *Muelleriella*. However, the evidence provided by Goffinet et al. (2004) supporting the inclusion of *Muelleriella* within *Orthotrichum* seems incontrovertible. Interestingly, Goffinet's inclusion of *Muelleriella* within *Orthotrichum* accords with the treatment of Dixon (1926, p. 170), who included a group "*Crassifolia*" of unspecified rank. The taxa previously assigned to *Muelleriella* clearly comprise a natural and probably monophyletic subgroup within *Orthotrichum*.

A synopsis of the systematic relationships Lewinsky (1993) accepted for Australasian taxa of *Orthotrichum* s.s. (excluding the species sometimes placed in *Muelleriella*) is presented below.

Recognition: Species of *Orthotrichum* can usually be differentiated from *Ulota* by having less crisped leaves when dry, much less thick-walled (especially the transverse walls) marginal basal laminal cells of the leaves, and by stomata that are either superficial or immersed and not confined to the capsule base. In *Ulota* the stomata are invariably superficial and confined to the capsule base. *Orthotrichum calvum* is the one species most likely to be misidentified as a species of *Ulota*.

Etymology: The generic name *Orthotrichum* refers to the straight hairs usually found on the calyptrae in this genus. *Orthotrichum* is one of few moss genera with a widely-applied English common name – bristle mosses – also in reference to the calyptra hairs.

- | | |
|----|---|
| 1 | <p>Plants on coastal rocks, mostly dark brown to black; leaves appearing very thick and opaque; upper laminal cells bistratose (or sometimes thicker) and smooth or nearly so; capsules smooth when dry; spores multicellular, variable in shape, mostly >40 µm [formerly in <i>Muelleriella</i>] 2</p> |
| 1' | <p>Plants epiphytic or on inland rocks, paler, mostly brown below and yellow-green to brown-green above, leaves not thick and opaque; upper laminal cells unistratose and nearly always papillose; capsules striate when dry; spores 1-celled, globose, <30 µm [<i>Orthotrichum</i> s.s.] 4</p> |
| 2 | <p>Capsules exserted or emergent, 1.0–1.8 mm; setae 1.0–2.6(–2.8) mm; leaves mostly ligulate-lanceolate or ligulate from an obovate or ovate base, mostly obtuse at apex; known from the South I., Stewart I., and southern offshore islands <i>O. crassifolium</i> subsp. <i>crassifolium</i></p> |
| 2' | <p>Capsules immersed, generally <1.2 mm; setae <1.1(–1.3) mm; leaves narrowly lanceolate, subulate or rarely ligulate from an ovate base; known only from southern offshore islands 3</p> |
| 3 | <p>Leaves narrowly lanceolate to broadly subulate from an oblong-ovate base, 3.0–4.7 mm, usually ± secund when dry; capsule mouth below the middle of enclosing perichaetial leaves; known from Campbell I. <i>O. angustifolium</i></p> |
| 3' | <p>Leaves narrowly ligulate from an ovate base, 1.8–3.0(–3.9) mm, not secund, twisted and inwardly curved when dry; capsule mouth usually between middle (or slightly lower) and the apices of the enclosing perichaetial leaves; known from the Auckland Is <i>O. aucklandicum</i></p> |
| 4 | <p>Stomata superficial; basal laminal cells usually with nodose and porose walls 5</p> |
| 4' | <p>Stomata immersed; basal laminal cells usually with smooth walls 12</p> |
| 5 | <p>Exostome erect-spreading when dry, roughly papillose; endostome often absent; preperistome present or absent; plants mostly on non-calcareous rock [<i>O. rupestre</i> s.l.] 6</p> |
| 5' | <p>Exostome recurved when dry, moderately-finely papillose; endostome present; preperistome absent; plants mostly epiphytic, occasionally on rock 7</p> |
| 6 | <p>Plants not glaucous; leaves moderately papillose; papillae of mid laminal cells usually 2–7 µm high, not conspicuously branched; leaf apex never erose-dentate <i>O. rupestre</i> var. <i>rupestre</i></p> |
| 6' | <p>Plants glaucous; leaves highly papillose; papillae of mid laminal cells usually 7–15 µm high and conspicuously branched; leaf apex erose-dentate, particularly in young leaves <i>O. rupestre</i> var. <i>papillosum</i></p> |

- 7 **Capsules** smooth or furrowed only in the upper half when dry; **endostome** with broad, papillose segments, mostly of two rows of cells (at least near base) 8
- 7' **Capsules** furrowed along entire length when dry; **endostome** with narrow segments, mostly of one row of cells 10
- 8 **Capsules** exserted or emergent, cylindric, mouth wide when dry; **exothecial cells** elongate, often with thickened longitudinal walls, weakly or clearly differentiated into bands [*O. tasmanicum* s.l.] 9
- 8' **Capsules** immersed, broadly ovoid or broadly ellipsoid, narrowed at the mouth when dry; **exothecial cells** mostly rounded-oblong or oblong-hexagonal, not differentiated into bands, thin-walled *O. graphiomitrium*
- 9 **Setae** elongate, mostly 4–7 mm, exposed for 1–4 mm beyond the perichaetial leaves (best seen in moist material); **capsules** usually 1, rarely 2–3 per perichaetium, exserted, furrowed or rarely smooth in upper half of urn when dry, 1.5–2.5 mm *O. tasmanicum* var. *tasmanicum*
- 9' **Setae** short, 1–3.5(–4.0) mm, not exposed or exposed for ≤2 mm beyond the perichaetial leaves (best seen in moist material); **capsules** mostly 2–4(–5) (but occasionally only 1) per perichaetium, immersed to short-exserted, smooth when dry, 1.0–1.5 mm *O. tasmanicum* var. *parvithecum*
- 10 **Leaves** from an oblong-lanceolate base, obtuse, rounded, or rarely rounded-acute; **calyptra** naked; **upper laminal cells** indistinctly papillose (usually visible only when cells are viewed on edge) *O. cyathiforme*
- 10' **Leaves** from an ovate-lanceolate base, long acute-acuminate; **calyptra** ± hairy; **upper laminal cells** usually more distinctly papillose (papillae usually visible in surface view) 11
- 11 **Exostome teeth** 8, pale yellow-hyaline, papillose with vermicular lines near apex; **endostome** of 8 hyaline-pale yellow segments with elongate papillae, sometimes smooth; **basal marginal cells** smooth to >300 µm above the leaf base, the papillae of marginal cells further from the base low, <c. 5 µm, unbranched *O. hortense*
- 11' **Exostome teeth** 16 orange-red, papillose with vertical lines near the base; **endostome** of 16 orange-hyaline segments with rounded papillae; **basal marginal cells** papillose to within c. 100–300 µm of the leaf base; the papillae of marginal cells further from base rapidly becoming tall (often 9–15 µm tall) and either unbranched or branched *O. sainsburyi*
- 12 **Capsules** with 16 or 8 furrows when dry; **exostome** erect-spreading when dry; **preperistome** mostly present, sometimes covering the entire surface of the exostome teeth; on calcareous rocks *O. cupulatum*
- 12' **Capsules** with 8 furrows when dry (lacking alternate short furrows); **exostome** recurved when dry; **preperistome** absent; mostly epiphytic, less commonly on calcareous or non-calcareous rocks 13
- 13 **Leaves** erect and appressed when dry, oblong-lanceolate from an ovate base with a short obtuse-acute apex, entire or rarely dentate at apex; **calyptra** with many or few hairs; **capsules** immersed-emergent *O. assimile*
- 13' **Leaves** contorted and twisted when dry, lanceolate from an ovate base with a long acute-slightly obtuse apex, entire; **calyptra** naked or rarely with a few hairs; **capsules** exserted or rarely emergent *O. calvum*

***Orthotrichum angustifolium* Hook.f. & Wilson, *London J. Bot.* 3: 547 (1844)**

≡ *Muelleriella angustifolia* (Hook.f. & Wilson) Dusén, *Bot. Not.* 1905: 304 (1905)

Isotype: N.Z., Campbell Island, *J.D. Hooker 34*, WELT M 004859! (Probable holotype in BM cited by Vitt 1976).

Plants in nearly black cushions or tufts c. 1–3 cm diam. **Stems** erect, usually unbranched or once-branched, sparsely beset with smooth brown rhizoids, c. 5–8 mm. **Leaves** stiffly secund to twisted and curved when dry, loosely spreading to weakly secund when moist, narrowly lanceolate to broadly

subulate from an oblong-ovate or oblong base, gradually narrowed to an acute apex, bistratose above, entire, plane, mostly 3.0–4.0 mm; **margins** 2–3-stratose; **mid** and **upper laminal cells** irregularly rounded to oval-rectangular, a few usually oblate, smooth, mostly 6–8(–10) μm wide; **basal interior cells** rectangular, mostly (18–)30–60 \times 7–11 μm , the basal portion of larger leaves bordered by 1 row of \pm clear cells that lack thickened transverse walls. **Costa** as per genus, stout, elliptic in cross-section at mid leaf, somewhat obscured by laminal cells near apex. **Gemmae** absent.

Gonioautoicous. Perichaetial leaves larger (to c. 4.7 mm) but otherwise similar to vegetative.

Perigonia gemmiform on lower stems or terminal on separate short branches. **Setae** stout, 0.3–0.7(–1.3) mm; **capsules** globose-ovate when moist, oblong-ovate when dry, abruptly contracted to the seta, deeply immersed and inconspicuous, yellow-brown, the mouth reaching $\frac{1}{2}$ or less the length of the perichaetial leaves, 0.8–1.1 \times 0.6–0.9 mm; **exothecial cells** rectangular, 22–33 μm long; **stomata** immersed, restricted to lower half of capsule; **annulus** apparently absent; **operculum** not seen. **Peristome** single; **exostome teeth** 16, spreading when dry, recurved when old and dry; irregularly papillose or papillose-striate; **preperistome** present, 1–4 cells high, sometimes not visible beyond the capsule mouth; **endostome** absent. **Calyptra** conic-mitrate, naked. **Spores** multicellular, irregularly spherical to ellipsoid, mostly 40–60(–80) μm in greater dimension, papillose.

Illustrations: Plate 12. Vitt 1976, figs 8–15, 33, 35, 37 (as *Muelleriella angustifolia*).

Distribution: C (Saint Col ridge, Beeman Hill, Mt Filhol, Jacquemart I.).

Endemic.

Habitat: On rock faces from c. 150–300 m. It is found commonly with *Andreaea acutifolia* and *A. subulata* on siliceous cliff faces in exposed situations. According to C. Meurk (pers. comm., 20 Feb. 2003) the sites from which *O. angustifolium* is known receive “low to moderate nutrient inputs from the sea”.

Notes: Vitt’s (1976, p. 98) suggestion that Sainsbury & Allison (1962) recorded this species from the Snares and the Otago coast was based on a misinterpretation of that publication.

Recognition: *Orthotrichum angustifolium* is characterised by having gradually narrowed, lanceolate to broadly subulate leaves. The costa is composed entirely of stereids and, except for the extreme apex, is not covered by shorter laminal cells. The upper leaf lamina is more consistently bistratose (sometimes tristratose at margin) than in *O. crassifolium*. The capsules are deeply immersed in the leaves, with the mouth reaching only to the middle (or less) of the enclosing perichaetial leaves. In shape, the capsules are narrowly ovate to oblong-ovate when dry and become nearly globose and sharply contracted to the setae when moist. The seta is rarely, if ever, longer than the capsule.

If capsules are not observed, *O. angustifolium* could easily be mistaken for a large species of *Andreaea*. *Andreaea subulata*, for which the present species would most likely be mistaken, is a red-brown plant with generally much shorter (<2 mm) leaves, ill-defined costae and ill-defined upper laminae. There are also marked differences in areolation and the sporophytes are unmistakably different.

Etymology: The species epithet means narrow-leaved.

***Orthotrichum assimile* Müll.Hal., Syn. Musc. Frond. 1, 704 (1849)**

Lectotype: Chile. (Designated by Lewinsky 1985.) Not seen.

= *Orthotrichum benmoreense* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 430 (1895)

Holotype: N.Z., Benmore Range, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum latifolium* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 441 (1895)

Holotype: N.Z., Mt. Torlesse, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum longithecum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 433 (1895)

Holotype: N.Z., Mt. Torlesse, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum magnothecum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 435 (1895)

Holotype: N.Z., near River Avon, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum acrolepharis* Müll.Hal., *Hedwigia* 37: 136 (1898)

Type: Victoria, Australia. Not seen.

Misapplications: *Orthotrichum alpestre sensu* Sainsbury 1955

Plants forming loose or dense tufts, yellow-green to olive-green above, light brown to almost black below. **Stems** branched by innovation, 3.5–12 mm, with rhizoids only near the base. **Leaves** erect and

slightly flexuose when dry, erect-spreading when moist, ovate- to oblong-lanceolate, acute, rounded-obtuse, or acuminate at apex, not plicate, finely and irregularly toothed or entire at apex, recurved from near base to near apex, (1.5–)1.8–3.5(–4.1) × 0.3–0.8(–1.2) mm; **mid** and **upper laminal cells** thick-walled, ± isodiametric, often ± oblate near margins, 6.5–15(–21) × 6.5–15(–20) μm, with 2–4 low, inconspicuous, and mostly unbranched papillae; **basal laminal cells** rectangular, 15–90 × 9.5–25 μm, usually thin-walled and lacking pores, but sometimes with thicker walls and porose, c. 6 rows at margins short rectangular and with thickened transverse walls. **Costa** as per genus.

Gonioautoicous. Perichaetial leaves not differentiated. **Perigonia** gemmiform, below the perichaetia. **Setae** c. 2 mm; **capsules** immersed, emergent, or weakly exerted, narrowly cylindrical, with 8 deep furrows nearly the full capsule length and constricted below the mouth when dry, less conspicuously furrowed when moist, 1 per perichaetium; **exothecial cells** differentiated into 8 yellow bands, each c. 4 cells wide, striate on surface; cells within bands rectangular with thick longitudinal and thin transverse walls; cells between bands rounded-elongate; **stomata** deeply immersed, restricted to mid and lower urn, the surrounding (“subsidiary”) cells strongly protruding, but not completely covering the guard cells; **operculum** as per genus. **Peristome** double; **exostome teeth** 8, yellow, recurved when dry, finely and evenly papillose, with the papillae sometimes confluent in lines near the apex; **preperistome** absent; **endostome** segments 8, narrow and uniseriate (except near the base where sometimes 2 cells wide), yellow or hyaline, granulated or smooth near the base or smooth throughout. **Calyptra** campanulate-mitrate, yellow to ± brown, mostly red-brown at apex, somewhat plicate and split near the base, with many or few, yellow or hyaline, smooth hairs. **Spores** globose, isosporous and 1-celled, 16–21 μm diam., papillose, yellow-brown.

Illustrations: Plate 13. Lewinsky 1984, figs 32–33 (as *O. longithecum*); Lewinsky 1985, figs 35–47.

Distribution: NI: N Auckland (near Waimate North), S Auckland (near Murupara), Hawke’s Bay (Otūpae, Sentry Box Scenic Reserve), Wellington (near Taihape, Masterton); SI: Marlborough, Canterbury, Otago, Southland; St.

Austral. Australia*. Reported from numerous localities in Chile and Argentina by Lewinsky (1985). Lewinsky (1984) characterised the N.Z. distribution of this species as “local in the central part of the North Island, common in the eastern and southern part of the South Island” and provided a detailed distribution map.

Habitat: Primarily epiphytic, but rarely on non-calcareous rock. The majority of collections come from *Salix* and *Populus* bark. Less commonly occurring on the bark of a wide range of indigenous woody plants as well as adventives including *Fraxinus*, *Sambucus*, *Ulmus*, and “old fruit trees” (see Lewinsky 1984, tab. 1). Occurring from near sea level to 800 m.

Notes: According to Lewinsky (1984), Dixon (1926) overlooked the immersed (cryptopore) nature of the stomata when he erroneously placed *O. longithecum* R.Br.bis in the synonymy of *O. hortense* Bosw. (which has superficial stomata). Many workers after Dixon, including Sainsbury (1955), have treated the N.Z. and Australian material of *O. assimile* as conspecific with the northern hemisphere *O. alpestre*, but Lewinsky (1984, p. 440) detailed several morphological and ecological features that distinguish *O. assimile* from that widespread northern hemisphere species. She also noted a relationship between *O. assimile* (cited as *O. longithecum*) and the northern hemisphere *O. pumilum* Sw. In her publication dealing with South American representatives, Lewinsky (1985, p. 75) placed the N.Z. *O. longithecum* in synonymy with the Chilean and Argentinian *O. assimile*.

Recognition: *Orthotrichum assimile* is recognised partly by its emergent and strongly 8-furrowed capsules with recurved peristome teeth. The leaves are erect and appressed when dry, in sharp contrast to the contorted leaves of *O. calvum*, the other predominantly epiphytic species with immersed stomata. The nature of the endostome and the degree of hairiness of the calyptra is somewhat variable. I have not seen gemmae (“fusiform or cylindrical, 5–7 cells long”), which Lewinsky described as sometimes present on leaves.

Confusion (in sterile or poor material) can occur between *O. assimile* and *O. cyathiforme*; material of *O. assimile* has more acute leaf apices than does *O. cyathiforme*, but this difference alone is not reliable. In my opinion, observation of either stomata (deeply immersed in *O. assimile* vs superficial in *O. cyathiforme*) or the nature of the calyptrae (hairy in *O. assimile* vs naked in *O. cyathiforme*) is required for the confident differentiation of these two superficially similar species.

Etymology: The epithet means “like” or “similar” and apparently refers to the similarities to *O. stramineum* and *O. alpestre* noted by Müller in the protologue (D. Meagher, pers. comm., 18 Nov. 2013).

***Orthotrichum aucklandicum* (Vitt) Goffinet in Goffinet et al., *Monogr. Syst. Bot. Missouri Bot. Gard.* 98, 287 (2004)**

≡ *Muelleriella aucklandica* Vitt, *J. Hattori Bot. Lab.* 40: 94 (1976)

Holotype: N.Z., Auckland I., Musgrave Inlet, on rocks at water level on NE shore of Lake Hinemoa, 25 m elevation, *D.H. Vitt 9172*, ALTA! Isotype: CHR 637831!

Plants in small, nearly black cushions, the tips often yellow-green to light green. **Stems** erect, mostly 2–4 times branched, rarely simple or once-branched, c. 3–12 mm. **Leaves** twisted and inwardly curved when dry, erect-spreading and straight or slightly secund when moist, ligulate-lanceolate to narrowly ligulate from an ovate base, broadly obtuse to sometimes acute, 2–3-stratose above, entire, plane, 1.8–3.0(–3.9) mm (including perichaetial); **margins** 2–4-stratose; **mid** and **upper laminal cells** irregularly rounded to irregularly hexagonal, a few usually oblate, smooth, mostly 5–9 µm wide; **interior basal cells** rectangular to elongate-rectangular, mostly 24–45 × c. 12 µm, slightly nodose toward the costa, shorter but lacking thickened walls at margins. **Costa** as per genus, stout, elliptic in cross-section at mid leaf, ending just below apex, obscured in surface view by laminal cells near apex. **Gemmae** lacking.

Gonioautoicous. Perichaetial leaves larger but otherwise similar to vegetative. **Perigonia** gemmiform or at the ends of separate branches. **Setae** stout, (0.4–)0.8–1.1 mm; **capsules** oblong and ± constricted below the mouth when dry, ovate-oblong to globose-ovate when moist, immersed, pale yellow-brown, the mouth reaching the upper half of the perichaetial leaves; gradually or abruptly narrowed to the seta, (0.8–)1.0–1.2 × 0.7–0.8 mm; **exothecial cells** rectangular, mostly 21–30 µm, with a faintly striate cuticle; **stomata** immersed, restricted to lower half of capsule; **annulus** absent; **operculum** not seen. **Peristome** single; **exostome teeth** 16, spreading when dry, recurved when old and dry; papillose; **preperistome** well-developed, sometimes up to ½ length of the exostome; **endostome** absent. **Calyptra** conic-mitrate, naked or nearly so, with small papillae near the apex. **Spores** multicellular, irregularly spherical to cubic-rectangular, 40–70 µm.

Illustrations: Plate 12. Vitt 1976, figs 1–7, 36 (as *Muelleriella aucklandica*).

Distribution: A (Lake Hinemoa, Falla Peninsula, near Logan Point, above Victoria Passage). Endemic.

Habitat: Occurring on boulders, cliff faces and rock ledges at elevations from 25 to 365 m on the Auckland Is.

Notes: *Orthotrichum aucklandicum* is extremely poorly documented; it has been collected from four localities on Auckland I. and Adams I.

Although Vitt (1976, p. 96) described the capsules of *O. aucklandicum* as “more or less oblong”, material has been seen in which the moist capsules are nearly globose in form and abruptly narrowed to the seta when moist.

Recognition: *Orthotrichum aucklandicum* is distinguished from *O. angustifolium* by differences in habit, leaf shape, and leaf length (see Vitt 1976, fig. 32). While differences in capsule dimension and form are less convincing than suggested by Vitt, the position of the capsule mouth in relation to the enclosing perichaetial leaves appears to be a more consistent character; this is best observed in dry plants.

Orthotrichum aucklandicum is best distinguished from *O. crassifolium* by sporophyte characters. In the present species the capsules are immersed, and ovate-oblong to nearly globose when moist. The gametophyte characters separating *O. aucklandicum* from *O. crassifolium* seem less convincing, and sterile material from areas where their ranges overlap cannot be confidently distinguished. Collection data suggest that *O. aucklandicum* may be less tolerant of salt spray than *O. crassifolium*.

Etymology: The species epithet refers to the Auckland I. type locality.

***Orthotrichum calvum* Hook.f. & Wilson in Wilson, *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II* 80 (1854)**

Holotype: N.Z., Manawatu, *W. Colenso*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum avonense* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 438 (1895)

Holotype: N.Z., near River Avon, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum minimifolium* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 439 (1895)

Holotype: N.Z., Moa Creek, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum minutum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 437 (1895)
Holotype: N.Z., Lyttelton Hills, trees, R. Brown, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum calvum* var. *brevisetum* Dixon, *Bull. New Zealand Inst.* 3: 173 (1926)
Holotype: N.Z., Mauriceville, Gray 6, BM. Isotype: LD. (Cited by Lewinsky 1984.) Not seen.

Plants in dense rounded tufts, yellow-green to pale olive-green above, grey-green to brown below. **Stems** branched by innovation, 4–15 mm, with well-developed, smooth and brown rhizoids below. **Leaves** contorted and twisted when dry, spreading when moist, narrow lanceolate to ovate-lanceolate, broadly acute to obtuse at apex, entire, plane or slightly recurved in middle, 1.6–2.3 × 0.5–0.6 mm; **mid** and **upper laminal cells** ± isodiametric, rounded or angular, with thin to fairly thick walls, unistratose, 7–11 × 7–10 µm, with 1–2 low, unbranched papillae per cell; **basal laminal cells** rectangular to rhomboidal, thin-walled, scarcely nodose, yellow or orange, 17–34 × 6–10 µm; with several rows at margins short, rectangular, and with moderately thickened transverse walls. **Costa** as per genus. **Gemmae** absent.

Gonioautoicous. **Perichaetial leaves** not differentiated; **vaginula** strongly hairy. **Perigonia** as per genus. **Setae** elongate, c. 2.0–4 mm, usually c. 1.5 mm exposed beyond the perichaetial leaves; **capsules** exserted, rarely emergent only, cylindrical-urceolate, pale yellow-brown, with 8 deep furrows reaching from the mouth almost to the base and somewhat constricted below the mouth when dry, weakly furrowed when moist, mostly single; **exothecial cells** differentiated into 8 bands of 3–5 thick-walled cells and bands of thinner-walled cells (corresponding with the furrows); **stomata** immersed, almost completely covered by the subsidiary cells, restricted to the lower half of capsule; **operculum** as per genus. **Peristome** double; **exostome teeth** 8, orange near the base and grading to almost hyaline at apex, strongly recurved when dry, evenly papillose; **preperistome** absent; **endostome segments** 8 (sometimes 16), narrow and usually uniseriate, hyaline, smooth or papillose. **Calyptra** campanulate-mitrate, constricted at the base when young, mostly yellow to copper but red-brown at apex and sometimes at base, sharply 8-plicate, mostly naked, rarely with a few hairs. **Spores** globose, isosporous and 1-celled, 20–24 µm.

Illustrations: Plate 13. Lewinsky 1984, fig. 36.

Distribution: NI: N Auckland (Te Pahi), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland (Kellys Creek, Franz Josef, Wanganui River, Haast River), Otago, Southland; St. Lewinsky (1984) characterised the N.Z. distribution of this species as "common in the North Island southwards from 38°S, more scattered in the South and Stewart Islands" and provided a detailed distribution map showing a concentration of records in southern Otago and eastern Southland. A collection from Te Pahi (N Auckland L.D.; *P. de Lange 10199*, AK 330986) extends the range considerably north of the distribution documented by Lewinsky.

Endemic.

Habitat: Epiphytic on a diverse range of plants, and occasionally epilithic on non-calcareous rock. Lewinsky's comment (1984, p. 443) that it tolerates a warmer climate than its congeners in N.Z. is confusing. While *O. calvum* (together with *O. tasmanicum*) appears to be the most commonly recorded species in relatively low rainfall areas of Hawke's Bay L.D., it is also commonly collected in Taranaki and recorded from Westland L.D. (Lewinsky 1984, fig. 37). She described it as "locally abundant" in some wetter parts of the country. Documented by Lewinsky (1984, tab. 1) on 22 genera of native and introduced woody plants. Occurring from near sea level (Wanganui River, Nelson L.D.) to at least 670 m elevation (at Hopuruahine Stream, Gisborne L.D.). Lewinsky (1984, p. 443) suggested that it may occur to c. 1000 m elevation.

Notes: Lewinsky indicated that *O. calvum* is unusual among the Australasian species for having a chromosome number of $n = 6$ and immersed stomata; the combination of these features obscures its relations within the genus.

Recognition: Although *O. calvum* is a variable species it is easily distinguished from the other cryptopore species of *Orthotrichum*. The contorted and twisted dry leaves and the configuration of the leaf cells, in particular its short rectangular basal marginal cells with thickened transverse walls, and its nearly naked calyptra, set it apart from other cryptopore species in the genus.

Its contorted and twisted dry leaves give this species, even in the field, a *Ulota*-like appearance. *Orthotrichum calvum* can be distinguished macroscopically from *Ulota* by its naked or nearly naked calyptra. Also, under the microscope, its immersed stomata scattered through much of the urn readily differentiate it from *Ulota*, in which the stomata are superficial and restricted to the neck and lower portion of the urn.

Etymology: The specific epithet means bald or glabrous, in reference to the hairless calyptra.

***Orthotrichum crassifolium* Hook.f. & Wilson, *London J. Bot.* 3: 546 (1844)**

≡ *Muelleriella crassifolia* (Hook.f. & Wilson) Dusén, *Bot. Not.* 1905: 304 (1905)
Lectotype: N.Z., Campbell I., *J.D. Hooker* 35, BM. (Designated by Vitt 1976.) Not seen.

Etymology: The epithet refers to the thick, 2–3 stratose leaves in this species.

Orthotrichum crassifolium* Hook.f. & Wilson, *London J. Bot.* 3: 546 (1844) subsp. *crassifolium

≡ *Muelleriella crassifolia* (Hook.f. & Wilson) Dusén, *Bot. Not.* 1905: 304 (1905) subsp. *crassifolia*

Plants mostly black-green, brown, or dark black, sometimes yellow-green above, forming tufts, cushions, or small mats. **Stems** erect, unbranched or once-branched, sparsely beset with smooth brown rhizoids, <10 mm. **Leaves** tightly or loosely erect and incurved when dry, erect-spreading or spreading when moist, ligulate-lanceolate or ligulate from an obovate or ovate base, a few ± ovate-lanceolate, obtuse or broadly or occasionally sharply acute, bistratose above, entire, plane, 1.4–3.2 × 0.5–1.0 mm (including perichaetial); **margins** 2–3-stratose; **mid** and **upper laminal cells** irregularly rounded to hexagonal-rounded, a few usually oblate, smooth, (6–)8–13 µm wide; **interior basal cells** short-rectangular to quadrate, c. 1–3: 1, mostly 18–30 × c. 9 µm, rarely with a border of clear cells. **Costa** as per genus, stout, elliptic in cross-section at mid leaf. **Gemmae** absent.

Gonioautoicous. Perichaetial leaves larger but otherwise similar to vegetative. **Perigonia** gemmiform on lower stems. **Setae** stout, straight or sometimes slightly curved, (0.8–)1.0–2.6(–2.8) mm, **capsules** oblong- to ovate-cylindric when moist, usually constricted below mouth when dry, occasionally asymmetric, erect, emergent to exerted (often appearing more clearly exerted when dry), yellow-brown, fairly sharply contracted to the seta, 1.0–1.8 × 0.5–0.9 mm; **exothecial cells** c. 20–40 µm at mid urn with strongly incrassate longitudinal walls; **stomata** immersed, numerous, and restricted to lower half of capsule; **annulus** absent; **operculum** obliquely rostrate, yellow-brown at maturity. **Peristome** single; **exostome teeth** 16, spreading when mature and dry, recurved when old and dry, triangular-lanceolate, inserted below the mouth, often irregular and ± perforate near apex, coarsely and irregularly papillose; **preperistome** irregular in outline and extending c. 1–4 cells beyond the capsule mouth, often also forming irregular papillose plates on upper portions of teeth; **endostome** absent. **Calyptra** conic-mitrate, naked. **Spores** multicellular, yellow-green, spherical to ovoid or irregularly cubic, (30–)40–100 µm.

Illustrations: Plate 12. Vitt 1976, figs 24–27, 34 (as *Muelleriella crassifolia* subsp. *crassifolia*); Seppelt 2004, fig. 82 (as *Muelleriella crassifolia* subsp. *crassifolia*); Ochyra et al. 2008, fig. 184 (as *Muelleriella crassifolia*).

Distribution: SI: Otago (Taieri River Mouth, Akatore River, Bull Creek, Curio Bay, Cannibal Bay); St; Ch (Ocean Bay); Sn; A; Ant; C; M.

Austral. Antarctic Peninsula*, S Shetland Is.*, Argentina*; recorded from the Brunswick Peninsula of Chile, Falkland Is., and Marion I. by Vitt (1976), who considered the subsp. *acuta* to be “almost certainly endemic to Kerguelen and Crozet Islands”.

Habitat: Restricted or nearly restricted to supratidal and salt spray zones, where it grows on the tops and sides of boulders or on rock outcrops; occasionally also occurring in the upper intertidal zone. On Auckland Is most collections (largely by D.H. Vitt) were made in *Metrosideros/Olearia* forest and range from “near sea level” to c. 50 m elevation. Vitt (1976, p. 102) also records several specimens from inland sites on Auckland I. (mostly from St. Col Ridge). Seppelt (2004) recorded it from sites up to 130 m elevation but stated that “it is sometimes encountered on rocks on elevated coastal slopes and a few collections have been made from isolated plateau localities, but its primary habitat is the supralittoral zone.” The known distribution of this species on the Otago coast is limited and it may be under-collected there; only two collections have been seen from Stewart I.

Notes: The restriction of a moss species to littoral sites is exceedingly rare. No other N.Z. moss, including its congeners, exhibits such a marked tolerance of salt as *O. crassifolium* subsp. *crassifolium*. The unrelated *Calyptrochaeta apiculata*, however, is largely restricted to habitats subject to salt spray, and occurs on a range of substrates including rock and sand. *Macromitrium longirostre* s.l. and *M. brevicaulle* occur on both bark and rocks subject to salt spray in part or all of their N.Z. range. The rare (in N.Z.) pottiaceous mosses *Tortella cirrhata* and *T. flavovirens* appear to be restricted to maritime sites here, as does the unrelated *Ischyrodon lepturus*. *Ulota phyllantha*, a

species growing most often on rock in the southern hemisphere and strongly restricted to maritime localities, is widely distributed in the northern hemisphere. It occurs (probably adventively) on Macquarie I. and in Patagonia.

Goffinet (in Goffinet et al. 2004) published the combination *Orthotrichum crassifolium* Hook.f. & Wilson subsp. *acutum* (Müll.Hal.) Goffinet, mirroring the taxonomic conclusions presented by Vitt (1976) in his monograph of *Muelleriella*. In publishing the subsp. *acutum* in *Orthotrichum*, Goffinet created the autonym *Orthotrichum crassifolium* Hook.f. & Wilson subsp. *crassifolium*, the name by which this taxon should be known in N.Z.

Recognition: *Orthotrichum crassifolium* subsp. *crassifolium* is a somewhat variable taxon, differentiated from *O. angustifolium* and *O. aucklandicum* by its leaves, which are blunter, more ovate, erect-incurved, and rather stiff, and by its emergent to exerted, cylindrical capsules.

The present species could be confused with *Zygodon menziesii* when sterile, but *O. crassifolium* subsp. *crassifolium* has more obtuse and bistratose leaves. The bistratose laminal cells of the present species make the leaves appear more opaque, even at low magnification. The smooth capsule and multicellular spores are strikingly different.

***Orthotrichum cupulatum* Brid., Muscol. Recent. 2(2), 25 (1801)**

Type: Europe. (Cited but not seen by Lewinsky 1984). Not seen.

= *Orthotrichum calcareum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 427 (1895)

Holotype: near Broken River, R. Brown, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum ornatum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 426 (1895)

Holotype: N.Z., Castle Hill, Broken River, R. Brown, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum pulvinatum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 426 (1895)

Holotype: N.Z., Castle Hill, Broken River, R. Brown, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum austrocupulatum* Dixon & Sainsbury, *J. Bot.* 71: 244 (1933) — as austro-cupulatum

≡ *Orthotrichum cupulatum* var. *austrocupulatum* (Dixon & Sainsbury) Lewinsky, *J. Hattori Bot. Lab.* 56: 433 (1984) — as austro-cupulatum

Holotype: N.Z., Mt Arthur, Nelson, on scattered limestone rocks, G.O.K. Sainsbury 611, WELT M004633! Isotypes: CHR 536633!, CHR 536634!

Plants mostly 12–20 mm, occasionally shorter, forming loose tufts or cushions, green, blue-green, olive-green or brown above, brown-black below. **Stems** moderately branched by innovation, with rhizoids variably developed. **Leaves** erect-appressed and sometimes slightly contorted when dry, spreading when moist, ± glaucous, lanceolate to ovate-lanceolate, acute, entire (or slightly dentate near apex when young), sometimes decurrent, narrowly or broadly recurved on one or both sides, (2.0–)2.3–3.2 × 0.5–0.8(–1.0) mm (including perichaetial); **upper laminal cells** thin- or thick-walled, isodiametric or nearly so, (5–)8–13 × 8–13 μm, with 2–3 low and usually unbranched papillae per cell; **basal laminal cells** rectangular or almost quadrangular, (19–)32–64 × 9.5–16 μm, thin-walled, lacking pores. **Costa** as per genus. **Gemmae** absent.

Gonioautoicous. **Perichaetial leaves** ± larger than vegetative. **Perigonia** gemmiform. **Setae** straight or ± curved, 0.6–1.5(–2.0) mm (excluding vaginula); **capsules** immersed-emergent and erect or exerted and bent downwards when dry, ovoid-urceolate or cylindrical-ovoid, yellow-brown, with 8 long furrows usually alternating with 8 shorter ones and somewhat constricted below the mouth when dry, faintly ribbed when moist, 1 per perichaetium; **exothecial cells** differentiated into alternate bands of thick-walled and thin-walled cells; the 8 thick-walled bands c. 3 cells wide and with thickened longitudinal walls; the thin-walled bands corresponding to the furrows of dry capsules; **stomata** immersed, slightly or almost completely covered by the subsidiary cells, restricted to the central and lower part of the capsule. **Peristome** single or double; **exostome teeth** 16, orange-yellow, erect-spreading when dry, covered by a mixture of vertical, ± vermicular lines and papillae (near the base the lines ± horizontally orientated); **preperistome** present or absent, if present sometimes covering the entire surface of the teeth; **endostome** variably developed, either absent, highly reduced, or of hyaline and finely papillose segments which are ½ to equal the exostome teeth. **Calyptra** conic or conic-oblong, yellow with red-brown apex, plicate, slightly split near the base, hairy (the hairs strongly papillose, yellowish, and reaching to top of calyptra). **Spores** globose, 18–22.5 μm, coarsely papillose.

Illustrations: Plate 14. Lewinsky 1984, figs 27 & 30 (variously cited); Smith 2004, fig. 224, 1–7.

Distribution: NI: N Auckland (Hikurangi Limestone Scenic Reserve, Waro Limestone Scenic Reserve), S Auckland (Piopio, near Tawarau River), Gisborne (Hopuruahine River, Panekire Range,

Maungapōhātu), Hawke's Bay (near Waipukurau, Tukituki River), Wellington (NW Ruahine Range); SI: Nelson, Marlborough (Blue Duck Scenic Reserve, Leatham River), Canterbury (Broken River Basin), Otago (Cripple Range, Crown Range, Motatapu Valley), Southland (Takahē Valley). While scattered in distribution in N.Z., this is a common species in the calcareous ranges of Nelson L.D. and in the Broken River Basin; a large proportion of herbarium specimens come from those areas.

Nearly cosmopolitan. Lewinsky (1984) recorded this species from a few localities in Australia, including N.S.W., A.C.T., and Vic. while Smith (2004) outlined its world distribution to include Europe, Iceland, Caucasus, Turkey, Cyprus, northern Asia, Macaronesia, North Africa, North America, Australia, and N.Z.

Notes: Mostly restricted to calcareous rocks, although a few collections from schist in Otago L.D. have been confirmed. Rarely collected from concrete (as at Clifton). On the North I. ranging from low elevations to c. 900 m (Panekire Range); on the South I. from near sea level (Clifton, Nelson L.D.) to at least 1830 m (Mt Owen, Nelson L.D.). Lewinsky considered this species to extend to elevations of c. 2050 m. The only Hawke's Bay L.D. specimens seen are two poorly localised 19th century collections by W. Colenso.

In addition to the taxonomic synonyms listed above, Lewinsky (1984) tentatively included the Robert Brown names *O. oamaruense* R.Br.bis. and *O. oamaruanum* R.Br.bis., (both published in *Trans. & Proc. New Zealand Inst.* 35: 332, 1903) as probable synonyms. Lewinsky presumed the types of these two names to be lost.

Orthotrichum cupulatum has a wide but scattered distribution in N.Z. It is variable here, as it is in other parts of its very wide range. It varies in size, growth form, leaf shape, and degree of leaf cell papilosity, length of seta and ornamentation of the exostome teeth. An endostome may or may not be present, and the vaginula and calyptra vary in hairiness. N.Z. plants, like European ones, mostly have simple leaf papillae.

Lewinsky's (1984) recognition of the allegedly endemic var. *austro-cupulatum* is not accepted here, due to a large number of morphological intermediates. Considerable variability of seta length occurs in single herbarium specimens. One of the specimens (*G.O.K. Sainsbury 4081*) cited by Lewinsky (1984, p. 436) as representative of the variety has short setae (c. 0.6 mm) and hence does not agree with one of Lewinsky's primary criteria for this variety. Other specimens with short (c. 0.8 mm) setae and ± erect capsules have well-developed endostomal segments c. $\frac{2}{3}$ the exostome height, thus further blurring the distinction. The species is particularly variable in the Broken River Basin.

For those wishing to apply the infraspecific concepts of Lewinsky, her concept of var. *austro-cupulatum* includes smaller, darker, and more compact plants with more nearly cylindrical capsules exerted on a bent seta, and with a well-developed endostome.

Recognition: *Orthotrichum cupulatum* is sometimes confused with *Zygodon menziesii*, which also commonly grows on limestone. The dry plants of *O. cupulatum* are dull and often faintly glaucous with nearly straight leaves in contrast to the distinctively lustrous, non-glaucous plants with often spirally twisted leaves of *Z. menziesii*. Further distinction is provided by the usually distinctly obliquely ranked and smooth upper laminal cells (giving a KOH positive yellow reaction) and the presence of fusiform axillary gemmae in *Z. menziesii*.

Etymology: The epithet refers to the cupulate shape of the capsule.

***Orthotrichum cyathiforme* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 436 (1895)**

Holotype: N.Z., Little River, *R. Brown*, June 1882, BM. Isotype CHR 540494! (Holotype cited by Lewinsky 1984.)

= *Orthotrichum brevirostrum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 437 (1895)

Holotype: N.Z., Lyttelton Hills, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum pseudopumilum* Venturi, *Rev. Bryol.* 23: 67 (1896)

Type: N.Z., Pine Hill. Dunedin, *W. Bell 643*, BM (not seen), CHR 633244! (Partially cited by Lewinsky 1984.)

= *Orthotrichum ligulatum* Müll.Hal., *Hedwigia* 37: 140 (1898)

Lectotype: N.Z., Birdlings Flat, *T.W.N. Beckett*, CHR 537637! (Designated by Lewinsky 1984.)

Plants small, 5–10 mm, forming ± dense tufts, green to olive-green above, brown to almost black below. **Stems** branched by innovation, with rhizoids well-developed near base. **Leaves** erect-

appressed or slightly curved around the stem when dry, erect-spreading when moist, mostly ovate-lanceolate, broadly obtuse, broadly rounded or rarely rounded-acute at apex, not plicate, entire, strongly recurved to revolute for most of length on one or both sides, (2.2–)2.4–2.9 × (0.4–)0.6–1.0 mm; **mid and upper laminal cells** irregular or ± isodiametric, mostly wider than long, incrassate, indistinctly papillose (usually visible only when cells are viewed on edge) or smooth, 6.4–12.8 × 6.4–14.4 μm, becoming longer and less opaque below and grading into the basal cells; **basal interior cells** mostly oblong-rectangular, rather thin-walled, not or weakly-porose, (32–)38–80 × 6.4–15 μm, 4–6 rows at margins short rectangular and with thickened transverse walls. **Costa** as per genus. **Gemmae** absent.

Gonioautoicous. **Perichaetial leaves** not differentiated from vegetative. **Capsules** emergent or occasionally immersed, pale yellow-brown, narrowly cylindrical with 8 deep furrows for their full length and slightly constricted below the mouth when dry, nearly smooth and cyathiform when moist, 1 per perichaetium; **exothecial cells** differentiated into 16 alternating bands of thick- and thin-walled cells, the thick-walled bands 5–6 cells wide and forming ridges when dry, mostly rectangular; **stomata** superficial, restricted to mid urn; **operculum** as per genus. **Peristome** double; **exostome teeth** 8, hyaline, yellow or light brown, recurved when dry, finely papillose and with the papillae increasing in height towards the tooth apex; **preperistome** absent; **endostome segments** 8, 1–2 cells wide at the base, almost as tall as the exostome, incurved when dry, hyaline and finely papillose. **Calyptra** campanulate-mitrate, yellow-brown, with the apex ± red and sometimes with red-brown striae below, plicate and ± split near the base, smooth, naked. **Spores** globose, isosporous and 1-celled, yellow-brown, 16–22.5 μm, papillose.

Illustrations: Plate 14. Lewinsky 1984, fig. 25.

Distribution: NI: S Auckland (near Barryville), Hawke's Bay (Wairoa, Puketitiri Road, near Napier), Wellington; SI: Marlborough, Canterbury, Otago, Southland.

Endemic. *Orthotrichum cyathiforme* is most common in eastern and southern parts of the South I. and does not extend northward of c. 38°S (the approximate latitude of Hamilton). Lewinsky (1984, p. 428) provided a detailed distribution map.

Habitat: Mainly epiphytic but rarely collected from non-calcareous rock. Lewinsky (1984, table 1) recorded it as epiphytic on six genera of native and at least nine genera of introduced woody plants. On the North I. ranging from sea level to 580 m (Puketitiri Road); on the South I. ranging to at least 470 m (Blue Duck Scenic Reserve, Marlborough L.D.).

Notes: The combination of the broadly obtuse and erect-appressed leaves, naked calyptra, and mostly emergent, strongly ribbed capsules with reflexed, dry peristome teeth make *O. cyathiforme* one of the most distinctive and easily recognised species of *Orthotrichum* in N.Z. Lewinsky's (1984, p. 429) comments that the leaves are completely smooth are misleading. While in surface view the laminal cells usually appear smooth, low (less than 4 μm high) papillae are present in all material I have examined (including type material). The papillae are usually visible when the upper laminal cells are viewed on edge; however, the material illustrated in Plate 14, fig. L, lacks papillae.

Plants belonging to *O. cyathiforme* were often determined by early collectors as *O. pumilum* Sw., a plant of the northern hemisphere with immersed stomata.

A critical collection by William Bell (part of which is the type of *Orthotrichum pseudopumilum* Vent.) is the source of considerable confusion. *W. Bell 643* is probably an aggregated collection (there are duplicates of *Bell 643* in the Beckett herbarium, and these include at least three different *Orthotrichum* spp.). It is possible that part of the collection came from trees and part from rock (judging from the assortment of species present in various duplicates). Lewinsky cited a duplicate in BM as an isotype of Venturi's *O. pseudopumilum*, which she placed in the synonymy of *O. cyathiforme* R.Br.bis. There is some *O. cyathiforme* present in one duplicate in the Beckett herbarium, but not in the other. It would be pointless to question Lewinsky's synonymy.

Recognition: *Orthotrichum cyathiforme* can easily be confused with *O. assimile*, given that both species have narrowly cylindrical, ribbed capsules and recurved peristomes when dry. The leaves in *O. cyathiforme* are usually more broadly obtuse or rounded apically compared to those of *O. assimile*. It is necessary to observe the stomata (superficial in *O. cyathiforme*; deeply immersed in *O. assimile*) to be certain of the identity of these plants; sterile material cannot be determined with confidence.

Sainsbury (1955, p. 211) stated that *O. cyathiforme* bears a strong but superficial resemblance to *O. hortense*; both have superficial stomata. Lewinsky (1984, p. 429) considered that the two species are easily separated by several features, including leaf shape, the nature of their laminal cells, and calyptra hairiness.

Etymology: The specific epithet refers to the cup-like or cyathiform shape of the capsules, which is best observed in a moist condition.

***Orthotrichum graphiomitrium* Müll.Hal. ex Beckett, *Trans. & Proc. New Zealand Inst.* 25: 291 (1893)**

Lectotype: N.Z., Arthur's Pass, *T.W.N. Beckett* 176, CHR 540489! Isolectotype: AK 10943!
(Lectotype designated by Lewinsky 1984.)

- = *Orthotrichum acuminatum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 434 (1895)
Holotype: N.Z., Moa Creek, *R. Brown*, BM 000982273. Image seen online, JSTOR Global Plants, accessed 16 Feb. 2017. (Cited by Lewinsky 1984.)
- = *Orthotrichum obesum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 435 (1895)
Holotype: N.Z., Moa Creek, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.
- = *Orthotrichum leiolecythis* Müll.Hal., *Hedwigia* 37: 140 (1898) nom. illeg. non *Orthotrichum leiolecythis* Müll.Hal. 1896
- ≡ *Orthotrichum subleiolecythis* Paris, *Index Bryol. Suppl.*, 260 (1900) nom. nov. pro *Orthotrichum leiolecythis* Müll.Hal. 1898
Holotype: N.Z., Canterbury, Ben More, Nov. 1890, *T.W.N. Beckett s.n.*, CHR 540490!
Isotype: CHR 540493!

Plants (10–)25–40 mm, forming loose tufts or mats, brown-yellow to olive-green above, darker below. **Stems** creeping or suberect, much-branched by innovation, flexuose, beset on older parts with abundant smooth, brown rhizoids. **Leaves** erect-appressed and straight or slightly twisted when dry, erect-spreading when moist, ovate-lanceolate, weakly plicate and sometimes slightly auriculate near the base, acuminate, entire, plane or recurved in the central part or below on one or both sides, 2.6–3.7(–4.1) × 0.7–1.1(–1.3) mm; **mid** and **upper laminal cells** isodiametric, oblong, or ± irregular, usually rounded, incrassate, unistratose, (6.0–)9–19(–24) × 6.5–13 µm, papillose with 1–2(–3) low, unbranched papillae per cell; **basal interior cells** elongate or ± rectangular, thick-walled, nodose, and porose, mostly orange-brown, (30–)51–60(–90) × 6–12 µm, with few to several rows at margins shorter, more regularly rectangular and with thickened transverse walls. **Costa** as per genus. **Gemmae** absent.

Gonioautoicous. **Perichaetial leaves** ± enlarged, c. 4 mm. **Perigonia** gemmiform, conspicuous below the perichaetia and on lower stem. **Setae** <1 mm; **capsules** immersed, broadly ovoid or broadly ellipsoid, pale yellow, smooth and constricted at mouth when dry, smooth and not furrowed when moist, 1 or occasionally 2 per perichaetium, persistent, with the older appearing laterally on stem; **exothecial cells** thin-walled, not differentiated into bands, mostly rounded-oblong or oblong-hexagonal; **stomata** superficial, numerous in the mid and upper part of the urn, often surrounded by a ring of radiating cells; **operculum** as per genus. **Peristome** double; **exostome teeth** 8, pale yellow or orange, strongly or weakly recurved (occasionally ± erect) when dry, the outer surface with dense, branched papillae, the inner surface with longitudinal papillose ridges; **preperistome** absent; **endostome** well-developed, when intact as tall as the exostome and forming a cone when dry, often broken in mature material, with 8 hyaline segments, each of 2 rows of cells, sometimes narrowed near base. **Calyptra** relatively small (covering c. ½ the capsule), golden-yellow, plicate and split at the base, densely covered with yellow hairs that extend past the calyptra apex. **Spores** globose, (18–)20–26(–32) µm, finely papillose.

Illustrations: Plate 15. Lewinsky 1984, fig. 19. The illustration in Sainsbury (1955, pl. 34, fig. 2) is misleading.

Distribution: NI: S Auckland (“Moerangi–Mangakino turn-off”), Wellington (Taihape); SI: Nelson (Lake Peel), Canterbury (Ben More, Mt Torlesse, Arthur's Pass, near Mt Cook Village), Westland (near Mt Davy, Ōtira Gorge, Franz Josef), Otago (Dunedin area), Southland (Rob Roy Glacier, near Mossburn, Te Ānau, near Wilmot Pass, Homer Tunnel).

Endemic.

Habitat: Epiphytic on trees and shrubs in areas of high rainfall. Best developed and most common on *Hoheria glabrata* in wet, subalpine areas, but also recorded by Lewinsky (1984, table 1) from *Aristotelia*, *Carmichaelia*, *Discaria*, and *Nothofagus* and the introduced genera *Populus*, *Quercus*, and *Salix*. Very rarely occurring on rocks. Usually growing with *Calyptopogon mnioides*, and less often with *Orthotrichum tasmanicum* and *Sauloma tenella*; nearly pure collections of this species are common. Occurring mainly in areas with high rainfall (>150 cm per year), but rarely extending into drier areas. Occurring from c. 200 (near Lake Te Ānau) to 920 m (at Arthur's Pass).

Recognition: *Orthotrichum graphiomitrium* is easily recognised by its short-ovoid and completely smooth capsules, which are immersed in the perichaetial leaves. The stems are commonly in excess of 25 mm and the plants form extensive mats of up to 150 mm or greater diameter; the robustness of the plants facilitates the distinction of this from other N.Z. species of *Orthotrichum*. Apart from variation in stature, the gametophytes exhibit little variability.

Orthotrichum graphiomitrium is often similar in size and by its semi-creeping habit to *O. rupestre*. Both species often have numerous perichaetia on much-innovated shoots, with each perichaetium bearing a single, weakly emergent capsule. In *O. graphiomitrium*, the dry mature capsules lack furrows, the exostome is variably reflexed, and its teeth lack a preperistome. The endostome is well developed and observable with a hand-lens in dry material (unless fractured) and the superficial stomata are numerous and distributed in the upper half of the urn. The plants are nearly always epiphytic. By contrast, in *O. rupestre*, the dry mature capsules have furrows and the exostome is erect-spreading when dry. The exostome teeth have a well-developed preperistome. The endostome can be present or absent, and the superficial stomata sparse and mostly confined to the lower half of the capsule. The plants are largely confined to rock.

Confusion with species of *Macromitrium* (because of the weakly creeping stems) seems less likely. Branching of the stems is here innovative (associated with perichaetia), while in *Macromitrium* it is not. The frequently produced sessile capsules, the erect-appressed dry branch leaves, the well-developed endostome, and the distribution of stomata over the urn in *O. graphiomitrium* should likewise prevent confusion with any *Macromitrium*.

Etymology: The epithet *graphiomitrium* perhaps refers to the brush-like appearance of the hairy calyptra (D. Meagher, pers. comm., 23 Oct. 2013).

***Orthotrichum hortense* Bosw., J. Bot. 30: 97 (1892)**

Lectotype: N.Z., Hanmer Plains, on trees in a garden, *Roper*, OXF (Designated by Lewinsky 1984.) Not seen.

= *Orthotrichum breve* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 426 (1895) nom. illeg. non *Orthotrichum breve* P.Beauv. 1805

Holotype: N.Z., Port Lyttelton Hills, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum brevisetum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 434 (1895)

Holotype: N.Z., Lyttelton Hills, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.

Plants 5–20 mm, forming loose and spreading tufts, bright green, yellow-green, or olive-green above, brown to almost black below. **Stems** erect, much branched by innovation, with well-developed rhizoids ± restricted to base. **Leaves** erect and slightly flexuose when dry, erect-spreading when moist, ovate-lanceolate, narrowly acute to acuminate, entire, narrowly recurved for most of their length, (2.2–)2.4–3.4 × 0.6–0.9 mm; **mid** and **upper laminal cells** isodiametric or slightly elongate, rounded or angular, incrassate, 8–15(–19) × 6.5–12(–14.5) μm, with 2–3 low and ± branched papillae per cell; **basal interior cells** mostly elongate-oblong, 45–60(–117) × 6–15 μm, thick- or thin-walled, mostly porose, yellow, with several rows at margins shorter, more regularly rectangular, with ± thickened transverse walls, smooth to at least 300 μm above leaf insertion; the papillae of the marginal cells extending further from the base, <c. 5 μm, unbranched. **Costa** as per genus. **Gemmae** absent.

Gonioautoicous. Perichaetial leaves not differentiated. **Perigonia** gemmiform, conspicuous below the perichaetia. **Setae** c. 0.8–1.5 mm; **capsules** emergent to short-exserted, oblong-cylindric and often ± swollen at base before maturity, pale brown, strongly 8-furrowed nearly to base and constricted below the mouth when dry, oblong-cylindric and weakly furrowed when moist, 1 per perichaetium (but perichaetia often closely aggregated), persistent and often with several of various ages on a single stem; **exothelial cells** rectangular, forming 8 bands of relatively thin-walled, unpigmented cells and 8 bands of thicker-walled, pigmented cells (which form ridges when dry); **stomata** superficial, restricted to mid urn, often surrounded by a ring of radiating cells; **operculum** as per genus. **Peristome** double; **exostome teeth** 8, pale yellow or beige, recurved when dry, sometimes perforate along middle line, the outer surface with ± confluent papillae and horizontal ± vermicular lines, the inner surface papillose with branched or unbranched papillae; **preperistome** absent; **endostome** with 8 pale yellow segments, $\frac{1}{2}$ – $\frac{3}{4}$ the height of exostome, incurved when dry, narrow, 1 cell wide (sometimes 2 cells near base), the outer surface smooth, the inner surface with papillae and vermicular lines. **Calyptra** campanulate-mitrate, yellow or pale brown, plicate, not or weakly split at base, with few to numerous hairs reaching to or slightly beyond the calyptra apex. **Spores** globose, isosporous and 1-celled, 16–21(–23) μm, densely and rather coarsely papillose.

Illustrations: Plate 16. Lewinsky 1984, fig. 21.

Distribution: NI: S Auckland (near Piopio, near Rangitāiki), Hawke's Bay (Puketitiri, Maraetōtara Scenic Reserve), Wellington (Tangiwai, Erewhon, Palmerston N.); SI: Marlborough, Canterbury, Otago, Southland.

Apparently austral. Recorded from four localities in mainland Australia (N.S.W.) and from South America by Lewinsky-Haapasaari & Ramsay (2006a).

Habitat: Mainly epiphytic, but occurring occasionally on non-calcareous rocks (as at Saddle Hill and at Wanaka, both Otago L.D.). There are isolated records from limestone rock at Broken River, Canterbury L.D. (CHR 105021) and from "waste concrete" from "near Beaumont, Blue Mountains", Otago L.D. (WELT M032880). Reported from a wide range of both indigenous and introduced host tree species by Lewinsky (1984, tab. 1). As in many epiphytic species of *Orthotrichum*, unmixed collections of *O. hortense* are exceptional. *Orthotrichum hortense* is very often mixed with *O. calvum*, *O. sainsburyi*, *O. tasmanicum*, and sometimes other species. Lewinsky (*in herb.* CHR) named collections with up to five other species of *Orthotrichum* present. *Calyptopogon mnioides* and *Syntrichia papillosa* are also often closely associated. Ranging from near sea level (Christchurch) to at least 860 m (Black Birch Range, Marlborough L.D.).

Notes: Lewinsky's decision to recognise *O. hortense* as distinct from the widespread northern hemisphere *O. affine* is adopted here. She discussed in detail both the difficulties of typifying *O. hortense* and the subtle morphological differences from *O. affine*. Lewinsky (1984, p. 422) emphasised differences in stance and shape of the dry leaves, which she considered "more erect-open and often somewhat flexuose" and less variable in shape in *O. hortense*. Given her wide experience with both species, little purpose would be served in questioning her taxonomic conclusion.

Recognition: The more strongly ribbed capsules on shorter setae, the pale exostome, and narrower endostome segments serve to distinguish *O. hortense* from the common and widespread *O. tasmanicum*.

Orthotrichum hortense differs from *O. sainsburyi* by having eight pale exostome teeth and eight endostome segments together with short papillae on the laminal cells, rather than 16 orange-red exostome teeth, 16 endostome segments and tall laminal papillae. Although the generally hairy calyptra of *O. hortense* also contrasts with the ± glabrous calyptra of *O. sainsburyi*, the confident separation of the two species without well-developed and mature peristomes is very difficult. The two species have a similar distribution.

Etymology: The epithet refers to gardens, and reflects the nature of the type locality.

***Orthotrichum rupestre* Schwägr., Sp. Musc. Frond. Suppl. 1(2), 27 (1816)**

Lectotype: Europe. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum latorum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 431 (1895)

Lectotype: N.Z., Moa Creek, R. Brown, H. (Designated by Lewinsky 1984.) Not seen.

= *Orthotrichum reflexum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 431 (1895)

Holotype: N.Z., Mt Torlesse, rocks, R. Brown, BM. Isotype: H. (Cited by Lewinsky 1984.) Not seen.

= *Orthotrichum praeperistomatum* Venturi, *Rev. Bryol.* 23: 67 (1896)

≡ *Orthotrichum pulvinatum* var. *praeperistomatum* (Venturi) Sainsbury, *Rev. Bryol. Lichénol.*, n.s. 21: 218 (1952)

Lectotype: N.Z., Mt Alfred, W. Bell, H. (Designated by Lewinsky 1984.) Isolectotype: CHR 540492!

= *Orthotrichum rupestriforme* Venturi, *Rev. Bryol.* 23: 67 (1896)

Probable holotype: N.Z., s. loc., W. Bell, TR (*fide* Lewinsky 1984). Isotype: CHR 635982!

Misapplications: *Orthotrichum pulvinatum sensu* Dixon 1926, p. 178; *sensu* Sainsbury 1955, p. 212.

Plants 15–45(–60) mm, in loose to dense tufts or mats, olive-green, yellow-brown or rarely ± grey and glaucous above, brown to black below. **Stems** often branched repeatedly (probably by both forking and innovation), with brown, smooth rhizoids below. **Leaves** erect-spreading when moist, appressed and almost straight when dry, ovate-lanceolate, (2.5–)3–4(–4.5) × 0.7–1.4 mm, often with 2 plicae near base, acute or sometimes acuminate, entire, strongly and sometimes broadly recurved from base to shortly below apex; **mid** and **upper laminal cells** isodiametric or oblong, usually rounded, incrassate, unistratose in N.Z. material (sometimes with bistratose patches outside N.Z.), (6.5–)10–17.5(–21) ×

6.5–13(–14.5) μm , with 2–3 branched or unbranched papillae per cell; **papillae** of mid laminal cells variable in height, commonly to c. 9 μm in var. *rupestre* and to 18 μm or more in var. *papillosum*; **basal laminal cells** narrowly rectangular or rhomboidal, 35–77(–105) \times (6.5–)10–18(–21) μm , with \pm thick and nodose walls, with or without pores, often yellow or brown; **cells of basal margins** difficult to observe because of recurved margins, similar to upper laminal cells in several rows. **Gemmae** absent.

Gonioautoicous. **Perigonia** numerous on stems. **Capsules** emergent, ovoid to short cylindrical, smooth or with 8 short and shallow furrows in upper part and slightly or not constricted below mouth when dry, not furrowed when moist, 1 per perichaetium; **setae** very short, c. 1 mm; **exothecial cells** slightly differentiated into strips in upper part of capsules, with several rows of rounded, thick-walled cells just below mouth; **stomata** superficial, variably distributed in capsule wall in N.Z. material, rarely surrounded by ring of short, radiating cells; **operculum** as per genus. **Peristome** single or double; **exostome teeth** 8, yellow-orange, mostly erect-spreading, occasionally \pm recurved when dry, perforate along middle line or completely split to form 16 free teeth, their outer surface with dense or sparse ornamentation of single or compound papillae; **preperistome** usually \pm well-developed, sometimes absent; **endostome** present or absent, when present with 8 short uniseriate segments, hyaline, smooth or finely granulated. **Calyptra** campanulate-mitrate, yellow with red-brown apex, plicate, slightly lobed at base, with numerous \pm yellow hairs which are straight or curled, sometimes papillose, and usually exceeding the calyptra apex. **Spores** globose, 1-celled, 20–26 μm , \pm roughly papillose, golden-brown.

Notes: The robust habit and occurrence of this usually olive-green species growing on non-calcareous rock facilitate its recognition. The emergent capsules are often numerous (but only one per perichaetium) and of various ages on single stems; they have short furrows restricted to the upper part of the capsule and erect-spreading exostome teeth when dry. There is usually a well-developed preperistome (which restricts the movement of the teeth upon drying). The strongly recurved leaf margins also facilitate the recognition of this species, which, in N.Z., remains known only from the South I.

Orthotrichum rupestre var. *rupestre* and var. *papillosum* were regarded collectively by Dixon (1926, p. 178) as a N.Z. endemic, which he termed *O. pulvinatum* R.Br.bis. Dixon noted a close relationship between *O. pulvinatum* and the widespread and predominantly northern hemisphere *O. rupestre*. Sainsbury (1955, p. 214) also recognised *O. pulvinatum* as endemic and stopped just short of treating it as a synonym of *O. rupestre* Schwägr. Sainsbury, however, noted that Brotherus (1925, p. 17) reported *O. rupestre* from N.Z. While Scott & Stone (1976, p. 228) also commented on the close similarity of N.Z. material and *O. rupestre*, Lewinsky (1984) seems to have been the first author since Brotherus to unequivocally apply the name *O. rupestre* Schwägr. to N.Z. material. Because Lewinsky had exceptionally wide experience of the genus and of the species involved, her taxonomy is followed here.

In *O. pulvinatum*, Sainsbury (1955, p. 214) hesitantly recognised var. *praeperistomatum* Sainsbury, differentiated by possession of a preperistome. Lewinsky (1984, p. 402) argued against the recognition of that variety, noting that variability in preperistome development is common in numerous species allied to *O. rupestre* and “not a character [of] ... any value on its own for separating subspecific taxa”. However, Lewinsky (1984, pp. 385–387; 396) argued that the bimodal variability of the height of leaf papillae in N.Z. material justified the recognition of a South I. endemic variety, *O. rupestre* var. *papillosum*, which is accepted here.

Distribution, ecology, and synonymy as for varieties.

Etymology: The species epithet refers to the species' epilithic substrate.

***Orthotrichum rupestre* var. *papillosum* Lewinsky, *J. Hattori Bot. Lab.* 56: 402 (1984)**

\equiv *Orthotrichum fimbriatum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 430 (1895) nom. illeg. non *Orthotrichum fimbriatum* P.Beauv. 1805

Holotype: N.Z., Mt Torlesse, *R. Brown*, BM. Isotype: H. (Cited by Lewinsky 1984.) Not seen.

Plants grey-green, \pm glaucous. **Leaf apices** erose-dentate. **Mid laminal cells** with conspicuously branched papillae (especially on young leaves) that are (5–)7–15(–18) μm tall; cells near leaf apex with papillae to 35(–65) μm .

Illustrations: Plate 17. Lewinsky 1984, figs 1, 1–3, 5; 11.

Distribution: SI: Nelson (Wairau Gorge), Marlborough (Branch River, Upper Awatere River, Charwell River, Hundalee, Kaikōura), Canterbury (Upper Clarence River, Waiau, Porters Pass, Broken River Basin, Black Birch Stream, near Twizel), Otago (near Lindis Pass, near Wanaka, Pigroot Creek). Endemic. Further locality details are provided by Lewinsky (1984, p. 405 & fig. 12).

Habitat: Mainly on non-calcareous rocks and boulders, but occasionally on *Populus* and *Salix*. Often associated with *Schistidium apocarpum* s.l. and apparently ranging from c. 600–1650 m in drier parts of the South I.

Notes: In all respects other than size of papillae and the associated glaucous colour, the variety falls within the variation of the species. The height and the much-branched nature of the upper laminal papillae are conspicuous even under the stereoscope. There seems to be no correlation between papillosity of the leaves and the nature of the calyptra hairs. When well-developed, the variety appears distinct but the distinction of the varieties primarily on the basis of laminal papillae height and the associated glaucous colour in plants with tall papillae (see discussion by Lewinsky 1984, pp. 385–387) seems arbitrary, and her histogram of papillae height and number is only weakly bimodal. A more detailed morphometric study of *O. rupestre* s.l. may show the variety to be merely a response to extreme environmental conditions and unworthy of taxonomic segregation. However, such a study is outside the ambit of this work and the varieties are recognised here as a convenience rather than from strong conviction.

Lewinsky annotated much material of this variety in N.Z. herbaria as "*O. rupestre* var. *fimbriatum*" but this combination was never published.

Etymology: The varietal epithet *papillosum* refers to the ornamentation of the laminal cells.

Orthotrichum rupestre* Schwägr., Sp. Musc. Frond. Suppl. 1(2), 27 (1816) var. *rupestre

Plants not glaucous when dry, olive-green to yellow-brown above, brown to black below. **Leaf apices** papillose but not erose. **Mid laminal cells** with papillae (1–)2–7(–9) µm tall and not or inconspicuously branched; cells near leaf apex with papillae to 22 µm.

Illustrations: Plate 17. Lewinsky 1984, fig. 8; Lewinsky 1987, figs 1–13; Vitt 1994, fig. 457; Ochyra et al. 2008, fig. 186.

Distribution: SI: Marlborough (Black Birch Range, Inland Kaikōura Range), Canterbury, Otago, Southland (near Athol). Lewinsky (1984, p. 398 characterised the N.Z. distribution of this variety as "common in Otago, scattered in Canterbury, rare in Marlborough" and provided a distribution map (fig. 9) for the country.

Nearly cosmopolitan. Mainland Australia*, North America*. Reported from Tasmania, Asia, E and S Africa, Europe, and South America by Lewinsky (1984, p. 398).

Habitat: Mainly on non-calcareous rock and boulders but occasionally on the bark of the adventive genera *Populus* and *Salix* and also recorded from *Discaria* (Lewinsky 1984, tab. 1). Ranging from c. 60 m (Berwick, Otago L.D.) to c. 2300 m (Inland Kaikōura Range). Lewinsky (1984) considered this taxon to be restricted to areas with annual rainfall of <150 cm. The most common epilithic bryophyte associates are *Schistidium apocarpum* and *Racomitrium crispulum* s.l., but other species of *Orthotrichum* can also co-occur with it on rock. When growing on bark, *O. rupestre* var. *rupestre* can be associated with *O. assimile*, *O. cyathiforme*, *O. hortense*, and *O. tasmanicum*, as well as *Calyptopogon mnioides* and *Ulota lutea*.

Lewinsky (1984, p. 396) characterised the leaves of *O. rupestre* as "sometimes partially bistratose in upper part" in her key. This is a feature used by other workers (e.g., Crum & Anderson 1981, p. 696) to characterise it in other parts of its wide geographic range. However, the bulk, and possibly all, of N.Z. collections of *O. rupestre* have entirely unistratose upper laminal cells, and it is doubtful whether Lewinsky actually observed bistratose leaves here.

Notes: Lewinsky (1984) indicated that the stomata here are restricted to mid urn and below. Lewinsky's observations agree with those of Crum & Anderson (1981) and Vitt (1994). However, material has been seen, including material determined by Lewinsky, in which the stomata are more numerous and more conspicuous above mid urn, and this pattern appears to be the norm in N.Z. material (e.g., *D. Scott* 140 from Upper Godley Valley, Canterbury L.D., CHR 613292; *A.J. Fife* 11443 from Lammermoor Range, Otago L.D., CHR 580181). This discrepancy in stomata distribution seems

to have been noted by both Dixon (1926, p. 179) and Sainsbury (1955, p. 212). The taxonomic significance of this feature is beyond the scope of this work.

Lewinsky (1987) reported that the spore diameters in Australasian (ranging from 20–26 µm) material are greater than the spore diameters in North American and European material but similar to those she observed in South American and African material.

Recognition: *Orthotrichum rupestre* var. *rupestre* bears a superficial similarity to the often equally robust *O. graphiomitrium*. Both species often bear numerous weakly emergent capsules of various ages on much-branched shoots. However, in *O. rupestre* the dry mature capsules are furrowed, and the exostome (with a well-developed preperistome) is erect-spreading when dry. The endostome of *O. rupestre* is poorly developed and the species is largely confined to rock. In *O. graphiomitrium*, by contrast, the dry mature capsules lack furrows, the exostome is reflexed when dry and lacks a preperistome. The endostome in *O. graphiomitrium* is well-developed and observable with a hand-lens in dry material, and the species is nearly always epiphytic. The nature of the stomata (superficial in both species) is of no value in distinguishing the two species.

Orthotrichum rupestre var. *rupestre*, when sterile, could easily be mistaken for a *Racomitrium*, but under the microscope the non-sinuose nature of the laminal cells readily distinguishes it. When fruiting, as it is commonly, the nature of the capsules, calyptra, etc. readily distinguish it from any *Racomitrium*.

***Orthotrichum sainsburyi* Allison, *Trans. & Proc. Roy. Soc. New Zealand* 77: 280 (1949)**

Holotype: N.Z., near Milton, on low shrubs chiefly *Carmichaelia*, K.W. Allison 996, CHR 540488! Isotypes: CHR 540495!, WELT M004771!

Plants 5–15 mm, tufted, bright green to olive-green above, yellow-brown to almost black below.

Stems erect, much branched by innovation, with well-developed rhizoids near base. **Leaves** erect or slightly flexuose and sometimes twisted around stem when dry, spreading when moist, lanceolate to ovate-lanceolate, acute or rarely acuminate, entire or sometimes with protruding cell ends near base, recurved on both sides from just above the base to shortly below the apex, 2.2–3.1(–3.5) × 0.5–0.7 mm; **upper laminal cells** thick-walled, isodiametric or ± oblong, 9.5–16.0(–21.0) × 8.0–13.0 µm, papillose with 1–2 short and mostly unbranched papillae per cell; **mid laminal cells** more regularly oblong and usually more strongly papillose; **basal interior cells** rectangular to rhomboidal, thick-walled, nodose, and porose, weakly pigmented (but often yellow at extreme base), c. 21–60 × 8–10 µm, with several (to c. 10) rows at margins of oblong or rounded-quadrate cells and these clearly papillose to within c. 100–300 µm of the leaf base; papillae of marginal cells further up the margin tall (often 9–15 µm) and either branched or unbranched. **Gemmae** absent.

Gonioautoicous. Perigonia gemmiform, conspicuous below the perichaetia and on lower stem.

Perichaetial leaves not differentiated. **Capsules** immersed to ± emergent, cylindric, strongly furrowed nearly to base and constricted below the mouth when dry (especially in older capsules), broadly ellipsoid and weakly or not furrowed when moist, 1 per perichaetium, often with several persistent on same shoot; **exothecial cells** oblong or rectangular, with ± thickened longitudinal walls, forming 16 alternate bands of relatively thin, unpigmented cells and relatively thick, more strongly pigmented cells (the latter c. 5 cells wide and forming ridges in dry capsules); **stomata** superficial, restricted to mid urn, very conspicuous. **Peristome** double; **exostome teeth** 16 or rarely paired to form 8, deep orange-red, recurved when dry, sometimes perforate along the middle line, the outer surface evenly and densely papillose, the inner surface with longitudinally oriented papillose ridges; **preperistome** absent; **endostome** well developed, with 16 variably pigmented (pale to bright orange-red) segments that are nearly as tall as the exostome, usually 1 cell wide except near base, with irregularly projecting margins, the outer surface smooth, the inner surface densely and finely papillose. **Calyptra** campanulate-mitrate, yellow or ± brown, and red-brown at apex, plicate, and ± split at base, naked or sparsely hairy (and then with hairs reaching or only slightly exceeding the top of calyptra). **Spores** globose, isosporous and 1-celled, 18–22.5 µm, papillose, often germinating within the capsule.

Illustrations: Plate 16. Lewinsky 1984, fig. 23.

Distribution: NI: Wellington (Kuratau River, near Lake Wairarapa); SI: Marlborough (Hāpuku River, Mt Fyffe), Canterbury (near Hawkwood, near Waikari, Cass, Geraldine, Lake Tekapō), Otago, Southland (near Gore). Lewinsky (1984) provides some additional records which have not been confirmed.

Endemic.

Habitat: Mainly epiphytic and particularly common on willow. Lewinsky (1984, tab. 1) records it from three genera of native and six genera of introduced woody plants. It occurs rarely on non-calcareous rock (CHR 348718 from Mt Fyffe). Often occurring admixed with other *Orthotrichum* spp., *Calypotropogon mnioides*, and *Syntrichia papillosa*. Sparse material (which is often collected) with either immature or only older capsules can be difficult to name. Occurring from near sea level (Kaitangata, Otago L.D.) to at least 640 m (near Naseby, Otago L.D.). *Orthotrichum sainsburyi* avoids high rainfall areas on the South I. and remains known from very few localities on the North I.

Recognition: The majority of fruiting specimens of *O. sainsburyi* are easily recognised by the immersed to weakly emergent, strongly furrowed capsules with very prominent superficial stomata, 16 deep orange-red, revolute exostome teeth and 16 well-developed but narrow, orange-red, endostome segments. The very distinctive peristome often permits confident naming of well-developed plants under the stereoscope. However, many herbarium specimens, including many collected by Lewinsky, are sparse and difficult to confirm without causing unacceptable damage by dissection. There is some peristome variability in this species, with some material (e.g., *J. Lewinsky 1679*, between Twizel and Lake Pūkaki, Canterbury L.D., CHR 348742) having 8 paired and erect, rather than 16 recurved, exostome teeth.

When the capsules are poorly developed or old, *O. sainsburyi* can often be recognised by tall papillae in the marginal cells near the leaf base. These papillae extend downwards in at least some leaves to within c. 200 µm (sometimes less) of the leaf base; sometimes the cells must be viewed on edge to see the papillae. Progressing up the leaf margin the papillae rapidly increase in size and, at c. 300–600 µm above the leaf base, are typically up to 9–15 µm tall and often branched. By contrast, the papillae of the marginal cells c. 300–600 µm above the leaf base in *O. hortense* are shorter (<5 µm) and unbranched.

Etymology: The epithet honours the great N.Z. bryologist G.O.K. Sainsbury (1880–1957), by profession a solicitor from Wairoa.

***Orthotrichum tasmanicum* Hook.f. & Wilson in Wilson, London J. Bot. 7: 27 (1848)**

Lectotype: Tasmania, N. Esk, Launceston, *R. Gunn 1629*, BM. Isotype: WELT M004824! (Cited by Lewinsky 1984.)

- = *Orthotrichum clintonii* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 429 (1895)
Holotype: N.Z., McKinnon's Pass, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.
- = *Orthotrichum conicorostrum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 425 (1895)
Holotype: N.Z., Puketeraki Range, Whistler River, *R. Brown*, BM. (Cited by Lewinsky 1984.)
Not seen.
- = *Orthotrichum cylindrothecum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 432 (1895)
Holotype: N.Z., Mt Torlesse, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.
- = *Orthotrichum inaequale* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 429 (1895)
Holotype: N.Z., Moa Creek, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.
- = *Orthotrichum lancifolium* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 429 (1895)
Holotype: N.Z., Port Lyttelton Hills, *R. Brown*, BM. (Cited by Lewinsky, 1984.) Not seen.
- = *Orthotrichum obliquum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 428 (1895)
Holotype: N.Z., River Taramakau, *R. Brown*, BM. (Cited by Lewinsky 1984.) Not seen.
- = *Orthotrichum austropulchellum* Müll.Hal., *Hedwigia* 37: 139 (1898) — as austro-pulchellum
Isotype: N.Z., Banks Peninsula, Birdlings Flat, *T.W.N. Beckett*, H. (Cited by Lewinsky 1984.)
Not seen.
- = *Orthotrichum beckettii* Müll.Hal., *Hedwigia* 37: 139 (1898)
Holotype: N.Z., Mt Torlesse, Little Kowai River, *T.W.N. Beckett 382*, BM. Isotype: CHR 540491! (Cited by Lewinsky 1984.)

Plants c. 10–30 mm, forming loose or dense tufts, olive-green to bright green or yellow-green above, brown to almost black below. **Stems** much branched by innovation and by dichotomy, with abundant smooth and brown rhizoids on older parts. **Leaves** spreading when moist, ± moderately crisped and contorted when dry, lanceolate to ovate-lanceolate, narrowly acute, entire, recurved on both sides from near base to near apex, 2.4–3.5 × c. 0.7–0.8 mm; **mid** and **upper laminal cells** mostly angular-

isodiametric to ± oblong, occasionally short- to long-rectangular, incrassate, unistratose, 8–14 × (6.5–)8–13 µm, with 1–2 low, branched or unbranched papillae per cell; **basal laminal cells** elongate, mostly rectangular, some ± rhomboidal, sometimes tapered at ends, thin-walled or incrassate, usually markedly nodose and porose, yellow or yellow-brown, 24–66(–75) µm, with 3–4 rows of cells at margins short-rectangular and with ± thickened transverse walls, the outermost row sometimes continuing far up the leaf margin. **Costa** as per genus. **Gemmae** absent.

Gonioautoicous. Perichaetial leaves not differentiated. **Perigonia** as per genus. **Setae** c. 3–4(–8) mm; **capsules** exserted (or emergent or rarely immersed in var. *parvithecum*), cylindric-ovoid, pale yellow-brown, strongly ribbed in the upper half or smooth (± smooth in var. *parvithecum*) and slightly constricted below mouth when dry, smooth or nearly so when moist, 1–5 per perichaetium, often of various ages persisting on a single shoot, c. 1.5–2.2 mm; **exothecial cells** elongate, weakly differentiated into 8 ± pigmented bands, each 3–4 cells wide and extending c. ½ the length of the urn; **stomata** superficial, restricted to the middle or upper half of urn, sometimes surrounded by a ring of radiating cells; **operculum** as per genus. **Peristome** double; **exostome teeth** 8 (each composed of two paired teeth, and each of the 8 teeth appearing composed of 4 columns of plates), pale yellow to deep orange, c. 300 µm × 150 µm, strongly recurved when dry, the outer surface densely covered by small, transversely oriented papillae that sometimes fuse near the base into transverse wavy lines, the inner surface with dense, longitudinally orientated papillose ridges or striae; **preperistome** absent; **endostome** with 8 hyaline segments ± equal to the teeth in length, each c. 60–75 µm wide near base and composed of two rows of cells, with a straight or zig-zag median line, appearing papillose. **Calyptra** campanulate-mitrate, covering c. ⅓ of the capsule, pleated, pale with a red-brown apex, hairy or seldom naked, the hairs smooth or somewhat papillose by protruding cell ends, yellow or hyaline, reaching ± to the top of calyptra. **Spores** globose, isosporous and 1-celled, 18–24(–32) µm, papillose.

Taxonomy: *Orthotrichum tasmanicum* is probably the most variable of the Australasian *Orthotrichum* species. Sainsbury (1955) discussed at length the difficulties he had in trying to distinguish it from other described species, and placed *O. lancifolium* and *O. beckettii* in synonymy. Lewinsky (1984) re-examined all the relevant material, concurred with Sainsbury's conclusions regarding those species and, partly following Dixon (1926, p. 176), added five more validly published N.Z. names and several illegitimate ones (including *Orthotrichum nudum* R.Br.bis., *Orthotrichum subulatum* R.Br.bis., *Orthotrichum curvatum* R.Br.bis., all hom. illeg.) to the synonym list. She also placed several Tasmanian and mainland Australian names here. Many of the names regarded as synonyms by Sainsbury and Lewinsky were based on differences of calyptra hairiness, degree of capsule ribbing, and exostome colour.

Notes: After examining several correlated features of sporophyte morphology, Lewinsky (1984, pp. 387–393) reached the taxonomic decision that material with multiple capsules per perichaetium, shorter setae, and generally smaller and less distinctly ribbed capsules deserved segregation as the var. *parvithecum*. Her decision is followed here, albeit with reservations. The difficulty in defining the varieties is discussed in greater detail below.

Distribution and ecology as for varieties.

Etymology: The species epithet refers to the Tasmanian type locality.

***Orthotrichum tasmanicum* var. *parvithecum* (R.Br.bis) Lewinsky, J. Hattori Bot. Lab. 56: 411 (1984)**

≡ *Orthotrichum parvithecum* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 27: 440 (1895)

Holotype: N.Z., Clinton Glen, head of Lake Te Ānau, R. Brown, BM. (Cited by Lewinsky 1984.) Not seen.

Setae short, 1–3.5(–4.0) mm (excluding vaginula), not exposed or exposed for ≤2 mm beyond the perichaetial leaves (best seen when moist); **capsules** usually 2–5 (occasionally 1) per perichaetium, cylindric-ovoid, immersed, emergent, or short-exserted, usually smooth throughout when dry, often persisting for several seasons, 1.0–1.5 mm.

Illustrations: Plate 18. Lewinsky 1984, fig. 17.

Distribution: NI: S Auckland (near Te Whāiti, Maunga Pōhatu, Ōpepe, Tauhara), Gisborne (L. Waikaremoana), Hawke's Bay (Tūrangakumu Hill), Taranaki (Pouākai Range, Mt Taranaki), Wellington (Ketetahi Track, near Tangiwai; SI: Nelson (Lake Cobb), Canterbury (Arthur's Pass, Bealey, Mt Thomas, Banks Peninsula), Westland (Ōtira Gorge, Kelly Range, Hōhonu Range, Adams Range,

Franz Josef), Otago (Mt Cargill, Leith Valley), Southland (Te Ānau, near Homer Tunnel, Gertrude Valley); St.

Endemic. Unknown from north of 38°S on the North I.

Habitat: An epiphyte that is particularly common on *Hoheria* spp., and is restricted to areas with high rainfall. In addition to the seven native genera recorded as hosts by Lewinsky (1984, tab. 1), *O. tasmanicum* var. *parvithecum* occurs on *Carpodetus* and the adventive genera *Larix*, *Populus*, and *Salix*. Usually associated with *Calyptopogon mnioides*; often with *O. calvum*, *O. graphiomitrium*, *Ulota lutea*, and *Metzgeria* “*flavovirescens*”.

Notes: *Orthotrichum tasmanicum* var. *parvithecum* was treated as *O. beckettii* Müll.Hal. by Dixon (1926, p. 176), while Sainsbury (1955, p. 209) considered *O. beckettii* Müll.Hal. to be inseparable from his concept of *O. tasmanicum* because of the large number of intermediate specimens. The status of *O. beckettii* Müll.Hal. was discussed at length by Lewinsky (1984, p. 414); she considered it best treated within her concept of *O. tasmanicum* var. *tasmanicum*. Lewinsky resurrected the neglected but less ambiguous name *O. parvithecum* R.Br.bis to serve as the basionym of a new combination at the varietal level.

The later name *O. beckettii* R.Br.bis., *Trans. & Proc. New Zealand Inst.* 35: 333 (1903), is an *hom. illeg. non O. beckettii* Müll.Hal., 1898] and was placed by Lewinsky as a taxonomic synonym of *O. tasmanicum* var. *parvithecum*.

Recognition: When well-developed, the var. *parvithecum* is distinctive in terms of sporophyte morphology and number, and it favours areas of higher rainfall than the var. *tasmanicum*. Lewinsky (1984, p. 414) noted no differences between the gametophytes of the two varieties (excepting a perceived weak tendency to larger, looser tufts in var. *parvithecum*). She also suggested that the sporophyte morphology and number might be influenced by environmental factors over time, even on the same shoot. Lewinsky (1984, p. 387–393) discussed variation in size and number of sporophytes and the number of archegonia per perichaetium of *O. tasmanicum* s.l., noting that their respective numbers and size varied from year to year within single populations. The morphological distinctions between the var. *tasmanicum* and var. *parvithecum* are thus not clear-cut and many collections of *O. tasmanicum* s.l. cannot be named confidently to varietal level. Occasionally material is seen illustrating a wide range of sporophyte number, setae lengths, and capsule ribbing (e.g., *J.K. Bartlett 17683* from Lake Cobb, Nelson L.D., WELT M008460). Also perplexing are specimens with multiple capsules that are large (c. 2.0 mm) and not ribbed when dry (e.g., *W. Martin 323.18* from Franz Josef Glacier, WELT M004646). While the variation within *O. tasmanicum* s.l. is intractable, Lewinsky’s segregation of the variety *parvithecum* is adopted as the most practical available solution.

The cylindrical-ovoid capsules, the usually longer (mostly 1–3.5 mm) setae and the bands of thick-walled exothelial cells of *O. tasmanicum* var. *parvithecum* distinguish it from the often associated *O. graphiomitrium*, which has shorter and fatter capsules, shorter setae (c. 1 mm), and lacks bands of thick-walled exothelial cells.

Etymology: The varietal epithet *parvithecum* refers to small capsules.

Orthotrichum tasmanicum* Hook.f. & Wilson in Wilson, *London J. Bot.* 7: 27 (1848) var. *tasmanicum

Setae 4–7 mm, exposed for 1–4 mm beyond the perichaetial leaves (best seen when moist), usually 1(–3) per perichaetium; **capsules** cylindrical-ovoid, long-exserted, mostly clearly ribbed (occasionally almost smooth) in upper half of urn when dry, 1.5–2.5 mm.

Illustrations: Plate 18. Lewinsky 1984, figs 3 (2), 4 (1), 13, 14; Lewinsky-Haapasaari & Ramsay 2006a, fig. 26 g–n.

Distribution: NI: S Auckland, Gisborne, Hawke’s Bay, Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland (Franz Josef, Lake Ianthe), Otago, Southland; St.

Australasian. Tasmania*, mainland Australia*.

Habitat: Predominantly an epiphyte and growing on a wide range of indigenous and introduced shrubs and trees; rarely collected from non-calcareous rocks. Lewinsky (1984, tab. 1) recorded this variety from 19 genera of N.Z. native and 10 genera of introduced woody plants. It is frequently associated with *Calyptopogon mnioides*, *Cryphaea* spp., *O. calvum* and other species of *Orthotrichum*, *Syntrichia papillosa*, *Tetraphidopsis pusilla*, and *Ulota lutea*.

The variety *tasmanicum* is relatively rare in the driest parts of the South I. and there are no confirmed North I. records north of c. 38°S latitude. On the Mt Arthur Range (Nelson L.D.) it is an abundant taxon in the alpine and subalpine zones; there are many collections from low elevations throughout the Wairarapa region (Wellington L.D.). On the North I. ranging from sea level to at least 1360 m elevation (Kāweka Range, Hawke's Bay L.D.) and on the South I. from near sea level (Hāpuku River, Marlborough L.D.) to at least 1650 m elevation (Mt Arthur Range, Nelson L.D.).

Recognition: *Orthotrichum tasmanicum* var. *tasmanicum* is most likely to be confused with *O. calvum*, a species in which the leaves are crisped when dry and the capsules similarly exerted. However, *O. calvum* has generally shorter (c. 1.6–2.3 vs. 2.4–3.9 mm) and more strongly contorted dry leaves than *O. tasmanicum* var. *tasmanicum*. The immersed stomata, the narrow and mostly uniseriate endostome segments, and the naked calyptrae of *O. calvum* further distinguish it from the present taxon. The two taxa often grow intermixed.

Orthotrichum graphiomitrium has leaves less contorted when dry than *O. tasmanicum* var. *tasmanicum*, as well as ovoid, immersed capsules that are smooth and narrow-mouthed when dry with shorter, thinner-walled exothecial cells.

Confusion sometimes occurs with *Ulota lutea*. That species has more strongly contorted leaves when dry, a more defined oblong leaf base and several marginal rows of ± colourless cells with strongly thickened transverse walls at the leaf base. The stomata in *U. lutea* are restricted to the base of the capsule, rather than distributed in the middle or upper half of the urn as in *O. tasmanicum* var. *tasmanicum*.

Schlotheimia Brid., *Muscol. Recent. Suppl. 2, 16 (1812)*

Type taxon: *Schlotheimia torquata* (Hedw.) Brid.

Vitt & Ramsay's (2006b) generic description was modified in preparing the following description.

Plants medium-size to robust, forming dense red-brown mats or cushions on bark or sometimes on rock. **Stems** creeping, with numerous ascendant and usually forked branches, less often unbranched, densely beset with brick-red, much-branched, and papillose rhizoids, in cross-section with thick-walled outer cells and no central strand. **Branches** ascendant, usually branched by forking, densely covered with rhizoids. **Branch leaves** imbricate and spirally twisted around the branch when dry (in N.Z. species), erect-spreading to spreading and ± rugose when moist (sometimes squarrose in non-N.Z. spp.), oblong or oblong-lanceolate, acute, mucronate or cuspidate at apex (sometimes aristate in non-N.Z. species), strongly keeled; **margins** reflexed below, plane and entire above (in N.Z. species); **upper laminal cells** elliptic to rounded-quadrate, smooth, thick-walled, arranged in oblique rows, gradually merging into the cells of the lower leaf, which are more elongate, porose, unevenly thickened, and often papillose or prorate; **cells at basal margins** not differentiated. **Costa** strong, ending just below leaf apex to excurrent, with two adaxial guide cells and abaxial stereids.

Phyllocladous. Perichaetia terminal, but often appearing lateral due to innovation, the **perichaetial leaves** longer than vegetative, but otherwise not differentiated in N.Z. species, enclosing numerous, golden, 5–6-celled paraphyses. **Male plants** dwarf and epiphyllous on ♀ plants. **Setae** elongate (in N.Z. spp.) or sometimes short, straight, or slightly curved, smooth, sinistrorse in N.Z. species; **capsules** long-exserted and cylindric (in N.Z. spp.), ribbed (strongly 8-ribbed in N.Z. species) or smooth; **exothecial cells** thick-walled, mostly short-oblong, in N.Z. species not in clearly differentiated vertical ranks; **stomata** superficial, numerous in lower portion of urn; **annulus** weakly differentiated or absent; **operculum** slenderly rostrate from a conic base. **Peristome** double; **exostome teeth** 16, linear, mostly reflexed when dry; **endostome** with 16 or 32 irregular, broad, and blunt segments that are $\frac{1}{2}$ – $\frac{2}{3}$ the length of the exostome. **Calyptra** mitrate-campanulate, large and enclosing the entire developing capsule, neither plicate nor hairy, with usually 4–6 broadly triangular and clasping lobes at base. **Spores** 1-celled, isomorphic, coarsely papillose.

Taxonomy: *Schlotheimia* is a large genus (c. 130 species *vide* Vitt & Ramsay 2006b and Brotherus 1925), predominantly distributed in the southern hemisphere. Vitt et al. (1993) considered Madagascar and eastern South America to be centres of diversity. Only two species occur in N.Z. and two others occur in Australia. *Schlotheimia funiformis* has smooth capsules and strongly differentiated perichaetial leaves and occurs in Qld and N.S.W. The widespread eastern Australian *S. brownii* is closely related to *S. knightii* but differs by appearing dull, with leaves more strongly rugose and more strongly spiralled around the branches when dry; it has mostly smooth basal laminal cells. *Schlotheimia brownii* could well be discovered in N.Z. Vitt et al. (1993) recognised five species for western Malesia, with three of those species endemic to New Guinea.

The large, campanulate, smooth calyptrae, which have triangular and clasping lobes at their base, are an obvious feature of this genus. The N.Z. species are very often fruiting and hence the calyptrae, together with the lustrous and twisted leaves and the abundant brick-red rhizoids are useful characters that permit recognition in the field. Under the microscope the arrangement of the smooth and thick-walled upper laminal cells in oblique rows are characteristic.

Vitt (1989) provided SEM micrographs of the N.Z. species, including the peristome and spores, and more detailed descriptions than are given here.

Etymology: The genus is named in honour of Ernst Friedrich von Schlotheim (1764–1832), a German palaeontologist and government administrator who was admired by Bridel.

- 1 **Branch leaves** stoutly cuspidate; **costa** of branch leaves excurrent, completely filling a long and stout cusp; **cells of the lower lamina** nearly smooth or weakly prorate on the upper abaxial surface *S. campbelliana*
- 1' **Branch leaves** mucronate; **costa** of branch leaves ending in or just below an apical mucro; **cells of the lower lamina** usually strongly prorate on the upper abaxial surface *S. knightii*

***Schlotheimia campbelliana* Müll.Hal., Syn. Musc. Frond. 1, 753 (1849)**

Type: Campbell I., *J.D. Hooker*. Not seen. (Lectotype in BM-Hooker designated by Vitt 1989.)

= *Macromitrium hectori* Mitt. in Hooker, *Handb. New Zealand Fl.*, 430 (1867)
Isotype: N.Z., Otago, *J. Hector* 57, 1864, WELT M004544!

Plants lustrous, forming dense cushions on bark or rock. **Stems** and **rhizoids** as per genus. **Branches** unbranched or branched by innovation, c. 4–10 mm. **Branch leaves** spirally twisted around branch when dry, erect-spreading when moist, oblong-lanceolate, acute or acuminate and cuspidate at apex, keeled, moderately rugose (best seen when moist), with a single plica of various length on each side of the costa, mostly 2.0–2.6 × 0.7 mm, KOH positive chestnut-red; **margins** entire, mostly narrowly recurved; **upper laminal cells** mostly oval to oblong, smooth, thick-walled, mostly 9–12 µm in greater diam., arranged in distinct oblique rows, those adjacent to costa mostly somewhat longer; **marginal cells** either slightly longer and oriented parallel to the margin or not differentiated, not forming a distinct border; **cells of the lower lamina** mostly elongate-rhomboid with ± curved walls, very thick-walled and distinctly porose, nearly smooth or weakly prorate on the abaxial surface; **cells at basal margins** not differentiated. **Costa** excurrent and filling an excurrent cusp of varying length, in lower leaf occupying c. 0.1 of the leaf width at base, and c. 40–50 µm wide near base, in cross-section as per genus.

Phylloidioicous. Perichaetia terminal (but often overtopped by innovations), with perichaetial leaves longer (to 3.5 mm) but not otherwise differentiated. **Male plants** dwarf, epiphyllous on ♀ plants, frequent, bearing 1 or more perigonia. **Setae** c. 6–8 mm, slender, straight or slightly curved; **capsules** cylindric, exserted and erect, strongly 8-ribbed, c. 2.0 mm; **exothecial cells** thick-walled, mostly short-oblong and c. 30–35 × 12–15 µm, not in clearly differentiated vertical ranks; **stomata** numerous in c. lower 1/3 of urn (apparently absent from neck), superficial; **annulus** as per genus; **operculum** with a very long and fine rostrum from a conic base, c. 2/3 the length of capsule. **Peristome** as per genus; **exostome teeth** 16, orange, ± reflexed when dry, with a distinct median line and coarse transverse or swirled striations on the outer surface; **endostome segments** less than 1/4 the exostome teeth (or longer *vide* Vitt), coarsely vertically striate. **Calyptra** as per genus. **Spores** ± spherical, coarsely papillose, 30–36 µm diam.

Illustrations: Plate 19. Vitt 1989, figs. 1–12.

Distribution: NI: Wellington (Dalefield); SI: Westland (Ōtira), Otago (*s.loc.*), Southland (near Mores Bush Scenic Reserve); St (Mt Anglem, Half Moon Bay, Pryse's Peak, Ulva I., Port Pegasus); C. Vitt (1989) recorded this species from three further localities in Southland.

Endemic.

Habitat: Little information is available as to the substrate preferences of this predominantly epiphytic species. It is documented from *Dracophyllum* sp. (on Campbell I.), "*Leptospermum*", *Weinmannia racemosa*, as well as *Dacrydium cupressinum*; it also occurs on rock. On the Southland coast near

Mores Bush, *S. campbelliana* occurred as isolated cushions among an extensive turf of *Macromitrium longirostre* on a conglomerate boulder at a site subject to salt spray. Vitt's (1989, p. 286) suggestion that it is not salt tolerant conflicts with my own limited field observations.

Ranging from near sea level to c. 400 m (on Campbell I.) and to at least 300 m on Stewart I. (Mt Anglem). *Holomitrium perichaetiale*, *Macromitrium longirostre*, and *M. retusum* are frequent associates.

Notes: The record of this predominantly southern and/or subalpine species at Dalefield (a lowland site in the Wairarapa district) is perplexing. Vitt (1989, fig. 13) recorded it from one other locality in Wellington L.D. The Dalefield specimen (*W. Martin 405.3*, CHR 587979) has some prorate lower laminal cells and its upper marginal cells are not differentiated, but in all its branch leaves the costa is excurrent to form a distinct cusp.

When well-developed, the strongly twisted leaves of the dry branches, together with a distinctly excurrent costa forming an elongate cusp, give *S. campbelliana* a characteristic look. However, the length of the apical cusp is highly variable in this species. The nature of the basal laminal cells (usually smooth or weakly prorate, but often difficult to see under a compound microscope) and the very slightly differentiated upper marginal cells are not reliable features. Collections from Mt Anglem (CHR 587978; WELT M004545) and Half Moon Bay (CHR 629620) have particularly short cusps and are ambiguous in respect of the laminal cell features. It seems best to accept these collections as somewhat aberrant *S. campbelliana*. Mixed collections of *S. campbelliana* and *S. knightii* occur and these can cause confusion.

Etymology: The epithet *campbelliana* means in honour of Campbell. However, Müller's protologue gives no indication that he used this epithet in anything other than a geographic sense, in reference to the island. The island was discovered in 1810 and named after a principal in the merchant/whaling company Campbell, Hook, & Co. (C. Meurk, pers. comm., Jan. 2016). The epithet "*campbelliensis*" would arguably have been more appropriate.

***Schlotheimia knightii* Müll.Hal., *Hedwigia* 37: 142 (1898)**

Lectotype: N.Z., "sine loco speciali," *Knight 136*, BM-Hampe (Designated by Vitt 1989.) Not seen. Paratype: N.Z. "littore australsico insulae australis prope Greymouth," *R. Helms*, 1886, NSW 848402!

Misapplications: *Schlotheimia brownii sensu* Sainsbury 1955, p. 238; *non S. brownii* Schwägr. 1826.

Plants small to robust, lustrous, forming dense cushions on bark or rock. **Stems** and **rhizoids** as per genus. **Branches** mostly branched by innovation, c. 3–20 mm. **Branch leaves** spiralled tightly or loosely around the branch when dry, erect-spreading when moist, oblong or ovate-oblong, broadly acute to obtuse, mucronate (costa mostly absent from mucro), keeled, indistinctly to moderately rugose (best seen when moist), often with a single plica of various length on each side of costa, mostly 1.5–2.5 mm, KOH negative or KOH positive chestnut-red; **margins** entire, narrowly recurved below, mostly plane above; **upper laminal cells** mostly oval to oblong, smooth, thick-walled, mostly 9–12 µm in greater diam., arranged in distinct oblique rows, juxtacostal cells mostly somewhat longer; **marginal cells** either not differentiated or slightly longer and oriented parallel to the margin but never forming a border; **cells of the lower lamina** mostly elongate-rhomboid, with very thick and ± curved walls, not or distinctly porose (often more distinctly porose adjacent to costa or at extreme base), usually strongly prorate at the upper abaxial surface of the cell but sometimes smooth or nearly so; **cells at basal margins** not differentiated. **Costa** mostly ending below the base of the mucro, occasionally short-excurrent into mucro, in lower leaf occupying less than 0.1 the leaf width and 30–45 µm wide, in cross-section as per genus.

Phylloidiocous. **Perichaetia** terminal, with perichaetial leaves scarcely differentiated or occasionally ± cuspidate. **Male plants** as per genus, frequent, c. 1 mm, the leaves acute, not mucronate. **Setae** c. 5–8 mm, slender, straight or slightly curved; **capsules** cylindric, exserted and erect, strongly 8-ribbed, c. 1.5–2.3 mm, with a short and weakly differentiated neck; **exothecial cells** thick-walled, mostly short-oblong, but some irregularly tapered at ends, mostly 30–60 µm, not in distinct vertical ranks; **stomata** relatively few, superficial, restricted to neck and the lowest ¼ or less of the urn (fewer than in *S. campbelliana*); **annulus** absent; **operculum** with a very long and fine rostrum from a conic base, c. ½–⅔ the length of capsule. **Peristome** as per genus; **exostome teeth** 16, bright orange, c. 350 µm, ± reflexed when dry, with a distinct median line and coarsely transversely striate on outer surface; **endostome** of 16 (or 32?) segments, some irregular, from a very low membrane, coarsely striate throughout or ± baculate above, c. ⅔ the height of the exostome teeth. **Calyptra** with 4–6 tightly

clasping, triangular basal lobes, c. 3 mm. **Spores** ± spherical, coarsely papillose, mostly 21–40 µm diam.

Illustrations: Plate 19. Vitt 1989, figs 14–28; Malcolm & Malcolm 2003, p. 62.

Distribution: NI: N Auckland (Ōmahuta Forest, Waipoua, Titirangi), S Auckland (Ōtānepai Bush, Gisborne (Lake Waikaremoana), Hawke's Bay (near Mōrere, Kaweka Range, Sunrise Hut, Makaroro (River?), northeast Ruahine Range), Wellington (Taihape, Erua Forest, Ōhakune, near Tangiwai, Ohau-iti River, Mt Holdsworth); SI: Nelson, Marlborough (Richmond Range), Canterbury, Westland, Otago, Southland; St. Vitt (1989, fig. 29) mapped the distribution and recorded a modest number of additional localities, particularly in the North I.

Endemic.

Habitat: While primarily growing on the bark of living trees, *S. knightii* occasionally occurs on rock (sandstone, greywacke, and ultramafics). As with many predominantly epiphytic species, epilithic occurrences seem most frequent at higher elevations. *Schlotheimia knightii* is especially frequent on *Fuscospora solandri* s.l. It also occurs on *Elaeocarpus dentatus*, *Fuscospora fusca*, *Griselinia littoralis*, *Knightia excelsa*, *Lophozonia menziesii*, and *Weinmannia* spp., and the gymnosperms *Dacrycarpus dacrydioides*, *Dacrydium cupressinum*, and *Prumnopitys taxifolium*. Frequently associated bryophytes include *Glyphothecium sciuroides*, *Holomitrium perichaetiale*, *Leptostomum inclinans*, *Lepyrodon australis*, *Macromitrium* spp., *Mesotus celatus*, *Ulota lutea*, and *Herbertus alpinus*. On the North I. from c. 260 m (Waipoua, N Auckland L.D.) to at least 1200 m (Ōhakune, Wellington L.D.); on the South I. from near sea level (Papatōwai, Otago L.D.) to 1100 m (Waingaro River, Nelson L.D.).

Notes: It is surprising that there is no potential type material in any N.Z. herbarium, including WELT, which holds many of Knight's original collections.

There appears to be some variation in response to 10% KOH solution in this species. The bulk of collections are KOH negative, but a number of herbarium collections have been seen in which the laminal cells exhibit a KOH positive chestnut-red reaction (e.g., *Martin 405.14* from Marsden Road, Greymouth, Westland L.D., CHR 617331 and *K.W. Allison 1651* from Waiau River, Southland L.D., CHR 611204). This variability does not seem to correlate with morphological differences.

Recognition: Although much N.Z. material of *S. knightii* was previously referred to *S. brownii* Schwägr. or *S. brownii* Brid. (by both Dixon 1926 and Sainsbury 1955), the Australian material of that taxon available for comparison has the leaves much more tightly spiralled around the branches when dry and is more strongly rugose than observed in *S. knightii*. The other differentiating features cited by Vitt (1989) in his key (particularly the dull leaf coloration, abrupt transition of cell size in the lamina) likewise seem to distinguish N.Z. material from *S. brownii*. Vitt's (1989) decision to differentiate the N.Z. *S. knightii* from the predominantly mainland Australian *S. brownii* Schwägr. is followed here.

Schlotheimia knightii is most likely to be confused with *Zygodon menziesii*. Compared to that species, *S. knightii* is generally a more robust and mostly epiphytic plant with larger leaves, and a much more prominently red-brown tomentum. The lower laminal cells in *S. knightii* are elongate-rhomboid with very thick and ± curved walls, usually strongly prorate, and KOH negative or KOH positive chestnut. This contrasts with the predominantly epilithic *Z. menziesii*, in which the lower laminal cells are rectangular or oblong, ± thin-walled, smooth, and KOH positive yellow. If calyptrae are present, these readily differentiate the two species.

Etymology: The specific epithet commemorates Charles Knight (1808–1891), who was N.Z.'s Auditor-General, and an avid cryptogamic botanist. Knight's lichens and some of his bryophyte collections are at Te Papa (WELT).

Ulota* D.Mohr, *Ann. Bot. [König & Sims] 2: 540 (1806)

= *Bryodixonia* Sainsbury, *Trans. & Proc. Roy. Soc. New Zealand* 75: 177 (1945)

Type taxon: *Ulota crispa* (Hedw.) Brid.

Plants mostly small, forming tufts on bark or on rock, dull, mostly green to yellow-green above and dark brown to ± black below. **Stems** erect or ascendant, simple or sparsely forked, densely leaved, beset below with smooth, brown rhizoids, in cross-section with small, incrassate cortical cells, thick-walled internal cells, and lacking a central strand. **Leaves** erect-spreading when moist, mostly strongly contorted when dry, lanceolate from a ± ovate and concave base, acute or acuminate, keeled above, entire, margins recurved (especially when dry) or ± plane; **upper laminal cells** subquadrate to irregularly rounded, often some oblate, thick-walled, unistratose or rarely bistratose, papillose, mammillose or smooth; **basal interior cells** elongate to linear, thick-walled and often porose,

coloured, usually smooth, often appearing to radiate from the base of the costa; **cells of basal margins** differentiated, \pm quadrate, pale, with thickened transverse walls, forming a basal border 1 to several cells wide. **Costa** strong, mostly ending just below apex, in cross-section lacking stereids. **Gemmae** rarely present.

Autoicous or rarely dioicous (mainland N.Z. taxa probably all gonioautoicous). **Perichaetial leaves** mostly not or only weakly differentiated, rarely strongly differentiated. **Perigonia** gemmiform, scattered below the perichaetium. **Setae** single, straight, elongate or rarely short; **capsules** \pm exserted or rarely immersed, mostly cylindric, occasionally obovoid-cylindric or rounded-urceolate, with a long, tapered neck, distinctly 8-ribbed when dry or occasionally merely puckered at mouth; **exothecial cells** \pm rectangular, in alternating bands (the thicker-walled cells corresponding with ribs in dry capsules), the longitudinal walls variably incrassate and the transverse walls usually relatively thin; **stomata** superficial, restricted to the neck and lower portion of urn, usually numerous; **annulus** weakly differentiated; **operculum** rostrate from a convex or conic base. **Peristome** usually double; **exostome teeth** 16, usually paired, broadly triangular and obtuse, with a median zig-zag line clearly visible on both surfaces, mostly reflexed when dry; **endostome** arising from a low membrane, the segments 8, rarely 16, or lacking; **preperistome** lacking. **Calyptra** mitrate-campanulate, lobed at base, mostly densely hairy. **Spores** unicellular or rarely multicellular.

Taxonomy: The Australasian species of *Ulota* were treated by Malta (1933). Malta's treatment was adopted, with minor changes, by Sainsbury (1955). In my opinion, both Malta's and Sainsbury's species concepts are excessively narrow and fewer species are recognised in this treatment.

Ulota is a moderately large genus occurring in temperate to cool regions of both hemispheres; it is absent from tropical regions. Smith (2004) indicated that the genus includes "about 35 species". These occur predominantly on bark, but some species occur on rock. Four indigenous species are recognised in N.Z., with a fifth, *U. phyllantha*, known only from Macquarie I. and apparently adventive there. This represents a substantial reduction compared to the nine species (plus one atypical variety and one species of *Bryodixonia*) recognised by Sainsbury (1955).

Etymology: According to Crum & Anderson (1981) the generic names alludes to the curled leaves in some of the species in the genus.

- | | | |
|----|---|--|
| 1 | <p>Apical (immature) leaves bearing conspicuous red-brown gemmae in clusters at their tips; dioicous and sterile (in Australasia); occurring mostly on rock (rarely on wood or peat), maritime and known regionally only from Macquarie I. <i>U. phyllantha</i></p> | |
| 1' | <p>Apical leaves lacking conspicuous gemmae; gonioautoicous and usually fruiting; mostly epiphytic, rarely on rock, not restricted to maritime areas and widespread in N.Z. 2</p> | |
| 2 | <p>Perichaetial leaves much longer than vegetative leaves; calyptra small, enclosing only the operculum and mouth of the developing capsule; capsules immersed; endostome absent <i>U. perichaetialis</i></p> | |
| 2' | <p>Perichaetial leaves not or weakly differentiated from vegetative leaves; calyptra enclosing the operculum and most or all of the developing capsule; capsules exserted; endostome present 3</p> | |
| 3 | <p>Spores multicellular and large (>65 μm, mostly 75–90 μm); cells of basal margins forming a border c. 3–4 cells wide; capsules narrowly obovoid when moist; endostome with 16 broad (but often fragile) segments <i>U. membranata</i></p> | |
| 3' | <p>Spores unicellular and smaller; cells of basal margins forming a wider border; capsules more or less cylindric when moist; endostome with 8 (rarely 16) narrow segments 4</p> | |
| 4 | <p>Vegetative leaves not or moderately crisped when dry; stems creeping and much branched; endostome segments 1 cell wide near base; stomata numerous in upper neck and lower portion of urn <i>U. viridis</i></p> | |
| 4' | <p>Vegetative leaves strongly crisped when dry; stems erect and sparsely branched; endostome segments usually (at least some in each capsule) >1 cell wide, and with a median line for at least part of their length; stomata restricted to neck, not extending to capsule urn <i>U. lutea</i></p> | |

***Ulotia lutea* (Mitt. in Wilson) Mitt., *J. Proc. Linn. Soc., Bot.* 4: 77 (1859)**

- ≡ *Orthotrichum luteum* Mitt. in Wilson, *Bot. Antarct. Voy. III. (Fl. Tasman.) Part II* 184 (1859)
Type material: Tasmania, Cumming's Head, Western Mountains, *W. Archer*, HO 71909!
- = *Ulotia weymouthii* Venturi in Rodway, *Pap. & Proc. Roy. Soc. Tasmania* 1912: 114 (1913)
Type material: Tasmania, Mt Wellington, 9 Dec. 1890, *W.A. Weymouth* 669, CHR 629628!
Same locality, 6 Mar. 1891, *W.A. Weymouth* 615, CHR 629629!
- = *Ulotia bellii* Malta, *Acta Horti Bot. Univ. Latv.* 7: 15 (1933)
Holotype: N.Z., Lake Harris, on *Discaria*, Feb. 1895, *W. Bell*, H-Brotherus 4337019!
- = *Ulotia breviseta* Malta, *Acta Horti Bot. Univ. Latv.* 7: 9 (1933)
Lectotype: N.Z., "Mungatui," [Maungatua?] Jan. 1888, *W. Bell*, H-Brotherus 433701! The *W. Bell* collection is apparently the only one of three syntypes present in the Brotherus herbarium and is the source of most of Malta's illustrations. The collection most likely originated from Maungatua, a small mountain c. 25 km west of Dunedin.
- = *Ulotia laticiliata* Malta, *Acta Horti Bot. Univ. Latv.* 7: 11 (1933)
Lectotype: Tasmania, S.E. Coast, Recherche Bay, Moss Glen, at sea level, on apple trees, 17 Jan. 1911, *W.A. Weymouth* 2487, H-Brotherus 4336012! Isolectotype: HO 71749!
- = *Ulotia bellii* var. *longicolla* Malta, *Acta Horti Bot. Univ. Latv.* 7: 16 (1933)
Isotype: N.Z., South I., Jan. 1902, *R. Brown s.n.*, WELT M005751!

Misapplications: *Ulotia pygmaeothecia sensu* Sainsbury 1955, p. 224

Ulotia rufula sensu Sainsbury 1955, p. 224

Plants yellow- to brown-green above, dark brown below. **Stems** sparsely branched by forking. **Leaves** erect-spreading when moist, strongly contorted when dry, lanceolate from a strongly defined, ovate or oblong and pigmented base, strongly constricted and reflexed at mid leaf margins, mostly crenulate, c. 1.0–2.5 × 0.4–0.5 mm (under cover slip); **upper laminal cells** rounded, ± isodiametric, short-elliptic, usually some oblate, mostly 9–12 µm in greater diam., unistratose, mammillose (usually with a single mammilla over the lumen); **basal interior cells** apparently smooth, yellow to orange, radiating from costa; **cells of basal margins** pale, with strongly thickened transverse walls, forming a distinct border 4–12 (rarely fewer) cells wide and extending nearly to the top of the leaf base. **Costa** ending shortly below the leaf apex. **Gemmae** absent.

Gonioautoicous. Perichaetial leaves not differentiated. **Setae** elongate or rarely short, strongly dextrose; **capsules** exserted or rarely merely emergent, cylindrical, strongly 8-ribbed when dry, c. 1.4–1.7 mm; **exothecial cells** as per genus; **stomata** restricted to neck; **operculum** rostrate from a conic base. **Peristome** double, pale; **exostome teeth** paired, reflexed when dry, broadly triangular, with a median zig-zag line clearly visible on both surfaces, inserted close to capsule mouth, papillose-striolate; **endostome segments** 8, c. 0.6–0.8 the height of the teeth, >1 cell wide and variable in width, a median line present and well-developed or ± absent, often variable in a single capsule. **Calyptra** campanulate, often becoming split on 1 side with age, densely hairy, enclosing the operculum and the urn of the developing capsule. **Spores** unicellular, spherical, thick-walled, incrassate, (30–)36–42 µm, papillose.

Illustrations: Plate 20. Malta 1933, figs 1 a–b, d–e; 2–3; Meagher & Fuhrer 2003, p. 175; Malcolm & Malcolm 2003, p. 70.

Distribution: NI: S Auckland, Gisborne, Hawke's Bay (Makaretu South), Taranaki, Wellington; SI: Nelson, Marlborough (Mt Stokes), Canterbury, Westland, Otago, Southland; St.

Australasian. Tasmania*. Scott & Stone (1976) recorded it from mainland Australia (Victoria).

Habitat: Most commonly on southern beech (*Lophozonia menziesii* and *Fuscospora solandri* s.l.), *Hoheria*, and divaricating species of *Coprosma*, but also on many other woody genera including *Aristolelia*, *Discaria*, *Dracophyllum*, *Fuchsia*, *Griselinia*, *Kunzea*, *Leptospermum*, and *Olearia*. Also on exotic trees and shrubs including *Betula*, *Carmichaelia*, *Quercus*, *Pinus*, *Salix*, and *Sambucus*, and rarely on rock. Mostly occurring on twigs and small branches. Frequently associated with *Calyptopogon mnioides*, *Dicnemon* spp., *Leptostomum inclinans*, *Ulotia perichaetialis*, and *U. viridis*. Ranging from 240 m (Wainuiomata Valley, Wellington L.D.) to at least 1250 m (Mt Taranaki, Taranaki L.D.) on the North I. and from c. 50 (near Berwick, Otago L.D.) to c. 1300 m (Avalanche Peak, Canterbury L.D.) on the South I.

Notes: *Ulota lutea* is both the most common and by far the most variable species of the genus in N.Z. The strongly contorted dry leaves, the cylindric and strongly ribbed capsules, and the lack of differentiated perichaetial leaves normally provide sufficient means of recognition for this widespread species.

Malta (1933) presented an excessively narrow concept of *U. lutea*. He stated in the introduction of his survey that this species could be separated from its congeners on the basis of leaf form alone. This is an oversimplification, and almost certainly the result of examination of too few specimens. The abruptness of the narrowing above the leaf base and the degree of marginal recurvature are variable in *U. lutea*, and these features are inadequate to permit the differentiation of the segregate species recognised by Malta.

Examination of endostomes from a range of N.Z. specimens shows segment development varies markedly in populations, and even in a single capsule (e.g., *Hodgson M84*, CHR 556094). In all but very few *U. lutea* specimens a median line is present for part of the length of some segments in each capsule. Malta's (1933, p. 4) separation of *U. laticiliata* from *U. lutea* based on the relative width and degree of development of a median line in the endostome segments is rejected here.

Sainsbury (1955, p. 220) noted the occurrence of rudimentary "intermediate" endostome segments in some material of *U. lutea*. Such occurrences (i.e., an endostome with 16 segments) appear to be very rare; the only plants seen with "intermediate segments" are in the holotype of *U. bellii* from Lake Harris, Southland L.D. However, this feature varies even in the type of *U. bellii* and I could locate only eight segments in one of the two capsules examined closely. Malta himself (*in herb.*) considered the type of *U. bellii* (in H-Brotherus) to include plants of *U. lutea*. *Ulota bellii* is not worthy of taxonomic recognition.

In all material of *U. lutea* examined, the peristome teeth are inserted close to the capsule rim and the modest variability of this feature is insufficient to allow the drawing of taxonomic distinctions. Setae length also varies considerably across a range of specimens. These are the features emphasised by Malta (1933, p. 9) in his protologue of *U. breviseta*, which is here also considered a synonym of *U. lutea*.

Orthotrichum luteum Mitt. *in* Hook.f. & Wilson (the basionym of the present species) is based on two syntypes. A portion of one of the syntypes, annotated by Mitten, is present in HO. Material of the other syntype has not been seen. A lectotype should be designated in the Mitten herbarium at NY. The HO type material (presumably an isosyntype) has a small number of older capsules in which endostome detail cannot be observed. The exserted capsules are borne on rather short (c. 3 mm) setae.

Only one of the several syntypes of *U. laticiliata* cited by Malta (1933, p. 11) appears to be represented in the Brotherus herbarium, from which Malta borrowed the bulk of the specimens used for his revision of Australasian *Ulota* (see p. 3). This Tasmanian specimen (*W.A. Weymouth 2487*), conforms with Malta's description and is also the material upon which he based his peristome drawings (Malta 1933, fig. 5). It is therefore selected as lectotype. Paratypes of *U. laticiliata* from Mt Manuoha (Gisborne L.D.) and Dawson Falls (Taranaki L.D.) are present in CHR and WELT.

The single specimen from an unspecified Marlborough locality (*J. McMahon*, Jan. 1936, WELT M021487!, CHR 576219!) referred to the South American *Ulota rufula* (Mitt.) A. Jaeger by Dixon (Sainsbury 1955, p. 225) is considered here to be aberrant *U. lutea*. It has capsules emergent or short-exserted beyond the perichaetial leaves rather than exserted on a long seta as in more representative material of *U. lutea*. In terms of both its gametophytic and sporophytic morphology, it is indistinguishable from material of so-called *U. breviseta*. The McMahon collection thus falls in the range of continuous variability of *U. lutea* in N.Z.

Sainsbury (1955, p. 224) recorded the southern South American species *U. pygmaeothecia* (Müll.Hal.) Besch. from Mt Taranaki. Three duplicates of Sainsbury's collection (*G.O.K. Sainsbury 777*) have been examined but no well-developed sporophytes are present. The overall habit of the sterile plants is representative of *U. lutea*. The vegetative leaves of some shoots have fewer rows of basal marginal cells than is usual for *U. lutea*, but on other shoots the basal marginal cells form 5–6 rows of hyaline and thick-walled cells. Although spores (reportedly 20–24 µm diam.) have not been seen, the weight of available evidence does not support the recognition of *U. pygmaeothecia* as part of the N.Z. flora.

Type material (which was not examined for this study) of five species described by Robert Brown in *Orthotrichum* between 1895 and 1903 (in *Transactions & Proceedings N.Z. Institute*, vols. 27 & 35) were placed by Dixon (1926, p. 180) in the synonymy of *Ulota lutea*. These species are *O. erectum* R.Br.bis, *O. gracillimum* R.Br.bis, *O. parvulum* R.Br.bis, *O. tortulosum* R.Br.bis, and *O. otiraense* R.Br.bis. No purpose would be served by questioning these placements.

Recognition: *Ulota lutea* appears to differ from the widespread northern hemisphere species *U. crispa* by having consistently larger spores and generally longer setae. However, the relationship

between these species could be beneficially examined in a wider context, perhaps using non-morphological characters.

Confusion in the field can occur between the present species and both *U. membranata* and *U. viridis*. Distinguishing features are discussed under those species.

Confusion occasionally occurs between *U. lutea* and *Orthotrichum tasmanicum* var. *tasmanicum*. *Ulota lutea* has more strongly contorted leaves when dry, a more defined oblong leaf base and several marginal rows of \pm colourless cells with strongly thickened transverse walls at the leaf base. The stomata in *U. lutea* are restricted to the base of the capsule, rather than occurring in the middle or upper half.

Etymology: The epithet *lutea* means yellow, and is apt considering the frequently yellow-green coloration of this species.

***Ulota membranata* Malta, Acta Horti Bot. Univ. Latv. 7: 18 (1933)**

Holotype: Tasmania, West Coast, Comet-Dundas Road, on wood, 17 Oct. 1893, W.A. Weymouth 1652, H-Brotherus 4336011! Isotype: HO 71928!

Plants yellow-green, becoming brown below, in tufts. **Stems** branched, to at least 15 mm. **Leaves** erect-spreading when moist, strongly contorted when dry, narrowly lanceolate from an ovate and pigmented base, acuminate, abruptly constricted and often narrowly reflexed above the base, entire, mostly 1.6–2.1 \times 0.4–0.45 mm (under cover slip); **upper laminal cells** mostly oval or short-elliptic, some oblate, mostly 8–12 μ m in greater diam., unistratose, mostly with a single mammilla over the lumen on both surfaces; **basal interior cells** linear-rhomboidal, smooth, yellow to orange, becoming porose towards leaf base, radiating weakly from the costa and gradually merging with cells of the upper lamina; **cells of basal margins** pale, forming a border c. 3–4 cells wide, extending nearly to the top of the base in most leaves. **Costa** ending shortly below the leaf apex. **Gemmae** absent.

Gonioautoicous. Perichaetial leaves not differentiated or slightly less contorted than vegetative leaves when dry. **Perigonia** gemmiform, at base of perichaetium. **Setae** well-developed, c. 3–4 mm, weakly dextrorse when dry; **capsules** exserted, narrowly obovoid when moist, oblong-cylindric and 8-ribbed when dry, with a long, gradually tapered, and \pm poorly defined neck, c. 2 mm; **exothecial cells** and **stomata** as per genus; **operculum** rostrate from a conic base, c. 0.5 mm. **Peristome** double; **exostome teeth** paired, broadly triangular, c. 300 μ m, pale, with a median zig-zag line clearly visible on both surfaces, papillose-striolate, inserted very close to the capsule mouth, reflexed or \pm erect when dry; **endostome segments** 16, c. $\frac{1}{2}$ the height of the teeth, fragile (often not observable in N.Z. material), \pm smooth, broad and irregular in outline, with a median zig-zag line of variable length; **preperistome** variably developed, sometimes rudimentary in N.Z. material. **Calyptra** campanulate, lacinate at base, densely hairy, enclosing nearly the entire developing capsule. **Spores** multicellular, mostly c. 6–8-celled, spherical to ovoid, mostly (65–)75–90(–120) μ m in greater diam., obscurely papillose, sometimes germinating in capsule.

Illustrations: Plate 21. Malta 1933, figs 1c, 8, 9; Sainsbury 1955, pl. 35, fig. 2.

Distribution: NI: Taranaki (Mt Taranaki), Wellington (several localities on Mt Ruapehu, Mauriceville, Ruahine Range); SI: Nelson (Iron Ridge, Mt Arthur Range, Anatoki River), Canterbury (Arthur's Pass including Avalanche Peak), Southland (Mt Burns).

Australasian. Tasmania*.

Habitat: Most records of this apparently uncommon species are from southern beech, probably *Fuscospora solandri* s.l. It occurs both on trunks and on small branches. One collection each from *Dracophyllum* sp. and *Veronica glaucophylla* has been seen. Ranging from c. 1125 to 1300 m on the North I. and from 850 to 1300 m on the South I. Apparently restricted to areas of high rainfall and often growing with *U. viridis*, *Frullania* spp., and *Menegazzia nothofagi*.

Notes: *Ulota membranata* is distinctive by its narrowly obovoid capsules when moist, its large, multicellular spores, and its endostome of 16 irregular and fragile segments. A preperistome may or may not be present. The peristome detail here (Plate 21, D) does not illustrate the papillose-striolate ornamentation of the paired exostome teeth.

Although Malta (1933, p. 18) cited two N.Z. specimens in his protologue, he indicated (p. 19) that he considered the Tasmanian specimen (W.A. Weymouth 1652) to be the type. The HO isotype has multicellular spores mostly 75–81 μ m, endostome segments nearly smooth, irregular in outline and mostly with a median line (but some lacking a median line and only one cell wide), and a rather

conspicuous preperistome. Malta's fig. 8, which illustrates a well-developed preperistome extending c. $\frac{1}{3}$ the teeth height, is an accurate representation of the type collection.

In N.Z. material, preperistome development is variable, and in most collections it is either weakly developed or apparently lacking (e.g., *A.J. Fife* 7543 from Mt Arthur Range, CHR 438834; *G.O.K. Sainsbury s.n.*, 10 Jan. 1945 from Mt Taranaki, WELT M021482). Tasmanian material (*W.A. Weymouth* 1653, packeted with type in HO) with a weakly developed preperistome has also been seen. All the N.Z. material examined has a stronger constriction above the leaf base than illustrated by Malta (1933, fig. 9). The margin near the constriction may be either narrowly reflexed or nearly plane.

Recognition: *Ulota membranata* can be difficult to distinguish from the more widespread *U. viridis*, particularly when the two species are growing mixed. The leaves of *U. membranata* are generally longer (1.6–2.1 vs 1.2–1.5 mm) and more strongly contorted when dry and the capsules decidedly more obovoid when moist. The large multicellular spores of the present species can usually be readily differentiated from the much smaller unicellular spores of *U. viridis*, even under the stereoscope.

Confusion is also possible with the more widespread *U. lutea*, another species with strongly contorted leaves when dry. However, the obovoid capsules of the *U. membranata* are usually readily distinguished from the more cylindrical and more strongly ribbed capsules of *U. lutea*, and microscopic examination of the spores and endostome features will easily separate the two.

Etymology: The epithet *membranata* refers to the presence of a preperistome “formed by a somewhat irregular, slightly striated membrane sometimes reaching as high as the middle of the teeth” (Malta 1933, p. 18).

***Ulota perichaetialis* (Sainsbury) Goffinet in Goffinet & Vitt, *Bryol. Twenty-first Cent.* 153 (1998)**

≡ *Bryodixonia perichaetialis* Sainsbury, *Trans. & Proc. Roy. Soc. New Zealand* 75: 177 (1945)

Lectotype: N.Z., Mt Egmont, Fanthams Peak Track, 16 Jan. 1945, G.O.K. Sainsbury 6005, WELT M005688! Isolectotype: CHR 570720!

Plants yellow-green above, becoming brown below, tufted or forming large cushions. **Stems** branched by innovation, to c. 30 mm, often ± denuded below. **Leaves** erect-spreading when moist, strongly contorted when dry, narrowly lanceolate from an ovate and pigmented base, narrowly acuminate, constricted and reflexed at mid leaf margins, entire or ± crenulate, 2–3 mm × 0.4–0.5 mm (under cover slip); **upper laminal cells** rounded, ± isodiametric, short-elliptic, usually some oblate, mostly 7–10 μm in greater diam., unistratose, mammillose (apparently on both surfaces); **basal interior cells** linear-rhomboidal, smooth, yellow to orange, radiating very weakly from the costa; **cells of basal margins** pale, forming a border mostly 6–8 cells wide, but merging ± gradually with the interior cells, extending nearly to the top of the base in most leaves. **Costa** ending shortly below the leaf apex.

Gonioautoicous. Perichaetial leaves strongly differentiated, erect when moist and dry, lanceolate, mostly with 1 elongate pleat on each side of the costa, c. 4.5 mm. **Perigonia** gemmiform, at base of perichaetium. **Setae** c. 0.2 mm; **capsules** ± sessile, deeply immersed, broadly obovoid, strongly 8-ribbed when dry, c. 2 mm; **exothecial cells** and **stomata** as per genus; **operculum** rostrate from a convex base, 0.4–0.6 mm long. **Peristome** single; **exostome teeth** paired, broadly triangular, pale, with a median zig-zag line clearly visible on both surfaces, inserted at the capsule mouth, papillose-striolate, strongly reflexed when dry; **endostome** absent. **Calyptra** campanulate, lacinate at base, moderately hairy, enclosing only the operculum and mouth of the developing capsule. **Spores** unicellular, green, spherical, thick-walled, mostly 42–48 μm, finely baculate-papillose.

Illustrations: Plate 22. Sainsbury 1955, pl. 36, fig. 1.

Distribution: NI: Taranaki (Mt Taranaki – several locations); SI: Nelson (Scarlett Range, Mt Zetland, Allen Range, Paparoa Range), Canterbury (summit of Arthur's Pass, Bridal Veil Track, Hawdon River), Westland (Pegleg Creek, Kelly Range), Southland (Percy Saddle).

Endemic.

Habitat: On twigs and small branches of *Lophozonia menziesii* and sometimes abundant on branches of *Hoheria glabrata*. In the mountain ranges of Nelson it often occurs at the margins of isolated copses of *Lophozonia menziesii* near the tree line. Also occurring on *Carmichaelia* sp., *Coprosma* spp. (including *C. rugosa*), and *Dracophyllum longifolium*. Frequently associated cryptogams include *Calyptopogon mnioides*, *Leptostomum inclinans*, *Orthotrichum graphiomitrium*, *Ulota lutea*, and

Menegazzia nothofagi. On the South I. ranging from c. 840 to 1230 m (at Scarlett Range, Nelson L.D.) but apparently to c. 1325 m on the North I. (at Mt Taranaki, where it is known from several localities).

Notes: In at least some herbarium material (e.g., *A.J. Fife 7409*, Pegleg Creek, CHR 406532) the conic base of the operculum becomes inverted (convex) when dry and thus gives a confusing impression of the operculum form. The operculum in most, probably all, populations is rostrate from a convex base. The distortion of the dried opercula in herbarium material may account for Goffinet & Vitt's (1998) description of the opercula as flat. Sainsbury's (1955, pl. 36) illustration of the operculum is also misleading.

Sainsbury (1945) questioned the provenance of the J.H. McMahon collection, which he cited as a syntype of this species. Sainsbury (1945) suggested that the McMahon collection (WELT M005691; CHR 629944) was "in all probability" from Mt Egmont (Mt Taranaki). Occurrence of this species in Marlborough L.D. requires confirmation, since it otherwise occurs only in areas of high rainfall.

Since Sainsbury (1945) designated two syntypes for this species, Goffinet's (in Goffinet & Vitt 1998) interpretation of the portion of *G.O.K. Sainsbury 6005* in the Sainsbury herbarium as the holotype of this species is incorrect, and the selection of a lectotype (done here) is required.

Recognition: *Ulotia perichaetialis* is the most easily recognised species of the genus in our flora. Goffinet & Vitt (1998) noted that this species is readily distinguished from its congeners by having highly differentiated perichaetial leaves, a diminutive calyptra, and an immersed capsule.

Etymology: The epithet *perichaetialis* refers to the enlarged perichaetial leaves that are a feature of this species.

Ulotia phyllantha* Brid., *Muscol. Recent. Suppl. 4, 113 (1818)

≡ *Plenogemma phyllantha* (Brid.) Sawicki, Plášek & Ochyra, *Acta Mus. Siles. Sci. Nat.* 64: 172 (2015)
Type: Germany. Not seen.

Minor elements in the following description are derived from North American specimens.

Plants relatively robust, yellow-brown. **Stems** sparsely branched by forking, to c. 30 mm in N.Z. material. **Leaves** erect-spreading when moist, strongly contorted when dry, broadly lanceolate, acute, sometimes narrowly acute, not or scarcely differentiated at base, with margins recurved below, mostly plane above, entire, (2.4–)2.8–3.0(–3.5) × 0.5–0.6 mm (under cover slip); **upper laminal cells** irregularly rounded, very thick-walled, mostly 9–12 µm in greater diam., unistratose, obscurely or clearly papillose (best seen in profile); **basal interior cells** elongate, apparently smooth or prorate, yellow, strongly porose, not radiating from the costa; **cells of leaf basal margins** differentiated in 1 or few rows, with weakly thickened transverse walls, forming a narrow and weak border. **Costa** stout, ending in the apex or swollen apically and excurrent, usually bearing multicellular gemmae (if gemmae fallen, the costa apex appearing cristate). **Gemmae** usually present in a dense, ± globose cluster at the costal apex of young leaves, linear to weakly fusiform, red-brown, mostly 165–240 µm, with several (6–)8–10 transverse septa, often fallen and abundant among leaves, occasional germinating *in situ*.

Reportedly dioicous. Sporophytes unknown from Macquarie I.

Illustrations: Plate 22. Crum & Anderson 1981, fig. 342; Seppelt 2004, fig. 83.

Distribution: M.

Adventive, or perhaps self-introduced. Patagonia*. Reportedly widespread in maritime areas of northern Europe, western and eastern North America, and eastern Asia (Crum & Anderson 1981).

Habitat: The Macquarie I. collections seen have no substrate information. Seppelt (2004) stated that most collections are from rock, while some are from "artificial substrates such as weathered rope and old weathered timber" as well as occasionally from "soil or plant roots and litter". Crum & Anderson (1981, p. 721) characterised its habitat in eastern North America (where it is "rare and localised") as "on cliff or boulders, less commonly on the bark of trees, near the sea and often wetted by sea spray". Most Macquarie I. collections are from near sea level, but Seppelt (2004) recorded it occasionally from sites over 200 m elevation. While it is possibly an adventive species on Macquarie I., the possibility that it is self-introduced from Patagonia is equally plausible. Seppelt noted it was first recorded from Macquarie I. in 1978 and that it is more abundant on the west coast of that island.

Notes: The few Macquarie I. collections studied have upper laminal cells less obviously papillose than North American material (*A.J. Fife 2016* from Newfoundland, CHR 615333). Seppelt (2004) also illustrated more obviously papillose material than I have studied. The pale cells of leaf basal margins

in this species are much less differentiated than in other Australasian species of *Ulota*; the basal border here is narrow (mostly a single row of cells) and obscure.

The eventual discovery of *U. phyllantha* on other subantarctic islands in the N.Z. botanical region seems likely.

Etymology: According to Crum & Anderson (1981, p. 721) this species was “named for brood bodies presumably resembling paraphyses of an inflorescence”.

***Ulota viridis* Venturi in Brotherus, Öfvers. Finska Vetensk.-Soc. Förh. 35: 43 (1893)**

Isotype: Tasmania, Mt Wellington, Oct. 1890, *W.A. Weymouth* 901, HO 71922!

= *Ulota anceps* Venturi in Brotherus, Öfvers. Finska Vetensk.-Soc. Förh. 35: 42 (1893)

Isotype: Tasmania, Mt Wellington, 17 Mar. 1893, *W.A. Weymouth* 900, HO 71729!

= *Ulota viridis* var. *adpressa* Mitt. ex Malta, *Acta Horti Bot. Univ. Latv.* 7: 22 (1933)

Lectotype: N.Z., Otago, Mt Bonpland, Jan. 1890, *W. Bell*, H-Brotherus 4337001!

Isolectotype: CHR 570721!

= *Ulota dixonii* Malta, *Acta Horti Bot. Univ. Latv.* 7: 19 (1933)

Lectotype: Tasmania, Hartz Mtns, on limbs of tree, alt. 3000 ft. 7 Jan. 1908, *W.A. Weymouth* 2299, H-Brotherus 4336006 *pro parte*!

= *Ulota novae-seelandiae* Sainsbury, *Bull. Roy. Soc. New Zealand* 5: 223 (1955)

Holotype: N.Z., Fantham's Peak Track, Mt Egmont, Taranaki; on bark of subalpine scrub; 16 Jan. 1945, *G.O.K. Sainsbury* 10443, WELT M005757! Isotypes: CHR 570719!, WELT M005862!

Plants yellow-green above, pale or yellow-brown below. **Stems** much forked and ± creeping. **Leaves** erect-spreading when moist, weakly contorted and often ± spiralled around stem when dry, lanceolate from an ovate and pigmented base, narrowly or broadly acute, usually narrowly recurved near mid leaf on 1 or both sides, mostly 1.5–2.2 × 0.3–0.5 mm (under cover slip); **upper laminal cells** rounded, ± isodiametric or short-elliptic, usually some oblate, mostly 9–12 µm in greater diam., unistratose, mammillose (but mammillae usually visible only in profile); **basal interior cells** apparently smooth, yellow, oriented parallel to the costa; ± linear, porose and ± sinuose, mostly 20–30 µm long; **cells of basal margins** pale, with strongly thickened transverse walls, forming a distinct border mostly 4–6 cells wide and extending nearly to the top of the leaf base. **Costa** ending shortly below the leaf apex. **Gemmae** absent.

Gonioautoicous. **Perichaetial leaves** slightly larger than vegetative, the innermost erect and ± clasping the setae, mostly c. 2.5 mm. **Setae** elongate, c. 3.5–4.0 mm, dextrorse; **capsules** exserted, oblong-cylindric, strongly 8-ribbed when dry, c. 1.8–1.9 mm; **exothecial cells** as per genus; **stomata** numerous, extending to the lower portion of urn; **operculum** rostrate from a conic base. **Peristome** double; **exostome teeth** paired, broadly triangular, with a median zig-zag line clearly visible on both surfaces, inserted close to capsule mouth and c. 240–270 µm long, papillose-striolate (ornamentation not shown in illustration), reflexed when dry; **endostome segments** fragile, 8, c. 0.8 the height of the teeth, narrow, predominantly 1 cell wide, smooth or weakly ornamented (not accurately illustrated here). **Calyptra** campanulate, becoming split on 1 side with age, densely hairy, enclosing the operculum and urn of the developing capsule. **Spores** unicellular, spherical, green, (24–)27–36(–42) µm, coarsely papillose.

Illustrations: Plate 21. Malta 1933, figs 1 i–k, 11, 12.

Distribution: NI: S Auckland, Taranaki, Hawke's Bay (South Makaretu), Wellington (Mt Ruapehu, Mt Tongariro); SI: Nelson (St Arnaud Range, Rahu Saddle, Paparoa Range), Canterbury, Westland (Croesus Track, Ōtira, Ferguson Creek), Otago, Southland (Borland Burn, Lake Manapōuri, Gertrude Valley); St.

Australasian. Tasmania*; recorded from Victoria by Scott & Stone (1976, p. 244).

Habitat: Most often on trunks of *Fuscospora solandri* s.l. but also on *Lophozonia menziesii*; occasionally occurring on small branches. Also on *Coprosma* spp., *Discaria toumatou*, *Dracophyllum* spp., *Leptospermum scoparium*, *Phyllocladus alpinus*, and *Cordyline australis*, and the exotic genera *Pinus*, *Betula*, *Larix*, and *Quercus*; very rarely occurring on rock. On the South I. occurring from c. 250–1400 m. Frequently associated with *Macrocoma tenue*, *Ulota lutea*, and *U. membranata*, a range of hepatics including species of *Radula*, *Frullania*, and *Metzgeria*, and *Menegazzia nothofagi*.

Although not restricted to eastern regions, this species is more common and better developed in drier parts of the country. More than 75% of the specimens in CHR are from Canterbury and Otago L.D., where it is widespread and relatively common.

Notes: The creeping and much-branched stems of this species, together with the relatively small leaves with a weakly-defined ovate base, are the most distinctive and reliable features of the present species. The creeping and branched habit is in many ways suggestive of a *Macromitrium*, but the distinct border of pale cells with strongly thickened transverse walls at the leaf base preclude confusion with species of *Macromitrium*. The very narrow endostomal segments in *U. viridis* can often be observed under the stereoscope in dry material. The peristome detail here (Plate 21, I) does not illustrate the papillose-striolate ornamentation of the paired exostome teeth.

The type material of *U. novae seelandiae* Sainsbury lies within the range of continuous variation of *U. viridis* with respect to vegetative leaf size and spore dimensions. The type collection of *U. novae-seelandiae* contains few capsules; in one the capsule spores were found to be 34–42 µm diam. Another capsule (of only two seen) in the type has mostly malformed spores, some persisting in tetrads. Similar malformed spores have been seen in *A.J. Fife 9912* (CHR 512694) from Arthur's Pass. In habit Sainsbury's type is indistinguishable from *U. viridis*.

It is clear that Malta (1933, p. 24) was uncertain about the value of the variety *U. viridis* var. *adpressa* Mitt. ex Malta prior to its publication. The primary character that he used to distinguish the variety is the length of the exostome teeth, which he considered to be "shorter than in the type" and "usually splitting afterwards". There is no information in Malta's protologue to distinguish any of the three syntypes of this name. However, in Beckett's herbarium (at CHR), an ample duplicate of the Mt Bonpland syntype bears the annotation in Brotherus' script "*Ulota adpressa* Mitt. in litt. ad W. Bell 25 April 1889". The fact that Mitten saw a portion of the Mt Bonpland collection makes it an appropriate choice for a lectotype. In the lectotype material the exostome teeth are between 240 and 270 µm long and not divided, and fall within the observed variability of *U. viridis* s.s. The var. *adpressa* is unworthy of recognition.

The relationship between *U. viridis* and the Patagonian *U. macrocalycinum* Mitt. is beyond the scope of this Flora. Patagonian material in N.Z. herbaria named as *U. macrocalycinum* is very similar to *U. viridis* and, if collected in Australasia, would undoubtedly be referred to the latter name. In the event of these names proving synonymous, the South American name would have priority.

Recognition: Confusion could occur between *U. viridis* and *Macrocoma tenue*. However, the larger and narrowly acute leaves of *U. viridis* contrast with the shorter (mostly <1 mm), broadly acute leaves of *M. tenue*. The *Macrocoma* also lacks the elongate basal cells and the incrassate basal marginal cells seen in virtually all species of *Ulota*.

In poorly developed material, confusion sometimes occurs between *U. viridis* and *U. lutea*. In well-developed material the leaves of *U. viridis* are decidedly less contorted when dry than those of *U. lutea*. The leaf base is generally less well-defined in *U. viridis* but this is not considered here to be a reliable character in itself. In difficult collections, the predominantly one-cell-wide endostome segments and the smaller spores (usually <36 µm) of *U. viridis* help to distinguish the two species.

Etymology: The epithet *viridis* means green.

Zygodon Hook. & Taylor, *Muscol. Brit.*, 70 (1818)

= *Codonoblepharon* Schwägr., *Sp. Musc. Frond. Suppl.* 2(1), 142 (1824)

Type taxon: *Zygodon conoideus* (Dicks.) Hook. & Taylor

Elements in the following description are taken from Crum & Anderson (1981) and Vitt (1994).

Plants small to robust, forming tufts or turves, mostly on bark or rock, dull or weakly lustrous, green, brown, yellow-brown, or red-brown. **Stems** erect or ascendant, simple, forked, or branched by innovation, usually covered with dense red-brown or pale brown and papillose rhizoids, in cross-section with small incrassate cortical cells, thick-walled internal cells, and lacking a central strand. **Leaves** imbricate, erect, and often contorted when dry, erect-spreading to reflexed when moist, often undulate, ovate to linear-lanceolate or ligulate, mostly acute to acuminate, entire or ± toothed near apex (sometimes crenulate from projecting papillae), keeled, with margins mostly plane, occasionally recurved below; **upper laminal cells** rounded-hexagonal to subquadrate, firm-walled, smooth or pluripapillose (occasionally unipapillose) on both surfaces, sometimes arranged in neat oblique rows; **basal cells** rectangular or linear, less papillose or smooth, thinner-walled, often ± yellow; **alar** and **marginal cells** not differentiated. **Costa** prominent, smooth throughout or papillose abaxially above,

ending below apex to excurrent. **Gemmae** borne in clusters on axillary stalks or on rhizoids, usually numerous, clavate to cylindrical, and transversely (and rarely longitudinally) septate. **Laminal KOH colour reaction** positive, yellow or occasionally red, rarely absent.

Sexuality various. **Male** and **female plants** mostly similar, rarely dimorphic. **Perichaetia** terminal, the **leaves** not or only weakly differentiated. **Perigonia** often gemmiform, terminal (but often becoming lateral by innovation). **Setae** terminal, ± elongate, ± yellow, smooth; **capsules** exerted, erect and symmetric, subcylindrical to obovoid, to narrowly pyriform, with a long neck, strongly 8-furrowed; **exothecial cells** in alternate longitudinal bands of thick-walled and thin-walled cells; **stomata** superficial, restricted to the neck and lower urn; **annulus** weakly differentiated or apparently lacking; **operculum** long-rostrate, often oblique, from a conic base. **Peristome** single (then endostomal), double, or none; **exostome teeth** united to form 8 pairs, at least when young, papillose or papillose-striate, recurved or erect when dry; **endostome segments** (if present) 8 or rarely 16, slender and linear, variably ornamented, arising from a low basal membrane. **Calyptra** cucullate, naked, smooth or papillose near the apex. **Spores** globose, small, unicellular.

Taxonomy: Malta's (1926) revision of the genus remains extremely useful. Lewinsky's (1990) beautifully illustrated revision of *Zygodon* for Australasia provides an introduction to many aspects of the genus, including its history. This treatment provided the basis for Lewinsky-Haapasaari & Ramsay's (2006b) treatment of the genus in the *Flora of Australia*. The taxonomy presented in these two treatments is mostly followed here, with the notable exception that one Australasian species is placed in the segregate genus *Leratia* Broth. & Paris, following the analysis of Goffinet et al. (2004). Further information about some N.Z. species may be found in Calabrese's (2006) well-illustrated revision of southern South American species.

The arguments presented by Goffinet & Vitt (1998) and Goffinet et al. (2004) in favour of resurrecting the genus *Codonoblepharon* are not accepted here. *Zygodon menziesii* (Schwägr.) Arn., the type species of the genus *Codonoblepharon*, and other N.Z. species with smooth laminal cells are retained here in *Zygodon*, as advocated by Lewinsky. Those interested in this segregate genus are referred to the writings of Goffinet and co-authors, and to Matcham & O'Shea (2005).

Goffinet & Vitt (1998) placed *Zygodon* and its close allies (including *Codonoblepharon*) in the tribe Zygodontae.

Zygodon is a large genus distributed in all temperate and tropical regions. Smith (2004) considered *Zygodon* to be a genus of c. 50 spp. worldwide; six species are accepted for N.Z.

Etymology: The generic name refers to the 16 peristome teeth which are joined to form 8 pairs.

The species descriptions of *Zygodon* spp., and the following key to species, are modified from Lewinsky (1990), whose revision of the Australasian representatives provides the base line for our regional understanding of this genus.

- 1 **Leaf cells** smooth 2
- 1' **Leaf cells** papillose 4
- 2 **Costa** usually excurrent, rarely percurrent or subpercurrent *Z. minutus*
- 2' **Costa** ending below apex 3
- 3 **Plants** yellow-green, mostly epiphytic; **leaves** 0.3–0.6 mm long, usually plane with flat margins *Z. gracillimus*
- 3' **Plants** olive-green to dark green to brown, mostly epilithic; **leaves** 1.0–1.6(–2.1) mm long, slightly undulate, mostly with margins recurved to revolute in central part *Z. menziesii*
- 4 **Leaves** strongly squarrose when moist; **gemmae** with transverse and longitudinal walls; **laminal cells** KOH positive red or KOH positive yellow, then red *Z. rufescens*
- 4' **Leaves** erect-patent to recurved when moist; **gemmae** with transverse walls only; **laminal cells** KOH positive yellow 5

- 5 **Dioicous; perichaetial leaves** lanceolate, acute; **vegetative leaves** mostly entire or slightly crenulate from projecting papillae, occasionally with a few small denticulations near apex (then with teeth formed only by part of protruding cell), 0.6–1.8 × 0.2–0.3 mm; **setae** 2.5–10 mm; **capsules** 1–1.5 mm; **peristome** double (*fide* Lewinsky); **spores** 13–20 µm *Z. intermedius*
- 5' **Synoiuous; perichaetial leaves** ovate-lanceolate, acuminate; **vegetative leaves** often dentate with teeth formed by entire cells, (0.9–)1.4–2.4 × 0.3–0.45 mm; **setae** 8–18 mm; **capsules** 1.5–2 mm; **peristome** single (*fide* Lewinsky); **spores** 20–25 µm *Z. hookeri*

Excluded Taxa: *Zygodon anomalous* Dozy & Molk. was applied by Dixon (1926, p. 164) to the N.Z. material recognised here under the name *Z. hookeri*. On p. 365, Dixon cited Malta's (1926) opinion that this name is founded on disparate elements. Lewinsky (1990) considered *Z. anomalous* to be a *nom. dub.* and rejected its application to N.Z. material; her views are accepted here.

Zygodon obtusifolius Hook. is here considered under the genus *Leratia*.

Zygodon reinwardtii (Hornsch.) A. Braun has been applied to N.Z. material by various authors, including Wilson (1854). Dixon (1926, p. 164) discussed the name *Z. reinwardtii* in relation to N.Z. material at some length and rejected its use. Lewinsky (1990) differentiated the widespread (predominantly southern Asian and Latin American) *Z. reinwardtii* from the Australasian *Z. hookeri* by the former's "more strongly dentate leaf margins and the more pronounced nerves which are widened towards the apex and excurrent in nearly all leaves" and by the nature of their gemmae. Her views are accepted here and this species is not discussed further.

***Zygodon gracillimus* M.Fleisch., *Musci Buitenzorg*, 392 (1904)**

≡ *Codonoblepharon gracillimum* (M.Fleisch) Matcham & O'Shea, *J. Bryol.* 27: 130 (2005) — as *gracillimus*

Lectotype: Indonesia, West Java, by Handang Badak; *Wichura*, FH. (Cited by Lewinsky 1990 and Matcham & O'Shea 2005.) Not seen.

= *Zygodon rodwayi* Broth. in *Rodway, Pap. & Proc. Roy. Soc. Tasmania* 1913: 260 (1914)

Isotype: Australia, Tasmania, Forth River near Sheffield, *L. Rodway 106*, WELT M009704! (Holotype at H cited by Lewinsky 1990.)

= *Zygodon subminutus* Broth. in *Dixon, Bull. New Zealand Inst.* 3: 167 (1926)

Isotype: N.Z., South Auckland, Thames; *Petrie 731*, CHR 527698! (Holotype at H cited by Lewinsky 1990.)

Plants very slender, mostly c. 3–7 mm tall, forming dense tufts, yellow green, dull. **Stems** delicate, branched (mostly by subperichaetial or subperigonal innovation), in cross-section with almost uniformly thick-walled cells or rarely the central cells with ± thinner walls, central strand lacking; **rhizoids** present on lower stems, brown, finely papillose. **Leaves** loosely secund when dry, spreading or erect-spreading when moist, broadly lanceolate, acute (sometimes broadly so), entire or weakly crenulate, not decurrent, 0.3–0.6 × 0.1–0.2 mm; **margins** plane; **upper laminal cells** mostly rhombic but nearly quadrate at margins, thick-walled and smooth, not in oblique rows, mostly 6–12 × 6–9 µm; **basal cells** differing little or ± more irregular. **Costa** stout and scarcely tapered, ending below apex, yellow-brown in older leaves, mostly 36–45 µm wide and filling c. 1/3 the leaf base, the cells on both surfaces elongate. **Gemmae** borne in clusters on axillary stalks, clavate or filiform, with 3–8 transverse septa, 30–110 µm. **Laminal KOH colour reaction** positive yellow.

Dioicous. Perichaetia terminal, usually overtopped by innovations, with leaves larger (to c. 0.8 mm) than vegetative but otherwise similar. **Perigonia** terminal, usually subtended and overtopped by an innovation (and then appearing lateral), with c. 5 antheridia and filiform paraphyses; **perigonal leaves** broadly ovate and concave at base. **Setae** 3–5 mm, dextrorse, smooth; **capsules** exserted, narrowly obovoid from a long and slender neck, narrowed at mouth, becoming ± cylindrical with age, deeply 8-furrowed throughout when dry, yellow- to red-brown at maturity, c. 1.0–1.2 mm; **exothecial cells** rectangular, in distinct thick-walled and thin-walled bands; **stomata** few, details not seen; **annulus** not seen; **operculum** short-rostrate from a conic base, c. 0.3 mm. **Peristome** double, sometimes with a fragmentary preperistome; **exostome** of 8 pairs of teeth, pale, reflexed when dry, irregularly papillose above, reticulate-papillose near base, c. 100 × 65 µm; **endostome** lacking a visible basal membrane, of 8 (or 16 *fide* Lewinsky) pale, linear, papillose-striolate segments which are c. 2/3 to 3/4 the height of the teeth. **Calyptra** cucullate, fugacious (*fide* Lewinsky). **Spores** globose, rather coarsely papillose, 12.5–14 µm.

Illustrations: Plate 23. Malta 1926, fig. 98; Lewinsky 1990, figs 57–76.

Distribution: NI: N Auckland (Hukatere Scenic Reserve, Waipoua, Auckland City), S Auckland (Puaiti Bush, Thames, near Lake Rotoehu, Rotomahana, Pukerimu Bush, Whirinaki River Track), Gisborne (Hangaroa River), Hawke's Bay (Balls Clearing), Wellington (Porirua, Wainuiomata–Orongorongo water catchment); SI: Nelson (Ōpārara River, Granite Creek), Westland (Kūmara, Gillespies Beach).

Anomalous. Recorded from Tasmania, Java, and Bolivia by Lewinsky (1990); this distribution is identical to that given by Malta (1926).

Habitat: *Zygodon gracillimus* is usually an epiphyte on rimu (*Dacrydium cupressinum*) but numerous herbarium specimens specify collection from exposed roots of unspecified tree species. Collections have been seen from *Myrsine salicina* and *Weinmannia racemosa* and P. Beveridge (pers. comm., 15 May 2012) informs me he has collected it from *Beilschmiedia tawa*. An ample fruiting collection from Gillespies Beach formed a “spongy clump c. 12 cm diam. on [a] rotten tree in shady forest” and a collection from Kūmara was made from rock. Often growing in association with *Orthorrhynchium elegans* and *Leratia obtusifolia*. On the North I. from c. 100 m (Hukatere Scenic Reserve) to c. 760 m (Pukerimu Bush) and on the South I. from near sea level (Gillespies Beach) to c. 150 m (Ōpārara River). P. de Lange (pers. comm., 20 Feb. 2012) informs me that he has seen this species at North Cape (N Auckland L.D.) and on Mayor I. (S Auckland L.D.).

Notes: P. Beveridge (PB MA-3, CHR 611188) has collected aberrant material of *Z. gracillimus* at Porirua with abundant filaments in the leaf axils and also forming a dense mat, suggestive of a persistent protonema, at the base of the stems. However the filaments have transverse walls (unlike typical protonema), are strongly papillose, and appear to bear gemmae.

Confusion is most likely with *Z. minutus*, with the distinction between the two requiring microscopic examination to determine the length of the costae and stem anatomy details. *Zygodon gracillimus* appears to be a naturally uncommon species, but its highly inconspicuous nature and restricted habitat suggest that targeted searches might reveal a wider distribution.

Etymology: The epithet *gracillimus* means “most slender” and refers to the delicate habit of this species.

***Zygodon hookeri* Hampe, *Linnaea* 30: 632 (1860)**

Holotype: Australia, Grampians, 1854, *F. Mueller*, BM. (Cited by Lewinsky 1990.) Image seen online, JSTOR Global Plants, accessed 27 June 2016.

= *Zygodon mucronatus* Müll.Hal., *Hedwigia* 37: 136 (1898) nom. illeg. non *Zygodon mucronatus* Broth. 1897

Plants medium-sized, usually in loose tufts or mats, green to yellow-green above, red-brown to brown below, dull. **Stems** (8–)10–30 mm, much branched (mostly or entirely by innovation), in cross-section with small, incrassate cortical cells, thick-walled internal cells, and lacking a central strand; **rhizoids** well-developed and extending well up the stem, red-brown, finely papillose. **Leaves** loosely twisted around the stems and often contorted when dry, loosely spreading or somewhat recurved and ± undulate when moist, lanceolate or linear-lanceolate, narrowly acute, entire or with a few teeth near apex, slightly decurrent, weakly keeled, ± undulate, plane at margins, (0.9–)1.4–2.4 × 0.3–0.45 mm (under cover slip); **upper laminal cells** irregularly rounded, almost isodiametric or some ± oval, thick-walled, mostly 7–12(–14) µm in greater diam., mostly with 4–7 short, simple, and round papillae on each surface; **basal cells** rounded-rectangular or rectangular, moderately thick-walled, smooth, c. 12.5–45 × 4.5–10 µm. **Costa** ending shortly below the apex or rarely percurrent and slightly widened in the apex, with cells on both surfaces elongate, protruding on the abaxial leaf surface and lustrous when dry. **Gemmae** rarely seen, axillary, clavate, green, usually with 2 transverse, hyaline septa, c. 65–90 µm.

Synoicous. **Perichaetia** terminal, usually overtopped by 1 or more innovations, with archegonia, antheridia and paraphyses; **perichaetial leaves** smaller than adjacent vegetative leaves, ovate-lanceolate and long acuminate. **Perigonia** lacking. **Setae** (6–)10–15(–20) mm, dextrorse above, pale yellow-brown; **capsules** exserted, oblong-cylindric when moist, oblong with a long slender neck when dry and becoming cylindric and deeply 8-furrowed with age, orange-brown to light brown, 1.5–2.2 mm; **exothecial cells** with longitudinal walls much thicker than transverse, arranged in alternating bands of thick- and thin-walled cells; **stomata** restricted to neck, superficial; **annulus** not seen; **operculum** obliquely long-rostrate from a conic base, c. ½ the length of the capsule. **Peristome** single; **endostome** of 8 (rarely 16), hyaline, smooth, filiform segments. **Calyptra** cucullate. **Spores** globose, papillose, brown, (14–)20–25(–28) µm.

Illustrations: Plate 24. Malta 1926, fig. 72; Lewinsky 1990, figs 156–175, 176–177; Calabrese 2006, 2b, 21 (as *Z. hookeri* var. *hookeri*).

Distribution: NI: S Auckland (near Ātiamuri, near Rangitikei), Hawke's Bay (Back Ridge), Wellington (Ōhakune, Mangawhero Falls); SI: Nelson, Marlborough (south flank of Red Hills), Canterbury, Westland (Taramakau), Otago, Southland. The N.Z. distribution was mapped by Lewinsky (1990, fig. 181). The majority of Canterbury L.D. records are from the Arthur's Pass area, extending eastward to Woodstock (near Springfield). It appears to be widespread in Otago L.D.

Australasian. Reported from Tasmania and mainland Australia (Vic. and southern N.S.W.) by Lewinsky (1990).

Habitat: *Zygodon hookeri* grows as an epiphyte on various species of southern beech (especially *Fuscospora solandri* s.l. and *Lophozonia menziesii*) and a range of other woody genera including *Coprosma*, *Discaria*, *Dracophyllum*, *Fuchsia*, *Griselinia*, *Leptospermum*, and *Myrsine*. It also occurs on rock and on earth at tree bases. *Lepyrodon australis* and *L. lagurus* are frequent associates. The few well-documented North I. collections are from 1280 m or greater elevation. Ranging on the South I. primarily from c. 500 to 1430 m (St. Arnaud Range, Nelson L.D.), although there are a few records from lower elevations in Otago L.D. (near Lake Hāwea) and in Southland L.D. (including Fiordland). There is a single W. Martin collection from the "Riverton Rocks", which was probably collected close to sea level. *Zygodon hookeri* is predominantly distributed on the South I., where its rarity in both drier regions and in Westland may reflect the rarity of southern beech in these regions rather than rainfall (cf. Lewinsky 1990).

Notes: Lewinsky (1990, p. 136) has pointed out the protologue of *Z. hookeri* Hampe is ambiguous, describing the costa initially as percurrent ("*nerve lutescente percurso apiculata*") and latterly as excurrent. I agree with Lewinsky that in *Z. hookeri* the costa usually ends shortly below the apex, while it is only rarely percurrent and never excurrent.

Recognition: While similar in many ways to the more widespread and closely related *Z. intermedius*, *Z. hookeri* is generally a more robust plant in which the vegetative leaves are both longer and wider, the perichaetial leaves more strongly differentiated, the setae and the capsules longer, and the spores larger. According to Lewinsky (1990), *Z. hookeri* has a more open growth and more twisted, undulate leaves. The synoicous inflorescence of the present species distinguishes it from *Z. intermedius* under the stereoscope.

Etymology: The publication date suggests that the species is named in honour of J.D. Hooker, rather than W.J. Hooker.

***Zygodon intermedius* Bruch & Schimp., *Bryol. Eur.* 3, 41 (1838)**

Holotype: N.Z., Dusky Sound, A. Menzies, BM. (Cited by Lewinsky 1990.) Not seen.

= *Zygodon conoideus* var. *elongatus* Hook. & Grev., *Edinburgh J. Sci.* 1: 132 (1824) — as *Zygodon conoideum* var. β *elongata*

Holotype: N.Z., Dusky Sound, A. Menzies, BM. (Cited by Lewinsky 1990.) Not seen.

= *Zygodon gracilicaulis* Müll.Hal., *Hedwigia* 37: 135 (1898)

Lectotype: N.Z., near Greymouth, R. Helms, H-Brotherus 3300361. (Designated by Lewinsky 1990.) Image seen online, JSTOR Global Plants, accessed 27 June 2016.

= *Zygodon nanus* Müll.Hal., *Hedwigia* 37: 135 (1898)

Lectotype: N.Z., near Greymouth, R. Helms, H-Brotherus 3300358. (Designated by Lewinsky 1990.) Image seen online, JSTOR Global Plants, accessed 27 June 2016.

Plants medium-sized, 5–25(–55) mm tall, in dense tufts or turves; green to yellow-green above, red-brown to brown below. **Stems** frequently branched (often by innovation), in cross section with small, incrassate cortical cells and lacking a central strand; **rhizoids** well-developed and extending well up the stem, much branched, red-brown, finely papillose. **Leaves** erect appressed and imbricate, loosely twisted round the stem, homomallous, or strongly contorted when dry, erect-spreading when moist, lanceolate or linear lanceolate, acute, entire or slightly crenulate from projecting papillae, sometimes with a few small denticulations near the apex formed by protruding cells, weakly decurrent, weakly keeled (more prominently in lower portions), often \pm undulate, plane at margins, 0.6–1.8 \times 0.2–0.3 mm (under cover slip); **upper laminal cells** irregularly rounded, almost isodiametric, 4–10(–15) μ m in greater diam., with moderately thick walls, with 4–8 short, simple, round papillae on each surface; **apical cells** usually papillose, rarely smooth; **basal cells** rounded rectangular or rectangular, moderately thick walled, smooth, mostly 15–25 \times 7–9 μ m, extending only a short distance up the leaf

and grading rapidly into shorter and papillose cells; **alar cells** not differentiated. **Costa** ending below leaf apex, with cells on both surfaces elongate, protruding and smooth or papillose in upper portions on the abaxial leaf surface, lustrous when dry. **Gemmae** small, rarely seen, clavate or ellipsoid, with hyaline transverse walls, usually 3-celled and 45–60 µm.

Dioicous. **Male and female plants** of similar size. **Perichaetia** terminal, usually overtopped by 1 or more innovations, with leaves longer and with the basal cells longer and extending further up the leaf than in vegetative leaves. **Perigonia** terminal and gemmiform, often appearing lateral by innovation, the inner bracts broadly ovate, obtuse, and brown. **Setae** 2.5–10 mm, dextrorse above, pale yellow-brown; **capsules** exserted, ± ellipsoid when moist, becoming pear-shaped, oblong or cylindrical and deeply 8-furrowed when dry, orange-brown to light brown, 1.0–1.5 mm; **exothecial cells** with longitudinal walls much thicker than transverse walls, arranged in alternating bands of thick- and thin-walled cells; **stomata** restricted to neck, superficial; **annulus** not seen; **operculum** obliquely long-rostrate from a conic base, mostly c. $\frac{1}{3}$ the length of the capsule. **Peristome** double; **exostome** of 8 short, sometimes reduced teeth or absent; **endostome** of 8 hyaline, smooth, more or less reduced segments. **Calyptra** cucullate, smooth. **Spores** globose, insulate-papillose, green or yellow-brown, 13–17(–20) µm.

Illustrations: Plate 24. Malta 1926, figs 39–40; Lewinsky 1990, figs 131–153; Calabrese 2006, figs 17, 18 a–b; Seppelt 2004, fig. 84.

Distribution: K; NI: N Auckland, including offshore islands (PK, LB, RT), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St; Ch; A; C; M. The N.Z. distribution was mapped by Lewinsky (1990, fig. 155).

Anomalous. Mainland Australia*. Reported from Tasmania and from a single locality in northern Queensland by Lewinsky (1990, fig. 154). Reported from South America, Africa and Asia by Malta (1926).

Habitat: *Zygodon intermedius* grows most commonly as an epiphyte, often on the undersides of branches and leaning trunks, but it also occurs commonly on rock and logs through a wide elevational range. Epilithic occurrences (often, but not always, on cation-rich rocks) are more frequent at higher elevations. Of the identifiably unique collections in CHR, 145 were epiphytic, 90 epilithic/terrestrial, 19 on logs/stumps, and 36 lack substrate information. There appears to be a tendency for this species to occur more frequently on rock in the southern part of the South I.

This species occurs epiphytically on a wide range of indigenous trees and shrubs, including podocarps and some tree ferns as well as the introduced genera *Cupressus*, *Populus*, and *Salix*. This species is very tolerant of a wide range of humidity and tolerates at least moderate levels of salt spray. It is one of the most widely distributed mosses in the country and, accordingly, co-occurs with a wide range of both epiphytic and terrestrial bryophyte species. On the North I. it ranges from c. 20 m (Dacre Point, N Auckland L.D.) to c. 1200 m (Mt Ruapehu, Wellington L.D.) and on the South I. from near sea level (Akatore, Otago L.D.) to 1650 m (Mt Arthur, Nelson L.D.).

Notes: Lewinsky (1990) discussed at some length the provenance of the type collection of *Z. intermedius* and concluded that it was collected by A. Menzies at Dusky Bay, Southland L.D. According to Lewinsky (1990), the type specimen for *Z. intermedius* is also the type for *Z. conoideus* var. *elongatus* and is probably the same material on which *Z. angustifolius* Hook. & Grev. was based.

Recognition: The majority of collections of *Z. intermedius*, when dry, are yellow-green with well-developed red-brown rhizoids, rather broad, homomallous leaves with a conspicuous costa that protrudes and is lustrous abaxially, and dull leaf lamina that give this species (and its close ally *Z. hookeri*) a characteristic look. While microscopic examination is usually required to confidently distinguish it from *Z. hookeri*, the generally smaller stature of *Z. intermedius*, its narrower leaves, and shorter setae and capsules permit at least provisional field recognition of this widespread species. *Zygodon intermedius* has a wider elevational range and is more common below c. 500 m than its more robust congener. Perigonia are usually easily demonstrated in *Z. intermedius*, but are absent in the synoicous *Z. hookeri*. Despite its dioicous sexuality, *Z. intermedius* frequently produces capsules. Gemmae in *Z. intermedius* appear to be produced only in poorly developed plants and they have little practical value in the recognition of this species.

Apart from confusion with *Z. hookeri*, *Z. intermedius* is most likely confused with members of the pottiaceous genera *Gymnostomum* and *Anoetangium*. *Zygodon intermedius* differs in many ways from *Gymnostomum calcareum*. The *Zygodon* is a coarser plant in which the leaves are both longer and wider (0.6–1.8 × 0.2–0.3 mm vs 0.7–1.0 × <0.2 mm in *Gymnostomum*). The costa in *Zygodon* is either smooth or papillose abaxially in its upper portions only, while that of *G. calcareum* is conspicuously abaxially papillose nearly to its base and also papillose on its adaxial surface. The

acute leaf apices of *Z. intermedius* contrast with the often obtuse or rounded leaf apices of *G. calcareum*. The setae in *Z. intermedius* are stouter and the capsules both strongly ribbed and stouter (>0.5 mm diam.) compared to the cylindrical, smooth, and slender (c. 0.2–0.3 mm diam.) capsules of *G. calcareum*. The often epiphytic occurrence of the *Zygodon* contrasts with the exclusively epilithic or terrestrial substrate of *G. calcareum*.

Confident distinction of *Z. intermedius* from *Anoetangium aestivum* is more difficult. Although the general stature of the plants and the leaf size can be similar, the leaves of *Z. intermedius* (and *Zygodon* spp. generally) are less keeled than those of the *Anoetangium*. The costa in the *Zygodon* is smooth abaxially in its lower portions and ends short of the leaf apex, while the costa of *A. aestivum* is papillose abaxially for its entire length and usually percurrent as a short cusp. The gametangia of the *Zygodon* are terminal (but often appear lateral due to innovation) while those of *A. aestivum* (and the genus *Anoetangium* as a whole) are lateral. The strongly ribbed capsules in *Z. intermedius* and its often epiphytic substrate contrast with the smooth, ± oblong capsules and the usually epilithic substrate of the *Anoetangium*.

When on rock, *Z. intermedius* frequently grows with *Amphidium* spp. and in some ways has a similar appearance. However, the vegetative leaves of *Z. intermedius* are much shorter (c. 0.6–1.8 mm vs 2.5–4.0 mm in our species of *Amphidium*) and less contorted with dry. The laminal cells of *Z. intermedius* are isodiametric with relatively high papillae only over the cell lumina, while the laminal cells of both our species of *Amphidium* tend to be oblate and have lower papillae extending over the cell lumina and adjacent cell walls. Elongate cuticular striations often occur in *Amphidium*. When fruiting the exerted ± ellipsoid capsules borne on elongate setae in *Z. intermedius* contrast with the urceolate and emergent to short-exserted capsules borne on short setae in *Amphidium*.

Etymology: The epithet *intermedius* refers to an intermediate condition between two European taxa of *Zygodon*; it has little relevance in a N.Z. context.

***Zygodon menziesii* (Schwägr.) Arn., *Disp. Méth. Mousses*, 15 (1826)**

≡ *Codonoblepharon menziesii* Schwägr., *Sp. Musc. Frond. Suppl.* 2(1), 142 (1824)

Type: N.Z., Dusky Sound, A. Menzies, G. (Cited by Lewinsky 1990.) Not seen.

= *Bryum oamaruense* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 31: 447 (1899)

Lectotype: N.Z., Oamaru, R. Brown, Nov. 1897, BM. (Designated by Lewinsky 1990.) Image seen online, JSTOR Global Plants, accessed 16 Feb. 2017.

= *Zygodon menziesii* var. *angustifolius* Malta, *Latv. Univ. Raksti* 10: 317 (1924)

≡ *Codonoblepharon menziesii* var. *angustifolius* (Malta) Matcham & O'Shea, *J. Bryol.* 27: 131 (2005)

Lectotype: N.Z., Mauriceville, Gray 50, BM. (Designated by Matcham & O'Shea 2005.) Image seen online, JSTOR Global Plants, accessed 16 Feb. 2017.

Plants to 10 (rarely to 20) mm tall, densely tufted, olive-green to dark green to nearly black above, red-brown to brown below, moderately lustrous. **Stems** branched (the ♀ plants often by subperichaetial innovation), with a cortex of moderately thick-walled cells surrounding a central core of thin-walled parenchyma and no central strand; **rhizoids** present on lower stems, brown, finely papillose. **Leaves** loosely or tightly twisted around the stem or erect-appressed when dry, erect-spreading when moist, ovate lanceolate or elliptic-lanceolate, entire, usually keeled above, with base not decurrent, apex acute, rounded acute, to obtuse, sometimes weakly cuspidate, 1.0–1.6(–2.1) × 0.3–0.5(–0.7) mm; **margins** narrowly recurved to revolute below or less often plane; **upper laminal cells** quadrate or rhomboidal, moderately to very thick-walled, smooth, often in oblique rows (and some cells often oblate), sometimes smaller along the margins, 6–12 × 9–12 µm; **basal cells** rectangular or oblong, thin-walled near costa, becoming more elongate and thicker-walled near the margins, smooth, commonly 20–45(–60) × 12–20 µm (midway to margin), grading into cells of mid lamina. **Costa** stout, subpercurrent or rarely extending into a cusp, usually red-brown in older leaves, 36–45 µm wide in lower leaf and scarcely tapering, the cells on both surfaces elongate. **Gemmae** borne in clusters on axillary stalks, clavate or filiform, with 3–7 transverse septa and 0–4 longitudinal septa, 45–150 µm, green or brown. **Laminal KOH colour reaction** positive yellow.

Dioicous. **Perichaetia** terminal, **perichaetial leaves** not differentiated. **Perigonia** terminal, usually subtended by an innovation (and then appearing lateral), c. 0.6 mm long and nearly globose, orange-brown, gemmiform, with c. 10 antheridia and numerous filiform paraphyses; inner perigonial bracts broadly ovate and strongly concave. **Setae** (2.5–)4–6 mm, dextrorse, smooth; **capsules** exerted, narrowly ovoid from a slender neck, narrowed at mouth, becoming ± cylindrical when old and dry, straw-coloured or pale yellow-green at maturity, deeply 8-furrowed throughout, 1.5(–2.0) mm; **exothecial cells** rectangular, in distinct thick- and thin-walled bands; **stomata** numerous, superficial, restricted to

neck; **annulus** not differentiated; **operculum** rostrate from a conic base. **Peristome** double; **exostome** of 8 pairs of teeth, white or pale yellow, strongly reflexed when dry, transversely striate below and longitudinally striate above on outer surface, c. 350 × 120 µm; **endostome** lacking a visible membrane, of 8 pale, linear, finely papillose or baculate segments that are $\frac{1}{2}$ – $\frac{3}{4}$ the height of the teeth. **Calyptra** cucullate, smooth, covering c. $\frac{1}{2}$ the capsule. **Spores** globose, finely papillose, 15–18 µm.

Illustrations: Plate 25. Brotherus 1925, fig. 428e, 429 (a form with almost straight leaves); Malta 1926, figs 94 (as *Z. menziesii* var. *angustifolius*), 95, 103 (as *Z. menziesii*); Lewinsky 1990, figs 100–111, 112–128; Seppelt 2004, fig. 85; Calabrese 2006, figs 1f, 3e, 4–5.

Distribution: NI: N Auckland, including offshore islands (GB), S Auckland, Gisborne, Hawke's Bay, Wellington; SI: Nelson, Marlborough, Canterbury (Arthur's Pass, Hawdon River, Banks Peninsula), Westland, Otago, Southland (Clifton, Riverton Rocks); St; Ch; A; C; M.

Austral. Tasmania*, mainland Australia*. Reported from Chile by Malta (1926). The mainland Australian distribution includes both south-eastern regions and southern W.A. (*vide* Lewinsky 1990).

Habitat: Although it is best developed on limestone and marble, *Z. menziesii* also occurs on other rock types including greywacke, sandstone, granite, and concrete, as well as trunks of a range of both native (including *Carpodetus serratus*, *Corynocarpus laevigatus*, *Dracophyllum traversii*, *Fuscospora solandri* s.l., *Hoheria sexstylosa*, *Melicytus ramiflorus*, and *Metrosideros umbellata*) and introduced (*Populus* spp. and *Sambucus nigra*) tree species. It is tolerant of salt spray. It appears to be a common species on garden walls in Auckland City. Herbarium material from the Hawdon River was collected from "decaying wood" and from the Port Hills (Canterbury L.D.) from "bark of [a] decaying log". Lewinsky (1990) recorded it from both *Eucalyptus* and introduced trees in Australia. Frequently associated epilithic species include *Barbula calycina*, *Didymodon australasiae*, *Macromitrium longirostre*, *M. retusum*, *Orthotrichum crassifolium*, *Schistidium apocarpum* s.l., and *Syntrichia antarctica*. Epiphytic associates can include *Calyptopogon mnioides*, *Syntrichia pygmaea*, *Zygodon hookeri*, and *Z. intermedius*. On the North I. occurring from near sea level to at least 1300 m (Ōhutu Ridge, Hawke's Bay L.D.) and on the South I. from near sea level to at least 1350 m (Mt. Arthur, Nelson L.D.).

Notes: *Zygodon menziesii* is a morphologically variable species. In its most representative form, the spirally twisted, often dark red-brown and lustrous leaves with stout subpercurrent costae make this species easily recognisable. The firm-walled, smooth, and usually distinctly obliquely ranked upper laminal cells have a distinctive appearance under the compound microscope. Perigonal plants are rarely seen. Given that this species frequently fruits, it is difficult to understand the rarity of male plants. Lewinsky (1990, p. 129) indicated that the endostome here can sometimes have 16 segments, but in my experience such material is very rare (seen only in *P. Beveridge* s.n., 12 Dec. 2008 from near Balclutha, Otago L.D. (WELT M039453)).

A relatively small proportion of populations have longitudinal as well as transversely septate gemmae. This single character difference has been used to define the var. *angustifolium* Malta. Given the general morphological variability of *Z. menziesii* in respect of many characters (e.g., stature, the shape of the leaf apex, the degree of reflexion of the leaf margins) and the fact that the presence of the longitudinal gemma walls does not appear to correlate with other character states, the recognition of the variety *angustifolium* Malta seems unjustified. Those wishing to attempt to segregate this variety should refer to Lewinsky (1990), but it is clear that she also had misgivings about its value.

Lewinsky (1990) illustrated and briefly discussed three growth forms of *Z. menziesii*. The most common form has brown or dark green leaves firmly twisted around the stems and lanceolate with the margins recurved at least in the lower half. The second has green leaves more loosely twisted around the stems, individually twisted at their apices, longer, often somewhat undulate, and plane at the margins. Lewinsky associated such material with wetter regions. A third form occurs primarily at high elevations in Nelson L.D. and has brown, fairly short, and ± straight leaves that are not twisted around the stems. These differences probably reflect the differences in environmental humidity and insolation. Many intermediate forms between the extremes were noted by Lewinsky, who gave the growth forms no formal taxonomic rank.

Recognition: *Zygodon menziesii* is sometimes confused with *Orthotrichum cupulatum*, which also commonly grows on calcareous rock. The dry plants of *Z. menziesii* have a distinctive lustre and usually spirally twisted leaves. In contrast, the dry plants of *O. cupulatum* are dull and faintly glaucous with nearly straight leaves. Further distinction is provided by the usually distinctly obliquely ranked and smooth upper laminal cells (giving a KOH positive yellow reaction) and the presence of fusiform axillary gemmae in *Z. menziesii*.

Etymology: The epithet *menziesii* honours the Scottish naturalist Archibald Menzies, who in 1791 collected the type at Dusky Sound while serving as naturalist on the Vancouver Expedition.

***Zygodon minutus* Müll.Hal. & Hampe in Hampe, *Linnaea* 28: 209 (1856)**

≡ *Codonoblepharon minutum* (Müll.Hal. & Hampe) Matcham & O'Shea, *J. Bryol.* 27: 132 (2005) — as *minutus*

Holotype: Australia, Victoria, Wilson's Promontory, Sealers Cove, *F. Mueller*, BM. (Cited by Lewinsky 1990 and Matcham & O'Shea 2005.) Not seen.

= *Zygodon mucronatus* Broth. in Beckett, *Trans. & Proc. New Zealand Inst.* 29: 441 (1897)

Isotype: N.Z., South Island, Kaikōura, *T.W.N. Beckett* 504, CHR 527695! Holotype in H cited by Lewinsky (1990).

Plants dimorphic, forming dense tufts on bark or rock, yellow-green to olive-green above, red-brown below, weakly lustrous; ♀ plants mostly c. 3 mm tall, usually unbranched; male plants smaller, mostly c. 1(–2.5) mm, often branched by innovation and bearing >1 perigonia. **Stems** simple or branched, in cross section with all cells uniformly thin-walled or with c. 1 layer of thickened cortical cells, central strand lacking; **rhizoids** present on lower stems, brown, finely papillose. **Leaves** erect and weakly spiralled around the stem when dry, spreading when moist, oblong- or elliptic-lanceolate, apiculate, entire, at base not decurrent, 0.5–1.5 × 0.20–0.35 mm; **margins** plane or rarely slightly reflexed in lower half; **upper laminal cells** rhombic to ± quadrangle, moderately thick-walled, smooth, usually in oblique rows, c. 8–12 × 6–9 μm; **basal cells** rectangular, thinner-walled, to c. 27–42 × 12–15 μm, smooth. **Costa** stout and little tapered, mostly short excurrent and filling the apiculus, rarely percurrent or subpercurrent, c. 42–60 μm wide near the base, yellow- or red-brown. **Gemmae** borne in clusters on axillary stalks, usually numerous, clavate with 4–7 transverse walls, (50–)90–150 μm. **Laminal KOH colour reaction** positive yellow.

Dioicous. Perichaetia terminal, with leaves larger than vegetative but otherwise similar. **Perigonia** gemmiform, c. 0.5 mm, terminal or appearing lateral because of innovation, with 8–10 antheridia and few or no paraphyses; perigonial bracts very small, broadly ovate, apiculate, the innermost with large, thin-walled cells and costa ending below the apex. **Setae** 1.5–3 mm, dextrorse above, often sinistrorse below, smooth; **capsules** exserted, narrowly obovoid from a rather short neck, becoming cylindrical with age, deeply 8-furrowed when dry, light brown at maturity, 1–1.5 mm; **exothelial cells** rectangular, in distinct thick- and thin-walled bands; **stomata** superficial, restricted to neck; **annulus** not seen; **operculum** conic, with a short, thick, slightly curved beak. **Peristome** double; no preperistome observed; **exostome** of 8 pairs of teeth, hyaline to pale brown, reflexed when dry, vertically point striated above, horizontally below; **endostome segments** 8, sometimes with 8 rudimentary segments in between, to 2/3 the height of the exostome, hyaline, smooth or scabrous on the outer surface, finely papillose or striate papillose on the inner surface. **Calyptra** cucullate, smooth, fugacious. **Spores** globose, finely papillose, 15–18(–20) μm.

Illustrations: Plate 23. Lewinsky 1990, figs 8–14; 79–97.

Distribution: NI: N Auckland, including offshore islands (PK, HC, Waiheke I.), S Auckland (Whatawhata Te Pohū Reserve in Raglan County), Gisborne (Panikau, Makaretu, Cape Runaway), Hawke's Bay (Wairoa – several collections, near Waipukurau), Wellington (Whanganui and environs, Wairarapa Lake Shore Scenic Reserve); SI: Marlborough (Kaikōura), Canterbury (Napenape, Banks Peninsula), Otago (Aramoana, Otago Peninsula, Akatore Stream), Southland (near Riverton); St; Ch. Lewinsky (1990) recorded this species from Pine Hill in Dunedin on the basis of an early W. Bell collection.

Australasian. Lewinsky (1990) recorded it from mainland Australia (south-east South Australia and coastal Victoria) and Tasmania (including Flinders I.), as well as one locality each in south-west Western Australia and south-east Queensland.

Habitat: *Zygodon minutus* is predominantly coastal in distribution and tolerant of some salt spray. This species is widespread in N Auckland L.D., and occurs at several localities on the east coast of the North I. Recorded from the west coast of the North I. only from the vicinity of Whanganui (Wellington L.D.) There is a single collection from the shore of Lake Wairarapa (Wellington L.D.). The few scattered collections from South I. are restricted to the eastern and southern coasts (see Lewinsky 1990, fig. 99). It ranges from near sea level (Warkworth, N Auckland L.D.) to at least 80 m (Waipoua River, N Auckland L.D.) on the North I. and to c. 160 m (near Riverton) on the South I.

Zygodon minutus is usually epiphytic and has been reported from both living and dead trees, often growing in bark fissures. Host species include the indigenous *Avicennia marina*, *Coprosma propinqua*, *Corynocarpus laevigatus*, *Piper excelsum*, *Melicactus ramiflorus*, *Myoporum laetum*, *Vitex lucens*, and *Podocarpus totara*, as well as the introduced genera *Populus*, *Salix*, and *Sambucus*. It also occurs as an epilith on dry, shaded limestone (as at Waro Limestone Scenic Reserve, N Auckland L.D.), concrete and volcanic rock (as at Motukōrea I., N Auckland L.D.). Frequently associated mosses include *Calyptopogon mnioides*, *Syntrichia papillosa*, *Tortula abruptinervis*, and *T. muralis*.

Recognition: The colouration and lustre of the plants, and the weakly obliquely arranged laminal cells are suggestive of small plants of *Z. menziesii*. The present species could also be confused with *Z. gracillimus* but can be differentiated from that species by its excurrent costae, generally larger leaves, and the much thinner-walled cells of the stem. The decidedly dimorphic nature of the sexual plants in *Z. minutus* also facilitates separation.

Etymology: The epithet refers to the extremely small stature of this moss.

***Zygodon rufescens* (Hampe) Broth. in Paris, *Index Bryol.*, ed. 2, 5, 141 (1906)**

≡ *Orthotrichum rufescens* Hampe, *Ann. Sci. Nat., Bot. sér. 5*, 4: 334 (1865)

≡ *Ulotia rufescens* (Hampe) A. Jaeger, *Ber. Thätigk. St. Gallischen Naturwiss. Ges.* 1872–1873: 163 (1874)

Holotype: Colombia, Bogota, Los Laches, A. Lindig, BM. (Cited by Lewinsky 1990.) Image of isotype seen online, JSTOR Global Plants, accessed 16 Feb. 2017

= *Zygodon vestitus* R.S. Williams, *Bull. New York Bot. Gard.* 3: 127 (1903)

Presumed holotype: Bolivia, Sorata, 2250 m, R.S. Williams 1875, NY 1244145. Image seen online, JSTOR Global Plants, accessed 27 June 2016. Isotype: WELT M40252!

= *Zygodon persquarriifolius* Dixon in Sainsbury, *Trans. & Proc. Roy. Soc. New Zealand* 75: 176 (1945) nom. nud.

Plants medium-sized to robust, yellow-green above, red-brown below. **Stems** unbranched or sparsely branched (apparently by innovation, but perhaps also by forking), mostly c. 7–20 mm., in cross-section with small incrassate cortical cells, thick-walled internal cells, and lacking a central strand; **rhizoids** well-developed, numerous on lower stems, sometimes extending nearly to stem apex, brown, finely papillose. **Leaves** loosely erect-contorted (not secund) when dry, strongly spreading-squarrose when moist, weakly or not undulate, lanceolate to ovate lanceolate, acute or acuminate, somewhat decurrent, c. 1.4–2.0 × 0.3–0.4 mm (longer leaves near stem apex); **margins** plane, entire (except for projecting papillae); **upper laminal cells** irregularly rounded, almost isodiametric (but shape obscured by papillae), not differentiated at margins, with 3–5 short, single papillae on both surfaces, 6–9.5 µm diam.; **apical cells** sometimes hyaline and smooth; **basal cells** rectangular or rhomboidal, moderately thick-walled, smooth, sometimes red-brown, grading abruptly into the papillose cells above. **Costa** stout, c. 35–45 µm wide in lower leaf, yellow-brown, ending below the apex, with cells on both surfaces elongate, weakly papillose abaxially in upper half. **Gemmae** borne in clusters on axillary stalks, broadly ovoid, mostly 54–70 × 30–35 µm, 5–6-celled, with two transverse and 1–2 longitudinal walls. **Laminal KOH colour reaction** positive red or yellow then red (also in costa and stem).

Apparently dioicous (only ♀ plants seen from N.Z.). **Perichaetia** apparently terminal and over-topped by innovations, with many archegonia and paraphyses; perichaetial leaves narrowly lanceolate, longer than vegetative leaves (c. 2.2 mm). **Setae** c. 3.5–8 mm long, dextrorse above; **capsules** exserted, cylindric, orange-brown, deeply furrowed along the entire length when dry, c. 1.5–2 mm long.

Operculum not seen. **Peristome** and **calyptra** not seen. **Spores** globose, coarsely papillose, green, 15–21 µm.

Illustrations: Plate 26. Malta 1926, fig. 46 (as *Z. vestitus*); Lewinsky 1990, figs 182–198.

Distribution: NI: S Auckland (Kaingaroa Plains, near Taupō); Hawke's Bay (Tarawera); SI: Marlborough (Black Birch Range), Canterbury (Cass, Hawdon River), Otago (Ōtōkia); St (Port William).

Lewinsky (1990) recorded this species from Paradise (Otago L.D.) based on a J. Child collection in BM but this specimen has not been sighted.

Anomalous. Lewinsky (1990) gave the world distribution as N.Z., Bolivia, and Colombia.

Habitat: This is a rarely collected species. It is recorded as an epiphyte on *Griselinia littoralis*, *Leptospermum scoparium*, and *Cordyline australis*, as well as on *Salix*. A collection from an

unidentified trunk at Port William included *Calyptopogon mnioides*, *Camptochaete angustata*, *Syntrichia serrata*, *Z. intermedius*, and *Metzgeria* sp. There are few reliable elevation data. Material from the North I. appears to come from between c. 250 and c. 500 m. The single Marlborough specimen, the best documented from the South I., is from 900 m, while the Ōtōkia collection almost certainly came from below 100 m elevation.

Notes: The only South American material examined is an isotype of *Z. vestitus* R.S. Williams from Sorata, Bolivia. I agree with Lewinsky (1990) that “the variation between the South American and New Zealand specimens is not large”. The upper abaxial surface of the costa in the Bolivian material is smooth in contrast to N.Z. material, which is weakly papillose. The leaves of the Bolivian material are slightly longer than those of N.Z. material. The dentation near the leaf base mentioned by Lewinsky for Bolivian material has not been seen.

Lewinsky (1990) noted three mature but incomplete sporophytes in Martin's collection from Stewart I.; she gave the setae as c. 8 and the capsule as c. 2 mm long. The only capsule seen in a collection from Black Birch Range by P. Beveridge (CHR 555561, a duplicate of WELT M035567) has a shorter (c. 3.5 mm) seta and capsule (1.5 mm), and abundant spores.

The Bolivian material seen (WELT M040252) has three setae each 5 mm long and inoperculate capsules each c. 2 mm long (including the neck). Malta (1926, p. 88) quoted R.S. Williams, giving the peristome of *Z. vestitum* as “of 8 cilia”.

Malta (1926) tentatively treated *Z. vestitus* and *Z. rufescens* as separate taxa, but he had not seen sporophytes of the latter taxon. Lewinsky's (1990) judgement that the South American name *Z. rufescens* (Hampe) Broth. should be applied to N.Z. material followed that of Sainsbury (1945; 1955) and is accepted here.

Despite being poorly documented, the relatively robust habit (shoots of *Z. rufescens* are c. 2.0–2.5 mm wide vs c. 2.0 mm for *Z. intermedius*), strongly spreading-squarrose leaves, and gemmae with both transverse and longitudinal septa make *Z. rufescens* a distinctive species in a N.Z. context. Glenny et al. (2011) ranked the threat status of *Z. rufescens* as naturally uncommon and data deficient.

Etymology: The epithet *rufescens* means becoming red or reddish.

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Conventions

Abbreviations and Latin terms

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

PK	Poor Knights Islands
P.N.G.	Papua New Guinea
<i>pro parte</i>	in part
Qld	Queensland
q.v.	which see (<i>quod vide</i>)
RT	Rangitoto Island
S.A.	South Australia
<i>s.coll.</i>	without collector (<i>sine collectore</i>)
<i>s.d.</i>	without date (<i>sine die</i>)
sect.	section
SEM	scanning electron microscope/microscopy
<i>sensu</i>	in the taxonomic sense of
SI	South Island
<i>sic</i>	as written
<i>s.l.</i>	in a broad taxonomic sense (<i>sensu lato</i>)
<i>s.loc.</i>	without location (<i>sine locus</i>)
Sn	Snares Islands
<i>s.n.</i>	without a collection number (<i>sine numero</i>)
Sol	Solander Island
sp.	species (singular)
spp.	species (plural)
<i>s.s.</i>	in a narrow taxonomic sense (<i>sensu stricto</i>)
St	Stewart Island
<i>stat. nov.</i>	new status (<i>status novus</i>)
subg.	subgenus
subsect.	subsection
subsp.	subspecies (singular)
subsp.	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 (<i>videlicet</i>)
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

Technical terms conform to Malcolm, B.; Malcolm, N. 2006: *Mosses and other Bryophytes: an Illustrated Glossary*. Edition 2. Micro-Optics Press, Nelson.

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

Supplementary Glossary for Orthotrichaceae

Term	Definition
funiculate	a sigmoid twisting of leaves such that the shoot (usually a branch) appears like a twisted cord; used in the sense of Vitt (1983)
isosporous	having spores in a single capsule all of a uniform diameter (opposite of anisosporous, having spores in a single capsule exhibiting a bimodal range of diameters)
littoral	of or on the shore of the sea and subject to some degree of salt spray

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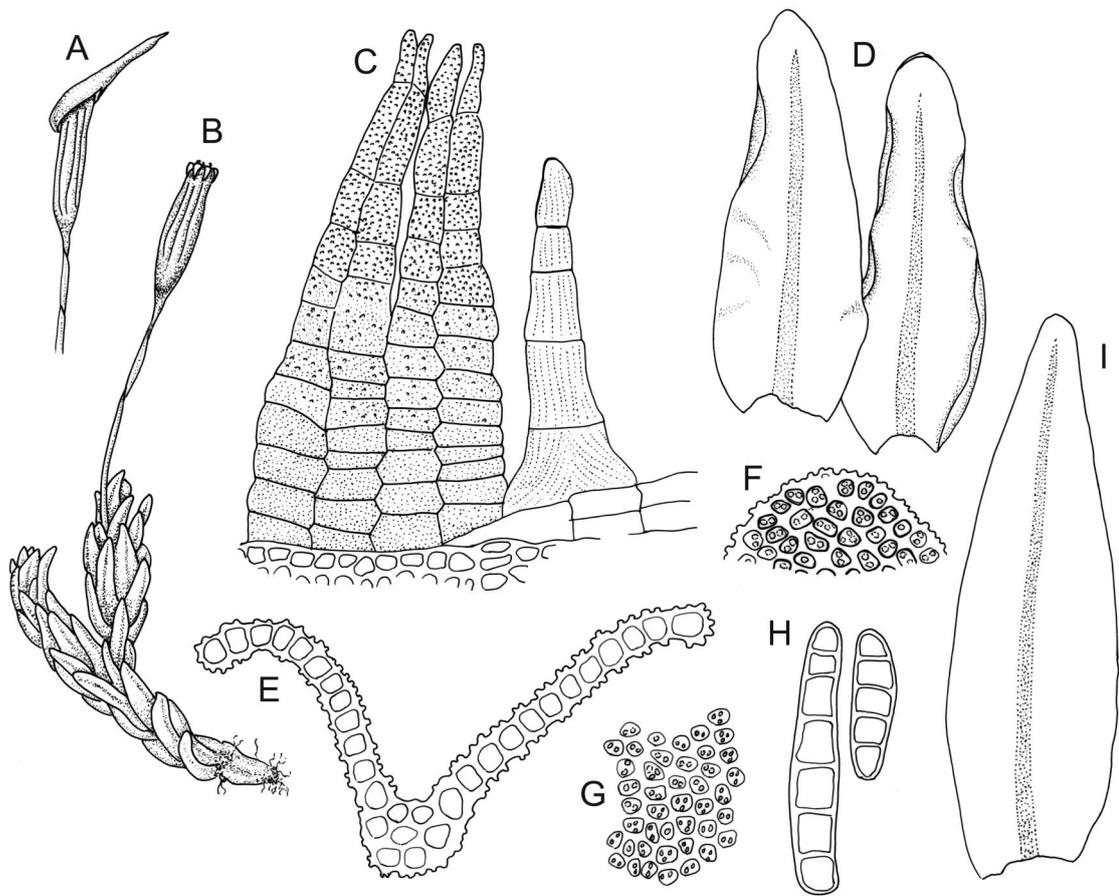


Plate 1: *Leratia*. A–I: *L. obtusifolia*. A, capsule with calyptra, moist. B, habit with capsule, moist. C, peristome detail with two paired exostome teeth and one endostome segment. D, stem leaves. E, cross-section of laminal cells including costa. F, leaf apex. G, upper laminal cells. H, gemmae. I, perichaetial leaf. Redrawn with permission from Lewinsky (1990).

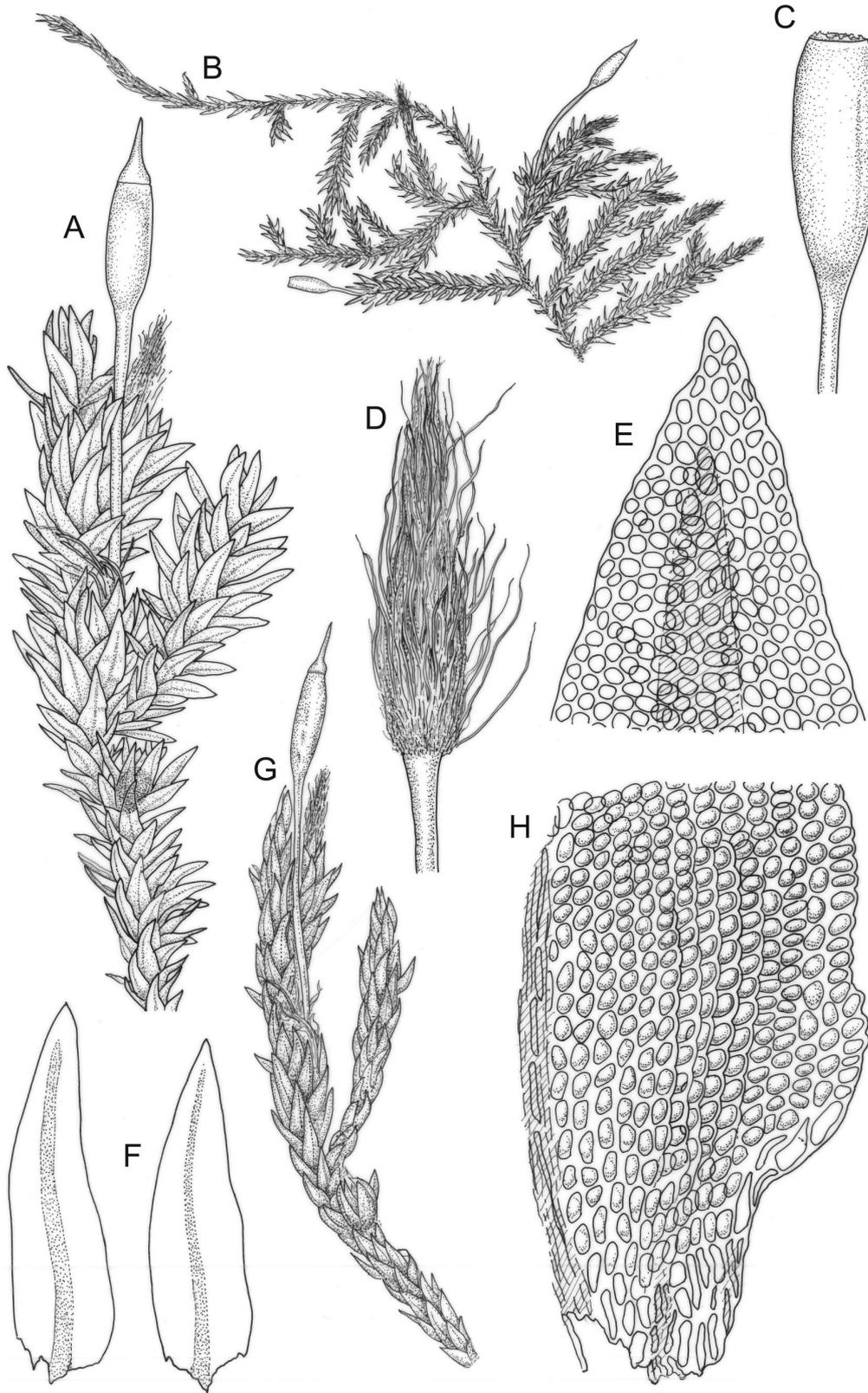


Plate 2: *Macrocoma*. A–H: *M. tenue* subsp. *tenue*. A, branch detail with capsule, moist. B, habit with capsules, moist. C, capsule, moist. D, immature capsule with calyptra. E, leaf apex. F, leaves. G, branch detail with capsule, dry. H, basal laminal cells, from costa to margin. Drawn from *A.J. Fife 5388*, CHR 351305.

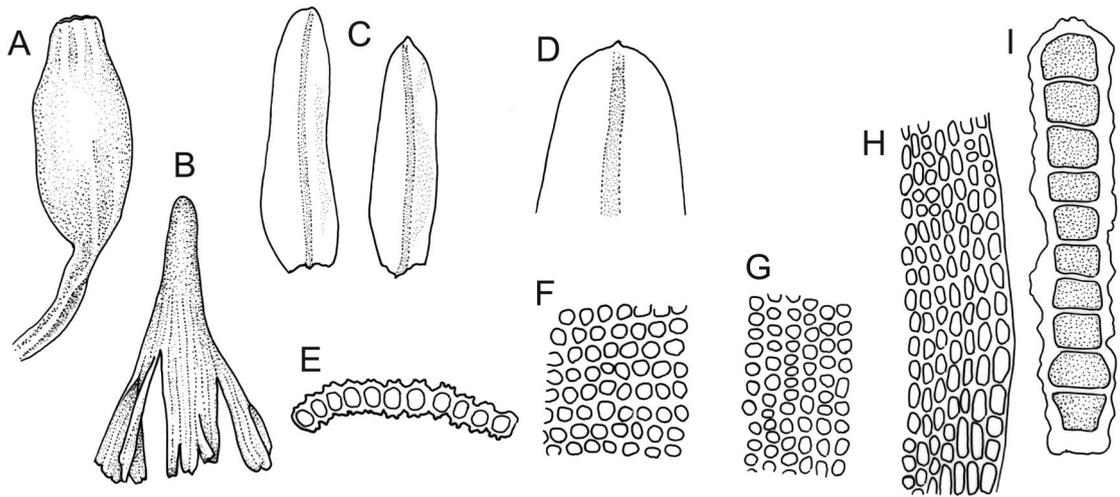


Plate 3: *Macromitrium*. A–I: *M. brevicaule*. A, capsule, dry. B, calyptra, dry. C, branch leaves. D, branch leaf apex. E, cross-section of upper laminal cells. F, upper laminal cells. G, transitional laminal cells. H, basal laminal cells at margin. I, gemmae. Redrawn with permission from Vitt (1983, cited as *M. wattsi*).

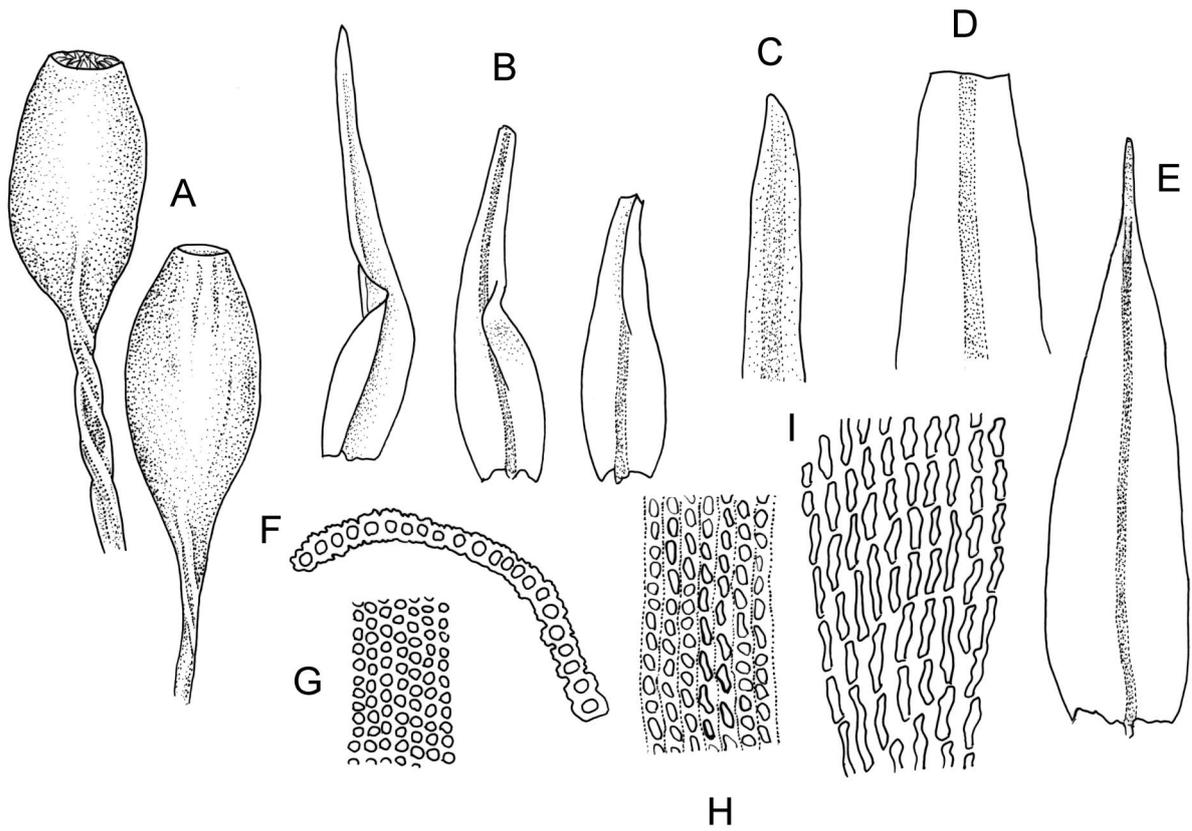


Plate 4: *Macromitrium*. A–I: *M. gracile*. A, capsules, moist. B, branch leaves. C, branch leaf apex, unbroken. D, branch leaf apex, with broken tip. E, perichaetial leaf. F, cross-section of upper laminal cells. G, upper laminal cells. H, transitional laminal cells. I, basal laminal cells. Redrawn with permission from Vitt (1983).

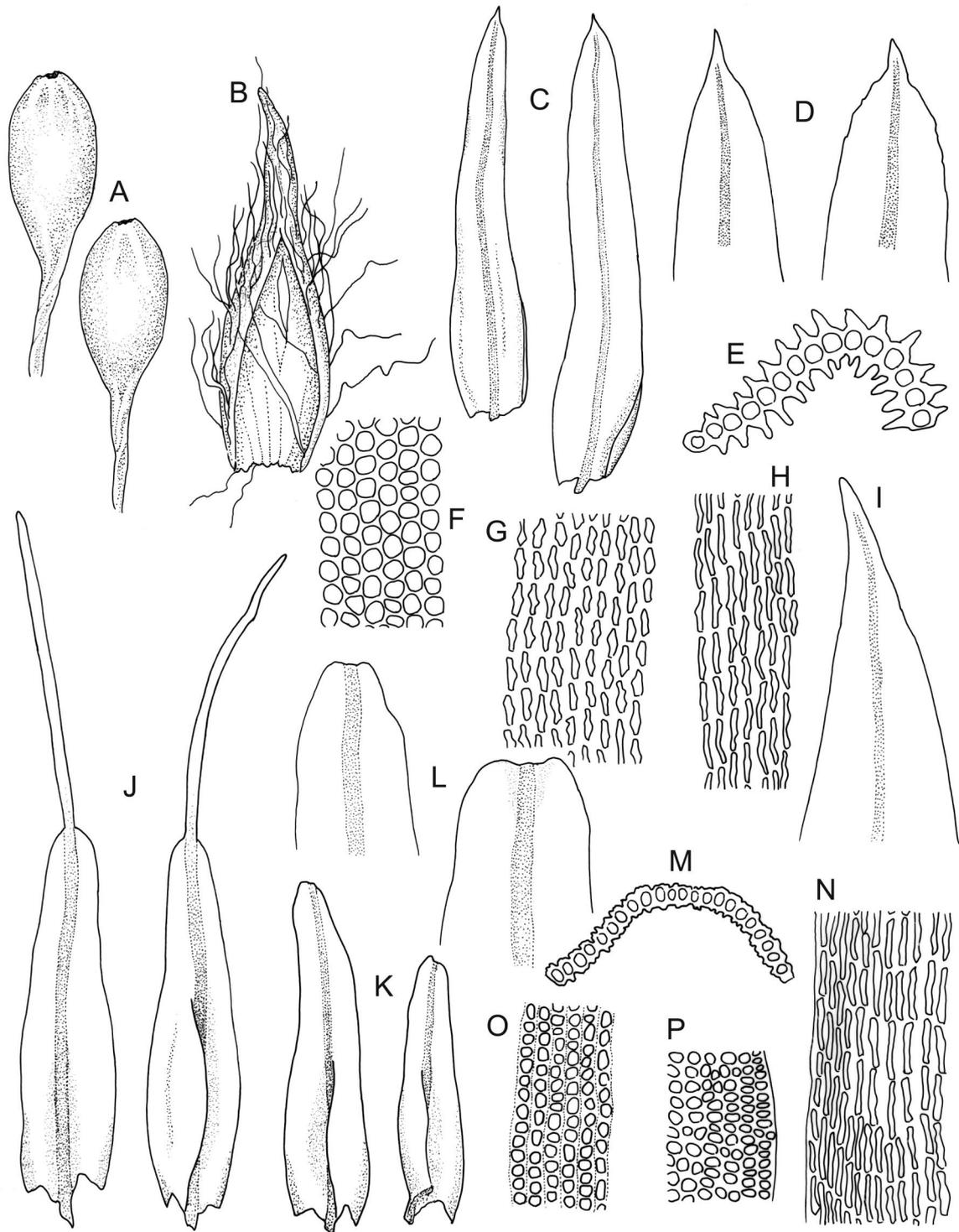


Plate 5: *Macromitrium*. A–I: *M. grossirete*. A, capsules, moist. B, calyptra, dry. C, branch leaves. D, branch leaf apices. E, cross-section of upper laminal cells. F, upper laminal cells. G, transitional laminal cells. H, basal laminal cells. I, perichaetial leaf apex. **J–P: *M. helmsii*.** J–K, branch leaves. L, branch leaf apices. M, cross-section of upper laminal cells. N, basal laminal cells at margin. O, transitional laminal cells. P, upper laminal cells at margin. Redrawn with permission from Vitt (1983).

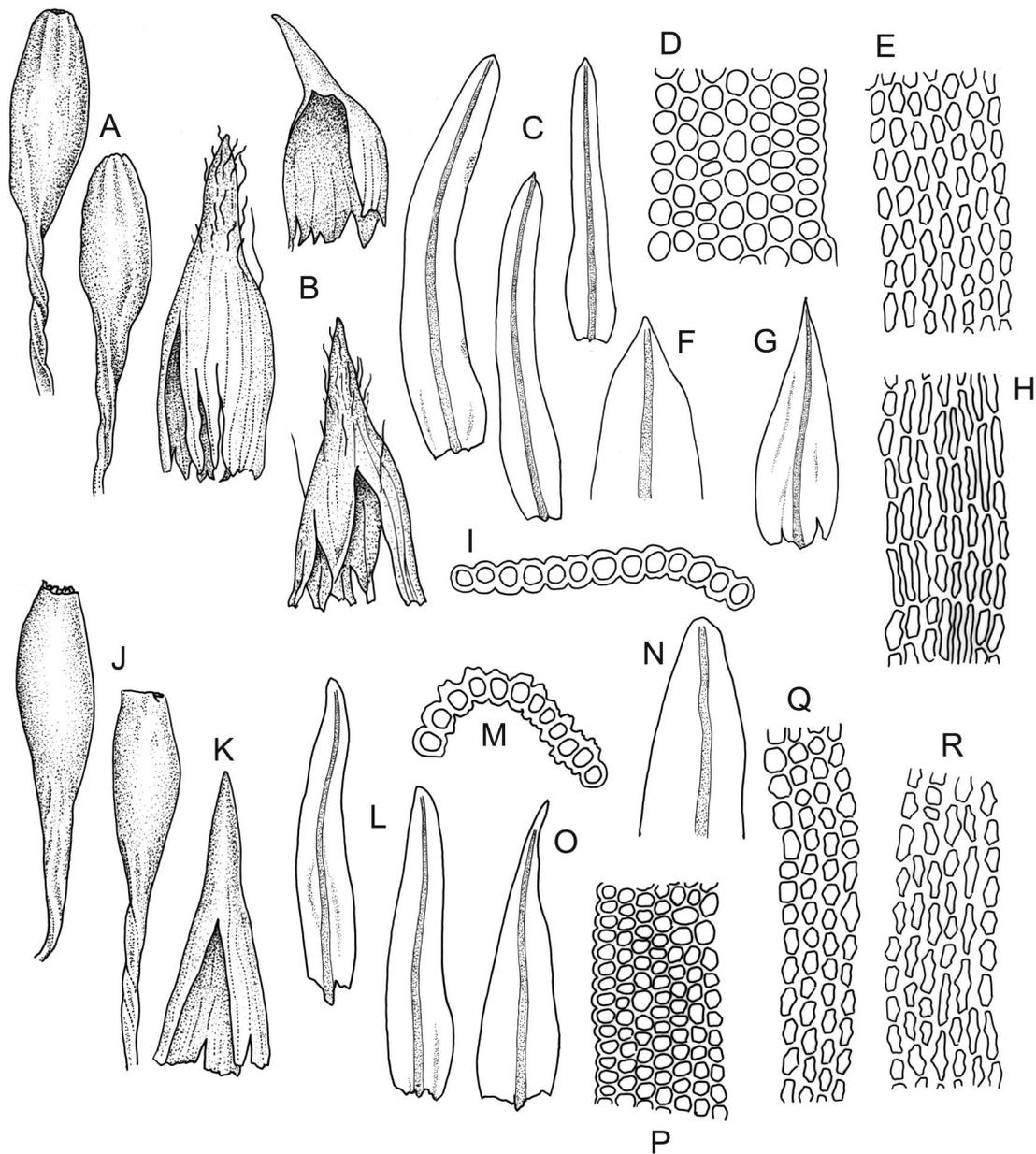


Plate 6: *Macromitrium*. A–I: *M. ligulaefolium*. A, capsules, dry. B, calyptrae. C, three branch leaves. D, upper laminal cells at margin. E, transitional laminal cells. F, branch leaf apex. G, perichaetial leaf. H, basal laminal cells. I, cross-section of upper laminal cells. **J–R: *M. ligulare*.** J, capsules, dry. K, calyptra. L, branch leaves. M, cross-section of upper laminal cells. N, branch leaf apex. O, perichaetial leaf. P, upper laminal cells at margin. Q, transitional laminal cells. R, basal laminal cells. Redrawn with permission from Vitt (1983).

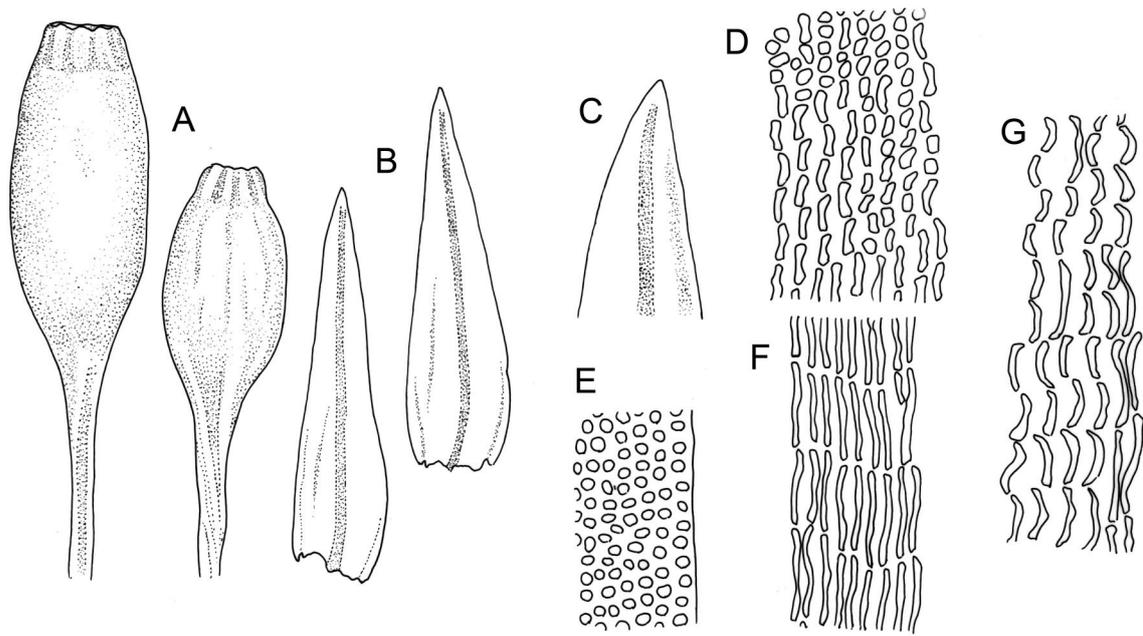


Plate 7: *Macromitrium*. A–G: *M. longipes*. A, capsules, dry not showing peristome. B, branch leaves. C, branch leaf apex. D, upper transitional laminal cells. E, upper laminal cells at margin. F, basal laminal cells. G, lower transitional laminal cells. Redrawn with permission from Vitt (1983).

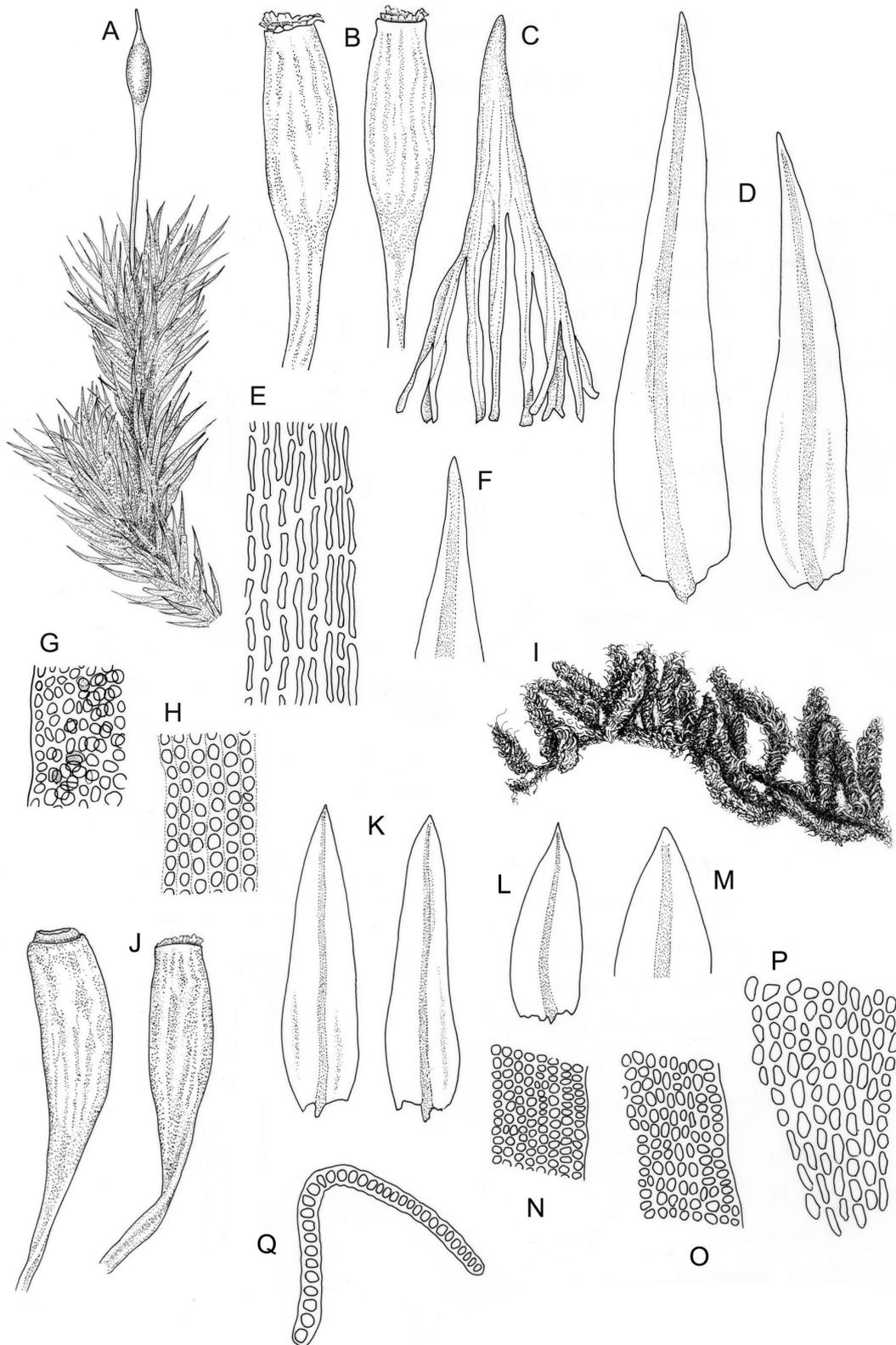


Plate 8: *Macromitrium*. A–I: *M. longirostre* var. *longirostre*. A, habit with capsule, moist. B, capsules, dry. C, calyptra. D, branch leaves. E, basal laminal cells. F, branch leaf apex. G, upper laminal cells at margin. H, transitional laminal cells. I, habit of sterile plant, dry. **J–Q: *M. longirostre* var. *ramsayae*.** J, capsules, dry. K, branch leaves. L, perichaetial leaf. M, branch leaf apex. N, upper laminal cells at margin. O, transitional laminal cells at margin. P, basal laminal cells. Q, cross-section of upper laminal cells. *M. longirostre* var. *longirostre*: A, I drawn from *D.H. Vitt 9725, CHR 448030*; B–H, J–Q redrawn with permission from Vitt (1983); *M. longirostre* var. *ramsayae*: J–Q redrawn with permission from Vitt (1983, cited as *M. ramsayae*).

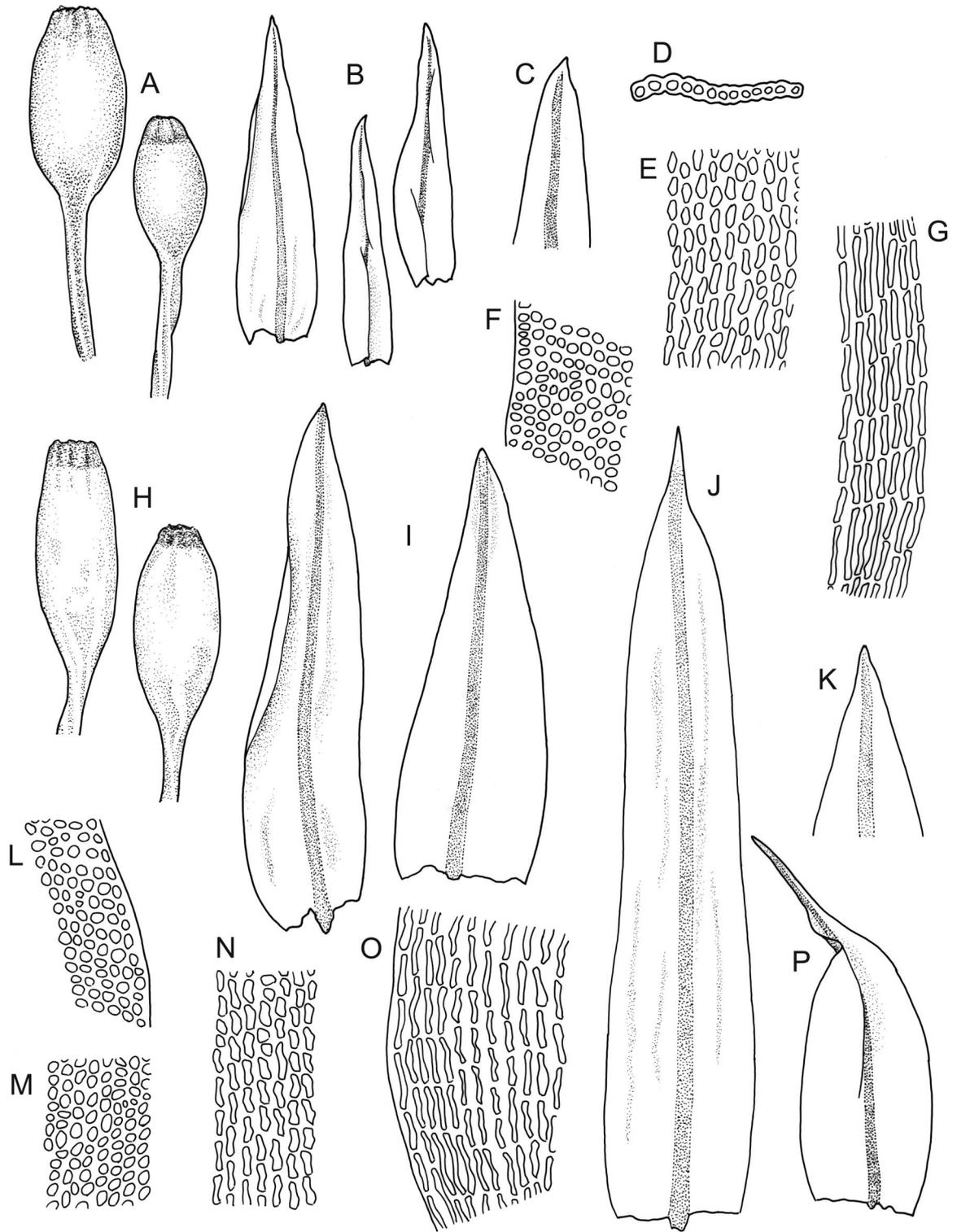


Plate 9: *Macromitrium*. A–G: *M. microstomum*. A, capsules, moist. B, branch leaves. C, branch leaf apex. D, cross-section of upper laminal cells. E, transitional laminal cells. F, upper laminal cells at margin. G, basal laminal cells. **H–P: *M. orthophyllum*.** H, capsules, moist. I, branch leaves. J, perichaetial leaf. K, branch leaf apex. L, upper laminal cells at margin. M, upper transitional laminal cells. N, lower transitional laminal cells. O, basal cells at margin. P, stem leaf. Redrawn with permission from Vitt (1983).

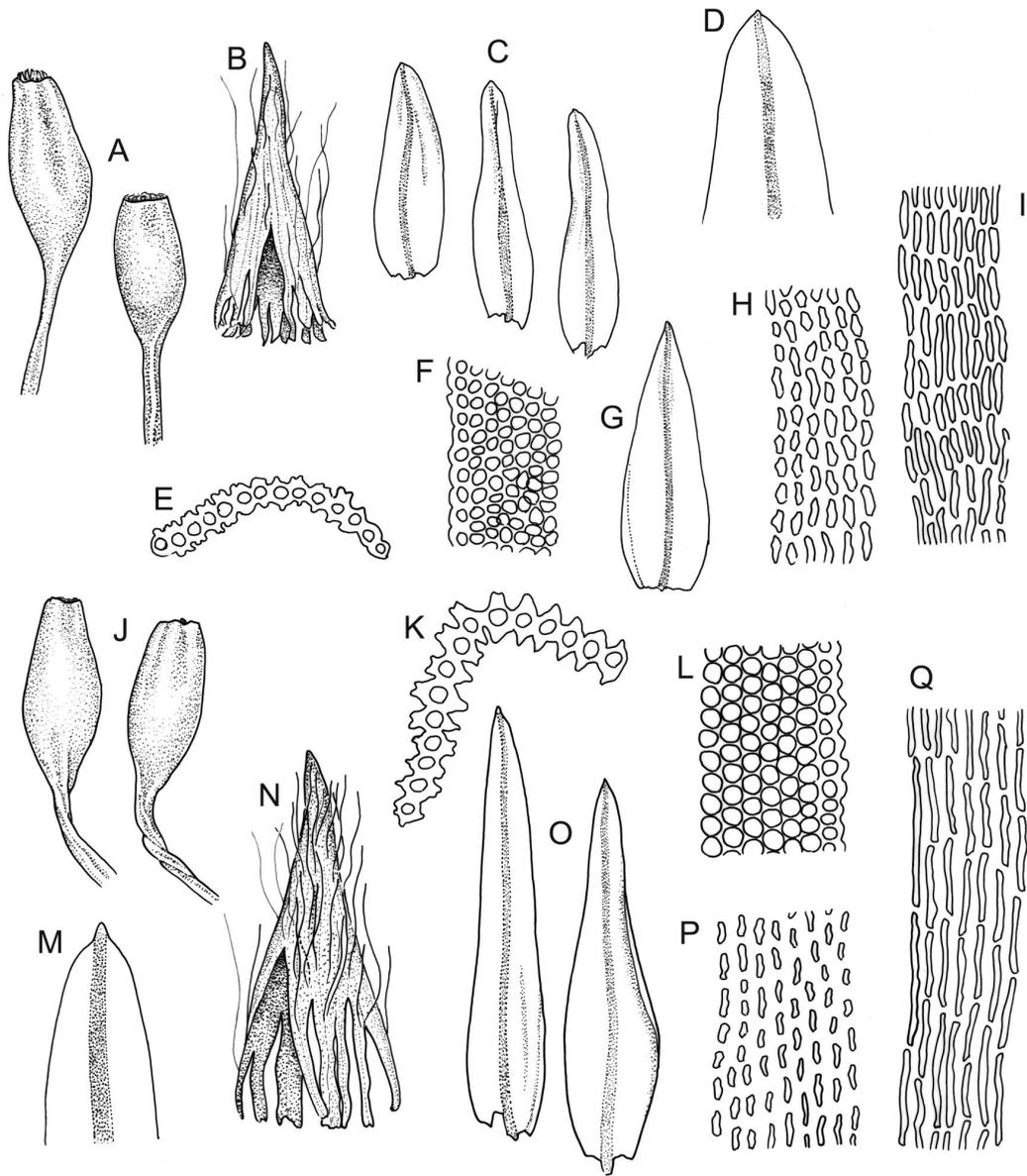


Plate 10: *Macromitrium*. A–Q: *M. prorepens*. A, capsules, moist. B, calyptra. C, branch leaves. D, branch leaf apex. E, cross-section of upper laminal cells. F, upper laminal cells at margin. G, perichaetial leaf. H, transitional laminal cells. I, basal laminal cells. J, capsules, dry. K, cross-section of upper laminal cells. L, upper laminal cells at margin. M, branch leaf apex. N, calyptra. O, branch leaves. P, transitional laminal cells. Q, basal laminal cells. Redrawn with permission from Vitt (1983, some cited as *M. submucronifolium*).

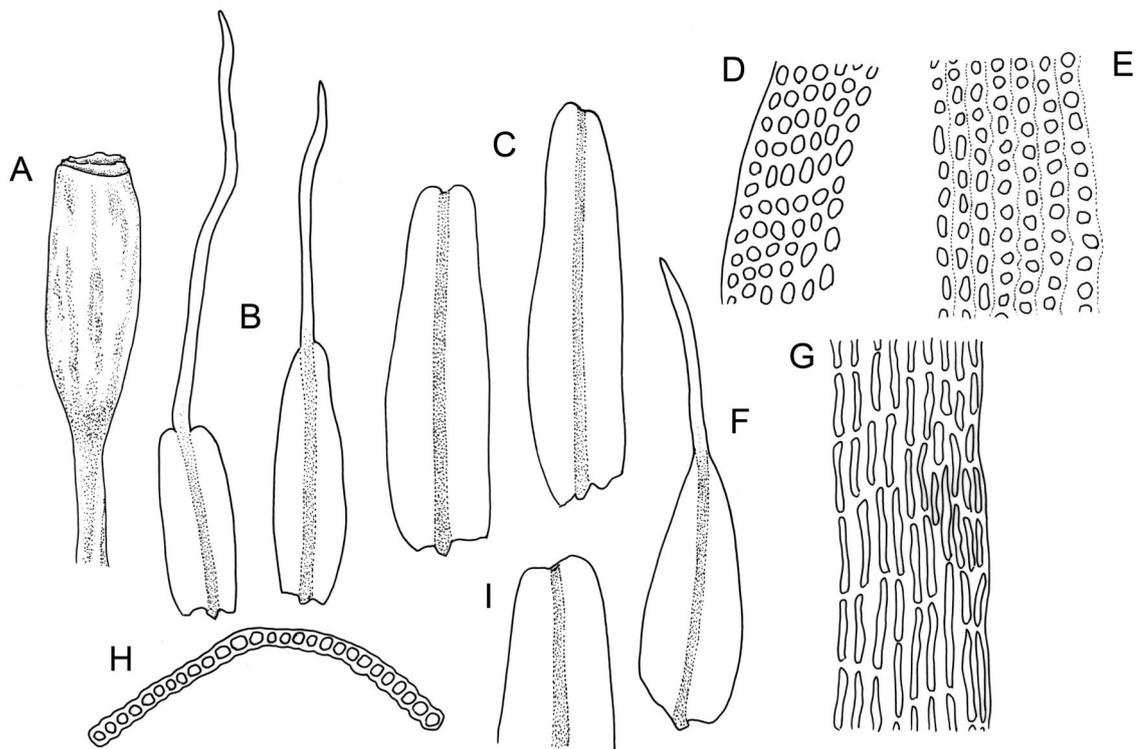


Plate 11: *Macromitrium*. A–I: *M. retusum*. A, capsule, moist. B, immature branch leaves, with arista intact. C, mature branch leaves, with arista fallen. D, upper laminal cells at margin. E, transitional laminal cells. F, perichaetial leaf. G, basal laminal cells at margin. H, cross-section of upper laminal cells. I, branch leaf apex, with arista fallen. Redrawn with permission from Vitt (1983).

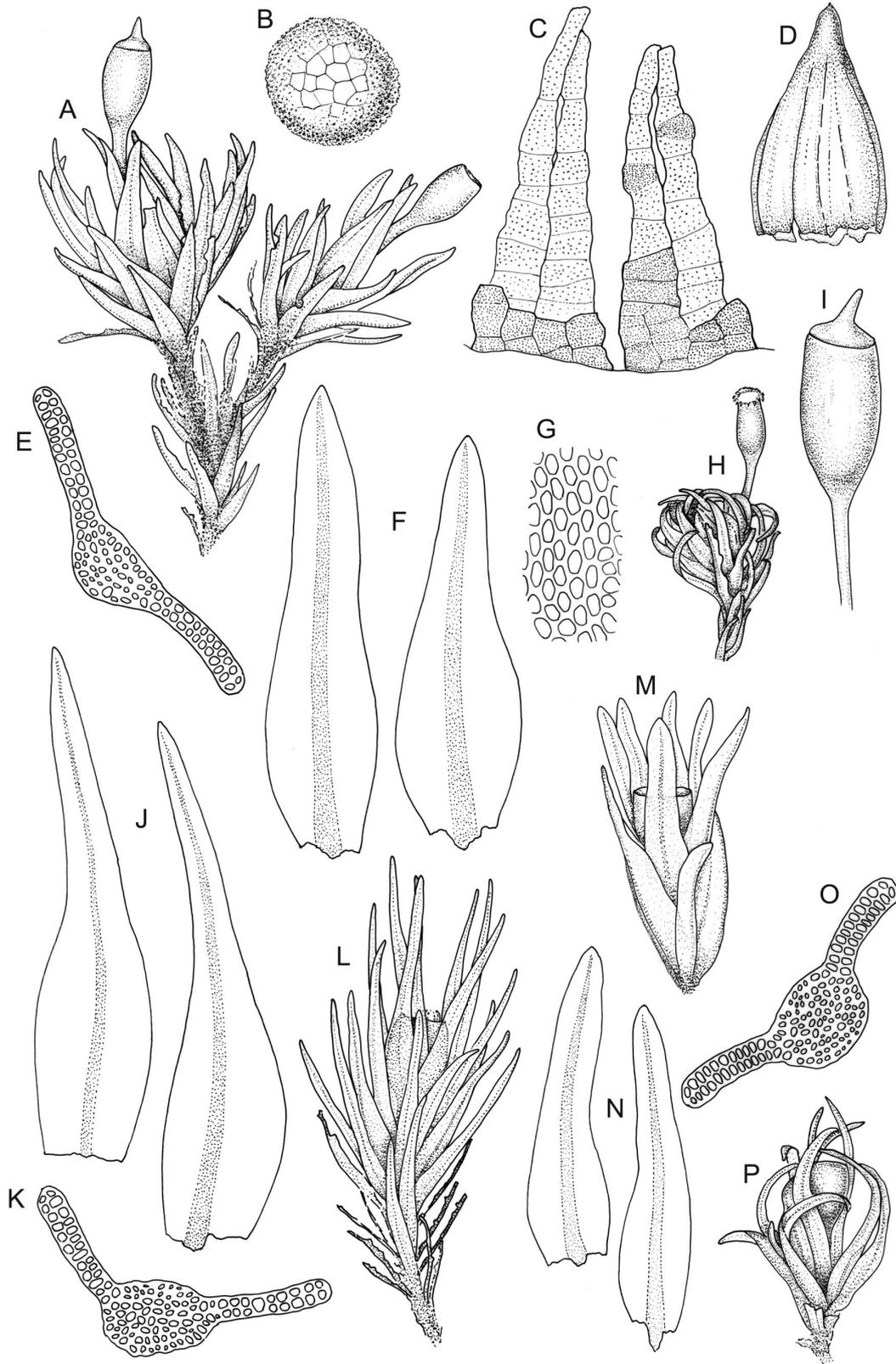


Plate 12: *Orthotrichum*. A–I: *O. crassifolium* subsp. *crassifolium*. A, habit with capsules, moist. B, spore. C, peristome detail. D, calyptra. E, cross-section of upper laminal cells including costa. F, leaves. G, upper laminal cells. H, perichaetial branch detail, dry. I, capsule. **J–L: *O. angustifolium*.** J, leaves. K, cross-section of upper laminal cells including costa. L, perichaetial branch detail, moist. **M–P: *O. aucklandicum*.** M, perichaetial branch detail, moist. N, leaves. O, cross-section of upper laminal cells including costa. P, perichaetial branch detail, dry. *O. crassifolium* subsp. *crassifolium*: drawn from D.H. Vitt 2316, CHR 556093; *O. angustifolium*: drawn from D.H. Vitt 2983, CHR 486044; *O. aucklandicum*: drawn from B.H. Macmillan 83/134, CHR 351617.

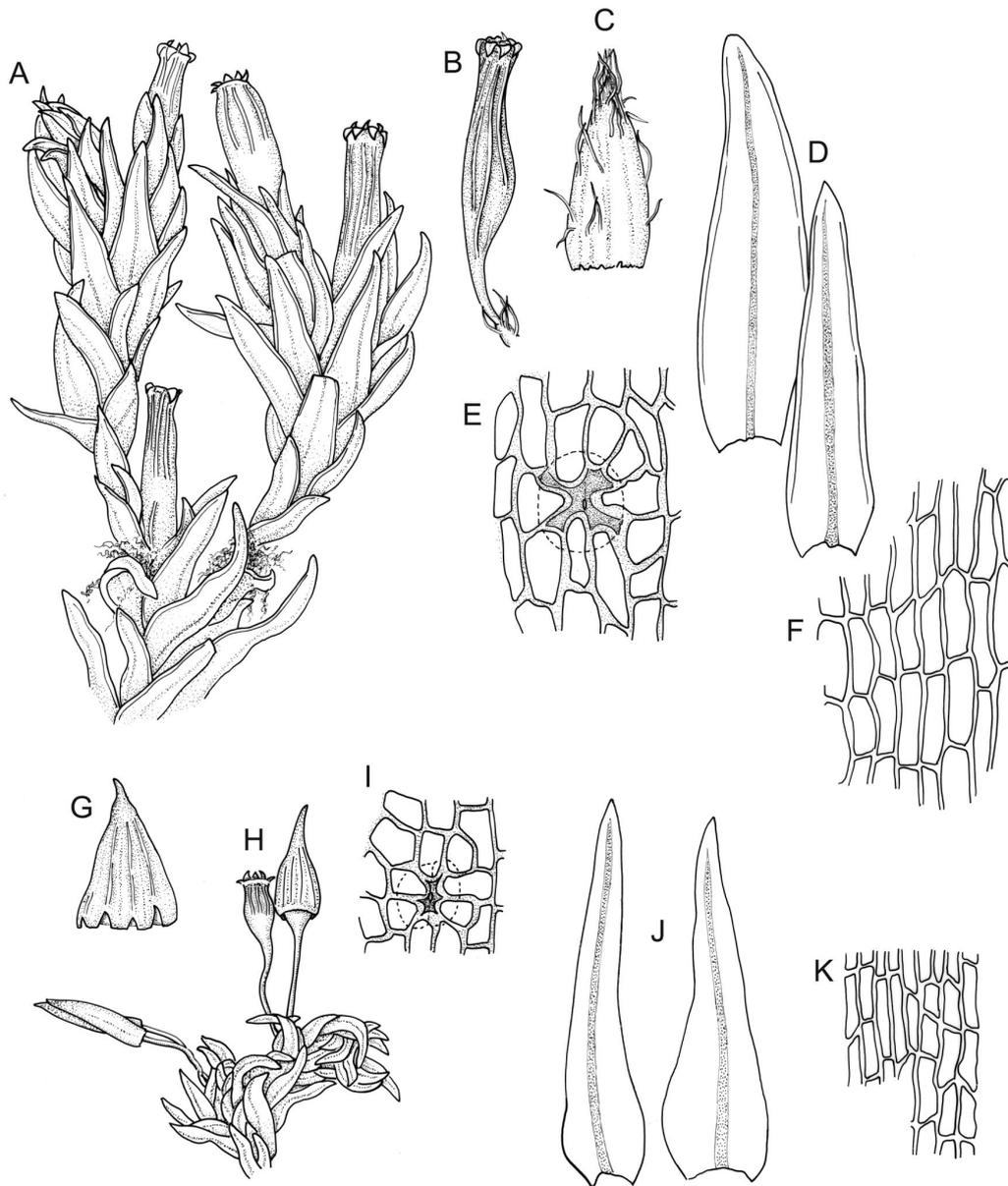


Plate 13: *Orthotrichum*. A–F: *O. assimile*. A, habit with capsules, moist. B, capsule, dry. C, calyptra, dry. D, leaves. E, stoma. F, basal laminal cells. G–K: *O. calvum*. G, calyptra, dry. H, habit with capsules, dry. I, stoma. J, leaves. K, basal laminal cells. Redrawn with permission from Lewinsky (1984).

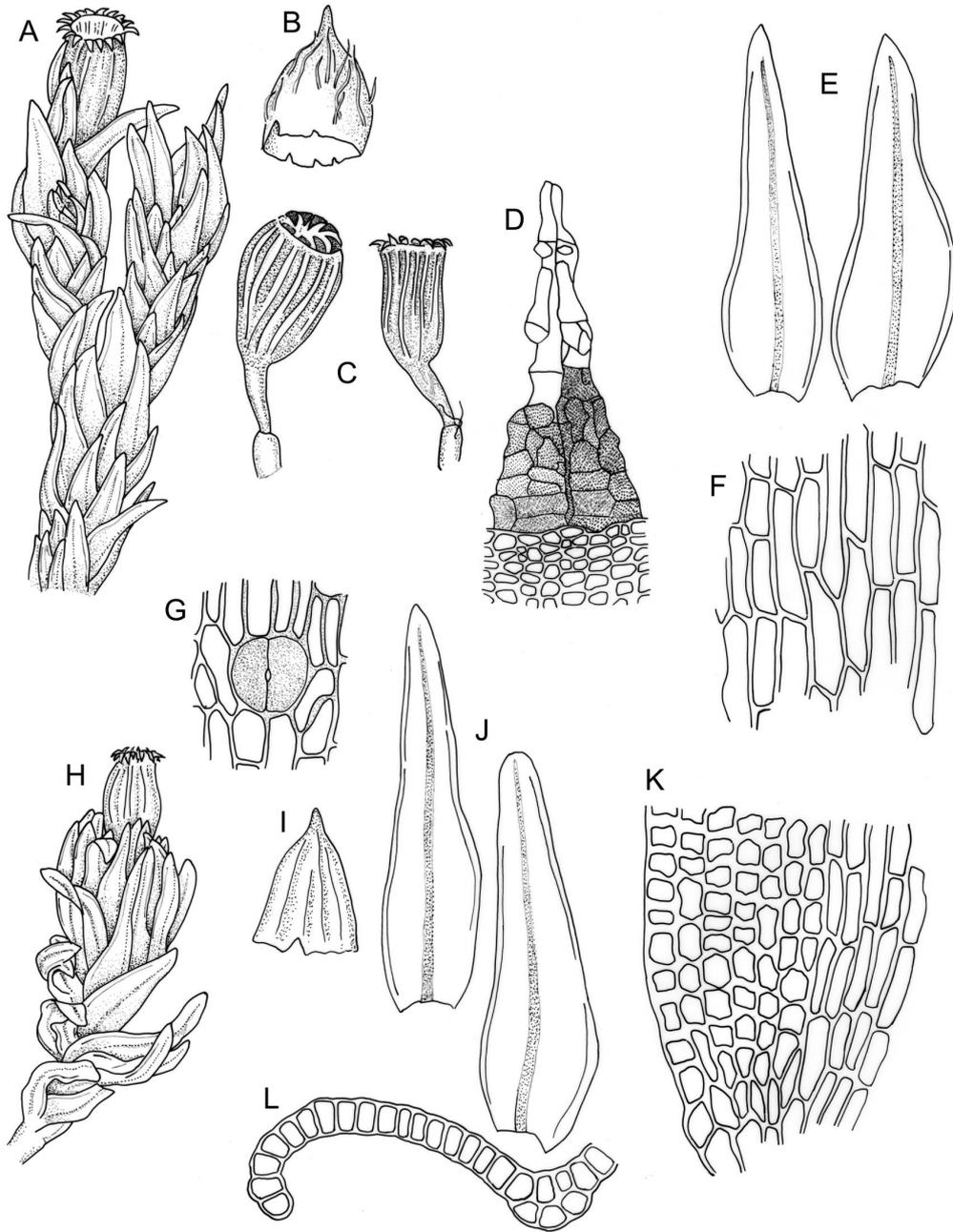


Plate 14: *Orthotrichum*. A–F: *O. cupulatum*. A, habit with capsule, moist. B, calyptra. C, capsules, dry. D, peristome detail. E, leaves. F, basal laminal cells. **G–L: *O. cyathiforme*.** G, stoma. H, habit with capsule, moist. I, calyptra. J, leaves. K, basal angle cells. L, cross-section of upper laminal cells including costa. Redrawn with permission from Lewinsky (1984).

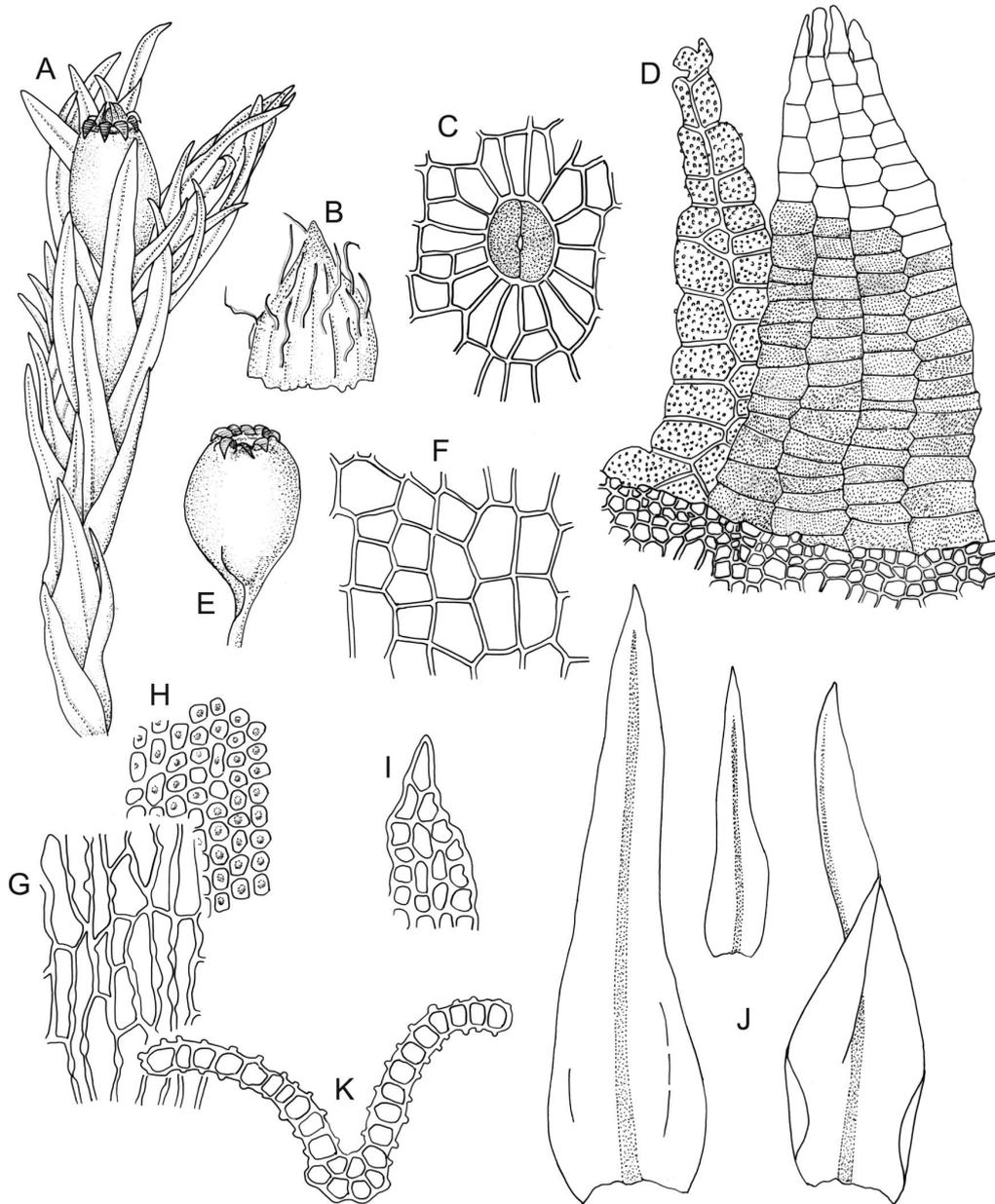


Plate 15: *Orthotrichum*. A–K: *O. graphiomitrium*. A, habit with capsule, moist. B, calyptra. C, stoma. D, peristome detail. E, capsule, moist. F, exothecial cells. G, basal laminal cells. H, upper laminal cells. I, leaf apex. J, three leaves. K, cross-section of upper laminal cells including costa. Redrawn with permission from Lewinsky (1984).

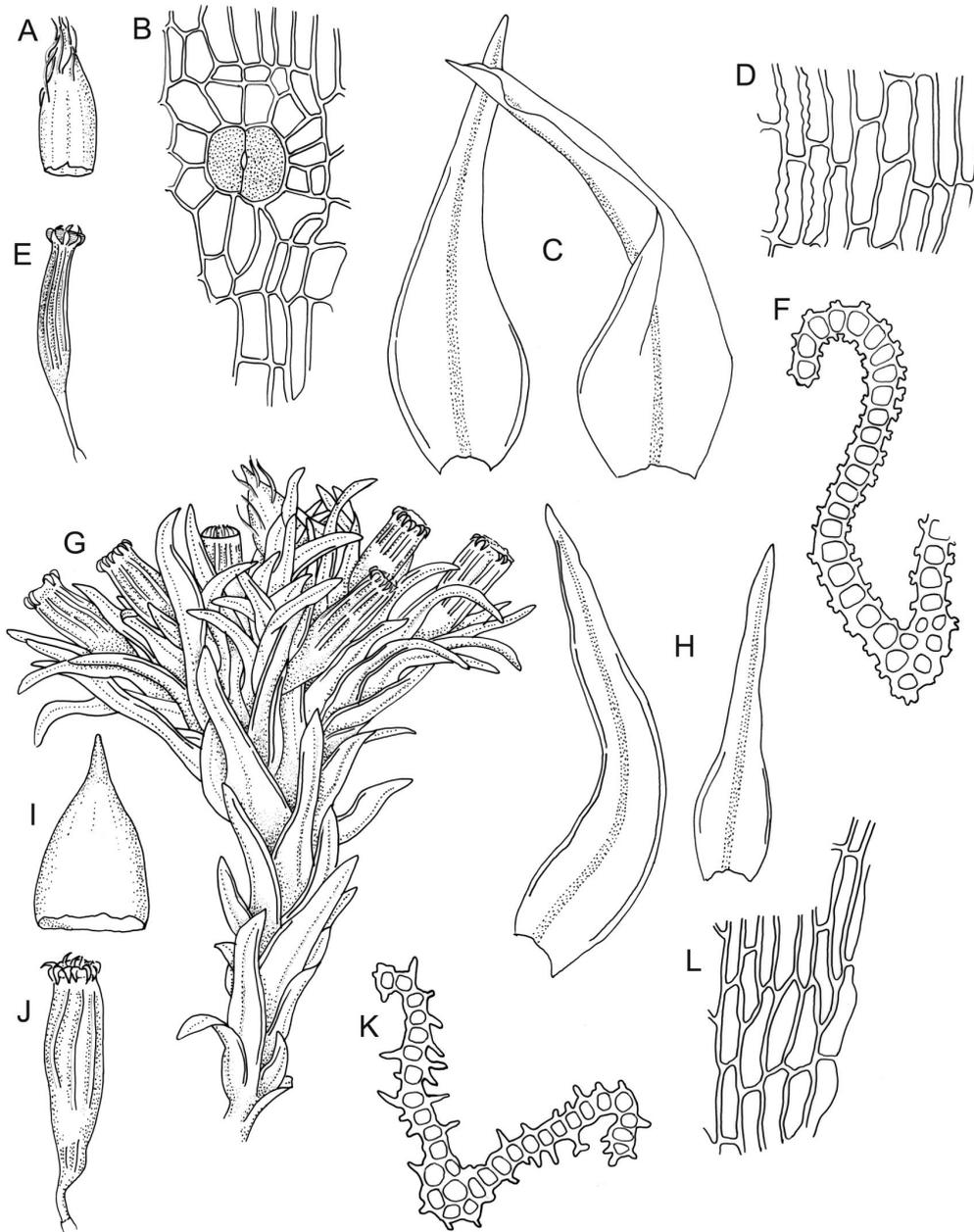


Plate 16: *Orthotrichum*. A–F: *O. hortense*. A, calyptra. B, stoma. C, leaves. D, basal laminal cells. E, capsule, dry. F, cross-section of upper laminal cells including costa. **G–L: *O. sainsburyi*.** G, habit with capsules, moist. H, leaves. I, calyptra. J, capsule, dry. K, cross-section of upper laminal cells including costa. L, basal laminal cells. Redrawn with permission from Lewinsky (1984).

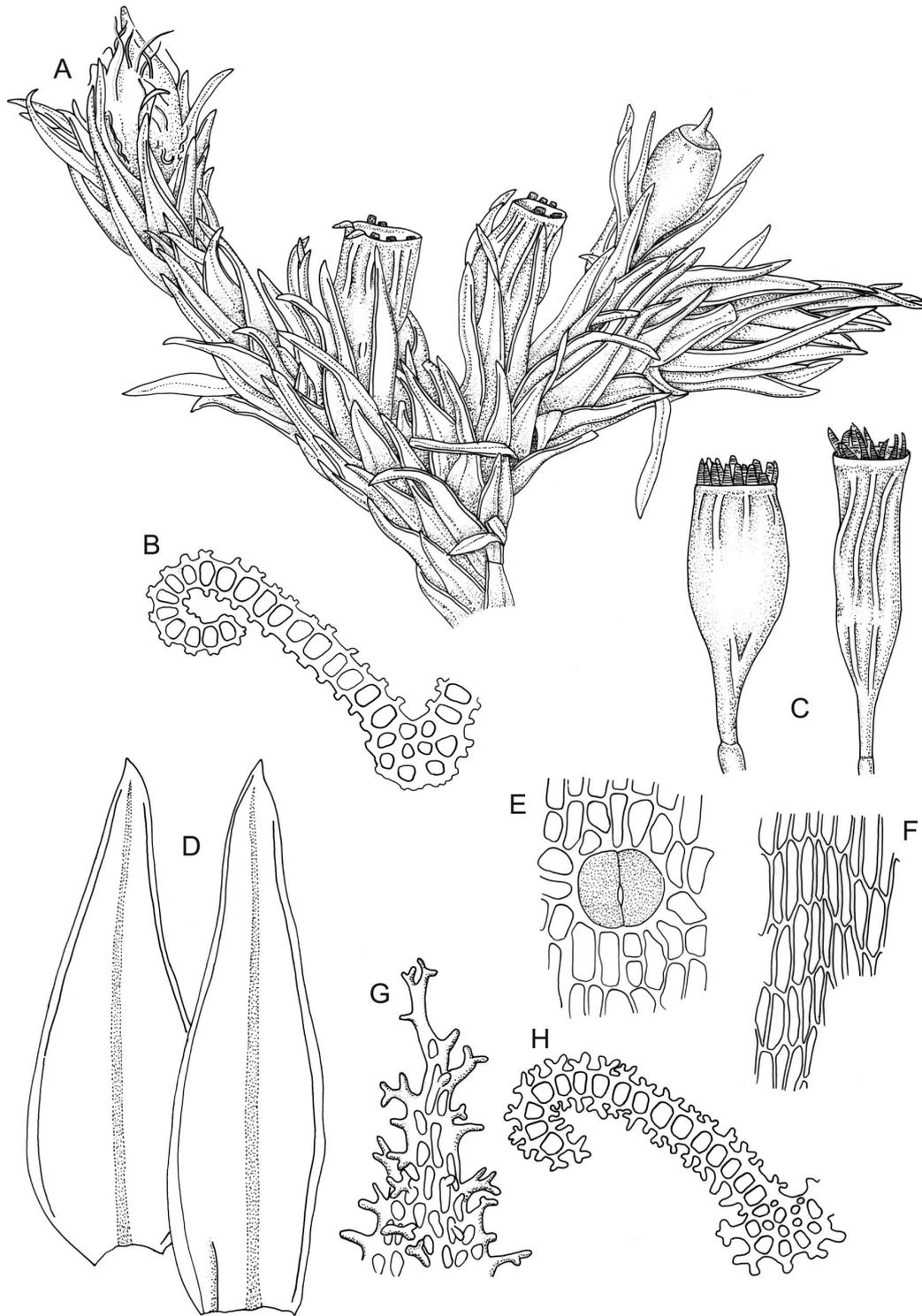


Plate 17: *Orthotrichum*. A–C: *O. rupestre* var. *rupestre*. A, habit with capsules, moist. B, cross-section of upper laminal cells including costa. C, capsules, moist and dry. **D–H: *O. rupestre* var. *papillosum*.** D, leaves. E, stoma. F, basal laminal cells. G, leaf apex. H, cross-section of upper laminal cells including costa. Redrawn with permission from Lewinsky (1984).

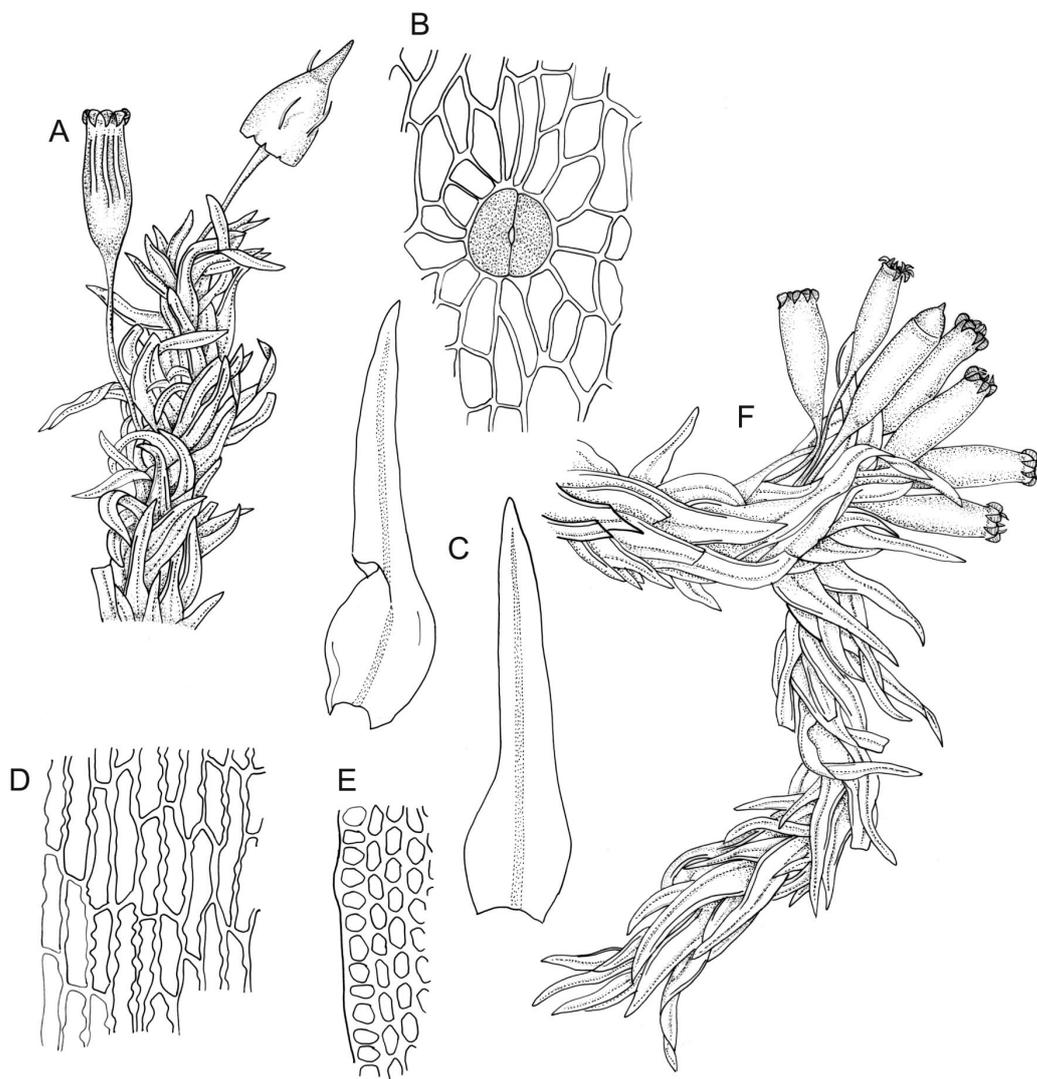


Plate 18: *Orthotrichum*. A–E: *O. tasmanicum* var. *tasmanicum*. A, habit with capsules, dry. B, stoma. C, leaves. D, basal laminal cells. E, upper laminal cells at margin. **F: *O. tasmanicum* var. *parvithecum*.** F, habit with capsules, moist. Redrawn with permission from Lewinsky (1984).

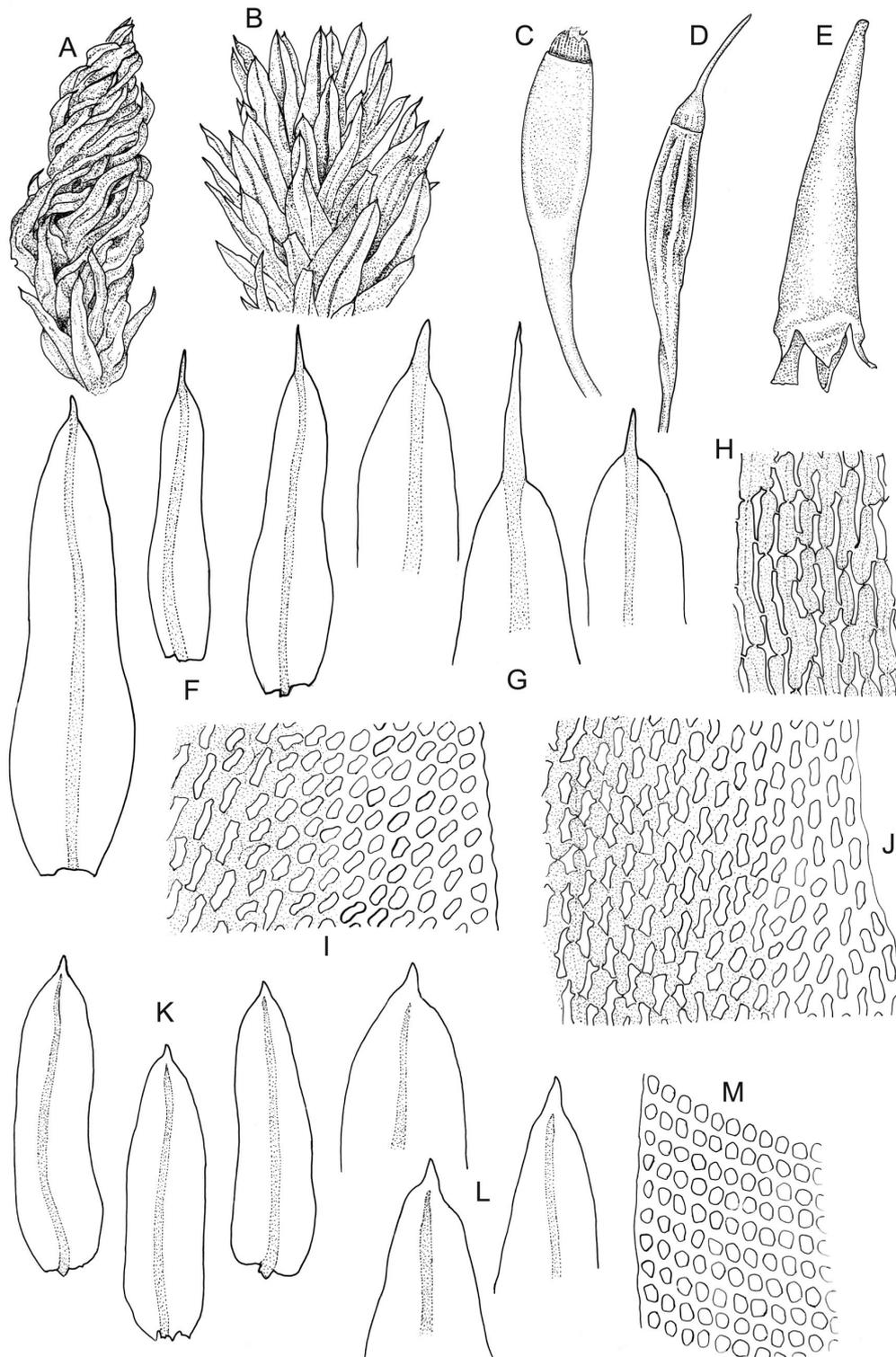


Plate 19: *Schlotheimia*. A–J: *S. campbelliana*. A, portion of branch, dry. B, portion of branch, moist. C, capsule, moist. D, capsule with operculum, dry. E, calyptra. F, three branch leaves. G, branch leaf apices. H, basal laminal cells. I, upper laminal cells at margin. J, mid laminal cells at margin. **K–M: *S. knightii*.** K, three branch leaves. L, branch leaf apices. M, upper laminal cells at margin. *S. campbelliana*: A–D, H–J drawn from *W. Martin s.n.*, Feb. 1947, CHR 98754; E–G redrawn with permission from Vitt (1983). *S. knightii*: K–L redrawn with permission from Vitt (1983); M drawn from *J. Lewinsky 2421*, CHR 350083.

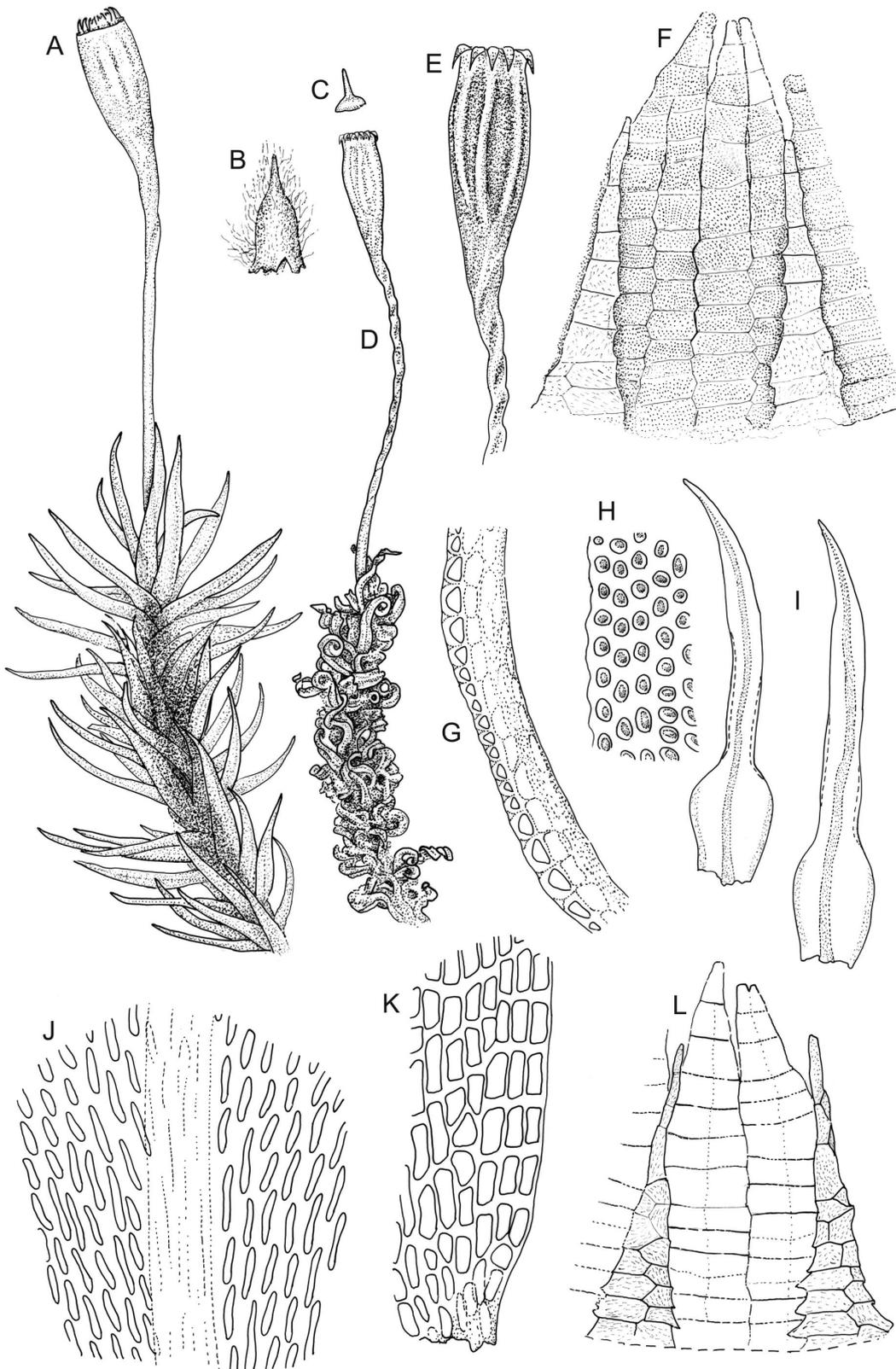


Plate 20: *Uloa*. A–L: *U. lutea*. A, habit with capsule, moist. B, calyptra. C, operculum. D, habit with capsule, dry. E, capsule, dry. F, peristome detail showing paired exostome teeth (shaded) and two endostome segments lacking median lines. G, capsule wall cross-section. H, upper laminal cells at margin. I, leaves. J, basal laminal cells adjacent to costa. K, basal laminal cells at margin. L, peristome detail showing paired exostome teeth (not shaded) and two endostome segments with partial median lines. A–K drawn from A.J. Fife 8084, CHR 436819; L drawn from E.A. Hodgson 84, CHR 556094.

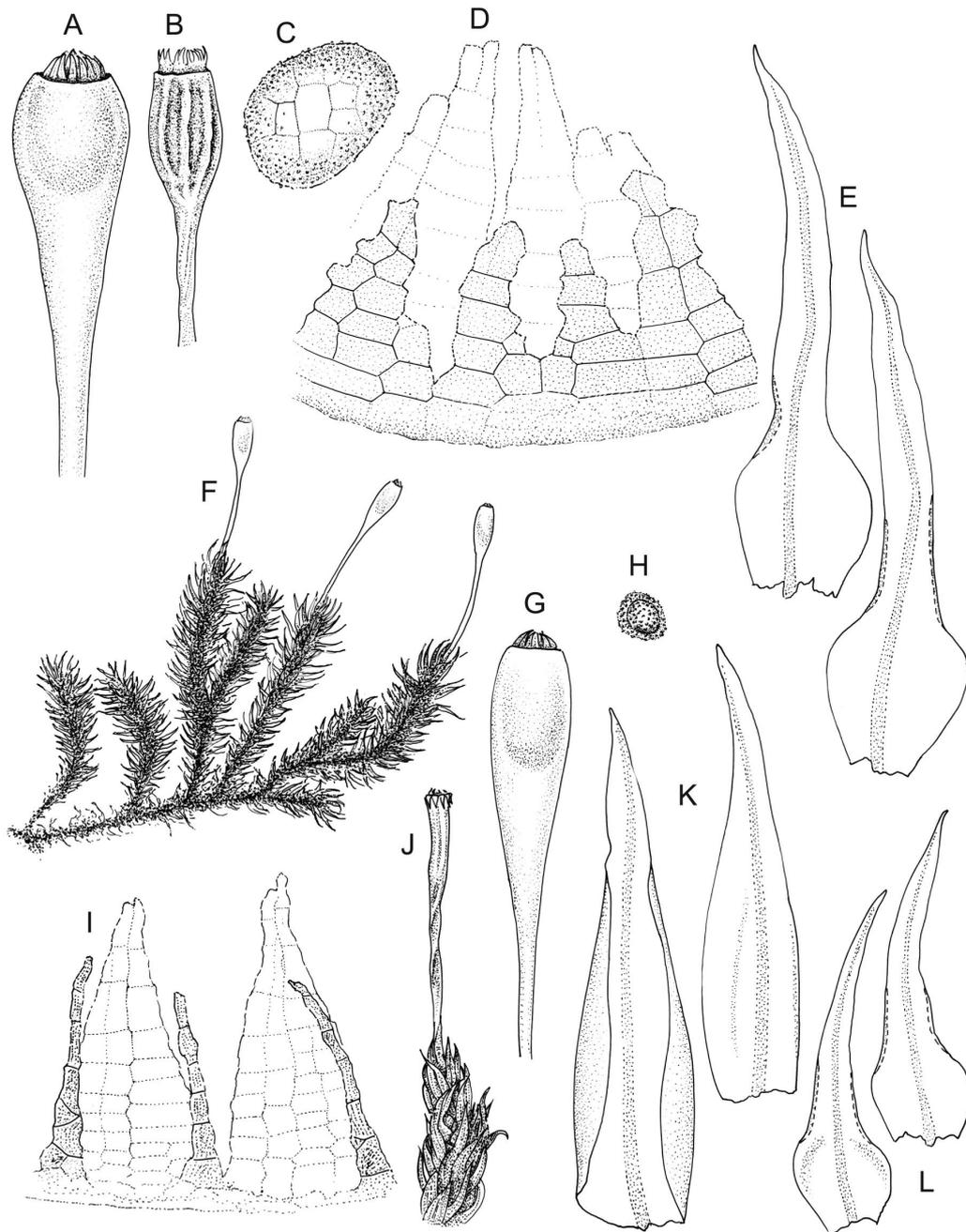


Plate 21: *Uloa*. A–E: *U. membranata*. A, capsule, moist. B, capsule, dry. C, spore. D, peristome detail showing paired exostome teeth (not shaded) and four endostome segments. E, leaves. **F–L: *U. viridis*.** F, habit with capsules, moist. G, capsule, moist. H, spore. I, peristome detail showing paired exostome teeth (not shaded) and three endostome segments. J, portion of branch with capsule, dry. K, perichaetial leaves. L, leaves. *U. membranata*: drawn from G.O.K. Sainsbury 5257, CHR 556095; *U. viridis*: drawn from A.J. Fife 9192 & G.B. Huang, CHR 477008.

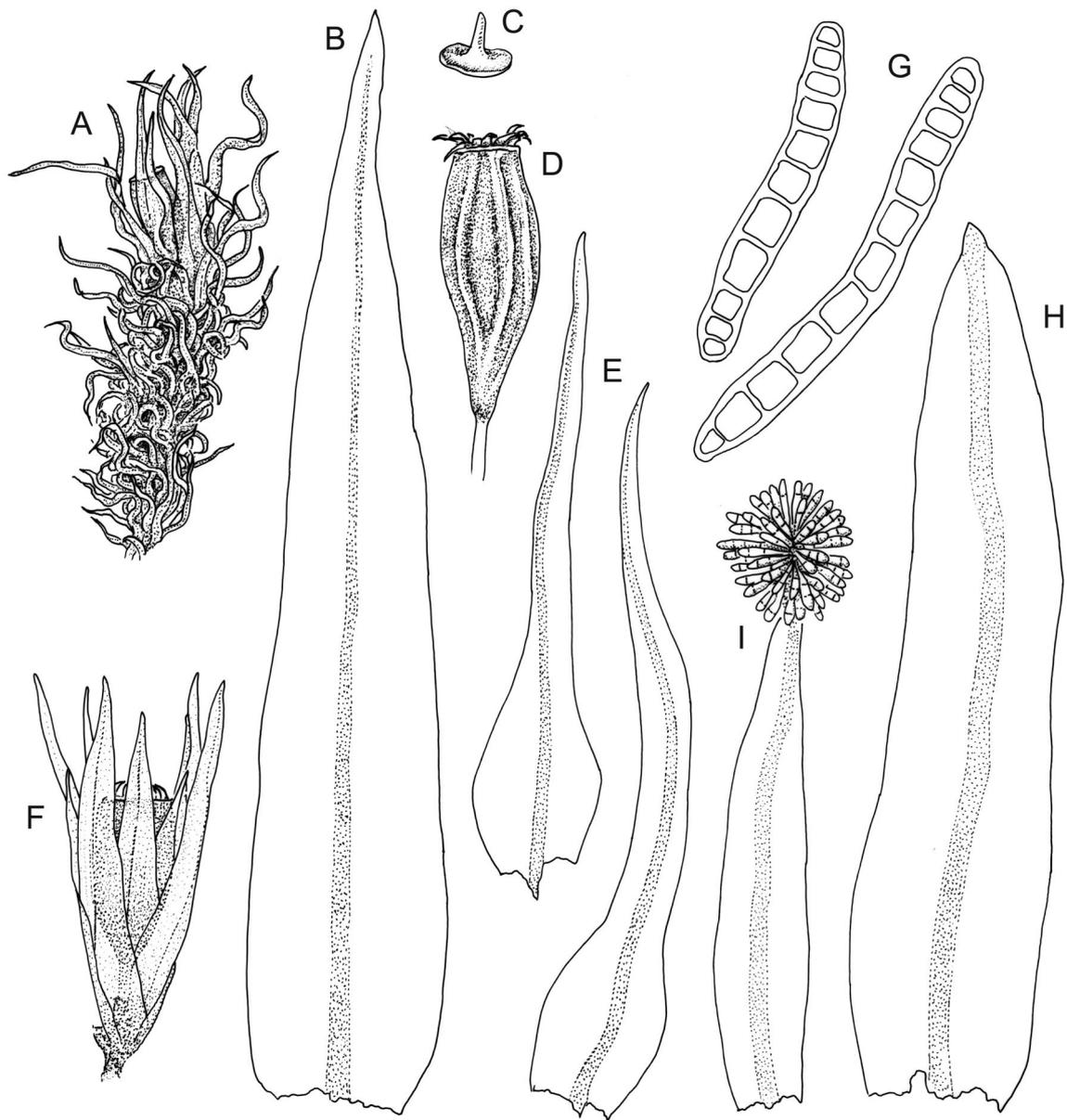


Plate 22: *Ulota*. A–F: *U. perichaetialis*. A, habit with capsule, dry. B, perichaetial leaf. C, operculum. D, capsule, dry. E, leaves. F, perichaetium with capsule, moist. **G–I: *U. phyllantha*.** G, detail of gemmae. H, leaf. I, juvenile leaf with gemmae cluster. *U. perichaetialis*: drawn from A.J. Fife 8045, CHR 436781 and A.J. Fife 6491, CHR 461720; *U. phyllantha* drawn from D.H. Ashton 15, Macquarie Island, CHR 557705.

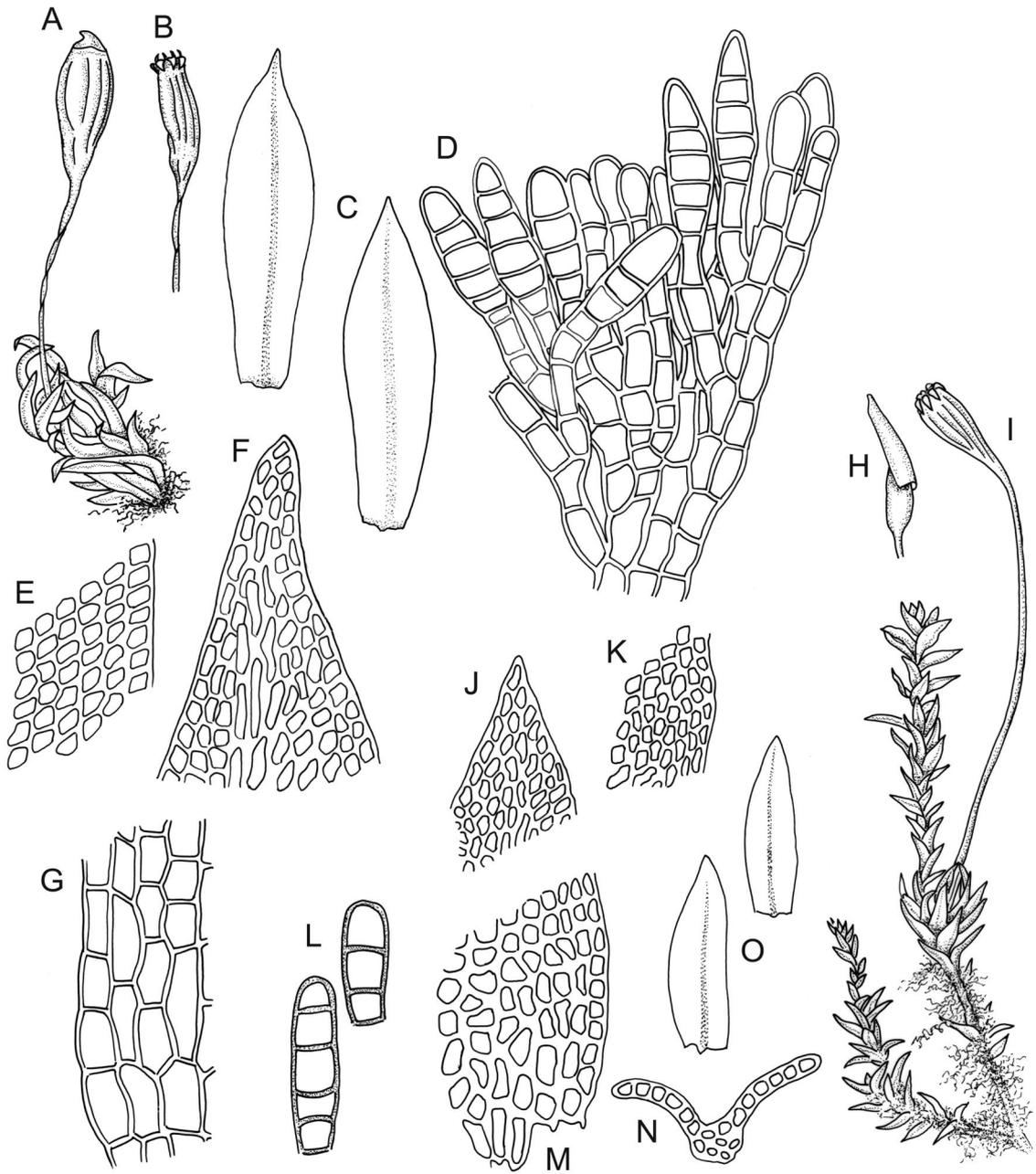


Plate 23: *Zygodon*. A–G: *Z. minutus*. A, habit with capsule, dry. B, capsule, dry. C, leaves. D, gemmae. E, upper laminal cells at margin. F, leaf apex. G, basal angle cells. **H–O: *Z. gracillimus*.** H, capsule with calyptra. I, habit with capsule, moist. J, leaf apex. K, upper laminal cells at margin. L, gemmae. M, basal angle cells. N, cross section of mid laminal cells including costa. O, leaves. *Z. minutus*: A–B, D–G redrawn with permission from Lewinsky (1990); C drawn from *L.B. Moore 605, CHR 105005A*; *Z. gracillimus*: H–K, L–O redrawn with permission from Lewinsky (1990).

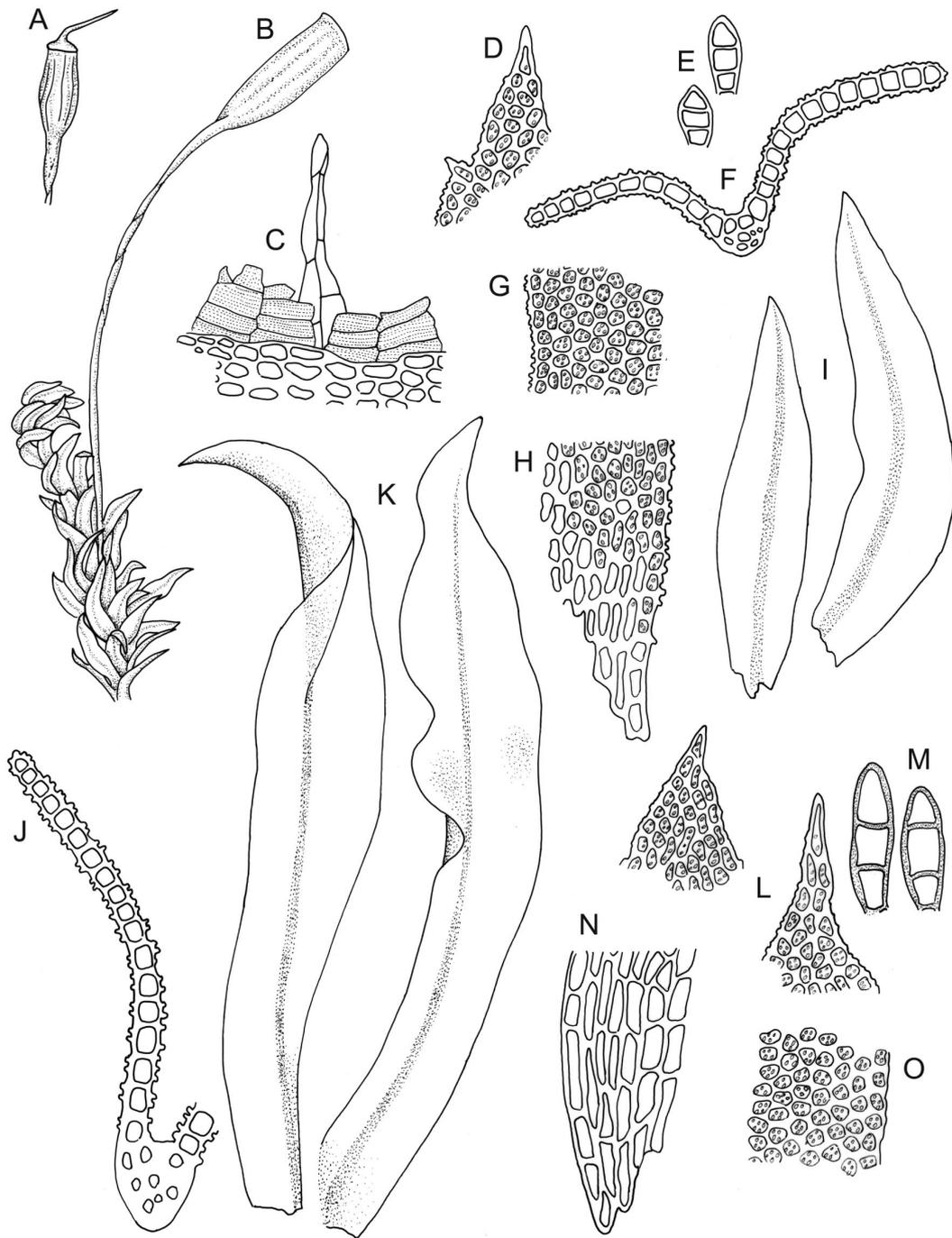


Plate 24: *Zygodon*. A–I: *Z. intermedius*. A, capsule, dry. B, habit with capsule, dry. C, peristome detail showing broken exostome teeth and intact endostome segment. D, leaf apex. E, gemmae. F, cross-section of mid laminal cells including costa. G, upper laminal cells at margin. H, basal laminal cells at margin. I, leaves. J–O: *Z. hookeri*. J, cross-section of mid laminal cells including costa. K, leaves. L, leaf apices. M, gemmae. N, basal laminal cells at margin. O, upper laminal cells at margin. *Z. intermedius*: A–H redrawn with permission from Lewinsky (1990); I drawn from A.J. Fife 5545, CHR 104153; *Z. hookeri*: J, L–O redrawn with permission from Lewinsky (1990), K drawn from J. Child 9645, CHR 431002B.

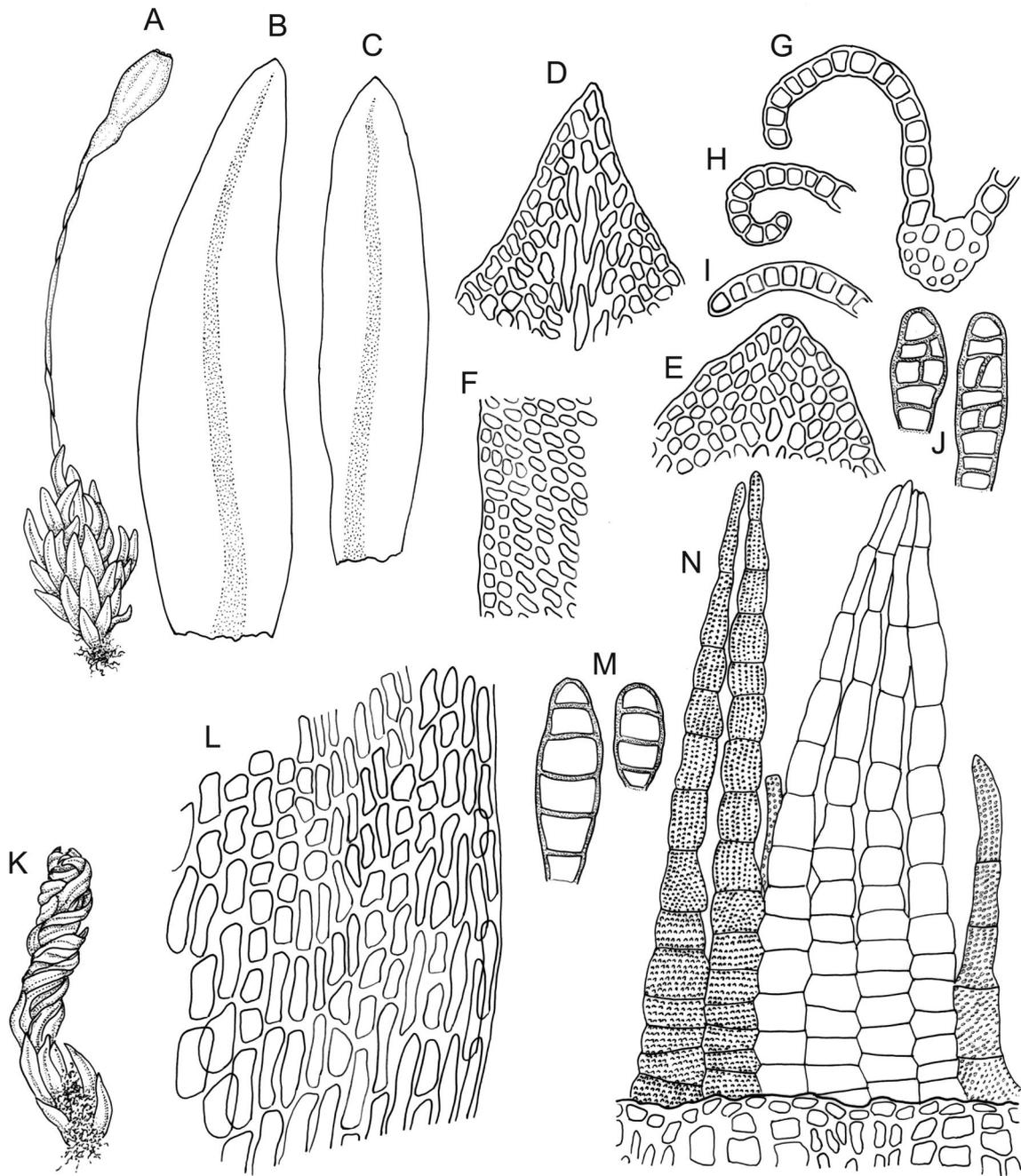


Plate 25: *Zygodon*. A–N: *Z. menziesii*. A, habit with capsule, moist. B, perichaetial leaf. C, leaf. D–E, leaf apices. F, upper laminal cells at margin. G–I, cross-sections of laminal cells including costa. J, gemmae (atypical). K, habit of sterile plant, dry. L, basal laminal cells. M, gemmae (typical). N, peristome detail of three paired exostome teeth, and two endostome segments (with one exostome tooth shaded, two unshaded). A, D–N redrawn with permission from Lewinsky (1990); B–C drawn from A.J. Fife 5086, CHR 103500.

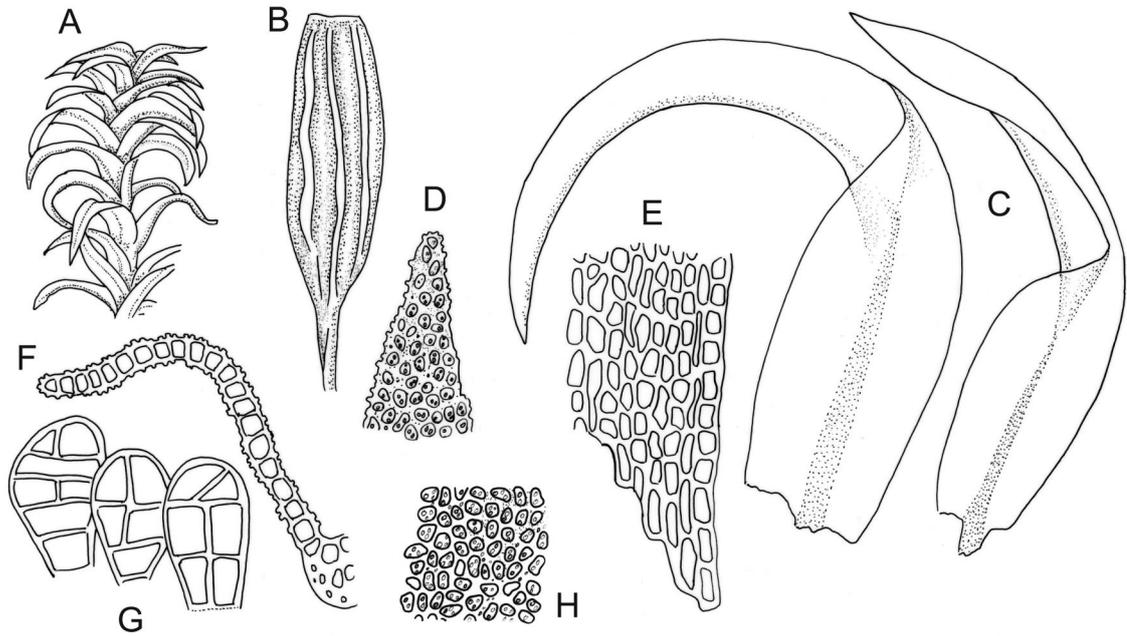
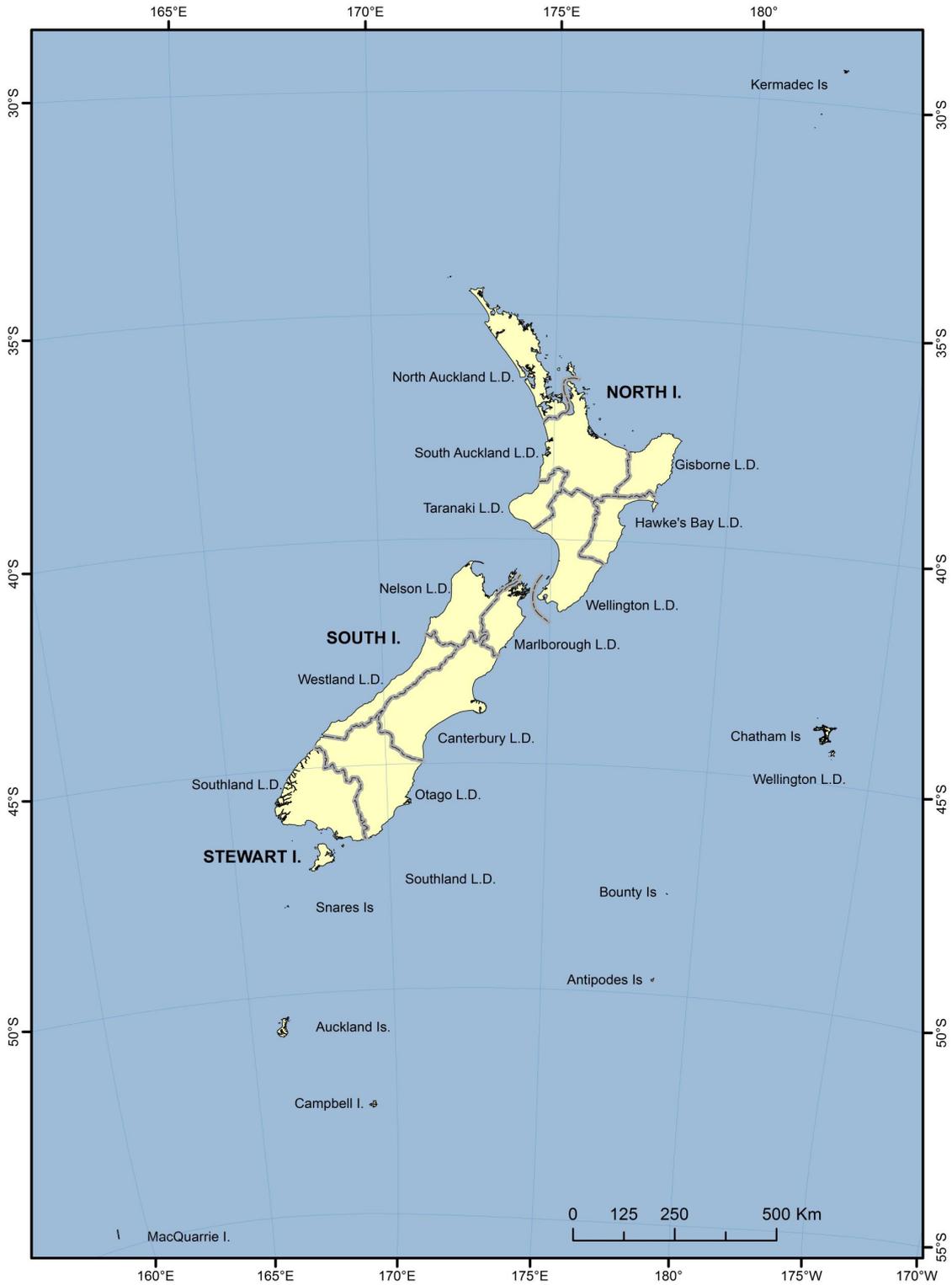
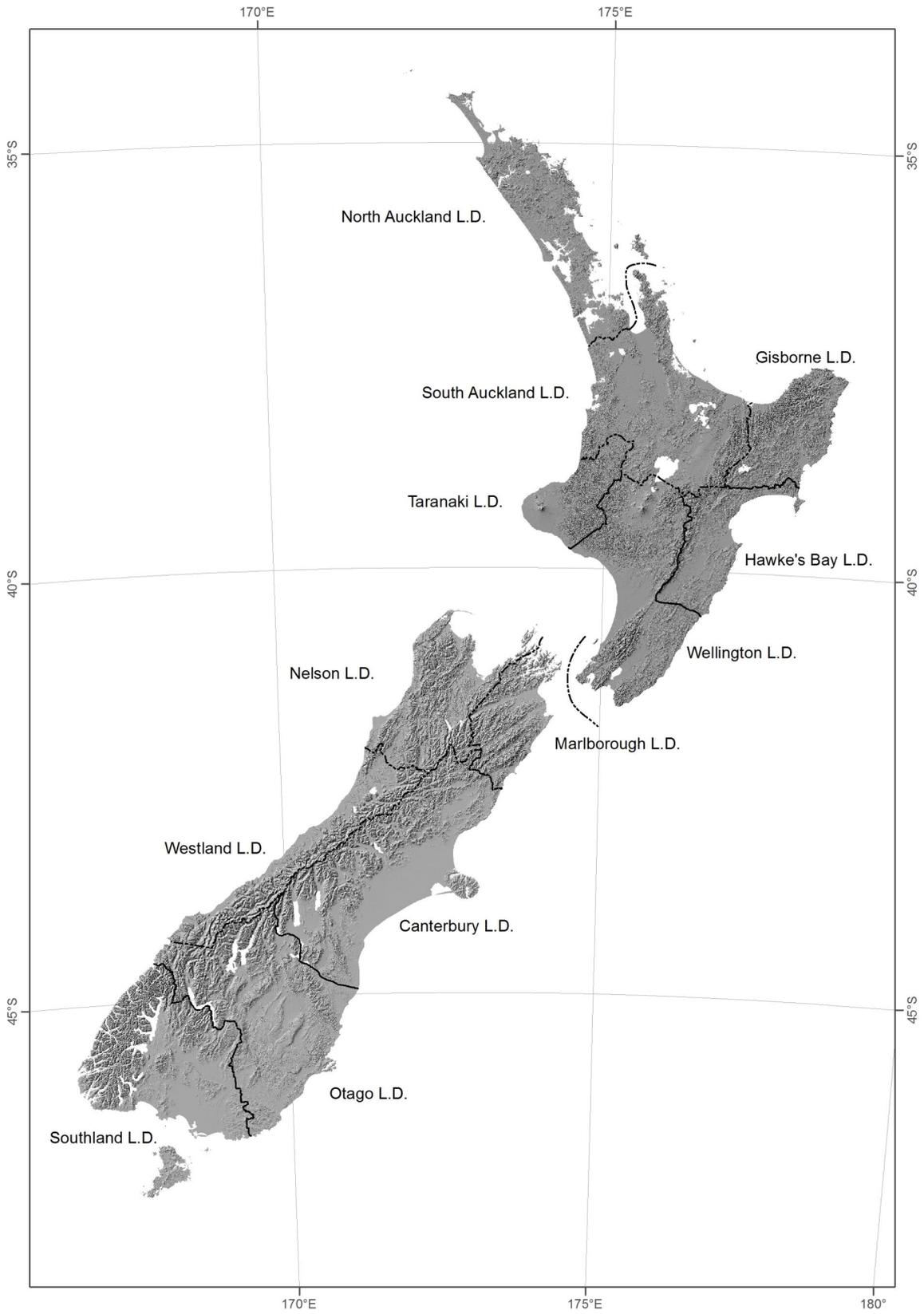


Plate 26: Zygodon. A–H: *Z. rufescens*. A, portion of branch, moist. B, capsule, dry. C, leaves. D, leaf apex. E, basal laminal cells at margin. F, cross-section of laminal cells including partial costa. G, gemmae. H, upper laminal cells. Redrawn with permission from Lewinsky (1990).



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

Index

Page numbers are in **bold** for the main entry, and *italic* for synonyms.

- Bryodixonia* Sainsbury 55
Bryodixonia perichaetialis Sainsbury 60
Bryomaltaea Goffinet 4
Bryomaltaea obtusifolia (Hook.) Goffinet 5
Bryum oamaruense R.Br.bis 69
Codonoblepharon Schwägr. 63
Codonoblepharon gracillimum (M.Fleisch) Matcham & O'Shea 65
Codonoblepharon menziesii Schwägr. 69
Codonoblepharon menziesii var. *angustifolius* (Malta) Matcham & O'Shea 69
Codonoblepharon minutum (Müll.Hal. & Hampe) Matcham & O'Shea 71
Leiotheca gracilis (Hook.) Brid. 13
Leratia Broth. & Paris 1-3, **4**, 64, 65
Leratia obtusifolia (Hook.) Goffinet 4, **5**, 66
Macrocoma (Müll.Hal.) Grout 1-3, **6**, 63
Macrocoma tenue (Hook. & Grev.) Vitt 6, **7**, 14, 16, 17, 20, 24, 29, 62, 63
Macrocoma tenue (Hook. & Grev.) Vitt subsp. *tenue* 6, **7**
Macromitrium Brid. 1-3, 6, **8**, **8**, 16, 26, 27, 29, 31, 44, 55, 63, 82
Macromitrium acutifolium (Hook. & Grev.) Brid. 22
Macromitrium appendiculatum Müll.Hal. 17
Macromitrium aristatum Mitt. 30
Macromitrium barbatum Mitt. 7
Macromitrium brevicaule (Besch.) Broth. 8, 9, **12**, 39
Macromitrium caducipilum Lindb. 30
Macromitrium coarctatum Müll.Hal. 28
Macromitrium erosulum Mitt. 28
Macromitrium eucalyptorum Hampe & Müll.Hal. 7
Macromitrium eucalyptorum var. *recurvulum* (Müll.Hal.) Sainsbury 7
Macromitrium flaccidisetum Müll.Hal. 25
Macromitrium gracile (Hook.) Schwägr. 9, **13**, 17, 18, 20, 24, 31
Macromitrium gracile var. *proboscideum* Dixon 13
Macromitrium gracile var. *retusum* (Hook.f. & Wilson) Sainsbury 30
Macromitrium grossirete Müll.Hal. 9, **15**, 26, 27, 29
Macromitrium hectori Mitt. 53
Macromitrium helmsii Paris 14, 15, **17**, 18, 31
Macromitrium incurvifolium (Hook. & Grev.) Schwägr. 9, 15, 18, **18**, 19, 21
Macromitrium ligulaefolium Broth. 9, 18, **19**, 21
Macromitrium ligulare Mitt. 9, 12, 16, 18, 19, **20**, 30
Macromitrium lonchomitrium Müll.Hal. 21
Macromitrium longipes (Hook.) Schwägr. 9, 14, 15, 17, **21**, 24, 26, 27, 31
Macromitrium longirostre (Hook.) Schwägr. 9, 12-14, 17, **22**, 24, 25, 31, 39, 54, 70
Macromitrium longirostre var. *acutifolium* (Hook. & Grev.) Hook.f. & Wilson 22
Macromitrium longirostre var. *caducipilum* (Lindb.) W.Martin & Sainsbury 30
Macromitrium longirostre (Hook.) Schwägr. var. *longirostre* 23, **23**
Macromitrium longirostre var. *ramsayae* (Vitt) Fife comb. nov. 1, 24, **24**
Macromitrium microstomum (Hook. & Grev.) Schwägr. 8, 15, 22, **25**, 27
Macromitrium mossmanianum Müll.Hal. 13
Macromitrium oocarpum Müll.Hal. 28
Macromitrium orthophyllum Mitt. 9, 14, 22, 26, **26**
Macromitrium papillifolium Müll.Hal. 28
Macromitrium petriei Dixon 28
Macromitrium prorepens (Hook.) Schwägr. 8, 9, 12, 15-17, **28**
Macromitrium prorepens var. *aristata* Allison 28
Macromitrium pseudohemitrichodes Müll.Hal. 21
Macromitrium ramsayae Vitt 24
Macromitrium recurvulum Müll.Hal. 7
Macromitrium retusum Hook.f. & Wilson 14, 17, 18, 23, 24, 29, **30**, 54, 70
Macromitrium rigescens Broth. & Dixon 15
Macromitrium sect. *Macrocoma* Müll.Hal. 6
Macromitrium subfragile Dixon & Sainsbury 12
Macromitrium submucronifolium Müll.Hal. & Hampe 28
Macromitrium tenue (Hook. & Grev.) Brid. 7
Macromitrium watsii Broth. 12
Macromitrium weymouthii Broth. 25
Micromitrium brevicaule Besch. 12
Muelleriella Dusén 31
Muelleriella angustifolia (Hook.f. & Wilson) Dusén 34
Muelleriella aucklandica Vitt 37
Muelleriella crassifolia (Hook.f. & Wilson) Dusén 39
Muelleriella crassifolia (Hook.f. & Wilson) Dusén subsp. *crassifolia* 39
Orthotrichaceae **2**
Orthotrichum Hedw. 1-3, 6, **31**, 38, 40, 42, 44, 45, 47, 49-51, 58, 82
Orthotrichum acrolepharis Müll.Hal. 35
Orthotrichum acuminatum R.Br.bis 43
Orthotrichum acutifolium Hook. & Grev. 22
Orthotrichum angustifolium Hook.f. & Wilson **34**, 37, 40
Orthotrichum assimile Müll.Hal. 6, **35**, 42, 47
Orthotrichum aucklandicum (Vitt) Goffinet **37**, 40
Orthotrichum austrocupulatum Dixon & Sainsbury 40
Orthotrichum austropulchellum Müll.Hal. 49
-

- Orthotrichum avonense* R.Br.bis 37
Orthotrichum beckettii Müll.Hal. 49
Orthotrichum benmoreense R.Br.bis 35
Orthotrichum breve R.Br.bis 44
Orthotrichum brevirostrum R.Br.bis 41
Orthotrichum brevisetum R.Br.bis 44
Orthotrichum calcareum R.Br.bis 40
Orthotrichum calvum Hook.f. & Wilson 33, 36, 37, 45, 51, 52
Orthotrichum calvum var. *brevisetum* Dixon 38
Orthotrichum clintonii R.Br.bis 49
Orthotrichum conicorostrum R.Br.bis 49
Orthotrichum crassifolium Hook.f. & Wilson 35, 37, 39, 70
Orthotrichum crassifolium Hook.f. & Wilson subsp. *crassifolium* 39
Orthotrichum cupulatum Brid. 40, 70
Orthotrichum cupulatum var. *austrocupulatum* (Dixon & Sainsbury) Lewinsky 40
Orthotrichum cyathiforme R.Br.bis 36, 41, 47
Orthotrichum cylindrothecum R.Br.bis 49
Orthotrichum fimbriatum R.Br.bis 46
Orthotrichum gracile Hook. 13
Orthotrichum graphiomitrium Müll.Hal. ex Beckett 8, 43, 48, 51, 52, 60
Orthotrichum hortense Bosw. 36, 42, 44, 47
Orthotrichum inaequale R.Br.bis 49
Orthotrichum incurvifolium Hook. & Grev. 18
Orthotrichum lancifolium R.Br.bis 49
Orthotrichum latifolium R.Br.bis 35
Orthotrichum latorum R.Br.bis 45
Orthotrichum leioleocythis Müll.Hal. 43
Orthotrichum ligulatum Müll.Hal. 41
Orthotrichum longipes Hook. 21
Orthotrichum longirostre Hook. 22
Orthotrichum longithecum R.Br.bis 35
Orthotrichum luteum Mitt. 57
Orthotrichum magnothecum R.Br.bis 35
Orthotrichum microstomum Hook. & Grev. 25
Orthotrichum minimifolium R.Br.bis 37
Orthotrichum minutum R.Br.bis 38
Orthotrichum obesum R.Br.bis 43
Orthotrichum obliquum R.Br.bis 49
Orthotrichum ornatum R.Br.bis 40
Orthotrichum parvithecum R.Br.bis 50
Orthotrichum praeperistomatum Venturi 45
Orthotrichum prorepens Hook. 28
Orthotrichum pseudopumilum Venturi 41
Orthotrichum pulvinatum R.Br.bis 40
Orthotrichum pulvinatum var. *praeperistomatum* (Venturi) Sainsbury 45
Orthotrichum reflexum R.Br.bis 45
Orthotrichum rufescens Hampe 72
Orthotrichum rupestre Schwägr. 44, 45, 47, 48
Orthotrichum rupestre var. *papillosum* Lewinsky 46, 46
Orthotrichum rupestre Schwägr. var. *rupestre* 46, 47
Orthotrichum rupestriforme Venturi 45
Orthotrichum sainsburyi Allison 45, 48
Orthotrichum subleioleocythis Paris 43
Orthotrichum tasmanicum Hook.f. & Wilson 16, 38, 43, 45, 47, 49, 51
Orthotrichum tasmanicum var. *parvithecum* (R.Br.bis) Lewinsky 50
Orthotrichum tasmanicum Hook.f. & Wilson var. *tasmanicum* 45, 51, 51, 59
Orthotrichum tenue Hook. & Grev. 7
Plenogemma phyllantha (Brid.) Sawicki, Plášek & Ochyra 61
Schlotheimia Brid. 1-3, 52, 82
Schlotheimia campbelliana Müll.Hal. 24, 53
Schlotheimia knightii Müll.Hal. 52, 54, 54
Uloa D.Mohr 1-3, 33, 38, 55, 58, 62, 63
Uloa anceps Venturi 62
Uloa bellii Malta 57
Uloa bellii var. *longicolla* Malta 57
Uloa breviseta Malta 57
Uloa dixonii Malta 62
Uloa laticiliata Malta 57
Uloa lutea (Mitt. in Wilson) Mitt. 47, 51, 52, 55, 57, 60, 62, 63
Uloa membranata Malta 59, 59, 62
Uloa novae-seelandiae Sainsbury 62
Uloa perichaetialis (Sainsbury) Goffinet 3, 57, 60
Uloa phyllantha Brid. 3, 39, 61
Uloa rufescens (Hampe) A.Jaeger 72
Uloa viridis Venturi 57, 59, 60, 62
Uloa viridis var. *adpressa* Mitt. ex Malta 62
Uloa weymouthii Venturi 57
Zygodon Hook. & Taylor 1-4, 6, 63, 68, 69, 82
Zygodon conoideus var. *elongatus* Hook. & Grev. 67
Zygodon gracilicaulis Müll.Hal. 67
Zygodon gracillimus M.Fleisch. 6, 65, 72
Zygodon hookeri Hampe 20, 25, 65, 66, 68, 70
Zygodon intermedius Bruch & Schimp. 67, 67, 70, 73
Zygodon menziesii (Schwägr.) Arn. 3, 40, 41, 55, 64, 69
Zygodon menziesii var. *angustifolius* Malta 69
Zygodon minutus Müll.Hal. & Hampe 66, 71
Zygodon mucronatus Müll.Hal. 66
Zygodon mucronatus Broth. 71
Zygodon nanus Müll.Hal. 67
Zygodon neglectus Müll.Hal. 5
Zygodon obtusifolius Hook. 5
Zygodon persquarriifolius Dixon 72
Zygodon rodwayi Broth. 65
Zygodon rufescens (Hampe) Broth. 72
Zygodon sect. *Obtusifolii* Malta 4
Zygodon subminutus Broth. 65
Zygodon vestitus R.S.Williams 72

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