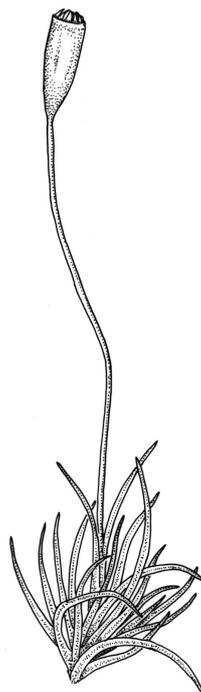




**FLORA OF NEW ZEALAND**  
**MOSSES**

**ORTHODONTIACEAE**



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**A.J. FIFE**

Fascicle 49 – JUNE 2021

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Cover image: *Orthodontium lineare*, habit with capsule. Drawn by Rebecca Wagstaff from *J.E. Beever 31-15*, CHR 406193.

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## Introduction

The definition of the Orthodontiaceae and the relationships of its core genus, *Orthodontium*, are confused. *Orthodontium* was traditionally placed in the Bryaceae (by Brotherus) within its own subfamily, characterised by an absent or very low endostomal membrane and filiform endostomal segments. Australasian authors have largely accepted this placement, albeit usually without reference to the subfamily. Modern molecular studies have concluded that the genera *Hymenodon* and *Leptotheca* (both widespread and common in New Zealand) are allied to *Orthodontium* and their transfer to the Orthodontiaceae has been recently proposed.

This family definition emphasises molecular data more than morphology, and it is followed here more from convenience than conviction. The substantial morphological differences between these genera are outlined and preclude a meaningful family morphological description. The three genera are each represented by one species in N.Z. *Orthodontium lineare* occurs as an epiphyte, on rotten wood, or on humic soil. A proposed segregate species, *O. ruahinense*, is rejected here. *Hymenodon pilifer* is broadly distributed regionally, occurring predominantly on the caudices of certain tree-ferns. *Leptotheca gaudichaudii* is likewise widespread, and occurs terrestrially on a range of substrates, most abundantly in southern beech forests.

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## Typification

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

***Bryum evei* R.Br.bis, Trans. & Proc. New Zealand Inst. 31: 456 (1899)**

Lectotype (designated here): N.Z., Canterbury, Mount Torlesse, *R. Brown s.n.*, January 1887, CHR 335249!

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## Orthodontiaceae

**Type taxon:** *Orthodontium* Schwägr.

**Taxonomy:** The status of the Orthodontiaceae and the relationships of its core genus *Orthodontium* are confused. *Orthodontium* has traditionally (Brotherus 1924) been placed in the Bryaceae within a small subfamily (Orthodontioideae), characterised by an absent or very low endostomal membrane and filiform endostomal segments. Sainsbury (1955a) accepted this placement, albeit without reference to the subfamily, as did Scott & Stone (1976). The elevation of the subfamily Orthodontioideae to family level as the Orthodontiaceae was proposed by Goffinet (in Buck & Goffinet 2000). Goffinet placed two genera within his new family: *Orthodontium* and the very small Asian *Orthodontopsis*. Shaw (2012) treated the family for Australia using Goffinet's 2000 circumscription and recognised only the single genus *Orthodontium*.

Bell et al. (2007) published an influential molecular study of pleurocarp relationships using mitochondrial and chloroplast DNA. Among their conclusions was that *Orthodontium* is closely allied with *Hymenodon*, *Leptotheca* (which both occur in N.Z.), and the more recently described Asian *Orthodontopsis*. By way of context, *Hymenodon* was placed in the Rhizogoniaceae by both Brotherus (1924) and Sainsbury (1955a), and *Leptotheca* was placed in the Aulacomniaceae by those same two authors. Their family placements for *Hymenodon* and *Leptotheca* were followed by Scott & Stone (1976) and by Churchill & Buck (1982).

Goffinet et al. (2009) reinterpreted the systematic significance of the Bell et al. (2007) study. Reflecting the fluidity of modern moss family (and higher rank) circumscription, Goffinet et al. (2009) proposed the transfer of both *Hymenodon* and *Leptotheca* (as well as *Orthodontopsis*) to the Orthodontiaceae. They placed this newly circumscribed family in the Rhizogoniales in the general relationship of the Rhizogoniaceae and Aulacomniaceae.

The family definition of Goffinet et al. (2009) is followed here less from conviction than from convenience. Their definition emphasises molecular data to a far greater degree than morphological characters. For example, *Orthodontium* has linear laminal cells, while those of *Leptotheca* and *Hymenodon* are isodiametric, and the three genera have different costal anatomy. (*Orthodontium* has a costa with a central stereid band; *Leptotheca* has median guide cells and both abaxial and adaxial stereids; and *Hymenodon* has a few, often two, guide cells and abaxial stereids.) *Orthodontium* is variably autoicous, with antheridia occurring in the axils of outer perichaetial leaves (parautoicous), or on short perigonal buds located either below the perichaetium or at the base of fruiting shoots (gonioautoicous) or occasionally on well-developed male shoots. *Leptotheca* is dioicous with terminal perichaetia, while *Hymenodon* is rhizautoicous with perigonia bud-like and nidulant among basal rhizoids or vegetative leaf axils. Both *Orthodontium* and *Leptotheca* have striate capsules with double peristomes (albeit with reduced endostomal membranes), while *Hymenodon* has smooth capsules with a single exostomal peristome.

The morphological differences between the N.Z. genera are substantial and preclude the drafting of a meaningful family description. This strongly suggests that undue emphasis has been placed by Goffinet and others on molecular information to the exclusion of morphological information.

## *Hymenodon* Hook.f. & Wilson, *London J. Bot.* 3: 548 (1844)

**Type taxon:** *Hymenodon pilifer* Hook.f. & Wilson

**Plants** small, glaucous, forming tufts, growing mostly on tree-fern caudices. **Stems** erect, branched at base, pale green or sometimes red-brown near base, beset at base with red-brown and papillose **rhizoids**. **Leaves** complanate or evenly distributed on shoots, erect-spreading, with a long, slender, and conspicuous hair-point, broadly elliptic to narrowly lanceolate, unbordered, crenulate or occasionally weakly dentate, reduced towards the stem base, with the lamina varying in width (in number of cells) between species. **Upper laminal cells** ± isodiametric or oblate, firm-walled, weakly to strongly mammillose, with an obscurely wrinkled cuticle (in N.Z. species), undifferentiated or becoming slightly larger towards the insertion; **alar cells** and **marginal cells** not differentiated; **hair-point** strongly developed, pale and conspicuous, persistent or sometimes caducous, sometimes consisting of a single cell for half or more of its length. **Costa** single, mostly percurrent and appearing to fuse with the hair-point or ending below the hair-point base (in the N.Z. species). **Axillary gemmae** absent (in the N.Z. species) or rarely present, many-celled and filamentous.

**Rhizautoicous**. **Perichaetia** at base of stem, red-brown, the leaves longer than vegetative leaves (in the N.Z. species). **Perigonia** bud-like, nidulant among basal rhizoids or rarely among leaf axils. **Setae** straight, smooth, pale brown; **capsules** erect or slightly inclined, ellipsoid, cylindrical, or ovoid, pale red-

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or yellow-brown; **exothecial cells** firm-walled, smooth, isodiametric or rectangular; **stomata** few and difficult to observe, superficial (*vide* Tessler 2012); **annulus** weakly differentiated or apparently absent; **operculum** obliquely rostrate. **Peristome** single or absent in some species; **exostome teeth** mostly pale, strongly striate (in N.Z. species) or not, arising from a very low basal membrane (in the N.Z. species); **endostome** lacking. **Calyptra** cucullate. **Spores** spherical, smooth or slightly roughened.

**Taxonomy:** Tessler (2012), in his recent revision of *Hymenodon*, recognised eight species in the genus, occurring in south-east Asia, Malesia, New Caledonia, Australia, N.Z., and tropical America. Koponen et al. (1986) have treated P.N.G. and western Melanesian species and included a key to the six species they recognised world-wide.

Six species are recorded by Tessler (2012) from the general area of Borneo south-east to New Caledonia. Among these six, *H. angustifolius* Sande Lac. seems a very distinctive species, but three others require further critical comparison. *Hymenodon sericeum* (Dozy & Molk.) Müll.Hal., *H. tenellus* Broth. & Paris, and *H. chenianus* Pócs may prove to be conspecific after further investigations. Combinations for two of these names have been proposed at the subspecies rank within *H. pilifer*, but these combinations seem inappropriate. The detailed consideration of the status of these three unconvincing species is beyond the scope of this treatment.

Shaw & Anderson (1986) investigated the nature of the peristome in *Hymenodon sericeus* and *H. angustifolius*, concluding that the single peristome in these two species is exostomal in nature. They confirmed the separation of the monotypic New Guinean *Hymenodontopsis* Herzog as distinct on the basis of it having an endostome. Earlier workers, including Brotherus (1924) and Koponen et al. (1986), considered the peristome of some or all species of *Hymenodon* to be endostomal in nature.

N.Z. material of *H. pilifer* is rhizautoicous. This corroborates tentative statements by Koponen et al. (1986) concerning the sexuality of *H. sericeus* and *H. angustifolius* (of P.N.G.) and observations by Tessler (2012) concerning the genus as a whole.

Recently Goffinet et al. (2009) placed *Hymenodon* (together with *Leptotheca*) in the Orthodontiaceae, following the molecular study of Bell et al. (2007). It is retained in this family here, albeit with reservations discussed above.

**Etymology:** The generic name refers to the perceived membranaceous and fugacious nature of the peristome teeth.

## ***Hymenodon pilifer* Hook.f. & Wilson, London J. Bot. 3: 548 (1844)**

as "piliferus"

Lectotype: Tasmania, on trunks of tree ferns, Banks of Huon River, *J.D. Hooker s.n.*, 1839–43 ["Wilson 724"], BM-Wilson. Designated by Tessler 2012; not seen. Isolectotypes: BM-Hooker!, BM-Bescherelle! Paratype: N.Z.: *J.D. Hooker 19* ["Wilson 410"], BM001086895!

= *Hymenodon helvolus* Müll.Hal., *Hedwigia* 36: 332 (1897)

Type: N.Z.: prope Greymouth, ("Herb. Helms no. 51"), CHR 494766!

**Plants** small, glaucous when fresh and dry, forming epiphytic tufts. **Stems** erect, branched at base to form tufts, pale green, c. 7–10(–15) mm long, in cross-section with c. 1–3 layers of thick-walled cells surrounding a parenchymatous cortex and a weak central strand, beset at base with red-brown, papillose rhizoids. **Leaves** evenly arranged around the stem or ± complanate, erect-spreading, symmetric, broadly elliptic with an obtuse apex and a long, slender hair-point, neither concave nor decurrent, unbordered, crenulate throughout, 0.65–0.9 × 0.25–0.3 mm (excluding hair-points), becoming smaller and scale-like towards the stem base; **upper laminal cells** firm-walled, mostly oblong, quadrate, or oblate, 7–9 µm in greater dimension, weakly mammillose, with an obscurely wrinkled cuticle, becoming slightly larger towards the insertion; **alar cells** and **marginal cells** not differentiated. **Hair-point** c. 0.25–0.50 mm and  $\frac{1}{3}$ – $\frac{1}{2}$  the length of the lamina, composed of a single thick-walled cell for more than  $\frac{3}{4}$  its length. **Costa** c. 30 µm wide near base, ending 75–100 µm below the hair-point base, in cross-section ± plano-convex, with 2 guide cells and an abaxial stereid group.

**Rhizautoicous.** **Perichaetia** at base of stem, red-brown, perichaetial leaves ovate-lanceolate, costate, not bordered, to c. 0.9 mm. **Perigonia** nidulant amongst basal rhizoids or rarely among leaf axils, brown and bud-like, with bracts c. 0.5 mm, ecostate, acute from an ovate, concave base, with c. 8 antheridia and with or without filiform paraphyses. **Setae** c. 9 mm, straight, smooth, c. 70–90 µm diam., scarcely twisted, yellow-brown; **capsules** erect, ellipsoid, c. 1.4 mm, smooth, pale red- or yellow-brown; **exothecial cells** rounded-quadrate, firm-walled, smooth; **annulus** apparently weakly differentiated (not seen clearly). **Operculum** obliquely rostrate from a conic base, c. 0.6 mm long. **Peristome** single, exostomal; **exostome** inserted at the capsule mouth, yellowish-brown, arising from

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a very low membrane, the teeth c. 350 µm long, strongly striate throughout; **endostome** lacking. **Calyptra** cucullate, 1.5 mm long. **Spores** spherical, 12–14.5 µm, yellow, smooth.

**Illustrations:** Plate 1. Wilson 1854, pl. 92, fig. 3; Scott & Stone 1976, pl. 59; Malcolm & Malcolm 2003, p. 34; Meagher & Fuhrer 2003, p. 111; Tessler 2012, fig. 10, A–G; Seppelt et al. 2019, pl. 69.

**Distribution:** K; NI: N Auckland, including offshore islands (TK, LB, GB, RT), S Auckland (including Mayor I.), Gisborne (Lake Waikaremoana), Hawke's Bay (Waiatai Valley, Mōrere Reserve), Taranaki, Wellington; SI: Nelson, Marlborough, Westland, Otago, Southland (Longwood Range, Fiordland National Park); St; Ch; A.

Australasian. Tasmania\*, mainland Australia\*.

**Habitat:** On trunks of tree-ferns (especially *Cyathea medullaris*, *C. smithii*, and *C. milnei*) and nīkau (*Rhopalostylis sapida*); less commonly on other ferns (e.g., *Loxogramme dictyopteris*) or tree species (e.g., *Leptospermum scoparium*) and sometimes also occurring on rock and thin soil. Beever (1984) found that *H. pilifer* in a N Auckland rainforest was most frequent on *C. medullaris* and *Rhopalostylis sapida*, very rare on *Dicksonia squarrosa*, and absent from *C. dealbata*. On the South I. *H. pilifer* is largely confined to areas west of the Main Divide and is common on the east coast only from Dunedin southwards. It is not recorded from Canterbury L.D. and is primarily distributed at low elevations. On the North I. ranging from near sea level (c. 15 m on Little Barrier I.) to at least 850 m (Ōhakune Track, Wellington L.D.); on the South I. ranging from sea level (numerous localities) to at least 610 m (Anatoki River, Nelson L.D.). Frequently associated species include *Catharomnion ciliatum* and *Calomnion complanatum*.

**Recognition:** The obscure wrinkling of the cuticle is most easily observed by placing dry material under the compound microscope. The well-developed leaves in all Australasian material have costae ending well below the base of the hair-point; in a few specimens the basal leaves have longer-than-typical costae. Sainsbury's (1955a, p. 294) statement that the costa is occasionally "excurrent and filling the hair-point" has not been confirmed.

The species most frequently confused with *H. pilifer* are *Leptostomum inclinans* and *Calomnion complanatum*. Its smaller stature, smaller leaves and plane leaf margins are sufficient to distinguish *H. pilifer* from the former, while the presence of a hair-point and a peristome, lack of dimorphic leaves, and lack of dendroid rhizoidal filaments easily differentiate *H. pilifer* from the latter.

**Etymology:** The epithet makes obvious reference to hair-points or pilifers. The original spelling of the epithet "*piliferus*" is an incorrect Latin termination and must be changed to *pilifer* in accordance with ICN (McNeill et al. 2012) Art. 32.2.

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## ***Leptotheca* Schwägr., Sp. Musc. Frond. Suppl. 2(1), 135 (1824)**

**Type taxon:** *Leptotheca gaudichaudii* Schwägr.

The following generic description draws on that of Churchill & Buck (1982).

**Plants** rather small to medium-sized, slender, yellow- to dark-green, turf-forming. **Stems** erect, branching by both forking and innovation, in cross-section with a distinct central strand, beset below with red-brown rhizoids. **Leaves** spreading when moist, more erect when dry, arranged in several rows, ovate-lanceolate or linear-lanceolate, weakly concave, plane or narrowly recurved at margins, aristate, not bordered, symmetric, narrowly decurrent,  $\pm$  coarsely and irregularly toothed above; reduced in size at stem base and  $\pm$  reduced at stem apex; **upper laminal cells**  $\pm$  isodiametric (in N.Z. species) or irregular and 1–3:1, incrassate, smooth; **marginal and alar cells** not differentiated. **Costa** stout, sinuose, variably excurrent, smooth abaxially, in cross-section strongly protruding and rounded abaxially, with median guide cells and abaxial and adaxial stereids, a single abaxial surface layer of cells  $\pm$  enlarged. **Brood bodies** (axillary gemmae) usually present, linear, orange-brown to nearly black, uniseriate and transversely septate, often conspicuous and present in large numbers on sterile stems.

**Dioicous. Perichaetia** terminal, with the leaves narrower and longer than the vegetative. **Perigonia** terminal and often obscure. **Setae** elongate and straight, slender, pale, twisted to the right above; **capsules** erect, straight or weakly curved, cylindrical, 8-ribbed, with a weak neck; **exothecial cells** oblong, firm-walled; **stomata** superficial, restricted to neck. **Peristome** double, inserted close to mouth; **exostome teeth** pale, lanceolate and obtuse at apex; **endostome** pale, with a very low membrane, the segments nearly equal the teeth, papillose and narrowly perforate throughout, alternating with single, variably developed, sometimes nodose cilia. **Spores** spherical, nearly smooth.

**Taxonomy:** A genus of perhaps three species distributed in Australasia, temperate and tropical South America, and South Africa. *Leptotheca boliviana* occurs at high elevations in the tropical Andes and adjacent regions and is distinct from the N.Z. species in terms of leaf shape, rhizoid morphology, and geographic distribution (*vide* Churchill & Buck 1982). Crum (1987) subsequently described *L. hamiltonii* from Peru. Bell et al. (2007) have questioned the relationship of *Leptotheca boliviana* and *L. gaudichaudii*.

*Leptotheca* was placed by Brotherus (1924) and several subsequent workers (e.g., Sainsbury 1955a) in the Aulacomniaceae, with the northern hemisphere genus *Aulacomnium*. Brotherus was probably influenced by the earlier inclusion of *Leptotheca* as a section of *Aulacomnium* by Mitten (1869, p. 317). Churchill & Buck (1982) argued for its removal from the Aulacomniaceae, based partly on chromosome number differences and geography. They argued instead for placement in the Rhizogoniaceae, but noted that *Leptotheca* would be anomalous in this family by having terminal rather than basal or lateral sex organs. Also, *Leptotheca* has erect, narrowly cylindrical, and ribbed capsules, which differ strongly from those of other genera of Rhizogoniaceae.

More recently Goffinet et al. (2009) have proposed the transfer of *Leptotheca* from the Rhizogoniaceae to the Orthodontiaceae. This placement is tenable for *Leptotheca* on the basis of peristome and capsule morphology, and geography. However, *Leptotheca* differs from *Orthodontium* by its isodiametric and incrassate laminal cells, its dioicous sexuality, and the presence of abundant specialised linear axillary gemmae. *Orthodontium*, by contrast, has linear, firm-walled laminal cells, autoicous sexuality (gonioautoicous or paroicous in N.Z. species), and no specialised gemmae (except for reduced, caducous leaves). The placement of *Leptotheca* in the Orthodontiaceae is accepted here with reservation.

**Etymology:** The generic name means slender theca or capsule.

## ***Leptotheca gaudichaudii* Schwägr., Sp. Musc. Frond. Suppl. 2(1), 135 (1824)**

as "Gaudichaudi"

Isotype: Australia, New South Wales, Port Jackson, *Gaudichaud s.n.*, BM-Bescherelle!

= *Bryum evei* R.Br.bis, *Trans. & Proc. New Zealand Inst.* 31: 456 (1899)

Lectotype: N.Z., Canterbury, Mount Torlesse, *R. Brown s.n.*, January 1887, CHR 335249!

**Plants** rather small to medium-sized, slender, yellow-green to dark green, forming turves or dense cushions. **Stems** erect, branching by both forking and subperichaetial innovation (or occasionally with innovations arising within the perichaetium), <5 to c. 50 mm, in cross-section with 2–3 outer layers of

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thick-walled and pigmented cells and a distinct central strand, beset below with dimorphic red-brown rhizoids (the finer smooth, the more robust densely but finely papillose). **Leaves** spreading when moist, more erect and curved inwardly when dry, arranged in several rows but sometimes  $\pm$  complanate near the stem apices or in small plants, ovate-lanceolate to linear-lanceolate (occasionally broadly ovate, especially on upper stems or innovations), aristate, weakly concave, plane at margins, not bordered, symmetric, narrowly decurrent,  $\pm$  coarsely and irregularly toothed above; c. 1.6–2.2(–3.1)  $\times$  0.5–0.8 mm and c. 2.4–4(–5):1, strongly reduced in size near stem base and  $\pm$  reduced near stem apex; **upper and lower laminal cells**  $\pm$  isodiametric, incrassate, smooth, mostly 9–14  $\mu$ m in greater diam.; **marginal cells** and **alar cells** not differentiated. **Costa** stout,  $\pm$  sinuose, c. 60–75  $\mu$ m wide in lower leaf, stoutly and short excurrent as an arista, smooth abaxially, in cross-section rounded and protruding abaxially, with median guide cells and both abaxial and adaxial stereid bands, a single abaxial cell layer  $\pm$  enlarged. **Gemmae** mostly present and abundant in upper leaf axils of sterile plants, conspicuous (under hand-lens), linear, orange-brown to nearly black, transversely septate and uniseriate, (5–)8–15 cells and (120–)240–410  $\mu$ m long.

**Dioicous.** **Perichaetia** terminal, usually overtopped by innovations, often serially; the leaves narrower and longer than vegetative leaves and often  $\pm$  secund. **Perigonia** terminal and usually obscured by innovations. **Setae** straight, slender, pale brown, twisted weakly to the right above, mostly c. 15–25 mm; **capsules** erect, straight or weakly curved, narrowly cylindrical, 8-ribbed, mostly 3.0–4.5 mm, with a weak neck; **exothecial cells** oblong and firm-walled; **annulus** of 2–3 rows of inflated and hyaline cells, mostly falling with operculum; **operculum** bluntly conic, not rostrate.

**Peristome** double; **exostome teeth** c. 300  $\mu$ m, obtuse at apex, abaxially papillose throughout, with a divisural line becoming nearly straight in upper portions, adaxially surface papillose and transversely barred but not or scarcely trabeculate; **endostome** pale, with a very low membrane, the segments nearly equal the teeth, papillose and narrowly perforate throughout, alternating with single, variably developed, and sometimes nodose cilia. **Calyptra** cylindrical and enclosing the entire capsule, splitting on one side or not, smooth, falling early. **Spores** nearly smooth, mostly 10–14  $\mu$ m.

**Illustrations:** Plate 2. Brotherus 1924, fig. 387; Sainsbury 1955a, pl. 41, fig. 2; Churchill & Buck 1982, figs. 3–4, 14–16; Malcolm & Malcolm 2003, p. 40; Meagher & Fuhrer 2003, p. 112; Seppelt et al. 2019, pl. 77.

**Distribution:** NI: N Auckland (Te Paki) including offshore islands (LB), S Auckland, Gisborne, Hawke's Bay, Taranaki, Wellington; SI: Nelson, Marlborough, Canterbury, Westland, Otago, Southland; St; A. Reported from C by Vitt (1974).

Austral. Tasmania\*, mainland Australia\*, temperate South America\*, South Georgia\*. Reported from Falkland Is and South Africa by Churchill & Buck (1982). Adventive in Ireland\*.

**Habitat:** A common and widespread species occurring in a wide range of habitats, but most abundant in terrestrial habitats in southern beech forest, where it often occurs on exposed roots, but is also common on rotten wood, earth mounds, soil banks, and humic and mineral soil over rock, including greywacke, granite, and limestone. Often on tree-fern and tree trunks (especially southern beech). Occurring in a wide range of native forest types, scrublands, and grasslands, including those dominated by *Chionochloa* spp., and in exotic tree plantations. *Leptotheca gaudichaudii* occasionally becomes detached from the substrate to form "moss balls". Not seen north of Mt Ruapehu (J. Beever, pers. comm., 4 Aug. 2015) and there are no herbarium records of *L. gaudichaudii* from either the Waitakere Ranges (N Auckland L.D.) or the Coromandel Peninsula (S Auckland L.D.). The only record from N Auckland L.D. is a J.K. Bartlett collection from Te Paki Bush Scenic Reserve (WELT M008429), confirmed by Beever. Herbarium records suggest it is a common species in the Rotorua area, Gisborne, and the Mt Taranaki area. On the South I. it is a very common to abundant species in the St Arnaud Range and adjacent parts of the Nelson Lakes N.P., in the southern beech forest of the ranges of Canterbury and Otago, and in Fiordland N.P.

On the North I. ranging from c. 150 to 1220 m (Ruahine Range, Wellington L.D.) and on the South I. from near sea level (Milford Sound, Southland L.D.) to at least 1675 m (Spenser Range, Nelson L.D.). Its South I. distribution exhibits an eastern bias and it is known from relatively few localities west of the Main Divide. Frequently associated mosses include *Bartramia papillata*, *Dicranoloma* spp., *Ditrichum cylindricarpum*, *Leucobryum javense*, *Pyrrhobryum mnioides* subsp. *contortum*, *Rhizogonium distichum*, the hepatics *Bazzania* spp. and *Lepidozia* spp., and the lichen *Cladia aggregata*. When epiphytic, *L. gaudichaudii* often occurs with *Leptostomum inclinans*.

**Notes:** The presence of the orange-brown to nearly black filamentous gemmae is highly diagnostic and a useful field character. However, gemmae are not produced on fertile plants and are sometimes absent even from sterile plants. Perigonia are usually obscured by subtending innovations and are difficult to find, even in fruiting populations (e.g., *A.J. Fife 5033a* from Mt Owen, Nelson L.D.).

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CHR 103615). Although individual stems in N.Z. specimens have leaves that are linear-lanceolate in shape, the leaves in the bulk of N.Z. material are ovate-lanceolate.

Some collections, particularly from higher elevations, have upper portions of the shoots decidedly complanate (e.g., *A.J. Fife 6351* from Morgan Tarn, Nelson L.D., CHR 461742), but the distinction is not worthy of taxonomic recognition.

A Tasmanian endemic, *L. watsii* Cardot, was reduced to varietal status by Churchill & Buck (1982), who noted that the material they had seen, including the Mt. Wellington type material collected by Watts, was intermixed with typical *L. gaudichaudii*. Type material of this name has been viewed only on JSTOR (image viewed online, JSTOR Global Plants, accessed 5 Aug. 2015.) and it apparently consists of only a few sterile shoots. No other material annotated by Churchill or Buck has been available for examination. However, *L. gaudichaudii* has variable leaf shape in N.Z., and in some N.Z. material leaves of upper shoots or innovations can be ovate, approaching those illustrated by Churchill & Buck for the var. *watsii*. The Tasmanian taxon seems doubtfully worthy of recognition. If var. *watsii* were to be accepted, then N.Z. material would, of necessity, be termed *L. gaudichaudii* Schwägr. var. *gaudichaudii*. However, it seems desirable to avoid this cumbersome name here given the doubtful status of the Tasmanian taxon.

**Recognition:** *Leptotheca gaudichaudii* is most likely to be confused with *Pyrrhobryum mnioides* subsp. *contortum* and *P. bifarium*. From both these species, *L. gaudichaudii* differs by having unpaired marginal teeth and short basal laminal cells. The abaxial costal surface in *L. gaudichaudii* is smooth or inconspicuously toothed, while those in *Pyrrhobryum* spp. are conspicuously toothed.

When sterile *L. gaudichaudii* could easily be confused in the field with species of *Pohlia*, but the very compact, isodiametric cells (which can be observed with a hand-lens) distinguish the present species.

**Etymology:** The species epithet honours Charles Gaudichaud-Beaupré, who collected the type at Port Jackson, N.S.W. (probably in 1823) while serving on the expedition commanded by Louis de Freycinet.

## ***Orthodontium* Schwägr., Sp. Musc. Frond. Suppl. 2(2), 123 (1827)**

**Type taxon:** *Orthodontium lineare* Schwägr.

**Plants** forming turves or cushions. **Stems** short or elongate, simple or branching by innovation, beset below with smooth, brown rhizoids. **Leaves** flexuose, linear-lanceolate, slenderly acute, unbordered, concave, entire. **Mid laminal cells** linear, smooth, firm-walled. **Costa** narrow, ending below the leaf apex or percurrent.

**Variably monoicous.** **Setae** elongate, slender, and ± flexuose; **capsules** erect or inclined, obovoid-cylindric, with a short or long neck, sulcate or smooth when dry; **stomata** superficial; **annulus** absent; **operculum** obliquely rostrate from a conic base. **Peristome** double, fragile; **exostome teeth** linear-lanceolate, papillose or smooth, with a nearly straight divisural line; **endostome segments** generally longer than teeth, linear, basal membrane and cilia absent. **Spores** spherical, medium-sized.

**Taxonomy:** The erect or suberect capsules and the near or total absence of an endostomal basal membrane lend coherence to the genus. *Orthodontium* was placed in a small subfamily within the Bryaceae by Brotherus (1924), while Goffinet et al. (2009) place it in the Rhizogoniales in the general relationship of the Rhizogoniaceae and Aulacomniaceae.

*Orthodontium* is a genus of c. 12–14 species distributed on all continents except Antarctica. The genus was revised by Meijer (1952), whose taxonomic concepts were narrow. The Australasian taxa he recognised are differentiated by a suite of overlapping quantitative characters. Sainsbury (1955a, 1955b) applied these concepts to N.Z. material and concluded that two species occurred here: the widespread *O. lineare* and the once collected *O. ruahinense*. *Orthodontium ruahinense* is not distinguished from *O. lineare* here, for reasons given below. The single collection (apparently by W. Bell) on which Meijer (1952, p. 44) based a N.Z. record of *O. australe* var. *robustusculum* (Müll.Hal.) Meijer has not been available for study.

**Etymology:** The generic name means straight tooth and probably refers to either the exostome teeth or to the endostome segments.

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***Orthodontium lineare* Schwägr., Sp. Musc. Frond. Suppl. 2(2), 124, pl. 188 (1827)**

Type: South Africa. Not seen.

= *Orthodontium sulcatum* Hook.f. & Wilson in Hooker, *Icon. Pl.* 8, 739B (1845)

≡ *Orthodontium lineare* subsp. *sulcatum* (Hook.f. & Wilson) Meijer, *Acta Bot. Neerl.* 1: 34 (1952)

Isotype: Western Australia, Swan River, *J. Drummond* 263, BM-Hooker!

= *Orthodontium ruahinense* Meijer, *Acta Bot. Neerl.* 1: 24 (1952)

Holotype: N.Z., N.W. Ruahines, Jan. 1948, *A.P. Druce* 1169/D, WELT M004860!

**Plants** bright- or yellow-green, or gold-brown, forming turves or cushions. **Stems** very short, mostly <2 mm, unbranched or branching by subperichaetial innovation, beset below with smooth, brown rhizoids, in cross-section with central strand weak or absent. **Leaves** strongly crowded at stem apex, widely and loosely spreading moist or dry, sometimes weakly secund, flexuose, linear-lanceolate, c. 3–4.5(–6) mm, concave, entire and plane at margins. **Mid laminal cells** linear, firm-walled, smooth, mostly 90–180 × c. 6 μm, becoming shorter towards apex, and wider, more oblong, and thinner-walled at leaf base; **marginal cells** not differentiated; **alar cells** scarcely differentiated. **Costa** percurrent or subpercurrent, filling <1/5 of the leaf base, in cross-section with a central stereid band and larger cells exposed on both surfaces. **Brood bodies** (reduced and falcate leaves) occasional on sterile plants; **tubers** absent.

**Polygamous** (mostly **paroicous** or **gonioautoicous**). **Perichaetia** terminal, with leaves little differentiated. **Antheridia** usually in axils of outer perichaetial leaves (paroicous) or on short buds below the perichaetium, at the base of fruiting shoots (gonioautoicous), or sometimes terminal. **Setae** (4–)6–15(–20) mm, pale brown, rather slender, flexuose; **capsules** erect or inclined, obovoid-cylindric, pale brown or straw-coloured (1.5–)2.0–2.5(–3.0) × c. 0.75 mm, with a short ill-defined neck, weakly to clearly sulcate (8-ridged) and weakly constricted below the transverse mouth when dry; **stomata** superficial; **annulus** absent; **operculum** obliquely rostrate from a conic base, c. 0.5 mm long. **Peristome** double, fragile; **exostome teeth** linear-lanceolate, often rounded apically, yellow-brown, strongly inrolled and inconspicuous when dry, erect when moist, trabeculate, slightly papillose, with a nearly straight divisural line; **endostome segments** pale, longer than teeth (commonly 180–250 μm long), conspicuous when dry, linear, with bulging nodes, finely papillose, with no basal membrane or cilia. **Calyptra** small and cucullate. **Spores** spherical, (16–)18–22 μm, papillose-insulate.

**Illustrations:** Plate 3. Meijer 1952, pl. VIII (as *O. lineare* var. *sulcatum*); Seppelt 2004, fig. 80

**Distribution:** NI: N Auckland (Bay of Islands), S Auckland, Gisborne, Hawke's Bay, Wellington; SI: Nelson, Marlborough, Canterbury, Westland (Craigieburn pākihi), Otago (Pine Hill, Dunedin region, Tahakopa Bay), Southland; St; Ch (Pitt I.); A; C. Reported from M by Seppelt (2004).

Austral. Tasmania\*, mainland Australia\*, South Africa\*. Reported from southern South America and widespread and adventive in Europe (Smith 2004).

**Habitat:** Epiphytic, on rotten wood, or terrestrial. When terrestrial, occurring mostly on humic or peaty soil, and less often on mineral soil. Tree-fern trunks, bases, and stumps provide the most common substrate, but *O. lineare* can also occur on accumulated humus on a variety of native and introduced trees including species of southern beech and the introduced conifers *Pseudotsuga menziesii* and *Sequoia sempervirens*. Also occurring on well-rotted, usually dry wood (often beneath overhangs) in a wide range of forest types and on thermally heated soil. Although *O. lineare* is widespread on both main islands, it appears to be a very uncommon plant in N Auckland and Westland L.D. (from the latter it is known only from a single depauperate collection, *P. Beveridge* s.n., 30 Oct. 2000, WELT M033415) and no collections have been seen from Taranaki L.D. The uncommonness of *O. lineare* in western parts of the main islands is mirrored by its relative rarity in the western parts of Britain (Smith 2004), where it is adventive. On the North I. ranging from near sea level (Mana I., Wellington L.D.) to c. 1100 m (Whakapapa, Wellington L.D.) and on the South I. and Stewart I. / Rakiura ranging from very close to sea level (Tahakopa Bay, Otago L.D.) to at least 900 m elevation (Mt Robert, Nelson L.D.). *Campylopodium lineare*, *Leptotheca gaudichaudii*, and *Rhizogonium distichum* are frequent associates, and *Calomnion complanatum* often co-occurs in epiphytic habitats.

**Notes:** Masses of modified (reduced, pale, and falcate) leaves occasionally develop on sterile plants and serve an asexual reproductive role. When growing on thermally heated soil the stems can become quite elongate (to c. 40 mm) and branched (e.g. *K.W. Allison* 516 from Rotorua, S Auckland L.D., CHR 490367).

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Given the range of variation of *O. lineare* in N.Z., the features used by Meijer (1952) to distinguish *O. ruahinense* are unconvincing. The paroicous and gonioautoicous sexuality (of Meijer's type) is representative of *O. lineare*. While more than one seta per perichaetium has been observed only in Meijer's type, more than one fertilised archegonium per perichaetium has been observed in other N.Z. collections (e.g., *K.W. Allison 3025*, CHR 490370). The seta length (mostly 5–7 mm) and leaf length in Meijer's type fall at the lower and upper end, respectively, of the range of continuous variation of N.Z. *O. lineare*. The lack of peristome tooth papillae cited by Meijer seems an unreliable feature as all capsules in the type of *O. ruahinense* are old and imperfect. The weight of evidence suggests that *O. ruahinense* does not deserve taxonomic recognition.

Shaw (2012) treated *Orthodontium* for Australia and recognised two species, *O. lineare* Schwägr. and *O. pallens* (Hook.f. & Wilson) Broth. [Nat. Pflanzenfam. 1, 3: 544, 1903]. He considered the latter species to be “possibly endemic to Australia” and distinguished it from *O. lineare* by a smaller stature and a more rudimentary endostome. Shaw also placed four Tasmanian or mainland Australia species into synonymy with *O. lineare* Schwägr.

*Orthodontium lineare* is an example of a southern hemisphere moss that has been introduced into Europe (probably from South Africa). It was first recorded from England by Watson (1922), who described it as a variety of *O. gracile*. The expanding range of *O. lineare* in Europe has been documented by Meijer (1952) and Ochyra (1982).

**Recognition:** The slenderly lanceolate, flexuose, subtly undulate, and golden leaves give *O. lineare* a distinctive appearance. The species is frequently fruiting, and the erect, weakly sulcate capsules atop slender setae provide a further means of recognition. When dry, the mature exostome teeth are characteristically strongly incurved and erect endostome segments are conspicuous.

When sterile *O. lineare* could be confused with *Leptobryum pyriforme* or *Pohlia tenuifolia*. The *Orthodontium* lacks the red axillary hairs that characterise *L. pyriforme*. *Leptobryum* has more clearly differentiated oblong leaf bases and setaceous subulae with denticulate leaf apices. *Pohlia tenuifolia* has much shorter leaves than *O. lineare* (mostly 1.8–3.2 mm vs 3–6 mm) and is dioicous. When fruiting, *Orthodontium* is distinct from both these species by its erect, sulcate capsules, and the absence of an endostomal membrane. Confusion sometimes occurs with *Campylopodium lineare*. *Orthodontium lineare* differs from *C. lineare* by having a double peristome, longer and flexuose rather than distinctly cygneous setae, longer capsules, and numerous other less easily observed characters.

**Etymology:** The species epithet presumably refers to the linear-lanceolate form of the leaves.

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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

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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)
subssp.	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

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<b>Symbol</b>	<b>Meaning</b>
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*.

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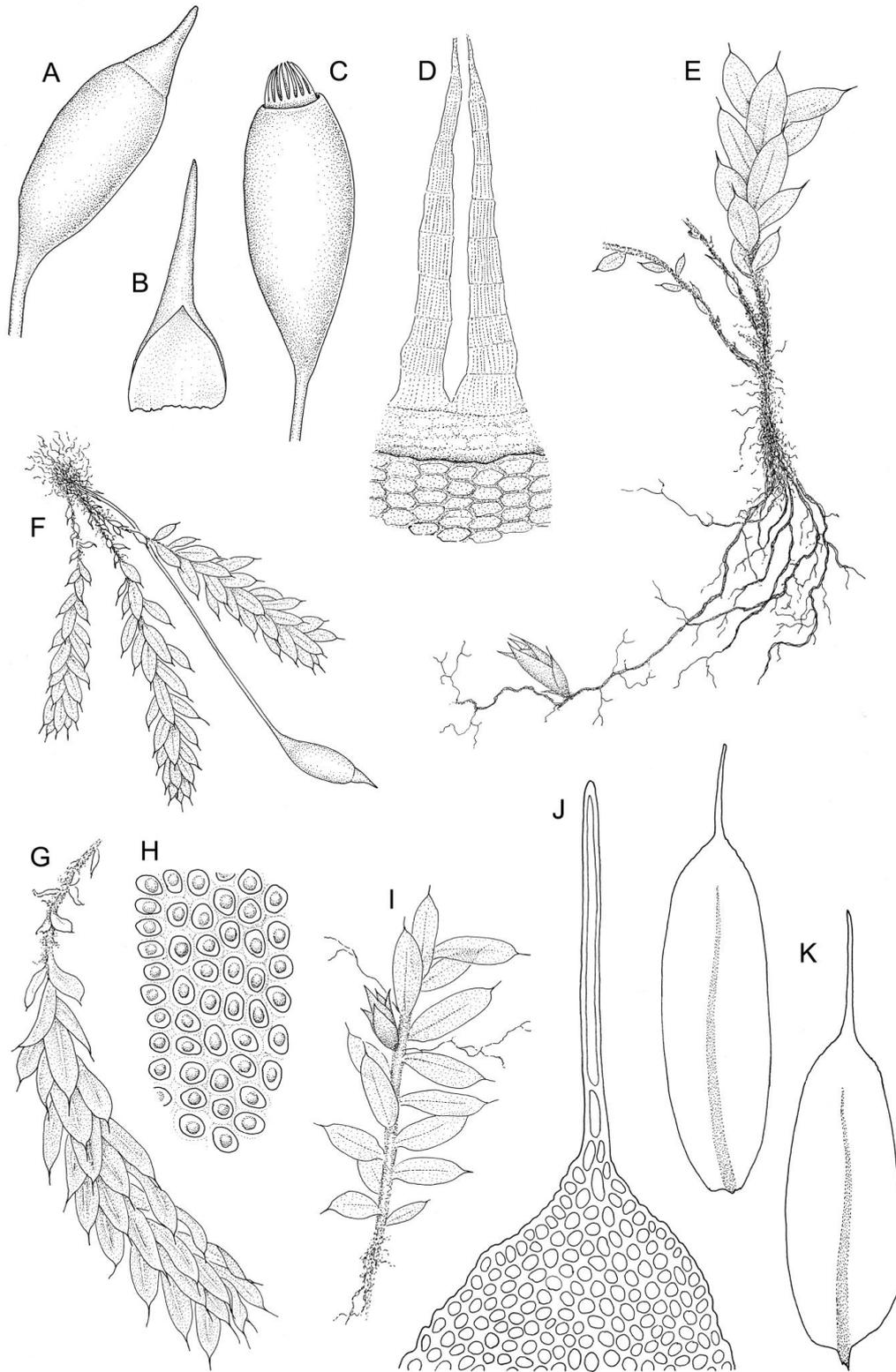
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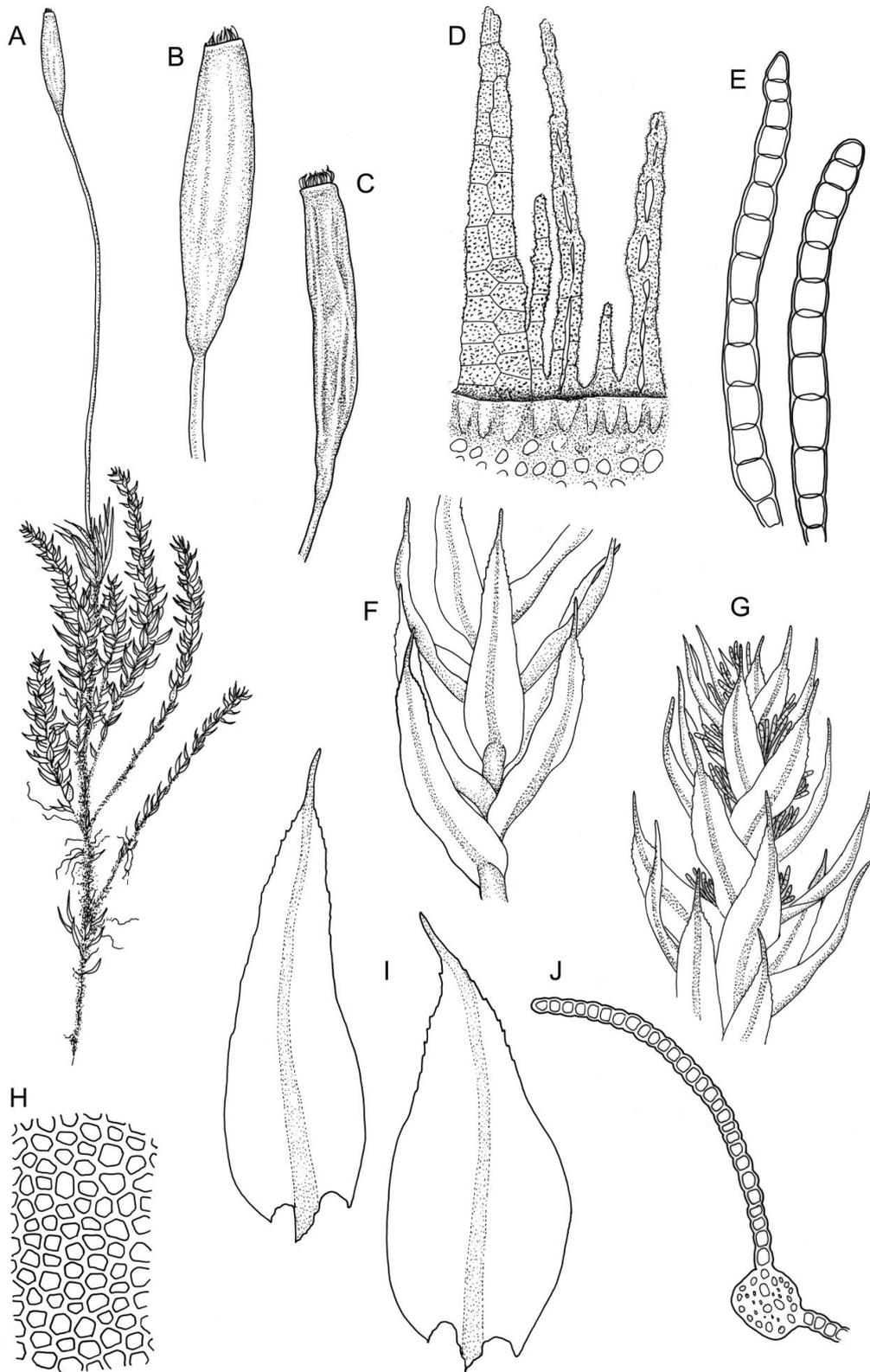
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### **A.J. Fife**

Manaaki Whenua – Landcare Research, PO Box 69040, Lincoln 7640, New Zealand

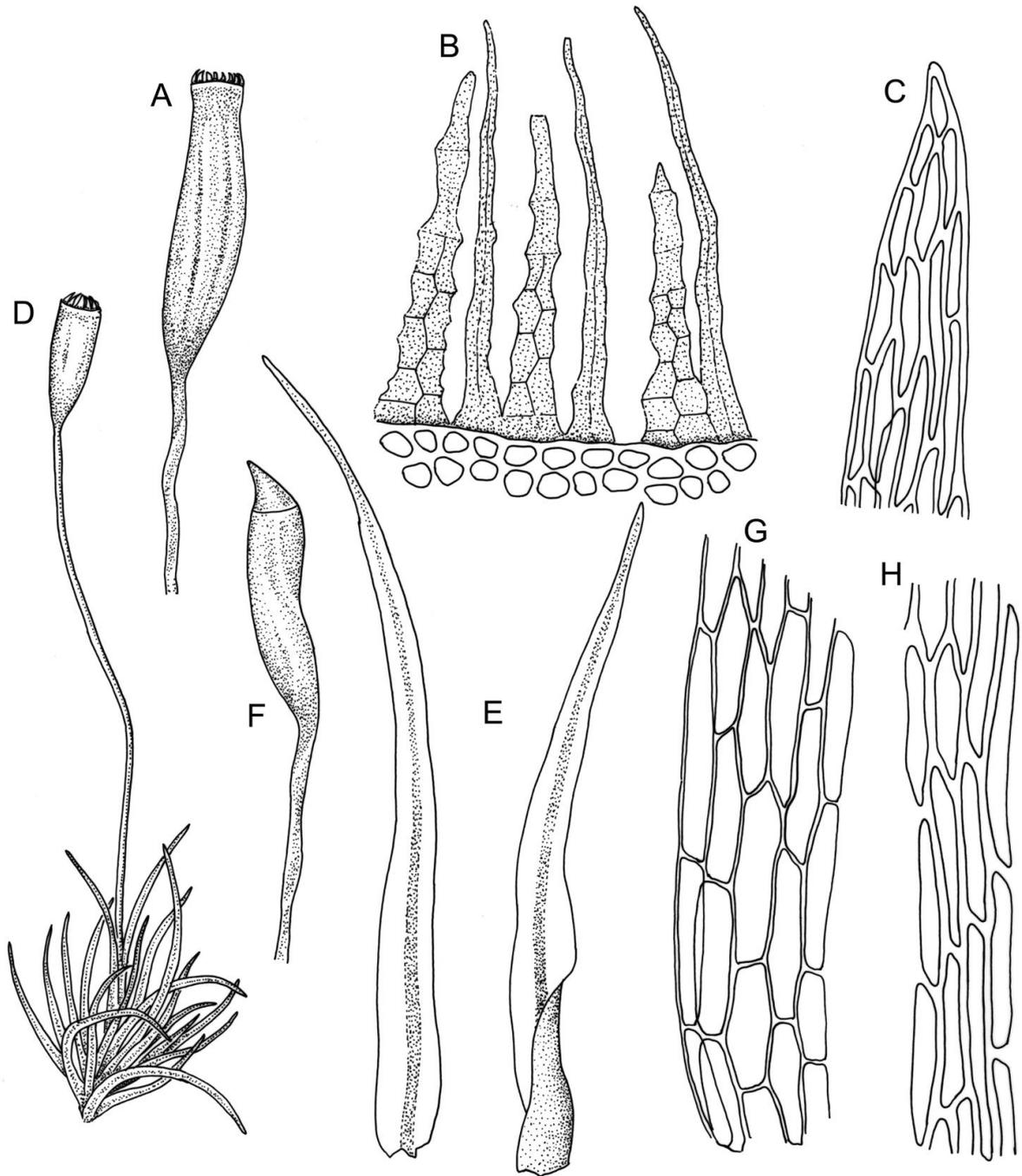


**Plate 1: *Hymenodon*. A–K: *H. pilifer*.** A, capsule with operculum, moist. B, calyptra. C, capsule, moist. D, endostome detail. E, habit of sterile plant, with perigonium on rhizoids. F, habit with capsule, oriented as *in situ*. G, shoot detail, oriented as *in situ*. H, upper laminal cells. I, portion of shoot, with perigonium on stem. J, leaf apex. K, leaves. A–D, F–H, J–K drawn from *K.W. Allison 157*, CHR 454561; E, I drawn from *A.J. Fife 6082*, CHR 405341.

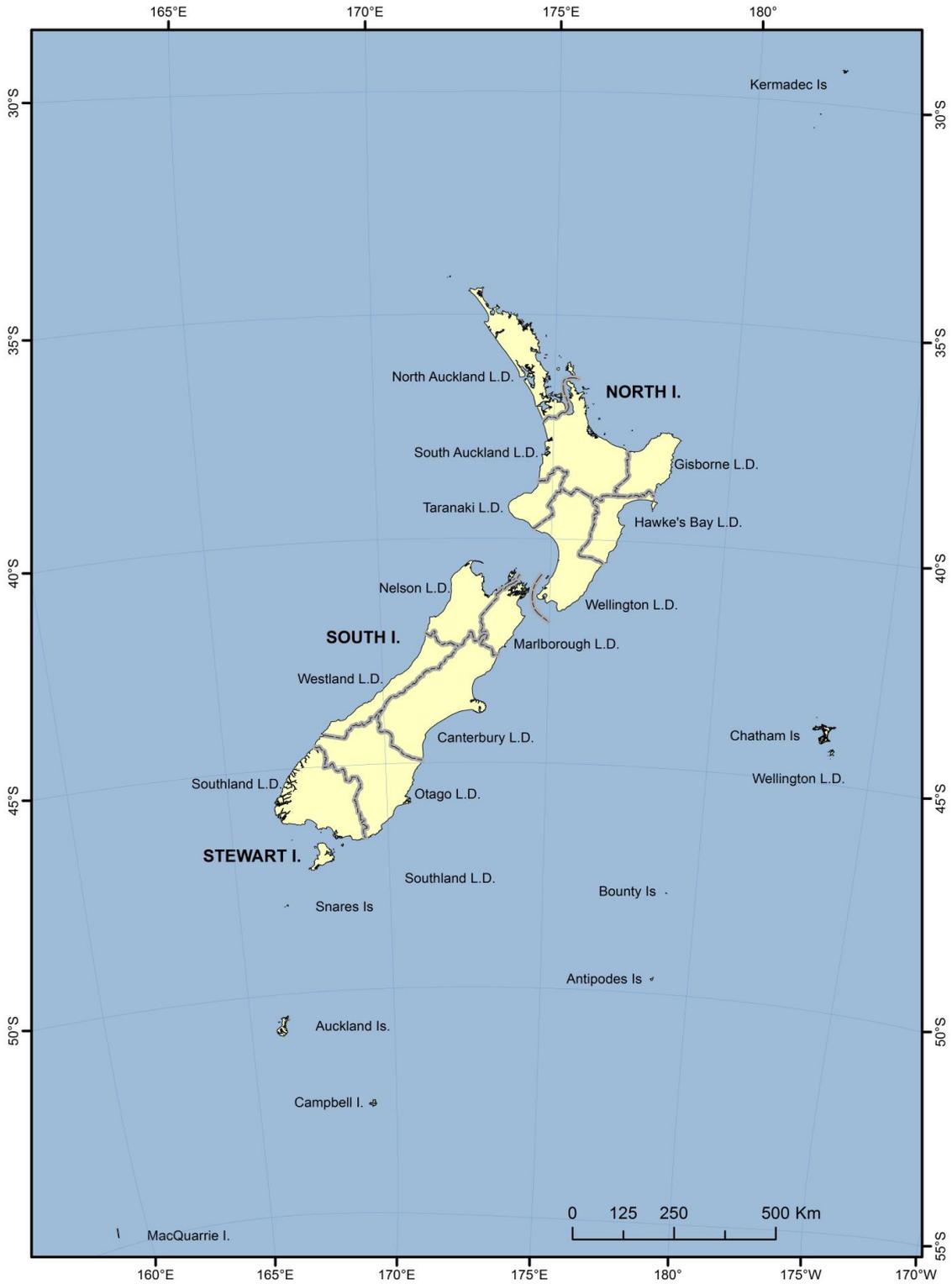


**Plate 2:**

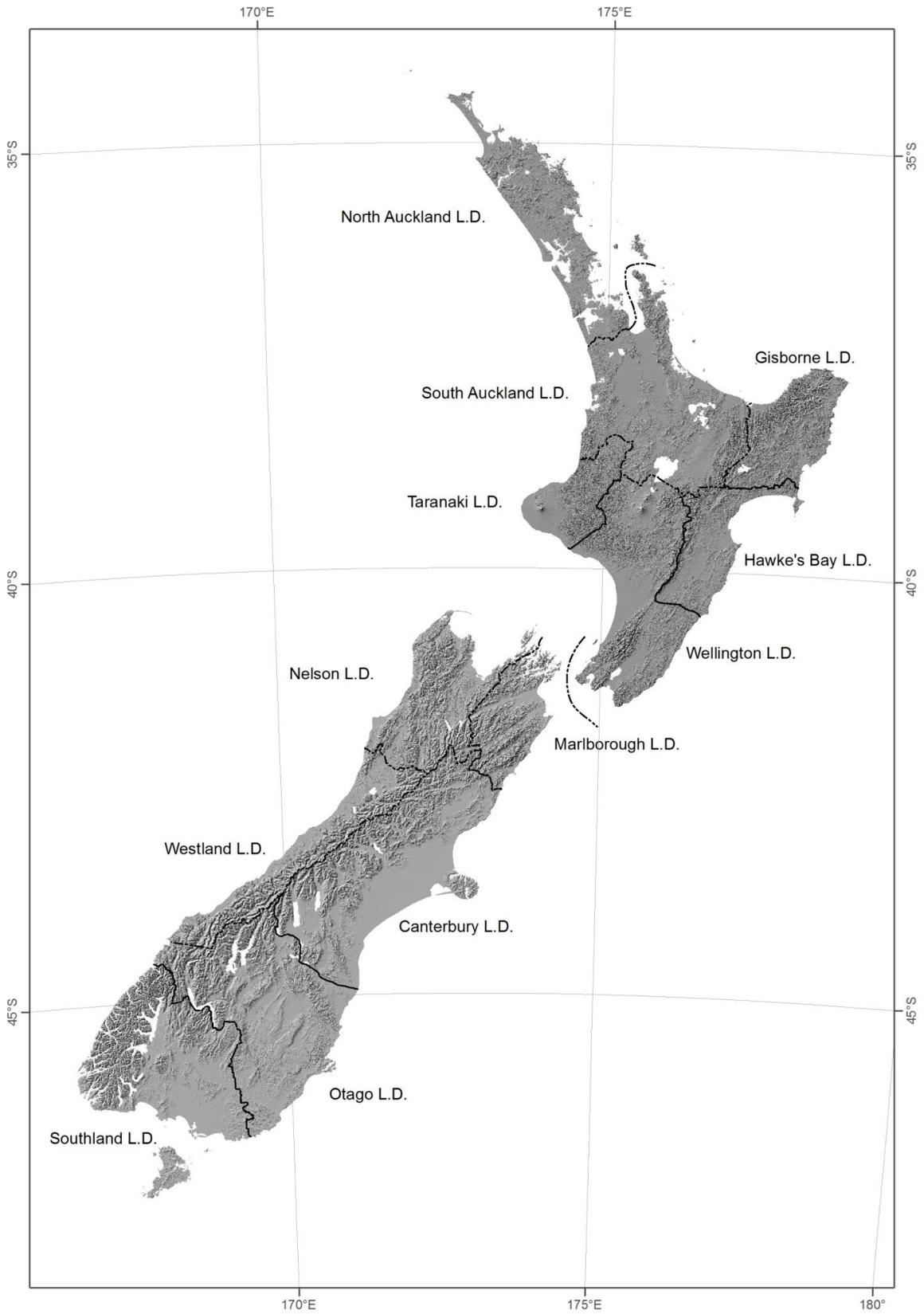
**Leptotheca. A–J: *L. gaudichaudii*.** A, habit with capsule. B, capsule, moist. C, capsule, dry. D, peristome detail showing one tooth, two endostome segments, and two cilia. E, axillary gemmae. F, portion of shoot, showing leaf bases. G, apex of sterile shoot with gemmae. H, upper laminal cells. I, leaves. J, cross-section of mid laminal cells including costa. Drawn from *B.H. Macmillan* 72/856, CHR 164360 and *A.J. Fife* 6347, CHR 405561.



**Plate 3: *Orthodontium*. A–H: *O. lineare*.** A, capsule, moist. B, peristome detail. C, leaf apex. D, habit with capsule. E, leaves. F, capsule with operculum, dry. G, basal laminal cells at margin. H, mid laminal cells. Drawn from J.E. Beaver 31-15, CHR 406193.



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



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

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Page numbers are in **bold** for the main entry,  
and *italic* for synonyms.

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& Wilson) Meijer 8  
*Orthodontium ruahinense* Meijer 8  
*Orthodontium sulcatum* Hook.f. & Wilson 8

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## Flora of New Zealand: PDF publications

The electronic Flora of New Zealand (**eFloraNZ**) project provides dynamic, continually updated, online taxonomic information about the New Zealand flora. Collaborators in the project are Manaaki Whenua–Landcare Research, the Museum of New Zealand Te Papa Tongarewa, and the National Institute of Water and Atmospheric Research (NIWA).

The eFloraNZ presents new systematic research and brings together information from the Manaaki Whenua–Landcare Research network of databases and online resources. New taxonomic treatments are published as fascicles in PDF format and provide the basis for other eFloraNZ products, including the web profiles.

eFloraNZ will have separate sets of PDF publications for algae, lichens, liverworts and hornworts, mosses, ferns and lycophytes, and seed plants.

For each eFloraNZ set the PDF files are made available as dated and numbered fascicles. With the advent of new discoveries and research the fascicles may be revised, with the new fascicle being treated as a separate version under the same number. However, superseded accounts will remain available on the eFlora website.

**Moss Set (ISBN 978-0-478-34747-0)**

The Moss Set covers indigenous and exotic mosses within the New Zealand Botanical Region.

Authors Allan Fife and Jessica Beever intend to publish *Flora of New Zealand Mosses* as a book. However, they decided to make completed family treatments available through the eFloraNZ project in advance of being published in hardcopy, to enable immediate use.

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