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Cover image: *Pakau pennigera*. Frond of mature plant.

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Introduction

The large family Thelypteridaceae is represented in New Zealand by five indigenous genera (*Christella*, *Cyclosorus*, *Macrothelypteris*, *Pakau* and *Thelypteris*) with five non-endemic species, and one naturalised genus (*Pseudophegopteris*) with one casual species. Four of the indigenous species have rather localised distributions confined to the northern part of the North Island, with two extending also to the Kermadec Islands. The fifth species, *Pakau pennigera*, is widely distributed throughout the North Island, much of the South Island and on the Chatham Islands. All members of the family in New Zealand are terrestrial ferns with pinnate to pinnate-pinnatifid fronds (except for *Macrothelypteris,* which is more divided), and they bear a variety of hairs, glands and scales. The veins are mostly free, except that the basal veins of the pinna lobes often unite below the sinus in a characteristic pattern, and the sori are round and protected by reniform indusia, except in *Pakau pennigera* and *Pseudophegopteris aurita,* which are exindusiate.

Thelypteridaceae Pic.Serm., *Webbia* 24: 709 (1970)

Type taxon: *Thelypteris* Schmidel

Terrestrial (NZ) or rarely epiphytic (not NZ) ferns. Rhizomes short- to long-creeping, erect or forming a short arborescent trunk, scaly. Fronds monomorphic or rarely dimorphic, not articulated to rhizome. Laminae undivided (not NZ) or 1-pinnate to 3-pinnate-pinnatifid (NZ), catadromous, herbaceous or coriaceous, usually hairy, sometimes bearing glands, rarely also scaly, often with aerophores in two lines on stipe and rachis and on abaxial surfaces at bases of pinnae. Veins free (NZ), or with one or more basal veins from adjacent pinna lobes uniting below the sinus (NZ), or rarely reticulate (not NZ). Sori round or slightly elongate, superficial, borne on abaxial surface away from margins; paraphyses usually absent or rarely present; indusia reniform, irregularly shaped or absent; sporangial maturation mixed. Sporangia with vertical annulus, usually 64 spores per sporangium. Homosporous; spores monolete (NZ) or rarely trilete (not NZ), lacking chlorophyll; perispores reticulate, winged, echinate or tuberculate.

Taxonomy: A family of 37 genera and almost 1200 species (Fawcett & Smith 2021; Fawcett et al. 2021).

Thelypteridaceae is one of the largest and most diverse families of ferns, and its taxonomy has been contentious, with many different classifications recognising anything from a single genus (Fraser-Jenkins et al. 2017) to 32 genera (Pichi Sermolli 1977). A detailed history of these classifications was provided by Fawcett & Smith (2021) and Fawcett et al. (2021). Their phylogenomic investigation of 621 samples encompassed all the known genera and about half the species in the family. They ultimately recognised 37 genera, including 14 that were re-circumscribed and seven that were newly described. Their classification is adopted here.

In New Zealand, Allan (1961) recognised only a single genus, *Thelypteris*, with five indigenous species. However, in a review of the family in the Pacific and Australasia, Holttum (1977), raised this to five genera – *Christella*, *Cyclosorus*, *Macrothelypteris*, *Pneumatopteris* and *Thelypteris* – a treatment that has been widely accepted until now. In stark contrast to the diversity in Australia (Bostock 1998), Fiji (Brownsey & Perrie 2011) and the south-west Pacific (Nakamura 2008), each of these genera is monotypic and easily distinguished in New Zealand. However, Fawcett et al. (2021) showed that *Pneumatopteris* was highly polyphyletic with species scattered in many different lineages. One of these was the New Zealand and south-east Australian species, *P. pennigera*, which was found to be distantly related to other taxa in the family, resolving on a long branch as sister to the rest of the christelloid clade. Fawcett & Smith referred it to a new, monotypic genus, *Pakau*, which is accepted here. In addition, a single species of the naturalised genus *Pseudophegopteris* is now known to occur in New Zealand (Ogle et al. 2021).

1	Fertile laminae at least 2-pinnate-pinnatifid; lamina hairs up to 2 mm long; indusia 0.2–0.4 mm wide	*Macrothelypteris*
	Fertile laminae 1-pinnate or 1-pinnate-pinnatifid, but not more divided; lamina hairs up to 1 mm long; indusia absent or, if present, 0.4–1.2 mm wide	2
2	All veins free	3
	At least the basal pair of veins in each pinna segment uniting with those from adjacent segments	4
3	Basal basiscopic pinnules on proximal primary pinnae longer than adjacent pinnules; rachis and stipe red-brown; indusia absent	*Pseudophegopteris*
	Basal basiscopic pinnules on proximal pinnae ± same length as adjacent pinnules; rachis and stipe pale brown or green; indusia present	*Thelypteris*
4	Rhizomes erect; sori lacking indusia	*Pakau*
	Rhizomes erect or creeping; sori with well-developed indusia	5
5	Basal pair of pinnae much shorter than those at mid-lamina	*Christella*
	Basal pair of pinnae about as long as those at mid-lamina	*Cyclosorus*

Distribution: Widespread in tropical and sub-tropical regions, with a few species extending into temperate zones. The greatest diversity is found in Malesia, with 440 species (Holttum 1982), and the Neotropics, with another 300 species (Smith 1990). There are about 100 species in the Pacific region (Holttum 1977) and 23 in Australia (Bostock 1998). Five non-endemic and one naturalised genera with six species in New Zealand; none endemic.

Biostatus: Indigenous (Non-endemic).

Table : Number of species in New Zealand within *Thelypteridaceae* Pic.Serm.

Category	**Number**
Indigenous (Non-endemic)	5
Exotic: Casual	1
Total	**6**

Recognition: The family Thelypteridaceae comprises mostly terrestrial ferns with undivided to 3-pinnate-pinnatifid fronds, which bear hairs and sometimes also glands and scales. Characteristically the veins are mostly free, except that the basal veins of the pinna lobes often unite below the sinus. The sori are usually round, away from the margin, and either exindusiate or protected by reniform indusia. The sporangia have a vertical annulus, and almost always produce monolete spores.

Christella H.Lév., *Fl. Kouy-Tchéou* 472 (1915)

Type taxon: *Christella parasitica* (L.) H.Lév.

Etymology: Named in honour of K.H.H. Christ (1833–1933), Swiss pteridologist and Professor of Botany at Basel.

Terrestrial ferns. Rhizomes erect to short- or long-creeping, scaly. Rhizome scales narrowly ovate, setiferous. Fronds monomorphic. Stipes hairy. Laminae 1-pinnate-pinnatifid, herbaceous, usually with 1–5 pairs of proximal pinnae gradually reduced in size to c. 20 mm long; basal pinnae auricled acroscopically; aerophores at base of pinnae not swollen; abaxial surface of laminae lacking scales, usually bearing erect acicular hairs, sometimes bearing short capitate hairs, and sometimes bearing thick red or orange glandular hairs (not NZ), lacking sessile spherical glands. Veins free (not NZ) or one or more basal veins from adjacent pinna lobes uniting below the sinus (NZ). Sori round, indusiate; paraphyses absent. Indusia reniform, bearing acicular hairs. Sporangia lacking glands or hairs near annulus, but bearing an elongate unicellular glandular hair on the stalk. Spores monolete, tuberculate or ridged.

Taxonomy: Allan (1961) included all indigenous New Zealand species of Thelypteridaceae within a broadly construed *Thelypteris.* Holttum (1976) recognised *Christella* as a distinct genus of Thelypteridaceae with about 50 species, mostly in the Old World tropics, and one species in New Zealand. He distinguished the genus principally by the presence of an elongate, unicellular, thick, blunt hair on the stalks of the sporangia (Holttum 1971a). In addition, the proximal pinnae are usually gradually reduced, the aerophores at the base of the pinnae are not swollen, acicular hairs are usually present on both surfaces of the lamina, short capitate hairs are sometimes present, thick red or orange glandular hairs are sometimes present (but not in New Zealand), sessile spherical glands are absent, the basal veins from adjacent pinnules usually join, and the sori are indusiate (Holttum 1977). The Australasian and Pacific species remain largely unchanged following the work of Fawcett & Smith (2021), except for three Hawai‘ian species transferred to the new genus *Menisciopsis*.

Distribution: A genus of 66 species distributed in the tropics and subtropics of the Old World and two extending to tropical America (Fawcett & Smith 2021); five species in Australia (Bostock 1998) and c. 16 in the Pacific (Holttum 1977). *Christella dentata* is naturalised in the New World (Smith 1971; Holttum 1976) and Hawai‘i (Palmer 2003). One species in New Zealand; none endemic.

Biostatus: Indigenous (Non-endemic).

Table : Number of species in New Zealand within *Christella* H.Lév.

Category	**Number**
Indigenous (Non-endemic)	1
Total	**1**

Cytology: The base chromosome number in *Christella* is x = 36 (Holttum 1977; Smith 1990; Fawcett & Smith 2021).

Notes: Holttum (1971b) accepted Léveillé's earlier name, *Christella*, for a genus that he was then in the process of recognising. He selected *C. parasitica* (L.) H.Lév. as the type of the genus and redefined some of the characters.

Davison (1995) investigated *Christella* in New Zealand for an M.Sc. at the University of Auckland, but the results of her work have never been published.

Christella dentata (Forssk.) Brownsey & Jermy, *Brit. Fern Gaz.* 10: 338 (1973)

≡ *Polypodium dentatum* Forssk., *Fl. Aegypt.-Arab.* 185 (1775)
≡ *Dryopteris dentata* (Forssk.) C.Chr., *Kongel. Danske Vidensk. Selsk. Naturvidensk. Math. Afh.* 6: 24 (1920)
≡ *Thelypteris dentata* (Forssk.) E.P.St.John, *Amer. Fern J.* 26: 44 (1936)
≡ *Cyclosorus dentatus* (Forssk.) Ching, *Bull. Fan Mem. Inst. Biol.* 8: 206 (1938)
Holotype: Yemen, Bolghose, *P. Forsskål 809*, C 10002814 (!online)

= *Polypodium nymphale* G.Forst., *Fl. Ins. Austr.* 81 (1786)
≡ *Aspidium nymphale* (G.Forst.) Schkuhr, *24. Kl. Linn. Pfl.-Syst. 1,* 36, t. 34 (1809)
≡ *Nephrodium nymphale* (G.Forst.) Desv., *Mém. Soc. Linn. Paris* 6: 258 (1827)
≡ *Dryopteris nymphalis* (G.Forst.) Copel., *Bernice P. Bishop Mus. Bull.* 59: 46 (1929)
≡ *Cyclosorus nymphalis* (G.Forst.) Ching, *Bull. Fan Mem. Inst. Biol.* 10: 247 (1941)
≡ *Thelypteris nymphalis* (G.Forst.) C.F.Reed, *Phytologia* 17: 297 (1968)
Lectotype (selected by Holttum 1976): *G. Forster Herbarium 279*, BM 000036001! (said by Forster and Holttum to be from New Zealand, but the sheet is annotated "type Tahiti")

= *Aspidium molle* Sw., *J. Bot. (Schrader)* 1800(2): 34 (1801) nom. nov. pro *Polypodium molle* Jacq. 1791 (non *Polypodium molle* Schreb. 1771)
≡ *Nephrodium molle* (Sw.) R.Br., *Prodr. Fl. Nov. Holland.* 149 (1810)
≡ *Dryopteris molle* (Sw.) Hieron., *Hedwigia* 46: 348 (1907)
Holotype (see Mabberley & Moore 2022): Plate 640 in Icones Plantarum Rariorum vol. 3, part 10 (Jacquin 1792)

= *Nephrodium remotum* Heward, *London J. Bot.* 1: 121 (1842)
Holotype: Norfolk Island, *A. Cunningham 21*, 1830, K 000951645 (!online)

= *Christella dentata* var. *caespitosa* Holttum, *Kew Bull.* 41: 518 (1986)
Holotype: Australia, Queensland, 19 km S of Russell River bridge, on Innisfail-Cairns road, *R.J Chinnock 5802 & P.J. Brownsey*, AD 98304157!

Etymology: From the Latin *dentatus* (toothed), a reference to the incised pinnae.

Vernacular name: soft fern

Rhizomes either creeping, up to 150 mm long (in herbarium specimens, but recorded up to 1000 mm in wild populations) with stipes arising 1–10 mm apart in tufts at or near the apex, 2.5–4 mm diameter, or erect and up to 70 mm tall, or very rarely up to 1000 mm tall; bearing scattered scales. Rhizome scales narrowly ovate, 3.5–14 mm long, 0.5–1.2 mm wide, pale or chestnut-brown, entire, with numerous superficial hairs. Fronds 340–1195 mm long, arching upwards. Stipes 45–350 mm long, pale or yellow-brown (or sometimes purple), hairy throughout, scaly proximally. Laminae 1-pinnate to 1-pinnate-pinnatifid, elliptic, narrowed to a pinnatifid apex, 200–945 mm long, 68–350 mm wide, pale to dark green on both surfaces, herbaceous. Scales absent on lamina surfaces; colourless acicular hairs up to 1 mm long abundant on both surfaces and margins; tiny colourless to yellow capitate hairs on abaxial surface. Primary pinnae in 8–30 pairs below pinnatifid apex, widely spaced especially proximally, narrowly ovate or narrowly oblong; the longest at about the middle, sessile, 36–255 mm long, 10–31 mm wide; the basal pair 5–89 mm long, auricled acroscopically. Primary pinnae divided ⅓ to ¾ to the midrib; ultimate segments 5–16 mm long, 3–6 mm wide; apices obtuse to truncate, margins entire and inrolled; sometimes the basal acroscopic segment extended and lobed up to 22 mm long and 11 mm wide. Basal veins on adjacent pinna segments joining, unbranched in each ultimate pinna segment. Sori round, in one row either side of midrib away from pinna margins; indusia reniform, 0.6–1.2 mm diameter, bearing acicular hairs.

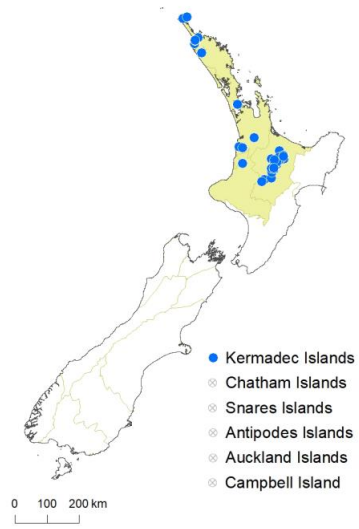

Fig. 1: *Christella dentata* distribution map based on databased records at AK, CHR and WELT.

Distribution: North Island: Northland, Auckland, Volcanic Plateau, Taranaki.

Kermadec Islands.

Altitudinal range: 0–400 m.

Christella dentata has been recorded in lowland sites on the Kermadec Islands (Raoul, Macauley and Cheeseman Islands), from Te Paki (Spirits Bay, Te Huka Bay, Akura Stream, Waitangi Stream), a few localities near Awanui north of Kaitāia, and in thermal regions from Rotorua to Tokaanu. It extends from near sea level to about 300 m on Raoul Island and 400 m near Taupō. It has also been collected from near Kāwhia Harbour, and from Paemako near Piopio, where the status of the populations as indigenous or naturalised is uncertain; neither population is extant. There are populations that are naturalised in a few sites in Auckland and Hamilton, and these may have originated from indigenous plants brought into cultivation at various sites nearby (e.g. AK 305923, Auckland). Others may have originated from cultivated plants with an overseas origin (see below). There is also a specimen in the Armstrong Herbarium (CHR 633413) supposedly collected from Heathcote, Christchurch by J.F. Armstrong in 1863 that might have come from a naturalised plant, although such a record is unlikely at this locality.

Widely distributed in the tropics and subtropics of the Old World from Africa to India, Asia, Australia and most of the islands in the Pacific; extends north to the Azores, Madeira and Crete (Brownsey & Jermy 1973). Naturalised in the Americas (Smith 1971; Holttum 1976) and Hawai'i (Palmer 2003); Strother & Smith (1970) noted that although common in greenhouses and botanical gardens, it was collected in the New World only twice before 1930, but has since spread very rapidly. Plants in the Neotropics and in Hawai'i have distinctive purple stipes similar to some naturalised plants in New Zealand (e.g. AK 305922, Auckland) and some plants of uncertain status (e.g. AK 212348, Kāwhia).

Biostatus: Indigenous (Non-endemic).

Indigenous: non-endemic (but naturalised in Auckland and Hamilton and possibly western Waikato).

The species was given a conservation status of 'At Risk / Naturally Uncommon' by de Lange et al. (2018). The 'thermal' form, not recognised here, was regarded as 'Nationally Endangered'.

Habitat: On the Kermadec Islands *Christella dentata* grows in *Metrosideros* forest, clearings, scrub, open grassland, pumice banks, under overhanging cliffs, disturbed areas, in swampy sites and at the entrance to petrel burrows with *Hypolepis dicksonioides*. Around Kaitāia and Te Paki it occurs very locally in disturbed and cattle-trampled sites in coastal wetland, on river banks, in streambeds, along roadsides, in drains, under rawiri (*Kunzea linearis*) forest and in alluvial podocarp forest. In geothermal areas on Raoul Island and the Rotorua/Taupō district it occurs on heated soil, beside hot streams and mud pools, often under mānuka and kānuka in sheltered places or in weedy vegetation. In the western Waikato it was recorded from kahikatea forest. Naturalised plants grow under willows and in disturbed or urban environments.

Recognition: *Christella dentata* is recognised by its herbaceous fronds, primary pinnae divided ⅓ to ¾ to the midrib with obtuse to truncate segments, basal pair of pinnae shortened, veins in adjacent segments joining, indumentum on the abaxial surfaces comprising acicular hairs and tiny capitate hairs but lacking scales, and indusia bearing acicular hairs. The rhizomes are creeping (up to 1 m long recorded in wild populations, de Lange, iNaturalist observation #1463496) to erect (up to 1 m tall, recorded by de Lange, AK 314009), and the fronds arise in tufts at or near the apices, with very short distances between adjacent stipes. This contrasts with the longer-creeping rhizomes with more widely spaced fronds in *Cyclosorus interruptus* and *Thelypteris confluens*.

Cytology: n = 72 (Brownlie 1961, as *Cyclosorus nymphalis*, Taupō); 2n = 144 (de Lange et al. 2004, Foley's Bush, Awanui).

Notes: Allan (1961) recognised only a single species of *Christella* in New Zealand (as *Thelypteris dentata*). Given (1981) suggested that plants from thermal areas might be different to those from around Kaitāia, which he related to "*C. dentata* of the tropics", but did not elaborate on how they could be distinguished. Brownsey et al. (1985) listed two taxa, *C. dentata* and *C.* sp., stating that "two species of *Christella* may occur in New Zealand, one in thermal areas and the Kermadec Islands, and one in north Auckland". Brownsey & Smith-Dodsworth (1989) distinguished the thermal plant by its

shorter rhizome and smaller frond compared to Northland plants but noted that "its taxonomic status and affinities are not yet determined". De Lange et al. (2010) stated that "populations of *Christella* from geothermally active parts of the North Island and from the crater region of Raoul Island lack the long, creeping rhizome typical of northern New Zealand and most Raoul Island *C. dentata*, instead producing over time a small, erect trunk. These plants also have narrower, hairier fronds." They concluded that "these plants are not the same as *C. dentata*, and appear to represent another possibly unnamed variant" but cautioned that further research was still needed.

The taxonomic status of the two forms of *C. dentata* has been re-evaluated by Brownsey & Perrie (2016a). From an analysis of the frond and rhizome morphology, spore size and cytology they found that the only difference between them was the nature of the rhizome and that, in contradiction to Brownsey & Smith-Dodsworth (1989), there were no quantitative frond measurements that could be used to distinguish two taxa. The available evidence strongly suggested that populations in New Zealand are uniformly tetraploid and that there were no differences in investigated DNA sequences between the two forms. Furthermore, they found that the rhizomes, whether creeping or erect, were fundamentally similar in producing tufts of fronds near the apex, rather than fronds that are widely spread along the rhizome (as in families with long-creeping rhizomes such as Dennstaedtiaceae, Hymenophyllaceae or Polypodiaceae). They suggested that the nature of the rhizome may not be of great taxonomic significance, and simply a reflection of different habitats in which the plants are found. Plants in Australia show similar variation. Brownsey & Perrie (2016a) concluded that "there is only one rather variable species indigenous to New Zealand, similar to that in Australia, which is correctly identified as *Christella dentata*.

The picture is complicated by the presence of plants in New Zealand with distinctive purple stipes that are very similar to plants that are naturalised in Hawai‘i and the Neotropics. It is likely that they have naturalised in New Zealand as escapes from cultivated plants originally introduced from overseas. The earliest record is a plant grown from spore collected near Kāwhia in 1987 (AK 212348), but several others have been collected since 1991. Given its history in the Americas, the plant could spread in New Zealand unless carefully controlled.

Fig. 2: *Christella dentata*. Mature plant growing at Te Huka Bay, Northland.

Fig. 3: *Christella dentata*. Mature plant growing on Raoul Island.

Fig. 4: *Christella dentata*. Young plant showing greatly reduced basal pinnae.

Fig. 5: *Christella dentata*. Underground, short-creeping rhizome giving rise to tufts of fronds at apex.

Cyclosorus Link, *Hort. Reg. Bot. Berol. 2,* 128 (1833)

Type taxon: *Cyclosorus gongylodes* (Schkuhr) Link

Etymology: From the Greek *kuklos* (a circle), a reference to the shape of the sorus.

Terrestrial ferns. Rhizomes long-creeping, scaly. Rhizome scales narrowly to broadly ovate, setiferous (not NZ) or entire (NZ). Fronds monomorphic. Stipes scaly, minutely hairy or glabrous. Laminae 1-pinnate to 1-pinnate-pinnatifid, coriaceous, proximal pinnae not reduced in size; basal pinnae not conspicuously auricled; aerophores absent; abaxial surface of laminae bearing scales on costae, bearing acicular hairs but lacking capitate hairs on the lamina surfaces, or glabrous, and often bearing spherical red or orange glands on the costae. One or more basal veins from adjacent pinna lobes always uniting below the sinus. Sori round, indusiate; paraphyses absent. Indusia reniform, bearing acicular hairs. Sporangia lacking glands or hairs near the annulus, but bearing a multicellular hair with a terminal spherical red or orange gland on the stalk. Spores monolete, finely and irregularly spinulose.

Taxonomy: Allan (1961) included all indigenous New Zealand species of Thelypteridaceae within a broadly construed *Thelypteris.* Holttum (1971a) distinguished *Cyclosorus* as a genus with long-creeping rhizomes, the basal pinnae not reduced, thin flat scales present on the lower surface of the costae, and spherical glands present on the lower surface of the veins and at the ends of multicellular hairs on the stalks of the sporangia. Holttum's concept remained unchanged following the classification of Fawcett & Smith (2021).

Distribution: A pantropical genus of 2–3 species (Fawcett & Smith 2021). One species in Australia (Bostock 1998) and the Pacific (Holttum 1977). One species in New Zealand; none endemic.

Biostatus: Indigenous (Non-endemic).

Table : Number of species in New Zealand within *Cyclosorus* Link

Category	**Number**
Indigenous (Non-endemic)	1
Total	**1**

Cytology: The base chromosome number in *Cyclosorus* is x = 36 (Holttum 1971a; Smith 1990; Fawcett & Smith 2021).

Cyclosorus interruptus (Willd.) H.Itô, *Bot. Mag. (Tokyo)* 51: 714, f. 9 (1937)

≡ *Pteris interrupta* Willd., *Phytographia* 13, t. 10, f. 1 (1794)
≡ *Thelypteris interrupta* (Willd.) K.Iwats., *J. Jap. Bot.* 38: 314 (1963)
Lectotype (selected by Fosberg & Sachet 1972): southern India, Reise nach Madras, *Klein s.n.*, Herb. Willd., B-W 19770 (!online)

= *Nephrodium propinquum* R.Br., *Prodr. Fl. Nov. Holland.* 148 (1810)
Lectotype (selected by Brownsey & Perrie 2016b): New Holland [Australia], Nova Cambria australis [now Queensland] prope [near] Endeavour River, *J. Banks & D. Solander s.n.*, 1770, BM 001044504!

= *Nephrodium inaequilaterum* Colenso, *Trans. & Proc. New Zealand Inst.* 20: 229 (1888)
Lectotype (selected by Allan 1961): Taupo, *C.J. Norton*, Herb. W. Colenso, WELT P003345!

Etymology: From the Latin *interruptus* (interrupted).

Rhizomes long-creeping, up to 115 mm long (in herbarium specimens) with stipes arising 5–30 mm apart, 1.5–4 mm diameter, bearing scattered scales. Rhizome scales ovate to broadly ovate, 1–3 mm long, 0.5–1.5 mm wide, pale to dark brown, entire. Fronds 225–1450 mm long, held stiffly upright. Stipes 120–970 mm long, yellow-brown to chestnut-brown, almost black at base, glabrous or scaly near base, slightly polished. Laminae 1-pinnate, usually elliptic or ovate, sometimes narrowly, rarely broadly so, abruptly narrowed to a pinnatifid apex, 115–580 mm long, 35–215 mm wide, dull green on both surfaces or sometimes lighter on abaxial surface, coriaceous. Ovate or broadly ovate, pale brown scales with hairy margins on abaxial surface of pinna midribs and costae; colourless, acicular hairs up to 0.4 mm long on both surfaces of the costae and veins; spherical orange glands variably present on abaxial surfaces of costae and veins. Primary pinnae in 6–18 pairs below the pinnatifid apex, widely spaced especially proximally, narrowly elliptic; the longest at or below the middle, short-stalked, 42–150 mm long, 6–18 mm wide; the basal pair not or scarcely reduced in length. Primary pinnae divided ⅓ to ½ to the midrib; ultimate segments 3–10 mm long, 2.5–6 mm wide; apices acute and bluntly apiculate, margins entire. Basal veins on adjacent pinna segments joining, unbranched in each ultimate pinna segment. Sori round, in one row either side of midrib away from pinna margins; indusia reniform, 0.5–0.9 mm diameter, bearing acicular or rarely capitate hairs or almost glabrous.

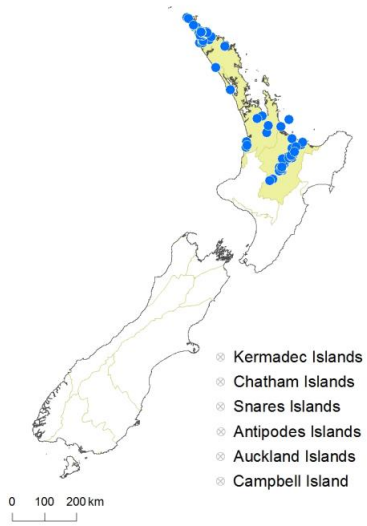

Fig. 6: *Cyclosorus interruptus* distribution map based on databased records at AK, CHR and WELT.

Distribution: North Island: Northland, Auckland, Volcanic Plateau.

Altitudinal range: 0–600 m.

Cyclosorus interruptus occurs in coastal and lowland areas of the North Island from Te Paki to Kāwhia and the Bay of Plenty, and throughout the geothermal region from Whakatāne to Tokaanu where it extends locally into montane areas. It grows from sea level to about 600 m near Wairakei.

Also widespread in the tropics and subtropics of the Americas, Africa, India, Asia, Australia and most of the islands of the Pacific, including Hawai'i.

Biostatus: Indigenous (Non-endemic).

The species was given a conservation status of 'At Risk / Declining' by de Lange et al. (2018).

Leach (2005) suggested that *Cyclosorus interruptus* might have been introduced to New Zealand by early Polynesian settlers, because it grows in abandoned taro pondfields in the Pacific Islands and could have been introduced with taro. Against this is the likelihood of self-dispersal, given the large number of fern species that are indigenous to New Zealand and shared with Australia and/or the Pacific Islands.

Habitat: Occurs in swamps, on peaty soils and lake margins in the northern part of its distribution, and on heated soil near hot springs and streams, or in swamps, in geothermal regions, sometimes under mānuka, and kānuka. In the Waikato it is also found under willows (*Salix cinerea* and *S. fragilis*). It is often associated with *Typha orientalis*, *Phormium tenax*, *Isachne globosa*, *Machaerina juncea*,

Carex spp., *Juncus* spp., *Schoenus brevifolius, Thelypteris confluens* and *Blechnum minus*, and with *Christella dentata*, *Lycopodiella cernua* and *Nephrolepis flexuosa* in thermal areas.

Recognition: *Cyclosorus interruptus* is recognised by its long-creeping rhizomes, erect and leathery fronds, primary pinnae divided one-third to halfway to the midrib with acute segments, basal pair of pinnae not shortened, veins in adjacent segments joining, indumentum on the abaxial lamina surfaces comprising broad scales, acicular hairs and spherical orange glands, and indusia usually bearing acicular hairs or sometimes glabrous. Plants vary considerably in size; the largest, with greatly extended stipes (longer than the laminae), occur in swamps in the Far North, whilst stunted plants are found on thermal soils in the central North Island with much smaller fronds and shorter rhizomes.

Cytology: n = 36 (Brownlie 1961, as *Cyclosorus gongylodes*).

Notes: The names *Polypodium unitum* L. and *Aspidium gongylodes* Schkuhr, and combinations based on them used in earlier Flora treatments (notably *Nephrodium unitum, Cyclosorus gongylodes*, *Dryopteris gongylodes* and *Thelypteris gongylodes*) are misidentifications of *Cyclosorus interruptus* (see Holttum 1977; Bostock 1998).

A collection made by J.G. Klein from southern India (B-W 19770) was designated as the lectotype for *Pteris interrupta* by Fosberg & Sachet (1972). This choice was challenged by Mazumdar (2016) who suggested that the specimen was collected after Willdenow's publication of the name in 1794. Mazumdar instead designated a plate of *P. interrupta* in Willdenow's protologue (t. 10, f. 1) as the lectotype. This interpretation was rejected by Fraser-Jenkins et al. (2017) who maintained that the date of collection was uncertain, and that the original choice should stand.

Fig. 7: *Cyclosorus interruptus*. Large population of mature plants growing in wetland.

Fig. 8: *Cyclosorus interruptus*. Mature plant growing in wetland.

Fig. 9: *Cyclosorus interruptus*. Mature frond showing erect habit and unreduced basal pinnae.

Fig. 10: *Cyclosorus interruptus*. Mature frond showing erect habit and unreduced basal pinnae.

Fig. 11: *Cyclosorus interruptus*. Abaxial surface of primary pinna showing segments divided less than halfway to the costa, basal pair of veins in adjacent segments joining, and ovate scales and short acicular hairs on the veins and costae.

Fig. 12: *Cyclosorus interruptus*. Abaxial surface of primary pinna showing acicular hairs on costae and veins, and reniform indusia protecting the sori.

Fig. 13: *Cyclosorus interruptus*. Abaxial surface of primary pinna showing basal pair of veins on adjacent segments joining, and reniform indusia protecting sori.

Fig. 14: *Cyclosorus interruptus*. Abaxial surface of primary pinna showing mature indusia and sori.

Macrothelypteris (H.ltô) Ching, *Acta Phytotax. Sin.* 8: 308 (1963)

Type taxon: *Macrothelypteris oligophlebia* (Baker) Ching

Etymology: From the Greek *makros* (large), and *thelypteris* (the name of a fern), a reference to the large fronds in this genus.

Terrestrial ferns. Rhizomes short-creeping or suberect, scaly. Rhizome scales narrowly ovate, thickened at their bases, with marginal and superficial hairs. Fronds monomorphic. Stipes scaly and hairy. Laminae 2-pinnate to 3-pinnate-pinnatifid, or rarely 1-pinnate-pinnatifid (not NZ), herbaceous, proximal pinnae not reduced in size; aerophores lacking; abaxial surface of laminae bearing scales and/or hairs; scales pallid, narrow and with or without ciliate margins, or absent; hairs acicular and either unicellular or multicellular; glandular hairs absent; short-stalked spherical glands sometimes present. Veins free, branched in the pinnules and not reaching the margins. Sori small, often irregularly shaped, indusiate (NZ) or exindusiate (not NZ); paraphyses absent. Indusia tiny, glabrous or bearing short-stalked glands. Sporangia bearing short-stalked glands near the annulus, lacking hairs on the stalk. Spores monolete, minutely reticulate and with slight wings.

Taxonomy: Allan (1961) included all indigenous New Zealand species of Thelypteridaceae within a broadly construed *Thelypteris.* However, *Macrothelypteris* is now widely recognised as a distinct genus of about 10 species in the Old World tropics and subtropics and the Pacific (Holttum 1969, 1971a; Smith et al. 2006; Fawcett & Smith 2021). It is characterised by a short-creeping rhizome, rhizome scales which are narrow and thickened at their bases, often with marginal hairs, usually at

least bipinnate laminae, veins in the pinnules which are branched and do not reach the margins, small sori with very small indusia, and sporangia that bear short-stalked glands near the annulus.

Distribution: A genus of 10 species distributed in Madagascar, subtropical and tropical Asia and Malesia, Australia and the Pacific islands (Fawcett & Smith 2021); two species in Australia (Bostock 1998) and three in the Pacific (Holttum 1977). *Macrothelypteris torresiana* is naturalised in the American tropics and subtropics (Holttum 1969), and in southern Africa (Crouch et al. 2011). One species in New Zealand; not endemic.

Biostatus: Indigenous (Non-endemic).

Table : Number of species in New Zealand within *Macrothelypteris* (H.Itô) Ching

Category	**Number**
Indigenous (Non-endemic)	1
Total	**1**

Cytology: The base chromosome number in *Macrothelypteris* is x = 31 (Holttum 1971a; Smith 1990; Fawcett & Smith 2021).

Macrothelypteris torresiana (Gaudich.) Ching, *Acta Phytotax. Sin.* 8: 310 (1963)

≡ *Polystichum torresianum* Gaudich. in Freycinet, *Voy. Uranie, Bot.* 333 (1828)
≡ *Lastrea torresiana* (Gaudich.) T.Moore, *Index Fil.* 106 (1858)
≡ *Thelypteris torresiana* (Gaudich.) Alston, *Lilloa* 30: 111 (1960)
Lectotype (selected by Holttum 1977): Mariana Islands, *C. Gaudichaud-Beaupré*, P (*n.v.*)

= *Aspidium uliginosum* Kunze, *Linnaea* 20: 6 (1847)
≡ *Dryopteris uliginosa* (Kunze) C.Chr., *Index Filic. Suppl. 3,* 100 (1934)
≡ *Thelypteris uliginosa* (Kunze) Ching, *Bull. Fan Mem. Inst. Biol.* 6: 342 (1936)
Lectotype (selected by Morton 1973): cult. Hort. Bot. Leipzig, originally from Java, BR (*n.v.*)

Etymology: Named in honour of Luís Vaz de Torres (b. 1565), a Spanish pilot on de Queirós's expedition to the Pacific (1605–1607), after whom Torres Strait is named.

Rhizomes short-creeping to erect, 3–5 mm diameter, scaly. Rhizome scales narrowly ovate, 6–10 mm long, 0.5–1 mm wide, pale to dark brown, with numerous marginal and superficial hairs. Fronds 235–1200 mm long, rarely up to 2000 mm, arching upwards. Stipes 90–750 mm long, glaucous when fresh, yellow-brown when dry, swollen and with scales and hairs near base especially when young, slightly rough proximally but smooth and glabrous distally. Laminae deeply 2-pinnate-pinnatifid to 3-pinnate-pinnatifid, ovate, gradually tapering to the apex, 145–1000 mm long, 95–700 mm wide, light green on both surfaces, herbaceous. Scales virtually absent; colourless, acicular hairs up to 0.6 mm long on adaxial costa surfaces, and multicellular hairs up to 2 mm long on the abaxial costae and vein surfaces; short-stalked glands up to c. 0.1 mm long on all lamina surfaces. Primary pinnae in 15–25 pairs, widely spaced especially proximally, narrowly ovate to ovate; the longest near the base, short-stalked, 60–450 mm long, 25–200 mm wide, reducing gradually in length to the apex; the basal pair often not much reduced in length. Secondary pinnae narrowly ovate, 16–120 mm long, 5–40 mm wide, midribs narrowly winged, apices acuminate, bases decurrent. Tertiary pinnae (when present) oblong, 8–24 mm long, 1–6 mm wide, apices obtuse, margins serrate to divided more than halfway to midrib, bases decurrent forming a wing on the secondary pinna midribs. Veins all free, branching in ultimate pinna segments, not reaching the margins. Sori round, on veins of ultimate segments, away from pinna margins; indusia reniform, 0.2–0.4 mm diameter, bearing capitate hairs or almost glabrous.

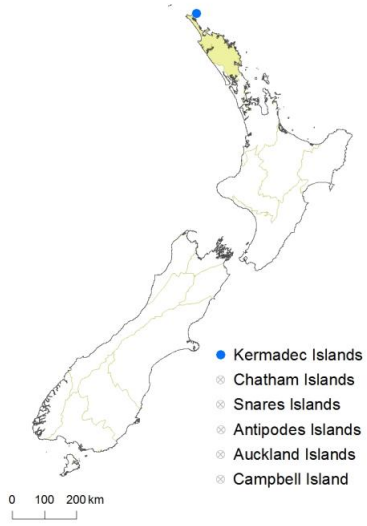

Fig. 15: *Macrothelypteris torresiana* distribution map based on databased records at AK, CHR and WELT.

Distribution: North Island: Northland

Kermadec Islands

Altitudinal range: 30–120 m.

In New Zealand *Macrothelypteris torresiana* occurs regularly only on the Kermadec Islands (recorded from Raoul and Macauley Islands). On Raoul Island it was reported as a "generally uncommon species" by Sykes (1977) but 20 years later was said to be increasing in abundance (de Lange & Crowcroft 1997), following cyclone disturbance which had enabled it to expand its range. It has been collected from 30–120 m. A vagrant occurrence at Surville Cliffs, North Cape was reported by de Lange & Crowcroft (1997) but has not been relocated since. This record is the southernmost occurrence of the species in the Pacific region.

Also in tropical and subtropical regions from Madagascar to India, China, Japan, south-east Asia, Australia and the Pacific islands as far as Pitcairn Island. Naturalised in the American tropics and subtropics (Holttum 1969, 1977), southern Africa (Crouch et al. 2011) and Hawai'i (Palmer 2003).

Biostatus: Indigenous (Non-endemic).

The species was given a conservation status of 'At Risk / Naturally Uncommon' by de Lange et al. (2018).

Habitat: *Macrothelypteris torresiana* has been recorded on Raoul Island from disturbed habitats and slip faces in open sunny areas, on banks, in swamps and on Macauley Island from the base of canyon walls growing with sparse *Hypolepis dicksonioides*. At North Cape, on Surville Cliffs, it was found on open ultramafic rock scree (de Lange & Crowcroft 1997).

Recognition: *Macrothelypteris torresiana* is recognised by its large fronds, glaucous stipes, 2-pinnate-pinnatifid or more divided laminae, free veins, indumentum of long multicellular acicular hairs on the abaxial surfaces and much shorter glands, absence of scales on the laminae, and tiny indusia.

Cytology: 2n = 124 (de Lange et al. 2004).

Notes: Names used in earlier Floras based on *Cheilanthes setigera* Blume (notably *Nephrodium setigerum* and *Dryopteris setigera*) are misidentifications. *Macrothelypteris setigera* is a Malesian species that has been much confused with *M. torresiana* (Holttum 1977).

It was reported by de Lange & Crowcroft (1997) that occasional cultivated specimens of *M. torresiana* have set viable spores, and given rise to sporelings in the vicinity of the adult plants (e.g. the experimental glasshouses at the University of Auckland, AK 231884, 231951). This location is a long way south of the southernmost known wild population at Surville Cliffs. However, de Lange & Crowcroft noted that such occurrences are uncommon and that few sporelings survive, even in the mild Auckland winters. Further north, however, *M. torresiana* self-sows outside and can withstand winters in Kerikeri; iNaturalist observation #67228856 shows a plant that has grown in an old compost heap for several years. Source material was not from New Zealand and was grown in a commercial fern nursery.

Fig. 16: *Macrothelypteris torresiana*. Mature plant growing from a short-creeping rhizome.

Fig. 17: *Macrothelypteris torresiana*. Mature plant with 3-pinnate fronds.

Fig. 18: *Macrothelypteris torresiana*. Mature 3-pinnate frond.

Fig. 19: *Macrothelypteris torresiana*. Abaxial surface of fertile pinna showing small sori.

Pakau S.E.Fawc. & A.R.Sm., *Sida, Bot. Misc. 59,* 61 (2021)

Type taxon: *Pakau pennigera* (G.Forst.) S.E.Fawc. & A.R.Sm.

Etymology: From pākau, a Māori name for this plant.

Terrestrial ferns. Rhizomes erect or suberect, scaly. Rhizome scales ovate, thin, appressed, entire. Fronds monomorphic. Stipes scaly. Laminae 1-pinnate to 1-pinnate-pinnatisect, herbaceous, several pairs of proximal pinnae gradually or abruptly reduced in size; basal pinnae auricled acroscopically; aerophores absent; abaxial surface of laminae bearing a few ovate scales, short acicular hairs, and sometimes a few capitate hairs, or ± glabrous; sessile spherical glands absent. One or more basal veins from adjacent pinna lobes uniting below the sinus. Sori round, exindusiate; paraphyses absent. Sporangia lacking hairs. Spores monolete, with many wings.

Taxonomy: Allan (1961) included all indigenous New Zealand species of Thelypteridaceae within a broadly construed *Thelypteris.* Holttum (1971a, 1973) re-circumscribed the genus *Pneumatopteris*, and included *P. pennigera* from New Zealand and south-east Australia in it, albeit as an atypical member with ovate scales on the abaxial surface of the costae when young, the abaxial surface of the lamina not pustular when dry, indusia lacking, and no glands or hairs on the sporangia (Holttum 1977). However, Fawcett et al. (2021) showed that species attributed to *Pneumatopteris* occurred in multiple lineages, and that Holttum's concept was highly polyphyletic. The New Zealand and Australian plant resolved on a long, isolated branch sister to the rest of the christelloid clade, and Fawcett & Smith (2021) described the new genus *Pakau* to accommodate this anomalous species. In

New Zealand, the genus is distinguished from *Macrothelypteris* by its 1-pinnate-pinnatifid laminae and much shorter lamina hairs, from *Christella* and *Cyclosorus* by its lack of indusia, from *Cyclosorus* and *Thelypteris* by its erect rhizome, and from *Pseudophegopteris* by the basal pair of veins in adjacent pinna segments joining below the sinus, rather than being free.

Distribution: A monotypic genus confined to New Zealand and south-eastern Australia (Fawcett & Smith 2021). One non-endemic species in New Zealand.

Biostatus: Indigenous (Non-endemic).

Table : Number of species in New Zealand within *Pakau* S.E.Fawc. & A.R.Sm.

Category	**Number**
Indigenous (Non-endemic)	1
Total	**1**

Cytology: The base chromosome number in *Pakau* is x = 36 (Brownlie 1954, as *Cyclosorus pennigerus;* Fawcett & Smith 2021).

Pakau pennigera (G.Forst.) S.E.Fawc. & A.R.Sm., *Sida, Bot. Misc. 59,* 62 (2021)

≡ *Polypodium pennigerum* G.Forst., *Fl. Ins. Austr.* 82 (1786)
≡ *Aspidium pennigerum* (G.Forst.) Sw., *J. Bot. (Schrader)* 1800(2): 34 (1801)
≡ *Nephrodium pennigerum* (G.Forst.) C.Presl, *Reliq. Haenk. 1,* 35 (1825)
≡ *Polystichum pennigerum* (G.Forst.) Gaudich. in Freycinet, *Voy. Uranie, Bot.* 328 (1828)
≡ *Lastrea pennigera* (G.Forst.) C.Presl, *Tent. Pterid.* 76 (1836)
≡ *Goniopteris pennigera* (G.Forst.) J.Sm., *J. Bot. (Hooker)* 4: 54 (1841)
≡ *Goniopteris forsteri* T.Moore, *Index Fil.* 99 (1858) nom. illeg., nom. nov. pro *Aspidium pennigerum* (G.Forst.) Sw. 1801, nom. superfl.
≡ *Dryopteris pennigera* (G.Forst.) C.Chr., *Index Filic.* 283 (1905)
≡ *Cyclosorus pennigerus* (G.Forst.) Ching, *Bull. Fan Mem. Inst. Biol.* 10: 247 (1941)
≡ *Thelypteris pennigera* (G.Forst.) Allan, *Fl. New Zealand 1,* 51 (1961)
≡ *Pneumatopteris pennigera* (G.Forst.) Holttum, *Blumea* 21: 305 (1973)
Lectotype (selected by Nicolson & Fosberg 2003): no locality, *Forster*, UPS-T 24698 (*n.v.*)

= *Phegopteris cunninghamii* Mett., *Fil. Hort. Bot. Lips.* 84 (1856)
Holotype: Cult. Leipzig ex New Zealand (*n.v.*, see Holttum 1977); isotype K 000951564 (!online)

= *Aspidium novae-zeelandiae* Ettingsh., *Denkschr. Kaiserl. Akad. Wiss., Wien. Math.-Naturwiss. Kl.* 23: 103 (1864)
Lectotype (selected by Brownsey & Perrie 2016b): Nova Zeelandia [New Zealand], *Hügel s.n., s.d.*, W 0052715 (!online)

= *Polypodium pennigerum* var. *giganteum* Colenso, *Trans. & Proc. New Zealand Inst.* 14: 339 (1882)
Lectotype (selected by Brownsey & Perrie 2016b): Manawatu River, *W. Colenso*, AK 142518! (two pinnae only)

= *Polypodium pennigerum* var. *hamiltonii* Colenso, *Trans. & Proc. New Zealand Inst.* 14: 338 (1882)
≡ *Dryopteris pennigera* var. *hamiltonii* (Colenso) Cheeseman, *Man. New Zealand Fl., ed. 2,* 36 (1925) – as hamiltoni
≡ *Cyclosorus pennigerus* var. *hamiltonii* (Colenso) Crookes in Dobbie, *New Zealand Ferns ed. 4,* 262 (1951) – as hamiltoni
Lectotype (selected by Allan 1961): Kereru, *A. Hamilton*, Herb. W. Colenso, WELT P003350! (isolectotypes? AK 142511, 221795!)

= *Polypodium subsimilis* Colenso, *Trans. & Proc. New Zealand Inst.* 20: 233 (1888)
Lectotype (selected by Allan 1961): 70 mile Bush, Herb. W. Colenso, WELT P003349!

Etymology: From the Latin *pennigerus* (with feathery leaves), a reference to the dissection of the fronds.

Vernacular names: feather fern; gully fern; piupiu; pākau; pākauroharoha

Rhizomes prostrate or erect, often forming short arborescent trunks, rarely up to 1.89 m tall, bearing scales at the apex. Rhizome scales ovate to narrowly ovate, 3–8 mm long, 1–4 mm wide, chestnut-brown, entire. Fronds 340–2070 mm long, rarely only 200 mm long at high elevations, arching upwards. Stipes 40–430, rarely up to 770 mm long, pale brown, scaly to almost glabrous. Laminae 1-pinnate to 1-pinnate-pinnatifid, narrowly elliptic or elliptic, gradually tapering to a pinnatisect apex, 270–1390 mm, rarely up to 1500 mm long, 80–400 mm wide, rarely only 160 mm long and 50 mm wide at high elevations, mid-green on both surfaces, thin and herbaceous. Ovate or broadly ovate, pale brown scales on abaxial surface of costae; colourless or pale brown acicular hairs up to 0.2 mm long on both costa surfaces; colourless capitate hairs <0.1 mm long on abaxial surfaces of costae. Primary pinnae in 8–35 pairs below pinnatisect apex, widely spaced especially proximally, narrowly oblong to narrowly ovate; the longest at or near the middle, sessile or short-stalked, the longest 44–220 mm long, rarely only 27 mm long at high elevations, 11–34 mm wide; the basal pair greatly reduced, 10–70 mm long, auricled acroscopically. Primary pinnae divided ⅓ to ½, or rarely ⅔, to the midrib; ultimate segments (excluding proximal pair) 5–17 mm long, 3.5–7 mm wide, apices obtuse or rounded, margins entire or minutely serrate; the proximal pair of ultimate segments often longer than the others with the basal acroscopic segment occasionally greatly extended into a pinnatifid secondary pinna up to 53 mm long and 24 mm wide. Basal veins in adjacent pinna segments joining, unbranched in each ultimate pinna segment. Sori round, in one row either side of midrib away from pinna margins; indusia absent.

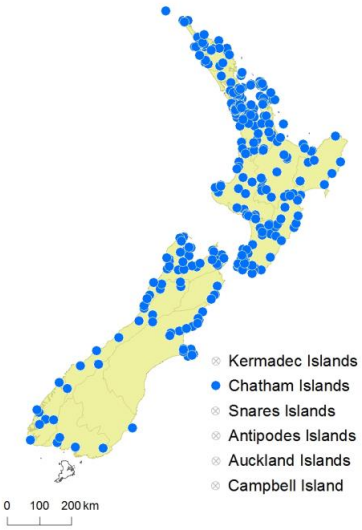

Fig. 20: *Pakau pennigera* distribution map based on databased records at AK, CHR and WELT.

Distribution: North Island: Northland, Auckland, Volcanic Plateau, Gisborne, Taranaki, Southern North Island.

South Island. Western Nelson, Sounds-Nelson, Marlborough, Westland, Canterbury, Otago, Southland, Fiordland.

Three Kings Islands, Chatham Islands

Altitudinal range: 0–700 m.

Pakau pennigera occurs in lowland areas, extending locally to montane sites, throughout the North Island, growing from near sea level to about 700 m on Mt Maungatautari in the Waikato region. In the South Island it is largely confined to lowland areas in the northern half of the island, although it extends locally to Fiordland, Southland and the Otago Peninsula, and from near sea level to about 600 m on Banks Peninsula.

Also Australia (Queensland, Victoria, Tasmania).

Biostatus: Indigenous (Non-endemic).

Habitat: A terrestrial fern that occurs under kauri, podocarp, broadleaved and beech forest, under mānuka, kānuka and *Salix* spp., and in *Carex secta* swamps. It grows on the forest floor, in gullies, on banks, streamsides and alluvial terraces, usually in heavy shade and damp sites, but sometimes in more open areas.

Recognition: *Pakau pennigera* is recognised by its erect rhizome, primary pinnae divided ⅓ to ⅔ to the midrib with rounded segments, greatly shortened basal pinnae, veins in adjacent segments joining, indumentum on the abaxial surfaces comprising ovate scales and acicular and capitate hairs but lacking glands, and sori lacking indusia. The network of dark veins on the thin green fronds distinguishes *P. pennigera* from other common forest ferns.

Cytology: n = 72 (Brownlie 1954, as *Cyclosorus pennigerus*).

Notes: Kunze (1850) evidently believed that Cunningham's (1837) concept of *Aspidium pennigerum* differed from that of Swartz (1801) and he created a *nomen novum* for it – *Aspidium cunninghamii* Kunze, *Linnaea* 23: 225 (1850). However, neither Kunze (1850), nor Cunningham (1837), provided a description and the name is therefore a *nomen nudum.* In any case, Kunze's name is illegitimate, being a later homonym of *Aspidium cunninghamii* Colenso (1843).

A trunk of 1.89 m was recorded on a plant of *Pakau pennigera* in the Waitākere Ranges by Ford (2020 – as *Pneumatopteris*).

Fig. 21: *Pakau pennigera*. Mature plant growing on a steep stream bank.

Fig. 22: *Pakau pennigera*. Apical portion of mature frond showing primary pinnae divided more than halfway to costa.

Fig. 23: *Pakau pennigera*. Plant with a short aerial trunk.

Fig. 24: *Pakau pennigera*. Mature plants with erect trunks.

Fig. 25: *Pakau pennigera*. Fronds arising from an erect rhizome. The basal pinnae are greatly reduced in length, but the basal acroscopic secondary segments are longer and more divided than the other segments.

Fig. 26: *Pakau pennigera*. Ovate, pale brown stipe scales.

Fig. 27: *Pakau pennigera*. Young crozier.

Fig. 28: *Pakau pennigera*. Abaxial surface of primary pinna showing basal pair of veins from adjacent segments joining and immature sori lacking indusia.

Fig. 29: *Pakau pennigera*. Abaxial surface of primary pinna showing mature sori lacking indusia.

Fig. 30: *Pakau pennigera*. Abaxial surface of primary pinna with segments divided about halfway to costa, bearing mature sori lacking indusia.

Pseudophegopteris Ching, *Acta Phytotax. Sin.* 8: 313 (1963)

Type taxon: *Pseudophegopteris pyrrhorhachis* (Kunze) Ching

Etymology: From the Greek *pseudos* (false), and *Phegopteris* a genus of ferns, a reference to the similarity of the two genera.

Terrestrial ferns. Rhizomes erect to short- or long-creeping, scaly. Rhizome scales narrowly ovate, with short hairs on the surface. Fronds monomorphic. Stipes scaly and sometimes hairy (not NZ). Laminae deeply 1–2-pinnate-pinnatifid, herbaceous or coriaceous, the proximal pinnae somewhat reduced in size; aerophores absent; abaxial surface of laminae lacking scales, bearing unicellular acicular hairs, sometimes bearing short-stalked glands, lacking sessile spherical glands. Veins free, ending in clavate hydathodes, not reaching the margin. Sori oblong, exindusiate; paraphyses absent. Sporangia glabrous or with short acicular hairs. Spores monolete, reticulate or foveolate.

Taxonomy: Holttum (1969, 1971a) recognised *Pseudophegopteris* as a distinct genus of Thelypteridaceae with about 20 species, mostly in the Old World tropics and subtropics. He considered it very close to *Macrothelypteris* in having ± bipinnate fronds with adnate pinnules, free veins, and a base chromosome number of 31. It differed in that the scales on the lamina axes were often reduced to a row of short cells with brown cross-walls, the hairs were never multicellular, and the sori always exindusiate. Holttum distinguished *Pseudophegopteris* from most other genera of Thelypteridaceae by the absence of grooves on the adaxial surface of the pinna midribs, and the presence of forking rather than simple veins, with tips not reaching the lamina margins or adjacent veins. Holttum's concept remained unchanged following the classification of Fawcett & Smith (2021).

Distribution: A genus of 28 species distributed in the tropics and subtropics of the Old World, from St Helena, through Africa, Madagascar, the Mascarenes, Asia, Malesia, to Samoa and Hawai'i (Fawcett & Smith 2021); two species in the Pacific (Holttum 1977). One introduced species in New Zealand.

Biostatus: Exotic; casual.

Table : Number of species in New Zealand within *Pseudophegopteris* Ching

Category	**Number**
Exotic: Casual	1
Total	**1**

Cytology: The base chromosome number in *Pseudophegopteris* is x = 31 (Holttum 1977; Smith 1990; Fawcett & Smith 2021).

Pseudophegopteris aurita (Hook.) Ching, *Acta Phytotax. Sin.* 8: 314 (1963)

≡ *Gymnogramma aurita* Hook., *Icon. Pl. 10,* t. 974 (1854)
≡ *Phegopteris aurita* (Hook.) J.Sm., *Cult. Ferns* 17 (1857)
≡ *Polypodium auritum* (Hook.) E.J.Lowe., *Ferns 2,* t. 51 (1858)
≡ *Leptogramma aurita* (Hook.) Bedd., *Handb. Ferns Brit. India* 377 (1883)
≡ *Aspidium auritum* (Hook.) Christ, *Bull. Herb. Boissier sér. 2,* 4: 616 (1904)
≡ *Dryopteris aurita* (Hook.) C.Chr., *Index Filic.* 253 (1905)
≡ *Nephrodium auritum* (Hook.) Hand.-Mazz., *Symb. Sin. 6,* 21 (1929)
≡ *Thelypteris aurita* (Hook.) Ching, *Bull. Fan Mem. Inst. Biol.* 6: 266 (1936)

Syntypes: N.E. India, Meghalaya, Khasia, *W. Griffith s.n.*, Herb. Hooker., K 000951395, 000951397, 000951398 (!online); *T. Lobb s.n.*, Herb. Hooker., K 000951396 (!online)

Etymology: From the Latin *auritus* (long-eared), a reference to the elongated basal basiscopic secondary pinnae.

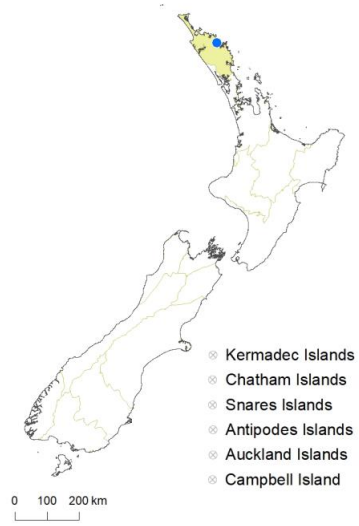

Fig. 31: *Pseudophegopteris aurita* distribution map based on databased records at AK, CHR & WELT.

Distribution: North Island: Northland.

Altitudinal range: c. 10 m.

Pseudophegopteris aurita has been recorded spreading from a cultivated plant in a garden at Kerikeri. The cultivated plant was grown by a commercial fern nursery.

Occurs naturally in Bhutan, north-east India, Nepal, China, Japan, and south-east Asia as far as Papua New Guinea (Fraser-Jenkins et al. 2017).

Biostatus: Exotic; casual.

Habitat: Recorded as a cultivation escape, growing on a south-facing slope 40 m from the parent plant.

First record: Ogle et al. (2021). AK 327895, 2008.

Recognition: In New Zealand *Pseudophegopteris aurita* is recognised by its long-creeping rhizome bearing ciliate scales, red-brown stipes and rachises, deeply 1-pinnate-pinnatifid laminae, the basal pair of pinnae shorter than those above, and the basal pair of pinnules on the proximal primary pinnae, especially the basiscopic ones, clearly longer than the adjacent pinnules. The rachis and costae bear short hairs, especially adaxially, but the laminae are otherwise glabrous. The veins are free, ending in hydathodes just before the margin. The sori are oblong and exindusiate, and the sporangia bear hairs on the stalk below the annulus.

Notes: *Pseudophegopteris aurita* is distinguished from its congeners by its creeping rhizome with well-spaced fronds, red-brown stipes and rachises, deeply 1-pinnate-pinnatifid laminae, elongated basal basiscopic pinnules on the primary pinnae, stiff hairs on the lamina axes, and elongate sori.

Fig. 32: *Pseudophegopteris aurita*. Herbarium specimen of a self-sown plant from Kerikeri, AK 327895, showing 1-pinnate-pinnatifid frond with red-brown stipes, and elongated basal basiscopic pinnules on primary pinnae.

Thelypteris Schmidel, *Icon. Pl., ed. Keller* 3, 45, t. 11, 13 (1763), nom. cons.

Type taxon: *Thelypteris palustris* Schott

Etymology: From the Greek *thelys* (female), and *pteris* (a fern), a name used by Theophrastus.

Terrestrial ferns. Rhizomes short- to long-creeping, scaly. Rhizome scales ovate, entire. Fronds monomorphic or slightly dimorphic. Stipes scaly. Laminae 1-pinnate-pinnatifid, herbaceous to coriaceous, the proximal pinnae not or little reduced in size; basal pinnae not conspicuously auricled acroscopically; aerophores absent; abaxial surface of laminae bearing flat thin scales, erect acicular hairs and short-stalked glands, but lacking sessile spherical glands. Veins free, sometimes forked in the pinnules and reaching the margins. Sori round, indusiate; paraphyses absent. Indusia reniform, bearing short-stalked glands. Sporangia bearing short-stalked glands near annulus, but lacking hairs on the stalk. Spores monolete, irregularly and minutely spinulose.

Taxonomy: Allan (1961) included all indigenous New Zealand species of Thelypteridaceae within a broadly construed *Thelypteris.* Holttum (1971a) redefined the genus globally to include just two species characterised by a long-creeping rhizome, unreduced basal pinnae, free veins that are often forked in the pinnules and reach the margins, scales on the lower surface of the costae, acicular hairs and short-stalked glands on the lower surface of the lamina, no sessile glands, indusiate sori, and sporangia that bear short-stalked glands. Holttum's concept remained unchanged following the classification of Fawcett & Smith (2021).

Distribution: A genus of two species with one in temperate Europe and Asia and the other in tropical and subtropical regions of the southern hemisphere in South America, Africa, India, Malesia and Australasia (Fawcett & Smith 2021). One species in New Zealand; none endemic.

Biostatus: Indigenous (Non-endemic).

Table : Number of species in New Zealand within *Thelypteris* Schmidel

Category	**Number**
Indigenous (Non-endemic)	1
Total	**1**

Cytology: The base chromosome number in *Thelypteris* is x = 35 (Holttum 1971a; Smith 1990; Fawcett & Smith 2021).

Thelypteris confluens (Thunb.) C.V.Morton, *Contr. U.S. Natl. Herb.* 38: 71 (1967)

≡ *Pteris confluens* Thunb., *Prodr. Pl. Cap.* 171 (1800)
Holotype: e Cap b. Spei [Cape of Good Hope, South Africa], *C.P.Thunberg s.n.*, UPS–T 24904 (*n.v.*, see Roux 2009)

= *Aspidium thelypteris* var. *squamigerum* Schltdl., *Adumbr. Fil.* 23, t. 11 (1825)
≡ *Aspidium squamigerum* (Schltdl.) Fée, *Mém. Foug., 8. d. Esp. Nouv.* 104 (1857)
≡ *Thelypteris palustris* var. *squamigera* (Schltdl.) Weath. in Johnston, *Contr. Gray Herb.* 73: 40 (1924)
≡ *Thelypteris squamigera* (Schltdl.) Ching, *Bull. Fan Mem. Inst. Biol.* 6: 329 (1936) – as squamulosa
Holotype: atque in Promontorio bonae spei ad Hexriver [Hex River, Cape of Good Hope, South Africa], *J.L.L.Mund et L. Maire, C.H. Bergius s.n.*, P 00482788 (!online)

= *Nephrodium squamulosum* Hook.f., *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II,* 39 (1854)
≡ *Nephrodium thelypteris* var. *squamulosum* (Hook.f.) Hook., *Sp. Fil. 4,* 88 (1862)
≡ *Dryopteris thelypteris* var. *squamulosum* (Hook.f.) Cheeseman, *Man. New Zealand Fl., ed. 2,* 33 (1925)
Lectotype (selected by Holttum 1977): New Zealand, *Colenso*, K! (photo WELT E471/13)

= *Lastrea invisa* J.B.Armstr., *Trans. & Proc. New Zealand Inst.* 13: 359 (1881)
Holotype: Waikato, Herb. Armstrong, CHR 633400!

Etymology: From the Latin *confluens* (running together).

Vernacular names: marsh fern; swamp fern; swamp lady fern

Rhizomes long-creeping, up to 175 mm long (in herbarium specimens) with stipes arising 8–37 mm apart, 1.5–3 mm diameter, bearing scattered scales. Rhizome scales ovate to broadly ovate, 1–3 mm long, 0.5–1.5 mm wide, pale brown, entire. Fronds 380–1150 mm long, held stiffly upright. Stipes 180–670 mm long, yellow-brown to chestnut-brown and often almost black at the base, glabrous or scaly near base, slightly polished. Laminae sometimes appearing slightly dimorphic with fertile pinna segments inrolled and a little narrower than the sterile, deeply 1-pinnate-pinnatifid to 1-pinnate-pinnatisect, narrowly elliptic to elliptic, or rarely narrowly obovate, usually narrowed to a short pinnatisect apex, 150–540 mm long, 40–145 mm wide, mid-green on both surfaces, herbaceous to coriaceous. Broadly ovate or broadly elliptic or almost orbicular pale brown scales on abaxial surface of pinna midribs and costae; colourless, acicular hairs and short-stalked glands up to 1 mm long on both surfaces of costae and veins. Primary pinnae in 14–27 pairs, widely spaced especially proximally, narrowly elliptic or narrowly ovate to almost oblong; the longest at about mid-lamina, short-stalked, 25–80 mm long, 6–18 mm wide; the basal pair not or scarcely reduced in length. Primary pinnae divided almost, or rarely completely, to the midrib; ultimate segments oblong, 3–10 mm long, 1.5–3 mm wide, apices acute to obtuse, margins usually inrolled, bases adnate to decurrent. Veins all free, forking in sterile pinna segments, undivided in fertile segments. Sori round, in one row either side of midrib away from pinna margins; indusia reniform, 0.4–0.6 mm diameter, bearing short-stalked glands.

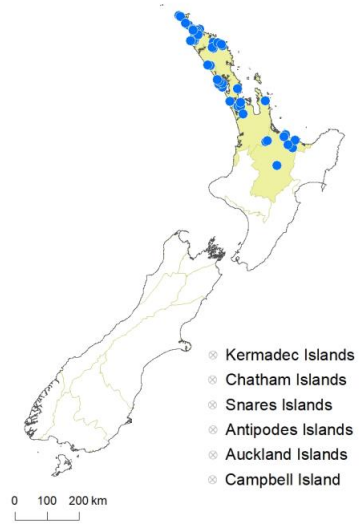

Fig. 33: *Thelypteris confluens* distribution map based on databased records at AK, CHR and WELT.

Distribution: North Island: Northland, Auckland, Volcanic Plateau

Altitudinal range: 0–300 m.

Thelypteris confluens occurs in lowland areas of the northern North Island from near North Cape to the Bay of Plenty and Rotorua district, with an outlying population at Lake Rotokawa near Taupō. It mostly grows close to sea level but extends to 300 m at Lake Rotoehu, near Rotorua.

Also tropical and subtropical regions of Africa, Madagascar, India, south-east Asia, Malesia and Australia (Queensland, Victoria) (Holttum 1977). Naturalised in Argentina (Zuloaga et al. 2008).

Biostatus: Indigenous (Non-endemic).

The species was given a conservation status of 'At Risk / Naturally Uncommon' by de Lange et al. (2018).

Habitat: Confined to lake, swamp and marsh vegetation, or on peat in raised bogs; mostly found within dune slacks and their associated wetlands, sometimes found under mānuka, willows or pines, or rarely on old *Carex* mounds in open sunny sites; often associated with *Typha orientalis*, *Machaerina juncea*, *Eleocharis acuta*, *Isachne globosa*, *Isolepis prolifera*, *Apodasmia similis*, *Cyclosorus interruptus* and *Blechnum minus*. It is largely confined to coastal areas, but extends inland in wetlands on geothermally heated soils in the southern part of its range.

Recognition: *Thelypteris confluens* is recognised by its long-creeping rhizomes, rigidly erect fronds, deeply 1-pinnate-pinnatifid to 1-pinnate-pinnatisect laminae, pinnae divided almost to the midribs, basal pair of pinnae not reduced in length, free veins, indumentum on the abaxial surfaces comprising broad scales, acicular hairs and short-stalked glands, and indusia bearing short-stalked glands.

Cytology: 2n = 70 (de Lange et al. 2004).

Fig. 34: *Thelypteris confluens*. Mature frond with unreduced basal pinnae growing in wetland.

Fig. 35: *Thelypteris confluens*. Apical portion of mature frond growing in wetland.

Fig. 36: *Thelypteris confluens*. Abaxial surface of primary pinna with segments divided almost to the costa, and the basal veins of adjacent segments not joining.

Fig. 37: *Thelypteris confluens*. Abaxial surface of primary pinnae showing ovate, pale brown scales on the costae.

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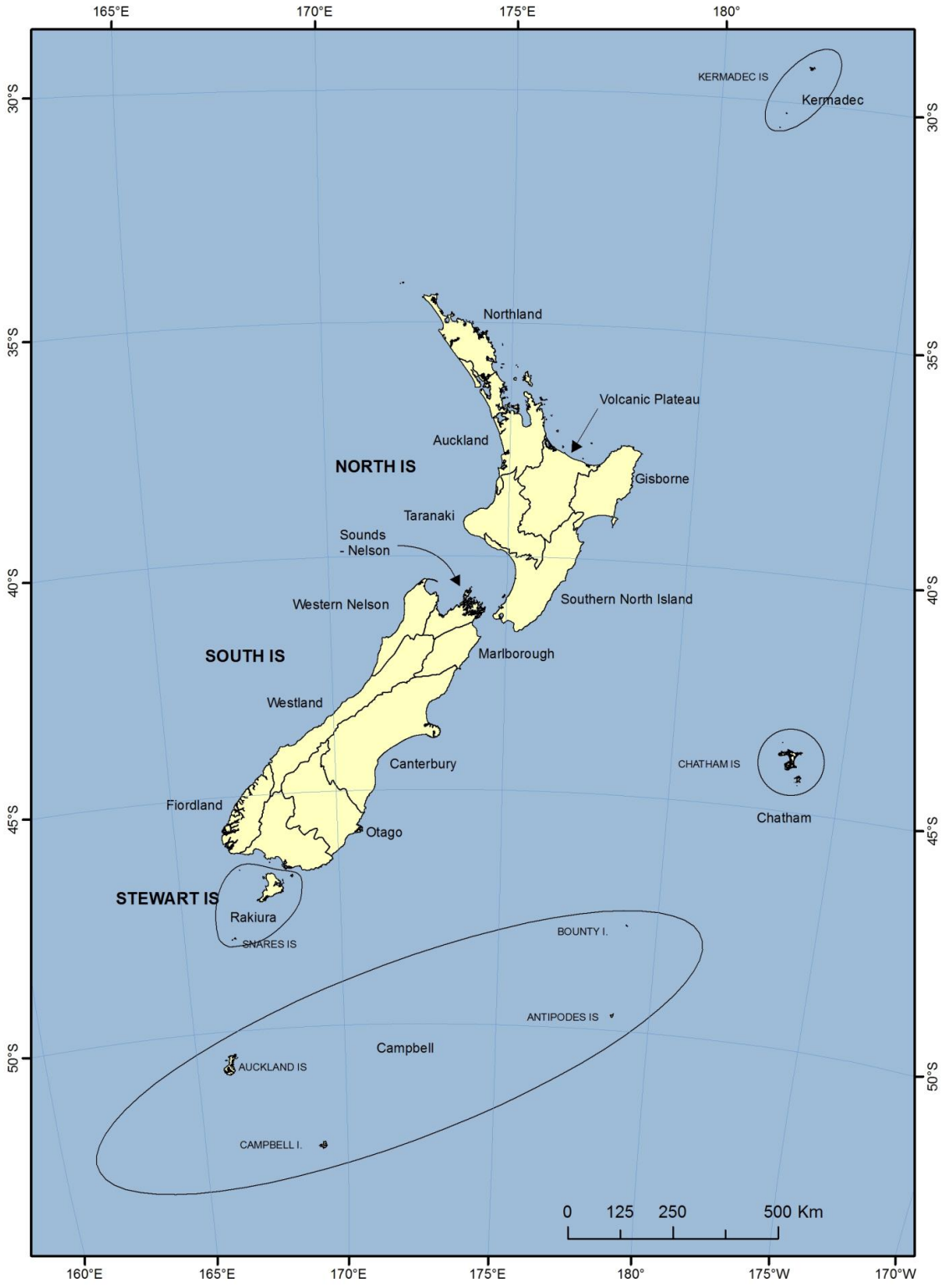
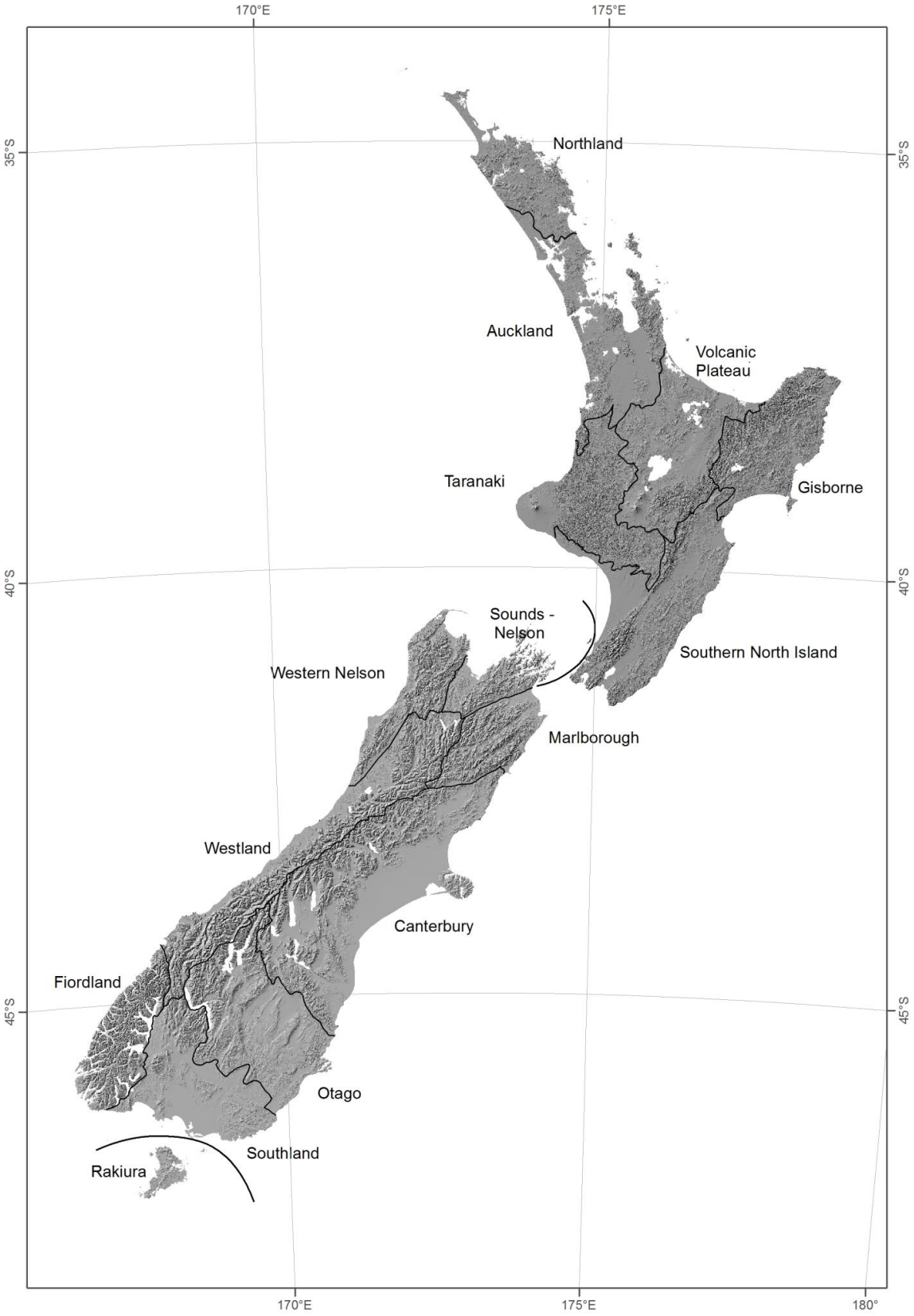


Map 1: Map of New Zealand and offshore islands showing Ecological Provinces



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