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FERNS AND LYCOPHYTES

OPHIOGLOSSACEAE



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Cover image: *Ophioglossum coriaceum*. Mature plant with sterile and fertile laminae, growing amongst mosses.

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Introduction

The family Ophioglossaceae is represented in New Zealand by two genera (*Botrychium* and *Ophioglossum*) with five species, two of which are endemic. *Ophioglossum coriaceum* is widespread throughout both main islands, whereas *O. petiolatum* is now very localised in the northern part of the North Island. *Botrychium australe* is widespread in the North Island but largely confined to eastern parts of the South Island; *B. biforme* is widespread in both main islands south of latitude 38° S; and *B. lunaria* is known only from two alpine localities in north-west Nelson. All members of the family in New Zealand are terrestrial ferns with a very distinctive morphology in which the fronds are divided into a sterile blade and fertile sporophore. The sporangia are not arranged in sori, have thick walls opening along a line of weakness, and produce thousands of trilete spores. Neither genus is typically fern-like in its appearance. Many species in the family are geographically widespread but poorly understood; a modern monograph, particularly of *Ophioglossum*, is badly needed.

***Ophioglossaceae* Martinov, *Tekhno-Bot. Slovar*, 438 (1820)**

Type taxon: *Ophioglossum* L.

Terrestrial (NZ) or epiphytic (not NZ) ferns. Rhizomes erect (NZ) or sometimes short-creeping (not NZ), protected by sheathing bases of older fronds, glabrous; roots lacking root hairs, often fleshy, occasionally contractile, sometimes proliferous (NZ) or bearing vegetative buds and gemmae (not NZ). Fronds monomorphic, not articulated to rhizome, circinate or convolute, divided into a sterile photosynthetic blade and a greatly reduced spore-bearing portion (sporophore), usually only 1 or 2 produced per season. Common stalk glabrous or hairy. Sterile blade entire or divided 1–several times, glabrous or hairy. Sporophore undivided or divided 1–several times. Veins free or reticulate. Sporangia not in sori, either sessile or subsessile on branches of a divided sporophore or deeply sunken in two rows either side of an undivided sporophore, massive, thick-walled, lacking an annulus, dehiscing along a single line, maturing ± simultaneously, with 1000s of spores per sporangium. Homosporous; spores trilete, lacking chlorophyll; perispores coarsely to finely verrucate.

Taxonomy: A family of four genera and c. 80 species (Smith et al. 2006). The family includes two large, widespread genera, *Ophioglossum* and *Botrychium*, together with the monotypic *Helminthostachys* and *Mankyua*. The two larger genera are sometimes divided into segregate genera.

Molecular evidence indicates that Ophioglossaceae is sister to the Psilotaceae, and that they together comprise an early-diverging branch of the ferns (Smith et al. 2006). The traditional view of the family as eusporangiate is consistent with this placement. However, Kato (1988) suggested that the Ophioglossaceae are living progymnosperms, citing especially their vascular anatomy and non-circinate vernation, and later suggested that the family provided a hypothetical archetype for the angiosperm carpel (Kato 1990, 1991). Whatever their relationships, the Ophioglossaceae are very different in their morphology to other living ferns.

The family is represented in New Zealand by two indigenous genera – *Ophioglossum* and *Botrychium*.

- 1 Sterile blade of frond dissected 1–several times; veins free; sporangia sessile or subsessile on a branched sporophore *Botrychium*
Sterile blade of frond undivided; veins reticulate; sporangia embedded in an undivided sporophore *Ophioglossum*

Distribution: *Ophioglossum* and *Botrychium* are virtually cosmopolitan but the other genera are more restricted in distribution (Wagner 1990; Smith et al. 2006). Ten species occur in Australia (Chinnock 1998). Two non-endemic genera with five species in New Zealand; two species endemic.

Biostatus: Indigenous (Non-endemic).

Table 1: Number of species in New Zealand within *Ophioglossaceae* Martinov

| Category | Number |
|--------------------------|----------|
| Indigenous (Endemic) | 2 |
| Indigenous (Non-endemic) | 3 |
| Total | 5 |

Recognition: The Ophioglossaceae in New Zealand comprises terrestrial ferns recognised by their fronds, which are divided into a sterile blade and a fertile sporophore. The sporophores bear sporangia that are not arranged in sori, have thick walls opening along a line of weakness, and produce thousands of trilete spores. The spores of all New Zealand species of Ophioglossaceae have been described and illustrated by Large & Braggins (1991).

Notes: The gametophytes of species of Ophioglossaceae are unusual amongst ferns in being subterranean, not green, mycorrhizal and tuberous – either flattened in *Botrychium*, or worm-like in *Ophioglossum* (Foster & Gifford 1974).

***Botrychium* Sw., *J. Bot. (Schrader)* 1800(2): 110 (1801)**

= *Sceptridium* Lyon, *Bot. Gaz.* 40: 457 (1905)

Type taxon: *Botrychium lunaria* (L.) Sw.

Etymology: From the Greek *botrychios*, a diminutive of *botrys* (a bunch of grapes), a reference to the arrangement of the sporangia.

Terrestrial ferns. Rhizomes erect, glabrous; roots thick and fleshy, contractile in some species, sometimes bearing vegetative buds or gemmae (not NZ), but not proliferous. Fronds circinate, divided into a sterile photosynthetic blade and a reduced spore-bearing portion (sporophore), 1 or 2 produced per season. Common stalk glabrous or bearing scattered hairs. Sterile blade divided 1–several times, herbaceous or coriaceous, glabrous or bearing scattered hairs. Veins free. Sporophore divided 1–several times. Sporangia not in sori, sessile or subsessile, clustered on branches of the divided sporophore. Spores trilete, cream to yellow, coarsely to finely verrucate.

Taxonomy: A genus of 50–60 species (Wagner & Wagner 1993). *Botrychium* was monographed by Clausen (1938a) but many more species have since been recognised, particularly in North America (see Wagner & Wagner 1993). The genus in New Zealand was revised by Braggins (1980) who recognised three species.

Wagner (1990) recognised four subgenera – *Osmundopteris*, *Japanobotrychium*, *Sceptridium* and *Botrychium*. New Zealand species belong to the latter two, which are sometimes raised to generic rank.

- | | |
|---|---|
| 1 | Sterile blade of frond 1-pinnate; stalk of sporophore 3–30 mm long <i>lunaria</i> Sterile blade of frond divided several times; stalk of sporophore 37–420 mm long 2 |
| 2 | Sterile blade divided 3–5 times; ultimate segments acute or obtuse, 1.3–5 mm wide; roots often contractile <i>australe</i> Sterile blade divided 5–7 times; ultimate segments acuminate, 0.2–1 mm wide; roots not contractile <i>biforme</i> |

Distribution: Mostly distributed in temperate and polar regions but also extending to mountains of the tropics, with the greatest diversity in North America and Asia; many species are rare and local (Wagner 1990). Two species in Australia (Chinnock 1998), one in the tropical Pacific and another (probably extinct) in Hawai'i (Palmer 2003), three in temperate South America, 30 in North America (Wagner & Wagner 1993) and 12 in China (Xianchun et al. 2013). Three species in New Zealand; one endemic.

Biostatus: Indigenous (Non-endemic).

Table 2: Number of species in New Zealand within *Botrychium* Sw.

| Category | Number |
|--------------------------|----------|
| Indigenous (Endemic) | 1 |
| Indigenous (Non-endemic) | 2 |
| Total | 3 |

Recognition: *Botrychium* is recognised by its fronds, which comprise a dissected sterile blade with free veins and a branched sporophore. The sporangia are sessile or subsessile and exposed on the branches of the sporophore. By contrast, *Ophioglossum* has an entire sterile blade with reticulate veins and an undivided fertile sporophore with sunken sporangia.

Cytology: The base chromosome number in *Botrychium* is $x = 45$ (Wagner 1990).

Notes: The occurrence of underground gemmae on the roots and rhizomes of some North American species of *Botrychium* was first reported by Farrar & Johnson-Groh (1990). Similar vegetative propagules have not yet been observed in New Zealand species.

***Botrychium australe* R.Br., *Prodr. Fl. Nov. Holland.*, 164 (1810)**

≡ *Sceptridium australe* (R.Br.) Lyon, *Bot. Gaz.* 40: 457 (1905)

≡ *Botrychium ternatum* var. *australe* (R.Br.) Domin, *Biblioth. Bot.* 20 (85): 224 (1913)

Lectotype (selected by Chinnock 1998): Parramatta, Port Jackson [Sydney, New South Wales], *R. Brown Iter. Austral.* 119, 1802–05, BM 001038216!

= *Botrychium erosum* Milde, *Bot. Zeitung (Berlin)* 22: 102 (1864)
≡ *Botrychium ternatum* var. *erosum* (Milde) Milde, *Verh. K. K. Zool.-Bot. Ges. Wien* 18: 509 (1868)
≡ *Botrychium ternatum* var. *australasiaticum* γ *erosum* (Milde) Milde, *Verh. K. K. Zool.-Bot. Ges. Wien* 19: 157 (1869)
≡ *Botrychium australe* var. *erosum* (Milde) Prantl, *Jahrb. Königl. Bot. Gart. Berlin* 3: 340 (1884)
Holotype: New Zealand, Auckland, *Hay s.n.*, *Novara Exped.*, W (see Braggins 1980, fig. 5).

Etymology: From the Latin *australis* (southern), a reference to the southern hemisphere distribution of this plant.

Vernacular names: parsley fern; pātōtara

Rhizomes erect, subterranean, 9–50 mm long, glabrous; roots thick, fleshy, ridged and contractile, up to 3.5 mm diameter. Fronds 50–600 mm long, divided into a sterile lamina and fertile sporophore. Stipes 8–100 mm long, yellow-brown to chestnut-brown, glabrous or with a few scattered hairs. Sterile laminae borne on a stalk 7–300 mm long, laminae divided 3–5 times, broadly ovate or pentagonal or broader than long, 20–220 mm long, 30–290 mm wide, green or bronze, fleshy or coriaceous, bearing scattered colourless hairs. Ultimate segments ovate or elliptic or oblong, acute to obtuse, margins entire or with a few blunt serrations, 1.3–5 mm wide. Sporophore held above the sterile lamina, borne on a stalk 37–420 mm long, divided 3–4 times, narrowly ovate to broadly ovate, 20–180 mm long, 10–80 mm wide, fleshy or coriaceous, bearing a few scattered colourless hairs. Sporangia sessile or subsessile, clustered on branches of the sporophore, 0.6–1.1 mm diameter.

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

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

Chatham Islands.

Altitudinal range: 0–1200 m.

Botrychium australe is widespread, but generally uncommon, in lowland, montane and subalpine areas of the North Island from Te Paki to Cook Strait, extending from near sea level to 1150 m in the Kaimanawa Ranges. However, it is more abundant in the central North Island where it occurs in a zone from 500 to 1150 m above sea level. In the South Island it is found east of the main divide, largely confined to the northern half of the Island, with only scattered records between Arthur's Pass and Te Anau. It occurs sporadically in lowland areas from 250 to 500 m, but is most frequent in montane and subalpine areas above 500 m; it reaches 1200 m on Mt Ida, near Naseby. *Botrychium australe* and *B. biforme* sometimes occur together, but only *B. australe* occurs north of the Waikato.

Also Australia (Queensland, New South Wales, Victoria, Tasmania; extinct in South Australia), Lord Howe Island, Argentina, Chile. In South America, subsp. *australe* and subsp. *negeri* (H.Christ)

R.T.Clausen are recognised as separate taxa (Zuloaga et al. 2008), but the distinction between them, and their relationship to Australasian material, requires further investigation.

Biostatus: Indigenous (Non-endemic).

Habitat: *Botrychium australe* is a plant of disturbed habitats, occurring under mānuka, kānuka and matagouri scrub and broadleaved forest, and in open areas on river flats, track sides, in bush clearings, frost flats and around bush margins, in grassy areas, peat bog, herbfield and in reverting pasture. Plants occur singly or in large patches, but populations are often widely separated; they die down completely in winter, emerging again in spring from the underground rhizome. Braggins (1980) noted that the contractile roots may aid survival in exposed sites and that the fleshy roots provide a reservoir of starch, enabling plants to regrow after damage to the frond.

Recognition: *Botrychium australe* is very similar to *B. biforme* in overall shape and size but is distinguished by its slightly less divided frond, and by the ultimate segments which are broader (1.3–5 mm wide) and acute or obtuse compared to those of *B. biforme* which are narrower (0.2–1 mm wide) and acuminate. Both species have green and bronze colour forms, and have large fleshy roots containing starch, but only in *B. australe* are they ridged and contractile (Braggins 1980).

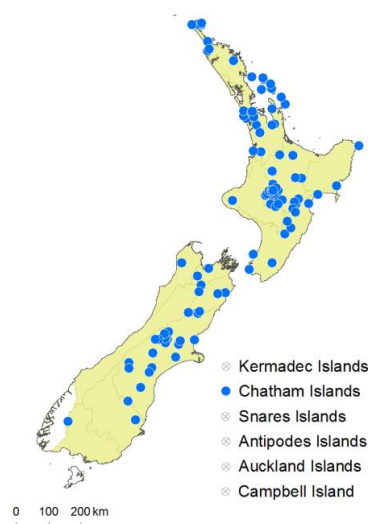


Fig. 1: *Botrychium australe* distribution map based on databased records at AK, CHR and WELT.

Cytology: $n = 45$ (Brownlie 1958); $2n = 90$ (Braggins 1980; de Lange et al. 2004).

Notes: The names *Botrychium virginicum* Willd., *B. cicutarium* Sw. and *B. ternatum* (Thunb.) Sw., and combinations based on them, have been widely misapplied by earlier authors to *Botrychium australe* in New Zealand.



Fig. 2: *Botrychium australe*. Sterile lamina with broad, obtuse segments and green coloration.



Fig. 3: *Botrychium australe*. Sterile lamina with broad, obtuse segments and bronze coloration.



Fig. 4: *Botrychium australe*. Uncoiling frond showing circinate vernation.



Fig. 5: *Botrychium australe*. Mature plant with sterile and fertile laminae.



Fig. 6: *Botrychium australe*. Mature plant with sterile and fertile laminae.



Fig. 7: *Botrychium australe*. Close-up of fertile lamina showing sessile sporangia on the lamina branches; the spores have been shed.



Fig. 8: *Botrychium australe*. Close-up of undehiscent mature sporangia on fertile lamina.



Fig. 9: *Botrychium australe*. Close-up of individual sporangia splitting to release spores.

***Botrychium biforme* Colenso, *Trans. & Proc. New Zealand Inst.* 18: 223 (1886)**

≡ *Sceptridium biforme* (Colenso) Lyon, *Bot. Gaz.* 40: 457 (1905)

Lectotype (selected by Braggins 1980): Dannevirke, H[awkes] B[ay], Herb. W. Colenso, WELT P003374 (central specimen)!, isoelectotypes: AK 950!, 221784!

= *Botrychium ternatum* var. *australasiaticum* ♂ *millefolium* F.Hochst. ex Milde, *Verh. K. K. Zool.-Bot. Ges. Wien* 19: 158 (1869)

≡ *Botrychium australe* var. *millefolium* (F.Hochst. ex Milde) Prantl, *Jahrb. Königl. Bot. Gart. Berlin* 3: 341 (1884)

Lectotype (selected by Braggins 1980): New Zealand, Tikitapu See [Blue Lake, Rotorua], F. von Hochstetter s.n., 1859, W (central specimen).

Etymology: From the Latin *biformis* (having two shapes), a reference to the different sterile and fertile portions of the lamina.

Vernacular name: fine-leaved parsley fern

Rhizomes erect, subterranean, 5–50 mm long, glabrous; roots thick, fleshy, not ridged or contractile, up to 3 mm diameter. Fronds 70–440 mm long, divided into a sterile lamina and fertile sporophore. Stipes 15–65 mm long, pale or chestnut-brown, glabrous or bearing scattered colourless hairs. Sterile laminae borne on a stalk 13–175 mm long, laminae divided 5–7 times, broadly ovate or pentagonal or broader than long, 11–170 mm long, 22–185 mm wide, green or bronze, herbaceous or coriaceous, glabrous or bearing scattered colourless or pale brown hairs. Ultimate segments narrowly ovate to linear, long acuminate, margins entire or with a few deep divisions, 0.2–1.0 mm wide. Sporophore held above the sterile lamina, borne on a stalk 38–300 mm long, divided 3–5 times, narrowly ovate to broadly ovate, 15–105 mm long, 10–60 mm wide, fleshy, glabrous or bearing scattered colourless hairs. Sporangia sessile or subsessile, clustered on branches of the sporophore, 0.6–1.1 mm diameter.

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

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

Chatham Islands, Stewart Island.

Altitudinal range: 20–900 m.

Botrychium biforme occurs in lowland and montane areas of the North Island from Hamilton and East Cape south to Cook Strait. There is a 19th century collection in the Cheeseman Herbarium from the Bay of Islands (AK 952), a long way north of its known distribution, which needs confirmation. The species extends from about 20 m in Wellington to 900 m in the central North Island. It is widely distributed, but uncommon, in lowland and montane areas of the South Island, and also reaches Stewart Island and the Chatham Islands. It extends to 750 m in the Eyre Mountains, Southland. *Botrychium biforme* and *B. australe* sometimes occur together.

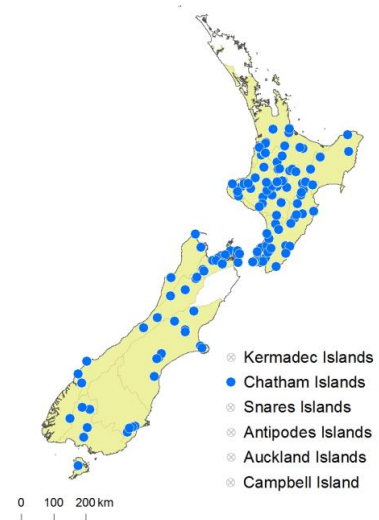


Fig. 10: *Botrychium biforme* distribution map based on databased records at AK, CHR, OTA and WELT.

Biostatus: Indigenous (Endemic).

Habitat: *Botrychium biforme* occurs in podocarp, beech and broadleaved forest, under mānuka and kānuka and in open areas, on track sides, river flats, stream banks, silty streambeds, lake margins, swampy ground, clay banks, bush margins, in tussock and grassland and on sandy or stony soils. It is more tolerant of shade and has a more southerly distribution than *B. australe*. Plants occur singly or in large patches, but populations are often widely separated; they die down completely in winter, emerging again in spring from the underground rhizome.

Recognition: *Botrychium biforme* is very similar to *B. australe* in overall shape and size. It is distinguished by its more divided frond, and by the ultimate segments which are narrower (0.2–1 mm wide) and rather more acuminate than those of *B. australe* which are broader (1.3–5 mm wide) and acute or obtuse. Both species have green and bronze colour forms, and have large fleshy roots containing starch, but *B. biforme* lacks the ridged and contractile roots of *B. australe* (Braggins 1980).

Cytology: n = 45 (Brownlie 1961).

Notes: The name *Botrychium dissectum* Sprengel, and combinations based on it, have been misapplied to *B. biforme*.

Braggins recorded plants with sterile lamina stalks up to 200 mm long and blades up to 250 mm long, but such large specimens have not been seen in this study.



Fig. 11: *Botrychium biforme*. Sterile lamina with very narrow, acute segments.



Fig. 12: *Botrychium biforme*. Sterile lamina with narrow, acute segments.



Fig. 13: *Botrychium biforme*. Sterile laminae showing green and bronze colour forms.



Fig. 14: *Botrychium biforme*. Mature plants with sterile and fertile laminae, showing green and bronze colour forms.



Fig. 15: *Botrychium biforme*. Mature plant with sterile and fertile laminae.



Fig. 16: *Botrychium biforme*. Close-up of fertile lamina showing sessile sporangia on the lamina branches.

***Botrychium lunaria* (L.) Sw., J. Bot. (Schrader) 1800(2): 110 (1801)**

≡ *Osmunda lunaria* L., *Sp. Pl.*, 1064 (1753)

Lectotype (selected by Bobrov 1984): Herb. Clifford 472, *Osmunda* 1, BM 000647551 (online).

Etymology: From the Latin *luna* (of the moon), a reference to the pinnae of the sterile blade which are shaped like a crescent moon.

Vernacular name: moonwort

Rhizomes erect, subterranean, c. 1 mm long, glabrous; roots slender, up to 0.7 mm diameter, not ridged or contractile. Fronds 22–85 mm long, divided into a sterile lamina and fertile sporophore. Stipes 15–57 mm long, yellow-brown proximally, green distally, glabrous or bearing scattered colourless hairs. Sterile laminae borne on a stalk 1–5 mm long, 1-pinnate, oblong, 7–32 mm long, 5–18 mm wide, green, fleshy or coriaceous, glabrous or bearing scattered colourless hairs. Pinnae in 3–6 pairs, flabellate, 2–9 mm long, 2–13 mm wide, sessile, margins entire. Sporophore held above the sterile lamina, borne on a stalk 3–30 mm long, divided 1–2 times, ovate or narrowly ovate, 3–15 mm long, 2.5–10 mm wide, fleshy, glabrous or bearing scattered colourless hairs. Sporangia sessile or subsessile, clustered on branches of the sporophore, 0.8–1.3 mm diameter.

Distribution: South Island: Western Nelson, Canterbury

Altitudinal range: 760–1500 m.

Botrychium lunaria was originally recorded in New Zealand from a single population found at c. 760 m on Mt Torlesse, Canterbury in 1882 (Enys 1884), a population which has apparently become extinct. It was not seen again until found by Druce (1981, 1984) at 1450–1500 m on Hoary Head, Mt Arthur and Billies Knob, Mt Owen in north-west Nelson.

Also widely distributed in temperate regions of North America, Europe, Asia and North Africa, and in Australia (New South Wales, Victoria, Tasmania).

Biostatus: Indigenous (Non-endemic).

Botrychium lunaria was given a conservation status of Nationally Critical by de Lange et al. (2013).

Habitat: Occurs in short herbfield and in or around sinkholes in subalpine or alpine areas.

Recognition: *Botrychium lunaria* is distinguished from the other two species in New Zealand by its much smaller stature, its pinnate sterile frond and its alpine habitat.

Notes: New Zealand plants of this species are very small and their relationship to generally larger overseas plants, particularly from the northern hemisphere, requires further investigation.

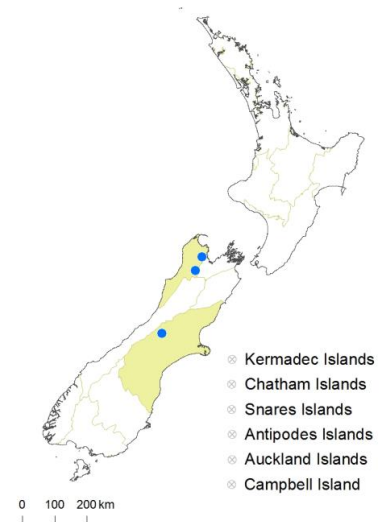


Fig. 17: *Botrychium lunaria* distribution map based on databased records at AK, CHR and WELT.



Fig. 18: *Botrychium lunaria*. Mature plants with fertile and sterile laminae.

***Ophioglossum* L., Sp. Pl., 1062 (1753)**

Type taxon: *Ophioglossum vulgatum* L.

Etymology: From the Greek *ophis* (serpent), and *glossa* (tongue), a reference to the appearance of the fertile spike.

Vernacular name: adder's tongue fern

Terrestrial (NZ) or sometimes epiphytic (not NZ) ferns. Rhizomes erect, glabrous; roots fleshy, not contractile, sometimes proliferous but lacking buds and gemmae. Fronds convolute, divided into a sterile photosynthetic blade and a reduced spore-bearing portion (sporophore), 1 or 2 produced per season. Common stalk glabrous or with occasional hairs. Sterile blade undivided, herbaceous or fleshy, glabrous or with occasional hairs. Veins reticulate. Sporophore undivided. Sporangia not in sori, deeply sunken in two rows on either side of the sporophore. Spores trilete, cream-white, coarsely to finely verrucate.

Taxonomy: A genus of 30–50 species, depending on authority. Brownsey et al. (1985) noted that “*Ophioglossum* is a taxonomically difficult genus in which satisfactory characters are largely absent and species limits more than usually open to different interpretations by different workers”. Despite earlier attempts by Clausen (1938a) and Wieffering (1964) to revise the group, a modern monograph

is still required. Brownsey et al. (1985) summarised understanding of the New Zealand species, but little progress has been made since then, and their conclusions are followed here.

Wagner (1990) recognised three subgenera in *Ophioglossum* – *Ophioderma*, *Cheiroglossa* and *Ophioglossum*. *Cheiroglossa* has a single epiphytic species in the New World tropics, Indo-China, Madagascar and Reunion, and is now often recognised at the generic level (e.g. Wagner & Wagner 1993). *Ophioderma*, with 1–4 epiphytic species, is confined to the Old World tropics. The majority of the species, including the two New Zealand species, are terrestrial and fall into subgenus *Ophioglossum*.

- 1 Sterile blade of frond 0.5–14(20) mm wide, base attenuate to acuminate;
veins often indistinct; sporophore with 3–17(20) pairs of sporangia *coriaceum*
Sterile blade of frond (5)8–34 mm wide, base cuneate to truncate; veins
usually distinct; sporophore with (13)18–48 pairs of sporangia *petiolatum*

Distribution: Cosmopolitan but with most species in the tropics (Wagner 1990). About eight species in temperate South America (Zuloaga et al. 2008), 15 in southern Africa (Crouch et al. 2011), seven in Australia (Chinnock 1998) and five or six in the Pacific. Two species in New Zealand; one endemic.

Biostatus: Indigenous (Non-endemic).

Table 3: Number of species in New Zealand within *Ophioglossum* L.

| Category | Number |
|--------------------------|----------|
| Indigenous (Endemic) | 1 |
| Indigenous (Non-endemic) | 1 |
| Total | 2 |

Recognition: *Ophioglossum* is recognised by its fronds which comprise an entire sterile blade with reticulate veins and an undivided sporophore. The sporangia are deeply sunken in the sporophore. By contrast, *Botrychium* has a dissected sterile blade with free veins and a branched sporophore with shortly stalked sporangia clustered on the branches. Species of *Ophioglossum* are unlike any other ferns in New Zealand in that the fronds unroll laterally from the centre rather than uncoiling lengthwise.

Cytology: The base chromosome number in *Ophioglossum* is $x = 30$ (Wagner 1990).

Notes: A single collection from “Gisborne”, without collector or date (AK 58916), has been identified by M.P. Robinson (University of Adelaide, Australia) as “probably” the Australian species *O. polyphyllum* A.Braun. It is unclear whether the specimen is from Gisborne, New Zealand or Gisborne, near Melbourne, Australia, but a specimen of *Asplenium hookerianum* with the same locality and handwriting (AK 58913) suggests that they came from New Zealand because *A. hookerianum* is extremely rare in Australia. No other collection of *O. polyphyllum* is known from New Zealand, and *Ophioglossum* is rare in the entire Gisborne Ecological Province with only two collections of *O. coriaceum* having been made from Mt Hikurangi at high altitude. In Australia *O. polyphyllum* is widespread in arid areas (Chinnock 1998), and its occurrence in dry parts of the east coast of New Zealand is therefore possible. However, its presence needs confirmation and cannot be accepted on the basis of this specimen alone.

***Ophioglossum coriaceum* A.Cunn., *Companion Bot. Mag.* 2: 361 (1837)**

- ≡ *Ophioglossum lusitanicum* subsp. *coriaceum* (A.Cunn.) R.T.Clausen, *Mem. Torrey Bot. Club* 19: 161 (1938)
Holotype: New Zealand, Matauri opposite the Cavallos [Cavalli Islands], *R. Cunningham s.n.*, 1834, K! (photo WELT E471/30).
- = *Ophioglossum vulgatum* var. *minimum* Hook.f., *Bot. Antarct. Voy. II (Fl. Nov.-Zel.) Part II*, 50 (1854)
Lectotype (selected by Brownsey & Perrie 2015): New Zealand, *Bidwill s.n.*, Herb. Hookerianum, K! (photo WELT E471/29–30)
- = *Ophioglossum minimum* J.B.Armstr., *Trans. & Proc. New Zealand Inst.* 13: 342 (1881)
Lectotype (selected by Brownsey & Perrie 2015): Christchurch, 1864, *J.B. Armstrong s.n.*, Herb. Armstrong, CHR 633610!

Etymology: From the Latin *coriaceus* (thick), a reference to the nature of the leaves.

Vernacular name: adder's tongue

Rhizomes erect, subterranean, 2–20 mm long, glabrous; roots fleshy, horizontal ones producing vegetative buds. Fronds 12–200 mm long, rarely up to 250 mm long in wet substrates, divided into a sterile lamina and fertile sporophore. Stipes 1–75 mm long, rarely up to 95 mm long in wet substrates, yellow-brown, glabrous or with very occasional hairs. Sterile laminae (on fertile fronds) undivided or linear or narrowly elliptic or ovate or narrowly obovate or spatulate, 4–70 mm long, rarely up to 110 mm long in wet substrates, 0.5–14 mm wide, rarely up to 20 mm wide in sheltered habitats; apex acute to acuminate or rarely obtuse; margins entire; base attenuate or acuminate, sessile or tapering to an indistinct stalk; both surfaces green or yellow-green; fleshy or herbaceous; glabrous or with very occasional hairs. Veins often obscure. Sporophore usually held above the sterile lamina, borne on a stalk 5–120 mm long, entire, linear or oblong, 3–21 mm long, very rarely up to 27 mm, 1–3.5 mm wide, fleshy, glabrous. Sporangia in 3–17 pairs, very rarely up to 20 pairs, deeply sunken in two rows on either side of the sporophore.

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

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

Kermadec Islands, Chatham Islands, Stewart Island.

Altitudinal range: 10–1650 m.

Ophioglossum coriaceum occurs in lowland, montane and subalpine areas throughout the North Island, but is rare in the Coromandel, Bay of Plenty, Gisborne and east coast regions. It extends from near sea level to 1450 m on Mt Hikurangi. It occurs throughout most of the South Island from lowland to subalpine areas, extending locally into the alpine zone. It extends from near sea level in the far south to 1650 m on Mt Arthur, north-west Nelson. The species also occurs on the Kermadec Islands, Chatham Islands and Stewart Island.

The species is treated here as a New Zealand endemic (see below), but very similar forms occur in Australia, South America and Europe.

Biostatus: Indigenous (Endemic).

Habitat: Occurs in forest and open mānuka scrub, in bush clearings and on bush margins, but more frequently in open areas and sometimes in thermal areas. It is found on dunes, in wet hollows, salt meadow and grassland, on grassy and mossy banks, in short turf vegetation, herbfield, on lake and tarn margins, on peat and *Sphagnum* in boggy areas, on tracksides, streambanks, river flats and river beds, on gravel, shingle or scoria, in open tussock, on scree and rock, on pākihi, around sinkholes and near waterfalls or in seepages on rock faces. It occurs more frequently in damper areas. The plant often dies down completely in winter, emerging again in spring from the underground rhizome.

Recognition: *Ophioglossum coriaceum* is much more common in New Zealand than *O. petiolatum*. Although most plants can be distinguished by a combination of characters, there is some overlap in

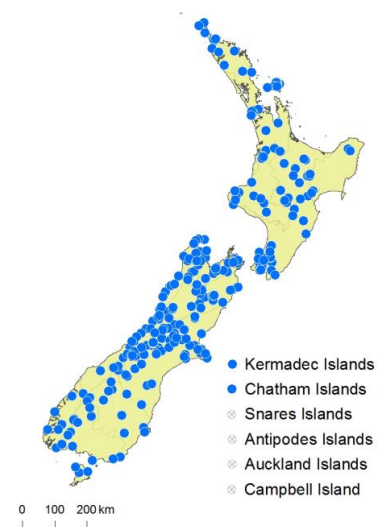


Fig. 19: *Ophioglossum coriaceum* distribution map based on databased records at AK, CHR, OTA and WELT.

their range of variation. *Ophioglossum coriaceum* has a generally narrower sterile blade (rarely more than 14 mm wide) that tapers to an attenuate or acuminate base and often has indistinct veins; the length:width ratio is usually more than 3:1. The sporophore is shorter (3–21 mm long) and has fewer sporangia (very rarely more than 17 pairs). By contrast, *O. petiolatum* has a broader sterile blade (rarely less than 8 mm wide) that is cuneate to truncate at the base and often has distinct veins; the length:width ratio is almost always less than 3:1. The sporophore is generally longer (10–55 mm long) with more sporangia (rarely less than 17 pairs).

Ophioglossum coriaceum is very variable in size and leaf shape but is more consistent with respect to the number of pairs of sporangia in the sporophore. Etiolated plants occur in bogs and wet substrates on the West Coast of the South Island and on the Chatham Islands, and have much longer dimensions than those elsewhere. The extreme sizes given in the description are from such plants, or from plants growing in very sheltered habitats, often at higher altitudes.

Harris (1955) and Large & Braggins (1991) noted differences in the spores of the two species. *Ophioglossum coriaceum* has smaller spores with larger and more widely spaced pits on the surface, whereas *O. petiolatum* has larger spores with smaller, closely packed pits, giving an almost micro-papillate appearance. Whilst confirming these observations, Brownsey & Lovis (unpublished results) also found that populations of *O. coriaceum* with $n = c. 360$ had larger spores than those with $n = 120$, but were indistinguishable in other morphological characters.

Cytology: $n = 120$ (Brownsey & Lovis in Dawson et al. 2000); $n = c. 360$ (Brownlie 1958). Lovis (in Dawson et al. 2000) reported several populations from Canterbury with 350–360 univalents, suggesting that they were probably apomictic. Counts of $n = 120$ have been reported from numerous populations in both main islands.

Notes: The correct name for this taxon in New Zealand is unclear. It was first described as a distinct species by Cunningham (1837), but Clausen (1938a) reduced all South American, Australian and New Zealand material to a subspecies of the northern hemisphere *O. lusitanicum*. Subsequently Marticorena & Rodríguez (1995) and Chinnock (1998) treated southern hemisphere material as *O. lusitanicum*. Chromosome counts of $n = 120$ for some populations of the species in New Zealand (see Dawson et al. 2000) are consistent with the count of $n = 125$ –130 for European material (Manton 1950). However, polyploid counts have also been recorded in this species complex, some of them possibly apomictic. Ninan (1956, 1958) reported $n = 240$ in Indian plants, Brownlie (1958) and Lovis (in Dawson et al. 2000) recorded $n = c. 360$ in New Zealand plants, and Verma (1957) reported $n = 510$ in the only Australian plant counted. Clearly this species aggregate is cytologically complex, and the relationship between plants of different ploidy unresolved. The name *O. coriaceum*, based on a New Zealand type, is conservatively retained here for the New Zealand taxon until the taxonomy of *Ophioglossum* is more fully resolved.

The names *O. lusitanicum* L. and *O. vulgatum* var. *lusitanicum* Hook.f. have been widely used by New Zealand authors for *O. coriaceum*. The names *O. vulgatum* var. *gramineum* (Willd.) Hook.f. and *O. gramineum* Willd. have also been applied to New Zealand material (Hooker 1854–1855; Armstrong 1881a), but these are also probably misidentifications of *O. coriaceum*.



Fig. 20: *Ophioglossum coriaceum*. Mature plants growing on forest floor.



Fig. 21: *Ophioglossum coriaceum*. Mature plant with sterile and fertile laminae, growing amongst mosses.



Fig. 22: *Ophioglossum coriaceum*. Mature plants growing in cultivation showing fertile and sterile laminae.



Fig. 23: *Ophioglossum coriaceum*. Close-up of fertile laminae showing undeveloped sporangia in two rows either side of midrib.

***Ophioglossum petiolatum* Hook., *Exot. Fl.* 1, 56, t. 56 (1823)**

Holotype: On the roots of a plant from the W[est] Indies, *Shepperd*, *Herb. Hookerianum*, K! (photo WELT E471/32).

= *Ophioglossum elongatum* R.Cunn. ex A.Cunn., *Companion Bot. Mag.* 2: 361 (1837)

Holotype: New Zealand, vicinity of Lake Ururuwena [?], between Waimate and Hokianga, *R. Cunningham s.n.* (given to him by Baron Huguel [Hügel]), 1834, K! (photo WELT E471/31).

Etymology: From the Latin *petiolatus* (petiolate), a reference to the long stalk of the sporophore.

Vernacular name: stalked adder's tongue

Rhizomes erect, subterranean, 3–20 mm long, glabrous; roots fleshy, horizontal ones producing vegetative buds. Fronds 70–345 mm long, divided into a sterile lamina and fertile sporophore. Stipes 27–185 mm long, yellow-brown or green distally, glabrous or with very occasional hairs. Sterile laminae (on fertile fronds) undivided, ovate or rarely elliptic, 11–115 mm long, 8–37 mm wide, rarely only 5 mm wide; apex acute to obtuse or rarely rounded; margins entire; base occasionally cuneate and sessile or often abruptly narrowed to an indistinct stalk; both surfaces yellow-green; fleshy or herbaceous; glabrous or with very occasional hairs. Veins usually distinct. Sporophore held above the sterile lamina, borne on a stalk 24–185 mm long, entire, linear, 14–55 mm long, rarely only 10 mm long, 2–3.5 mm wide, fleshy, glabrous. Sporangia in 17–48 pairs, rarely only 13 pairs, deeply sunken in two rows either side of the sporophore.

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

South Island: Sounds-Nelson, Westland.

Kermadec Islands, Three Kings Islands, Chatham Islands.

Altitudinal range: 0–380 m.

Ophioglossum petiolatum has been recorded throughout much of the western part of the North Island from Te Paki to near Levin, but populations are small and widely distributed, and some are no longer extant. It has been collected only in lowland areas, mostly from near sea level, but up to 380 m in the Waitakere Ranges, Auckland. Only two collections have been made in the South Island, both from lowland sites, but it has not been seen there for over 90 years. It is also known from the Kermadec, Three Kings and Chatham Islands. Its limited distribution in New Zealand has been documented by Brownsey (1985) and de Lange et al. (2010), the latter indicating that it was then known from only 11 northern North Island sites.

Also widely distributed in the tropics and subtropics of Central and South America, and in the Old World tropics from Africa to India, Asia and Australia (Western Australia, Northern Territory, Queensland, New South Wales, Victoria). In the Pacific it has been recorded from New Caledonia, Fiji, Niue, the Society Islands and Hawai'i, but is poorly distinguished from *O. reticulatum* and may be more widespread.

Biostatus: Indigenous (Non-endemic).

Ophioglossum petiolatum was given a conservation status of Nationally Critical by de Lange et al. (2013).

Habitat: Occurs in the open, in open bush, or under kānuka or podocarp forest, usually on the margins of swamps, lakes, ponds and streams, in alluvial soils and damp hollows, amongst *Dacrycarpus dacrydioides* roots, in short grassland or on thermally heated soil. The plant dies down completely in winter, emerging again in spring from the underground rhizome.

Recognition: *Ophioglossum petiolatum* is a rare fern in New Zealand. It is distinguished from *O. coriaceum* by its broader sterile blade (rarely less than 8 mm wide) which has a cuneate or truncate base, and often has distinct veins; the length:width ratio is almost always less than 3:1. The sporophore is generally longer (10–55 mm long) and has more sporangia (rarely less than 17 pairs). By contrast, *O. coriaceum* has a generally narrower sterile blade (rarely more than 14 mm wide) that tapers to an attenuate or acuminate base and often has indistinct veins. The sporophore is shorter (3–21 mm long) and has fewer sporangia (rarely more than 17 pairs).

Ophioglossum petiolatum is variable in size and leaf shape. Larger plants are readily distinguishable from *O. coriaceum* by their broader sterile laminae with truncate bases, but small plants and stunted forms from thermal sites overlap significantly in their range of variation. In particular, plants from Scott Point, near Cape Maria van Diemen, have short fertile spikes even on bigger plants, and some are very stunted, resembling *O. coriaceum*. No true *O. coriaceum* has been recorded from this locality.

Cytology: No accurate chromosome count has been obtained for *Ophioglossum petiolatum*, but Brownsey in Dawson et al. (2000) and de Lange et al. (2004) both recorded irregular pairing at meiosis.

Notes: Many earlier authors referred this species in New Zealand to *O. pedunculatum* Desv. or *Ophioglossum vulgatum* var. *pedunculatum* (Desv.) Domin, but the nomenclatural confusion surrounding the use of these names has been resolved by Clausen (1938a, 1938b) and the implications for New Zealand plants explained in detail by Brownsey et al. (1985). The names *O. vulgatum* L., *O. costatum* R.Br. and *O. vulgatum* var. *costatum* (R.Br.) Hook.f. have also been used incorrectly for *O. petiolatum*, or erroneously recorded for New Zealand.

Clausen (1938a, 1938b) referred the New Zealand plant to *O. petiolatum*. He distinguished it from the closely related *O. reticulatum* L. by its “lance-ovate blade, which is acute at the apex, by the rather long, slender fertile segment, and by the lax venation”, but conceded that the two intergraded in India, China and Mexico. Wieffering (1964) went further and reduced *O. petiolatum* to synonymy with *O. reticulatum*, although admitting that it was “highly polymorphous” with chromosome numbers ranging

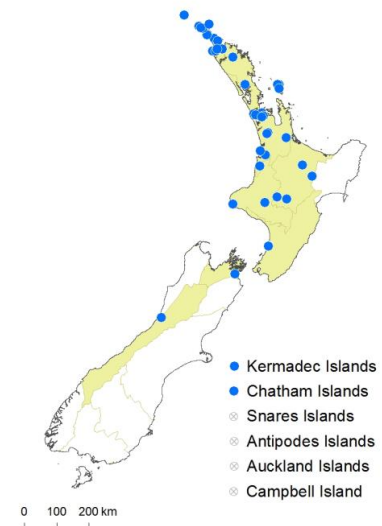


Fig. 24: *Ophioglossum petiolatum* distribution map based on databased records at AK, CHR and WELT.

from $n = 120$ to c. 630. The name *O. reticulatum* has been used for Australian material (Chinnock 1998). However, in the absence of any conclusive evidence, Brownsey et al. (1985) followed Brownlie (1969, 1977) in recognising the species in the Pacific as *O. petiolatum*, a precedent which is followed here in the interests of consistency and stability.



Fig. 25: *Ophioglossum petiolatum*. Mature plants growing in cultivation showing fertile and sterile laminae.

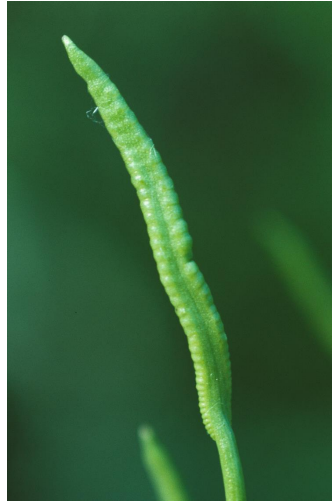


Fig. 26: *Ophioglossum petiolatum*. Close-up of fertile lamina showing embedded sporangia in two rows either side of midrib.



Fig. 27: *Ophioglossum petiolatum*. Mature plants growing in rock crevice.

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Acknowledgements

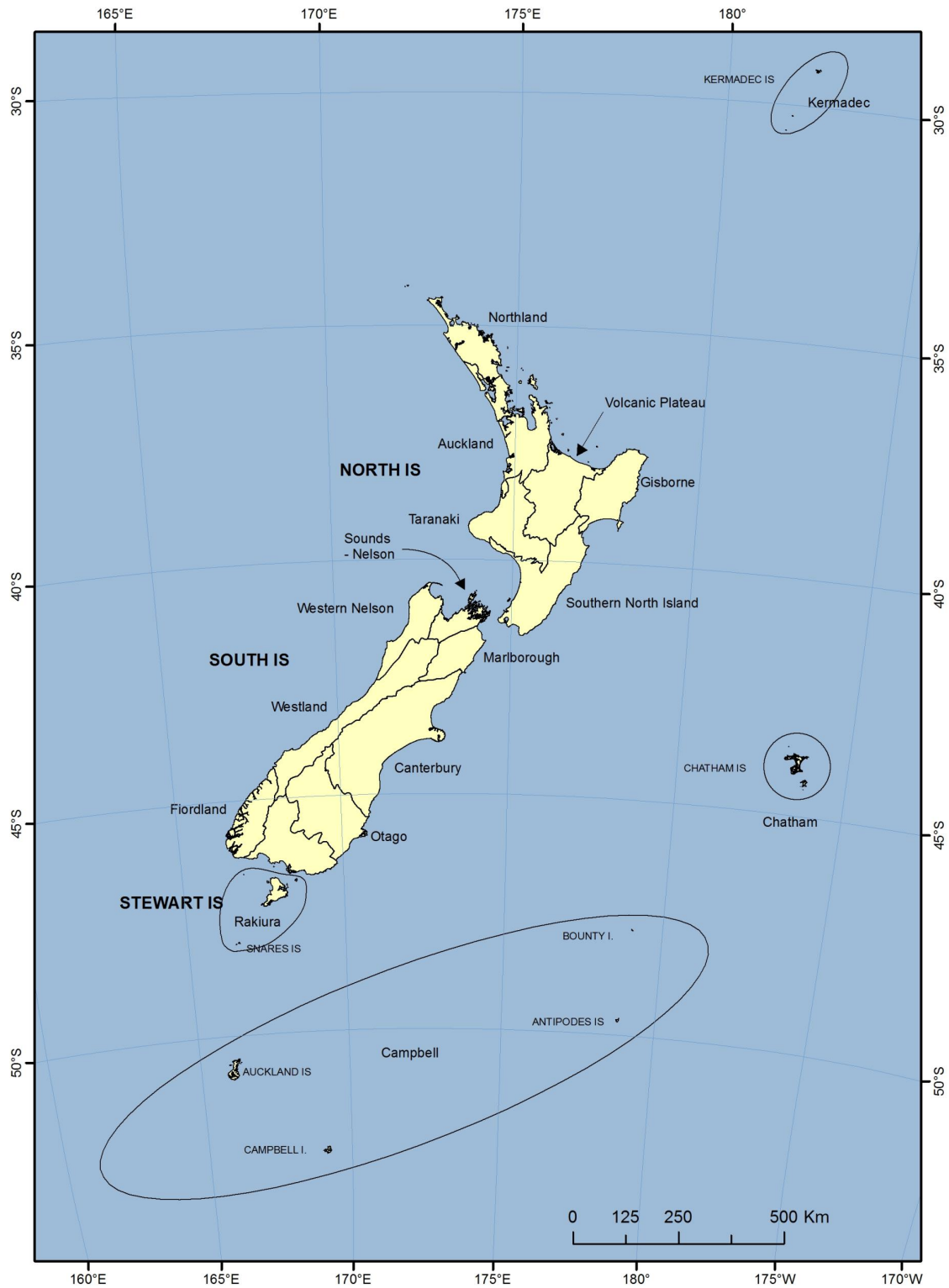
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P.J. Brownsey and L.R. Perrie

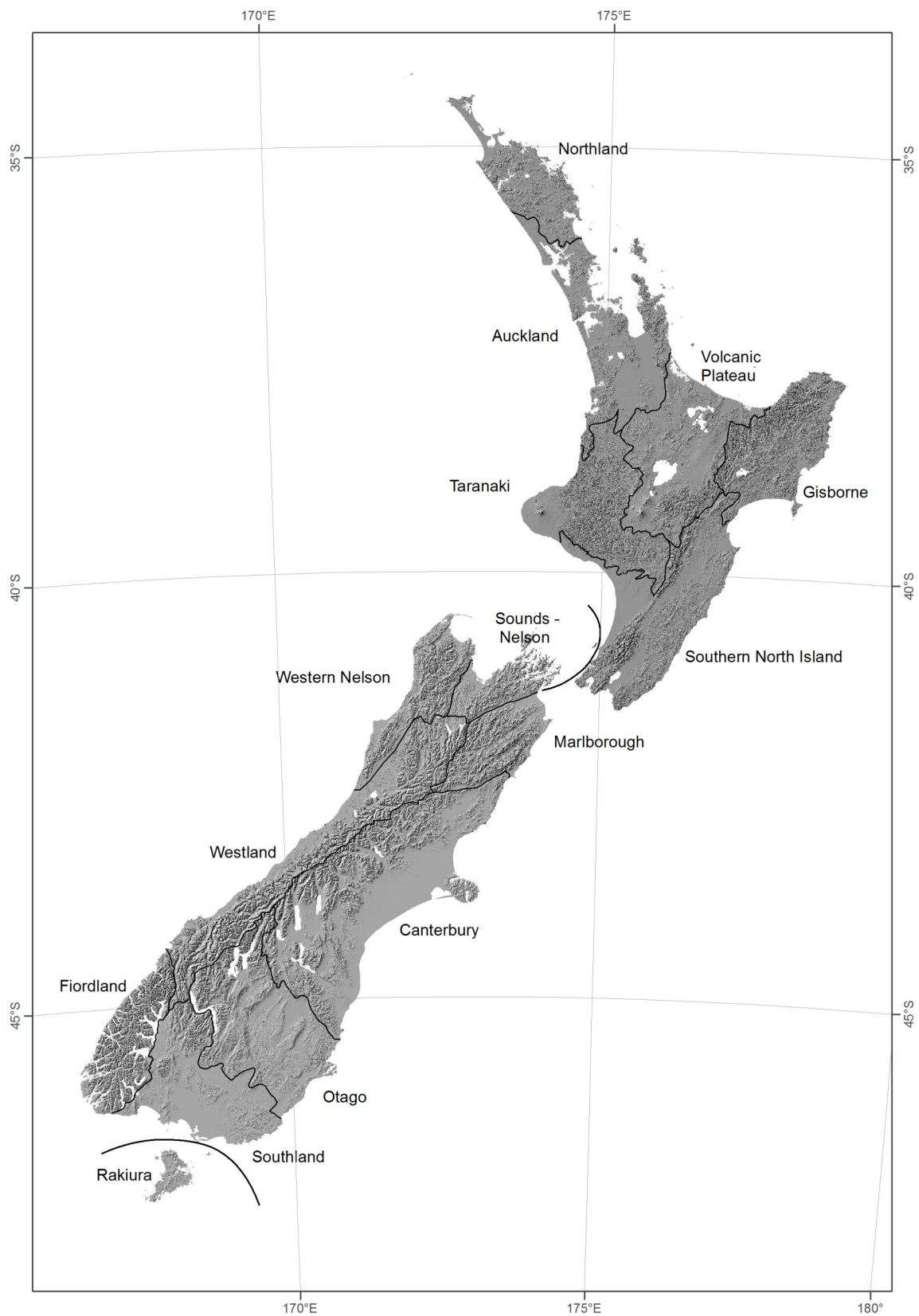
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Map 1: Map of New Zealand and offshore islands showing Ecological Provinces



Map 2: Map of New Zealand showing Ecological Provinces

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